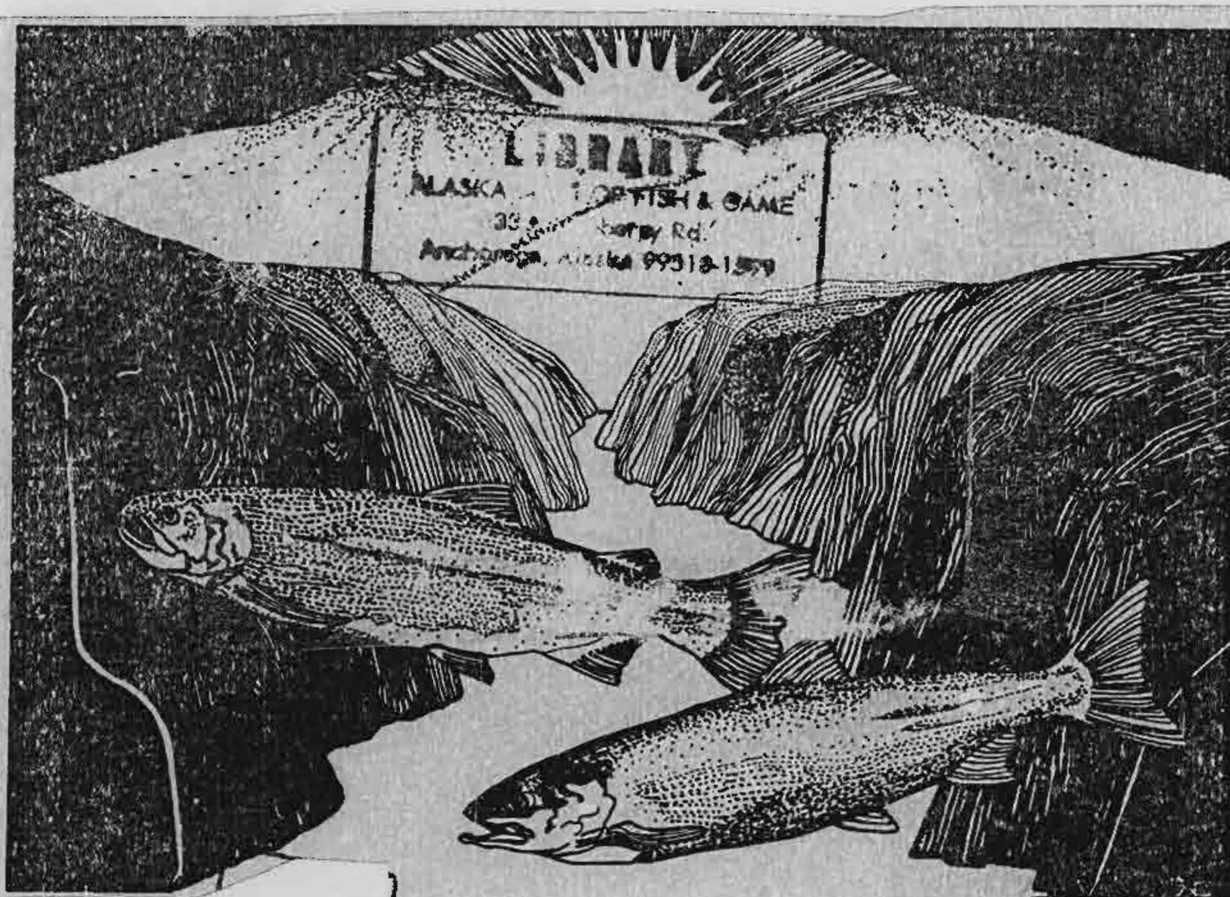

Subtask 7.10

AQUATIC STUDIES PROCEDURES MANUAL

PHASE I - Final Draft

Appendices I - VIII

ALASK
DEPARTMENT OF F

ALASKA POWER AUTHORITY

SUSITNA HYRDROELECTRIC PROJECT

Subtask 7.10

AQUATIC STUDIES PROCEDURES MANUAL

PHASE I - Final Draft

Appendices I - VIII

-by-
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APPENDIX I

A. ADULT ANADROMOUS FISHERIES STUDIES

Sonar Installation and Operation Manual

THE
BENDIX
CORPORATION

Electrodynamics
Division
North Hollywood
California

INSTALLATION

AND

OPERATION

MANUAL

SIDE SCAN

SALMON COUNTER

(1980 Model)

Report No.
SP-78-017
10 March 1980)

Prepared For:
The State of Alaska
Department of Fish
And Game
Anchorage
Alaska

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INTRODUCTION

Before attempting to operate or install the Side Scanner, thoroughly read this manual to become familiar with the system operation.

Section I will familiarize you with all the controls and their purpose. It is probably the most important section of this manual.

Section II will show you how to initially set up the unit and test it to determine that it is operating properly. Read this section before applying power to the unit.

Section III will aid you in pinpointing any source of problems and in making any necessary field repairs by replacing printed circuit cards.

Section IV will show you how to install the artificial substrate in the river.

1 06

I. FUNCTION OF FRONT PANEL CONTROLS

A. PRINTER

1. Printout

The printer prints out 12 lines of data.1/ The number at left designates the river sector, the next column is a letter identifying various conditions such as normal, command print, or auto test. These letters are explained on the front panel. If normal, the letter "A" will be printed.2/ The following 4 digits are the number of fish counts that have been accumulated in each sector. Each sector represents a length of river, perpendicular to the shore that is equal in length to 1/12 of the "COUNTING RANGE" control setting, with sector 1 being closest to shore. E.G., if the "COUNTING RANGE" control is set to 60 feet, then each sector represents 5 feet in distance. A + in the 3rd column indicates debris has been detected in the corresponding sector. Anytime PRINTOUT TIME OR AUTOTEST TIME is changed, the time must be reset.

2. Set Time (Printer)

The purpose of this pushbutton is to initially set the printout time and auto test time at any point. The "SAFETY SWITCH" must be "OFF" to do this.3/

3. Print Command

The printer may be commanded to print its contents at any time without affecting the timing. The letter "C" is printed when this pushbutton is depressed to permit you to know that this is a command print and not in the normal time sequence. The printout timing is not affected but the counts are erased after printout.4/

4. Printer On-Off Switch

This switch does not affect the timing or data in any way and is merely used to shut off the printer. The sounder will sound to alert you to put the printer ON-OFF switch back on. It normally takes only a minute to change paper so try to plan your paper change between prints.5/ models using the "DATEL" printer, be sure to shut off printer switch when changing printer paper.

5: Replacing Printer Paper - See next page.

B. Data Clear Time

Data is cleared (erased from memory) after each print out. Set for AT Print position on 1978 and 1979 models.

C. Clear Pushbutton

The red CLEAR pushbutton located on the left side of the panel will clear the data in the memories controlling the printer and 4 digit

5. Replacing Printer Paper

A blue line on the paper alerts you about 1 day in advance of depletion. To change paper, shut off the printer switch and un screw the 2 small silver knurled screws on the printer face. a new pad of paper in the rear tray with the blue lines toward tray bottom. Feed the paper over the silver roller in front a between the plastic face and rubber roller. Start the paper by revolving the rubber roller with your finger. When replacing printer, push it in while making sure the paper is not pinched tween the printer and panel by manually pulling some paper out the slot. Make sure the printer seats completely flush with th panel since an electrical connector must make contact. Retight the two knurled screws as tightly as possible with your fingers If the ink becomes dim after 2 to 4 years operation, loosen the two black screws on the printer face and pull out the ink pad. new pad may then be screwed in. Spare pads have been supplied Alaska and spare printers have been included. Any printers may interchanged between systems, as they are identical.

1/ Set to print out on the hour. During operation place a binder on the end of the tape as it comes out of the counter. Hanging clip over the edge of the counter stand will allow tape to move smoothly out of the counter, eliminating printer malfunction.
2/ 1978 model this may appear as a dot.
3/ On the hour.
4/ Erasure of data on '78 and '79 models can be avoided by setting DATA CLEAR TIME switch in NEVER position until printout is over
5/ Or a complete printout could be missed without your knowledge.
6/ Screws on printers must be tightened daily as vibrations can cause them to loosen.

C. <u>Clear Pushbutton Contd.</u>

liquid crystal display. It does not affect the cumulative counter at right. To clear the data, the "SAFETY" switch must be "OFF". The sounder alerts you when this switch is left off.

D. <u>4-Digit Display and Manual Sector Selector</u>

The liquid crystal display shows you the number of counts accumulated in any of the 12 sectors that is selected by the black thumbwheel switch above it. It is always on since it uses only 1 microamp of current. Being liquid crystal, it is a reflective display and requires some ambient light to be seen. At night a flashlight or match may be necessary to see it.

E. <u>Meter, Meter Switch and Battery</u>

When in the "BATT" position, the meter reads the condition of the GEL-CELL battery. When in the "SOLAR CHARGE" position, the meter reads the output of the solar panel. In full, unobscured sunlight the meter will read at the extreme right indicating the solar panel is supplying 12 times the current that the Side Scanner is using with the excess going to charge the supplied GEL-CELL battery. When the meter is at the point where the red and green meet (such as cloudy weather) the solar panel is supplying twice as much current as the Side Scanner is consuming with the excess going to charge the GEL-CELL battery. This would be enough to indefinitely carry it through the night hours. <u>Although a 12V, 16 amp hour rechargeable GEL-CELL battery is supplied with each system, any 12V battery of equal or greater capacity may be used</u>. The supplied battery, when fully charged, will operate the Side Scanner for approximately 300 hours, or about 2 weeks, day and night, with no solar charging. Internal protection is provided against battery overcharging in the event of constant full sun.

F. <u>Fish Velocity Control</u>

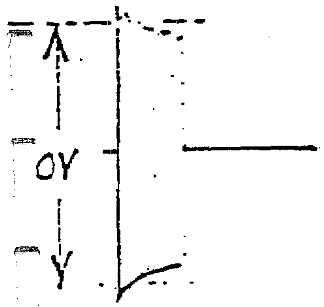
This thumbwheel switch controls the transmit repetition rate of the system. It has been observed that salmon migrate upstream at about 1.75 feet per second (ground speed). Since the switch is labeled in seconds per foot, the reciprocal of 1.75 feet per second is 0.571 seconds per foot so until new fish speed information is obtained, set the control to 0.571. (33T on Susitna west bank).

G. <u>Sensitivity Control</u>

This controls the amount of power transmitted to the transducer and is essentially a system sensitivity control.

To adjust it initially requires a fine bladed screwdriver or knife blade and an oscilloscope. It is adjusted as follows:

(1) Connect the oscilloscope input to the red test point on the panel marked XM2°. Set the vertical sensitivity of the scope to 5V per division and the scope trigger to internal. Set the horizontal scope sweep speed to 50 μsec per division. Make sure the transducer is properly connected and in the water.



(2) Set the beamwidth switch to 2°. Adjust the front panel sensitivity control for an average peak to peak (top to bottom) signal of 30V. It will look something like the Waveform at left so adjust for an average as shown.

(3) In very muddy rivers such as the Susitna, set this level to 35V.

H. <u>Dead Range Control</u>

This controls the distance from the face of the transducer that the system is "blanked out." That is, any echos received within this preset range will <u>not</u> be accepted for processing. The control may be set from 0 to 10 feet. This control is necessary to blank out transducer "ringing" which occurs for about 2½ feet and would result in false counts. Sometimes a source of air bubbles near shore exists which could cause false counts. In this case, increase the DEAD RANGE control until the count stops in sector 1 (as evidenced by the #1 fish light blinking). <u>The fish would then have to be weired out to beyond the dead range</u>. See "weirs" under Misc.

I. <u>Counting Range Control</u>

This controls the total perpendicular distance to which fish counts will be accepted. This preset distance starts immediately after the DEAD RANGE ceases, thus the <u>total</u> range from the face of the transducer is the <u>total</u> of both the "DEAD RANGE" and "COUNTING RANGE" settings.

J. <u>Transducer Aiming</u>

The end of the artificial substrate contains a target, approximately 60 feet from the transducer face. This is necessary for proper

J. Transducer Aiming (Contd.)

initial aiming of the transducer beam. 1/ To do so, merely set the range controls for a total somewhat over 60 feet and manipulate the transducer until the sector #12 fish light consistently blinks. The 2^{o} beam should be used for this although the 4^{o} beam may be used to initially locate the beam. When in position, tighten the transducer mounting knurled handles.

The beam should be as low as possible without actually reflecting back from irregularities on the pipe so the best way to set the beam is to start high and lower the beam until it hits the target, then lower it further until echos begin returning from some point before the target, then raise it just enough to miss the early target.

To facilitate transducer aiming, the knurled handles should be partially tightened and the 3 foot rod supplied with the system alternately inserted in the vertical and horizontal holes in the transducer plate to move the transducer. Make sure that the final tightening does not upset the aiming.

An oscilloscope should be used in lieu of the #12 FISH LIGHT for more precise aiming. To do so, trigger the oscilloscope from the XM 2^{o} panel test point, connect the scope ground to the GND, test point and the scope input to the RCVR test point. Set the scope vertical control to 1 V/CM and the horizontal control to 5 milliseconds per CM. 2/ The target will be observed on the scope 24 milliseconds from the start of the trace and the transducer may be manipulated for a maximum "spike" at that point. If the transducer is aimed too low, early echos coming from rough surfaces on the pipe will be seen before 24 msec. 3/

The new (1978) artificial substrates have an improved method of transducer adjustment and have transducers modified for the new substrates. (See Figure 4 on the last sheet.) The transducer plate should be installed in the shroud on the shore end member. The 3 studs attached to the plate will be secured to the plate with the 3/8-16 locknuts. 4/ About 1½ inch away there will be a 1/2-20 nut followed by a flat washer, a spring and flat washer in that order. The three studs should be pushed through the three corresponding holes in the shroud with the last flat washer against the inside of the shroud. A hand wheel should then be screwed onto the outside of the shroud on each of the protruding studs. 5/ The transducer cables should be fed over the top of the transducer and back to shore, securing them with tape to prevent chafing and to

1/ Prior to submersion, transducer plate should be flushed on all sides with transducer housing. This can be accomplished by "feel" or using a straight edge.

2/ See section titled Oscilloscope Operation for the Side Scanner.

3/ See section titled Typical Side Scanner Oscilloscope Waveforms for various transducer aiming conditions.

4/ Use lockwashers and tighten with channel lock pliers.

5/ Extreme care should be taken when installing or removing

J. Transducer Aiming (Contd.)

provide a little service loop to prevent their being torn off the transducer. The three hand wheels should be tightened with an equal amount of stud protruding through the wheel. The transducer will now be approximately aimed at the target end 60 feet away. (The remaining three hand wheels should be used after final transducer adjustment by running them up the stud and tightening them against the first wheel to lock them in place.)

The transducer should be accurately aimed at the target by the oscilloscope method discussed in the previous section with the following new exception. To raise the beam, screw the upper wheel clockwise (to the right) one turn for each 3/4 foot beam movement 60 feet away (or counterclockwise to lower it). To move the beam to the right, turn the lower right wheel clockwise and the lower left wheel the same amount counterclockwise at the same time. To move the beam to the left, reverse the procedure.1/ Each full turn of both wheels together will move the beam horizontally 1-1/2 feet. By turning them together, the vertical aiming remains unchanged and the upper wheel does not affect horizontal beam movement. The 2^{o} beam is 2 feet wide at 60 feet away. See attached section on Transducer aiming.

K. Cumulative Counter

This counter maintains a running total of all counts. It is an 8-digit counter and being of the L.E.D. type, consumes a fair amount of power when lit. For this reason a "READ" pushbutton is provided below it to read the total when desired. To clear the cumulative counter, shut OFF the SAFETY switch and depress the "CLEAR" pushbutton located below the counter. The alarm will alert you that the "SAFETY" switch is OFF.

L. Safety Switch

This switch is an interlock provided to prevent accidental clearing of the data or accidental resetting of PRINTER time or AUTOMATIC TEST time. Whenever it is left in the "OFF" position the sounder will sound, alerting you of this fact.

M. Sounder

The sounder will alert you whenever any of the following three switches are left in the "wrong" position to prevent walking away from the unit in that condition: (The sounder will "click" whenever fish is counted.2/

1/ Horizontal movements should involve exactly the same amount of turning on each wheel to avoid "skewing" the beam out and up or down.

2/ Speaker may be covered when working to lessen obnoxious noise. However, the speaker is not a gum repository.

M. Sounder (continued)

a. Sounds when "DATA" switch is left "OFF".

b. Sounds when "PRINTER" switch is left "OFF".

c. Sounds when "SAFETY" switch is left "OFF".

N. Test Pushbutton and Data Switch

The purpose of this test is to verify proper functioning of almost the entire system (except the transmitter). This button, when depressed, electronically simulates fish in the first 11 sectors. When the system is operating properly, the first 11 fish lights will blink, the sounder will sound, the cumulative counter and the 4-digit counter at left will record these counts. If only a partial system test is desired, without interfering with data already present in the memories or the cumulative counter, the "DATA" switch should be left "OFF". This will prevent these "false counts" from being recorded but will permit the FISH lights to blink. When a full system test is desired at the cost of losing the data already present, the "DATA" switch may be left "ON".

O. Fish and Sector Lights

The two red SECTOR L.E.D.'s indicate that the electronics logic card is probably functioning properly. The sector lights must always blink. If a light(s) does not blink, the cause may be merely a burned out light. This can be verified by dialing the large thumbwheel switch to the sector in question and simulating fish by depressing the "TEST" pushbutton with the "DATA" switch "ON". If data is recorded in that sector, it merely means that either the light is bad or the L.E.D. card in the system is bad, which will not affect proper operation.

To check sector 12, merely increase the "RANGE" control setting a few feet to "count" the target at the end of the substrate. The FISH lights will blink whenever fish are detected in the corresponding sector and the sounder will sound.

P. Automatic Test

This feature permits automatic self testing of the entire system including the transducer and its proper aiming. It functions automatically each 12 hours as follows:

Note: 1978 and 1979 models can be set at 6, 12, or 24 hours.
Set at 24 hours.

P. Automatic Test Cont'd.

To start the 12 hour timing sequence at any point in time, press the "SET TIMES" red pushbutton. This initiates both the printer and auto test times. Precisely 2 seconds after the normal printout 12 hours later, the system will go into an automatic test mode. It will automatically electronically simulate between 2 to 7 fish in each of the first 11 sectors and it will automatically extend its range by 3 feet, thus counting the artifical target 60 feet away and recording these counts in sector 12. It will then print out all these counts and the letter E in the second column to indicate a self start.1/ None of these counts will enter the cumulative counter at right, and will be erased right after the print.

Q. Test Points on Panel

The test points have the following purposes:

1. XMALT. This test point is connected to the 4° section of the transducer which shows the transmitted voltage when the unit is transmitting at 4°.

2. The XM2° test point is directly connected to the transducer sector that is selected by the beamwidth switch and permits oscilloscope reading of the transmitted voltage, thus checking the transmitter card in the system. The 4° transmit will always be considerably higher than the 2° transmitted voltage except when the beamwidth switch is set to 2°. When the "BEAM WIDTH" switch is in the "ALT" position, the transmitted voltage can be seen to alternately go high and low as the 2° and 4° sectors are automatically selected.

3. RCVR Test Point. This test point is the receiver output and gives a true "analog picture" on an oscilloscope of what is happening in the water. Any echos received are amplified and presented at this test point. Any time the echo exceeds 3 volts at this point for the proper pre-programmed number of "hits" it will result in a count. To use this feature, the scope input is connected to the "RCVR" test point, the scope ground connected to the "GND" test point and the scope may be

1/ 1978 and 1979 models will have letter I in the second column.

Q. Test Points on Panel Contd.

triggered from either the "XM" test point which permits observation of the entire 60 feet or from any one of the "SCOPE - TRIG" test points which starts the scope trace at the beginning of any of the 12 sector "listening times." The scope trigger must be set to - . By doing this and properly expanding the scope sweep speed, any one or more of the 12 sectors may be individually observed.

R. Beamwidth Switch

This switch electronically controls the transducer beamwidth by connecting only the center section of the transducer for a 4^{o} beamwidth or paralleling both the center and outer transducer sections for a 2^{o} beamwidth. Any of the three modes may be selected, but for optimum coverage, the "ALT" position should be used since this tends to make the lateral coverage more uniform. When in the "ALT" position, the system alternately transmits on the 2^{o} sector then on the 4^{o} sector and back to the 2^{o} sector, etc. After transmitting on the 4^{o} sector, only those echos received during the first half of the active range are accepted (sectors 1 thru 6). When transmitting on the 2^{o} sector, only those echos received during the last half of the active range are accepted (sectors 7 thru 12). The system electronically gives more weight to sectors closer to the transducer face since the fish will be in the beam a shorter period of time because of the fact that the closer to the transducer, the narrower the beamwidt A number of samples of each fish are taken, permitting different "aspects" of the fish to be sampled as it crosses the beam. A varying number of valid "hits" are required before the system "decides" the target is a fish and enters it into permanent memor The number of valid hits required for detection is a function of which of the 12 sectors the fish was detected. For example, although a fish travelling at 1.75 feet/sec is sampled 9 times, i it is detected in sector 9, only 5 valid "hits" are required to count, so if 5, 6, 7, 8 or 9 hits are made during the passage of the fish, only 1 count will result.

This feature essentially eliminates downstream passing debris whi typically is travelling at the river velocity which is usually much faster than 1.75 ft/sec and which would not be in the "beam" long enough to count. To prevent single debris counts occurring over a period of time from adding up to the number required for a valid fish count, the temporary fish decision memories are automatically cleared 4 transmissions after receipt of any single ech

5. Debris Alerting

Any time 24 counts are made in any one of the 12 sectors in a 35 second period (starting from the first count), the system assumes that this cannot be fish and is probably a piece of debris hung up on the artificial substrate. When the next printout occurs, the corresponding sector column will contain the symbol "+" in the 3rd column next to the sector identification number.1/ After printout, the debris detector is cleared and starts out "fresh" again. If the debris is still present, the system will again accept up to 24 counts in 35 seconds and indicate "+" again. If the debris has washed away, it will resume normal operation.

NOTE: Some of the front panel switches are of the "PULL TO CHANGE" types. This is to prevent inadvertent changing of the switch positions. The switch handle must be pulled away from the panel and then changed. Make sure that the switch is firmly seated in the desired position.

T. Tape Recorder Operation

The salmon counter is designed with the provision to tape the following two outputs on a JVC-1636 cassette stereo tape recorder:

a. RECEIVER - This output is the raw but amplified echos received by the transducer.

b. FISH - This output provides a 65 microsecond pulse every time the system decides that the echos received were that of a fish and not passing debris (unless the debris becomes hung up on the pipe and counts continuously.

c. TAPE PWR - This output provides a regulated 8.7 volts to power the tape recorder automatically for 3.6 minutes after each printout.

The purpose of the tape feature is to permit calibration of the system, after the fact, at some later date. It has been found that visual oscilloscope observation of the receiver output is an excellent indicator of fish passage, even in glacially silty water. Test conducted in Wood River have shown that, with a little practice, an oscilloscope observer can count the fish passage with a better than 95 percent correlation with an observer on the fish counting tower since passing debris echos are of a fleeting nature while fish can be seen entering and leaving the beam with a gradual build-up and decay of its echos.

Thus, by recording the receiver echos and the actual simultaneous fish counts that the salmon counter has electronically decided upon, the two may be compared and system accuracy determined for any given site. The fish velocity control may then be changed to permanently calibrate system.

To record, merely plug the dc power cord of the tape recorder into the side scan TAPE PWR plug, plug the RECEIVER output into the right channel line input of the tape recorder. Plug the FISH output into the left channel line in of the tape recorder.1/ Set the tape recorder controls as follows: SUPER ANRS, CRO2, line, (use only TDK SA-C90 tape).2/ Set the recorder level controls to maximum, press the RECORD and PLAY buttons. Be sure the tape is inserted and at its beginning. When the TAPE PWR switch is in the AUTO position, the tape recorder will automatically come on for 3.6 minutes after each print, thus recording a 3.6 minute sample of the echos and counts each hour at the usual printout setting of 1 hour. Since each side of the cassette has 45 minutes recording time and there are twelve 3.6 minute periods in 45 minutes this means that the recorder can operate unattended for a 12 hour period before turning over the tape.

NOTE: Never leave the TAPE PWR switch in the "ON" position, since this position is only used to set up the tape recorder or to record for greater time periods. Even if no tape recorder is plugged into the side scanner, this would cause the system to consume 20 percent more power needlessly.

II. INITIAL SET UP AND SYSTEM TEST

To verify proper system operation when first turned on or anytime desired, do the following:

Before the battery is plugged in, which turns on the system, place the following switches in the noted positions:

(1) PRINTER OFF.

(2) TRANSDUCER NOT PLUGGED IN.

(3) SAFETY SWITCH OFF.

(4) METER SWITCH in BATT position.

(5) FISH VELOC to 0.571.

(6) DATA ON.

(7) ACTIVE RANGE to about 50 feet.

The remainder of the controls may be left in any position.

Next, plug in the battery and then press the SET TIMES pushbutton. (This synchronizes the system.) Some of the FISH lights may remain on. To clear the system, press and hold the red TEST pushbutton noting that each of the FISH lights blink in sectors 1 thru 11. The system is now cleared and ready for operation. At this time, the SECTOR lights should be blinking and the BATTERY CONDITION METER should be in the green.

1/ FISH output is left or white cord.
2/ Tapes should be run through fast forward and reverse once to lessen wow and flutter effects.

Press the two red CLEAR pushbuttons to erase any counts from the memories.

Press and hold the red TEST pushbutton. This will simulate counts on sectors 1 thru 11. Hold it in until a few hundred counts appear on the CUMUL counter. (You have to press the black READ pushbutton to see this.)

The next step will be to verify that counts have been registered on each section of the 4-digit liquid crystal display and that the printer is functioning, and that all counts agree. To do this, turn on the PRINTER switch and momentarily press the black PRINT COMM pushbutton. The printer should now print out 12 lines of data. The left will be the sector identification number and should sequentially read 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2. The next column should have printed the letter "C" Dial the large black thumbwheel switch through its 12 positions and compare the numbers in the 4-digit numerical display with the corresponding blue printed columns. They should agree.

Next, add up the column of figures. The total should agree with the total CUMUL count within one or two digits.

Solar Panel

The purpose of the solar panel is to charge the 16AH GEL-CELL battery supplied with the system.

Mount the solar panel such that it will receive a maximum average amount of light throughout the day. Plug it into the side connector marked SOLAR PANEL (observing polarity).1/ Put the METER switch in the SOLAR CHARGE position. If full sunlight is falling directly on the solar panel, the meter will be at the extreme right. In very cloudy weather the meter will probably be in the red. When it is at the red/green crossover point, the solar panel is supplying twice as much current as the system is consuming, with the excess going to the battery. This condition will be adequate to indefinitely carry the system through the night hours. Make sure no part of the solar panel is shaded because shading one cell is the same as shading the entire panel.

If the solar panel is connected backward, no damage will result, but the meter will read no solar charge when exposed to light.

III. TROUBLESHOOTING

Many complete sets of printed circuit card spares have been supplied to Alaska Department of Fish and Game. They contain pre-tested cards of every type used in the Side Scanner System.

They are identified by a function name etched on the component side of the cards at the upper left corner of the card. The following table lists the P.C. card names and their functions to aid in troubleshooting.

1/ This means red to red and black to black.

Printed Circuit Card Name & Location in P.C. Card File	Card Function
MEMORIES (Slot 1 & Slot 2) (These 2 cards are identical)	The memory cards store valid fish counts after the electronic decision has been made if debris or fish. They drive the 4 digit liquid crystal display and the printer. They have <u>nothing</u> to do with the cumulative counter display. The 2 cards are identical and interchangeable. The memory card in slot 1 controls the two most significant digits of the display and printer fish counts, i.e., the two digits on the left. The memory card in slot 3 controls the 2 least significant digits of the display and printer fish counts, i.e., the two digits on the right.
LOGIC (Slot 5)	The logic card controls the system repetition rate (or "ping" rate). It controls the duration of the transmit signal, the 11 simulated fish counts for test, the automatic range extension during auto test, the counting range, the dead range, the smolt vs. fish function, the power to the receiver, all the L.E.D. functions, the 12 sector scan, the cumulative counter, the sounder duration when fish are detected and the temporary memories which decide whether the echo detected is fish or debris. If debris, it is erased; if fish, it is routed to the previously mentioned permanent memories cards for storage and then erased from this card. This card also controls the 2°, 4° and ALT beam routing in conjunction with the beamwidth switch.
PRINTER (Slot 7)	The printer card controls the printer time clock, the printer command, the 12 print sequencing, the printer sector I.D. number printed on the left of the printed paper, the letters printed next to the left on the printed paper, the automatic self test timing, the erasure or automatic clearing of the data after print, the tape recorder automatic power turn-on for 3.6 minutes after each print, and makes the decision whether a very high rate of counts is fish or debris and if debris it tells the printer to print the symbol "+".

Printed Circuit Card Name & Location in P.C. Card File	Card Function
RECEIVER (Slot 11) CAUTION: If this card is changed, it will be necessary to readjust the sensitivity screwdriver control on the front panel as discussed earlier in this manual.	The receiver card contains the receiver which takes the minute fish echos, amplifies them 23,000 times and if the echo exceeds a predetermined threshold it triggers a device which sends a signal to the temporary memory card for subsequent decision as to whether it was fish or debris. This card also contains a 9V regulator to power the entire system. It also controls the battery and solar charge meter and provides T.V.G. which means time variable gain which causes fish echos detected far away to be amplified at a greater factor than fish close by since the echo decreases with distance in a log manner. This card also contains the transmitter which transmits a 515 kHz signal to the transducer. The card also contains part of the circuitry to electronically simulate fish in the first 11 sectors for automatic and manual test. The tape recorder power regulator is located on this card also.
LIQUID CRYSTAL DISPLAY CARD. Located on front panel.	This card contains a 4-digit liquid crystal display on the front panel. If it becomes defective it may be removed from the <u>inside</u> by removing the two retaining 6-32 nuts and replacing it with a spare display card. If this done, be sure the two flat plugs that are inserted in its connector are <u>firmly</u> inserted in the new card in identical orientation. The display has an average life of about 7 years. It will be noticed that in cold weather the display takes longer to change its numbers. This is a <u>normal</u> characteristic of liquid crystal displays.

Most of the card functions are self-explanatory so that in the event of trouble, a card may be replaced. Since many of the card functions are inter-related, a problem may sometimes not be definitely localized to a specific card and more than one card may have to be interchanged to cure the problem (one at a time).

To change a printed circuit card, <u>disconnect</u> the <u>battery</u> and <u>solar panel.</u> Remove the 6 screws holding the front panel and carefully lift the front panel <u>straight</u> up. It may then be turned and laid down next to the electronics.

<u>CAUTION:</u> The electronic components on the cards are suceptible to immediate destruction by static electricity. They should never be handled in an offic where carpets generate static electricity.

1.20

Replace the suspect card with a new one and retest. The system can be operated in the open position so it will not be necessary to close the system to test it, but be very careful not to short anything.

To remove a card, pull up on the two card ejectors. To replace a card, press the card firmly down and hook the combination black card ejector/inserter under the ridge of the card file and push the two black interters down. These will force the card into its sockets and may have to alternately be "rocked" until the card is firmly seated in its socket.

CAUTION: NEVER remove or replace a card with power from the battery or solar panel connected.

To replace the panel, reverse the removal procedure being careful not to pinch any cables between the panel and the case. The 6 nuts are on sliding plates and may have to be repositioned with a knife blade if they were moved.

IV. SIDE SCAN ARTIFICAL SUBSTRATE

General Description

The array (Figure 1, 2 and 3) is made up of three 18½ foot long sections of tubes that plug together with an 18 inch overlap forming a single tube.

Off shore and on shore sections terminate the assembly ends. A 1/4 inch diameter wire rope runs through the assembly and is pinned to the off shore cap. The on shore cap has a threaded shaft and handwheel which is used to provide tension holding the array sections together by tensioning the cable.1/ Alignment of the vortex shedding fins on each section is required in order to prevent oscillation or vibration of the array in fast currents. Install and tighten the 1/4" bolts on the welded brackets. These will squeeze the slots together thus securing the pipes together.2/

NOTE: The bolts should be tightened with the pipe upside down from the way it will lie on the river bottom. This will help straighten the pipe.

The off shore cap provides the wire rope termination, has a water check valve used for blowing out and floating the array, mounts the off shore cable attachment point and has a target attached for acoustic signal alignment.

The on shore cap has a 2 inch diameter hole in the end which is used to stake the array in position on the shore. A second 2 inch hole may be used

1/ Cable should be threaded on downstream side of bolts which hold sections together.

2/ 1978 and 1979 arrays: tighten 1/2 inch diameter bolts to 45 ft/lbs (second bolt from target end - tighten to 20 ft/lbs only). If too loose, the array will bend excessively, allowing fish to escape under the beam. If tightened to greater than 60 ft/lbs, the bolts will break or the tube deform.

to tie off the array for safety. A mount for the transducer is provided on this cap. Both verical and horizontal adjustment of the transducer is possible. A 1/2 inch diameter x 2 feet long bar is provided to use as a lever for aligning the transducer on the 1976 systems. The new systems have adjustment hand wheels. Mount the transducer in the upper 3 holes of it's housing.

A traveler, attached to the cable swivel, rides on a bar preventing rotation of the cable when tightening.

NOTE: The cable must be as tight as possible to prevent array breakup in fast rivers. Hand tighten only.

A 1/2 inch threaded plug is provided for an air hose to blow out and float the array prior to removal from the river bed. Netting is tied to the lower vortex fin. 1/8 inch diameter holes spaced at 1-1/2 inch intervals provide net tie points. Holes are provided on both top and bottom fins as installation on the opposite shore requires turning the array end for end and rotating 180°.

NOTE: It has been found by A.D.F.&G. that if no air is available, the array may be raised by allowing the pipe to tilt down in the direction of the water flow. The fairings act as ailerons and will raise the pipe to the surface. Conversely, when sinking the array, the stake on the shore end should be attached via a "come-along" to a tree and should be tilted upstream a few degrees to help sink the array and hold it firmly on the river bottom.

Assembly Procedure for 60 Foot Array

1. Layout the following parts on a reasonably level surface parallel to the river bed in the order listed. Leave 1 foot space between parts.

   1 each Off Shore Cap.

   2 each 18-1/2 foot section with couplers attached.

   1 each 18-1/2 foot section without coupler.

   1 each On Shore Cap (screw in tension screw handwheel all the way).

2. Attach swivel end of 1/4 inch cable (36-1/2 foot long) to eye on threaded tension screw.

3. Feed opposite end of cable (with eye) through the 18-1/2 foot tube sections. Cable must pass through center hole in bulkheads (2 places), and on downstream side of 3/8" bolts.

4. With the on shore cap transducer housing straight up, slip the first 18-1/2 foot section onto the shore cap (male), reduced diameter, align the bolt holes and install 1/4 inch diameter bolts. Be sure 18-1/2 foot section is facing in right direction. Fins go downstream. 1/

5. Install second and third sections in similar manner. 1/

NOTE: If couplings hang up and do not seat the cable and tension secrew can be used to pull the couplings together. However, care must be taken to align the fins during coupling insertion as turning the sections after complete assembly may be difficult.

6. Insert cable eye through the off shore cap and install cap on last section. Insert bolt. Target (curved projection) should be up.

7. Install end plate (with slot for pin) onto off shore cap. Cable should project through cap center hole and extend out about 12 inches if all couplings are seated.

8. Start to tighten handwheel inside on shore cap until cable eye is aligned with slot in end plate.

9. Install pin through eye and seat in slot of end plate.

10. Tighten cable hand tight, using handwheel. All couplings should now be fully seated.

11. Install coupling bolts and cap nuts not previously installed. Tighten to 20 ft/lbs only; apply silicone.

12. Install end cap onto end plate covering cable and pin using two 3/8 inch bolts.

2/

13. The array is now ready for placing into the river.

Array Installation Procedure

Installation of the array into the river will vary from one location to another dependent on local terrain and river conditions. Primarily, current speed will determine whether the array can be floated and swung into place from a parallel to the river position, see Figure 2A (slow currents 2-3 feet per second) or pushed into the river at right angles to the current with the off shore end controlled by a cable, see Figure 2B, current of 4 to 7 feet per second.

1/ Coat outside of reduced diameter portions with clear silicone to prevent air leaks. Also coat both ends of bolts.

2/ To prevent air leaks (when raising):
1) Wrap all seams tightly with grey 2" pvc tape (this may require cutting fins back 2-3" on each side of seam).
2) Place 2 connected 8" hose clamps on each side of seam and over tape.
3) Tighten clamps being careful to keep clamp nuts to downstream side of array and out of beam path.

A judgement as to the best procedure must be made at each site based on the results of past experience. The following steps will apply to both methods.

1. Attach an appropriate shore cable 1/4 inch minimum diameter to upstream end of clamp provided on off shore cap.1/

2. Attach opposite end of shore cable to stake, tree or other available attachment point. CAUTION NOTE: In 7 foot per second currents cable tension of floating array will be as high as 850 pounds.

3. Push the array into the river with transducer housing in a vertical position. (Vortex fins parallel to water flow.) Array must be positioned with reasonable speed as water will leak into the numerous unsealed joints allowing the array to sink in 5 to 10 minutes. The array will have an initial positive buoyancy of about 900 pounds when floating.2/

4. A 1-1/2 inch diameter steel stake should be ready to drive through the on shore cap into the river bed during deployment of the array. This stake must be long enough to be driven securely into the river bed as well as extend out of the water. See following page for new inshore end instructions.

5. Remove the 1/2 inch plug on top and the plastic plug on the side to permit the pipe to sink quickly.

6. The array when installed should have at least 1/2 foot of water over the transducer.

7. Alignment of the transducer beam with the target mounted on the off shore cap is accomplished by separate horizontal and vertical adjustment procedures, see Figures 1B and 1C.

Horizontal

Loosen Knob "A" and the two horizontal adjustment plate bolts. Install adjustment bar into horizontal adjustment hole (do not loosen opposing side knobs B and D). Adjust beam by moving bar forward or aft as required. When correctly positioned tighten the horizontal adjustment plate bolts.

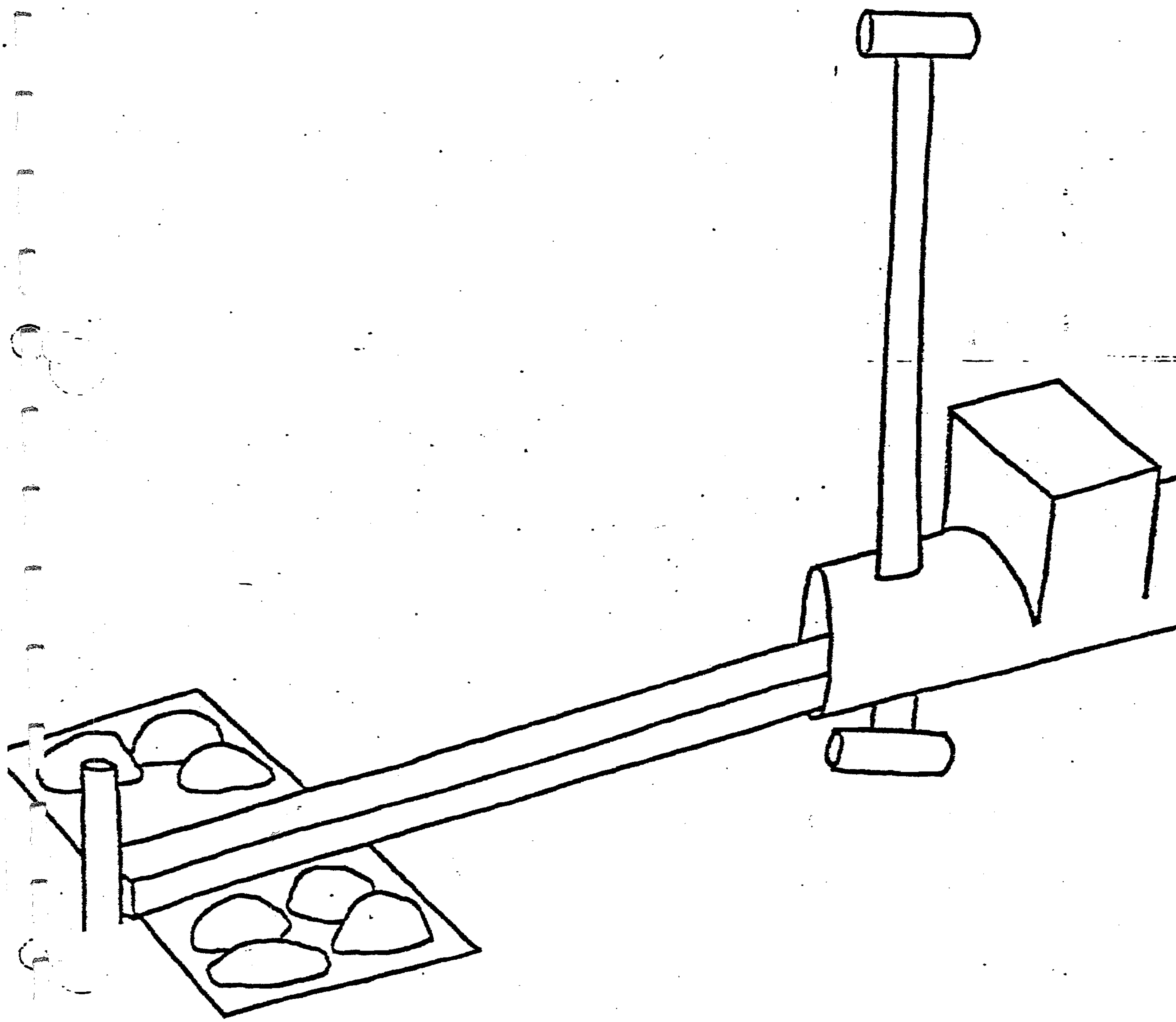
> NOTE: This adjustment is a one-time adjustment and should not require readjustment until the transducer is replaced.

Vertical

Loosen knobs A, B, C, and D. Install adjustment bar into vertical adjustment hole. Adjust by moving bar forward and aft in slotted hole. When adjusted tighten knobs A, B, C, and D.

1/ Easier in and out movement of array while in water can be accomplished by using an inshore cable also. REMEMBER the longer the cable, the easier it will be to move the array in and out.
2/ If correct sealing procedures are followed, the tube will not sink rapidly.

4) The 1 1/2" diameter stake should be replaced with a 2" O.D. x 4' long steel pipe thread on both ends which acts as a "pivot point". Pipe "T"'s are attached to both ends after it is pushed through the holes provided on the inshore end. Movement of the array inshore from current pressure is prevented by placing a 4 x 4 or pole in the opening below the transducer housing and butting it up against the pivot pole. Weights or stakes can then be used to hold the 4 x 4 or pole in place (see drawing).



Array Removal Procedure

1. Blow out water in the array through the check valve located in the shore cap. This is done by removing the 1/2 inch pipe plug located in the shore cap and replacing with an air hose. Air pressure applied here (as from a diver's tank) will force water out the check valve floating the array assembly.

   If no air is available, the alternate raising method described earlier may be used, i.e., allow the shore end stake to tilt forward (downstream) which will raise the array by the aileron action of the fins.

2. The floating array can now be hauled ashore either by pulling straight out or by pulling in the off shore cable.

Array Disassembly Procedure, See Figure 1A, 1B and Figure 3

1. With the array on a reasonably level area remove the end cap by unscrewing the two 3/8 inch bolts.

2. Untighten (screw in) the handwheel inside the on shore cap. This will loosen the tension cable and allow removal of the pin on the off shore end plate.

3. Remove the end plate.

4. Drive a stake through the 2 inch on shore cap hole into the ground. Also drive a second stake into the ground about 10 feet from the opposite end of the array.

5. Attach the "Y" cable to the off shore cap, see Figure 3. Install come-along between stake and "Y" cable.

6. Remove through bolt of first section to be disassembled (any order is OK).

7. Pull apart with come-along.

8. Install 2 eye short cable between sections pulled apart. See Figure 3.

9. Remove next through bolt and pull apart next section.

10. Continue process until all sections are pulled apart.

General Caution Notes

1. Before placing array in water inspect check valve operation.

2. Cable must be tensioned before array deployment.

3. Do not turn array votex fins into current in currents over 4 feet per second. Excessive load may damage array.

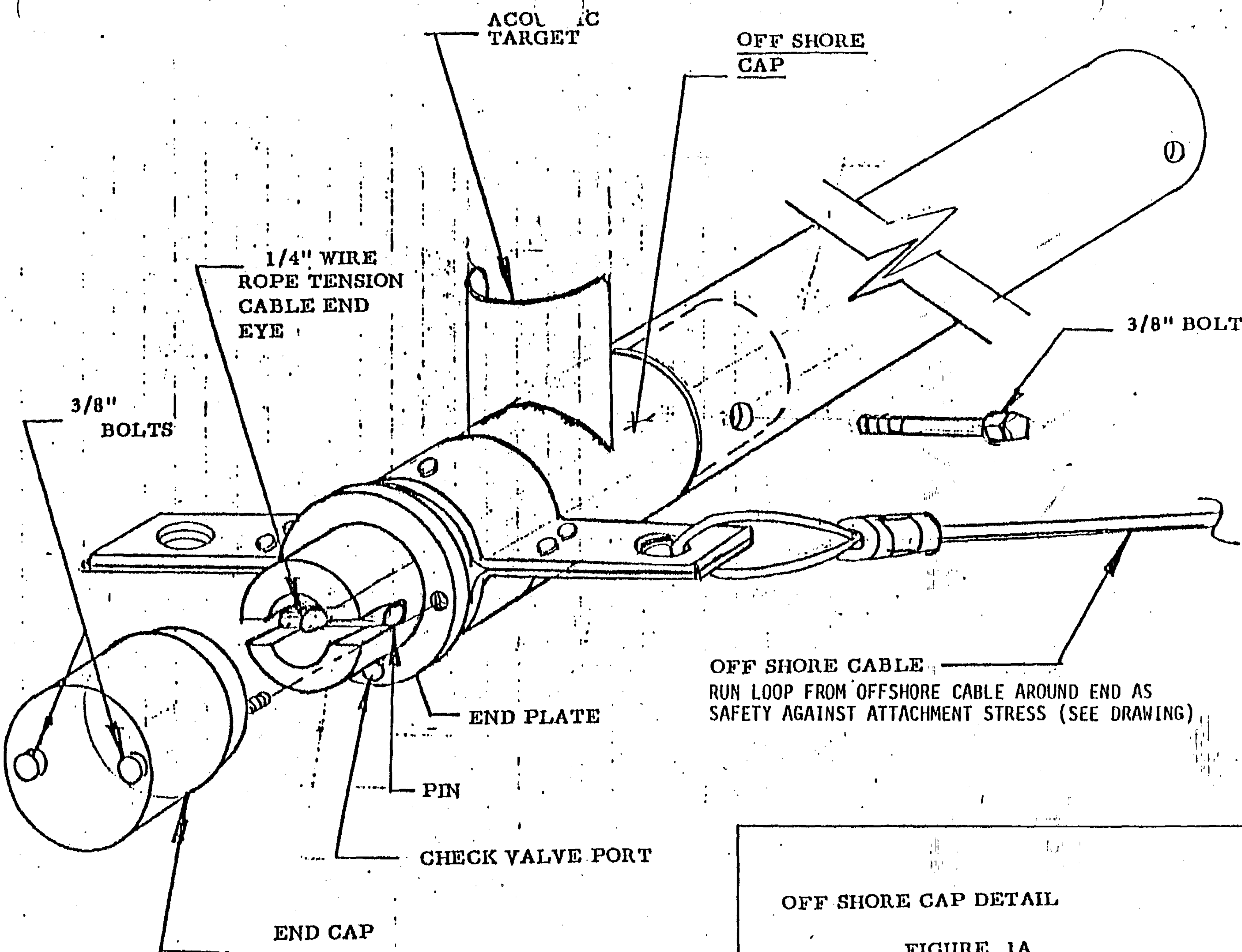
4. Installation of a cable around the <u>on shore cap</u> to a stake upstream on shore may be useful in a fast current river.

5. If corrosion prevents loosening of cable tension wheel on assembled array, the off shore cap pin may be driven out, after removal of the cap, thus releasing cable tension.

6. Handle exposed section ends with reasonable care to avoid nicks or tube distortion.

7. Be sure 1/2 inch diameter carrage bolt in coupling sections are tightened to 45 ft. lbs. in order to eliminate coupling to tube clearance thus preventing array sag. <u>Never</u> exceed 50 ft. lbs.

8. Transducer. The transducer, although reasonably rugged would be destroyed if dropped on a rock. Before use, the radiating polyurethane face should be washed with a detergent, preferably liquid detergent with the liquid left on the face. This cleans off finger oils. Any oil or grease will completely block the high frequency output and make the transducer inoperative. In some rivers, a buildup of various forms of "crud" may develop on the transducer face after a week or two, so a quantity of liquid detergent should be placed in the hand and the hand quickly put under water to rub the face of the transducer. This should be done whenever too much buildup of "junk" is felt or seen on the transducer face. A moderate amount of detritus will not affect normal operation.



OFF SHORE CAP DETAIL

FIGURE 1A

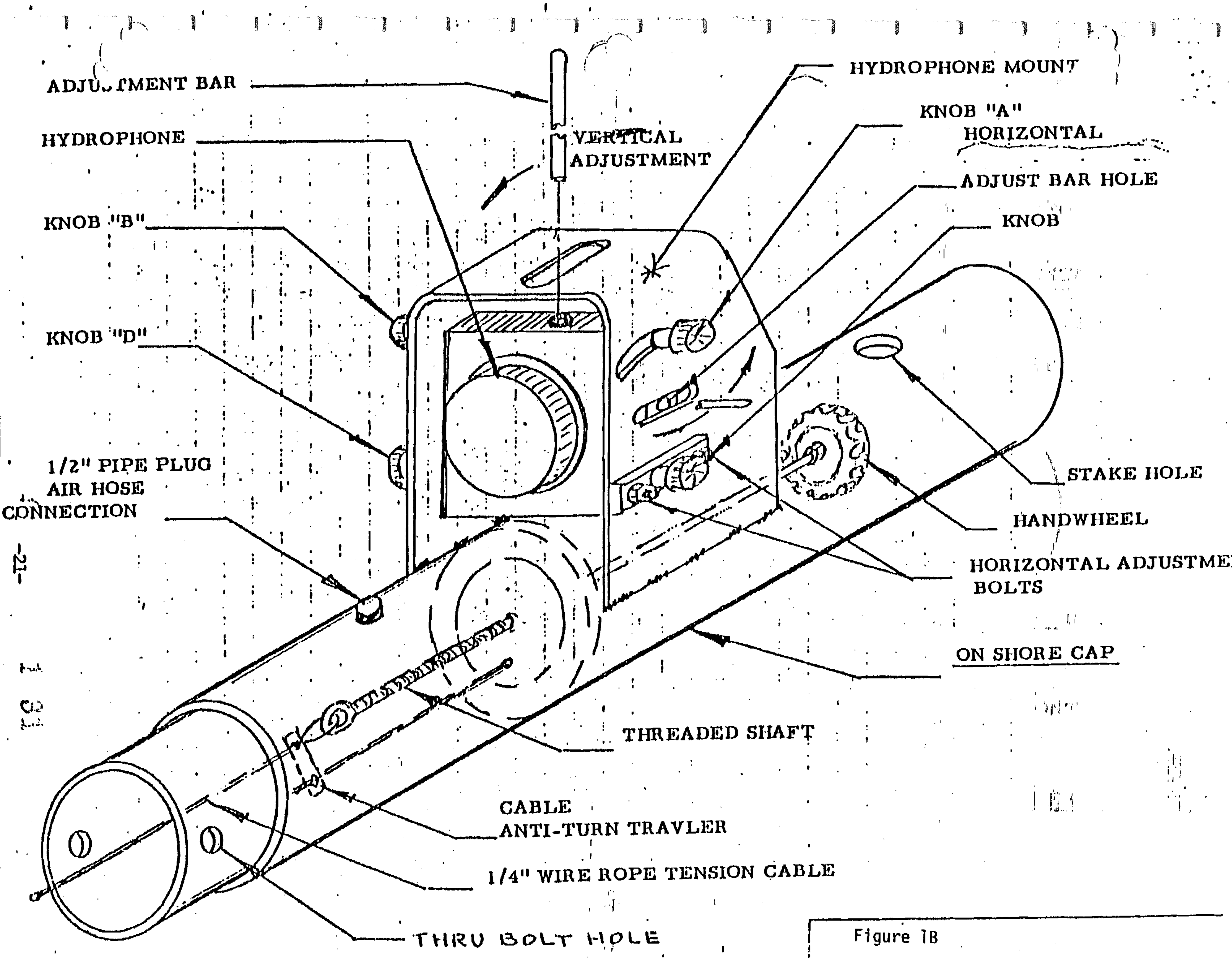

ADJUSTMENT BAR
HYDROPHONE
VERTICAL ADJUSTMENT
HYDROPHONE MOUNT
KNOB "A" HORIZONTAL
ADJUST BAR HOLE
KNOB
KNOB "B"
KNOB "D"
1/2" PIPE PLUG AIR HOSE CONNECTION
STAKE HOLE
HANDWHEEL
HORIZONTAL ADJUSTME BOLTS
ON SHORE CAP
THREADED SHAFT
CABLE ANTI-TURN TRAVLER
1/4" WIRE ROPE TENSION CABLE
THRU BOLT HOLE

Figure 1B

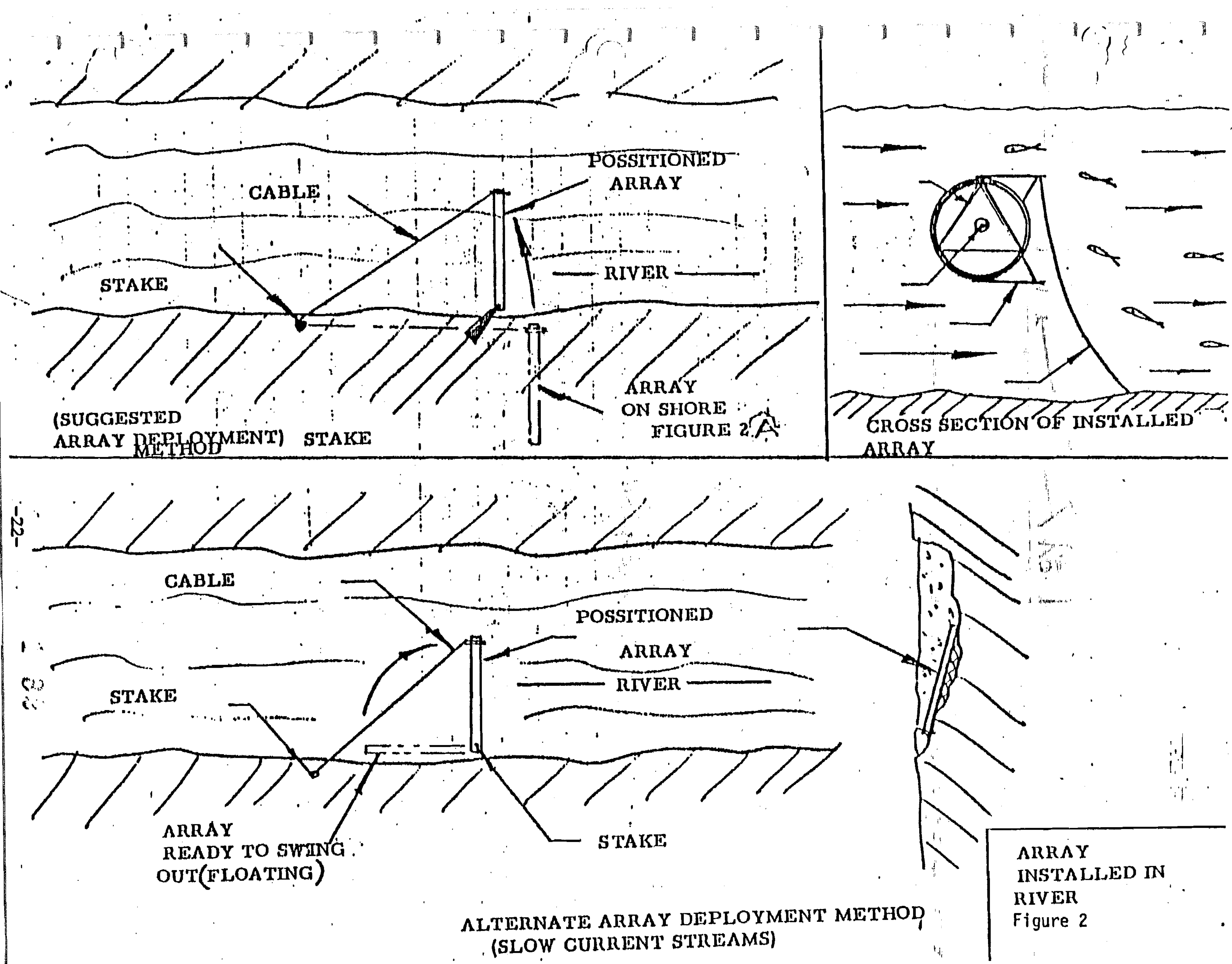
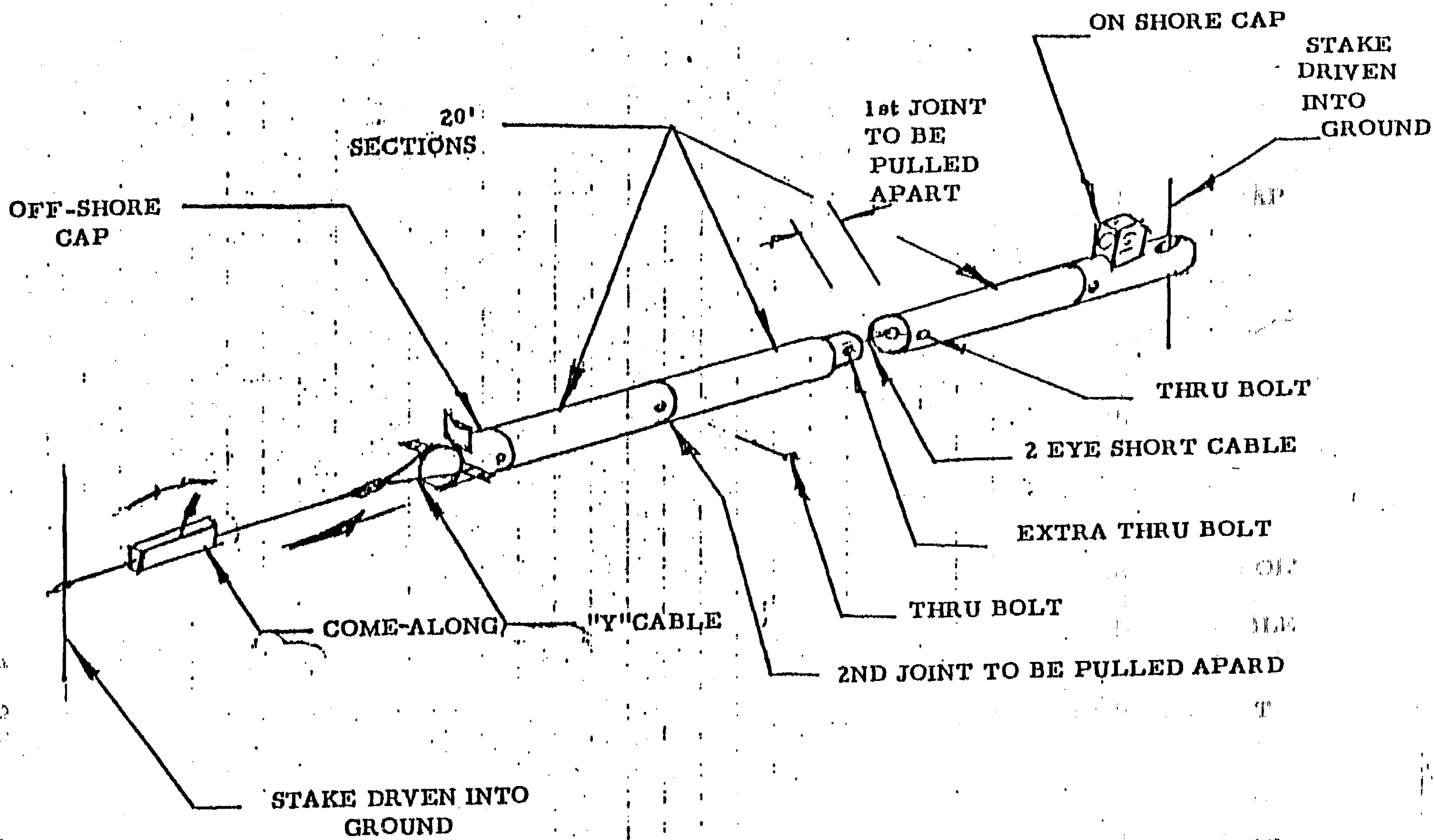

POSSITIONED
ARRAY
CABLE
RIVER
STAKE
(SUGGESTED
ARRAY DEPLOYMENT)
METHOD
STAKE
ARRAY
ON SHORE
FIGURE 2 A
CROSS SECTION OF INSTALLED
ARRAY
CABLE
POSSITIONED
ARRAY
RIVER
STAKE
ARRAY
READY TO SWING
OUT(FLOATING)
STAKE
ALTERNATE ARRAY DEPLOYMENT METHOD
(SLOW CURRENT STREAMS)
ARRAY
INSTALLED IN
RIVER

Figure 2



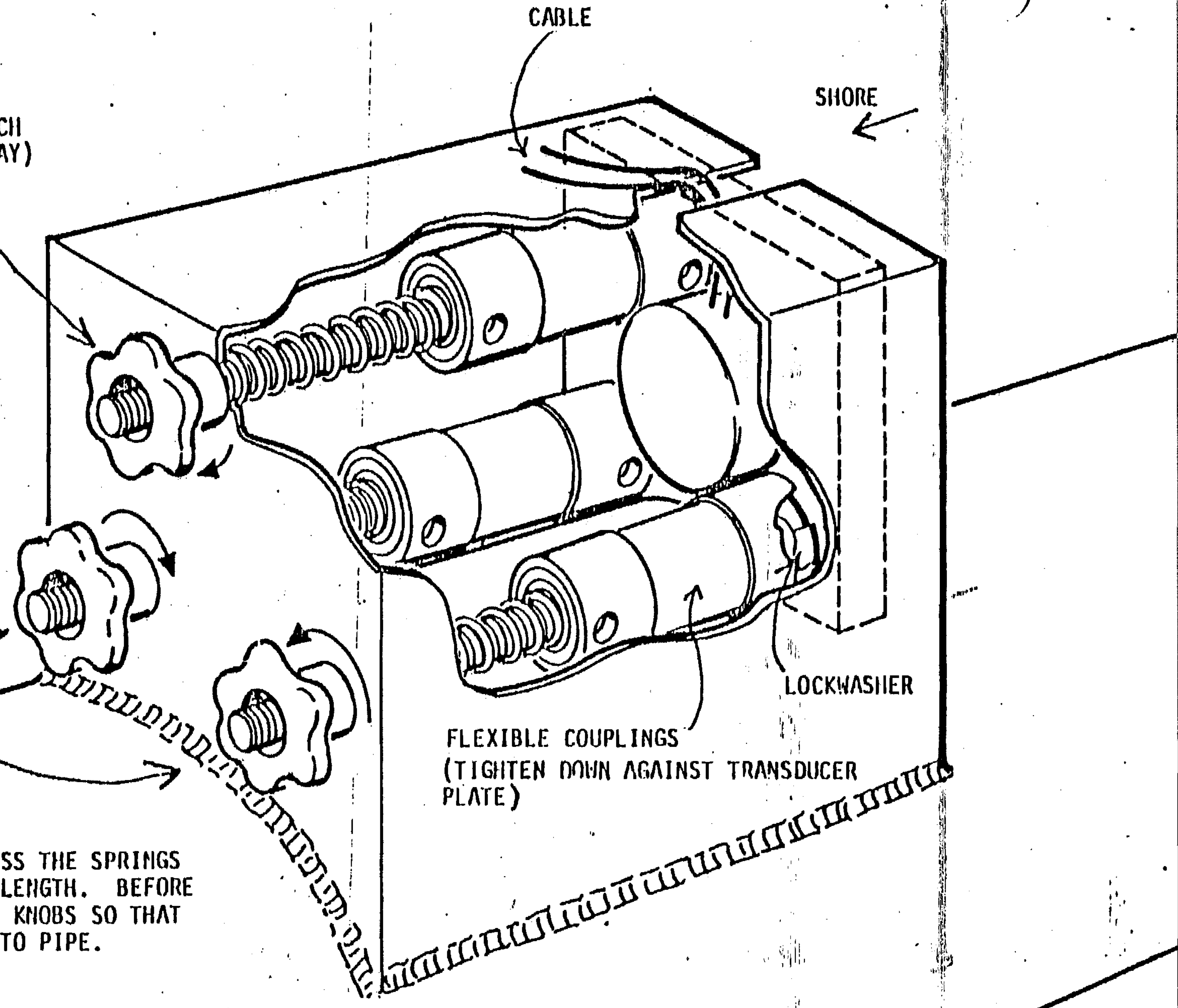
ARRAY DISASSEMBLY

VERTICAL ADJUSTMENT

(TIGHTEN 1 TURN CLOCKWISE FOR EACH 3/4 FOOT BEAM RISE AT 60 FEET AWAY) OR VICE VERSA TO LOWER BEAM

HORIZONTAL ADJUSTMENT

TIGHTEN LEFT KNOB AND LOOSEN RIGHT KNOB SIMULTANEOUSLY 1 TURN FOR EACH $1\frac{1}{2}$ FT. BEAM SHIFT TO THE LEFT AT 60 FT. AWAY OR VICE VERSA TO SHIFT RIGHT



INITIALLY TIGHTEN KNOBS TO COMPRESS THE SPRINGS TO ABOUT 2/3 OF THEIR NO-TENSION LENGTH. BEFORE INSTALLING IN WATER, ADJUST THE 3 KNOBS SO THAT TRANSDUCER FACE IS PERPENDICULAR TO PIPE.

NOTE: Use upper three holes.

September 6, 1978
NEW VERSION OF TRANSDUCER

APPENDIX II

A. ADULT ANADROMOUS FISHERIES STUDIES

Oscilloscope Operation

July 16, 1979

A. Menin

OSCILLOSCOPE OPERATION

for the

SIDE SCANNER

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This manual describes how to use the oscilloscope in conjunction with the side scanner. Although it is specificially written around the Tektronix model 323 "scope", the same basic rules apply to virtually any model scope except for the location of controls.

THEORY OF SCOPE OPERATION

The scope is basically a time variable voltmeter. A bright dot moves across the screen at a constant rate from left to right. The speed at which it moves is determined by the TIME/DIV control setting on the scope. At most settings, the dot moves so quickly that it looks like a continuous horizontal line to the human eye.

The VERTICAL INPUT of the scope (on the left side of scope) is the same as the + & - input leads on a voltmeter except that a voltage connected to VERTICAL INPUT scope connector will cause an upward vertical deflection of the moving dot of light proportional to the amount of voltage at the input at the point in time that the moving dot happens to be when that voltage is connected. For example, if there is no voltage on the scope input for the first half of the trace, you will see a straight line. If a + voltage is then applied during the middle of the trace (or sweep as it is usually called), the bright dot will go vertically up to the corresponding place on the scope's face as determined by the VOLTS/DIV setting of the scope. Example: With a 2V/DIV setting, the dot would rise three divisions at the precise instant in time that you connected the + of a 6V battery to the scope's VERTICAL INPUT with the - of the battery connected to the scope ground.

TRIGGERING

The bright dot on the screen requires an electrical voltage on the TRIGGER INPUT of the scope (on the left side of scope) to start the dot moving at the rate (or speed) set by the TIME/DIV control on the scope's front panel. This trigger is required for <u>each</u> "sweep" of the dot. At the instant in time that a voltage is applied to the TRIGGER INPUT of the scope, the dot will start moving from left to right. This provides <u>synchronization</u> of what you see on the screen with the side scanner. In the case of the side scanner, the TRIGGER INPUT will be connected to either XM2°, XM4° (or XM ALT. in the latest version of the side scanner). Each time the side scanner transmits a "burst of sound", the transmitted voltage momentarily appears on the XM pin connector of the side scanner. At this instant in time, this voltage causes the dot to start moving from left to right. Since you will have the TIME/DIV set to 2 ms (MILLISECONDS) for proper operation with the side scanner, this dot is now moving across the screen at the rate of 2 milliseconds (2 thousanths of a second) per division. This of course is too fast for the human eye to follow so it looks like a straight line to the eye. Since sound travels (in water) at about 5000 feet per second which equals 5 feet per milliseconds (1 thousanth of a second), when the scope's VERTICAL INPUT is connected to the RCVR (receiver) pin connector of the side scanner, an echo (a vertical line) from a fish (or other object) 25 feet away from the transducer would be seen as a vertical line at 5 divisions from the left of the <u>start</u> of the sweep of the bright dot. This is because it took 5 milliseconds for the sound to travel the 25 feet to the "fish" and another 5 milliseconds for the "echo" from the fish to return to the transducer for a total of 10 milliseconds round trip travel time. Since the scope is set to 2 milliseconds per division, 10 milliseconds would be 5 divisions.

To see the metal target at the end of the pipe which is about 59 feet away from the transducer, you should expect to see this target 23.6 milliseconds from the face of the transducer (the start of the sweep) because at 5 feet per millisecond travel time, it will take 11.8 milliseconds for the sound to hit the metal target and another 11.8 milliseconds for the "echo" to return to the transducer or a round trip travel time of 11.8 + 11.8 = 23.6 milliseconds. Since the TIME/DIVISION of the scope is set to 2 Msec/DIVISION, that would be just beyond the 10 divisions on the scope screen and would not be seen, so a fine variable adjustment knob located in the center of the TIME/DIV coarse control should be rotated a little counter clockwise so that the echo from the metal target can be seen on the scope's face. <u>Rotating this small control counterclockwise increases the time per division to some amount greater than the 2 milliseconds per division that the coarse control was set to</u>.

SCOPE CONTROLS AND THEIR FUNCTIONS

1. POWER SWITCH-ON (see fig. 1) - <u>CAUTION</u>: <u>Be sure</u> to shut off power when scope is not being used since it draws much more power than the side scanner and would rapidly discharge the battery.

2. POWER SOURCE SELECT SWITCH (see fig. 2) - This is a small slide switch on the rear of the scope and should be pushed down to the EXT DC position which means that the scope is being powered by an external 12V from the side scanner.

3. VOLTS/DIV. ROTARY CONTROL (see fig. 1) - This switch may be set as desired for viewing the side scanner RCVR output. It should be set to either 1V or 2V. If it is set to 1V per division you may want to rotate the small "fine control" center knob inside the coarse control VOLTS/DIV to reduce the height of the vertical lines or fish echos to about 1 inch.

4. <u>POSITION CONTROLS</u> (see fig. 1) - These 2 controls merely affect the horizontal and vertical position of the scope display. You may want to set the vertical position control so that the horizontal trace of the scope is a little above the bottom of the screen and the first vertical line on the left

is about 1/4 inch inside of the screen. (This corresponds to the transmitted burst of sound or the transducer position).

5. INPUT LEVER SWITCH (see fig. 1) - This should be down (in the DC position).

6. TRIGGER LEVER SWITCH (see fig. 1) - This important switch should be in one of the 2 bottom external trigger positions, either AC or DC. This switch is located on the right side of the model 323 scope.

7. TRIGGER KNOB (see fig. 1) - This is probably the most important (and most often mis-set control). Its function is to assure that the start of the sweep of the scope picture exactly coincides with the instant the side scanner transmits its burst of sound. This will cause the transmit burst vertical line to be at the start of the sweep (the extreme left side of the trace). If this knob is rotated completely clockwise or completely counterclockwise, the scope trace will "free run", that is to say, it will never be synchronized with the transmit burst and therefore the transmit burst vertical line on the scope's face may occur anywhere along the scope sweep.

8. TIME/DIV, ROTARY CONTROL (see fig. 1) - This controls the speed at which the bright dot crosses the screen. For use with the side scanner, it should be set to the 2 Ms (MILLISECONDS) position.

9. ATTEN. SLIDE SWITCH (see fig. 1) - This switch is located on the left side of the scope. Although it can be operated in either position, stable triggering is a little easier to adjust if this slide switch is in the 10X position.

10. FOCUS AND INTENSITY (see fig. 1) - These two controls are located on top of the scope.

The intensity control should be rotated fully clockwise for maximum brightness of the trace. After adjusting the brightness, rotate the focus control for the sharpest vertical lines.

At night you may want to decrease the brightness. If you do, refocus the FOCUS control.

OSCILLOSCOPE CONNECTIONS TO SIDE SCANNER

1. EXT. D.C. POWER (see fig. 2) - This twin connection is located on the right side of scope. This should be connected to the mating connector labeled "SCOPE" on the right side of the side scanner. CAUTION: This is the 12 volt power connection to the scope and does not have reverse polarity protection. If these leads are reversed, the scope will burn out instantly.

2. EXT TRIG. (see fig. 1) - This connector is located on the left side of scope. It should be connected to either the 2° or 4° (or ALT. in 1980 model side scanner). This is to provide triggering of the scope from the side scanner. Use either one of the supplied connector cables. The black pin on the connector cable is ground and may be connected to the gnd. pin of the side scanner or left disconnected if you like, since the scope will be grounded anyway through the power connector.

3. VERT. INPUT (see fig. 1) - This connector is also located on the left side of the scope. It should be connected to the RCVR connector on the face of the side scanner using the supplied connector cord which is identical to the ext. trig. cord. The black pin is ground and need not be connected to the side scanner ground since the scope is already grounded through the 12V power cord.

This is the vertical input to the scope and causes the bright moving dot of the scope to go up vertically when a voltage is present on the RCVR output of the side scanner as it would be when a fish echo is present.

OSCILLOSCOPE ADJUSTMENTS

1. After all three connectors are in place (trigger, vertical input and external 12V power) turn on the scope power.

2. Turn the brightness control fully clockwise.

3. Place the rear slide switch in the down (ext DC) position (Fig. 2).

4. Place the ext. trig. switch on the left side of scope to the 10X position.

5. Place the input lever switch on the scope face to the DC position (down).

6. Place the trigger lever switch (on the right side of scope face) down, to the EXT TRIG DC position.

7. Set the TIME/DIV rotary switch to 2 ms.

8. Rotate the small center knob inside the TIME/DIV switch about 1/3 of a revolution counterclockwise from its fully clockwise (detent) position.

9. Set the VOLTS/DIV rotary switch to 1 volt.

10. Rotate the small center knob inside the VOLTS/DIV switch about 1/3 of a revolution counterclockwise from its fully clockwise (detent) position.

11. Push in the 2 POSITION controls located on the bottom center of the scope face. These 2 rotary controls are also push-pull switches and should always be pushed in.

12. Rotate the trigger knob on the lower right side of scope face fully counterclockwise to its detent position. This will cause the scope to operate even without an external trigger so that you can adjust the two position controls.

13. Rotate the vertical position knob on the bottom center of the scope until the trace on the screen is about 1 division from the bottom of the screen.

14. Rotate the horizontal position control on the lower center of the scope face until the trace starts about one division from the left side of the scope screen.

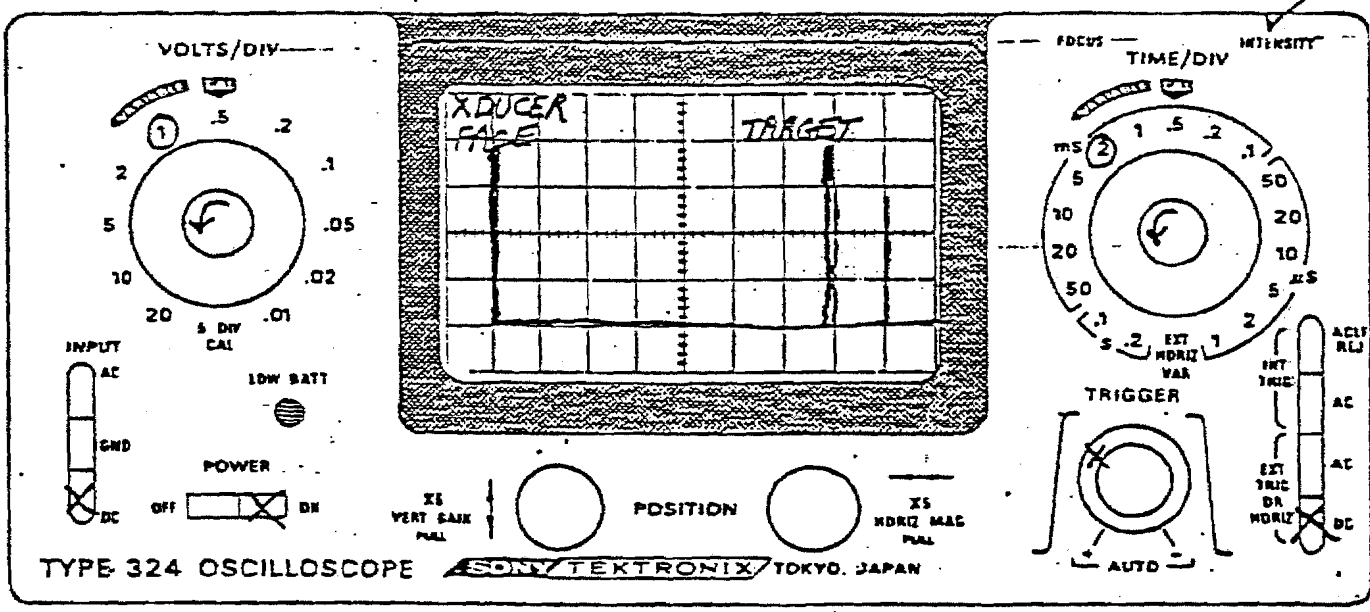
The scope is now ready for final trigger adjustments.

15. Put the side scanner beamwidth switch in the 2° position and connect the EXT TRIG. cable to the XM2° pin connector on the face of the scope. Rotate the TRIGGER knob on the right side of scope face to about the 10 o'clock position. Somewhere near this point, the scope should be triggering properly as evidenced by a stable vertical "spike" being seen on the extreme left (the beginning) of the scope trace. Now place the beamwidth switch on the side scanner to the Alternate position. The scope trace should look the same as it did in the 2° position meaning that you are still triggering only on 2°. If it looks different or seems to speed up or get brighter that means you are slightly misadjusted. If so, rotate the TRIGGER knob a bit until the scope picture does not change as you switch between the 2° to the ALT positions on the side scanners beamwidth switch.

Now put the EXT TRIG connector cord in the XM4° connector (or the XM ALT. on the 1980 model). When the side scanner beamwidth switch is in the ALT position the trace on the scope should now be triggering twice as fast (brighter) as in the 2° position since now you are alternately triggering the scope twice as fast as you were. You are causing the scope to alternately trigger on 2°, 4°, 2°, 4° etc. If you now move the EXT TRIG. cable connector back to the XM2° connector you will see a change in the trace since it will only be triggering on the 2° beam (half as often).

You should now see a stable vertical spike, about 1 inch high on the left side of the trace and you should see the metal target echo (about 1 inch high) near the right side of the trace if you increase the COUNTING RANGE control on the side scanner to beyond 60 feet. To operate the side scanner normally, you should now reduce the COUNTING RANGE control slowly until it just ceases to count the target (on sector 12) and then reduce it about one foot more for safety.

FACE OF SCOPE



LOCATED ON LEFT SIDE OF SCOPE

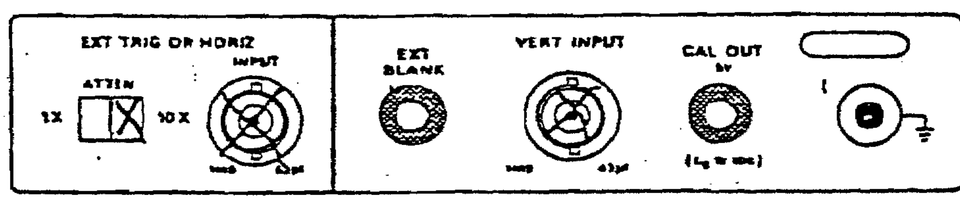
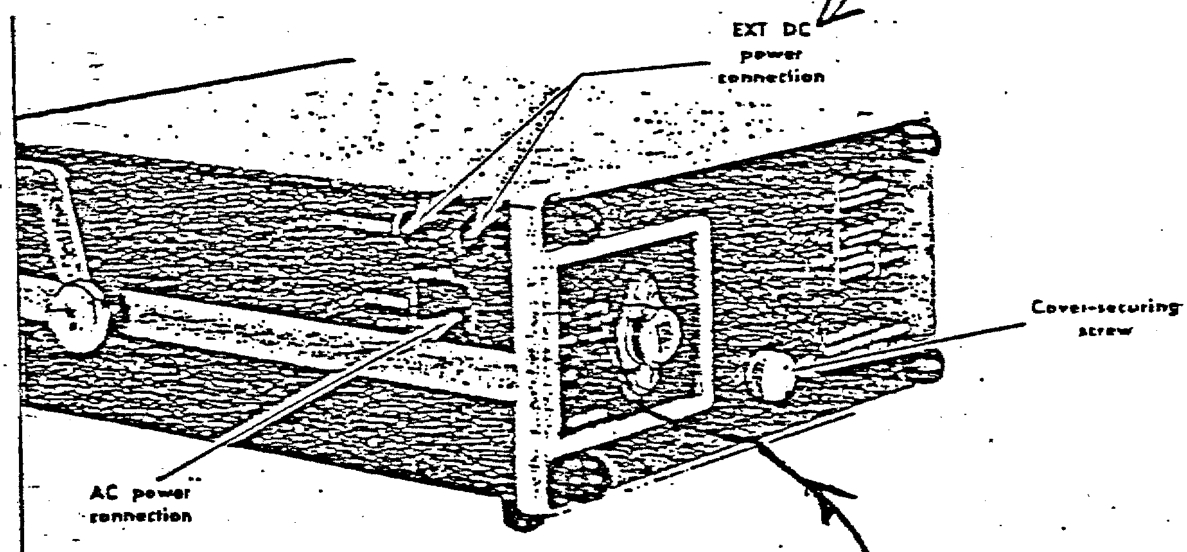


Figure II-1. Oscilloscope controls. Sony Tektronix type 324 oscilloscope.

FIG, 1

CONNECT THIS TO SCOPE POWER CONNECTOR ON SIDE SCAN.



PUT THIS SLIDE SWITCH IN DOWN (EXT. DC) POSITION

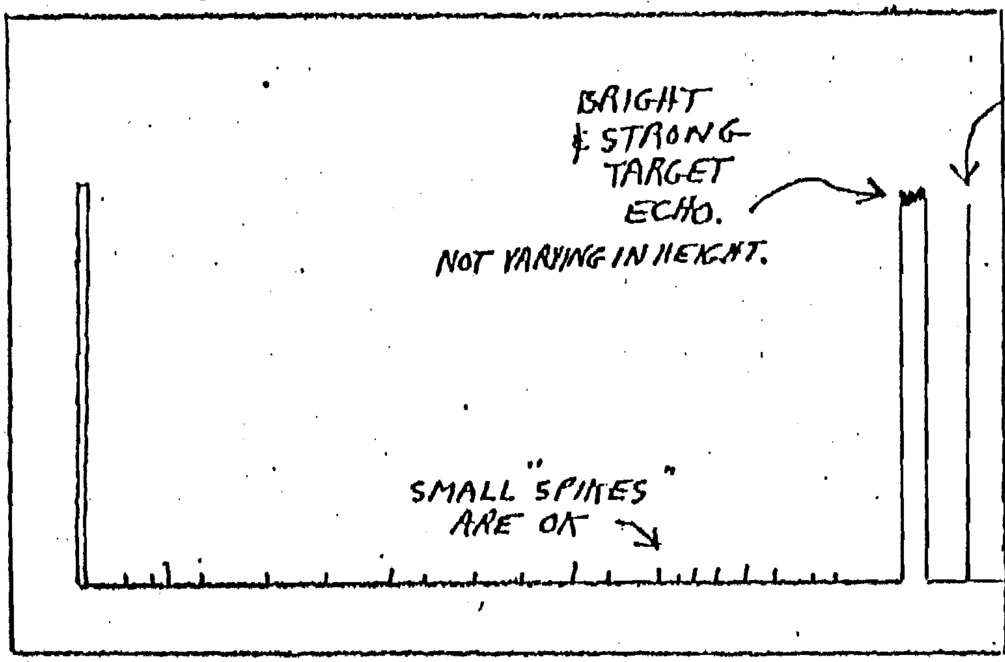
Figure II-2. Oscilloscope adjustments. Sony Tektronix type 324 oscilloscope.

FIG 2.

Table II-1. TYPICAL SIDE SCANNER OSCILLOSCOPE WAVEFORMS FOR VARIOUS TRANSDUCER AIMING CONDITIONS

FIGURE #	CONDITION
II-3.	PROPER VERTICAL AIMING. 2°
II-4.	PROPER VERTICAL AIMING. ALT. BUT SCOPE TRIG. ON 4°
II-5.	PROPER VERTICAL AIMING. ALT. BUT SCOPE TRIG. ON 2°
II-6.	IMPROPER VERTICAL AIMING. (AIMED TOO LOW)
II-7.	IMPROPER VERTICAL AIMING. (AIMED TOO HIGH). 2°
II-8.	IMPROPER VERTICAL AIMING. (AIMED TOO HIGH). 4°
II-9.	IMPROPER HORIZONTAL AIMING. (AIMED TOO FAR DOWNSTREAM)
II-10.	PROPER HORIZONTAL AIMING.
II-11.	IMPROPER VERTICAL AIMING. (TOO LOW AND BOUNCING OFF SUBSTRATE
II-12.	ECHOS FROM BOAT WAKE
II-13.	IMPROPER VERTICAL AIMING IN SHALLOW WATER

FIG.



RANGE CONTROL
ON SIDE SCANNER
SET TO JUST BEYON
TARGET.
(SECT 12 WILL COUN

Figure II-3.

PROPERLY AIMED TRANSDUCER
WHEN BEAMWIDTH SWITCH IS SET
TO 2° AND SCOPE TRIGGERRED FROM XM 2°

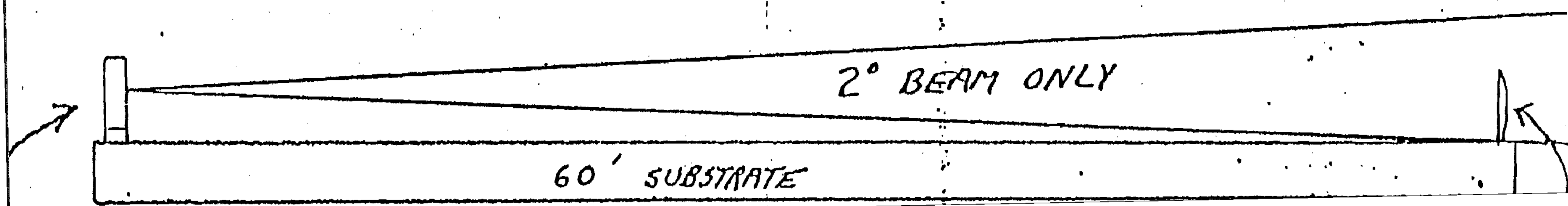


FIG 7

OSCILLOSC E SCREEN

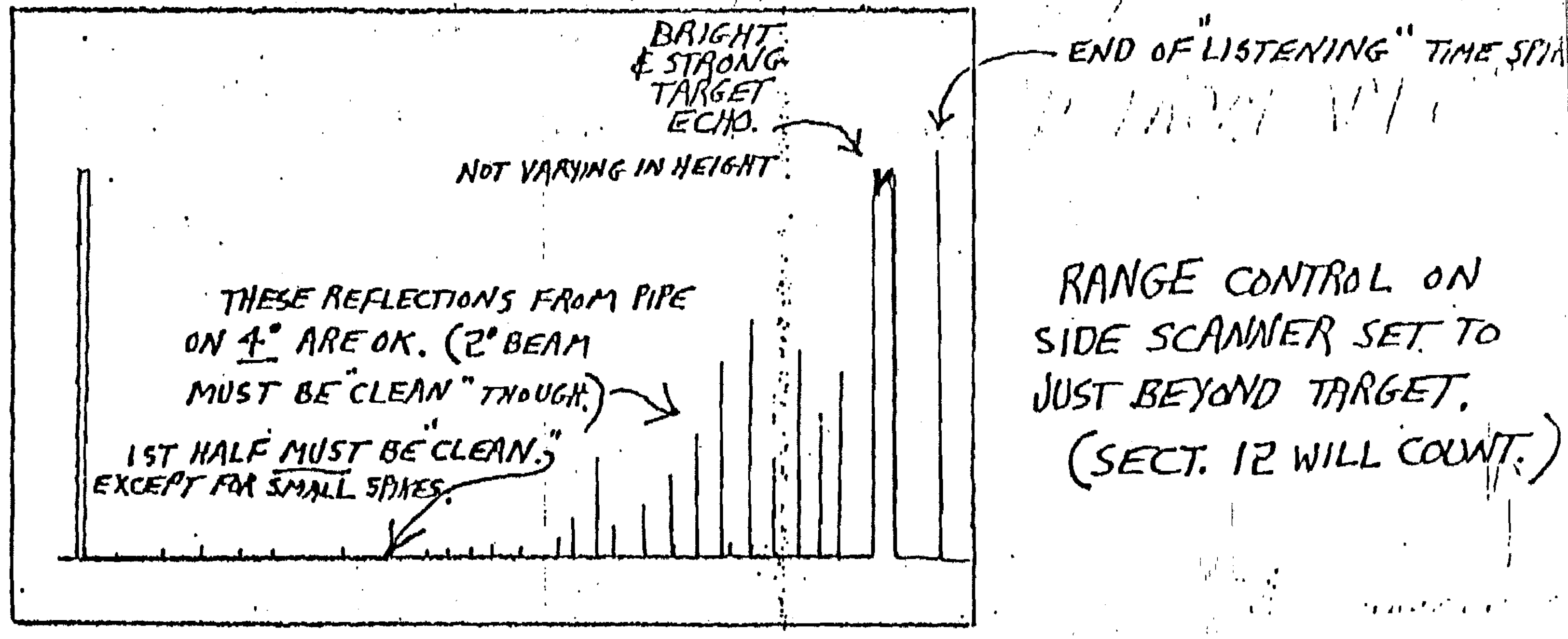


Figure III-4.

PROPERLY AIMED TRANSDUCER WHEN BEAMWIDTH SWITCH IS SET TO ALTERNATE & SCOPE IS TRIGGERRED FROM XM 4°. NOTE 4° BEAM IS SKIMMING SURFACE OF SUBSTRATE BEYOND THE 50% POINT ON SUBSTRATE THUS CAUSING REFLECTIONS FROM IMPERFECTION ON SUBSTRATE SURFACE. THIS IS OK, SINCE THE 4° BEAM WILL NOT COUNT ANY ECHOS BEYOND THE 50% POINT.

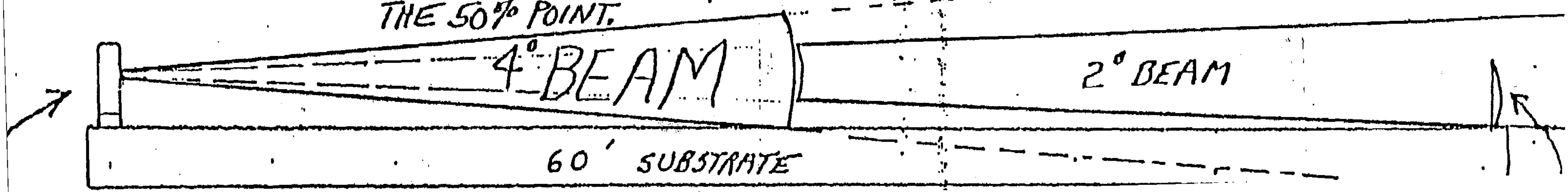
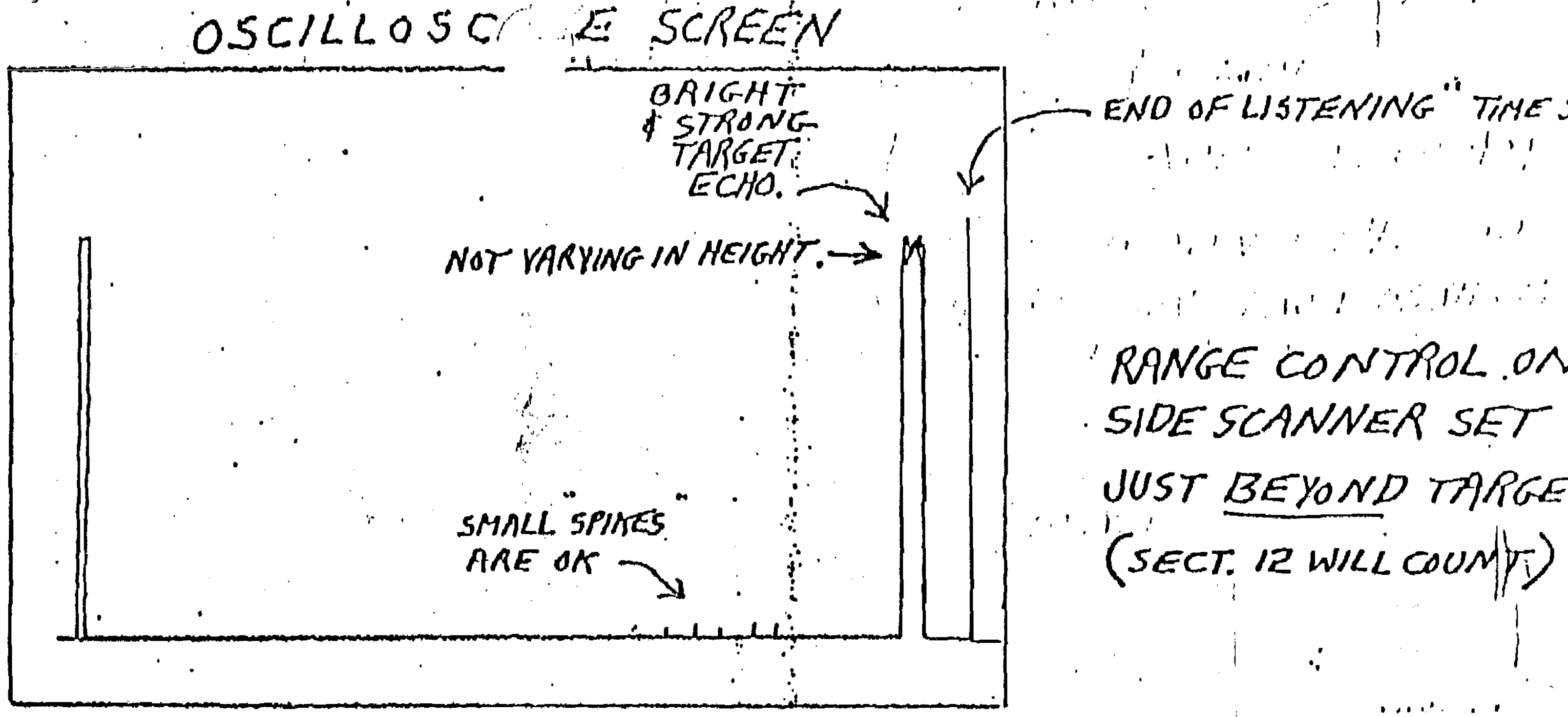


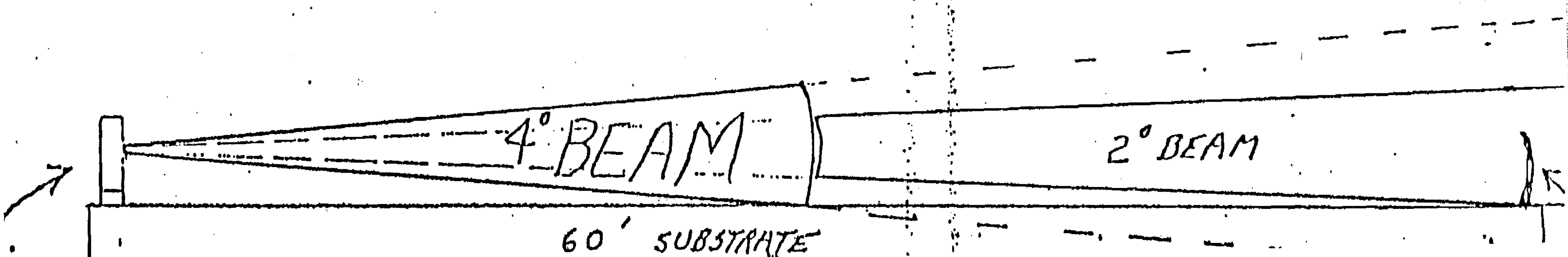
Fig ?



RANGE CONTROL ON SIDE SCANNER SET JUST BEYOND TARGE (SECT. 12 WILL COUNT)

Figure II-5.

PROPERLY AIMED TRANSDUCER WHEN BEAMWIDTH SWITCH IS SET TO ALTERNATE BUT SCOPE TRIGGERRED FROM XM 2°



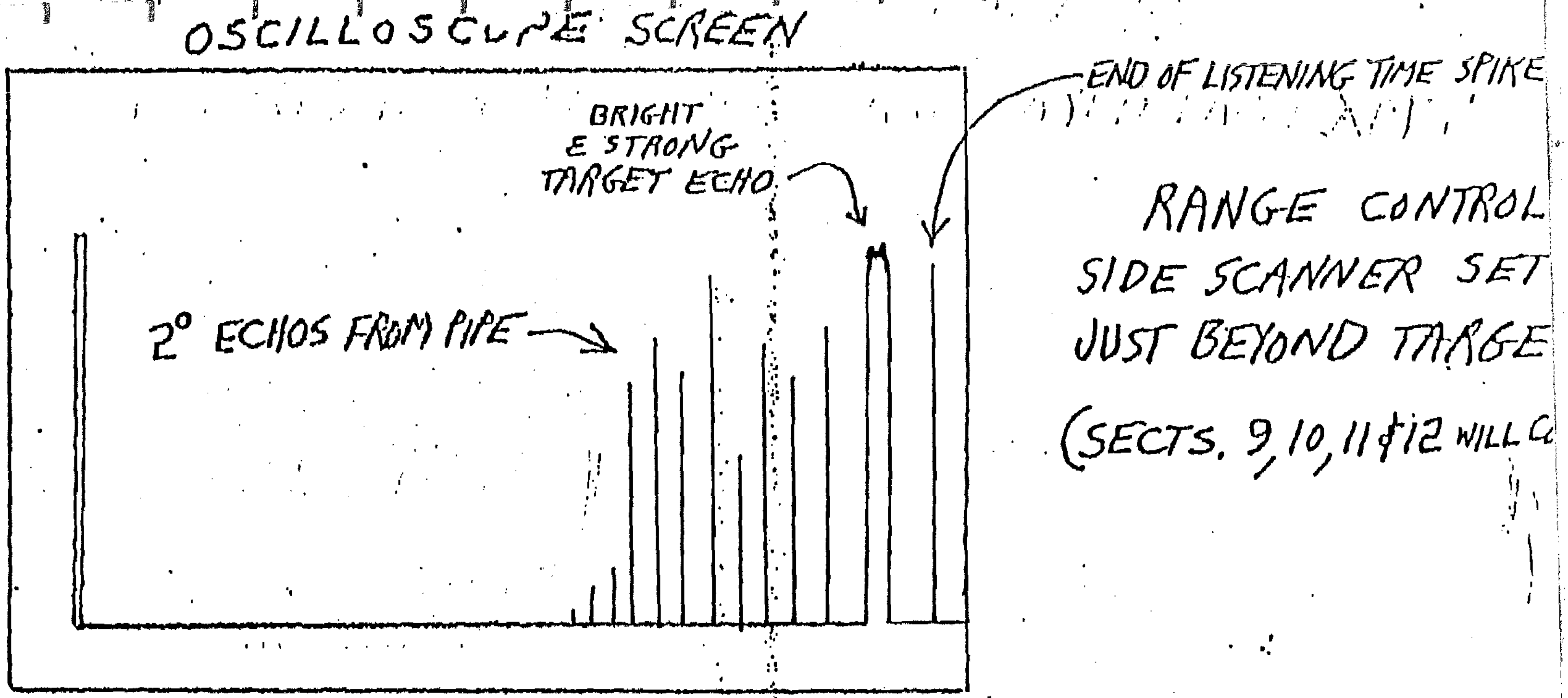
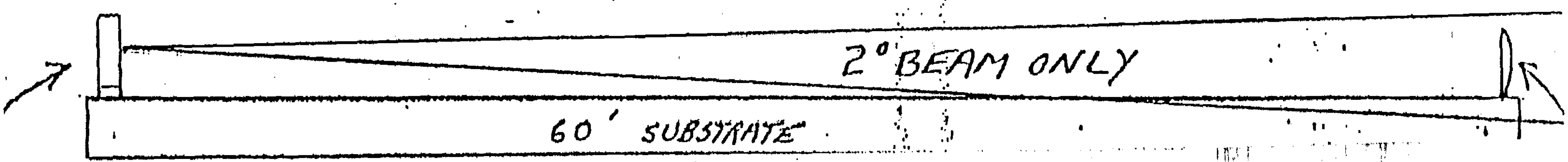


Figure II-6. IMPROPERLY AIMED TRANSDUCER WHEN BEAMWIDTH SWITCH IS SET TO 2° & SCOPE IS TRIGGERRED FROM XM 2°. NOTE THAT BEAM IS AIMED TOO LOW, CAUSING ECHOS TO BE RETURNED FROM LAST 1/3 OF SUBSTRATE IMPERFECTIONS EVEN THOUGH TARGET ECHO IS STRONG & DOESN'T VARY IN HEIGHT.



FIG,

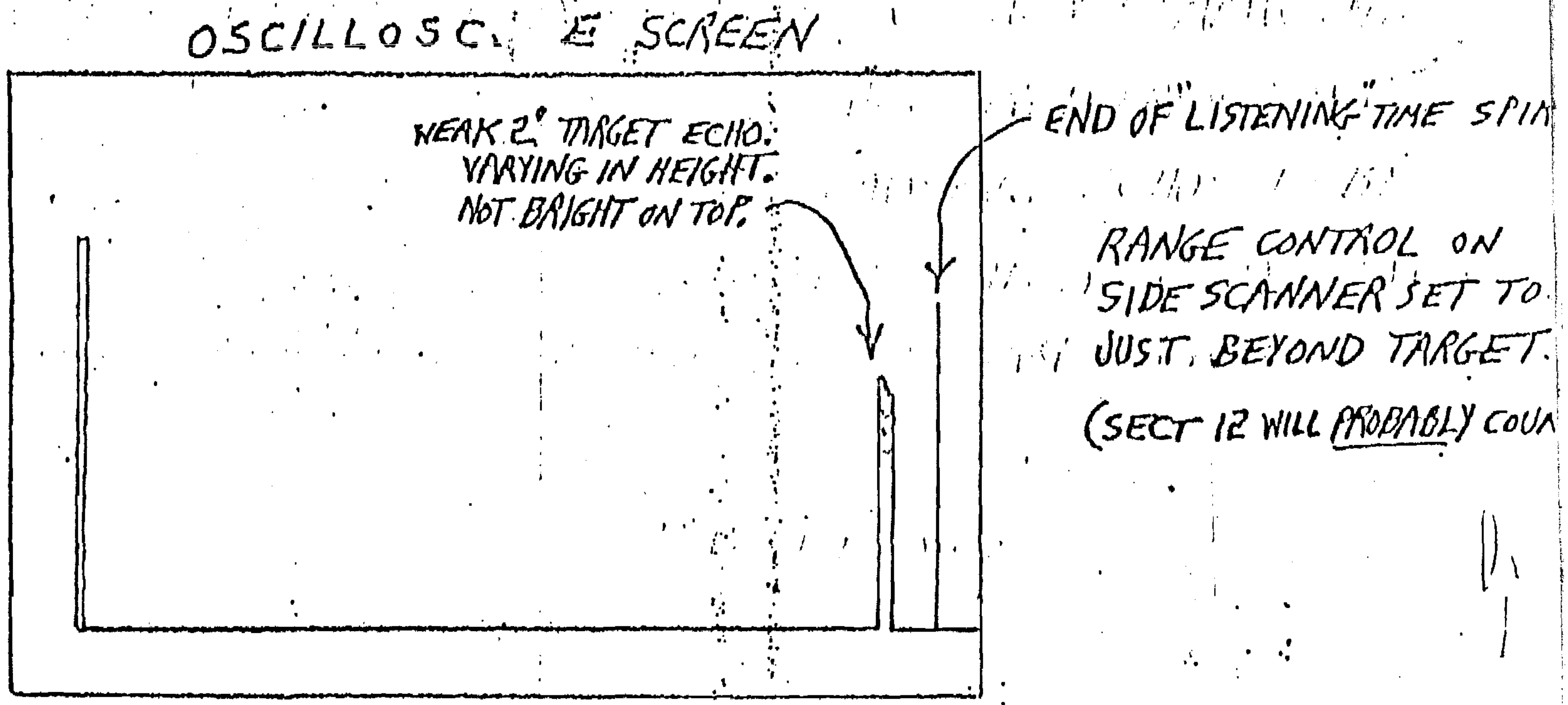


Figure II-7.

IMPROPERLY AIMED TRANSDUCER. BEAMWIDTH SWITCH IS SET TO AL & SCOPE IS TRIGGERRED FROM XM 2°. NOTE THAT BEAM IS AIMED TOO HIGH, JUST BARELY CATCHING TARGET IN 2° BEAM ALTHOUGH 4° BEAM DOES HIT TARGET. (SEE FIG. 6.) LOW PASSING FISH MAY BE MISSED.

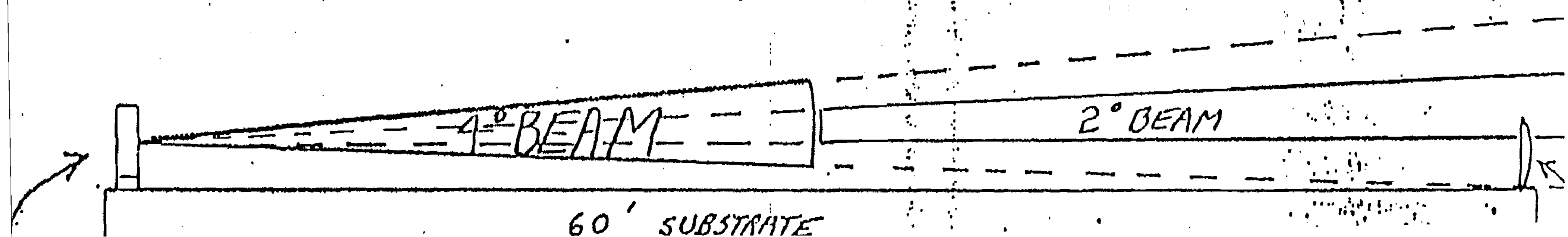
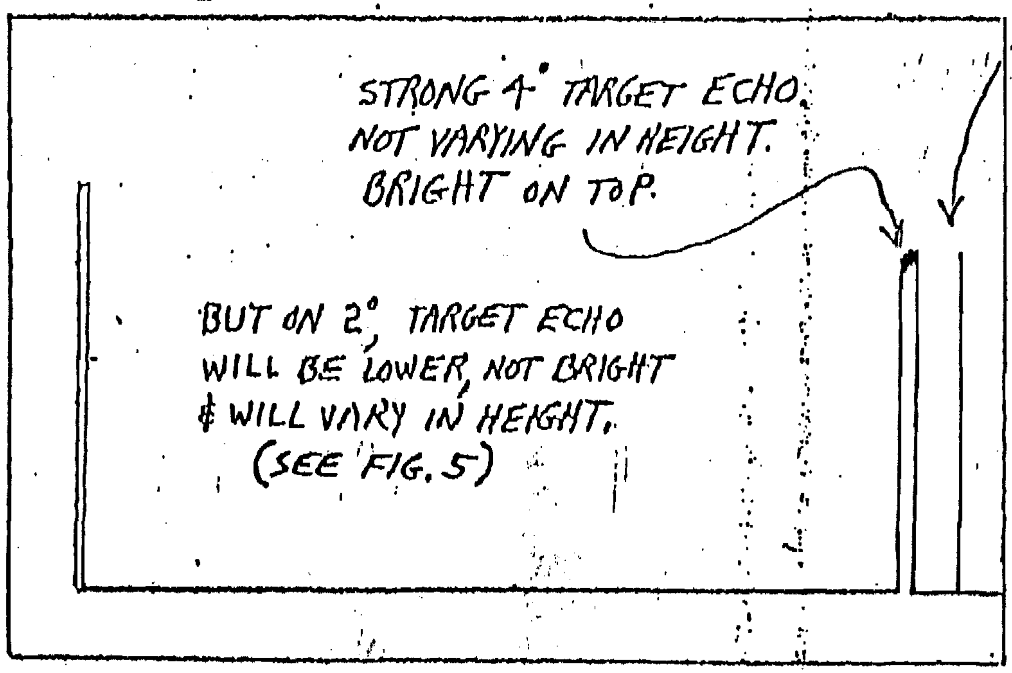


FIG. 6

OSCILLOSCOPE SCREEN

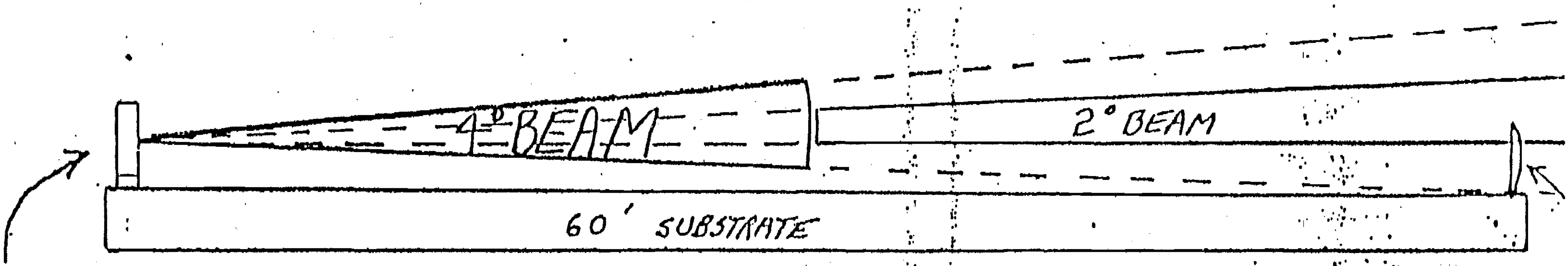


END OF LISTE — TIME SPIKE

RANGE CONTROL SET TO JUST BEYOND TARGE[T]

(SECT 12 WILL COUNT WHEN BEAMWIDTH SWITCH IS IN 4° POSITION. SECT 12 MAY COUNT WITH SWITCH IN 2° OR ALT. POSITION.)

Figure II-8. IMPROPERLY AIMED TRANSDUCER. BEAMWIDTH SWITCH IS SET TO ALT. (OR 4°). SCOPE IS TRIGGERRED FROM XM 4°. NOTE THAT BEAM IS AIMED TOO HIGH, ALTHOUGH THE 4° BEAM SOLIDLY HITS THE TARGET, THE 2° BEAM JUST BAREL[Y] HITS TARGET (SEE FIG. 5 FOR 2° SCOPE WAVEFORM). FISH MAY BE MISSED.



FIG

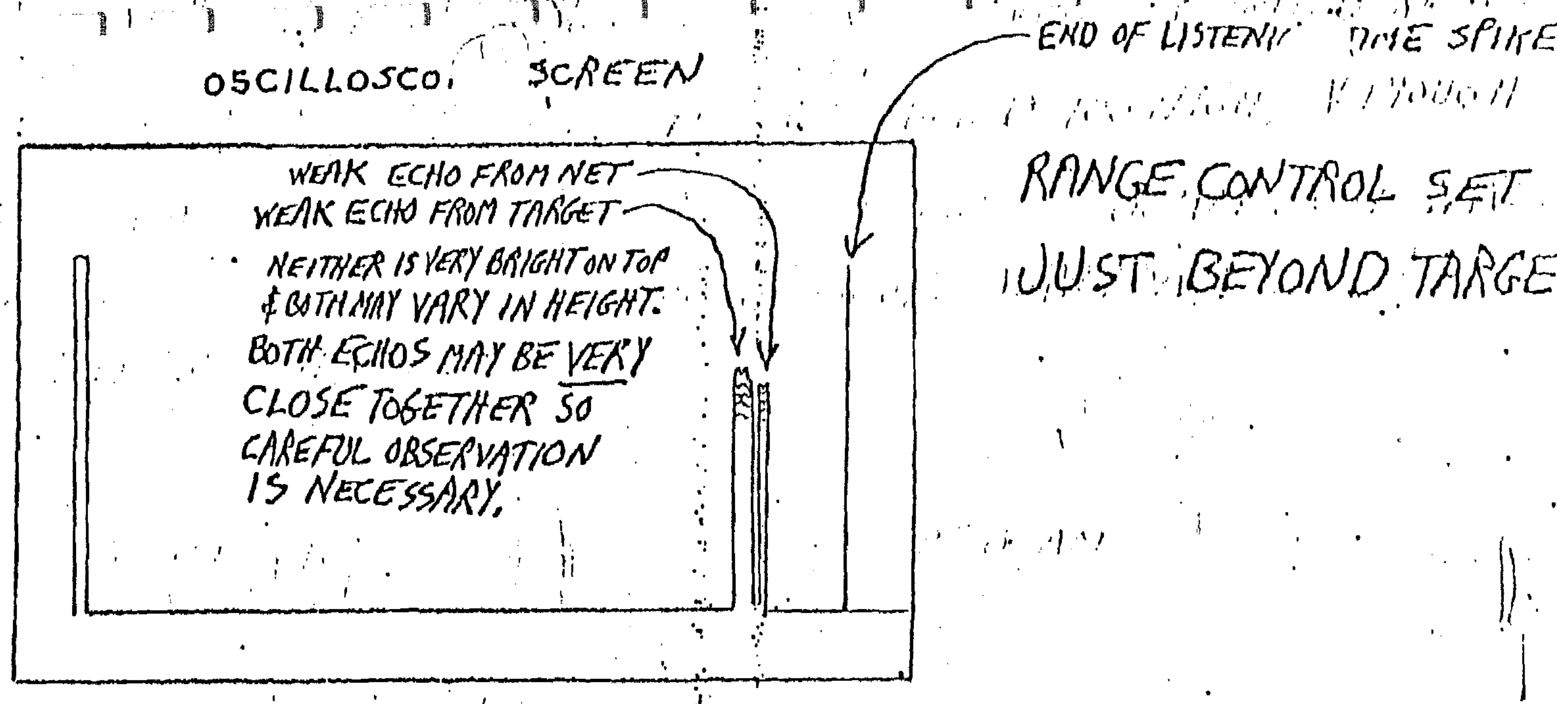
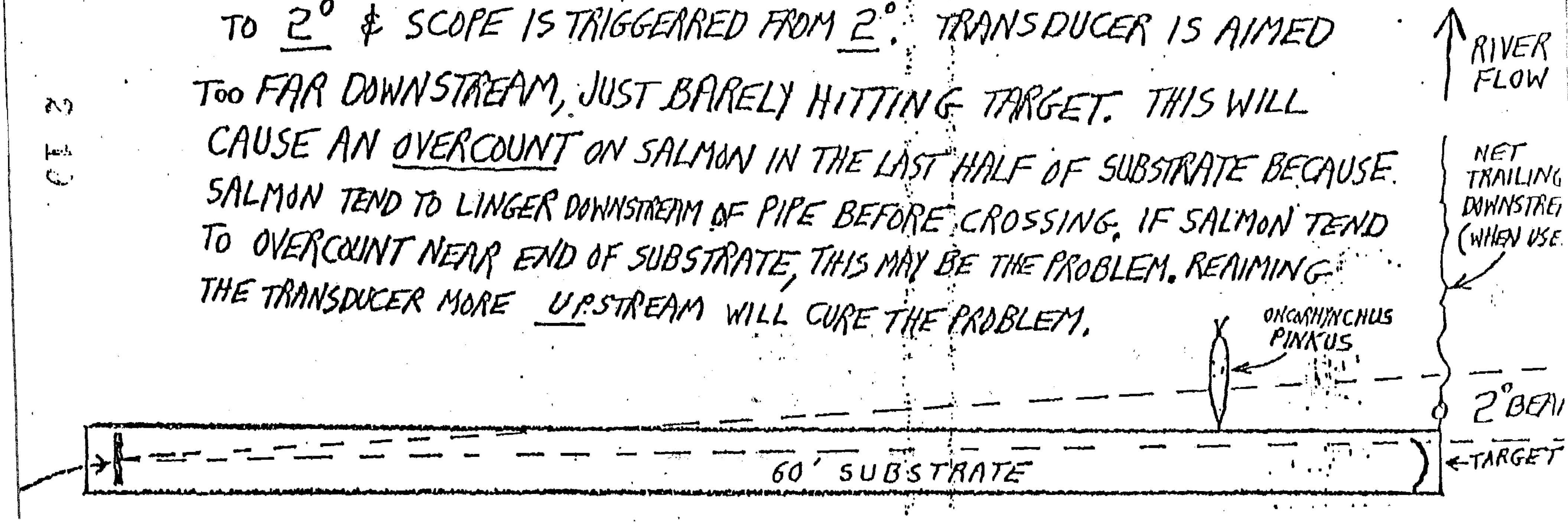
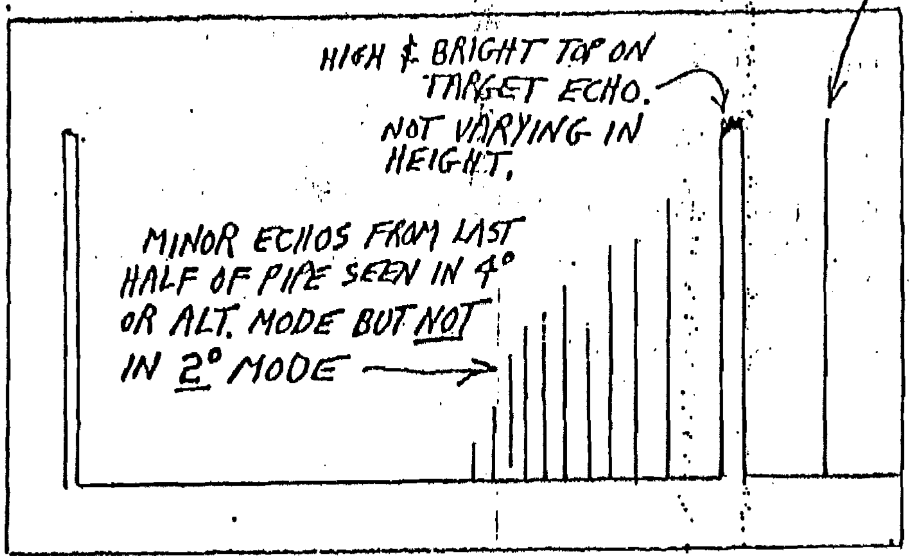


Figure II-9. IMPROPERLY AIMED TRANSDUCER. BEAMWIDTH SWITCH IS SET TO 2° & SCOPE IS TRIGGERRED FROM 2°. TRANSDUCER IS AIMED TOO FAR DOWNSTREAM, JUST BARELY HITTING TARGET. THIS WILL CAUSE AN OVERCOUNT ON SALMON IN THE LAST HALF OF SUBSTRATE BECAUSE SALMON TEND TO LINGER DOWNSTREAM OF PIPE BEFORE CROSSING. IF SALMON TEND TO OVERCOUNT NEAR END OF SUBSTRATE, THIS MAY BE THE PROBLEM. REAIMING THE TRANSDUCER MORE UPSTREAM WILL CURE THE PROBLEM.



FIG

OSCILLOSCOP SCREEN



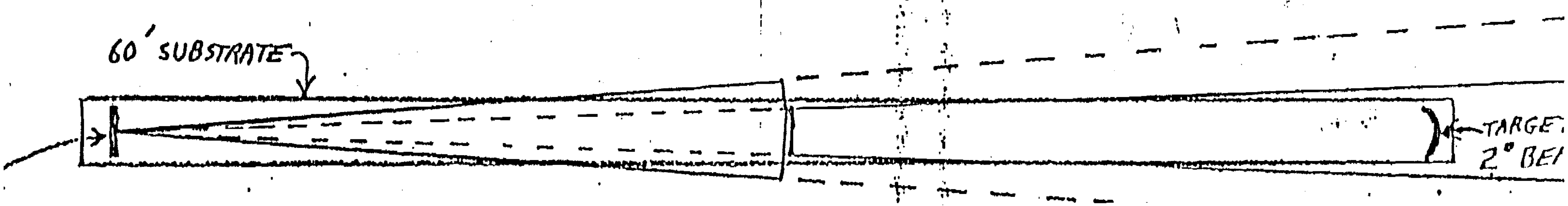
OF LISTENING

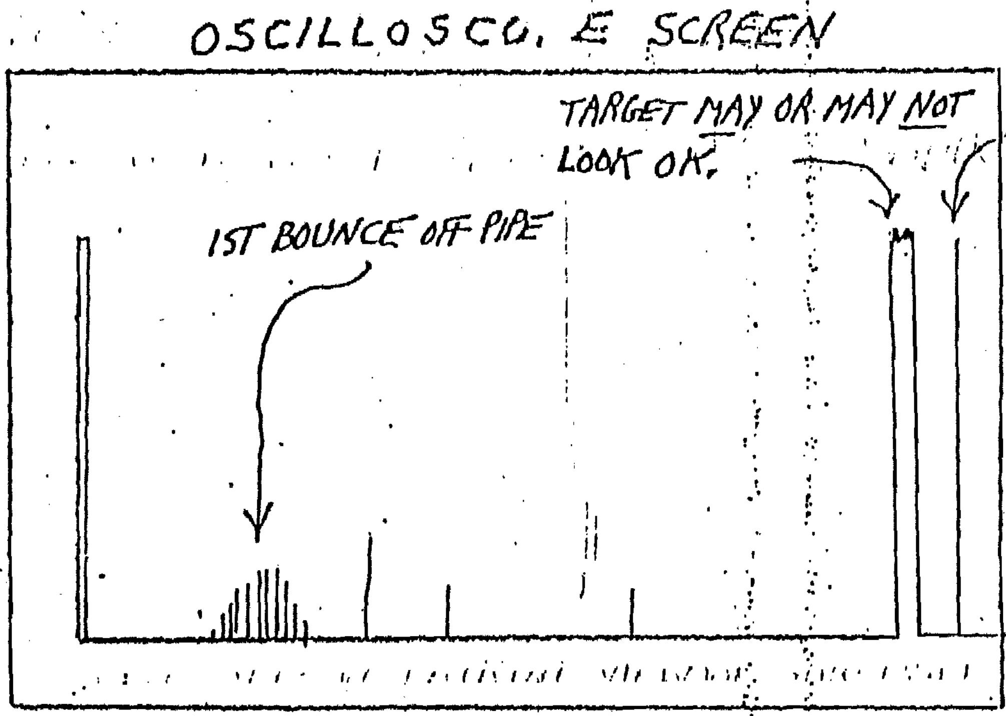
RANGE CONTROL SET
JUST BEYOND TARGE
(SECT. 12' ONLY WILL COUNT.)

Figure II-10. PROPERLY AIMED TRANSDUCER.

TRANSDUCER BEAMWIDTH SWITCH IS SET TO ALT.
SCOPE IS TRIGGERRED FROM XM 4°

(ASSUMING VERTICAL AIMING OF TRANSDUCER IS CORRECT.)



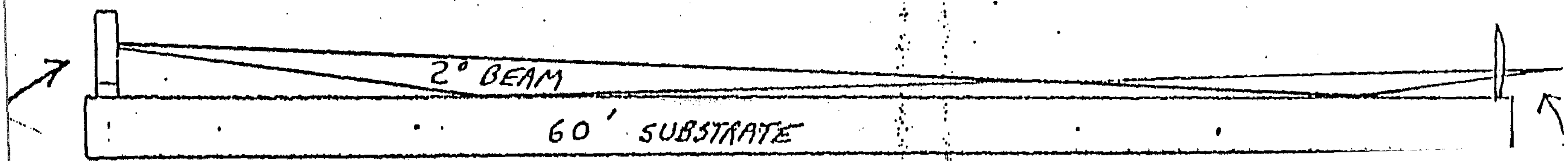


RANGE CONTROL SE
TO JUST BEYOND TARG

(VARIOUS SECTS, MAY COUNT,

Figure II-11. IMPROPER TRANSDUCER AIMING.

BEAMWIDTH SWITCH SET TO 2° & SCOPE TRIGGER TO XM 2°. TRANSDUCER IS AIMED MUCH TOO LOW & BEAM IS BOUNCING OFF PIPE NEAR TRANSDUCER, THEN HITS TARGET & RETURNS BY SAME PATH.



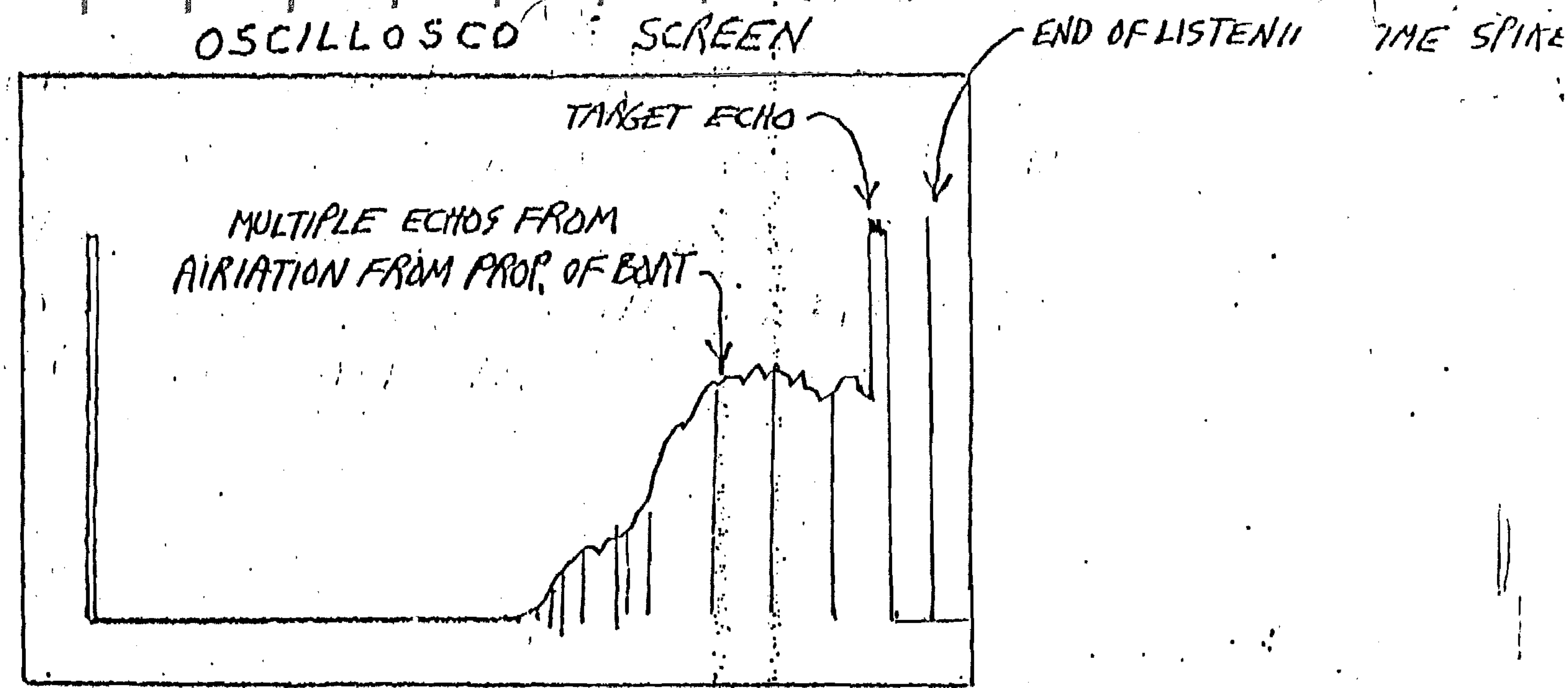
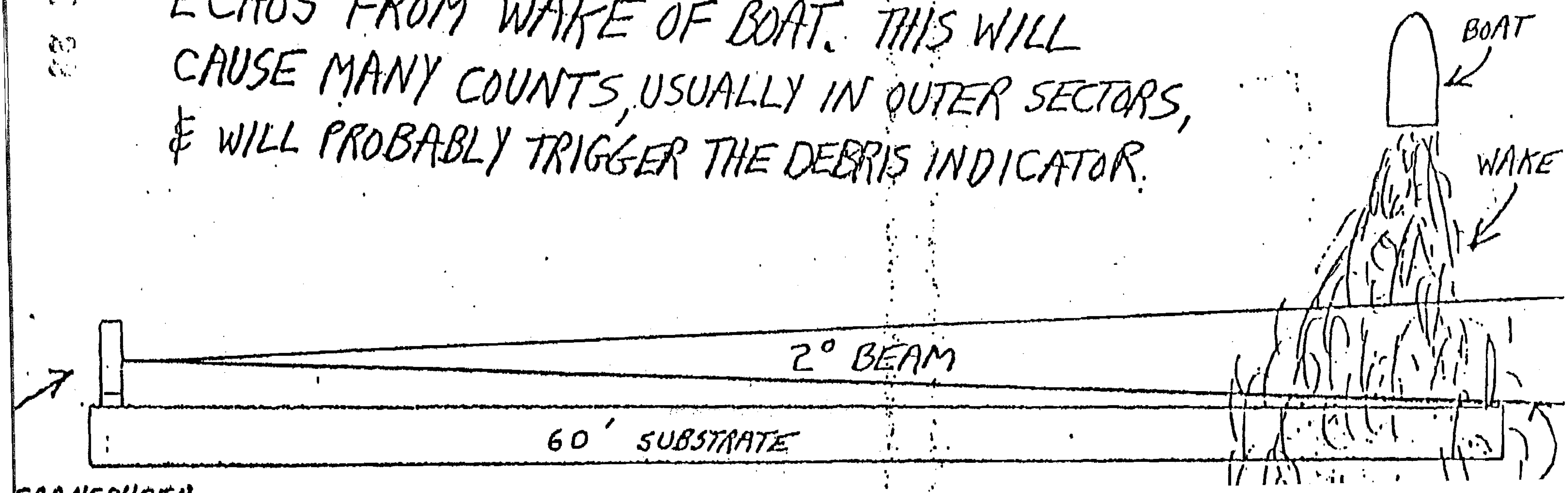
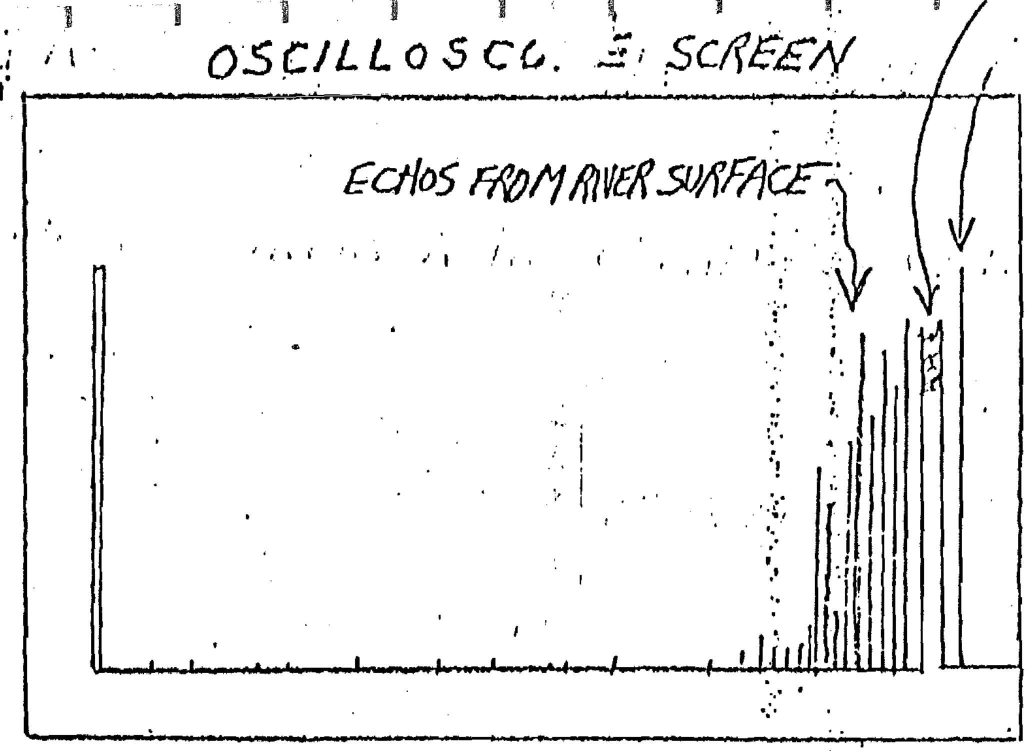


Figure II-12.

PROPERLY AIMED TRANSDUCER BUT MULTIPLE ECHOS FROM WAKE OF BOAT. THIS WILL CAUSE MANY COUNTS, USUALLY IN OUTER SECTORS, & WILL PROBABLY TRIGGER THE DEBRIS INDICATOR.



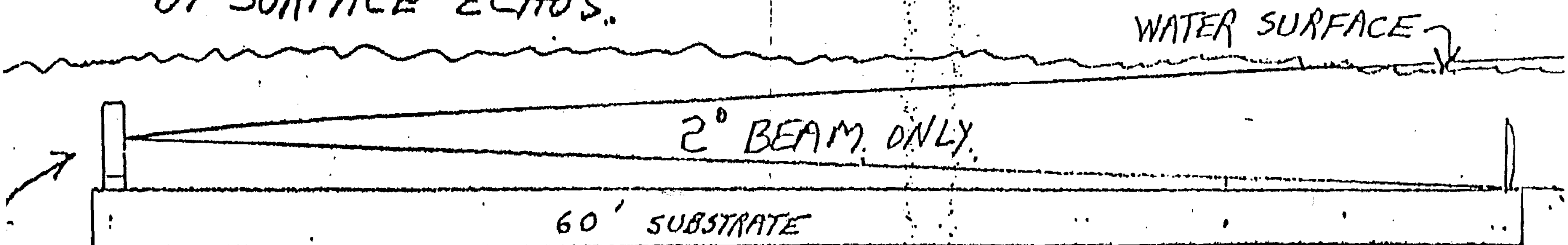


RANGE CONTROL SET JUST BEYOND TARGET.

(WILL PROBABLY COUNT ON SECTS 10, 11 & 12.)

Figure II-13.

IMPROPERLY AIMED TRANSDUCER. BEAMWIDTH SWITCH SET TO 2 AND SCOPE TRIGGERRED FROM 2°. NOTE WATER IS TOO SHALLOW EVEN FOR 2° BEAM WHICH IS "BOXED IN". COUNTING RANGE ON SIDE SCANNER WOULD HAVE TO BE REDUCED TO ABOUT 50' TO PREVENT SURFACE ECHOS FROM COUNTING. TARGET WILL BE OBSCURED BY SURFACE ECHOS.



APPENDIX III

A. ADULT ANADROMOUS FISHERIES STUDIES

Fishwheel Operation

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APPENDIX III

A. ADULT ANADROMOUS FISHERIES STUDIES

Fishwheel Operation

Design

A schematic of the type of fishwheel to be deployed on the Su/Hydro program is shown in Figure III-1. The axle is adjustable to accomodate water depths ranging from seven (7) to four (4) feet: the axle turns on nylon pillow blocks. The pillow blocks are designed to allow friction adjustments therein providing a breaking mechanism. Native spruce poles form the baskets and paddles. Basket web or netting is rubber coated fencing material. Floatation is provided by styrofoam logs shielded by plywood. The wheel is equipped with a plywood livebox which is collared between the two (2) offshore floatation logs. A fish sampling platform spans the two (2) outside floats on the downstream side of the livebox. The fishwheel is anchored by a cable or rope bridle anchored to a deadman upstream of the fishwheel. The wheel is kept offshore by a boom log arrangement as shown in Figure III-2.

Lead Weir

The purpose of positioning the livebox on the offshore side of the fishwheel is to allow placement of a weir on the inshore side between the bank and the near shore float. A sketch of the weir is presented in Figure III-3. The weir is comprised of several willow or alder pannels contoured to the stream bed. The pannels are held in place by the downstream boom log and on the bottom, by the stream bed. The latter is accomplished by sliding the weir pannels into the water at an upstream angle to the riverbed. The weir is a critical component of the fishwheel. An improperly installed or incomplete weir will allow bank migrant fish to pass inshore of the wheel thus reducing catch.

Debris Deflection

At a few fishwheel sites it will be necessary to install a debris lead. A deflector which is reasonably efficient in channeling debris past a fishwheel is illustrated in Figure III-4.

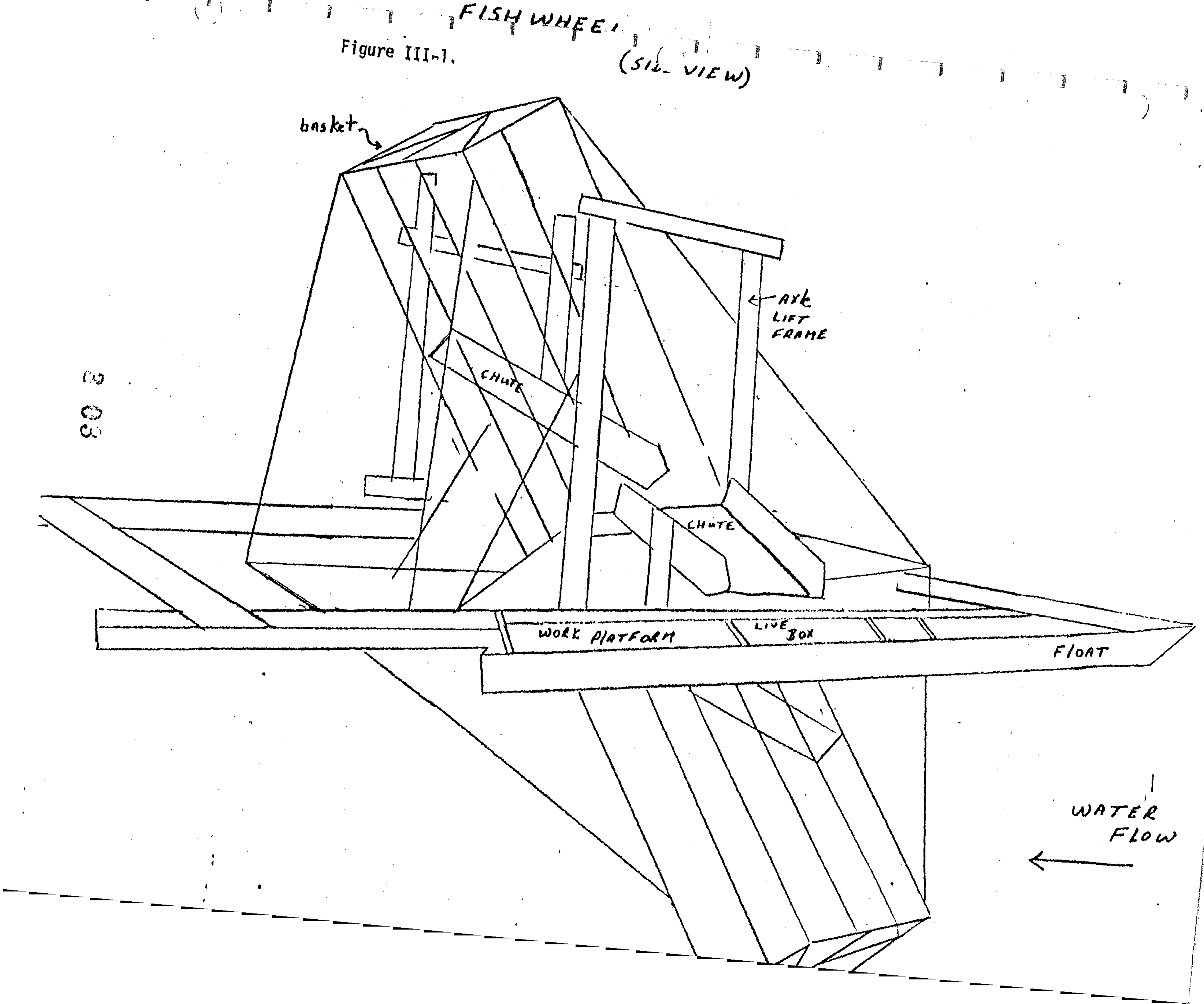
Operation

The fishwheels are designed to operate at 2.5 revolutions per minute (rpm). Under no circumstances should a fishwheel be operated at a speed greater than 3.5 rpm. The preferred speed is 2.5 rpm with a range between 2.0 and 3.0 rpm. For maximum catch efficiency, fishwheel baskets should be adjusted to scoop within six (6) inches of the bottom. Anything more than six (6) inches will reduce catch efficiency.

Maintenance

Lead weirs should be inspected to insure they are functioning once every (3) days. Debris cleaning should be performed as often as necessary but at least once every day. Inspection must be made twice daily for wear, broken components and loose riggings. Appropriate repairs are to be effected at first indication of a problem. Fishwheel basket depth should be monitored twice daily and appropriately adjusted.

Figure III-1.


FISH WHEEL
(SIDE VIEW)
basket
axle
LIFT
FRAME
CHUTE
CHUTE
WORK PLATFORM
LIVE BOX
FLOAT
WATER
FLOW

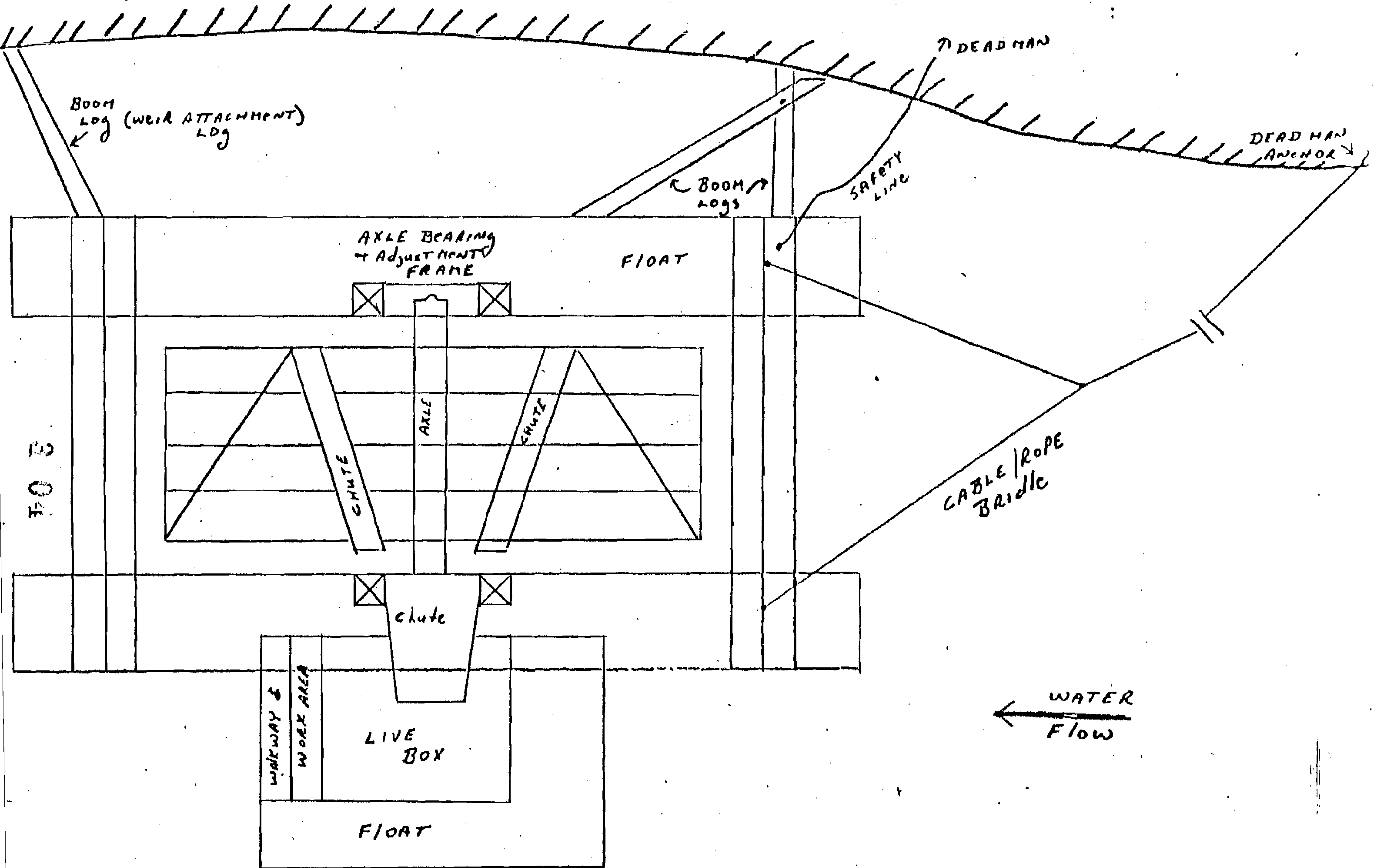
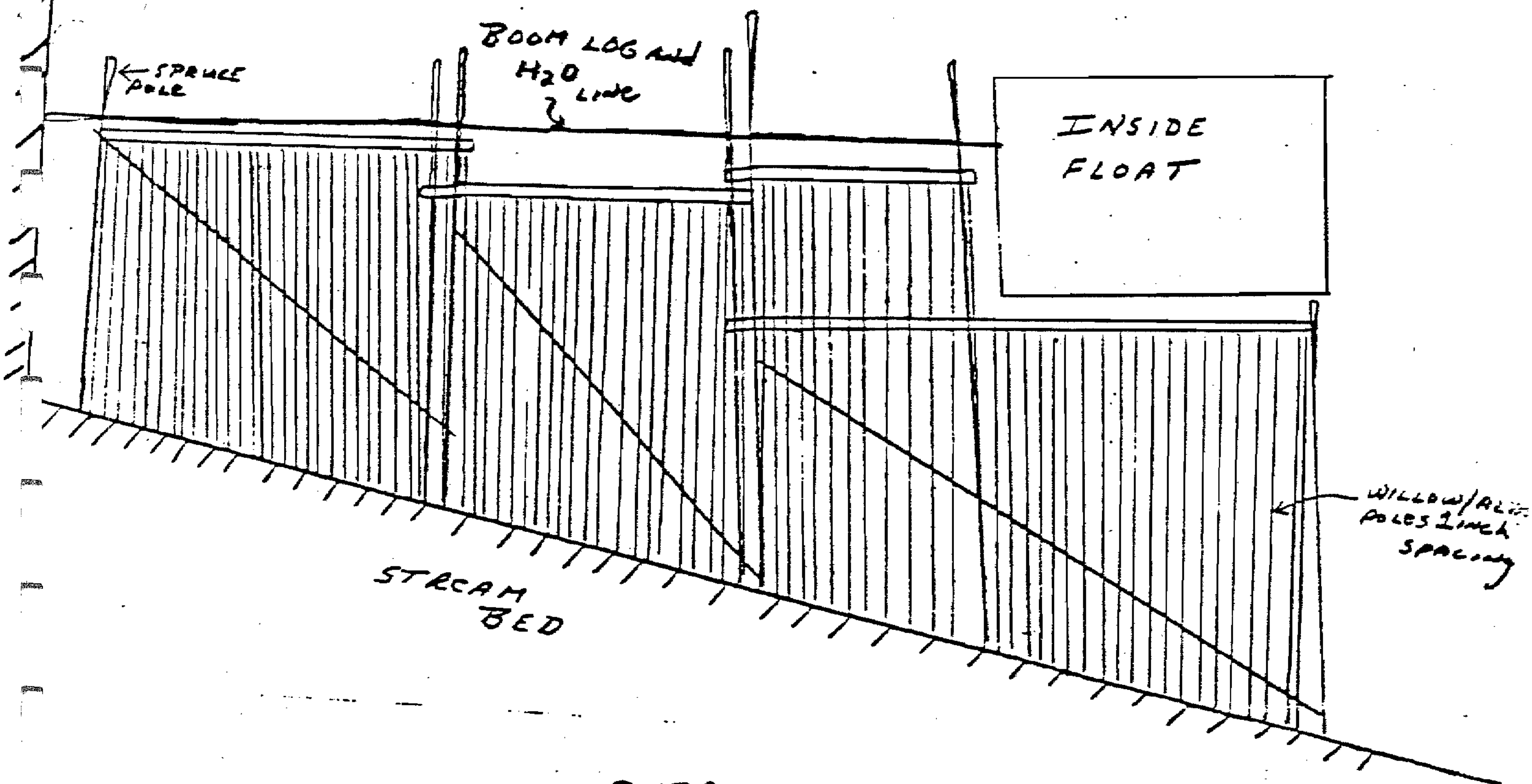


Figure III-2. FISHWHEEL (TOP VIEW)

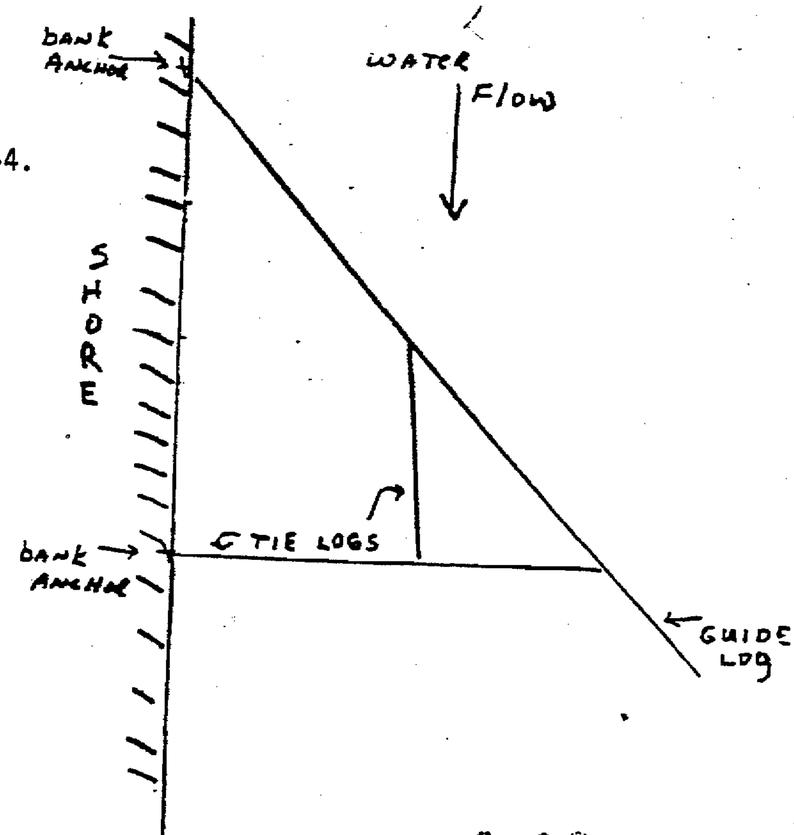
FISHWHEEL LEAD WEIR
(UPSTREAM VIEW)

Figure III-3.



DEBRIS
DEFLECTOR
(TOP VIEW)

Figure III-4.



APPENDIX IV

A. ADULT ANADROMOUS FISHERIES STUDIES

Fish Tagging

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DISK-DANGLER TYPE TAG... 000 07

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APPENDIX IV

A. ADULT ANADROMOUS FISHERIES STUDIES

Fish Tagging (ADF&G, 1976)

Development of Marking of Fish

A mark can be defined as a brand, label, seal or tag which identifies an object to show the maker or owner. Early tagging of fish was begun by land owners along streams who were interested in conserving salmon and trout runs. Charles Atking tagged Atlantic salmon in 1873 in Maine's Penobscot River and several recoveries were noted in following years. T.W. Fulton of Scotland (1893) and C.G.J. Petersen of Denmark (1894) both used numbered buttons or disks on plaice (flatfish) and other fish species in the Atlantic Ocean. The Petersen disk has been one of the most successful types of tags and most widely used over the years.

Exact figures on the rate of development of tagging are hard to accumulate, but there are estimates that by 1910 about 100,000 fish had been marked with tags. By 1936, the total was around 600,000 marked fish. Presently many millions of fish (also molluscs, crustacea and sea mammals) are being tagged every year for the purpose of studying population dynamics and migrations.

Ideal Fish Marks

Information on what constitutes an ideal fish mark, the types of marks, purposes of tagging and methods of tagging and recovery are spread through the fisheries literature.

Arnold (1966) suggested the following criteria for an ideal fish mark.

1. It should be retained essentially unaltered for life of fish regardless of the age at which applied.

2. It should have absolutely no effect of fish's behavior, reproductions, life-span, growth, feeding, movement, vulnerability to predation, angling or other external factors.

3. It should not tangle in vegetation or nets of any kind.

4. It should be inexpensive and easily manufactured.

5. It should be usable on any size fish without significant alteration.

6. It should not be found in nature nor should it be possible to confuse it with any other mark, natural or artificial.

7. It should be easily applied to fish in the field without the need for an anesthetic.

8. It should be easily detected in the field by untrained personnel or the public.

9. If the marked fish is preserved as a scientific specimen, or for later examination, the mark should not be affected by the preservation.

10. There should be enough possible variations of the mark so that many individuals or many small groups can be identified separately.

11. The marking substance should not present any health or safety hazard to the biologist, fish, or the public.

12. The mark should not cause adverse public relations by spoiling edible parts of the fish.

Obviously, no one mark satisfies all the above listed requirements and it generally only satisfies a few of them. One of the critical problems of a research project is to decide on the best mark for the particular circumstances.

Both Floy and Peterson disc tags have been utilized in the Susitna River drainage in the past and will be used to tag fish at the Sunshine, Talkeetna and Curry tag recapture sites.

Peterson Disc Tags

One (1) inch diameter, sequentially numbered Peterson disc tags will be utilized at the Curry site. The color code will be international orange.

Tagging procedures will be reviewed in the field as it is difficult to explain without having tags and a fish in hand. Generally, the following steps are followed:

1. Hold prepared tag (pin, disc, and numbered tag) with pliers and insert through the cartilage immediately under the dorsal fin.

2. Place a blank tag on the pin and cut off all but 3/8 inch of the pin with a cutting pliers.

3. Twist remaining pin in an inward and rolling motion so that the pin lies flat against the disc and forms a loop.

Here are a couple suggestions that will help:

1. Use a sharpening stone to make a sharp point on the tagging pins. This can be done ahead of time and will make penetration easier.

2. Prepare tags prior to making fishwheel checks. Assemble tags in sequential order and stick them in a piece of styrofoam: pin, clear buffer disc, tag.

Floy Tags

Sequentially numbered FT-4 Floy tags will be utilized at the Sunshine and Talkeetna sites. Color code for the Sunshine site will be international orange and yellow for the Talkeetna Site.

Tagging procedures will be demonstrated in the field; generally the following steps are followed:

1. Slide tag over barbed end of tagging needle. Run the needle completely through the fish in the anterior cartilage immediately below the dorsal fin.

2. Disconnect tube from the needle and tie-off with overhand knot.

Several suggestions are:

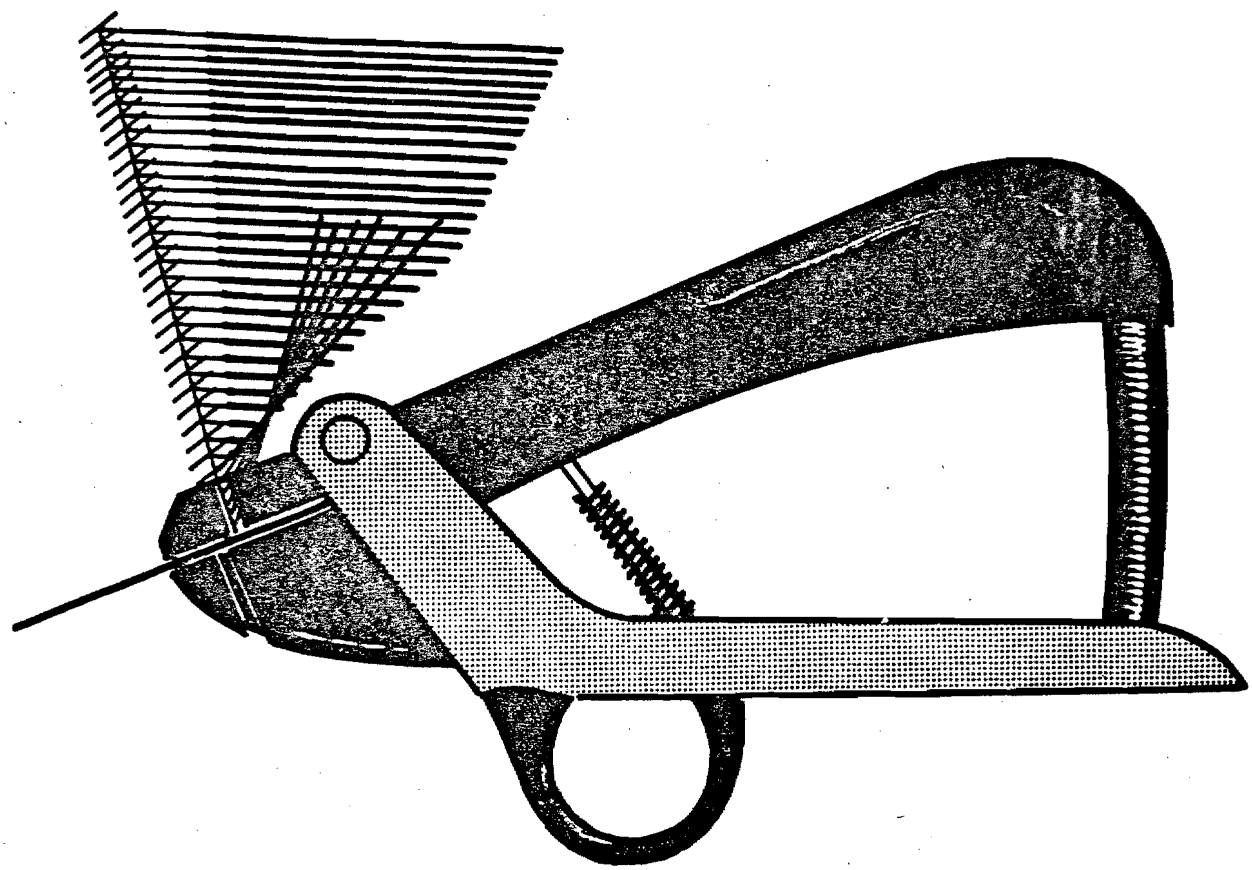
1. Keep two (2) or three (3) tagging needles available in the event of a loss.

2. Use a sharpening stone to maintain a sharp point on the tagging needle. This can be done ahead of time, making tagging easier.

3. Prepare tags prior to making fishwheel checks. Assemble tags in sequential order on a board and tape them in place, thus allowing them to be withdrawn easily.

B. RESIDENT AND ANADROMOUS FISHERIES STUDIES

Figure IV-1. FDM-68 TAGGING GUNS AND ANCHOR TAGS



(actual size)

MODIFIED GUN INSERTS TAG UP TO 1-1/8 INCH

THE FDM-68 MODIFIED GUN HAS PROVED TO BE VERY EFFICIENT IN TAGGING VERY SMALL FISH AS WELL AS LARGE FISH. THE LONGER NEEDLE MAKES IT POSSIBLE TO INSERT A TAG INTO A SMALL BODIED FISH AT THE DESIRED ANGLE. THIS ALLOWS THE TUBING BEARING LEGEND AND NUMBER TO "FLOW" ALONGSIDE THE FISH"S BODY AS IT SWIMS. THIS PLACEMENT OF THE TAG IS NOT AS POSSIBLE WITH A SHORT GUN. THE REGULAR NEEDLE IS .085 OD. THE HEAVY DUTY NEEDLE (RECOMMENDED FOR FISH 10 POUNDS AND UP) IS .096 OD. THE LIGHT NEEDLE IS .073 OD.

FDM-68 Tagging Guns and Anchor Tags

Operating Instructions

Loading Gun

1. Place gun in left hand with forefinger through the trigger ring.
2. Hold tag clip between the thumb and index finger of the right hand with the extension of the "runner" (the bar holding the tags) toward the gun.
3. Insert the runner into the feed slot of the gun. Press the runer down until the first tag engages the feed mechanism.

Suggested Tagging Procedure

1. A clip of blank tags is provided for practice tagging.
2. Make certain the fish is held FIRMLY or anesthetized when being tagged. A squirming fish may bend the needle.
3. Insert needle on the left side of the fish forcing it forward through the dorsal rays and toward the anterior of the dorsal. This placement will lock the "T-bar" firmly behind the interneural rays.
4. Once the needle has been inserted, hold the gun FIRMLY against the fish's body while compressing the handle. Do not release the compressed handle until the needle has been withdrawn.

Unloading Gun

1. Pull the release lever (the black metal lever in front of the trigger
ring.) Withdraw clip.

If Gun Jams

1. DO NOT attempt to clear the jam by forcing the tags through the mechanism. This will cause damage.
2. Remove clip from gun.
3. Turn the plastic lock lever (right side near needle) 180 degrees so lever points forward and remove needle.
4. Remove jammed tag from from needle or gun. Inspect needle and ram.
5. The tag (if not damaged) can be re-used by inserting the T-bar into the needle two thirds back from the point of the needle. This can be accomplished only if the tag clip has been removed from the gun. BE CERTAIN TO LINE UP THE SLOT IN THE NEEDLE WITH THE SLOT IN THE GUN.

Care of Gun and Needle

1. Operate gun without tags in warm soapy water to remove dirt, slime and scales.
2. Rinse carefully in warm (not hot) water. Shake and wipe dry.
3. Store in warm area to remove moisture from inside gun.
4. Lubricate with "WD-40" which prevents rust, penetrates and displaces moisture.
5. WHEN TAGGING UNDER SALINE CONDITIONS, THE GUN SHOULD NOT BE EXPOSED TO AIR ANY LONGER THAN ABSOLUTELY NECESSARY. A PAN OF FRESH WATER SHOULD BE KEPT AT HAND TO "SLOSH" OFF THE GUN CONTINUALLY. IF TAGGING IS INTERRUPTED, THE GUN (INCLUDING TAGS) SHOULD BE KEPT IMMERSED IN FRESH WATER.

Disk-Dangler Type Tag

The disk-dangler type tag is attached to the body of the fish beneath the dorsal spine with two strands of wire. A small, viselike clamp holding two hypodermic needles of size number 18 is used to pass the wires through the fish's body. The needles are put in place and pushed through the body in one motion. The tag wires are then inserted into the hollow needles and the clamp pulled outward. Tags are attached with one wire anterior and one posterior to the origin of the dorsal fin. The needles are spaced so that their points are approximately one-half inch apart. A spacing strap may be placed between the wires to keep them from pulling together and tearing flesh when the wires are twisted together. If a single person is tagging, however, such a strap may be impossible to hold in place. If care is used in twisting the wires, excess injury to the fish may be avoided without the use of such a spacer. Excess wire is cut off the twisting end, and the exposed wire and tag are bent back.

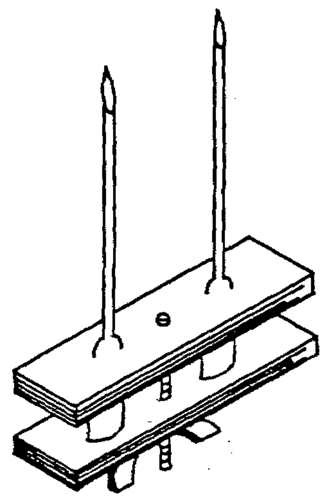


Figure IV-2. Tag clamp holding two hypodermic needles (from Pelgen, 1954)

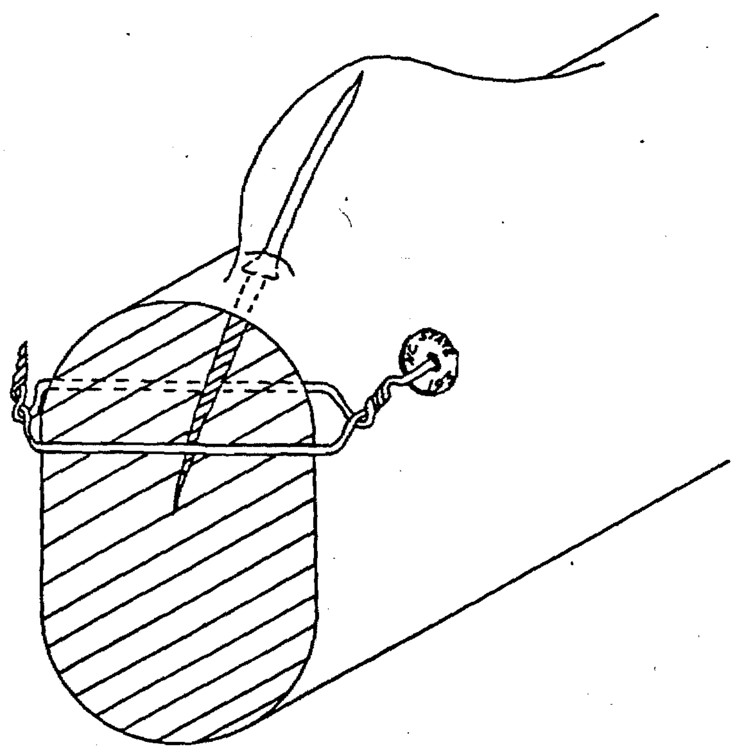


Figure IV-3. Disk-dangler tag in place (after Pelgen, 1954)

APPENDIX V

A. ADULT ANADROMOUS FISHERIES STUDIES

Electro-Shocking Boat Operations

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APPENDIX V

A. ADULT ANADROMOUS FISHERIES STUDIES

Electro-Shocking Boat Operations

Safety Precautions

These procedures must be adhered to for the safety of all operators of this equipment.

1. A minimum of two (2) persons is required to safely and efficiently operate the unit, provided the control box can be easily monitored by the boat operator. For two (2) man operations, the boat operator should be capable of adjusting voltage and amperage, activating the power switches on the control box, and shuting down the generator without having to leave his station as outboard operator.

   Should these conditions not be met, then a minimum crew would be three (3). One (1) person should monitor the control box at all times.

2. All personnel should be thoroughly familiar with the equipment and its operation. Personnel should be briefed as to emergency procedures should the situation arise.

3. All equipment, connections and wiring should be checked before each day's operation. Particular attention should be payed to the platform railing and safety foot switch. The railing should be strong and secure enough to support a man's weight. The safety switch must be free of rust and corrosion. It would be advisable to have the metal railing insulated with foam pipe insulation or plastic electrical tape. Wiring should be left exposed to facilitate inspection of the insulation.

4. Only dip nets with fully insulated handles will be used.

5. Personnel will wear only hip boots or chest waders that are completely leak proof. The platform surface should be of a non-skid type. Rubber gloves are advisable as an added safety measure.

6. All personnel will wear life jackets or other adequate floatation devices. Should anyone fall overboard, it is unlikely that he will have enough muscle control to swim.

7. Never start the generator until all connections for the particular mode of operation are complete. While traveling between points of operation, the electrodes should be disconnected from the electrical source if the generator is to be left running, i.e., for night operations.

8. Never change the position of the boom or handle the electrodes unless the leads are disconnected and all switches on the control box are in the "off" position.

9. When disconnections are made or lines left disconnected, all switches on the control box should remain in the "off" position to preclude any load on the wiring.

10. All personnel should be familiar with first aid treatment for shock victims and be trained in artificial respiration. At least one (1) member of the crew should have completed a recognized first aid course (hopefully he will not be the one injured).

11. The equipment shall not be operated in such a manner so as to endanger the public. The current shall be turned off anytime the public is in the immediate proximity of the aparatus, be it on shore, in the water, or in a boat.

In an emergency, the electrical current into the water may be broken in three ways:

1. By releasing the foot pedal switch which is located on the platform and controlled by the dip net operator.

2. By turning off all switches on the control box. One (1) man must be operating the control box at all times.

3. By actuating the grounding switch effectively killing the generator. If possible, switches should be located both on the dipping platform and near the motor operator and wired so that activation of either switch will kill the generator.

First Aid for Victims of Electrical Shock

Should anyone fall overboard or receive an electrical shock, the unit will be immediately shut off. Rescue the victim from the water or free him from the electrical circuit as quickly as possible. Act quickly, as any delay in removing the person from the electrical field or circuit will lessen the chance of resuscitating him. Do not endanger yourself attempting to rescue someone with the power on.

If the victim is not breathing, begin artificial respiration at once. Mouth-to-mouth resuscitation is recommended. Continue resuscitation until you are certain breathing is restored. Frequently, after a temporary recovery, a victim will stop breathing again. If natural breathing stops, resume artificial respiration at once.

Physical shock is a serious complication that is likely to occur after electrical shock. Shock can interfere with the normal action of the heart, respiration and circulation, so every precaution should be taken to prevent this condition from further weakening the victim. The victim should be lying flat and it is most important that he be kept as warm as possible, even during artificial respiration.

The following procedure is recommended in cases where it appears the victim's heart has stopped:

1. Place the victim on his back.
2. Position yourself on your knees beside his chest.
3. Find the lower end of his breast bone.
4. Place the heel of your hand one inch above that end.
5. Place your other hand on top of the first hand.
6. Press down firmly with about sixty (60) pounds of weight.
7. Repeat every second until heart starts.
8. If necessary, apply mouth-to-mouth resuscitation as follows: one (1) operator - 15 compressions, two breaths or two (2) operators - one breath every fifth compression.

The above procedure would be life sustaining should the victim go into ventricular fibrillation.

Admittedly, the above first aid procedures are brief, but due to lack of more competent means to deal with electrical accidents, this should serve as a guide for emergency treatment until the patient can be taken to medical facilities.

NOTE: A COPY OF THIS PROCEDURE MUST BE ONBOARD THE SHOCKING BOAT AT ALL TIMES!!!!

B. RESIDENT AND JUVENILE ANADROMOUS FISHERIES STUDIES

Model XV-BPG Self-Contained Gas Powered Electrofisher
(Backpack Mounted)

Since the introduction of the lightweight, quiet and reliable TAS-300 alternator, Smith-Root, Inc. now offers the type XV-BPG, a gasoline powered backpack electrofisher. Designed for very low to medium conductivity waters, the Type SV-BPG delivers a high 1100 volt peak DC for the very low conductivity waters and as much as 2.5 amps for the higher conductivity waters.

Both the electrofisher and alternator are mounted on a comfortable, reinforced plastic pack frame. The new pack frame not only outlasts aluminum packs, it provides an extra margin of safety from electric shock providing an insulation between the operator and the electrical apparatus. The pack frame harness has been designed to provide instant release should it become necessary to quickly drop away the complete pack frame from the operator.

SPECIFICATIONS:

Power Source	TAS Model QEG-300 Watt gas-powered generator
Recommended Conductivity Range	Approximately 10 to 200 micromhos/cm2 max. Useable to 400 micromhos
Input Power	300 watts, 450 watts intermittent (all voltage ranges)
Output Modes:	
AC	130-390 VRMS in 130 volt steps
Pulsed DC	180-550 VDC peak fast rise, slow decay
Pulsed DC (x 2)	360-1100 V
Metering	Output current 0 - 2.5 amp
Voltage Selection	Rotary Switch
Circut Protection	Electronic circuit breaker with reset
Safety Protection	Tilt switch kills engine if shocker is tilted beyone 45 degrees
Engine Kill	Push-button switch mounted on pack frame

Backpack Frame	Lightweight, comfortable frame with padded shoulder straps, padded hip belt and emergency quick release
Weight	36 lbs.

Standard Equipment: TAS-300 Generator, Anode Pole with Pull-Behind Cathode: optional Cathode pole available.

Specifications Subject to Change Without Notice

1/81

APPENDIX VI

A. ADULT ANADROMOUS FISHERIES STUDIES

Habitat Site Locations

B. INTEGRATED RESIDENT AND JUVENILE ANADROMOUS FISHERIES AQUATIC HABITAT AND INSTREAM FLOW STUDIES

Habitat Site Locations

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System of Specifying Geographic Locations

For conciseness and for use in the computer processing, it is convenient to use a modification of the General Land Office method of specifying locations as developed by federal and state agencies in Montana (MDFWP, 1979).

In this report, locations of features such as sampling points are specified by using 12 characters. The first three characters of the location give the township, the next three characters the range. The next two give the section number within the township, and the next tract, the quarter-quarter section (40-acre tract), and the quarter-quarter-quarter section (10-acre tract). These subdivisions of the 640-acre section in the northeast quadrant. If there is more than one feature in a 10-acre tract, consecutive digits beginning with 2 are added to the number. For example, if a sample was collected in Section 21, Township 9 North, Range 20 West, it would be numbered 09N20E21DAA2. The letters DAA indicate that the site is in the N1/4 of the N1/4 of the SE1/4, and the number 2 following the letters DAA indicates there are at least two sampling locations in this 10-acre tract.

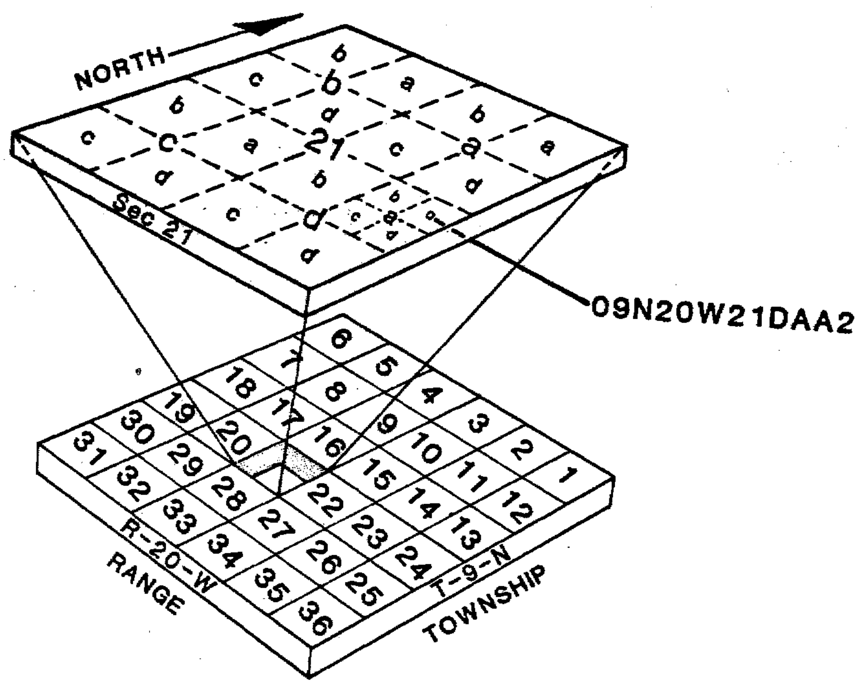

Figure VI-1. System used by ADF&G in this study to specify geographic locations.

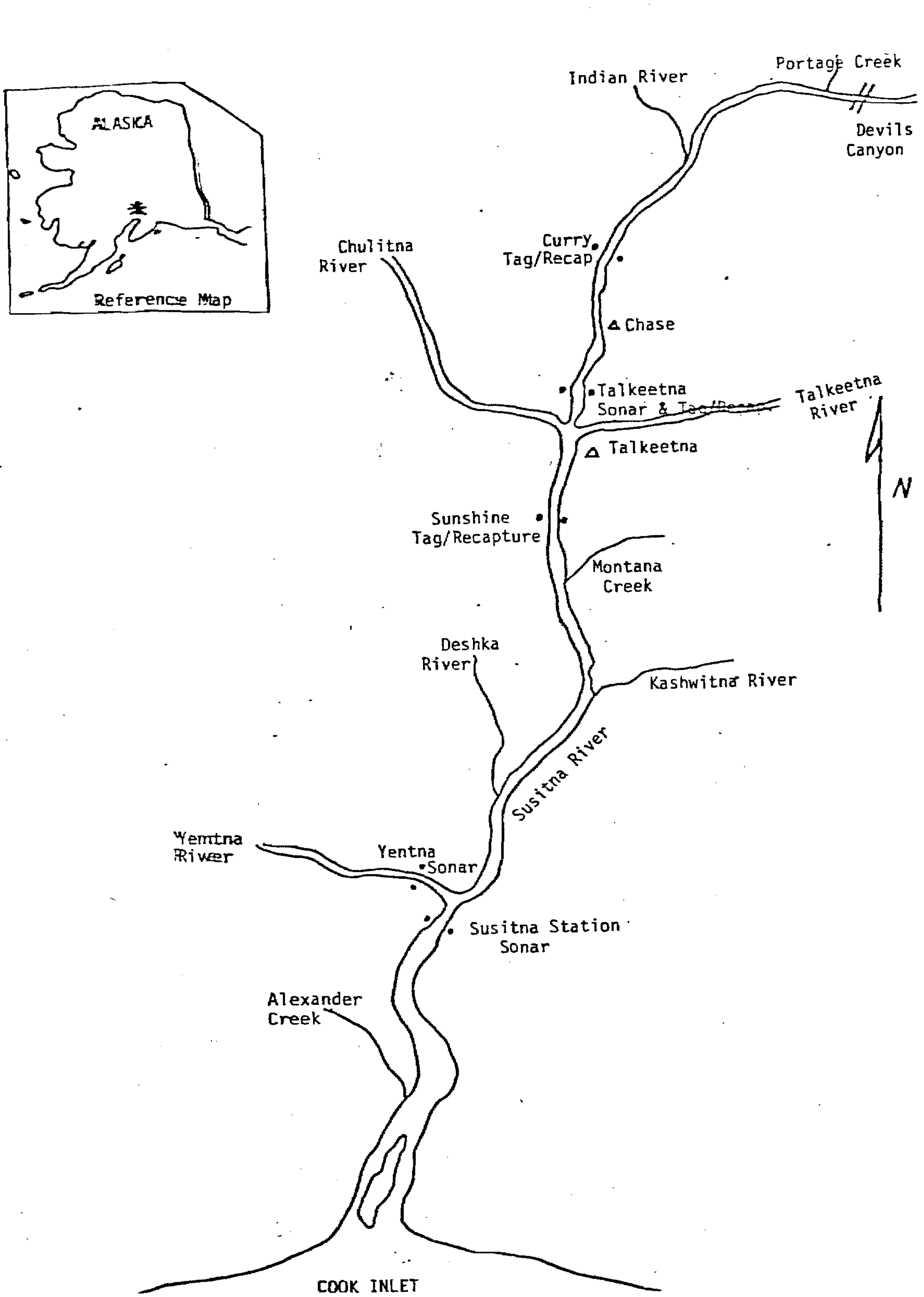

Figure VI - 2. Anadromous Adult Project study locations, 1981.

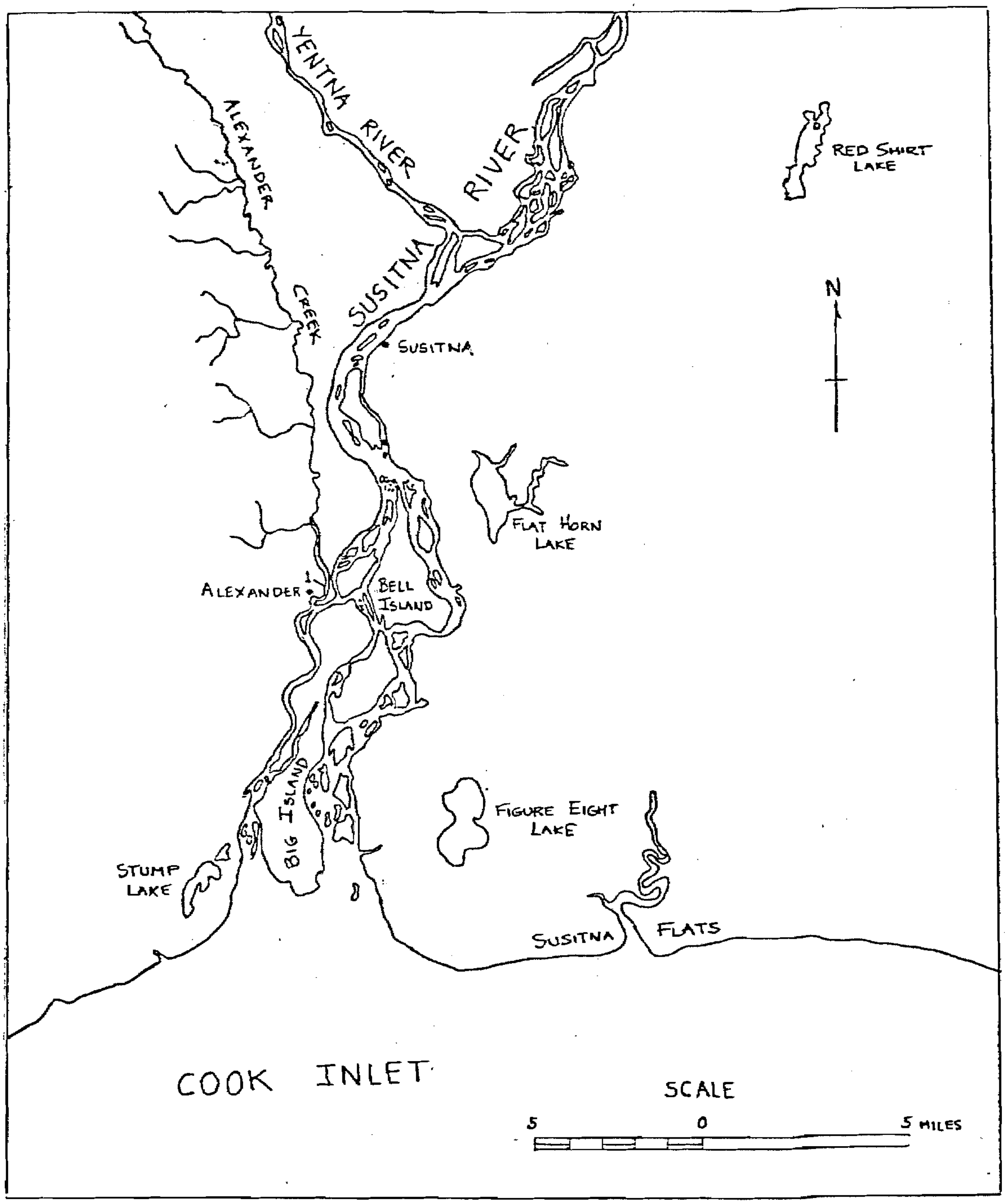

Figure VI - 3. RJ and AH sampling locations, 1981.

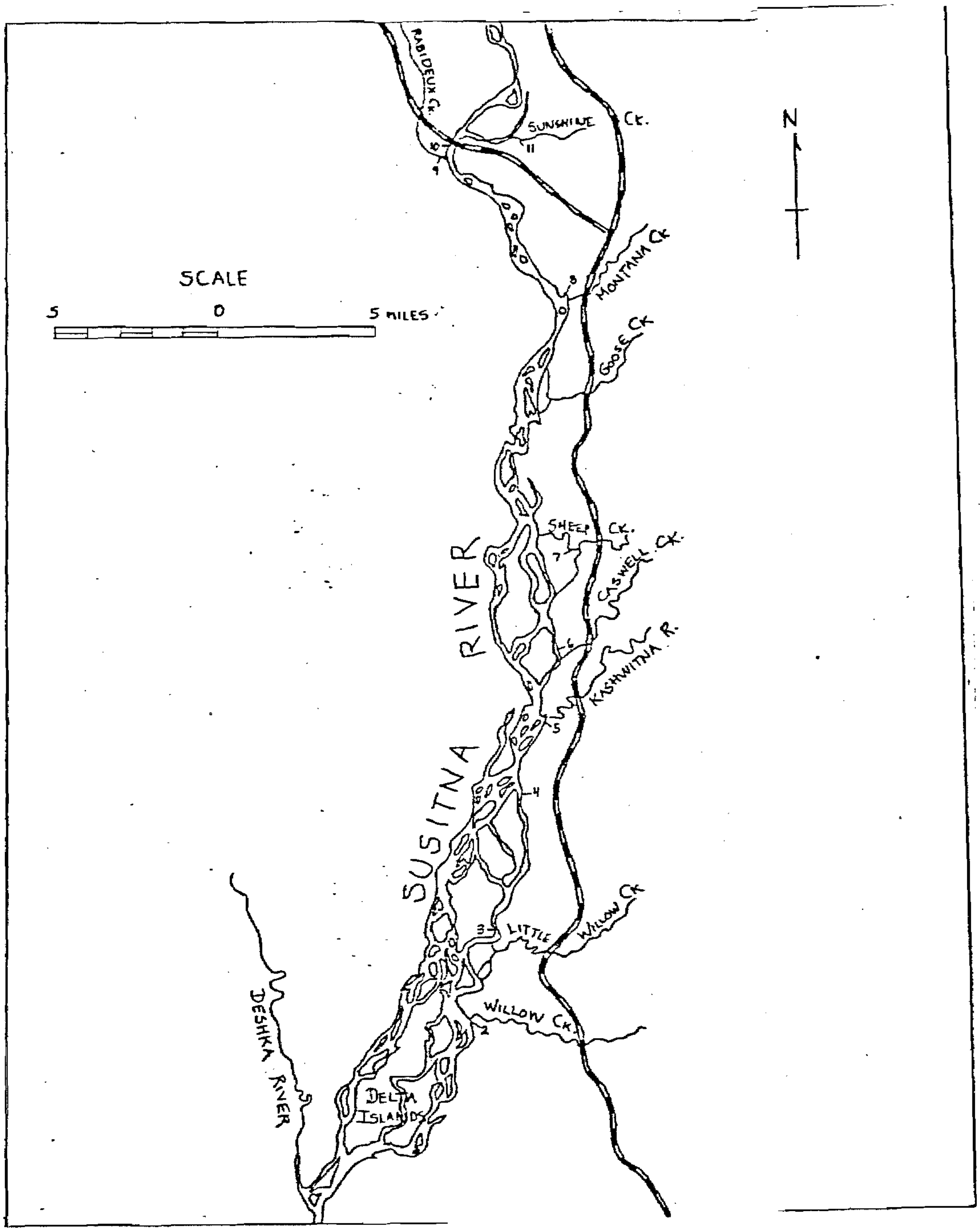

Figure VI - 4. RJ and AH sampling locations, 1981.

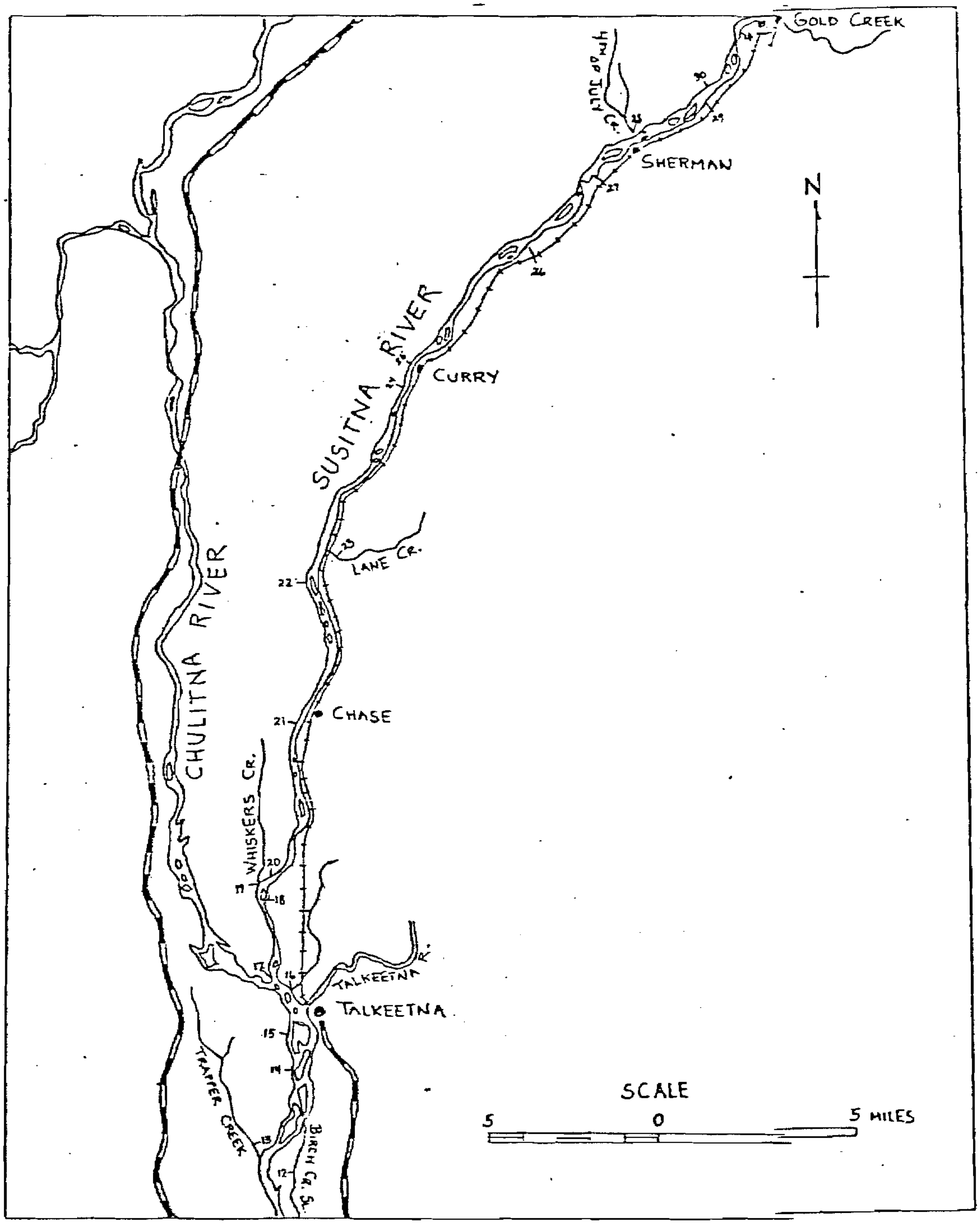

Figure VI - 5. RJ and AH sampling locations, 1981.

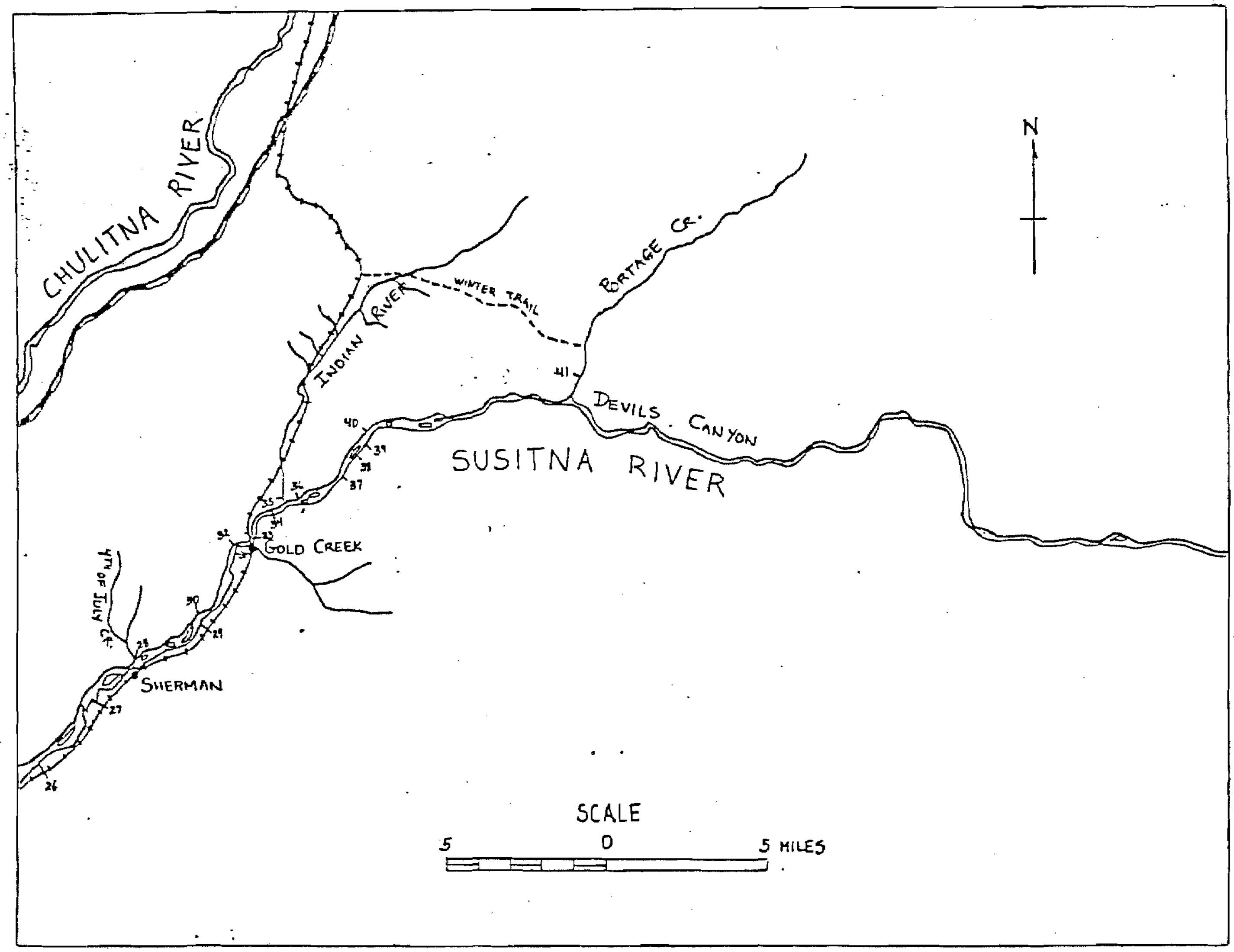

Figure VI - 6. RJ and AH sampling locations, 1981.

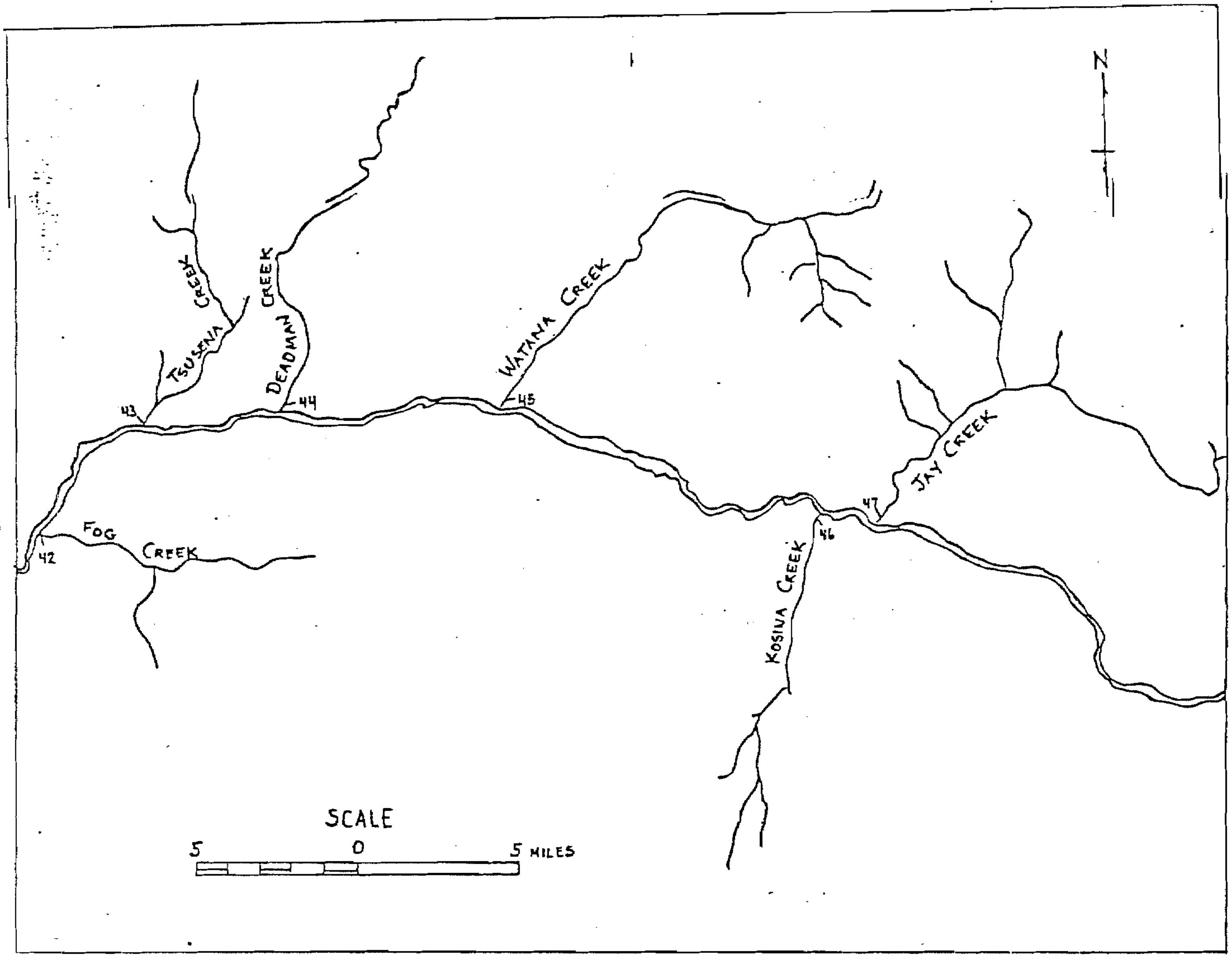

Figure VI - 7. RJ and AH sampling locations, 1981.

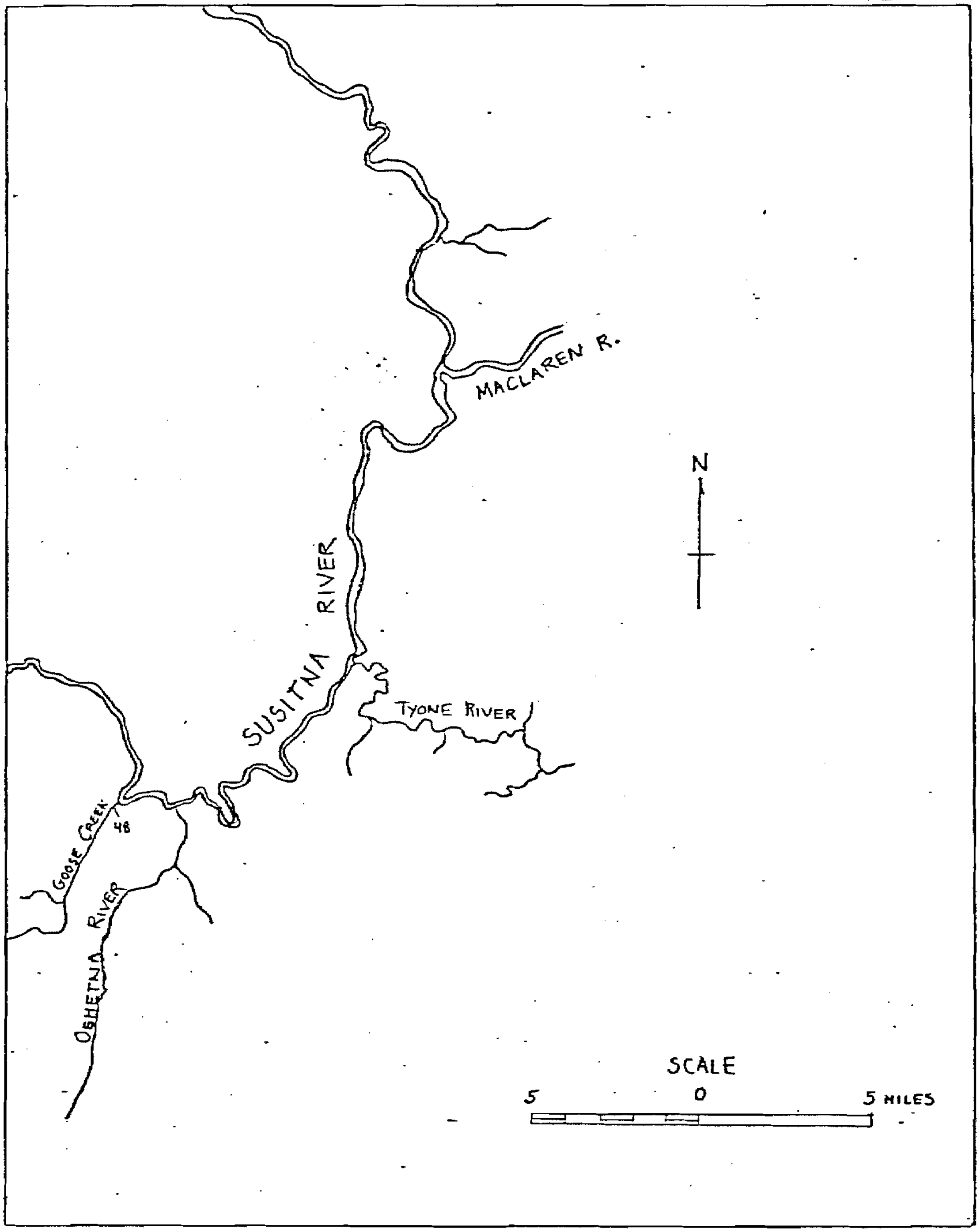

Figure VI - 8. RJ and AH sampling locations, 1981.

Table 1. Susitna River Resident and Juvenile Anadromous Fish Sampling Locations, 1981.

MAP CODE	SAMPLING LOCATION	LOCATION			
		TOWNSHIP	RANGE	SECTION	GRID
	Estuary to Talkeetna:				
1	A. Mainstem Susitna (.75 mile south of				
	Alexander River Mouth)	15 N	07 W	07	
	B. Alexander River				
	(Mouth)	15 N	07 W	07	AB
	(.75 Mile Upstream)	15 N	07 W	05	
	(1.5 Mile Upstream)	16 N	07 W	31	
	C. Mainstem Susitna				
	(Side-Channel Opposite Alexander R. Mouth)	15 N	07 W	07	
	D. Mainstem Susitna (1.0 mile North of				
	Alexander River Mouth)	15 N	07 W	05	
2	A. Mainstem Susitna (Willow Creek Mouth)	20 N	05 W	34	CA
	B. Willow Creek (Mouth)	20 N	05 W	34	
	(Parks Highway)	19 N	04 W	06	AC
3	A. Mainstem Susitna (100 yards Above Little				
	Willow Creek)	20 N	05 W	27	BA
4	A. Slough A (Rustic Wilderness Subdivision)	21 N	05 W	25	CB
	B. Mainstem Susitna (East Bank, 700 yards				
	above Slough A)	21 N	05 W	23	DD
	C. Mainstem Susitna (West Bank, Opposit Sl.A)	21 N	05 W	23	DA
	D. Mainstem Susitna (East Bank, below Slough				
	E Head)	21 N	05 W	24	BA
	E. Slough E (.25 mile above Rustic Wilderness				
	Subdivision)	21 N	05 W	25	BC

Table 1 - Cont'd.

MAP CODE	SAMPLING LOCATION	LOCATION			
		TOWNSHIP	RANGE	SECTION	GRID
5	A. Mainstem Susitna (West bank, adjacent to				
	Susitna Landing) (C)	21 N	05 W	13	BC
	(West bank, Slough Mouth) (A)	21 N	05 W	12	CC
	B. Mainstem Susitna (.25 mile, West of				
	Kashwitna River Mouth)	21 N	05 W	13	AB
	C. Mainstem Susitna (100 feet below				
	Kashwitna River Mouth)	21 N	05 W	13	AC
	D. Kashwitna River (Mouth)	21 N	05 W	13	AAC
6	A. Caswell Creek (Mouth)	21 N	04 W	06	BA
7	A. Mainstem Susitna (Site A, below Sheep				
	Creek Slough Mouth)				
	(Site B, below Sheep Creek Slouth Mouth)				
	B. Sheep Creek Slouth (Mouth)	22 N	05 W	25	DD
	C. Mainstem Susitna (East channel, .5 mile				
	above Sheep Creek Slough Mouth) (D)	22 N	05 W	24	DD
	(East channel, .6 mile above Sheep Creek				
	Slough Mouth) (E)	22 N	05 W	24	DA
	D. Slough (.50 mile NW of Sheep Creek				
	Slough Mouth) (F)	22 N	05 W	24	DB
	(.75 mile NW of Sheep Creek Slough				
	Mouth) (H)				
	E. Mainstem Susitna (Center Channel, .9 mile				
	across from Sheep Creek Slough Mouth) (I)	22 N	05 W	23	DB
	(Center Channel, .9 mile above Sheep				
	Creek Slough Mouth) (G)	22 N	05 W	24	BC

Table 1 - Cont'd.

MAP CODE	SAMPLING LOCATION	LOCATION TOWNSHIP	RANGE	SECTION	GRID
7	E. Mainstem Susitna (Cont'd.)				
	(Center Channel, 1.0 mile above Sheep				
	Creek Slough Mouth) (J)	22 N	05 W	23	AB
	F. Slough L (West Center Channel, below				
	Echo Island) (L)	22 N	05 W	14	CD
	G. Mainstem Susitna (Below Echo Island) (M)	22 N	05 W	14	CD
	(Adjacent to Echo Island) (K)	22 N	05 W	14	DC
8	A. Mainstem Susitna (Below Montana Creek				
	Mouth) (B)	23 N	04 W	07	AB
	B. Mainstem Susitna (West Channel, Slough				
	Mouth, 1.25 mile above Montana Creek) (F)	23 N	05 W	13	DC
	C. Side-Slough (West Channel, small slough				
	1.0 mile below Montana Creek) (G)	23 N	05 W	13	AD
	D. Side-Slough (West Channel, slough .25 mile				
	below Montana Creek) (E)	23 N	05 W	12	DB
	E. Montana Creek (Mouth) (A)	23 N	05 W	07	AB
	F. Mainstem Susitna (East Channel, .25 mile				
	above Montana Creek) (C)	23 N	04 W	06	CD
	(East Channel, .50 mile above Montana				
	Creek) (D)	23 N	04 W	06	CD
	G. Beaver Pond (West Bank, 1.0 mile above				
	Montana Creek Mouth)				
	H. Mainstem Susitna (West bank, slough				
	Mouth above Montana Creek)				
	(East Bank, 1.0 mile above Montana Creek)				

Table 1 - Cont'd.

MAP CODE	SAMPLING LOCATION	LOCATION TOWNSHIP	RANGE	SECTION	GRID
8	H. Mainstem Susitna (Cont'd.)				
	(Center Channel, 1.25 mile above				
	Montana Creek)				
	I. Slough (West bank, 2 miles above Montana				
	Creek)				
9	A. Rabideux Creek	24 N	05 W	16	AAB
	(Mouth)				
	(500 feet Upstream)				
10	A. Mainstem Susitna (.25 mile below				
	Parks Highway Bridge)	24 N	05 W	15	BA
	B. Mainstem Susitna (Parks Highway Bridge)	24 N	05 W	15	BA
11	A. Mainstem Susitna (1.0 mile South of				
	Sunshine Creek Mouth)	24 N	05 W	10	
	B. Mainstem Susitna (.75 mile South of				
	Sunshine Creek Mouth)	24 N	05 W	14	
	C. Mainstem Susitna (At Sunshine Creek)	24 N	05 W	14	AA
	D. Sunshine Creek	24 N	05 W	14	AA
	(Mouth)				
12	A. Birch Creek Slough (Mouth)	25 N	05 W	25	
	(.25 mile below Birch Creek Mouth)	25 N	05 W	25	
	(Birch Creek Mouth)	25 N	05 W	25	
	(Head)	25 N	05 W	12	
13	A. Trapper Creek (Mouth)	25 N	05 W	15	
14	A. Slough Fed by Cache Creek (Mouth), 1.5 mi.				
	South West of Birch Creek Slough Head	25 N	05 W	14	

Table 1 - Cont'd.

MAP CODE	SAMPLING LOCATION	LOCATION TOWNSHIP	RANGE	SECTION	GRID
14	B. Slough-Susitna (1.0 mile South West of				
	Birch Creek Slough Head	25 N	05 W	11	
	C. Mainstem Susitna (.25 mile below head of				
	Birch Creek Slough)	25 N	05 W	12	
	D. Mainstem Susitna (South West side of				
	Island, 1.5 mile South of Cache Creek Mouth)	25 N	05 W	01	
	E. Mainstem Susitna (South West side of island				
	1.0 mile South of Cache Creek Mouth)	25 N	05 W	01	
	F. Mainstem Susitna (West channel, .75 mile				
	South of Cache Creek Mouth)	26 N	05 W	35	
	G. Mainstem Susitna (Below Mouth of Cache				
	Creek Slough)	26 N	05 W	36	CB
	(Mouth of Cache Creek Slough)	26 N	05 W	35	DA
15	A. Cache Creek (Mouth)	26 N	05 W	36	CB
	(Inside Mouth)	26 N	05 W	35	ABC

Table 1 - Cont'd.

MAP CODE	SAMPLING LOCATION	LOCATION			
		TOWNSHIP	RANGE	SECTION	GRID
	Talkeetna to Devil's Canyon:				
16	A. Mainstem Susitna (Billian Slough Mouth)	26 N	05 W	23	AAD2
	B. Billian Slouth (Mouth)	26 N	05 W	23	AAD3
	(Open Lead Below Railroad Trestle)	26N	05 W	13	CCD
17	A. Mainstem Susitna (West side of Island,				
	Chulitna River Confluence)	26 N	05 W	14	
	B. Mainstem Susitna (East side of Island, .25				
	mile North of Chulitna River Confluence)	26 N	05 W	14	
	C. Mainstem Susitna (.75 mile North of				
	Chulitna River Confluence)	26 N	05 W	14	
	(1.0 mile North of Chulitna R. Confluence)	26 N	05 W	11	
	(1.25 mile North of Chulitna R. Confluence)	26 N	05 W	11	
18	A. Mainstem Susitna (Side-Channel Below				
	Slough 2 Mouth)	26 N	05 W	02	CBD
	B. Mainstem Susitna (Side-Channel above				
	Slough 2)	26 N	05 W	02	BCD
19	A. Mainstem Susitna (Below Mouth of Whiskers				
	Creek Slough)	26 N	05 W	03	ADC
	(Adjacent to Mouth of Whiskers				
	Creek Slough)	26 N	05 W	03	ABC3
	B. Whiskers Creek Slough (200 yards				
	above Mouth)	26 N	05 W	03	ADB
	C. Whiskers Creek (Mouth)	26 N	05 W	03	
	D. Mainstem Susitna (Side-channel, 1.0 mile				
	east of Whiskers Creek)	26 N	05 W	02	

Table 1 - Cont'd.

MAP CODE	SAMPLING SITES	LOCATION			
		TOWNSHIP	RANGE	SECTION	GRID
20	A. Mainstem Susitna (.25 mile NW of Whiskers				
	Creek Mouth)	26 N	05 W	02	
	B. Slough 3 (Above Whiskers Creek Slough)	27 N	05 W	35	CCC2
	C. Slough 3B (Mouth)	27 N	05 W	35	CCB
	D. Mainstem Susitna (Side Channel Adjacent				
	to Slough 3)	27 N	05 W	35	CCA
21	A. Mainsetm Susitna (Adjacent to Slough 5)	27 N	05 W	01	CCA
22	A. Slough 6A	28 N	05 W	13	CAB3
23	A. Lane Creek (Mouth)	28 N	05 W	12	ADD2
24	A. Oxbow II-(Mouth)	29 N	04 W	16	CAD4
25	A. Mainstem Susitna (Curry)	29 N	04 W	10	CBB2
26	A. Side Channel Below Slough 8A (Above Mouth)	30 N	04 W	25	DBA
	(Below Mouth of Slough 8A)	30 N	04 W	25	DAB
	B. Slough 8A (Mouth)	30 N	03 W	30	CBB
	(Above Mouth)	30 N	03 W	30	BCD
	(Beaver Pond)	30 N	03 W	30	AAA
	C. Mainstem Susitna (Above Slough 8A)	30 N	03 W	20	ACB
27	A. Slough 9 (Mouth)	30 N	03 W	16	CBB
	(Above Mouth)	30 N	03 W	16	CBAB
	(Below Bend)	30 N	03 W	16	CBAA
28	A. Mainstem Susitna (300 yards below 4th of				
	July Creek)	30 N	03 W	03	DCAB
	(200 yards below 4th of July Creek)	30 N	03 W	03	DCAA
	B. Mainstem Susitna (Side channel, adjacent				
	to 4th of July Creek)	30 N	03 W	03	DAD

Table 1 - Cont'd.

MAP CODE	SAMPLING LOCATION	LOCATION			
		TOWNSHIP	RANGE	SECTION	GRID
28	C. Side Channel (Beaver pond outlet, above				
	4th of July Creek)	30 N	03 W	03	ADD
29	A. Slough 9A (Above Mouth)	31 N	03 W	36	DCB
	(First Pool)	31 N	03 W	36	DCA
	(Open Lead)	31 N	03 W	36	DBDC
	(Second Pool)	31 N	03 W	36	DBD
	B. Mainstem Susitna-Between 9A & 10				
	(Lower, Lead)	31 N	03 W	36	DBC
	(Middle, Lead)	31 N	03 W	36	ACD
	(Upper, Lead)	31 N	03 W	36	ADC
30	A. Mainstem Susitna-Below Slough 10	31 N	03 W	36	AAC4
	B. Slough 10 (Lower, Pool)	31 N	03 W	36	AABD2
	(Middle, Pool)	31 N	03 W	36	AABA
	(Tributary Stream)	31 N	03 W	25	DDC
31	A. Slough 11 (Lower Reach)	31 N	02 W	19	DDD
	(Middle, Reach)	31 N	02 W	20	CBA
	B. Mainstem Susitna (Above Slough 13)	31 N	02 W	19	ADB3
	C. Side-Channel (Above Slough 13)	31 N	02 W	19	ADA
32	A. Slough 14 (Lower Bend)	31 N	02 W	19	ACA
	(Beaver Pond)	31 N	02 W	19	ABD
33	A. Mainstem Susitna (Beneath Gold Creek				
	Railroad Bridge)	31 N	02 W	20	BAC2
	B. Mainstem Susitna (Tributary Creek				
	Above Gold Creek)	31 N	02 W	20	BAA
	C. Mainstem Susitna (North Bank above Gold Creek Railroad Brodge)	31 N	02 W	17	CDD

Table 1 - Cont'd.

MAP CODE	SAMPLING SITES	LOCATION			
		TOWNSHIP	RANGE	SECTION	GRID
34	A. Slough 16 (Mouth)	31 N	02 W	17	ABD
	(First Lead)	31 N	02 W	17	ABD
	(Second Lead)	31 N	02 W	17	ABD
35	A. Indian River (Mouth)	31 N	02 W	09	DD2
	B. Indian River (Approx. 3 miles Upstream)	32 N	02 W	33	ABD5
	C. Indian River-Beaver Pond (Approx. 7 miles				
	Upstream)	32 N	02 W	11	ADC2
	D. Mainstem Susitna (Above Indian River)	31 N	02 W	09	DCB2
36	A. Slough 17 (Mouth)	31 N	02 W	09	DCA
	(Above Mouth)	31 N	02 W	09	DBD
	B. Mainstem Susitna (Above Slouth 18)	31 N	02 W	10	CBD
37	A. Slough 20 (Mouth)	31 N	02 W	10	ADA
	(Middle Reaches)	31 N	02 W	11	BBD
	(Upper Tributary)	31 N	02 W	11	BBA
38	A. Side Channel Below Slough 21 (Lower)	31 N	02 W	02	CAC
	(Middle)	31 N	02 W	02	CAA
	(Upper)	31 N	02 W	02	ABD
39	A. Slough 21 (Mouth)	31 N	02 W	02	AAB
	(Middle)	31 N	02 W	02	AAA
	(Upper)	32 N	02 W	36	CCC
40	A. Mainstem Susitna (Above Slough 21)	32 N	02 W	36	ACD
41	A. Portage Creek (Mouth)	32 N	01 W	25	CDB4
	B. (8 miles Upstream-Below Thoroughfare Creek)	33 N 33 N	01 E 01 E	25 25	DBA4 ACD2
	C. (11 miles Upstream-Mouth of Thoroughfare				
	Creek)	33 N	02 E	17	CCB3

Table 1 - Cont'd.

MAP CODE	SAMPLING LOCATION	LOCATION			
		TOWNSHIP	RANGE	SECTION	GRID
	Devil's Canyon to Tyone River:				
42	A. Fog Creek (Mouth)	31 N	04 E	16	DBB
43	A. Tsusena Creek (Mouth)	32 N	04 E	36	ADB
44	A. Deadman Creek (Mouth)	32 N	05 E	26	CDB
45	A. Watana Creek (Mouth)	32 N	06 E	25	CCA
46	A. Kosina Creek (Mouth)	31 N	08 E	15	BAB
47	A. Jay Creek (Mouth)	31 N	08 E	13	BCC
48	A. Goose Creek (Mouth)	30 N	11 E	32	DBC
49	A. Oshetna River (Mouth)	30 N	11 E	34	CCD

APPENDIX VII

B. RESIDENT AND JUVENILE ANADROMOUS FISHERIES STUDIES

~~Under Ice~~ Sampling Techniques

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APPENDIX VII

B. RESIDENT AND JUVENILE ANADROMOUS FISHERIES STUDIES

Under Ice Sampling Techniques

Minnow Traps:

Assemble as depicted in Figure 1

Materials:

One each-Minnow trap (17 1/2" long, 9" diameter, 1/4" square mesh
One each-Minnow trap clip
One each-(4 oz.) pint, screw-top plastic sampling bottle
15.0'-nylon seine twine, #72

1) Drill 1/4" holes through the plastic sampling bottle at 90° intervals around the circumference of the bottle 1" and 2" above its bottom.
2) Drill a 1/8" hole through the center of the bottle's screw cap.
3) Thread a 6" piece of stout nylon line through the hole in the cap. Tie several overhead knots at the end of the line inside the cap so that the cap can be suspended from the line. Tie the other end of this line to the mesh on the minnow trap near the metal clip which secures the trap shut. Screw the cap onto the perforated plastic bottle and the bait container is complete. (Note-steps 1-3 should be completed prior to going into the field).
4) Tie one end of the 15' nylon twine to the metal clip which is used to fasten the two halves of the minnow trap together.

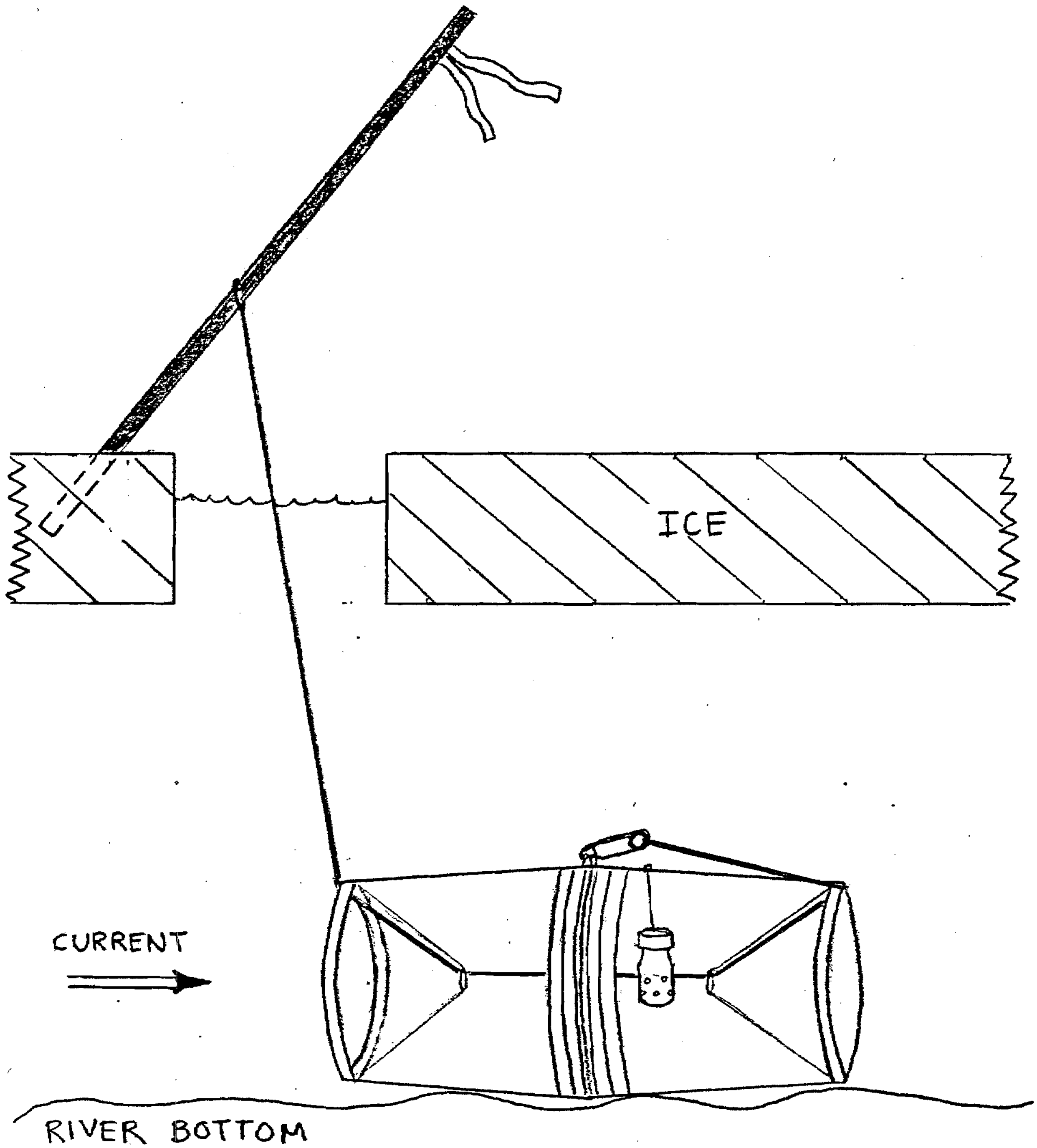
Setting (Figure 2):

Materials:

One each-ice auger with 10" diameter bit and an extension
One each-spud bar
One each-shovel
One each-ice scoop
One each-tablespoon, salmon eggs for bait
One each-5' wooden marker stick
One each-5' orange surveyors flagging tape

1) Placement of gear. Minnow traps can be set in open leads or under the ice in areas that are generally 10 inches to 4 feet deep with slow to moderate currents. Traps are set at 5 yard intervals with 10 traps per sampling site.
2) In order to set a trap underneath the ice, shovel all snow off the spot selected and auger one 10 inch diameter hole in the ice.
3) Clean slush and ice chips out of the hole with the ice scoop.
4) Measure and record the depth of the ice and the water beneath the ice.

Figure 1. Minnow trap set under the ice.



5) Probe the river bottom with the spud bar to determine the type of bottom which exists at the trap (silt, sand, gravel stone, etc.).
6) Place approximately 1 tablespoon of salmon eggs in the bait jar and screw the top on securely. Thread the clip and the attached seine twine through both ends of the minnow trap as shown in the illustration.
7) Insert the pair of metal hooks on the bottom inside edge of each half of the minnow trap. Once attached these hooks act like a hinge and the trap can be closed and fastened together at the top with the metal clip.
8) Lower the trap through the hole in the ice and orient the trap length wise with the current. Feed out enough line so that the trap sits on the bottom. (Note-in areas with strong currents, additional weight such as a rock can be placed inside the trap to anchor the trap in place.)
9) Anchor the 5 foot wooden marker stick in the snow or ice next to the hole as shown in Figure 1. Tie the remaining end of the seine twine from the minnow trap to the marker stick. Attach approximately 1.5 feet of orange surveyors tape to the top of the stick to help identify the spot. (Note-when temperatures are below freezing, cover the hole with a piece of slit cardboard. The slit in the cardboard will allow you to align the seine twine in the center of the hole so that it won't freeze to the edges. Then cover the cardboard with snow to retard ice formation in the hole.)
10) The same general procedure is used to set minnow trap sets in open leads.

Checking:

1) Minnow traps are rebaited after 24 hours and pulled after 48 hours.

Trot Lines:

Materials:

One each-1" X 2" x 18" board w/V-notched end
One each-30'-36'-#72 nylon seine twine
Two each-large (2/0) snap swivels
One each-16-24 oz. sinker
One each-1/4-1 oz. sinker
Six each-leaders or ganging w/baited hooks (Sizes of hooks dependent on species: #4-6 for burbot, #8 for trout

Assembly (Figure 2):

1) Cut a length of seine twine to 36 feet and tie a 2/0 snap swivel to one end; attach a 1 oz. Bell sinker to swivel.

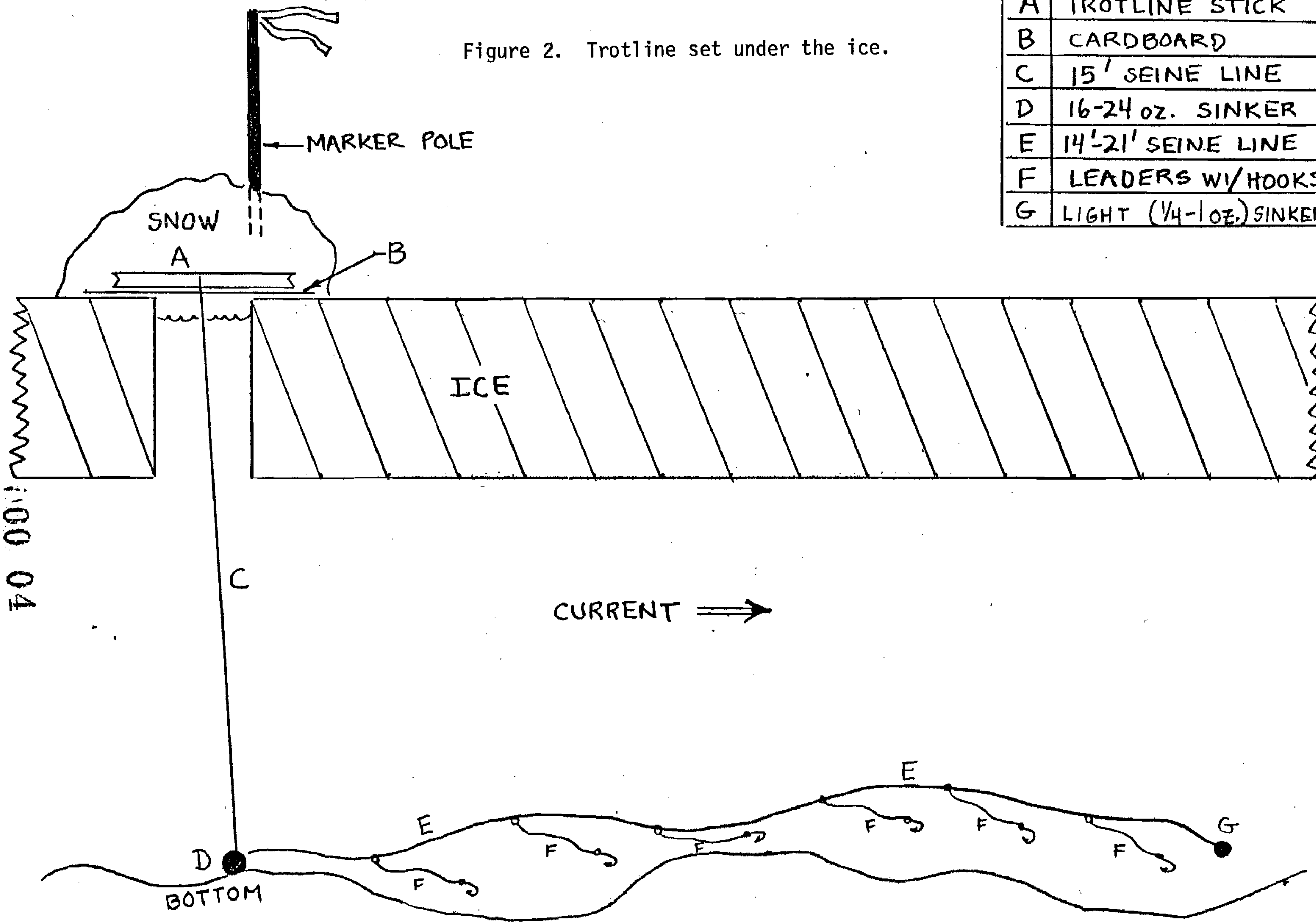


Figure 2. Trotline set under the ice.

A	TROTLINE STICK
B	CARDBOARD
C	15' SEINE LINE
D	16-24 oz. SINKER
E	14'-21' SEINE LINE
F	LEADERS W/ HOOKS
G	LIGHT (1/4-1 oz.) SINKER

2) Attach a second 2/0 snap swivel 15 feet from the other end of the twine. Fasten the 16-24 oz. sinker to this swivel.
3) Tie a total of 6 overhand loops into the line at three foot intervals between the two weights. (Note-the loops should be at least 1 inch in diameter.)
4) Tie the end of the line, w/o the snap swivel to the 1" X 2" X 18" board. Wrap the entire length of line around the board lengthwise, from notch to notch. (Note-by not attaching the hooks until you're actually setting the line, tangling and loss of time is avoided.

Setting the line (Figure 2):

1) To use this trotline method, a reasonable amount of current and a minimum water depth of 2 feet is needed. A larger hole (10") is usually used for ease in recovery and landing fish.
2) Unwind the trotline beside the hole and attach the small bell sinker to the end snap swivel.
3) Hooks are baited variously depending upon species sought. In general cut fish, such as herring or whitefish are the preferred bait for burbot. Salmon eggs singly or in clusters are preferred for trout.
4) Lower the sinker into the hole until you come to the first loop, where you attach a prebaited leader line. Continue lowering the line and attaching leaders until all 6 loops are hooked up.
5) After the 6th loop, attach the larger (16-24 oz.) sinker to the snap swivel. Lower this sinker down until it rests on the bottom.
6) Tie a half hitch around the board with the line and center the line and board over the hole. The set is complete.
7) Set two trot lines per sampling site at 10 yard minimum intervals.
8) Trot lines are checked and rebaited after 24 hours and pulled after 48 hours.

Pulling a set:

1) Reverse the setting procedures. As the line is pulled in, remove the hooks and sinkers and rewind the line on the board.

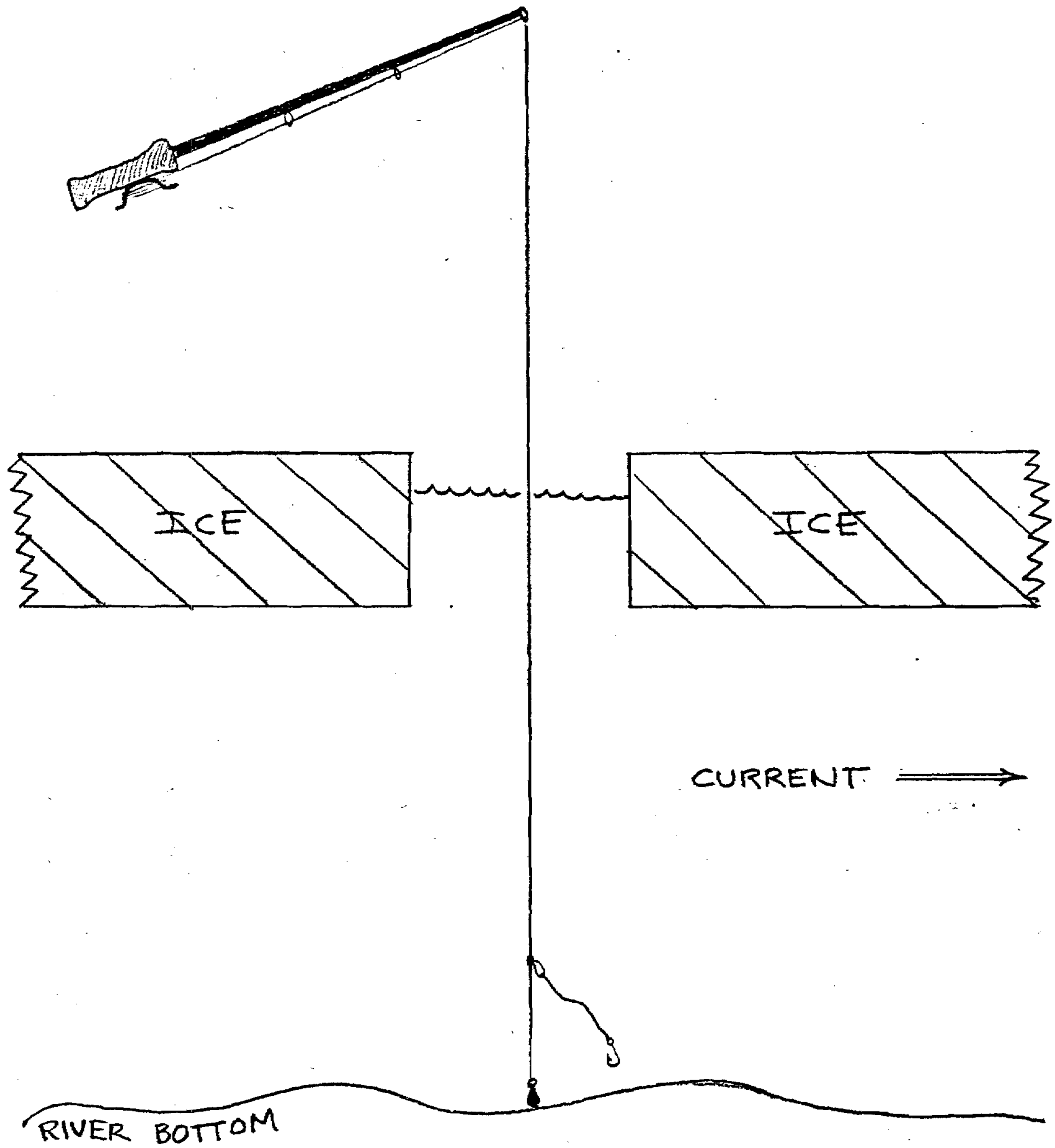
Hook & Line (Jigging):

Assembly (Figure 3):

Materials:

One each-Fiberglass jigging pole (Approx. length-2.5')
30'-20 lb. test, monofilament line

Figure 3. Hook and line jigging under the ice.



One each-pack, assorted weights
One each-pack, assorted single shank fish hooks (size-10 to 5/0)

Setting (Figure 3):

Materials:

One each-ice auger with 6" to 10" diameter bit, plus an extension
One each-spud bar
One each-shovel
One each-ice scoop
Bait-salmon eggs, salmon roe, whitefish, herring, etc.

1) Placement of gear. The hook and line technique or jigging can be used in almost any area of the river that has stable ice conditions with at least 2 feet of water beneath the ice. However, it is generally reserved for use in deeper sections of the river such as pools, eddys, and tributary mouths.
2) When fishing through the ice, shovel all snow off the sampling site and auger one 6" to 10" diameter hole in the ice for each jigging site. Jigging holes should be drilled no closer than 5 yards apart and 2 units of gear fished per sampling site.
3) Clean slush and ice chips out of the hole with the ice scoop.
4) Select the hook and bait of your choice, (Table 1).
5) Affix the hook and bait of your choice to the 20 lb. test monofilament line which has previously been wound on the jigging pole handle and threaded through the eyes of the pole.
6) A sinker can also be attached above or below the baited hook if the current at the sampling site warrants one.
7) Lower the hook, line, and sinker through the hole in the ice into the water until the sinker rests on the bottom or at a satisfactory depth.
8) Note the time and begin bobbing the jigging pole up and down gently. At this point the procedure can be continued until a fish is caught, the bait is lost, or until the sampler decides to change bait, tackle, or move to a more productive site.
9) Standard effort forms should be filled out completely regarding sets and habitat fished. The unit of effort consists of man hours spent fishing per baited hook.

Burbot Sets (Under Ice Application Only):

Assemble as depicted in Figure 4

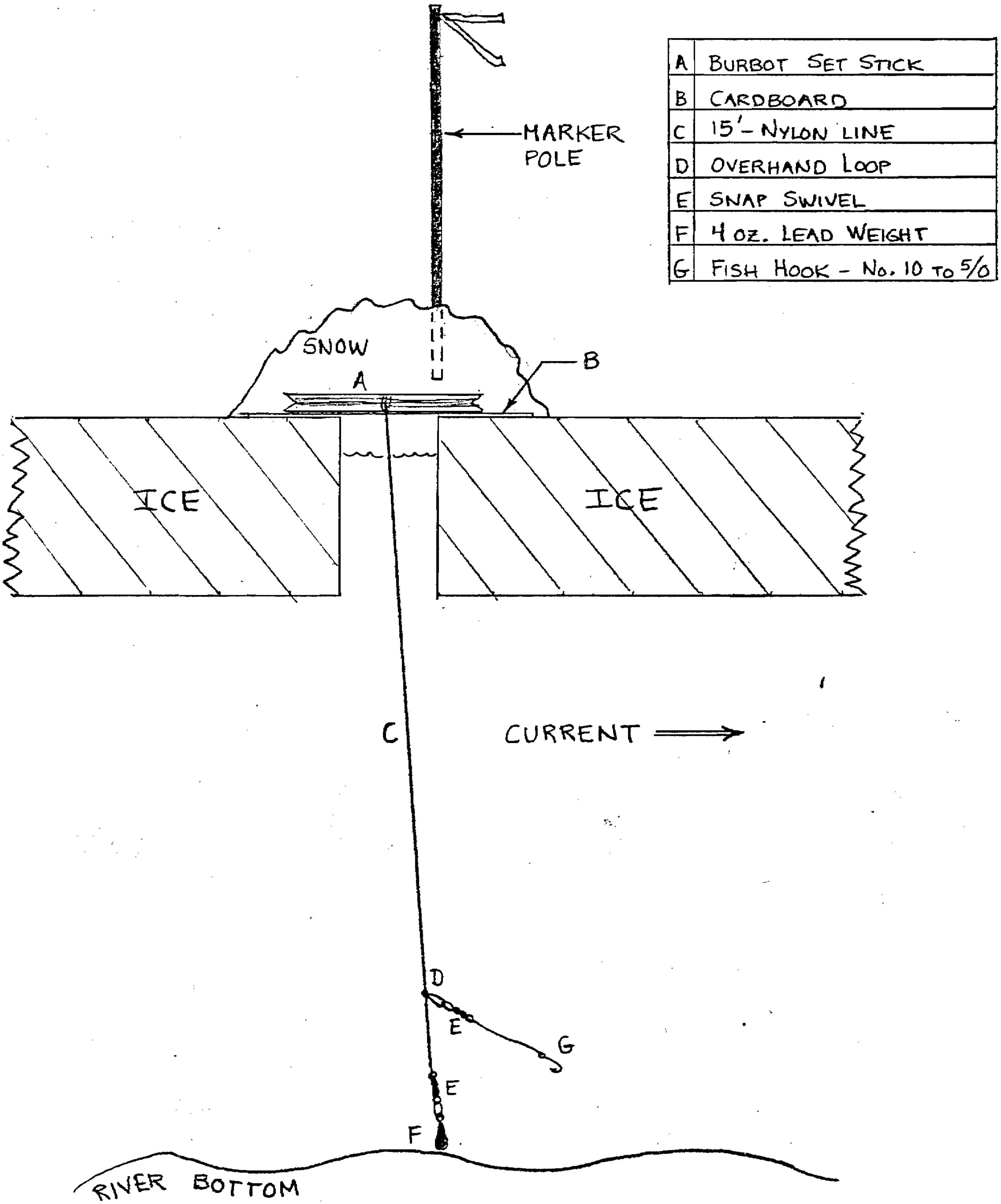
Materials:

One each-1" X 2" X 18" board w/V-notched ends
15'-80 lb. test nylon line, yellow

Table 1. Preferred hook size and bait type by fish species.

Resident Susitna Fish Species	HOOKS SIZES No. 10	No. 6	No. 2/0	No. 5/0	BAITS Insect Larva	Salmon Eggs	Salmon Roe	Herring	Whitefish	Shrimp	Artificial Lure
Burbot			X	X			X	X	X		
Dolly Varden		X				X	X				
Grayling		X			X	X					
Rainbow Trout		X				X	X				
Whitefish/sp.											
Humpback	X				X	X					
Round	X				X	X					

Figure 4. Burbot set under the ice.



Two each-No. 2/0 brass snap swivels or No. 1500 trot line clip
One each-4 oz. lead weight
Two each-wide rubber bands
One each-single shank fish hook (size-No. 10 to No. 5/0)
One each-9" leader line (nylon or monofilament)

1) Wrap a rubber band around each end of the notched 1" X 2" X 18" board, about 3 1/2" from the ends.
2) Tie one end of the 15' piece of 18 lb. test nylon line to the center of the notched board with a half hitch.
3) Wind the remainder of the nylon line around the 1" X 2" X 18" board between its notches.
4) Tie a 2/0 snap swivel to the free end of the nylon line with a clinch knot and attach a 4 oz. lead weight to the swivel. Secure the sinker to the board with a rubber band.
5) Use another clinch knot to attach the 9" leader line to the single shank fish hook of your choice. The other end of the leader should be tied to a 2/0 snap swivel or a No. 1500 trot line clip. (Note-this hook and leader assembly can be attached to the burbot set when you are ready to make your set. Hooks and leaders can be made up in groups of 8 to 12 and inserted in sheets of cardboard which are labeled according to hook size. Use of this method provides a safe and efficient way of transporting and storing hooks which are easily accessible when needed.
6) Tie an overhand knot with a 1" loop in the 80 lb. nylon line approximately 12" above the lead weight assembly.

Setting (Figure 4):

Materials:

One each-ice auger
One each-spud bar
One each-shovel
One each-ice scoop
One each-5' stick with orange surveyors tape attached
Bait-herring, salmon eggs, cheese, etc.

1) Placement of gear. Usually an area 2' to 7' deep with slow to moderate current and stable conditions.
2) Shovel all snow off the spot selected and auger one 6" to 10" diameter hole in the ice for each burbot set to be put out. Holes should be spaced at 5 yard intervals with 5 sets fished per sampling site.
3) Clean slush and ice chips out of the hole with the ice scoop.
4) Select the hook and bait of your choice.
5) Affix the baited hook and leader to the snap swivel by the 4 oz. lead weight or to the 1" loop above it.
6) Lower the hook, line, and sinker through the hole in the ice into the water until the sinker rests on the bottom or a satisfactory depth.

7) Using the remaining line, tie a half hitch around the middle of the notched board. Center the line in the middle of the hole and lay the board across the hole. (Note-in below freezing weather, place a slit piece of cardboard under the board so that it covers the hole. Then cover the set with snow. This will retard ice formation in the hole.
8) Erect a 5' stick near the site and tie orange surveyors tape to its top to mark the location of the burbot set.

Checking:

1) Burbot sets are checked and rebaited after 24 hours and pulled after 48 hours.

Gill Net:

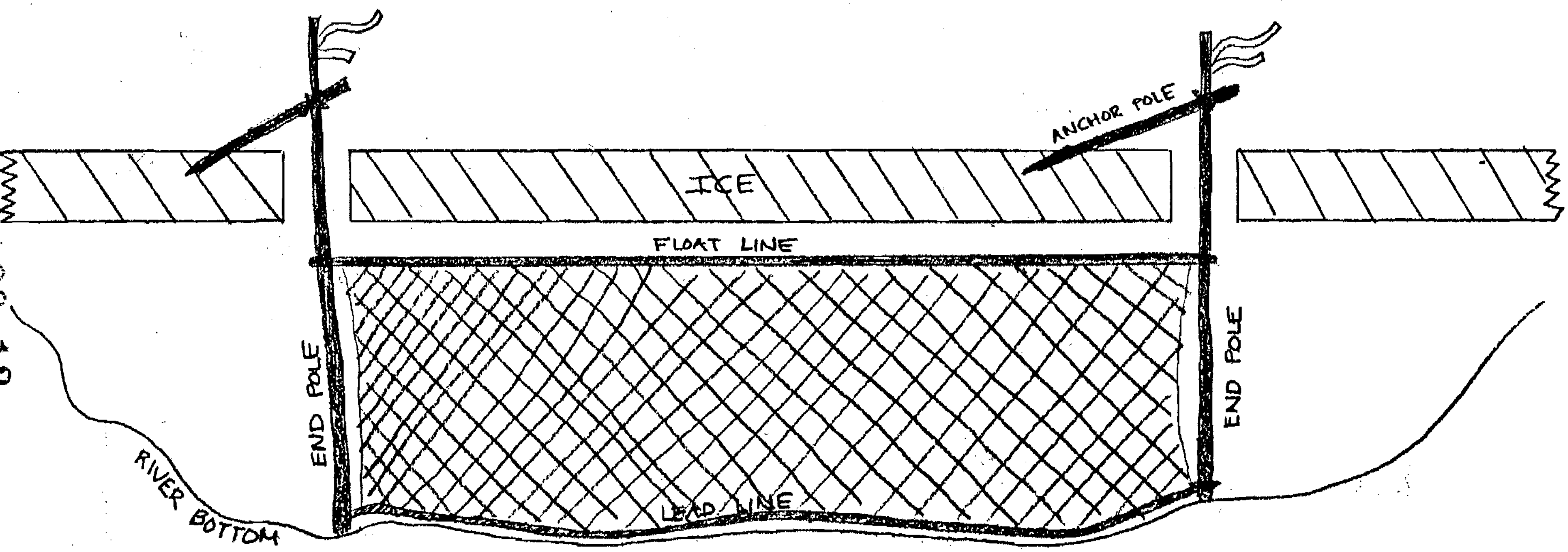
Setting (Figure 5):

Materials:

One each-Gill net (length, depth & mesh size vary depending on species and size of anticipated catch. Enter on data dorms specifications and quantity.
One each-ice auger with a 10" diameter bit and an extension
One each-murphy stick
One each-spud bar
One each-hooked pole (approx. 6' to 8' long)
One each-shovel
One each-ice scoop
60'-1/4" nylon line
Two each-stout wooden end poles (approx. height 10' to 15')
3.0'-orange surveyors flagging tape

1) Placement of gear. Under-ice gillnets are generally utilized in the wider and deeper stretches of the river with slow to moderate currents. However, by rolling up the length and width of the net, they can be set in tributaries and side-sloughs that are as small as 3' deep and 10' wide. Set only 1 gillnet per sampling site.
2) Bore holes with the ice auger along the general line of set to determine the depth of the water under the ice.
3) Shovel the snow from the ice along a transect where the net will be set. The length of this transect should be equal to the length of the net.
4) Measure off the hole centers to be drilled along the transect so that they correspond with the length of the Murphy Stick. Mark these auger points by starting them with the spud bar.
5) Using a 10" auger, drill a cluster of three or four holes through the ice at the end points of th net and a single hole at each auger point in between. If the ice is thick, bore all the holes one-half way, add the entension to the bit, and then finish drilling the holes.

Figure 5. Gillnet set under the ice.



6) Tie the 1/4" set line to the loop in the float line attached at the lead end of the Murphy Stick. Push the Murphy Stick under the ice and maneuver it in a direction that is slightly upstream of the next hole.
7) Partner holds a hooked pole straight down the second hole to catch the Murphy Stick as it swings downstream in the current or torque on the butt end until the lead end appears in the hole.
8) Use the hooked pole to catch the loop in the float line which is attached to the set line. Untie the set line and secure it at the hole with the spud bar. Withdraw the Murphy Stick from the initial hole and repeat the process listed above until the set line is strung through the final hole.
9) Roll the net to the proper height so that the float line will not contact the ice and freeze in.
10) Tie the set line to one end of the gillnet and pull the other end of the set line to string the net under the ice.
11) Before the net is pulled completely through, an end pole is attached to the end still on the ice. This pole must be stout and long enough to reach the river bottom and protrude two to three feet above the ice.
12) The end pole should be secured either by anchoring or driving the lower end into the river bottom or by lashing the top end to a cross pole frozen into the ice at the surface.
13) Attach the final end pole to the other end of the net after pulling it the remainder of the way through. Be careful not to pull too hard and lose the far end. Secure the final end pole.
14) Cover the holes at each end of the net with snow to retard their freezing.
15) Attach orange surveyors tape to each end pole to mark the set. An illustration of the final set it enclosed.

Checking:

1) Under-ice gillnets are picked after 24 hours and pulled after 48 hours.

<u>Open Water Sampling Techniques</u>

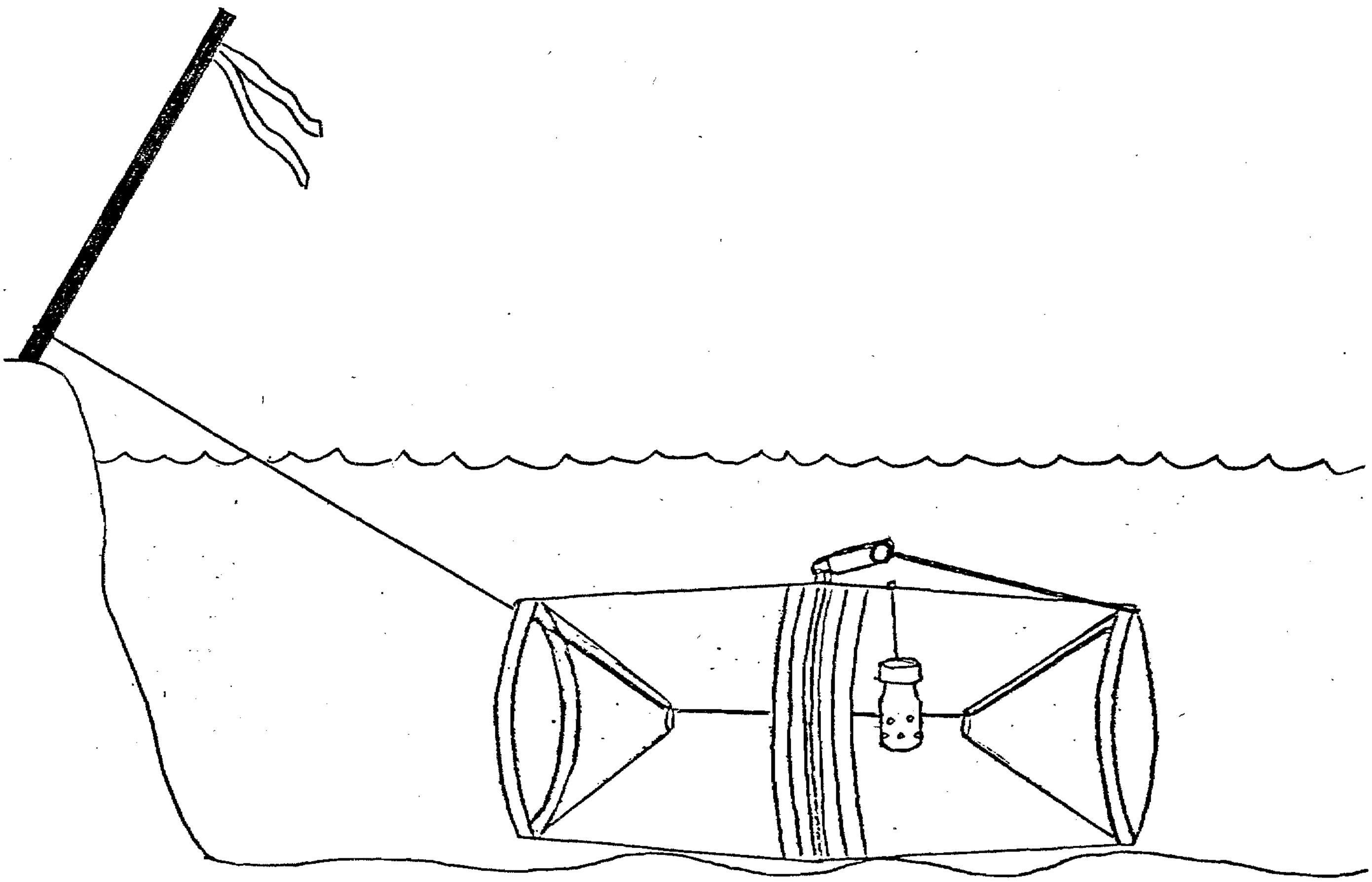
Minnow Traps (Open Water Application):

Assemble as depicted in Figure 6:

Materials:

One each-Minnow trap (17 1/2" long, 9" diameter, 1/4" square mesh)
One each-Minnow trap clip

Figure 6. Minnow trap set in open water.



One each-(4 oz.) pint, screw top plastic sampling bottle
15.0'-nylon seine twine, #72

1) Drill 1/4"holes through the plastic sampling bottle at 90° intervals around the circumference of the bottle 1" and 2" above its bottom.
2) Drill a 1/8" hole through the center of the bottle's screw cap.
3) Thread a 6" piece of stout nylon line through the hole in the cap. Tie several overhead knots at the end of the line inside the cap so that the cap can be suspended from the line. Tie the other end of this line to the mesh on the minnow trap near the metal clip which secures the trap shut. Screw the cap onto the perforated plastic bottle and the bait container is complete. (Note-steps 1-3 should be completed prior to going into the field).
4) Tie one end of the 15' nylon twine to the metal clip which is used to fasten the two halves of the minnow trap together.

Setting (Figure 6):

Materials:

One each-5' wooden marker stick
One each-1.5' orange surveyors flagging tape

1) Placement of gear. Minnow traps can be set in areas that are generally 10" to 4' deep with slow to moderate currents. Traps are set at 5 yard intervals with 10 traps per sampling site.
2) Measure and record the depth of the water.
3) Using sight, pole, or a lead weight tied to a heavy nylon seine twine probe the river bottom to determine the type of bottom that exists at the sampling site (silt, sand, gravel, stone, etc.) and record on habitat form.
4) Place approximately 1 tablespoon of salmon eggs in the bait jar and screw the top on securely. Thread the clip and the attached seine twine through both ends of the minnow trap as shown in the illustration.
5) Insert the pair of metal hooks on the bottom inside edge of each half of the minnow trap. Once attached these hooks act like a hinge and the trap can be closed and fastened together at the top with the metal clip. Refer to illustration.
6) Toss the trap out into the water so that it becomes oriented length wise with the current. Feed out enough line so that the trap sits on the bottom. (Note-in areas with strong currents, additional weight such as a rock can be placed inside the trap to anchor the trap in place.)
7) Anchor the 5' wooden marker stick in the ground along the river bank as shown in the illustration. Tie the remaining end of the seine twine from the minnow trap to the marker stick. Attach

approximately 1.5 feet of orange surveyors tape to the top of the stick to help identify the spot.

Checking:

1) Minnow traps are rebaited after 24 hours and pulled after 48 hours.

Beach Seine:

Assembly (Figure 7):

Materials:

Two each-8' poles (aluminum or willow)
One each-25' to 100' beach seine, 6' deep, desired mesh size, weighted bottom line and trailing center trap (length, mesh size, depth of seine used to vary with sampling situation. Specs will be entered on data form). Amount of water actually fished will be highly variable in upper sampling areas, i.e., samples not quantitatively comparable.
30'-#36 tarred nylon seine twine

1) Tie each end of the seine net to an 8' pole using the tarred nylon seine twine, aligning the weighted bottom line with the base of each pole.

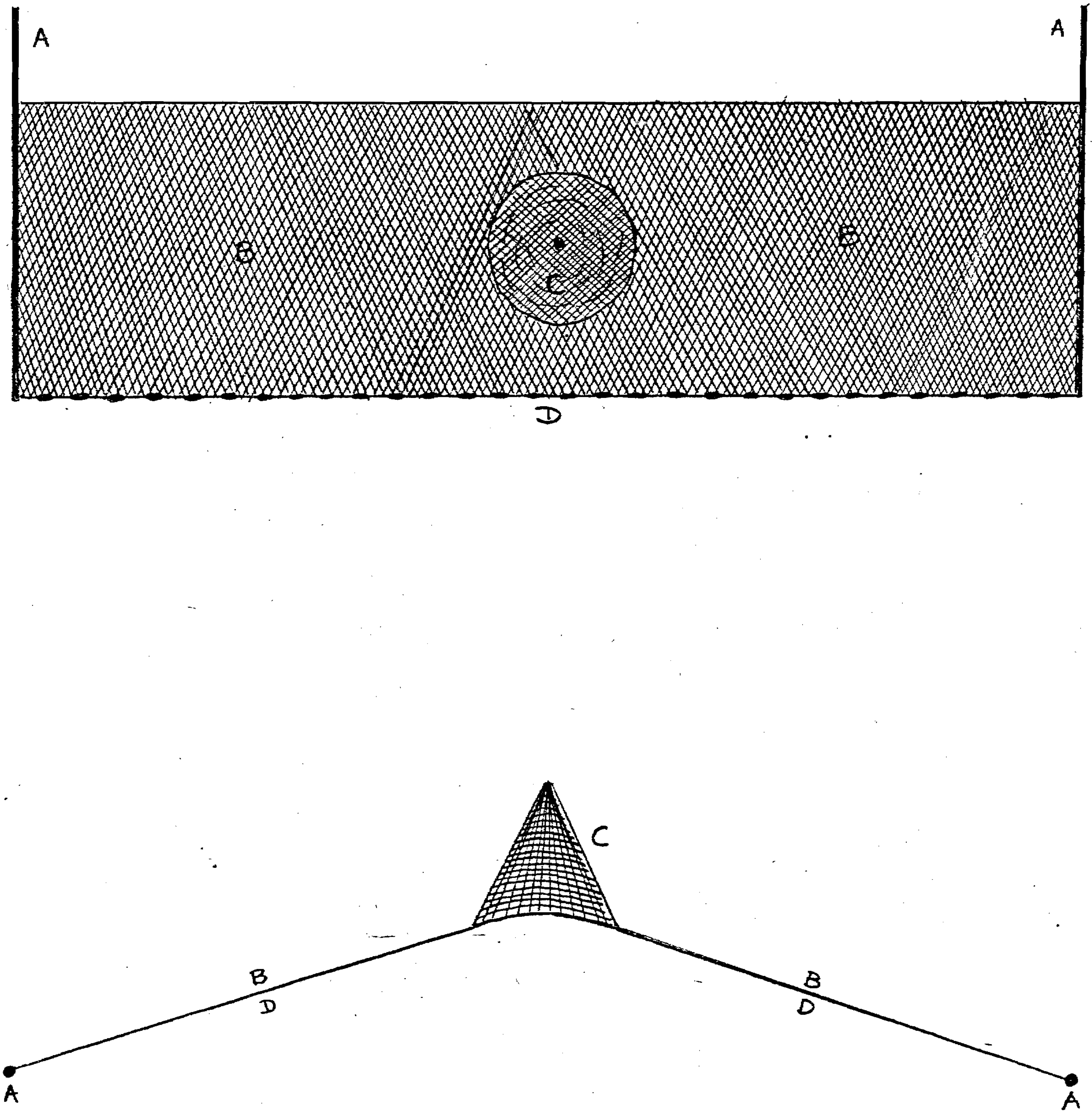
Beach Seine Haul:

Materials:

Two each-crew members equipped with hip boots or chest waders
Two each- 2 1/2 gallon sample buckets
Anesthetic (MS-222 or equivalent)

1) Select a suitable seining area at the sampling site. (Note-the site should be free of debris and snags, and allow safe walking.) ~~conditions.)~~
2) One crew member ~~(A)~~ remains next to shore handling one pole of the seine.
3) The second crew member ~~(B)~~ enters the water channel handling the remaining pole. The seine is stretched between ~~A and B~~ the poles (A) so that the center trap (C) is trailing upstream, (Figure 7 ~~13b~~). (Note-the seine (B) may be rolled onto the poles to decrease the seine length to the desired distance. Roll even quantities of seine net onto both poles to maintain the center trap 1/2 way between each pole.)
4) Both crew members walk at an even pace downstream. (Note-care must be taken to keep the weighted bottom line (D) of the seine in contact with the substrate to prevent fish escapement under the net.)

Figure 7. Beach Seine



5) When the desired distance is sampled, ~~A~~ one crew member stays stationary while ~~B~~ the second crew member walks downstream and toward shore.

6) When 1/2 of the seine length remains between ~~B~~ the second crew member and shore, ~~B~~ he walks towards ~~A~~ the first crew member.

7) Both poles are held together and the seine is brought to shore by grasping the weighted bottom lines and pulling the seine so that the center trap trails the net. (Note-the weighted bottom line must continually remain in contact with the substrate until the seine retrieve is complete.)

8) Place all captured fish into the sampling bucket containing water and anesthetic.

9) Complete desired analysis on fish, return fish to bucket containing clean water, and release fish after anesthetic recovery is complete.

10) Roll net onto poles when sampling is completed and allow beach seine to dry before storing.

Hook and Line:

Assembly:

Materials:

One each-7' casting rod or 8.5' fly rod
One each-medium size casting reel or fly reel
Use 6-30 lb. test for line in casting rod with a lighter test for leader. For fly fishing using floating fly line with 10 inches or lighter test for leader.
One each-tackle box with assorted lures, flies, single hooks, weights, snap swivels, extra line, bail springs, etc.

Setting:

Materials:

Bait-single salmon eggs, salmon eggs in clusters, corn, or artificial lure, etc.

1) Placement of gear. Begin fishing by using a standard method of casting and reeling in. For fly fishing, your technique may vary but your final goal is to catch fish.
2) Select an appropriate hook size and bait or proven artificial lure.
3) Affix the hook and bait or lure to your snap swivel.
4) A sinker may be used when using hook and bait.
5) Note the time and begin fishing until you are successful or change bait, lure, or hook size, or move to a more productive site.

Checking:

1) Record fishing time in 0.25 hour increments.
2) Record hook sizes and bait types or lure sizes and types for each sampling site.

Electroshocker:

Materials and procedures will be provided upon receipt of operating instructions from the manufacturer, Smith-Root, Inc. Information available is attached. (Appendix V, Section B.)

Open Water Gill Net (Drift and Set):

Setting:

Materials:

One each-floating gill net (length, depth, and mesh size vary, gear specifics to be recorded on data sheets).
One each-orange float, 24" in diameter
One each-outboard motor
One each-riverboat
One each-Anchor

1) DRIFT gill nets will be fished by pulling the net out, as nearly perpendicular to the river channel as possible, with the outside end of the float line attached to a buoy and the other end held in the boat. Operate the boat under just enough power to keep the net reasonably straight and perpendicular to the current. Mainstem areas fished by the method should be substantially free of surfact and subsurface debris and sufficiently shallow enough to allow the net to reach within a foot or less of the bottom. Gill nets will be drifted once a maximum of 100 yards at each sampling site.
2) SET gill nets will be deployed by all crews in slack water areas and eddies on Susitna River mainstem.
3) Deploying a gill net is achieved by tying one (1) end of the float line to the shore and "playing out" the net from the side or bow of the boat and then releasing the end of the lead line and float line respectively. Properly positioned, the net should extend offshore in a straight line or with a slight downstream arc.
4) Pulling a set gill net is achieved by taking the anchored end first into the boat and going ashore as you restack the net. Stacking the net is accomplished by coiling the lead line and floating line in two separate piles leaving the net in between.

Checking:

1) DRIFT gill nets are monitored and picked after each drift through the sampling site.
2) SET nets are picked after 24 hours and pulled after 48 hours.

APPENDIX VIII

C. AQUATIC HABITAT AND INSTREAM FLOW STUDIES

Instruction Manual

How The 4041 Works

When the 4041 is in operation, the four parameters are being measured simultaneously at the sonde unit (underwater unit). The resulting signals are transmitted in parallel up the cable to the indicator unit. In the indicator unit, the signals may be amplified or shifted. After this processing, the signals are ready to be selected by the user (via the panel switch) for digital conversion and immediate read-out.

Calibration control(s) for each parameter are provided on the front panel of the indicator unit for user access. These controls are used to adjust the instrument before going to the field. This pre-field calibration adjusts for changes due to new pH fluid, a fresh D.O. membrane, re-polished conductivity electrodes, and so on.

Zero-adjust controls are not provided because the 4041 circuits automatically null any zero-offsets that may appear in the system.

Some Details

Twelve wires connect the sonde unit to the indicator unit: (4) for Conductivity, (1) each for pH, D.O., and Common; (3) for Temperature; and (2) for Power.

Temperature is measured by a high accuracy thermistor, whose resistance goes down as its temperature increases. The thermistor is in the slim stainless steel tube in the bottom of the sonde unit. This single temperature signal is used to generate the automatic temperature compensation for the other three parameters.

Dissolved Oxygen is measured by the popular Clark polarographic cell. It is the plastic device with a gold ring in its end and a dull silver pellet in its center cavity. As oxygen diffuses through the Teflon membrane (according to its partial pressure), it is reduced by a polarizing voltage established between the gold and silver electrodes. This produces a measurable current proportional to the partial pressure. A constant polarizing voltage is maintained by the small, 2.7 volt, mercury battery located in the sonde unit. This battery should be changed approximately every three months. See the maintenance section for directions.

The pH of the sample is measured using a pH-sensitive glass electrode, which due to the sample pH, reaches a certain potential with respect to a reference electrode. This potential is amplified and buffered by the circuits in the sonde unit, and the resulting signal is sent to the indicator unit. The pH electrode is the glass tube with the small bulb on the end. The reference electrode is covered by a larger white plastic cover.

Conductivity is measured using the four-electrode technique. A large enough current is forced between two electrodes, through the resistive sample, to create a certain potential between two other electrodes. The current required to maintain this potential is proportional to the conductivity, and this current is measured for display. The conductivity probe is easily recognizable by its gray epoxy body with four electrodes protruding from it into a white plastic cell.

The display is read in the following manner: temperature, pH and dissolved oxygen are read out directly. For example, a temperature of 21.8°C. will be displayed as 21.8. A D.O. or pH reading of 8.1 will be displayed as 08.1. Conductivity is read out directly on the 2K scale. If the 20K scale is being used the number that is displayed will need to be multiplied by 10. In the 200K scale the reading will be multiplied by 100. For example, suppose the sample being measured has a conductivity of 1527 uS/cm. Using the 2K scale the display will show 1527 (direct read-out). Using the 20K scale the display will show 153 (153 x 10 = 1530 uS/cm.). Using the 200K scale the display will show 015 (015 x 100 = 1500 uS/cm.).

INITIAL PREPARATION

Your system has undergone a thorough calibration and testing procedure immediately prior to shipment. There are a few precautions that should be taken, however, before you attempt to connect the system components for operation:

BATTERY CHARGE: The battery should be fully charged when you receive it. It is advisable however to charge the battery for a period of 24 hours to avoid an unexpected loss of power during operation.

UNDERWATER CONNECTORS: In order to prevent unnecessary abrasion of the sealing surfaces of any underwater connector pair, a very light coating of the underwater connector lubricant should be applied to both sealing surfaces before you attempt to mate them.

CONNECTING THE SYSTEM COMPONENTS

SONDE UNIT TO UNDERWATER CABLE: This paragraph applies only to those units that were ordered with Marine Connectors. Connect the Sonde Unit to the Underwater Cable by carefully aligning and mating the two halves of the 12-pin connector pair. This operation often requires considerable force and care should be taken to expel any air that may be trapped within the connector cavity.

CIRCULATOR MOTOR TO SONDE UNIT: This paragraph applies only to those units that were ordered with a Circulator. Connect the (2-pin) connector that breaks out from the top cap connector to the 2-pin motor lead by aligning the large pin on the male half with the raised nub on the female half. Expel any air that may be trapped within the connector cavity.

BATTERY PACK TO INDICATOR UNIT: Attach the battery cable to the Indicator Unit connector marked "12 VOLTS DC INPUT".

CALIBRATION

The procedures for calibrating the 4041 are simple and easy to perform. However, in order to expect good results in the field, all calibration checks which are pertinent to the measuring systems must be performed. TAKE NO SHORTCUTS. This is important since calibration errors will be reflected in the accuracy of all subsequent measurements.

FREQUENCY OF CALIBRATION: A complete calibration check should be accomplished before going to, and after returning from the field. This dual calibration procedure will afford judgment as to drift due to sensor fouling and to the frequency and type of sensor maintenance required between field operations. Because of a multitude of variables encountered under differing field conditions, there is no rule-of-thumb in establishing: 1) the length of time that a system may be deployed without recalibration or 2) the extent of cleaning and maintenance required between field operations. These judgments are made on a case-by-case basis and should be expected to change in time.

CONDITIONS: The calibration procedures should be carried out in a place where ambient conditions are under control and where there is a readily available supply of distilled or de-ionized water, reliable calibration standard solutions and maintenance items. Generally, the laboratory is best suited but a field office or closed-in shelter will suffice.

REQUIRED MATERIALS: In order to properly calibrate the 4041 the following items will be needed:

1) Calibration Cup
2) Two reliable KCl standard solutions (known conductivity)
3) Two freshly prepared pH buffer solutions. Generally pH 7.0 and either pH 4.0 or 9.18 are used, depending upon the measuring assignment.
4) Distilled Water or De-ionized Water (approx. two liters)
5) Absorbent tissue
6) Two screwdrivers (supplied in Accessory Kit)

CALIBRATION PROCEDURE: At least one hour prior to calibrating the system (preferably the night before), take the following preparatory steps.

1) Remove the "Storage-Cup" from the Sonde Unit.

2) Remove the protective guard from the dissolved oxygen sensor.

3) Install the "Calibration-Cup" on the Sonde Unit and fill to the brim with tap water.

4) Seal the Calibration Cup with the soft plastic cap and store the sonde unit, calibration standards, and the distilled water at constant room temperature for at least one hour in order to bring the various sensors, temperature compensating elements, and the calibration solutions into thermal equilibrium (within a few degrees)

All of the calibration controls are located on the front panel of the Indicator Unit. Adjustments, if necessary, should be made in the following manner:

1) Remove the appropriate seal-screw for the parameter being adjusted.

2) Insert the small screwdriver through the access hole and adjust the calibration control in the direction which brings the reading into agreement with the value of the standard solution being employed.

3) Replace the seal-screw.

A RINSE STEP will be used several times during the calibration procedure. It is to be performed in the following manner: Fill the calibration cup halfway with de-ionized water (or distilled). Snap on the soft plastic cap; shake the sonde unit for ten seconds and then pour out the water. Repeat twice more using fresh de-ionized water. Remove the cup and shake as much of the rinse water as possible from the electrodes.

DISSOLVED OXYGEN CALIBRATION: The Dissolved Oxygen system is the first to be calibrated since the water that has been stored in the calibration cup is used to maintain control of the temperature inside the cup. The calibration standard is "water-saturated air at the temperature of the D.O. cell".

Invert the Sonde Unit and remove the soft plastic cap. Pour off enough water to bring the level to just below the D.O. membrane-retaining O-ring. With a clean paper towel or tissue blot any moisture from the D.O. membrane. Cover the calibration cup mouth with one of the hard plastic caps provided in the Accessory Kit. This will keep drafts from blowing on the membrane. <u>Do not</u> seal the cup with the soft plastic cap, because that could cause a partial-pressure change in the cup. Wait approximately 5 minutes, or until the reading is stable, then switch to the TEMPERATURE position and record the temperature reading. Refer to the solubility table for the correct oxygen concentration at this temperature. Since the table values refer to concentrations at Standard Pressure it will be necessary to correct the value for local barometric pressure. This should be done in the following manner:

Correct D.O. Setting = (Pressure/760mm) x (Table value at Cup Temperature)

EXAMPLE: If T = 28.7^{o}C and Pressure = 800mm,

Correct D.O. Setting = (800mm/760mm) x (7.67mg/l) = 8.07mg/l

If you don't have a barometer, the equivalent pressure may be estimated from your altitude by recalling that atmospheric pressure drops from standard sea-level pressure (760mm Hg) at the approximate rate of 2.5mm for every 100 feet of elevation. Therefore, the approximate atmospheric pressure at an altitude of 1240 feet, for example, would be: Local Atmospheric Pressure = 760mm - (2.5 x 12.4) = 729mm Hg.

Adjust the Dissolved Oxygen calibration control until the proper value (rounded to nearest tenth) is displayed. Pour out the water; and then follow with the RINSE STEP.

pH CALIBRATION: Calibrating the pH system requires the use of two pH buffer solutions. Depending upon the application, either pH 4.0 or pH 9.18 is used in addition to pH 7.0. Invert the Sonde Unit and fill the calibration cup with fresh pH 7.0 buffer solution. Switch to "pH", and wait approximately 5 minutes for thermal equilibrium. Then adjust the pH Calibration control until 7.0 is displayed on the read-out.

Pour out the 7.0 buffer and repeat the RINSE STEP. Invert the Sonde Unit and screw on the calibration cup; fill with 9.18 or 4.0 buffer. After approximately 5 minutes, adjust the pH "Slope" control until either 9.2 or 4.0 is displayed on the read-out. Pour out the buffer and repeat the RINSE STEP <u>Two Times</u>.

CONDUCTIVITY CALIBRATION: After the second RINSE STEP, take a clean paper towel or tissue, and blot most of the moisture in the electrode area so that the standard will not suffer dilution.

Install a clean calibration cup and invert the Sonde Unit. The Conductivity system is calibrated using at least two prepared KCl standard solutions with a known conductivity at 25^{o}C. From the table select two standard solutions with values of approximately one third and two thirds of the range you are most likely to encounter in the field. For example, if you are going to be working in fresh water (0-2K scale) you would want to use a 0.01M standard and a 0.005M standard. Select the more concentrated of the two standards and pour it slowly down the side of the calibration cup until full. If there are any bubbles in the bores of the conductivity cell block, fill the calibration cup again. When the reading is stable, adjust the Conductivity calibration control until the display matches the value listed in the table. Empty the calibration cup and repeat the RINSE STEP Two times. Pour in the second standard. Check the reading on the Display. It should be correct within ± 1% of the range being used. For example, if the 0-2K scale is used the reading for the second standard should be correct ± 20uS/cm. Pour out the standard solution.

TEMPERATURE CALIBRATION: The Temperature system is factory calibrated and is accurate to ± 0.2°C. No calibration adjustment is provided. A periodic check of the temperature system against a customer-owned ASTM thermometer could be helpful in detecting a system malfunction. Twenty minutes in a large, vigorously-stirred bath is necessary.

FINAL PREPARATION

Turn the system off and disconnect the system components. Replace all rubber dust caps. Remove the Calibration Cup from the Sonde Unit and replace the protective guard on the dissolved oxygen electrode. Install the Storage Cup, filled with tap water, onto the Sonde Unit. The system is now calibrated and ready for transport to the field.

FIELD OPERATION

Remove the Storage Cup from the calibrated Sonde Unit and install the guard or the optional sample circulator. Connect the system components. Lower the Sonde Unit into the water (sideways, if possible) and shake it to dislodge air bubbles trapped in the conductivity cell block. Release the Sonde

Unit and lower it to sample depth. Wait until the readings stabilize (D.O. is the best indicator), then record the value for each parameter. Repeat at new depths or locations.

Fig. 1 provides the user with a way to determine sea water salinity from the Conductivity readings obtained via the 4041. Fig. 2 allows the user to correct Dissolved Oxygen readings for the "salting-out" effect of ionic solutions. The Dissolved Oxygen correction factor is temperature-dependent, so use the appropriate curve. The 25°C curve should always be used in Fig. 1, however.

Check the battery voltage occasionally; charge or change batteries if the level drops below 10.5 volts. DO NOT charge the battery routinely after each day's use. Doing so may shorten the life of the battery. Use the battery until the voltage level drops to between 10.5 and 11.0 volts. At this point put the battery on charge for 24 hours.

The instrument case is hermetically sealed against moisture and dust. As long as the case seals are intact, the 4041 may be operated without harm in heavy rain or spray. The liquid crystal display is protected during cold weather by a built-in heater circuit which is automatically energized when temperatures drop below freezing. As long as the external battery is connected to the instrument the liquid crystal display is protected against freezing, down to a temperature of -20°C.

STANDARD MAINTENANCE

As long as the 4041 is functioning properly there is no need to perform the following maintenance procedures. However, in the event of biological or chemical fouling these steps are necessary to restore the measuring elements to like-new condition.

Servicing the Probes:

1) Remove the conductivity cell block by unscrewing the two screws that hold it to the gray epoxy electrode mount. Carefully remove the O-rings from the electrodes. Polish the electrodes with a strip of fine emery cloth, being careful not to scratch the nearby pH bulb. Polish the entire surface of each electrode, including the ends. Now, rinse any sanding residue away from the Conductivity electrodes, and push the O-rings onto the electrodes. Carefully re-install the cell block and tighten it until the O-rings are about 2/3 as thick as they were when not compressed.

2) Remove the reference electrode sleeve by pointing it toward the floor (it's full of buffer solution) and twisting it while pulling downward (it's held on by a single O-ring). Discard the old buffer. Fill the reference electrode sleeve to the brim with fresh pH 7.00 buffer solution. Without tilting it, push it back on until it seals on the O-ring. Invert the assembly (sleeve pointing up now). Push and twist the sleeve down until it butts against the bottom cap. The 7.00 buffer solution should have bubbled through the porous tip of the sleeve; if not, repeat the procedure. For illustration, please refer to Figure 4.

3) Remove the Dissolved Oxygen cell guard. Remove the D.O. cell membrane-retaining O-ring. Discard the old membrane and shake out the old electrolyte solution. With the gold electrode facing up, hold a membrane against the side of the D.O.

cell with a thumb. Using the other hand, fill the cell cavity with fresh D.O. electrolyte. If a bubble is visible in the cell beneath the silver pellet electrode, shake out the cell and refill the cavity slowly. Overfill the cavity, creating a high meniscus, then (still holding the membrane with a thumb) grasp the free end of the membrane and pull it quickly and tightly over the meniscus. Please refer to Figure 3.

A quick firm pull is necessary to prevent wrinkling and additional bubble entrapment. If bubbles are visible beneath the membrane, or if tiny wrinkles are visible just outside the gold ring, start over with a new membrane. Otherwise, secure the membrane by rolling the membrane O-ring over the membrane, into its groove. Check the membrane again for wrinkles, then trim the excess membrane. Replace the D.O. guard.

4) Screw on the calibration cup and fill it about half full of water. Add some detergent. Install the soft plastic cap and shake the sonde unit for 20-30 seconds. Pour out the soapy water. Fill the calibration cup half full of clean water; install the soft plastic cap and shake it for 10 seconds. Pour out the water and repeat twice using clean water each time. Remove the calibration cup. Fill the storage cup three-quarters full of clean water and screw it onto the sonde unit.

   NOTE: If the sonde unit is to be stored for several days or more, add some Alconox or similar detergent to the water in the storage cup. This will help retard biological growth.

SERVICING THE D.O. POLARIZING BATTERY:

1) Remove the two allen-head screws from the top of the sonde tube.
2) Pull off the top cap by grasping the exposed plastic portion. (It might be helpful to insert the tip of a small screw-driver between the tube and top cap to start the process) DO NOT pull on the connector.
3) Remove the battery retaining clip and install the new battery. Replace the retaining clip.
4) Make sure the sealing O-rings on the top cap are clean. Clean off any residue that may be present inside the tube.
5) Take a small amount of the white O-ring grease and smear a light coating on the O-rings and on the sealing surface of the tube.
6) Install the top cap and screws.
7) Hold the sonde unit up to the light, in a horizontal position, and check to see that all of the O-rings have made a good seal. If not repeat steps 1, 2, 6, and 7.

COMMON PROBLEMS AND SOLUTIONS

SYMPTON	CAUSE	SOLUTION
(1) D.O. Reads Low	Low Battery in Sonde Unit.	.Confirm battery voltage is 2.7v
	Insufficient Stirring.	.Check to see that Circulator is working properly i.e. No shorts in the motor lead
	Contaminated Cell or Membrane.	.Replace the membrane
(2) D.O. Reads "00.0"	Mercury Battery in Sonde Loose	.Open sonde and check connection and voltage on mercury battery, replace battery or secure connection
	No Power to Sonde Board.	.For power problems, consult factory
(3) D.O. Too High to Calibrate	Wrong Membrane (Too Thin), Membrane Stretched Too Tight, Hole in Membrane, Wrinkle in Membrane	.Replace membrane making sure the membrane is from a packet marked "standard"
(4) D.O. Reads abnormally high or low (EX: 55.0mg/l)	Dead Battery in Sonde Unit	.Replace mercury battery
	No Power to Sonde Board.	.For power problems, consult factory
(5) D.O. Reading Drifts or is unstable during Calibration	Contaminated Membrane.	.Replace Membrane
(6) D.O. Reading Drifts or is unstable In-Situ	Air Bubble on Outside of Membrane.	."Jig the sonde unit up and down in the water to dislodge any trapped bubbles
	Contaminated Membrane.	.Replace Membrane
	Erratic Circulation.	.Check circulator operation, or if no circulator, maintain circulation of at least 1 FPM.

	SYMPTOM	CAUSE		SOLUTION
1)	pH Slope Will Not Adjust to 9.2 or 4.0	Bad Buffer	. . . .	Mix up new Buffer and repeat
		Clogged Reference Junction or Buffer Solution inside Reference is bad	.	Refill reference probe with fresh pH 7.0 Buffer
		Cracked or Scratched pH Bulb	. . . . .	Check pH Probe for scratches, cracks, or internal bubbles. If pH Probe is bad consult factory for replacement.
2)	pH Response very slow	Clogged Reference Junction, Cracked or Scratched pH Bulb	. . . . .	Please refer to #1 above.
3)	pH Won't Respond	Cracked Bulb; No Power to Sonde Board		Consult factory for replacement of broken Probe or power problems
		Reference Filling Solution Low	. . . .	Refill Reference Probe with fresh pH 7.0 Buffer.
4)	pH Unstable	Bubble in pH Bulb; Cracked or Scratched pH Bulb	. . . .	Consult factory for pH Probe replacement
		Clogged Reference Junction	. . . . . .	Refill Reference with fresh pH 7.0 Buffer
		Loose Reference Sleeve	. . . .	Make sure the Reference Sleeve is seated tightly over the O-Ring
5)	pH Negative or Over 14	No power to Sonde Board; Electrode(s) Disconnected	. . . .	Consult factory for repair checks
		Electrode(s) Not in Solution	. . . . .	Make sure Probes are in solution

SYMPTOM	CAUSE	SOLUTION
1) Conductivity Reads Low In-Situ or during Calibration	Bubble in Cell Bore or in Probe Area of Sonde Unit	"Jig" the Sonde Unit up and down in the water to dislodge any trapped bubbles
	Dirty Electrodes	Clean the Electrodes
	Bad Calibration	Recheck Calibration with fresh standards
2) Conductivity Unstable In-Situ or during Calibration	Bubble in Cell Bore; Bubble in Probe Area of Sonde Unit	Dislodge any Bubbles as described in #1 above
	Cell Block Loose	Check Cell Block to see that it is secure
	Dirty Electrodes	Clean the Electrodes and recalibrate
3) Conductivity Does Not Fall Into Specs ($\pm$1.0% of Range) During Calibration	Bubble in Cell Bore	Check for Bubbles and dislodge any that are present
	Dirty Electrodes	Clean the Electrodes
	Bad Standard	Mix new standards and recalibrate

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TABLE OF OXYGEN SOLUBILITY @ 0 o/oo CHLORINITY, 760mm Hg

TEMP.	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	14.16	14.12	14.08	14.04	14.00	13.97	13.93	13.89	13.85	13.81
1	13.77	13.74	13.70	13.66	13.63	13.59	13.55	13.51	13.48	13.44
2	13.40	13.37	13.33	13.30	13.26	13.22	13.19	13.15	13.12	13.08
3	13.05	13.01	12.98	12.94	12.91	12.87	12.84	12.81	12.77	12.74
4	12.70	12.67	12.64	12.60	12.57	12.54	12.51	12.47	12.44	12.41
5	12.37	12.34	12.31	12.28	12.25	12.22	12.18	12.15	12.12	12.09
6	12.06	12.03	12.00	11.97	11.94	11.91	11.88	11.85	11.82	11.79
7	11.76	11.73	11.70	11.67	11.64	11.61	11.58	11.55	11.52	11.50
8	11.47	11.44	11.41	11.38	11.36	11.33	11.30	11.27	11.25	11.22
9	11.19	11.16	11.14	11.11	11.08	11.06	11.03	11.00	10.98	10.95
10	10.92	10.90	10.87	10.85	10.82	10.80	10.77	10.75	10.72	10.70
11	10.67	10.65	10.62	10.60	10.57	10.55	10.53	10.50	10.48	10.45
12	10.43	10.40	10.38	10.36	10.34	10.31	10.29	10.27	10.24	10.22
13	10.20	10.17	10.15	10.13	10.11	10.09	10.06	10.04	10.02	10.00
14	9.98	9.95	9.93	9.91	9.89	9.87	9.85	9.83	9.81	9.78
15	9.76	9.74	9.72	9.70	9.68	9.66	9.64	9.62	9.60	9.58
16	9.56	9.54	9.52	9.50	9.48	9.46	9.45	9.43	9.41	9.39
17	9.37	9.35	9.33	9.31	9.30	9.28	9.26	9.24	9.22	9.20
18	9.18	9.17	9.15	9.13	9.12	9.10	9.08	9.06	9.04	9.03
19	9.01	8.99	8.98	8.96	8.94	8.93	8.91	8.89	8.88	8.86
20	8.84	8.83	8.81	8.79	8.78	8.76	8.75	8.73	8.71	8.70
21	8.68	8.67	8.65	8.64	8.62	8.61	8.59	8.58	8.56	8.55
22	8.53	8.52	8.50	8.49	8.47	8.46	8.44	8.43	8.41	8.40
23	8.38	8.37	8.36	8.34	8.33	8.32	8.30	8.29	8.27	8.26
24	8.25	8.23	8.22	8.21	8.19	8.18	8.17	8.15	8.14	8.13
25	8.11	8.10	8.09	8.07	8.06	8.05	8.04	8.02	8.01	8.00
26	7.99	7.97	7.96	7.95	7.94	7.92	7.91	7.90	7.89	7.88
27	7.86	7.85	7.84	7.83	7.82	7.81	7.79	7.78	7.77	7.76
28	7.75	7.74	7.72	7.71	7.70	7.69	7.68	7.67	7.66	7.65
29	7.64	7.62	7.61	7.60	7.59	7.58	7.57	7.56	7.55	7.54
30	7.53	7.52	7.51	7.50	7.48	7.47	7.46	7.45	7.44	7.43
31	7.42	7.41	7.40	7.39	7.38	7.37	7.36	7.35	7.34	7.33
32	7.32	7.31	7.30	7.29	7.28	7.27	7.26	7.25	7.24	7.23
33	7.22	7.21	7.20	7.20	7.19	7.18	7.17	7.16	7.15	7.14
34	7.13	7.12	7.11	7.10	7.09	7.08	7.07	7.06	7.05	7.05
35	7.04	7.03	7.02	7.01	7.00	6.99	6.98	6.97	6.96	6.95

CONDUCTIVITIES OF POTASSIUM
[illegible]RID[illegible]OLUT[illegible]S A[illegible]°C
M.W. = 74.555

CONDUCTIVITY READING ON
[illegible]041 [illegible]PLA[illegible]DR [illegible]EN
RANGE SETTING (uS/cm)

TABLE OF CONDUCTIVITY CALIBRATION STANDARDS

CONC. M	GRAMS/L KCl	uS/cm	(0-2K)	(0-20K)	(0-200K)
0.0005	0.03728	73.9			
0.001	0.07456	147.0	147		
0.002	0.1491	292.0	292		
0.005	0.3728	717.8	718		
0.01	0.7456	1.413K	1413	141	
0.02	1.491	2.767K	---	277	
0.05	3.728	6.668K	---	667	
0.1	7.456	12.90K	---	1290	129
0.2	14.911	24.82K	---	---	248
0.5	37.278	58.64K	---	---	586
1.0	74.555	111.9K	---	---	1119

NOTES: (1) Two conductivity standards are recommended for each range setting (boxed-in values). Make calibration adjustments with the higher concentration and check with the lower concentration.

(2) Shaded areas are not recommended for calibration checks.

CUSTOMER SERVICE

In the event of instrument malfunction, please notify HYDROLAB immediately by telephone (512) 255-8841. If telephone assistance will not suffice, authorization for the return of any part or all of the system will be given with instructions for shipping under a Returned Goods Authorization Number. (RGA No.________).

Upon authorization, goods should be shipped by:

1) UPS, AIR FREIGHT, FEDERAL EXPRESS, OR MOTOR FREIGHT TO:

   HYDROLAB CORPORATION
   12921 BURNET ROAD
   AUSTIN, TEXAS 78759

   ATTN: SERVICE DEPARTMENT
   RGA No.___________

2) Shipment of goods by US Mail is NOT AUTHORIZED.

3) All shipments must be shipped PREPAID and INSURED unless otherwise agreed in advance.

4) For Technical or Applications Assistance please contact HYDROLAB by Telephone (512) 255-8841.

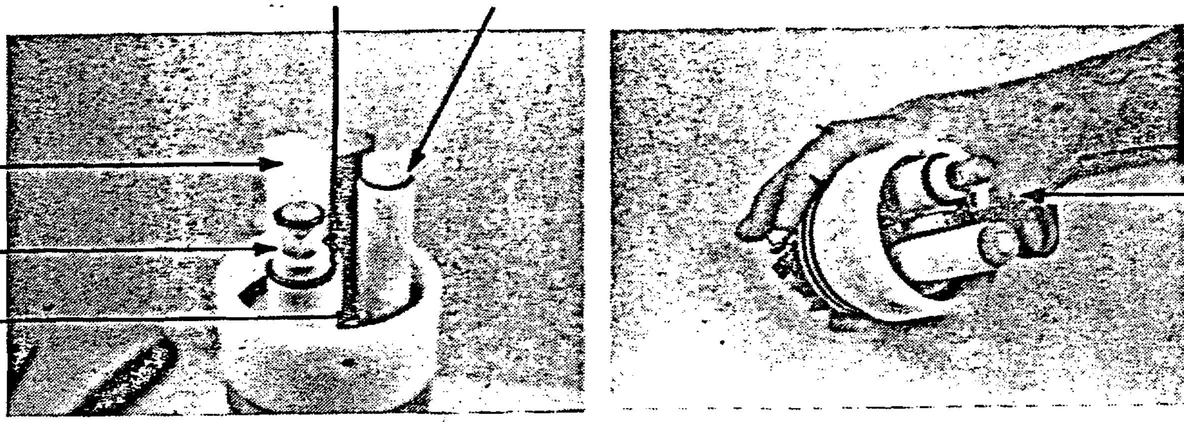
APPLICATION NOTE: (4000 SERIES INSTRUMENTS) January, 1980

USING CABLES LONGER THAN 100 METERS

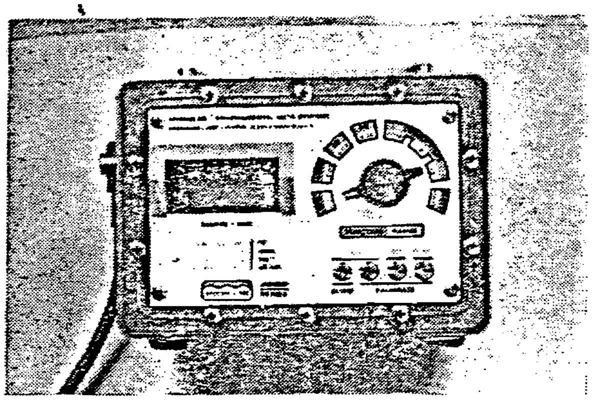
Due to cable capacitance, cable combinations that exceed 100 meters in length will slightly decrease the accuracy of measurements in the 0-2K conductivity range. The 0-20K and 0-200K ranges will not be affected.

For best results on the 0-2K range:

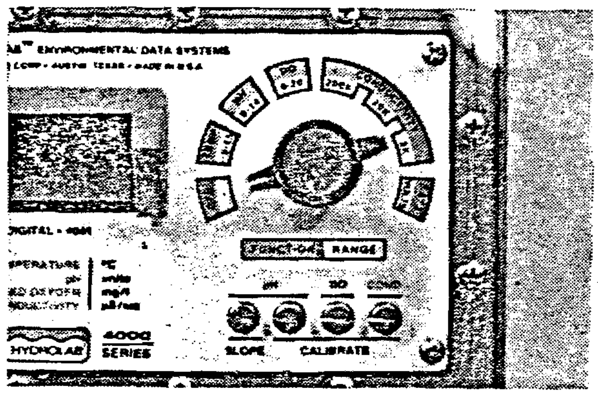
1) Re-calibrate the conductivity circuit when changing from a short cable to a long cable, or vice-versa.
2) When using the long cable, note the conductivity reading with the conductivity cell dry. Subtract this reading from subsequent measurements.



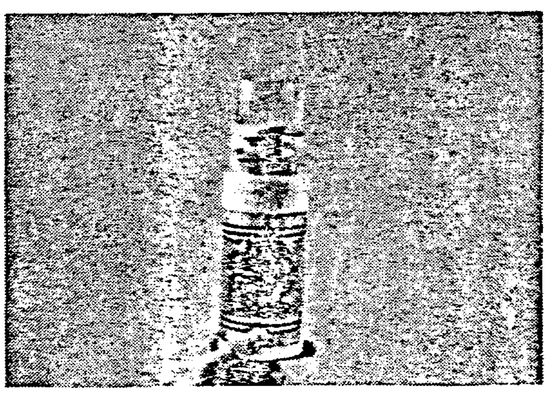
..4041 PROBE ASSEMBLY



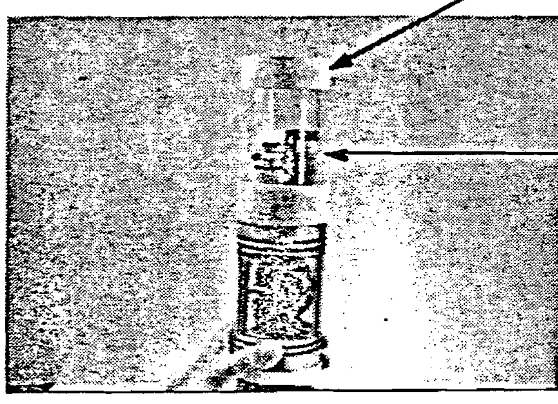
..4041 INDICATOR UNIT



CALIBRATION CONTROL
SEAL SCREWS

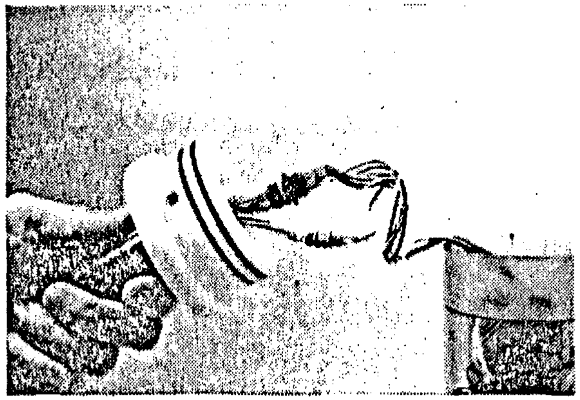


SONDE UNIT IN THE
INVERTED POSITION.

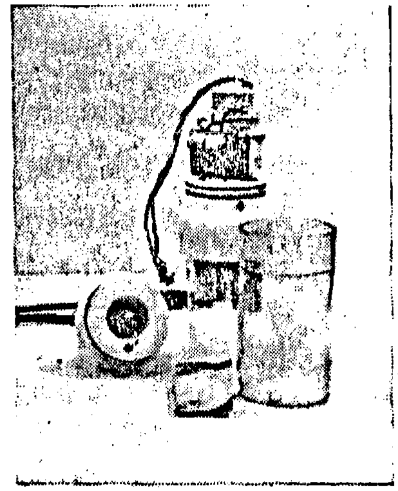


SONDE UNIT INVERTED
FOR D.O. CALIBRATION.

REMOVE TOP CAP.
STEP 1

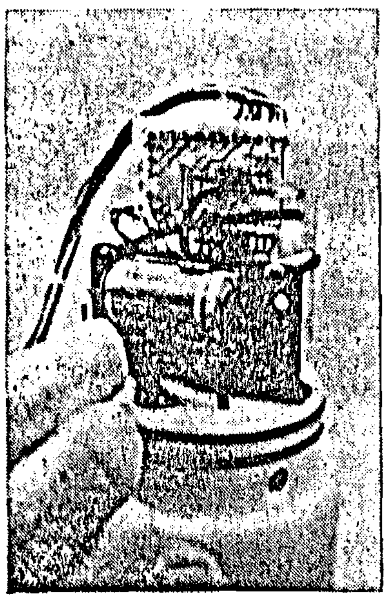


10 PIN & 2 PIN CONNECTORS
(DISCONNECT THESE)
STEP 2

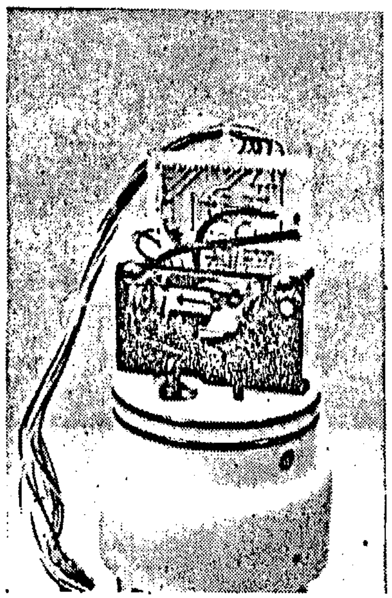


SONDE WITH TUBE AND
DESICCANT REMOVED
STEP 3

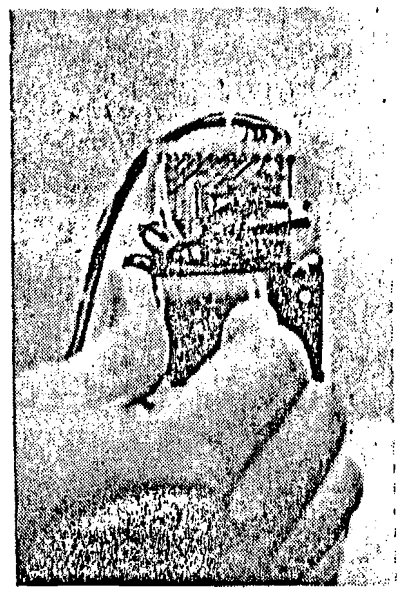
100 22



REMOVE BATTERY RETAINER
CLIP.
STEP 4

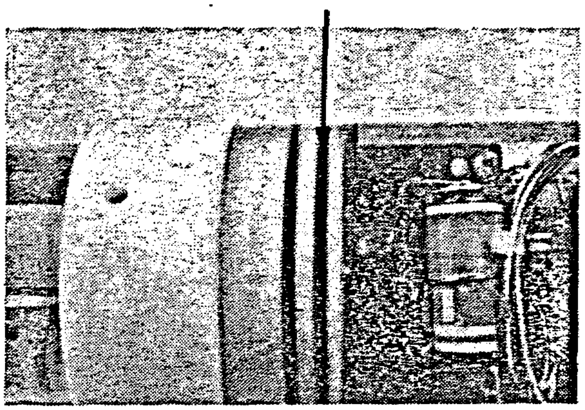


BATTERY REMOVED.
NOTE: POLARITY MARKERS
STEP 5



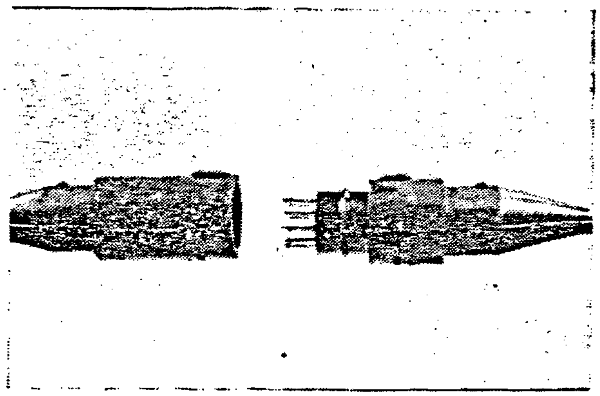
INSTALL NEW
BATTERY
STEP 6

NOTE: SEAL



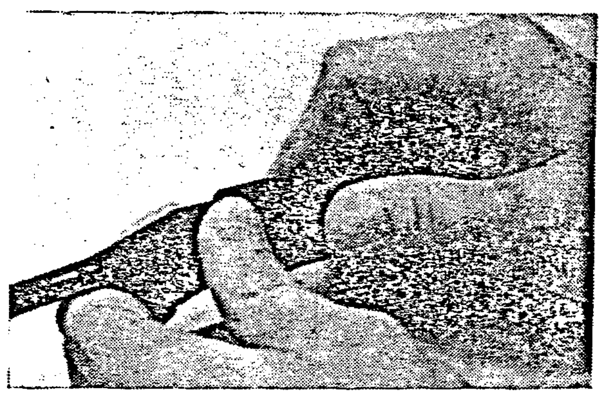
CHECK O-RING SEAL AFTER
SONDE IS RE-ASSEMBLED.

INSTALLING MARINE CONNECTORS



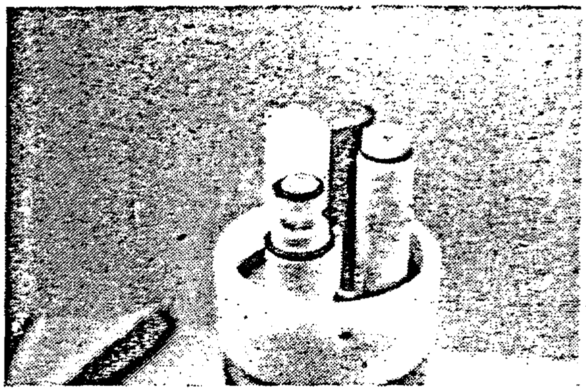
ALIGN THE RAISED NUBS AND
PUSH STRAIGHT TOGETHER.
DO-NOT-BEND
STEP 1

EXPEL TRAPPED AIR WHILE
PUSHING THE CONNECTORS TOGETHER.
STEP 2

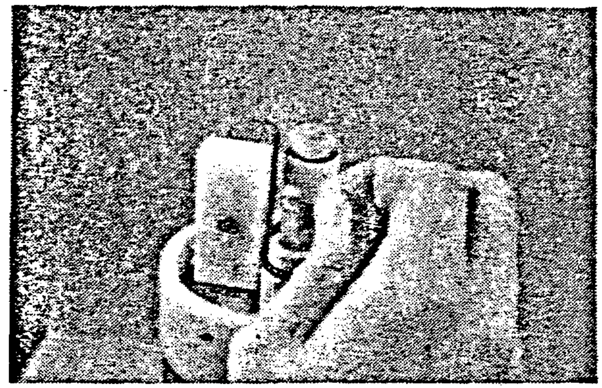


EXPEL TRAPPED AIR AGAIN
AFTER CONNECTION IS COMPLETE.
STEP 3

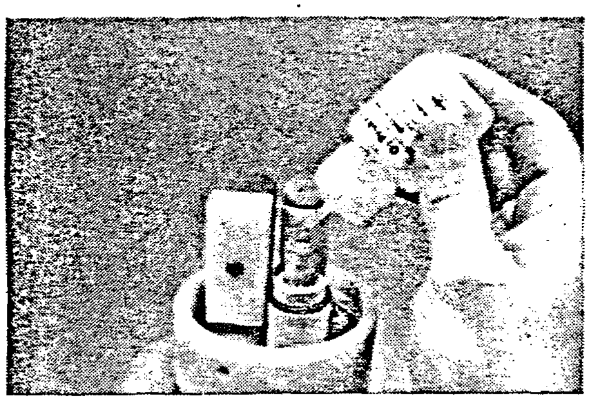
CHANGING THE D.O. MEMBRANE



D.O. PROBE READY FOR
MEMBRANE REMOVAL
STEP 1

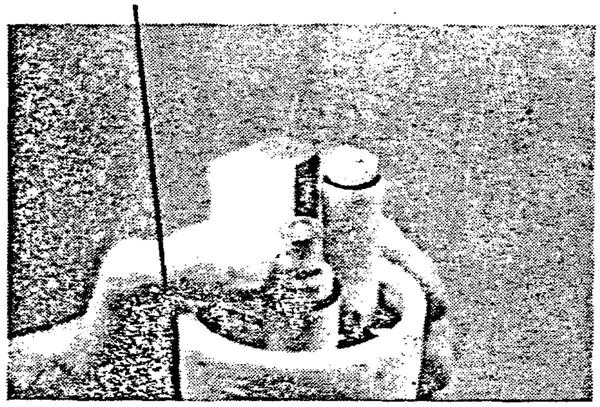


REMOVE OLD MEMBRANE
STEP 2

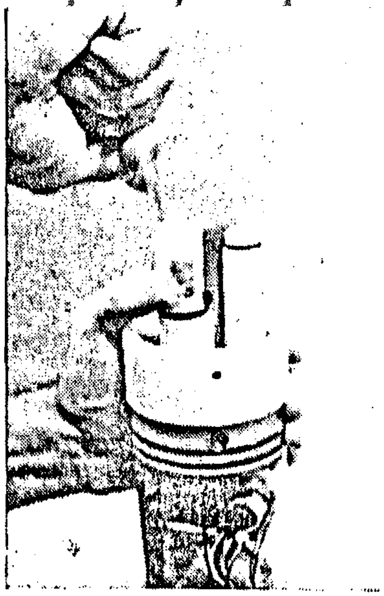


REFILL THE D.O. CELL
WITH FRESH ELECTROLYTE
STEP 3

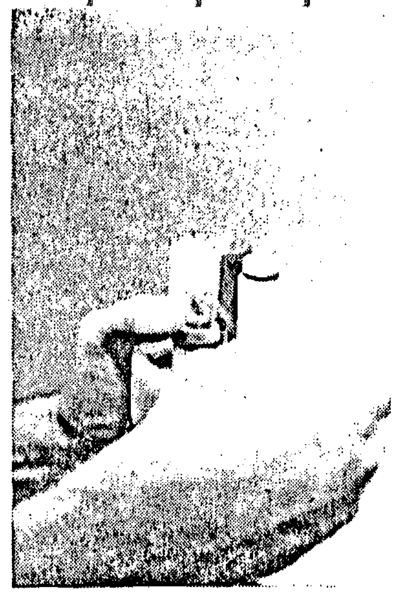
NOTE: MEMBRANE



READY TO INSTALL
NEW MEMBRANE
STEP 4

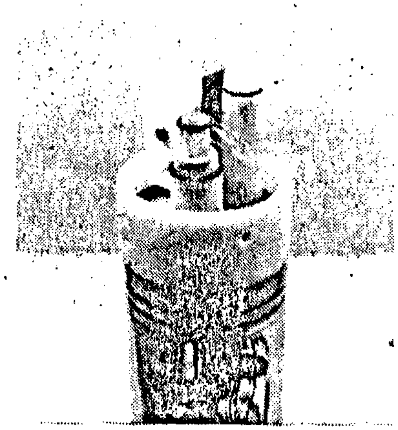


MEMBRANE READY TO BE
STRETCHED INTO PLACE
STEP 5



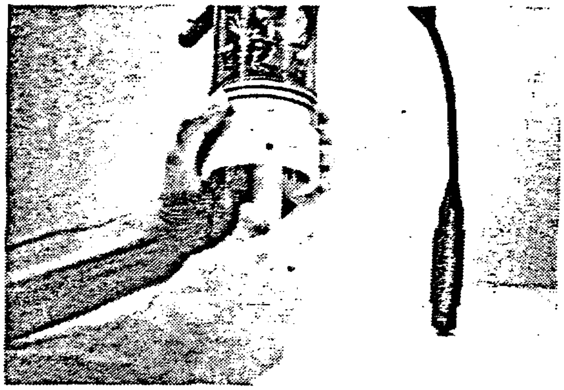
WITH QUICK OVER-AND-DOWN
MOTION, STRETCH
MEMBRANE OVER CELL.
STEP 6

HOLD MEMBRANE TIGHTLY ON
BOTH SIDES OF THE PROBE.
INSTALL RETAINING O-RING.
STEP 7

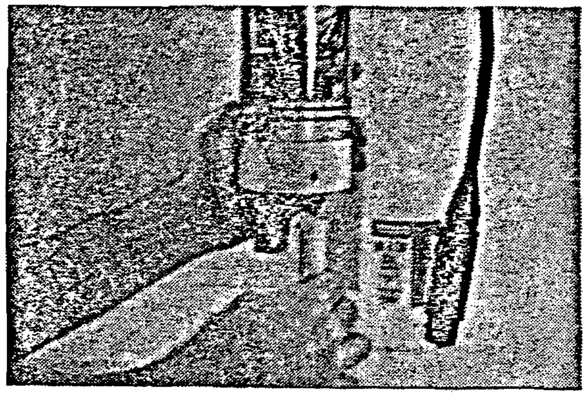


NEW MEMBRANE INSTALLED.
TRIM OFF EXCESS.
STEP 8

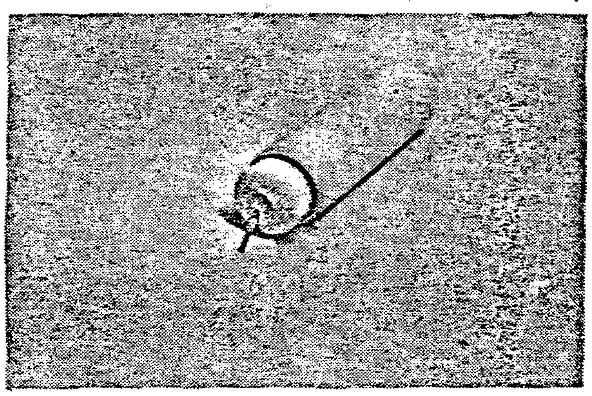
SERVICING THE pH REFERENCE PROBE



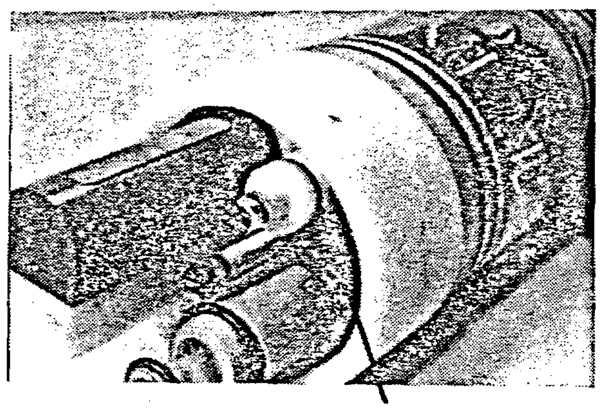
REMOVE THE REFERENCE SLEEVE.
STEP 1



REFERENCE PROBE WITH SLEEVE REMOVED.
STEP 2

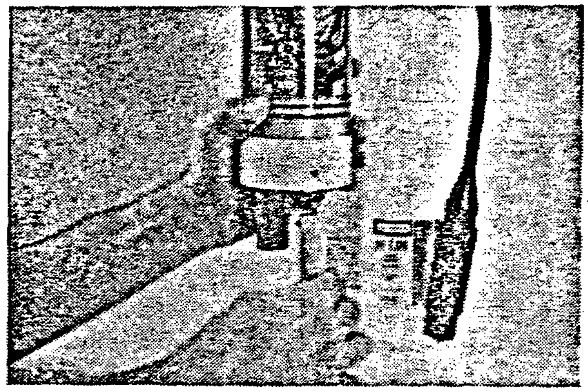


REFERENCE SLEEVE.
(NOTE: TEFLON JUNCTION)
STEP 3

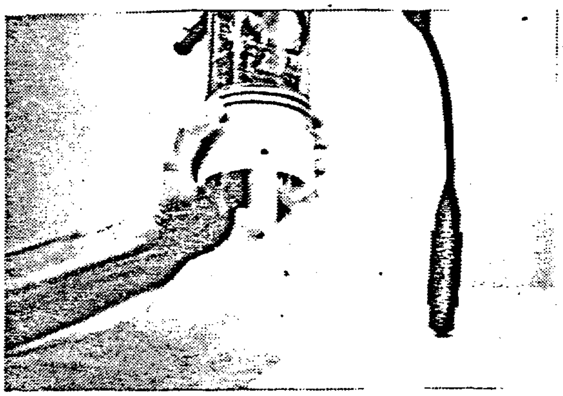


REFERENCE PROBE O-RING
THE OUTER SLEEVE SEALS
ON THIS O-RING.
STEP 4

REFILL SLEEVE WITH FRESH pH 7.0
BUFFER (CREATE A MENISCUS).
STEP 5



BEGIN REPLACING THE REFERENCE SLEEVE.
STEP 6



PUSH THE REFERENCE SLEEVE ON
UNTIL IT SEALS ON THE O-RING.
STEP 7

INVERT SONDE UNIT AND PUSH
REFERENCE SLEEVE BACK INTO PLACE.
STEP 8

Techniques of Water-Resources Investigations of the United States Geological Survey

Chapter B2

CALIBRATION AND MAINTENANCE OF VERTICAL-AXIS TYPE CURRENT METERS

By George F. Smoot and Charles E. Novak

Book 8

INSTRUMENTATION

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SYMBOLS AND UNITS

Symbol	*Definition*	*Unit*
C	Constant.	
K	Proportionality constant.	
N	Angular velocity of meter rotor.	revolutions/sec
V	Velocity.	ft/sec

CALIBRATION AND MAINTENANCE OF VERTICAL-AXIS TYPE CURRENT METERS

By George F. Smoot and Charles E. Novak

Abstract

The purpose of this chapter is to describe the procedures used in the manufacture and calibration of current meters and to present in detail information pertinent to their proper maintenance and repair. Recent intensive studies on the calibration of current meters and the effects of wear of the component parts on the performance of the meters have led to the adoption of new procedures for the manufacture, calibration, maintenance, and repair of meters. This chapter, therefore, updates the provisional manual "Care and Rating of Current Meters" (1957) by including these new procedures.

Introduction

Precision instruments and their proper use and maintenance are prerequisites for the collection of accurate data. Current meters are precision instruments and their proper use and maintenance are doubly important because of the hard usage often received by them in measuring stream velocities. The following quotation from an earlier provisional manual emphasizes the importance the Water Resources Division attaches to this aspect of streamflow measurements:

> The operation of a current meter, as of any scientific instrument, will be largely affected by the way in which it is used. While the design, material, and construction of the meter may be large factors in its successful operation, these factors may not prevent errors due to improper care and use of the instrument. In this connection each fieldman is urged to use the greatest possible care to see that his meter is kept in proper condition.

The condition of the fieldman's current meter is one of the most important building stones in the foundation of good streamflow records. Routine servicing, inspection for minor damage, and proper lubrication should be standard operating procedure. The amount of pride taken in maintaining his meter in optimum condition is also a measure of the pride a man can be expected to take in other areas of his work.

This chapter updates the provisional manual "Care and Rating of Current Meters" (1957, out of print).

Description of the Small Price Current Meter

Rotating-element current meters can be broadly classified into two general categories according to the orientation of the revolving axle; the axis may be vertical, or it may be horizontal and parallel to the direction of flow. Current meters having horizontal axes with propeller—shaped rotors and those having vertical axes with cup or vane-type rotors have been experimented with extensively to determine their respective advantages and disadvantages.

Although many characteristics of different current meters are still unknown, the experiments and investigations thus far conducted are conclusive in one respect, namely, that current meters of either the horizontal- or vertical- axis type when carefully designed and constructed, and when used under favorable conditions, will measure accurately the velocity of flowing water.

When streamflow investigations were undertaken by the Geological Survey in 1888, engineers of the Survey began experimenting with the various types of current meters available at that time to find one that could be used under a wide variety of field conditions. About 1896, as a result of these investigations, they developed a meter containing certain features of the Price acoustic and the large Price electric meters. This meter, which was called the small Price (fig. 1), has since been used by the Survey almost exclusively because of its adaptability to general stream gaging.

The small Price current meter probably has been used more extensively and has been subjected to more investigation than any other type of current meter. As a result of this extensive investigation and because of the natural advantages afforded by the type, the small Price has been perfected in its details; the type-AA Price meter is now better suited to general use than any other meter. It is light and yet strong, sensitive yet durable. It will measure with a high degree of accuracy velocities ranging from 0.1 foot per second to more than 20 feet per second. It is easily repaired, it can be quickly taken apart for cleaning and oiling, and it can be quickly reassembled without change in rating.

To properly use and care for a current meter, the user must be familiar with all of its parts, as well as with the assembled meter. If any part fails completely because of excessive wear or damage, the condition is usually obvious, but small irregularities that may introduce large percentage errors in velocity determinations are not always readily detected. For this reason the parts of the type-AA meter and their functional characteristics are described; the numbers assigned to the various parts in this description correspond to the numbers used in the assembly diagram of the type-AA current meter shown in figure 2.

Yoke

The yoke (8) is a 1-piece horseshoe-shaped casting made of chromium-plated bronze. A short horizontal rear extension contains a hole for connection of the tailpiece. This extension contains two bosses—one which is slotted vertically and and drilled horizontally for the hanger and hanger screw, and one which is drilled vertically for the keeper screw of the tailpiece. The slot for the hanger is of such dimensions as to limit the tilting of the meter so that neither the yoke nor the tailpiece will strike the weight. The upper arm of the yoke is drilled to receive the stem of the P-shaped contact chamber; the lower arm is drilled to receive the pivot. These holes are coaxial so as to properly aline the rotor assembly and the pivot. The contact chamber and pivot are held in position by a keeper screw having a knurled fillister head.

Tailpiece

The tailpiece is made of a hard-rolled nickel-plated brass, and it consists of two separate vanes which, when assembled, are locked together at right angles to each other by means of a lever arrangement. This two-piece construction permits the tailpiece to be taken apart readily for convenience in packing. The nosepiece of the tail fits into the rear extension of the yoke. A means to balance the meter assembly is provided in the lower part of the tailpiece by a long horizontal slot containing a short heavy screw that may be adjusted to the proper position to obtain the desired balance.

Bucket wheel

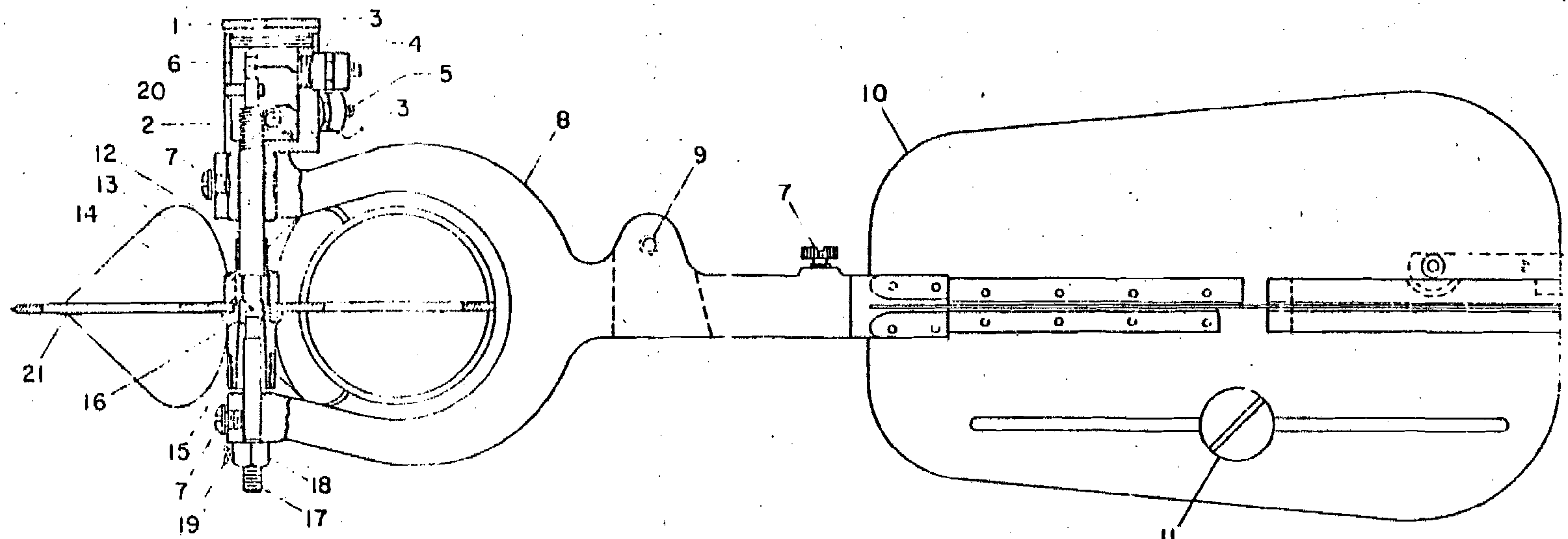
The bucket wheel (21) consists of six cone-shaped cups soldered to a frame to form a symmetrical and balanced assembly 5 inches in diameter and 2 inches high. The cups and frame are made of nickel-plated hard rolled brass. The frame is centrally drilled for the shaft and notched for a dowel pin. The letter "S" is stamped on the frame to identify the top side of the bucket wheel. The year of manufacture is also identified—S-67, S-68, for example.

Bucket-wheel hub

The bucket-wheel hub (13) encases the pivot bearing and the lower end of the shaft and supports the bucket wheel. The hub is threaded in three places: (1) for the bucket-wheel hub nut, (2) for the bucket-raising nut, and (3) for the shaft. A small dowel pin maintains the bucket wheel in a fixed position with reference to the bucket-wheel hub. The bucket-raising nut is provided so that the pivot bearing can be raised from the pivot when the meter is not is use.

Shaft

The shaft (12) is made of stainless steel and is of sufficient length to extend from the bucket-wheel hub to a point 0.008 inch below the cap of the



EXPLANATION

1. Cap for contact chamber
2. Contact chamber
3. Insulating bushing for contact binding post
4. Single-contact binding post
5. Penta-contact binding post
6. Penta gear
7. Set screw
8. Yoke
9. Hole for hanger screw
10. Tailpiece
11. Balance weight
12. Shaft
13. Bucket-wheel hub
14. Bucket-wheel hub nut
15. Raising nut
16. Pivot bearing
17. Pivot
18. Pivot-adjusting nut
19. Keeper screw for pivot-adjusting nut
20. Bearing lug
21. Bucket wheel

Figure 2.—Assembly diagram of type-AA Price current meter.

contact chamber. The upper one-half inch of the shaft is turned to 0.125-inch diameter and is rounded at the top to provide a smooth bearing surface for the thrust of the shaft against the bottom of the contact-chamber cap. An eccentric is cut in the 0.125-inch diameter part of the shaft to provide a means for making an electrical contact for each revolution of the bucket-wheel hub. The shaft also contains an acme thread that meshes with the penta gear within the contact chamber. A small hole is drilled at about the midpoint of the shaft to facilitate the use of a pin for tightening the shaft into the bucket-wheel hub.

Pivot

The pivot (17) is made of tempered, precipitation-hardening stainless steel. The upper end of the pivot is ground and polished to form an angle of 90° and the point rounded to a radius of 0.005 inch. The lower end of the pivot is threaded to provide for the hexagonal stainless-steel nut that is used to adjust the clearance between the pivot point and the pivot bearing. A slightly tapered flat surface on the pivot above the threads serves as a contact surface for the pivot-keeper screw.

Pivot bearing

The pivot bearing (16) is made of tungsten carbide and has highly polished bearing surfaces. It is pressed into the cylindrical recess in the lower end of the bucket-wheel hub. The bearing being of greater hardness than the pivot causes the major part of the wear to take place on the pivot which is easily replaceable.

Penta gear

The penta gear (6) is made of stainless steel and is fitted to mesh smoothly with the acme threads on the shaft. The gear makes one complete revolution for each 10 revolutions of the bucket wheel. Two gear teeth, 180° apart, are extended beyond the others to provide a means for making two electrical contacts for each revolution of the gear, with the result that contacts are made at each fifth revolution of the bucket wheel. The gear is mounted in a bronze frame in a horizontal position, and the assembly is housed in the contact chamber where it is held in place by means of a brass screw. The base of the frame through which this screw passes is slotted to permit the adjustment of the gear teeth with the worm on the shaft.

Contact chamber

The contact chamber (2) is a P-shaped chromium-plated brass unit which houses the penta gear, the upper part of the shaft, the shaft bearing, and the single- and penta-contact binding posts. The upper end of the chamber is drilled and threaded internally to carry a knurled cap. A small phosphor-bronze lug, brazed to the chamber wall, serves as the upper bearing for the shaft. The stem of the contact chamber extends through the upper arm of the yoke and is drilled axially so that the shaft can pass into the chamber with ample clearance. The cap is tightly fitted so that the chamber serves as an air trap to prevent silty water from entering the bearing.

Binding posts

Two stainless-steel binding posts (4) and (5) are placed at the rear of the contact chamber. One post is designed to contact the eccentric of the shaft and the other to contact the two extended teeth of the penta gear. They are identical in construction except for the lengths of the slender stainless steel cables that terminate in beads of silver solder through which the contacts are made. Each binding post is insulated from the contact chamber by a bushing (3) made of nylon.

Calibration of Current Meters

The principal of operation of a rotating-element type velocity meter is based on the proportionality between the local flow velocity and the resulting angular velocity of the meter rotor. The velocity of the water is determined by counting the number of revolutions of the rotor during a measured interval of time and consulting the meter calibration table.

If an ideal current meter, that is, one equipped with a correctly shaped rotor and a frictionless bearing mechanism, were to measure the flow velocity of a perfect liquid, the relation between the flow velocity and the rotor speed would be very simple:

$$V = KN \qquad (1)$$

where V denotes the local flow velocity, K is the proportionality constant, and N is the rotor speed expressed in revolutions per unit of time. In actual practice there are resistances opposing rotation caused by friction between the liquid and the rotor and by the mechanical friction of the bearings. Consequently, this simple relationship does not exist, and one must be determined empirically. The establishment of this relation, known as "rating the current meter," is done for the Survey by the National Bureau of Standards.

The current-meter rating station operated by the National Bureau of Standards in Washington, D.C., consists of a sheltered reinforced concrete basin 400 feet long, 6 feet wide, and 6 feet deep. Atop the vertical walls of the basin and extending its entire length are steel rails that carry an electrically driven rating car. This car is operated to move the current meter at a constant rate through the still water in the basin. Although the rate of travel can be accurately adjusted, the average velocity of the moving car is determined for each run by making an independent measurement of the distance it travels during the time that the revolutions of the bucket wheel are electrically counted. A scale graduated in feet and tenths is used for this purpose.

A small Price meter is rated by towing it at eight different velocities (0.25, 0.50, 0.75, 1.10, 1.50, 2.20, 5.00, and 8.00 feetp er second). A pair of runs are made at each velocity. A pair consists of two traverses of the basin, one in each direction. The data obtained consists of 16 observations of the velocity of the car (V) and revolutions per second of the rotor (N). The meter rating is determined from these data and is expressed as two linear equations:

For N less than 1.00,

$$V = K_1N + C_1, \qquad (2)$$

For N greater than 1.00,

$$V = K_2N + C_2, \qquad (3)$$

where

$$K_2 = K_1 + C_1 - C_2. \qquad (4)$$

Because there is rigid control in the manufacture of the small Price meter, virtually identical meters are produced and, for all practical purposes, their rating equations are identical. Therefore, there is no need to calibrate each meter individually. Instead, a standard rating is established by calibrating a large number of meters that have been constructed according to Survey specifications, and this rating is then supplied with each meter.

To insure that all small Price meters are virtually identical, dies and fixtures for their manufacture were purchased by the Water Resources Division and supplied to the manufacturer in 1967 for use in constructing meters. These same dies and fixtures will be supplied to the successful bidder in subsequent years. All rotors manufactured by use of the standard dies and fixtures are stamped "S" on the top side of the bucket wheel. The year of manufacture is also identified—S–67, S–68, for example. To further insure that all meters are identical, quality control procedures are followed, including the rating of a sample of meters from each new group procured.

For convenience in field use, the data from the current-meter ratings are reproduced in tables, a sample of which is shown in figure 3. The velocities corresponding to a range of 3–350 revolutions of the bucket wheel within a period of 40–70 seconds are listed in the tables. This range in revolution and time has been found to cover general field requirements. To provide the necessary information for the few instances where extensions are required, the equations of the rating table are shown in the spaces provided in the heading. Because of limited space, the equations are presented in an abbreviated form.

The expression V = 2.140N + 0.015 (2.155) V = 2.150N + 0.005 shown in the heading of the table in figure 3 is to be interpreted as follows:

V represents velocity in feet per second.

N represents the number of revolutions of the bucket wheel per second.

That part, V = 2.140N + 0.015, to the left of the parentheses is the equation used for computing velocities shown in the table less than 2.155 feet per second.

That part, V = 2.150N + 0.005, to the right of

DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY

Water Resources Division

RATING TABLE FOR TYPE AA CURRENT METER

EQUATIONS: V = 2.140N + 0.015 (2.155) . . V = 2.150N + 0.005 . . . . STANDARD RATING NO. . . . X . . . .

Time in Seconds	VELOCITY IN FEET PER SECOND — Revolutions 3	5	7	10	15	20	25	30	40	Time in Seconds	Time in Seconds	VELOCITY IN FEET PER SECOND — Revolutions 50	60	80	100	150	200	250	300	350	Time in Seconds
40	.176	.282	.390	.550	.818	1.09	1.35	1.62	2.15	40	40	2.69	3.23	4.30	5.38	8.07	10.76	13.44	16.13	18.82	40
41	.172	.276	.380	.537	.798	1.06	1.32	1.58	2.10	41	41	2.63	3.15	4.20	5.25	7.87	10.49	13.11	15.74	18.36	41
42	.168	.270	.372	.525	.779	1.03	1.29	1.54	2.06	42	42	2.56	3.08	4.10	5.12	7.68	10.24	12.80	15.36	17.92	42
43	.164	.264	.363	.513	.762	1.01	1.26	1.51	2.01	43	43	2.50	3.00	4.00	5.00	7.50	10.00	12.50	15.00	17.50	43
44	.161	.258	.355	.501	.745	.988	1.23	1.47	1.96	44	44	2.45	2.94	3.91	4.89	7.33	9.78	12.22	14.66	17.11	44
45	.158	.253	.348	.491	.728	.966	1.20	1.44	1.92	45	45	2.39	2.87	3.83	4.78	7.17	9.56	11.95	14.34	16.73	45
46	.155	.248	.341	.480	.713	.946	1.18	1.41	1.88	46	46	2.34	2.81	3.74	4.68	7.02	9.35	11.69	14.03	16.36	46
47	.152	.243	.334	.470	.698	.926	1.15	1.38	1.84	47	47	2.29	2.75	3.66	4.58	6.87	9.15	11.44	13.73	16.02	47
48	.149	.238	.327	.461	.684	.907	1.13	1.35	1.80	48	48	2.24	2.69	3.59	4.48	6.72	8.96	11.20	13.44	15.68	48
49	.146	.233	.321	.452	.670	.888	1.11	1.33	1.76	49	49	2.20	2.64	3.51	4.39	6.59	8.78	10.97	13.17	15.36	49
50	.143	.229	.315	.443	.657	.871	1.09	1.30	1.73	50	50	2.16	2.58	3.44	4.30	6.45	8.60	10.75	12.90	15.06	50
51	.141	.225	.309	.435	.644	.854	1.06	1.27	1.69	51	51	2.11	2.53	3.38	4.22	6.33	8.44	10.54	12.65	14.76	51
52	.138	.221	.303	.427	.632	.838	1.04	1.25	1.66	52	52	2.07	2.49	3.31	4.14	6.21	8.27	10.34	12.41	14.48	52
53	.136	.217	.298	.419	.621	.823	1.02	1.23	1.63	53	53	2.03	2.44	3.25	4.06	6.09	8.12	10.15	12.17	14.20	53
54	.134	.213	.292	.411	.609	.808	1.01	1.20	1.60	54	54	2.00	2.39	3.19	3.99	5.98	7.97	9.96	11.95	13.94	54
55	.132	.210	.287	.404	.599	.793	.988	1.18	1.57	55	55	1.96	2.35	3.13	3.91	5.87	7.82	9.78	11.73	13.69	55
56	.130	.206	.282	.397	.588	.779	.970	1.16	1.54	56	56	1.93	2.31	3.08	3.84	5.76	7.68	9.60	11.52	13.44	56
57	.128	.203	.278	.390	.578	.766	.954	1.14	1.52	57	57	1.89	2.27	3.02	3.78	5.66	7.55	9.43	11.32	13.21	57
58	.126	.199	.273	.384	.568	.753	.937	1.12	1.49	58	58	1.86	2.23	2.97	3.71	5.56	7.42	9.27	11.13	12.98	58
59	.124	.196	.269	.378	.559	.740	.922	1.10	1.47	59	59	1.83	2.19	2.92	3.65	5.47	7.29	9.12	10.94	12.76	59
60	.122	.193	.265	.372	.550	.728	.907	1.09	1.44	60	60	1.80	2.15	2.87	3.59	5.38	7.17	8.96	10.76	12.55	60
61	.120	.190	.261	.366	.541	.717	.892	1.07	1.42	61	61	1.77	2.12	2.82	3.53	5.29	7.05	8.82	10.58	12.34	61
62	.119	.188	.257	.360	.533	.706	.878	1.05	1.40	62	62	1.74	2.09	2.78	3.47	5.21	6.94	8.67	10.41	12.14	62
63	.117	.185	.253	.355	.525	.694	.864	1.03	1.37	63	63	1.71	2.06	2.74	3.42	5.12	6.83	8.54	10.24	11.95	63
64	.115	.182	.249	.349	.517	.684	.851	1.02	1.35	64	64	1.69	2.02	2.69	3.36	5.04	6.72	8.40	10.08	11.76	64
65	.114	.180	.246	.344	.509	.673	.838	1.00	1.33	65	65	1.66	1.99	2.65	3.31	4.97	6.62	8.27	9.93	11.58	65
66	.112	.177	.242	.339	.501	.663	.826	.988	1.31	66	66	1.64	1.96	2.61	3.26	4.89	6.52	8.15	9.78	11.41	66
67	.111	.175	.239	.334	.494	.654	.814	.973	1.29	67	67	1.61	1.93	2.57	3.21	4.82	6.42	8.03	9.63	11.24	67
68	.109	.172	.236	.330	.487	.644	.802	.959	1.27	68	68	1.59	1.90	2.53	3.17	4.75	6.33	7.91	9.49	11.07	68
69	.108	.170	.232	.325	.480	.635	.790	.945	1.26	69	69	1.57	1.88	2.50	3.12	4.68	6.24	7.79	9.35	10.91	69
70	.107	.168	.229	.321	.474	.626	.779	.932	1.24	70	70	1.54	1.85	2.46	3.08	4.61	6.15	7.68	9.22	10.76	70
	3	5	7	10	15	20	25	30	40			50	60	80	100	150	200	250	300	350	

Figure 3.—Sample current-meter rating table.

the parentheses is the equation used for computing the values for V more than 2.155 feet per second.

The term within parentheses (2.155) is the velocity common to both equations.

Data do not indicate that there is any significant difference between a rod rating and a cable suspension rating when Columbus-type weights and hangers are properly used with the meter. Therefore, no suspension coefficient is indicated, and none should be used.

Assembly and Disassembly of the Small Price Current Meter

To provide the proper care to a current meter, which is of extreme importance as pointed out earlier, each fieldman should become thoroughly acquainted with all the component parts as well as with the assembled meter. He should also be familiar with the steps outlined below, which are necessary to assemble or disassemble a meter.

Assembly

The procedure in assembling the small Price current meters may best be followed by referring to figure 2 which shows a sectional view of a type-AA meter and the names of the parts.

1. Assemble the two vanes of the tailpiece (10).
2. Insert the tailpiece assembly, with balance weight underneath, into the yoke (8) and tighten the tailpiece set screw (7).
3. Place the bucket wheel (21) onto the bucket-wheel hub (13) with the side marked "S" upward, and with the dowel pin on the hub fitting the notch in the bucket-wheel frame. These parts are held together by means of the bucket-wheel hub nut.
4. Place the bucket-wheel assembly within the arms of the yoke (8) and pass the shaft (12) through the hole in the upper arm of the yoke. Screw the shaft directly into the bucket-wheel hub (13), then insert a pin into the hole in the shaft and use the pin to tighten the shaft in the hub.
5. Loosen the penta gear (6) in the contact chamber (2) by a single turn of the small screw that passes through the adjusting slot of the gear pa. Do not remove this screw completely as it is difficult to replace.
6. Slip the contact chamber, with the cap (1) removed, over the upper end of the shaft and into the hole in the upper limb of the yoke. This should be done with great care in order not to damage either the threaded shaft or the penta gear.
7. Aline the contact chamber with the yoke by making the centerline of the yoke bisect the angle formed by the two contact binding posts. Some meters have been provided with grooved marks on the front of the contact chamber and on top of the upper arm of the yoke; making these marks coincide insures the proper alinement.
8. Tighten the yoke set screw (7) to hold the contact chamber in place.
9. Screw the cap (1) onto the contact chamber.
10. Insert the pivot (17) through the hole in the lower arm of the yoke after placing a drop of oil in the lower bearing and on the pivot.
11. Adjust the pivot as described in table 1. This adjustment allows a vertical play of 0.008 inch, the amount of play used when the meter is rated.
12. Return the meter to an upright position, and remove the cap from the contact chamber. Adjust the penta gear to mesh properly with the threads on the shaft and tighten the small (unnumbered) screw which holds the penta gear assembly.
13. Spin the bucket wheel rapidly while

Table 1. Adjustment of pivot

Sequence	*Operation*
1	Make sure that the meter has been properly oiled; then hold meter in inverted position with pivot uppermost.
2	Release keeper screw (19) for pivot adjusting nut (18) and unscrew the nut a few turns.
3	Release set screw (7) and advance pivot until all vertical play of the hub assembly is eliminated.
4	Tighten set screw (7) temporarily and advance pivot adjusting nut (18) until it touches the yoke.
5	Release set screw (7) (not too far because the pivot should not revolve) and advance the pivot adjusting nut one-fourth turn. Then tighten keeper screw (19).
6	Push the pivot inward as far as it will go and tighten set screw (7).

watching the action of the penta gear to make sure that there is complete freedom of action between the gear and the threads on the shaft. Then apply oil to the penta gear and to the three bearing surfaces (one drop on the vertical shaft and two on the horizontal shaft that supports the gear).

14. Adjust the contact wires so that these wires touch the edge of the single and penta eccentrics very lightly. Then replace the cap on the contact chamber and listen with a headset for a sharp click.

15. Place the assembled meter on a solid surface with the shaft vertical, and make a spin test (see page 10).

Disassembly

In general, the disassembly of small Price current meters offers no difficulties and hence it will not be described in detail. The following precautions, however, should be observed.

1. Removal of the contact chamber from the yoke should be done carefully and without exerting appreciable force, so that the penta gear and shaft will not be damaged.

2. The contact-chamber cap should never be unscrewed when the upper end of the shaft bears forcibly against its underside, a condition which exists if the bucket-wheel raising nut has been previously tightened, and if the pivot adjustment has been made so tight that there is no play between the end of the shaft and the underside of the cap.

When the bucket-raising nut has been tightened, the upper end of the shaft bears against the underside of the cap at a point that is about three-sixteenths of an inch "off center" with respect to the center of the cap. If those two parts are in contact with each other when the cap is being either tightened or loosened, a severe bending force occurs at the point where the upper end of the shaft emerges from the upper bearing. Lack of attention to this subject is a common cause for "bent shafts" on Price-type current meters.

When the bucket-wheel-and-hub assembly is raised from the pivot by means of the raising nut, the bucket wheel should always be held stationary and the raising nut should be turned by hand. The bucket wheel should never be spun with the raising nut held stationary, as this method may cause several excess turns which may result in the shaft becoming bent or the yoke becoming sprung.

Inspection and Repair of Current Meters

To make sure that the current meter is in good condition and is properly lubricated, the operator should examine it, both before and after each discharge measurement, with regard to the details under the heading immediately following. Because all meter parts are manufactured to be interchangeable without affecting the calibration of the meter, replacement of any of the component parts can be made in the field.

Rotor and shaft alinement

By spinning the bucket wheel slowly and then watching the metal frame to which the cups are fastened, eccentricity in the bucket-wheel-and-hub assembly may be readily detected. If eccentricity is observed while making this test, either the wheel or shaft is bent, and further tests should be made to find the source of the eccentricity. The cap should be removed and the movement of the shaft inside the contact chamber should be observed. If, while the bucket wheel is rotating, any eccentricity in the movement of the top of the shaft is observed, the shaft should be removed from the assembly and should be further tested by observing its performance while rolling it on a clean flat surface. Any meter found to have a bent shaft should be repaired by replacing that shaft with a new one. If eccentricity is not found in the shaft, it may be present in the bucket wheel. Should the fault lie there, the rotor should be replaced with a new one.

Sprung yoke

The yoke may become sprung so that the distance between the upper and lower arms is too small or too great to permit proper adjustment of the rotor assembly within this space. It may also be distorted so that the coaxial holes will no longer properly aline the rotor assembly and the pivot. If either of these conditions is suspected, the alinement and spacing should be checked with a special yoke alinement gage that is available from the Property Maintenance Section, Silver Spring, Md.

In addition to the above, the stem of the yoke (that part from the slot for the hanger to the end onto which the tailpiece fits) occasionally becomes bent. A bent stem causes the bucket wheel to assume a position that is out of proper alinement with the flow lines of the water. If the amount of distortion in the yoke is minor and can be properly straightened, this should be done; if not, the yoke should be replaced with a new one.

Damaged cups

The bucket wheel and cups on it have more influence on the meter rating than has any other component. Cups should therefore be examined closely as any small distortion will cause a change in rating. Only for the most minor dents where the cups can be straightened to "like new" condition should repairs be attempted; otherwise the bucket wheel should be replaced with a new one.

Damaged tailpiece

The tailpiece should be examined for damage. It may be straightened if the damage is not too serious; otherwise it should be replaced with a new one.

Contact chamber

The contact chamber should be examined for proper meshing of the penta gear with the acme thread on the shaft and for proper adjustment of the contact wires. Proper adjustment of these parts should be maintained at all times. It should also be inspected for excessive wear of the upper bearing. Any missing or damaged parts such as screws, chamber caps, or binding posts should be replaced. Should the need arise, the entire contact chamber may be replaced with a new one.

Pivot and bearings

The pivot should be examined with a magnifying glass to see whether the point is fractured, rough, or warn flat at the apex. The point of a new pivot is rounded to a radius of approximately 0.005 inch; wear resulting in a radius greater than 0.010 inch is excessive. If any of these conditions exist, the pivot should be replaced with a new one.

To examine the pivot bearing conveniently, the contact chamber should be removed carefully and the bucket-wheel-and-hub assembly should be tilted to one side so that the lower arm of the yoke will not obstruct examination. The pivot bearing should then be examined for possible fracture, pits, or roughness. If any of the above are found, the entire hub assembly should be replaced with one containing a new pivot bearing.

No current meter should be packed or transported with the pivot bearing resting on the pivot. The pivot and pivot bearing should always be separated by the raising nut.

Lubrication

All bearing surfaces should be inspected to see that they have a thin coating of instrument oil. The small Price current meter has bearing surfaces above the bucket wheel in addition to the pivot bearing. These consist of (1) the bearing surfaces between the penta gear and the acme threads on the shaft, (2) the cylindrical bearing of the small shaft of the penta gear, (3) the cylindrial bearing of the shaft within the bearing lug, and (4) the thrust bearing between the shaft and the cap.

Spin tests

The spin test is an easy method of determining the condition of the bearings of a current meter. In making this test, the meter should be placed so that the shaft is in a vertical position and the bucket wheel is protected from air currents. The bucket wheel is then given a quick turn by hand to start it spinning, the duration of which is timed with a stopwatch. As the rotating bucket nears the stopping point, its motion should be carefully observed to see whether the stop is abrupt or gradual. Regardless of the duration of the spin, if the bucket wheel comes to an abrupt stop, the cause of such behavior should be found and corrected before the meter is used. In such instances, a lack of oil, the maladjustment of the penta gear, and a misalinement of the yoke are possible sources of trouble that should receive early attention.

The normal spin for a small type-AA Price should be approximately 4 minutes and should under no circumstances be less than 1½ minutes. Large variations in the duration of the spin test will be introduced by slight varations from the vertical position of the shaft. Some operators accordingly provide themselves with a small circular level vial that can be placed on the cap of the meter to help them make such a test with the shaft alined in a truly vertical position.

Another common test to determine the condition of the bearing of a current meter is to hold the meter so that the shaft is in a vertical position and while keeping the shaft in as nearly a fixed position as possible, to revolve the yoke and tailpiece in a horizontal plane around it. If the bucket wheel remains in a fixed position, it is an indication that the bearings are satisfactory, whereas if the bucket wheel tends to revolve with the yoke and tailpiece, it is an indication that the meter requires attention.

Routine Cleaning and Oiling of Current Meters

At the end of each day's use, the current meter should be thoroughly cleaned and oiled. The pivot and pivot bearing need special attention; unlike all other parts of the meter they are subject to rusting and, therefore, it is desirable that they be dried before they are oiled.

The outline below gives a step-by-step procedure for the cleaning and oiling of current meters.

Equipment:

1. Screwdrivers of proper size for use on set screws in the yoke and on the pivot-adjusting nut.
2. Large soft cloth that will readily absorb water for wiping the outer surfaces of the meter.
3. Cotton-tipped swabs for cleaning the bearing surfaces.
4. Supply of oil (instrument oil that is available from the Property Maintenance Section is recommended) in a container with facilities that permit a drop of oil to be applied in places that otherwise are difficult to reach.

Dismantle the current meter as follows:

1. Release the raising nut.
2. Release the two set screws in the yoke, holding the contact chamber and the pivot in place with forefinger and thumb.
3. Remove the contact chamber from the yoke slowly and carefully. Do not remove the cap at this time.
4. Remove the pivot from the yoke.

Clean the parts as follows:

1. Pivot bearing.
   a. Clean and dry the air pocket and the pivot bearing, using a cotton-tipped swab.
   b. Inspect the pivot bearing.
2. Pivot hole in the yoke.
   Swab the pivot hole in the yoke with a cotton-tipped swab.
3. Shaft.
   Clean and dry the shaft—particularly the acme threads.
4. Pivot.
   Wipe the pivot until it is thoroughly dry.
5. Contact chamber.

a. Remove the cap and shake out any water that may be trapped within the contact chamber. Occasionally, clean the chamber thoroughly by allowing hot water to flow into it under pressure. A jet of water such as that issuing from a hot-water tap is recommended. Hoppe's powder solvent has been used successfully to remove gummed oil if cleaning with hot water is not successful.

b. Wipe the interior of the stem of the contact chamber.

c. Swab the hole in the bearing lug by means of a cotton-tipped swab inserted through the stem of the contact chamber. Cleaning the hole in the bearing lug from the top frequently causes the contact wires to bend and eventually break, whereas cleaning it from the bottom neither bends the wires nor affects their adjustment.

Oil as follows:

1. Shaft.

Apply a film of oil to (a) the acme threads (liberally, so that the excess oil will later spread over the penta gear and the penta shaft), (b) the area that enters the bearing lug, and (c) the uppermost end of the shaft.

2. Pivot bearing.

Apply a thin film of oil over all exposed parts of the pivot bearing.

3. Pivot hole in yoke.

Apply a drop of oil to the sides of the hole through which the pivot passes.

4. Pivot.

Apply a thin film of oil to the pivot.

Reassemble as follows:

1. Replace the pivot and tighten the set screw that holds it in place. Make sure that the pivot lock nut bears against the yoke, and that the set screw bears against the flattened part of the pivot.

2. Fit the contact chamber over the end of the shaft and into its hole in the lower arm of the yoke. Do this slowly and carefully without applying much force, otherwise the penta gear or shaft may become damaged.

3. Match the marks on the contact chamber and yoke, and tighten the set screw holding the contact chamber in place.

4. Check the contact wires. The adjustment of both the single- and penta-contact wires should be examined to be sure that the adjustments are as light as possible without impairing the electrical contact.

5. Replace the cap on contact chamber.

6. Move the bucket-wheel-and-hub assembly up and down to determine whether the pivot adjustment is correct.

7. Check the operation of the current meter with a spin test.

8. Unless the current meter is to be used immediately, raise the pivot bearing off the pivot by means of the bucket-raising nut.

Low-Velocity Price Meter

The low-velocity meter differs from the genera purpose Price meter in that the penta gear is removed and the single eccentric is replaced by a double eccentric which makes two electrical contacts for each revolution of the bucket wheel.

These meters are produced by the same dies and fixtures used in the manufacture of the general purpose meter. Consequently, they also have a single standard rating, and any parts may be replaced without the necessity of calibration. The duration of the normal spin should be 4½–5 minutes, and it should never be less than 2½ minutes.

In all respects other than those pointed out above the two types of meters are identical and all of the preceding paragraphs apply to the low-velocity meter.

Pygmy Current Meters

The Geological Survey designed the first of its pygmy current meters (see fig. 1) in 1936. The pygmy current meter is of the Price type in that it contains a cup-type bucket wheel mounted on a vertical shaft having bearings that operate in air pockets. The bucket wheel is 2 inches in diameter (two-fifths the size of that in the small Price current meter). The pygmy meter is designed particularly for the measurement of discharges of those streams that are so shallow that the small Price current meter fails to perform accurately, but which have too great a flow to be measured conveniently by either volumetric means or with small weirs.

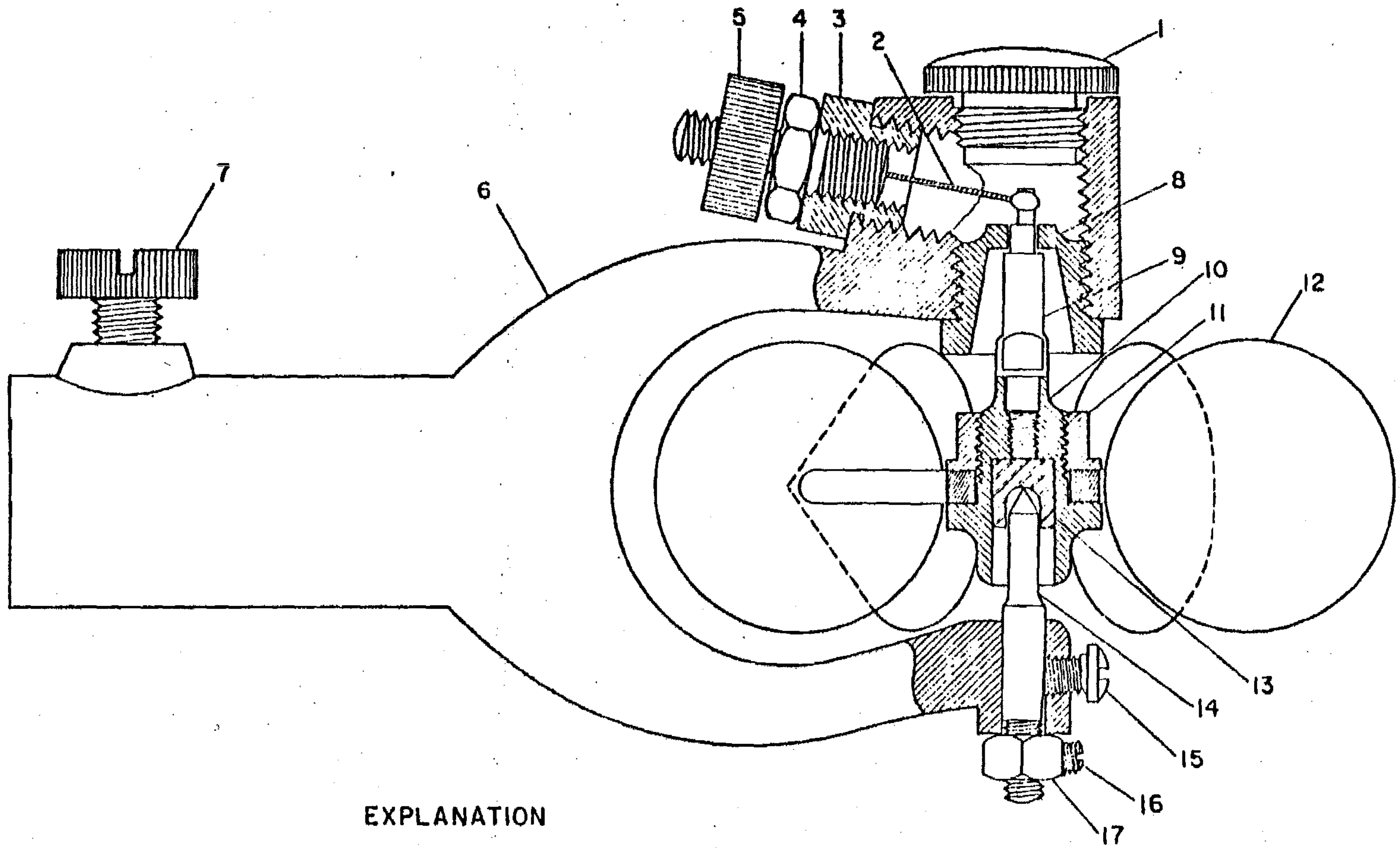
The pygmy meter differs from the type-AA small Price current meter in respects other than size (see fig. 4). The contact chamber is an integral part of the yoke and contains a single-revolution contact only. The meter has no tailpiece nor has it any provision for suspension from a cable. There is no bucket-wheel raising nut on the pygmy meter, but a small brass plug is provided to replace the pivot when the meter is stored or transported.

The bucket wheel revolves about 2¼ times as fast as that of the small Price current meter. This relatively high speed, combined with the fact that no multiple-contact arrangement is provided, limits its use to conditions where the revolutions are counted aurally to velocities not exceeding 3 feet per second.

The Survey's pygmy current meters are constructed so that the bucket-wheel-and-hub assembly may be removed from the yoke as a unit for convenience in cleaning and oiling. Instructions for removing and replacing such assemblies follow:

To remove the bucket-wheel-and-hub assembly from the yoke:

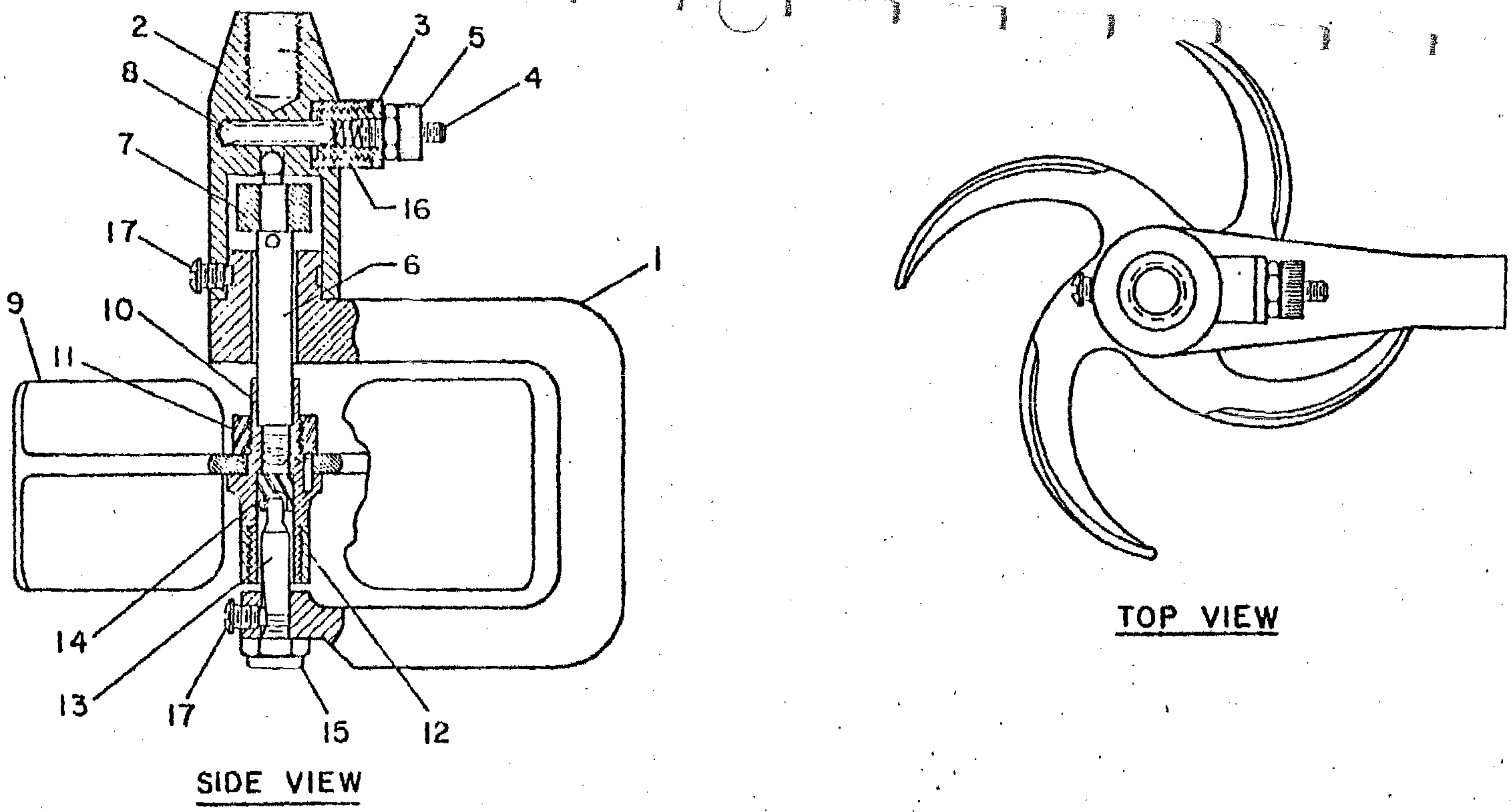
1. Remove the cap.
2. Release the set screw holding the pivot in the yoke.
3. Remove the pivot.
4. Tighten the set screw into the yoke (otherwise, it may offer difficulties in removing the bucket wheel).
5. Lower the bucket wheel to the lowest position in the yoke and carefully slide it forward and outward. If it is found that the bucket-wheel-and-hub assembly does not come out freely, return it to its original position and rotate it one-sixth of a turn. Repeat this operation until successful. **Never apply force in removing the bucket-wheel-and hub assembly** because the shaft and eccentric may become bent.



EXPLANATION

1. Cap for contact chamber
2. Binding-post beaded wire
3. Binding-post insulating bushing
4. Binding-post body
5. Binding-post nut
6. Yoke
7. Yoke set screw
8. Upper bearing
9. Shaft
10. Bucket-wheel hub
11. Bucket-wheel hub nut
12. Bucket wheel
13. Pivot bearing
14. Pivot
15. Pivot set screw
16. Pivot-adjusting nut keeper screw
17. Pivot-adjusting nut

Figure 4.—Assembly diagram of pygmy current meter.



EXPLANATION

1. Yoke
2. Contact chamber
3. Binding-post insulating bushing
4. Binding post
5. Binding-post nut
6. Shaft
7. Magnet
8. Glass switch
9. Vane
10. Vane hub
11. Vane hub nut
12. Raising nut
13. Pivot
14. Pivot bearing
15. Pivot-adjusting nut
16. Compression-spring assembly
17. Set screw

Figure 5.—Assembly diagram of ice meter.

To insert the bucket-wheel-and-hub assembly into the yoke:

1. With the pivot removed, set screw tightened, cap removed, and yoke and shaft held upside down, direct the upper end of the shaft into the hole of the upper bearing, and carefully adjust the bucket wheel into position within the arms of the yoke. Do not apply force. If the bucket wheel cannot be placed within the yoke without forcing, remove it, turn it one-sixth of a revolution, and repeat until successful.
2. Unscrew the set screw to a position that will permit the pivot to be inserted.
3. Insert the pivot.
4. Tighten the set screw and turn the yoke right side up.
5. Replace the cap.

Investigations have shown that there are very slight differences in the rotors of pygmy meters that prevent a standardized rating. Because the rotors are not identical, they cannot be replaced in the field. Meters are calibrated individually and each is supplied with its own rating table. A pygmy current meter which has been damaged should be returned to the Property Maintenance Section for repair and recalibration. The duration of the normal spin should be approximately 1¼ minutes and should never be less than half a minute.

Ice Meters

Ice meters (see fig. 1) are also the vertical-axis type but differ from the Price in that the rotor used consists of four curved vanes. Other differences may also be seen in figure 5, which illustrates the assembly diagram of the ice meter. They are:

1. There is no rear extension of the yoke. The meter is supported by a section of special wading rod that screws into the top of the contact chamber. The object of this arrangement is to reduce the size of the ice hole required for inserting the meter.
2. The upper bearing is a small sphere instead of a sleeve.
3. The electrical contact is a magnetically actuated glass-sealed switch. There are two contact closures for each revolution of the rotor, one each time the poles of the magnet are alined with the leaves of the switch.

Assembly or disassembly of the ice meter offers no special problems except that the magnet is very brittle and must be handled with care, as all parts should be. Care and lubrication should be of the same type described for the Price meter.

Investigations have shown that there are very slight differences in the rotors of ice meters that prevent a standardized rating. Because the rotors are not identical, they cannot be replaced in the field. Meters are calibrated individually and each is supplied with its own rating table. An ice meter which has been damaged should be returned to the Property Maintenance Section for repair and recalibration. The duration of the normal spin should be approximately 5 minutes and should never be less than 2 minutes.

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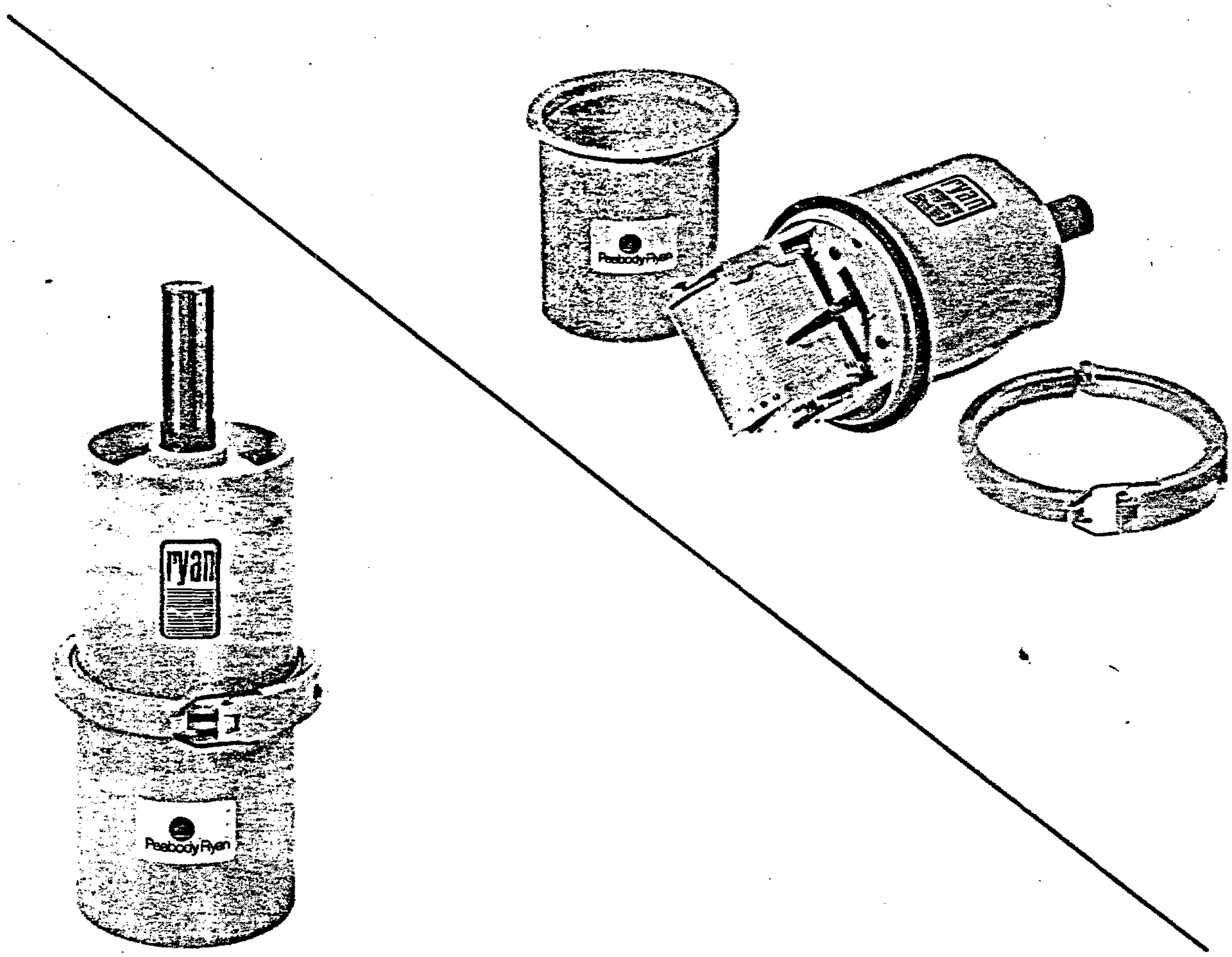


OPERATING INSTRUCTIONS
for
MODEL "J" THERMOGRAPH

IMPORTANT: READ CAREFULLY

TEMPERATURE CONVERSION TABLE

C°	F°	C°	F°
-5	23.0	21	69.8
-4	24.8	22	71.6
-3	26.6	23	73.4
-2	28.4	24	75.2
-1	30.2	25	77.0
0	32.0	26	78.8
1	33.8	27	80.6
2	35.6	28	82.4
3	37.4	29	84.2
4	39.2	30	86.0
5	41.0	31	87.8
6	42.8	32	89.6
7	44.6	33	91.4
8	46.4	34	93.2
9	48.2	35	95.0
10	50.0	36	96.8
11	51.8	37	98.6
12	53.6	38	100.4
13	55.4	39	102.2
14	57.2	40	104.0
15	59.0	41	105.8
16	60.8	42	107.6
17	62.6	43	109.4
18	64.4	44	111.2
19	66.2	45	113.0
20	68.0		

PLEASE READ CAREFULLY BEFORE HANDLING THE INSTRUMENT

Peabody Ryan has been the leading manufacturer of portable thermographs for more than 55 years. Our instruments have proven ideal for unattended, long-term monitoring of ambient air or water temperatures.

The Model "J" is a new generation of portable thermographs. It has not only the fast response of the Ryan Model "F" and "H", but has the timing of the quartz movement. The chart size has been enlarged for easier reading and interpretation and a new type of chart advance has been added to allow longer periods, up to 180 days, unattended. Provisions for unloading and loading during field use have been incorporated into the design.

Ryan thermographs are engineered and built to be as rugged as possible. But, please remember they are precision instruments. Improper handling can damage the sensitive clockworks and mechanical linkage.

These thermographs should always be treated as you would any laboratory instrument. If you follow these instructions thoroughly, and take reasonable care in handling and using the instrument, it will operate reliably and accurately.

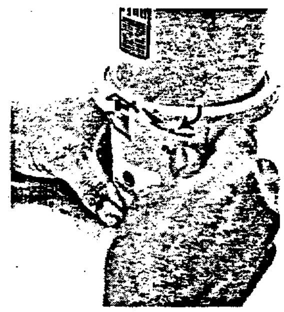
ENGINEERING DATA

Models	J-180 (six months) J-90 (three months)
Movement	Quartz timing mechanism
Power	One 1-1/2 volt "C" cell battery (included)
Chart Advance	Sprocket drive
Sensor	Fast response probe: Hi-expansion, liquid filled system operating a bellows mechanism. Time constant: 75 sec. (2/3 span in 75 sec, full span in less than 8 mins.)
Chart	Pressure sensitive strip chart perforated to accommodate sprocket drive 2 inches wide, 24 feet long with lineal day span length.
Calibration	Chart is 30°C span (86°F) 1°C div
Range	5 ranges: −5° to +25°C, 0 to +30°C, +5° to +35°C, +10° to +40°C, +15° to +45°C
Accuracy	Temp ±2% or .6°C Time ±.2% or 3 min / day
Weight	2.5 lbs.
Dimensions	Largest diameter: 4.875 in. Tank length: 8.25 in. Sensor extension: 2.90 in.
Enclosure	Heavy cross-section polycarbonate thermo plastic, international yellow
Maximum depth of use	500 ft.
Accessory items	1 additional clamp 1 additional "0" ring 1 additional chart transport with chart

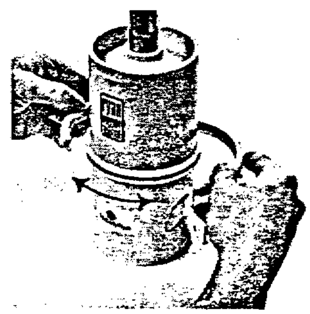
U.S. Patent 3,487,691
Other Patents Pending

HOW TO OPEN

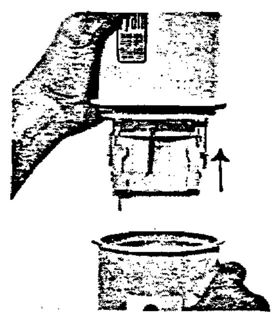
Please note the hinged coupling around the middle of the instrument. The purpose of this coupling is to maintain the water tight integrity of the unit. (See picture on cover.)



1 Grip latch of coupling firmly with one hand and the unit with the other. Pull latch in an outward motion allowing it to pivot. The draw wire will then disconnect from the other side of the coupling.



2 Spread coupling and remove from unit. Set aside for reuse in sealing the unit.



3 With one hand, grip the bottom half of the unit and with the other hand grip the top half (cover) of the unit.

4 With an easy pulling motion, separate the two halves.

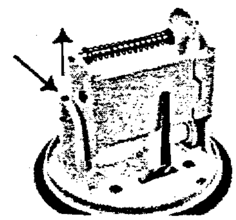
IMPORTANT NOTE: DO NOT TRY TO REMOVE THE TANK HALF FROM AROUND THE SENSOR UNIT.

5 Set the lower half on a level surface with opening up. Then turn the other half upside down (sensor pointing down) and set inside the other half with sensor down inside.

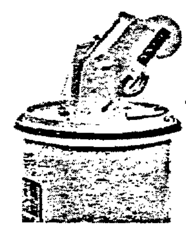
REMOVING CARTRIDGE FROM UNIT

This unit has a removable cartridge for easier loading and unloading. The chart has approximately 22 ft. of usable length, if used continuously: a rate of 1-1/2" per day on the 180 day unit and 3" per day on the 90 day unit. The charts are pre-rolled on a core to make loading easier.

1 With the pen assembly facing you, find the locking screw on the left side of the instrument. Unscrew this screw until the end of it clears the top of the shaft.

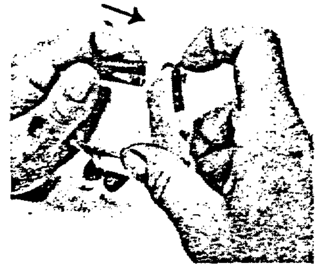


2 Grip instrument firmly with one hand and with other rotate cartridge from the top holding grooves.

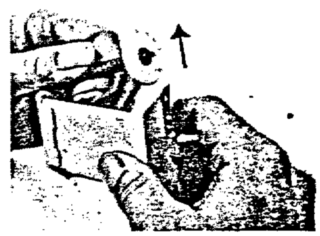


3 Firmly pull the cartridge from the bottom holding grooves in an outward motion at approximately the same angle as the grooves.

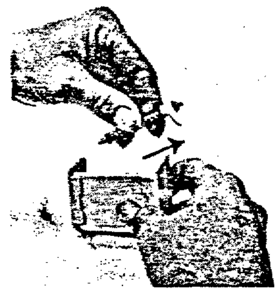
INSTALLING CHART INTO CARTRIDGE



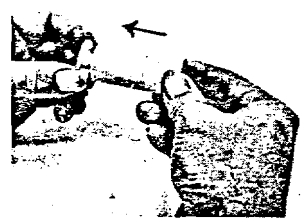
1 Holding the cartridge firmly in one hand, release the core shaft retaining clip. This can be done with a slight pulling motion with the finger nail.



2 Lift the shaft assembly from the groove in an upward motion until the gear clears the edge of the cartridge.



3 Shaft assembly should then pull away from cartridge with ease. Set cartridge aside.



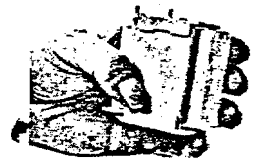
4 With the shaft assembly in one hand, pick up a pre-rolled chart. Insert the shaft assembly into the spool core. Line up lugs on gear with grooves in chart core. Seat firmly against gear.

NOTE: MAKE SURE THE SPROCKET HOLES IN THE CHART ARE ON THE OPPOSITE SIDE OF THE WHITE GEAR.

5 Insert small shaft end into the cartridge, then slip flatted shaft end into groove until retaining clip locks shaft in place.

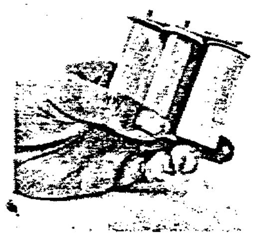
THREADING AND ATTACHING CHART

1 Remove the tape from the end of chart. Hold chart firmly so that it will roll, but not unravel.

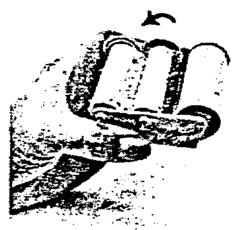


2 Thread chart across platten (under the guides) around the drive sprocket and under the take-up spool.

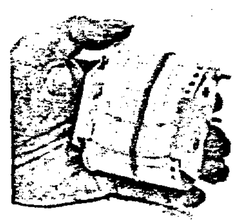
3 Attach the end of the chart (gray backing side up) to the take-up spool with a piece of tape.



4 Rotate the take-up spool one or two turns. Maintain a light pressure on the chart roll. This will eliminate buckling or bulging of the chart.



NOTE: IF CARTRIDGE IS NOT TO BE USED IMMEDIATELY, WRAP A LIGHT RUBBER BAND AROUND CARTRIDGE TO KEEP THE CHART FROM UNROLLING.

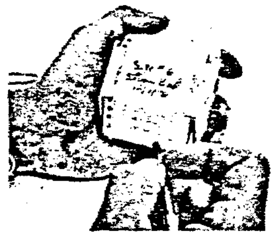


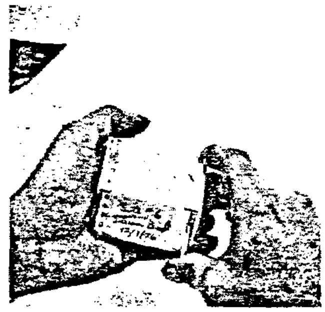
The unit comes with an extra cartridge so preloading of the chart can be done in the lab and the cartridge used later at the site location.

LOADING CARTRIDGE INTO UNIT

NOTE: IF RUBBER BAND WAS USED, REMOVE IT.

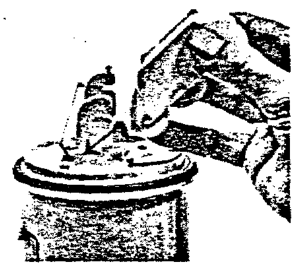
Before loading the cartridge into the unit, reference data may be placed on the chart. Place cartridge on a flat, dry surface and write data across chart using the flat part of the cartridge as a writing surface.



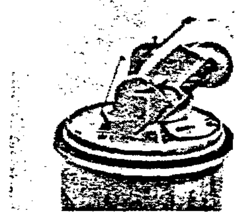


1 Before loading cartridge, rotate take-up spool until the top of the reference data is at the edge of the flat portion of the cartridge.

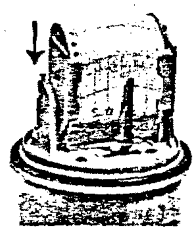
2 Gripping cartridge and instrument firmly, with flat side of cartridge facing the penpoint, slide the shaft ends into the bottom holding grooves. Push firmly until they are well seated.



3 Rotate cartridge so the other set of shaft ends slide into top holding grooves. Make sure they are well seated.



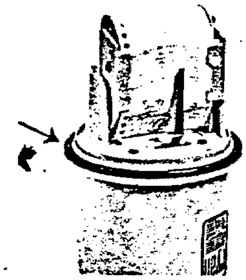
4 With your screw driver, reset the locking screw.



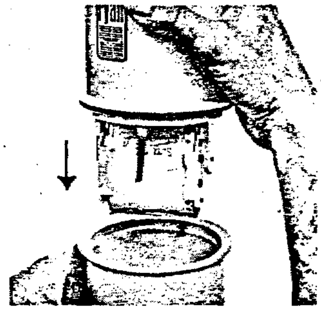
CLOSING AND SEALING UNIT

1 Check "0" ring to be sure it is clean.

Use vasaline on the "O" ring!

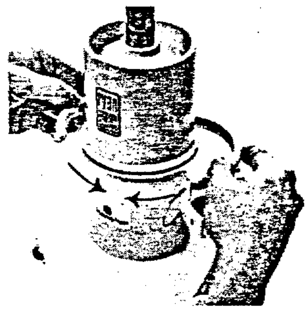


2 With one hand holding the bottom half, pick up the other half (with sensor and chart transport). Reverse it so the sensor is pointing up. carefully insert the chart transport into the opening of the other half.



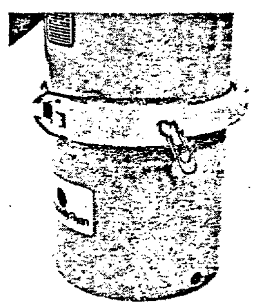
3 Make sure two tank halves are seated evenly over the "0" ring.

4 Pick up clamp and place it around the flanges in the center of the tank. Make sure the flanges are inside the clamp groove all the way around.

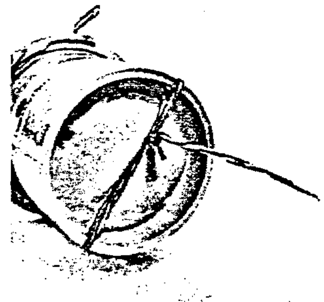


5 Holding the clamp firmly around unit with one hand, attach the draw wire over the hook on the opposite clamp half. Pivot the clamp latch toward the instrument. (If excessive force is required, check to see if the "0" ring is seated on the flanges and if the clamp is seated over the tank flanges.)

6 When the clamp is secured, there is a post on the clamp with a hole in it protruding through the hole in the latch. Insert a paperclip or small piece of wire into the hole in the post and bend it over so that it will not fall out. This will prevent the latch from coming undone while the unit is in use.



INSTALLING YOUR INSTRUMENT

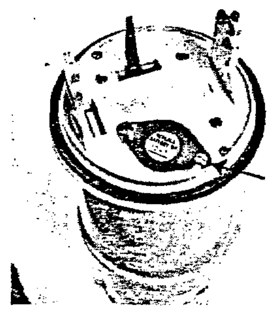


Because of the air trapped inside the sealed container, it may have a tendency to float.

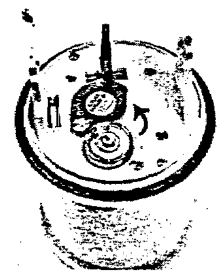
When the instrument is installed at the site location, it should be anchored securely to some object that will not readily move. This can be done by looping a cord or wire through the holes in the outside of either end of the instrument and then securing the cord or wire to the object.

CHANGING THE BATTERY

To change the battery, first remove the chart transport assembly according the instructions.



1 With a flat tip screw driver, loosen the slotted screw.



2 Pivot the cover plate, exposing the battery.

3 Turn the instrument upside down and the battery will fall out.

4 Replace with a new battery, size C, 1-1/2 volts. (Recommend use of Eveready Alkaline Powercell.) Make sure (+) is pointing up.

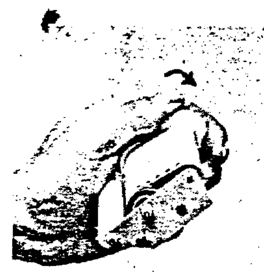
Push battery down slightly and pivot cover plate back into position. Tighten slotted head screw and replace transport assembly.

There is a sticker on the cover plate indicating when the battery should be replaced. An Eveready Alkaline Powercell should give at least 12 months of continual use.

REMOVING USED CHART

Follow the same procedure from "How to Open" through "Removing Cartridge from unit".

If the chart was allowed to run the full length:



1 Take the loose end (should have a piece of tape already on it) and re-attach it to the spool core.

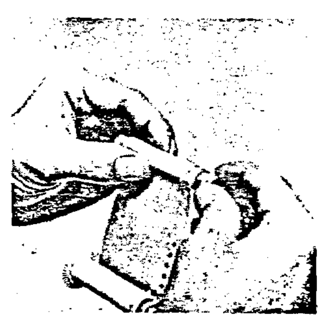
2 Rewind it and follow 1 through 3 of "Installing Chart into Cartridge".

3 Remove used chart and reload with new chart.

If the chart has run for only a portion of the length:

1 With a sharp object, cut the chart along the edge of the platten. Hold Chart Spools so it will not unroll.

2 Stick a small piece of tape on the end of the chart.



3 Using a cylindrical object, attach the loose end of the used chart with a piece of tape and unroll the chart from the take-up spool onto the cylinder.

4 From here, follow procedure outlined in "Threading and Attaching Chart".

REPAIR AND MAINTENANCE

If the unit does not work properly, or is damaged, return to:

Ryan Instruments, Inc.
402 6th St. South,
Kirkland, WA 98033

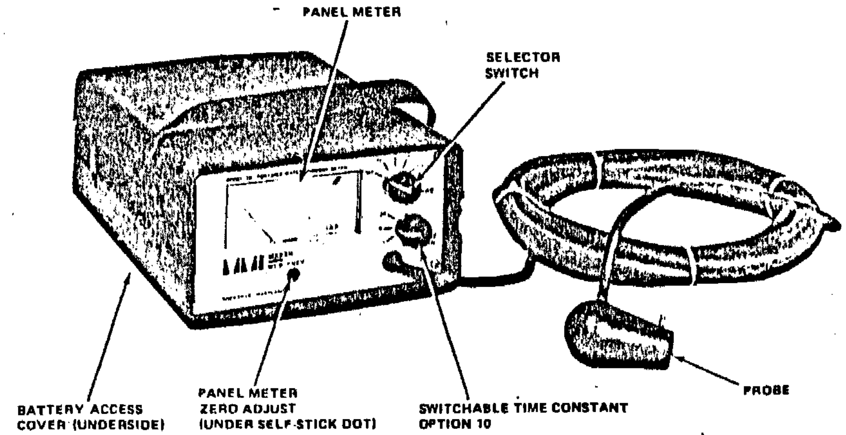
Any questions concerning the operation of the instrument, phone: (206) 827-9572.

After each use, and BEFORE the instrument is opened, clean off all grit or other matter, and wipe the case and clamp completely dry.

NOTE: THE AIR THAT WAS TRAPPED INSIDE THE SEALED INSTRUMENT MAY HAVE A TENDENCY TO CONDENSATE AND CAUSE SMALL AMOUNTS OF MOISTURE. EACH TIME THE UNIT IS OPENED, WIPE DRY THE INSIDE OF THE TANK AND AS MANY OF THE OTHER PARTS AS POSSIBLE. MAKE EVERY EFFORT TO KEEP THE INSIDE OF THE INSTRUMENT AS CLEAN AND DRY AS POSSIBLE.

The large "0" ring on these instruments may be used dry, but should be cleaned each time the unit is opened. The flanges of the tank should be cleaned before reseating the "0" Ring.

The small probe port "0" ring on the Model J was installed at the factory and not accessible for close examination. Lightly clean grit and other matter off the ring area so it will not nick the ring and possibly cause leaking. Do not use a lot of force, as it might cause the seal to be broken.



GENERAL DESCRIPTION

The Marsh-McBirney Model 201 Portable Water Current Meter is a general purpose instrument, designed for maximum versatility in both laboratory and field applications. The instrument consists of (1) a transducer probe with cable, and (2) a signal processor housed in a portable case.

The instrument senses water velocity in one direction and presents this velocity reading directly in feet per second on a panel meter.

The instrument is powered by six standard D size cells contained in a battery compartment in the instrument case. Access to this compartment is through a cover plate on the bottom of the case.

The case is approximately 7 inches wide by 4 inches high by 10 inches deep. The standard length of the cable attached to the transducer probe is 20 feet.

RANGE OF MEASUREMENT

The instrument will measure flow velocities up to 10 feet per second. The panel meter has three full scale ranges: 2.5, 5, and 10 feet per second, any of which can be selected by a rotary switch on the front panel.

ACCURACY

The overall accuracy of the instrument is based upon three factors:

1. Long term zero drift which is less than ±0.07 ft./sec.
2. Linearity of response which is ±2% of reading.
3. Absolute calibration which is ±2% of reading.

Long Term Zero Drift

The Model 201 incorporates features which reduce long term zero drift to less than ±0.07 feet per second. This effect is separate and distinct from the slight motion of the panel meter which is due to electronic noise.

Linearity of Response

The reading can deviate from an exactly linear response to increasing water flow due to minor variations in flow streamlines at increasing velocity. This factor is small enough to guarantee that the reading is within 2% of nominal over the velocity range of the instrument.

Absolute Calibration

Calibration of all MMI water current meters is traceable to a calibration facility where the flow is known to within ±1%.

SECTION 2
OPERATING INSTRUCTIONS

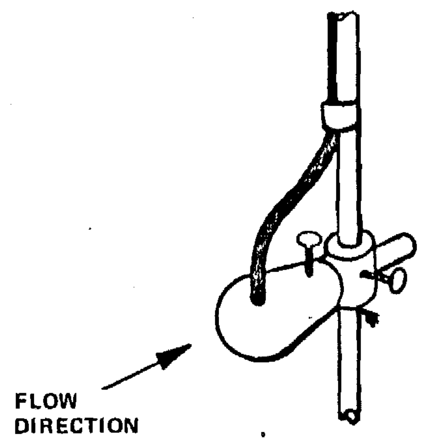
UNPACKING AND PRELIMINARY SETUP

1. Carefully remove the instrument from the shipping carton.

2. Remove the battery compartment cover (bottom side of instrument) and insert six D size cells according to the polarity indicated in each battery slot. If the probe connector option is included, plug the probe connector into the mating connector on the front panel.

3. Set the selector switch to the CAL position. The meter should indicate in the CALibrate sector of the scale. This indicates the batteries are good and the instrument is operating properly. Insert new batteries if the meter fails to register in the CAL sector. If the meter still fails to register correctly, contact the factory.

4. Place the probe in a non-metallic (plastic) bucket filled with water, and rotate the selector switch to the 2.5 ft./sec. setting. Move the probe gently in the bucket, and

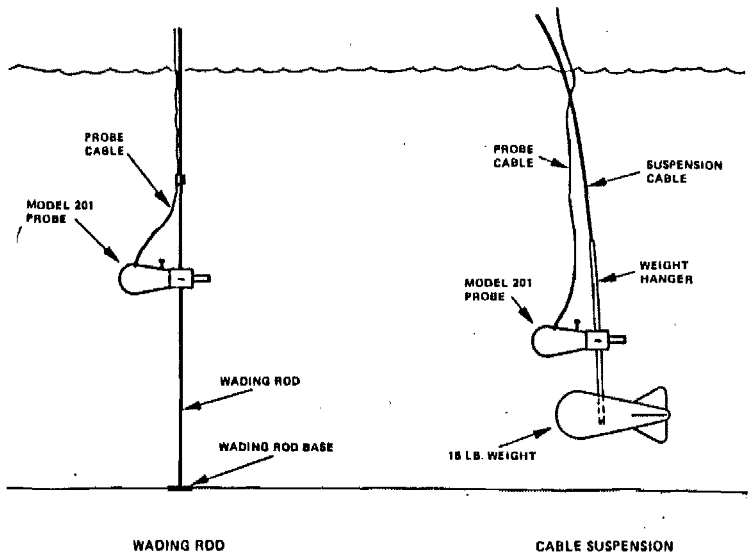


PROBE ORIENTATION TO FLOW DIRECTION

the meter should respond to the motion by indicating the velocity of the probe. Remember that the instrument has a filter which will cause the meter output to lag behind the actual velocity of the probe when it is oscillated.

This filter time constant can be changed if required; contact the factory for details. If the instrument reading appears erratic, see Section 5.

5. Mount the probe in either a wading rod or cable suspension configuration as shown. The meter is now ready for making measurements. Remember to wait at least 20 seconds after positioning the probe before reading the panel meter.



MOUNTING CONFIGURATIONS

EXTERNAL CONTROLS AND CONNECTIONS

The photograph on page 1 shows the external features of the Model 201 Portable Water Current Meter. The following items are called out in the figure.

1. Panel Meter.
2. Selector Switch – selects meter function.
   a. OFF – turns entire unit off.
   b. CAL – checks both the meter circuits and the batteries.
   c. 2.5, 5, 10 – selects meter full scale range.
3. Battery cover location.
4. Panel Meter Zero Adjust.
5. Probe.

SECTION 3
THEORY OF OPERATION

The Model 201 consists of a sensor probe with attached cable and an electronic processor with a panel meter readout. The probe consists of an electromagnet inside a molded plastic housing and a pair of electrodes spaced 180° apart on the sensor surface. Water flowing around the sensor probe interacts with the electromagnetic field to produce a small voltage in the water near the probe which is sensed by the electrodes. This extremely small voltage is amplified, demodulated, filtered, and displayed on the panel meter as shown in the block diagram on page 13.

SECTION 4
CIRCUIT DESCRIPTION

This instrument is a sophisticated measuring device consisting entirely of solid state circuitry. The circuits which are used have been designed in a straight-forward manner for ease in troubleshooting. These circuits can be divided into the following major areas.

1. Digital Processor and Magnet Driver.
2. Amplifier and Detector.
3. Calibrate Circuit.

The block diagram provided on page 13 depicts the signal paths through the instrument.

DIGITAL PROCESSOR AND MAGNET DRIVER

The digital processor generates signals used in the magnet driver, calibrate circuit, sample and hold circuit, and phase sensitive demodulator. The digital processor consists of an integrated circuit oscillator and digital decoders to generate a 50-50 duty cycle square wave at 30 Hz. This signal drives a power amplifier which controls the electrical current flowing in the electromagnet contained in the probe.

AMPLIFIER AND DETECTOR

This circuit first amplifies the flow-induced voltage (approximately 6 microvolts per foot per second) which is present at the electrodes mounted on the probe surface. Then it samples this signal, amplifies the sampled signal, and synchronously detects and filters the signal to provide an output which drives the panel meter.

CALIBRATE CIRCUIT

A resistor in series with the magnet leads generates a voltage proportional to magnet current. This voltage is then reduced by a resistor divider to a level comparable to the flow voltage. When the front panel switch is in the CAL position, this voltage is injected into the unit before the sample gate, testing most of the circuitry. Proper operation is indicated by the meter remaining within the CAL region.

EXTERNAL FEATURES

The Model 201 contains the following front panel features:

1. Selector Switch –
   a. Provides a sensitivity control for the panel meters.
   b. Allows the user to verify that the unit is still in calibration.
   c. Provides a check on the condition of the batteries.
2. Meter. – The panel meter has three scales which are selectable by the panel switch. This switch changes the resistor in series with the panel meter.

POWER SUPPLY

The standard operating voltages of the instrument are plus and minus 4.5 volts DC provided by six D size batteries. The batteries can operate the instrument for over 100 hours continuously. Normal battery drainage is approximately ±40 ma at ±4.5 volts.

PERIODIC MAINTENANCE

Routine maintenance of this instrument is confined simply to cleaning of the probe with a mild soap and water to keep the electrodes free of non-conductive grease and oils. The meter face, switch knob, and front panel can also be cleaned with soap and water. Do not use any hydrocarbon solvents on the meter face or probe as these may damage the surface.

To check the meter zero, place the probe in the center of a non-metallic (plastic) container of fresh water, wait 30 minutes to insure that the water is stationary, and then proceed as follows:

1. Set the Selector Switch to the 2.5 ft./sec full scale position.
2. Note the meter reading. If less than 0.1 ft./sec., zero is satisfactory.

Routinely check the condition of the batteries by setting the front panel Selector Switch to the CAL position and noting that the meter indicates in the CAL section of the scale. If the meter does not indicate properly, replace the batteries as instructed on page 3, step 2.

TROUBLESHOOTING

Initial Operation

Initial operation of the instrument may require familiarity with its characteristics. The following notes may assist the first time user.

1. Symptom: Noisy or erratic zero while held stationary in a small container of water.

   Cause: Using the probe in a confined space is an artificial environment. Holding the probe near the side of the container exaggerates the anomaly by interfering with the free field magnetic and electrical fields. This is especially true if the container is electrically conductive and made of ferrous material.

   Remedy:

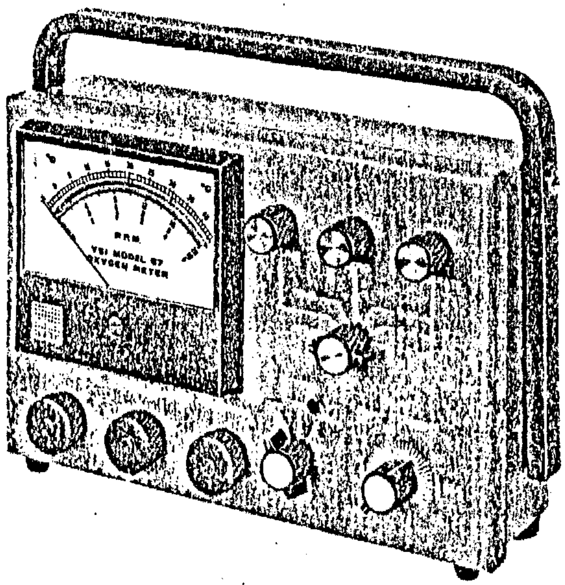
   a. Use the largest water container available.
   b. Use only a nonconductive, non-magnetic container.
   c. Hold the probe away from any container walls.

2. Symptom: Noisy or erratic zero when probe is initially immersed in water, which improves after several minutes for no apparent reason.

   Cause: The electrode material requires immersion for a short length of time to become completely wetted. This problem may also appear momentarily when testing between water samples of sharply different conductivities, such as between fresh and salt water.

   Remedy: Immerse probe for several minutes in the water to be used before taking readings. This problem is normally only noted with new probes, but could occur if a probe is completely dry from lack of use. Washing the probe with a mild soap and warm water will aid in removing any nonconductive films. It is permissible to lightly wet sand the electrodes with 600 grit sandpaper if washing does not reduce the noise level.

INSTRUCTION MANUAL
YSI MODEL 57
DISSOLVED OXYGEN METER



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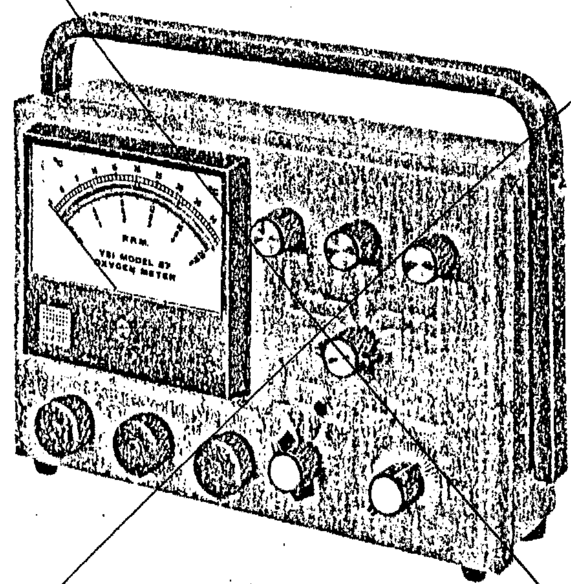
Yellow Springs Instrument Co., Yellow Springs, Ohio 45387

PRICE $5.00

INSTRUCTION MANUAL
YSI MODEL 57
DISSOLVED OXYGEN METER



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SUMMARY OF OPERATING INSTRUCTIONS

1. CALIBRATION
   A. Switch instrument to OFF and adjust meter mechanical zero.
   B. Switch to RED LINE and adjust.
   C. Prepare probe for operation, plug into instrument, wait up to 15 minutes for probe to stabilize. Probe can be located in calibration chamber (see instruction manual) or ambient air.
   D. Switch to ZERO and adjust.
   E. Adjust SALINITY knob to FRESH.
   F. Switch to TEMP and read.
   G. Use probe temperature and true local atmospheric pressure (or feet above sea level) to determine correct calibration values from Table I and II. (See pages 13 and 14).

      EXAMPLE: Probe temp = 21°C, Altitude = 1000 ft. From Table I the calibration value for 21°C is 9.0 PPM. From Table II the altitude factor for 1000 ft. is about .96. The correct calibration value is:

      9.0 PPM X .96 factor = 8.64 PPM

   H. Switch to desired dissolved oxygen range 0-5, 0-10, or 0-20 and with calibrate control adjust meter to correct calibration value determined in Step G.

      NOTE: It is desirable to calibrate probe in a high humidity environment. See instruction manual for more detail on calibration and other instrument and probe characteristics.

2. MEASUREMENT
   A. Adjust the SALINITY knob to the salinity of the sample.
   B. Place the probe and stirrer in the sample and switch the STIRRER control to ON.
   C. When the meter has stabilized switch to the appropriate range and read D.O.
   D. We recommend the instrument be left on between measurements to avoid necessity for repolarizing the probe.

3. GENERAL CARE
   A. Replace the instrument batteries when unable to adjust to red line. Use (2) Eveready No. 935 "C" size or equivalent.
   B. In the BATT CHECK position the voltage of the stirrer batteries is displayed on the red 0-10 scale. Do not discharge below 6.0 Volts. Recharge for 14-16 hrs. with YSI No. 5728 charger.
   C. Membranes will last indefinitely, depending on usage. Average replacement is 2-4 weeks. Probe should be stored in humid environment to prevent drying out.
   D. Calibrate daily.

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GENERAL DESCRIPTION

The YSI Model 57 Dissolved Oxygen Meter is intended for dissolved oxygen and temperature measurement in water and wastewater applications, but is also suitable for use in certain other liquids. Dissolved Oxygen is indicated in PPM (parts per million) on 0-5, 0-10, and 0-20 PPM scales. Temperature is indicated in °C on a -5° to +45°C scale. The dissolved oxygen ranges are automatically temperature compensated for solubility of oxygen in water and permeability of the probe membrane, and manually salinity compensated.

The probes use Clark-type membrane covered polarographic sensors with built in thermistors for temperature measurement and compensation. A thin, permeable membrane stretched over the sensor isolates the sensor elements from the environment, but allows oxygen and certain other gases to enter. When a polarizing voltage is applied across the sensor, oxygen that has passed through the membrane reacts at the cathode, causing a current to flow.

The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure inside the membrane is zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the absolute pressure of oxygen outside the membrane. If the oxygen pressure increases, more oxygen diffuses through the membrane and more current flows through the sensor. A lower pressure results in less current.

SPECIFICATIONS

I. Instrument

Oxygen Measurement

Ranges: 0-5, 0-10, and 0-20 PPM (0-2.5, 0-5 and 0-10 PPM with YSI 5776 High Sensitivity Membrane)

Accuracy: ±1% of full scale at calibration temperature (±0.1 PPM on 0-10 scale), or 0.1 PPM (whichever is larger).

Readability: .025 PPM on 0-5 scale; .05 PPM on 0-10 scale; 0.1 PPM on 0-20 scale.

Temperature Measurement

Range: -5° to +45°C

Accuracy: ±0.5°C plus probe which is ±0.1°C

Readability: 0.25°C

Temperature Compensation

±1% of D.O. reading for measurements made within ±5°C of calibration temperature.

±3% of D.O. reading over entire range of -5 to +45°C probe temperature.

System Response Time

Typical response for temperature and D.O. readings is 90% in 10 seconds at a constant temperature of 30°C with YSI 5775 Membranes. D.O. response at low temperature and low D.O. is typically 90% in 30 seconds. YSI 5776 High Sensitivity Membranes can be used to improve response at low temperature and low D.O. concentrations. If response time under any operating conditions exceeds two minutes, probe service is indicated.

Operating Temperature Range

Instrument and probe operating range is -5° to +45°C. Large ambient temperature changes will result in 2% loss of accuracy unless Red Line and Zero are reset.

Recorder Output

0 to 114-136 mV. Recorder should have 50,000 ohms minimum input impedance.

Power Supply

The YSI Model 57 is powered by two disposable "C" size carbon zinc batteries (Eveready 935C or equal) providing approximately 1000 hour operation.

II. Probe

Cathode: Gold
Anode: Silver
Membrane: .001" FEP Teflon
(.0005" FEP Teflon available)
Electrolyte: Half saturated KCl
Temperature Compensation: (See SPECIFICATIONS, I. Instrument)
Pressure Compensation: Effective 1/2% of reading with pressures to 100 psi (230 ft. sea water)
Polarizing Voltage: 0.8 volts nominal
Probe Current: Air at 30°C = 19 microamps nominal
Nitrogen at 30°C = .15 microamps or less

III. Accessories and Replacement Parts

YSI 5720 — Self Stirring BOD Bottle Probe
YSI 5750 — Non Stirring BOD Bottle Probe
YSI 5739 — Oxygen Temperature Probe for field use. Combine with one of the following 4 cables for desired lead length:
Detachable leads for use with YSI 5739:

YSI 5740- 10	10' Cable
YSI 5740- 25	25' Cable
YSI 5740- 50	50' Cable
YSI 5740-100	100' Cable
YSI 5740-150	150' Cable
YSI 5740-200	200' Cable

YSI 5721 — Battery and charger pack operates YSI 5791 and 5795 Submersible Stirrers.
YSI 5791 — Submersible Stirrer for field use.
YSI 5795 — Submersible Stirrer.
YSI 5075 — Calibration Chamber for use with field probe.
YSI 5988 — Carrying Case.
YSI 5775 — Membrane and KCl Kit, Standard — includes 2 each 15-membrane packets (.001" thick standard membranes) and a 30 ml bottle KCl with Kodak photo flo.
YSI 5776 — Membrane and KCl Kit, High Sensitivity — includes 2 each 15-membrane packets (.0005" thick membranes) and a 30 ml bottle KCl with Kodak photo flo.

YSI 594... "O" R... Pack... includ... (?) "O" ...s for ... YSI D.O. Probe.

YSI 5486 — Beater Boot Kit — includes (6) A-05486 Boot, (1) A-05484 Tip, (4) A-05485 Spring. Used only on 5720 and discontinued 5420A.

YSI 5986 — Diaphragm Kit for use only with YSI 5739 D.O. Probe.

YSI 5734 — Adaptor makes is possible to use discontinued YSI 5400 Series Probes with YSI Model 57.

YSI 5735 — Adaptor makes it possible to use YSI 5739, YSI 5720 and YSI 5750 Probes with discontinued YSI Models 51A, 54RC and 54BP.

OXYGEN PROBES AND EQUIPMENT

There are three oxygen probes for use with the YSI Model 57 Dissolved Oxygen Meters. Descriptions of where they are used are contained in the following paragraphs.

I. YSI 5739 D.O. Probe

The YSI 5739 probe, with built-in lead weight and pressure compensation, is an improved design that replaces the discontinued YSI 5418, 5419, 5718 and 5719 probes. (See Figure 1)

For user convenience the probe is equipped with a disconnecting cable to facilitate changing cable lengths and replacing damaged cables or probes. The probe and cable assembly is held together with a threaded retaining nut. The connection is *not* designed for casual disconnection and should only be disconnected when necessary.

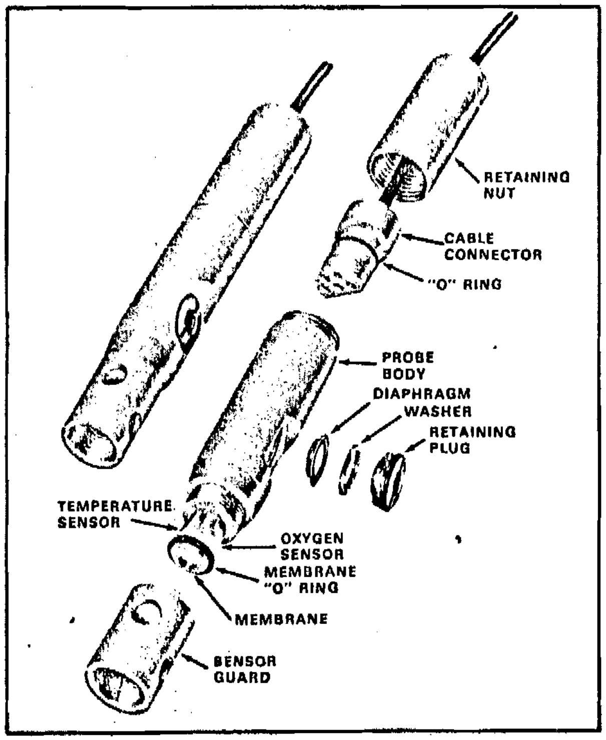


FIGURE 1

... disco... the ... uns... the ...ing ... and sli... down ... cable to expose the connector. Pull gently on the cable and connector until the connector comes away from the probe body.

To reassemble, inspect the connector and "O" ring for cleanliness. If the "O" ring is frayed or damaged remove it by squeezing it in the groove causing it to bulge, then roll it out of the groove and off the connector. A replacement "O" ring is supplied with the cable.

Push the connector into the probe body, rotating it until the two halves mate. A light coating of vaseline or silicone grease on the "O" ring will make reasssembly easier. Air trapped between the connector halves which may cause them to spring apart slightly, is normal. Screw on the retaining nut, *hand tight only.* NOTE: If erratic readings are experienced, disconnect the cable and inspect for water. If present, dry out and reconnect, replacing the "O" ring, if necessary.

Pressure Compensation

The vent on the side of the probe is part of a unique pressure compensating system that helps assure accurate readings at great depths of water. Pressure compensation is effective to 1/2% of reading with pressures to 100 psi (230 ft. water). The quantity of air bubbles trapped under the membrane determines how serious the pressure error will be, which is why proper preparation of the probe is essential. (See OPERATING PROCEDURES.) The system is designed to accommodate a small amount of trapped air and still function properly, but the amount should be kept to a minimum.

The compensating system normally does not require servicing and should not be taken apart. However, if electrolyte is leaking through the diaphragm or if there is an obvious puncture, the diaphragm must be replaced. A spare is supplied with the probe. Using a coin unscrew the retaining plug and remove the washer and the diaphragm, flush any salt crystals from the reservoir, install the new diaphragm (convolution side in), replace the washer, and screw in the retaining plug.

II. YSI 5720 B.O.D. Bottle Probe

The YSI 5720 B.O.D. Bottle Probe replaces the discontinued YSI 5420A B.O.D. Bottle Probe for measuring dissolved oxygen and temperature in standard B.O.D. bottles. It is provided with an agitator for stirring the sample solution, available in models for 117VAC (95-135VAC, 50-60 Hz) or 230VAC (190-250VAC, 50-60 Hz) operation. (See Figure 2)

When using the probe, plug the agitator power supply into line power and the probe plug into the instrument. With the agitator turned off place the tapered probe end into the B.O.D. bottle and switch agitator "ON" with switch on top of probe. The probe should be operated with a minimum of trapped air in the B.O.D. bottle. A slight amount of air in the unstirred region at the top of the bottle may be neglected, but no bubbles should be around the thermistor or oxygen sensor.

Stirrer Boot

The probe uses a flexible stirring boot to transmit motion from the sealed motor housing to the sample. If the boot shows signs of cracking or other damage likely to allow leaking into the motor housing, the boot must be replaced.

In fresh water applications boot life is normally several years, but this may be shortened by exposure to hydrocarbons, moderate to strong acids or bases,

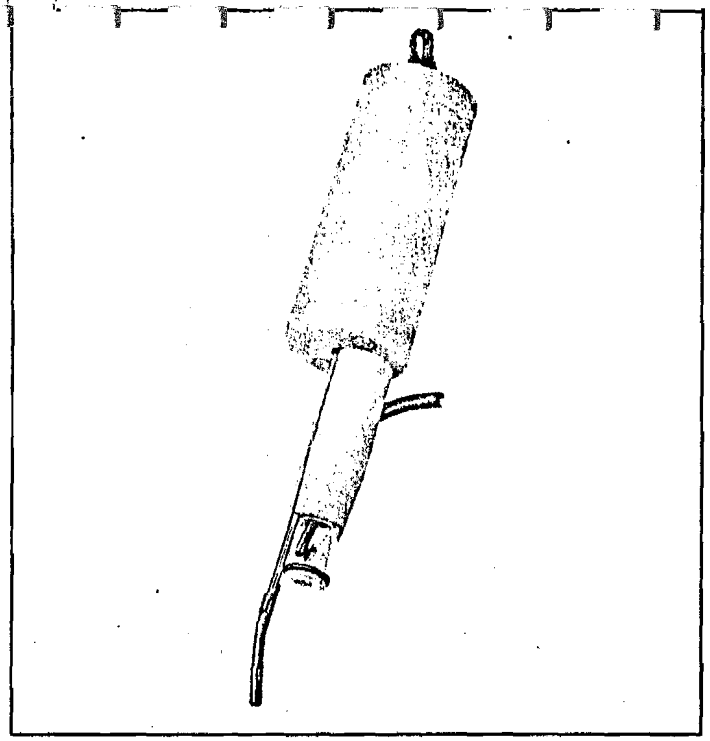


FIGURE 2

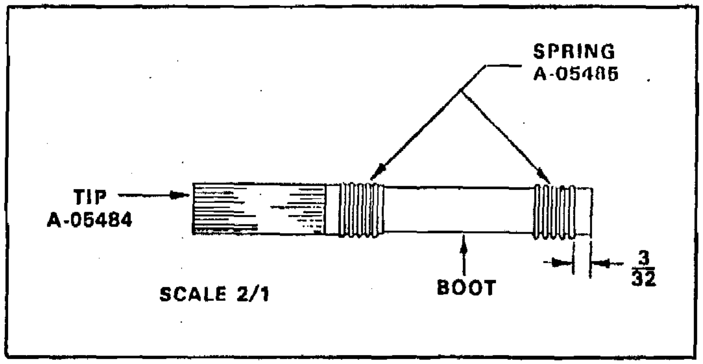


FIGURE 3

ozone, or direct sunlight. For maximum life rinse the boot after use in contaminated samples. (See Figure 3)

Boot replacement is as follows:

1. Pull off old assembly and clean shaft.
2. Slide on new assembly making sure the back spring is on the grooved area of the shaft. A small amount of rubber cement may be used.
3. Check that there is sufficient clearance between the tip and the end of the shaft to permit turning without binding.

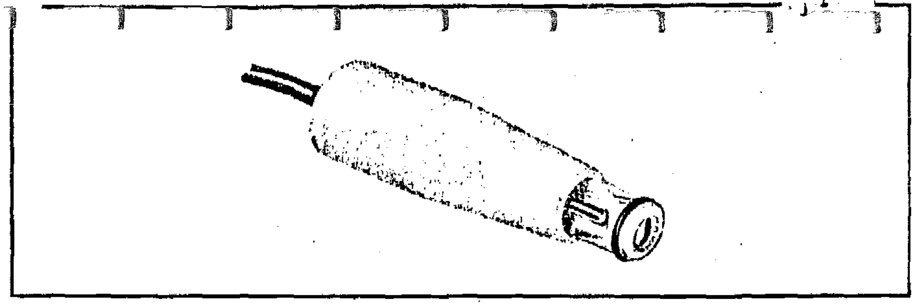


FIGURE 4

III. YSI 5750 B.O.D. Bottle Probe

The YSI 5750 B.O.D. Bottle Probe replaces the discontinued YSI 5450 B.O.D. Bottle Probe. It is similar to the YSI 5720 B.O.D. Bottle Probe, except that it does not have a stirrer. Agitation of the sample must be provided by other means, such as a magnetic stirrer. (See Figure 4)

IV. Cable Adaptors

All YSI 5700 Series Probes are designed for direct use with the YSI Model 57 Dissolved Oxygen Meter. However, to use the discontinued YSI 5400 Series Probes with the YSI Model 57, cable adaptor YSI 5734 is required. (See Figure 5)

V. YSI 5791 and 5795 Submersible Stirrers

The YSI submersible stirrers are accessories that perform the function of stirring the sample being studied when making dissolved oxygen measurements in the field. The YSI 5791 stirrer can be used with the following dissolved oxygen probes: YSI 5418, 5419, 5718, 5719, and 5739. The YSI 5795 stirrer is only for use with the YSI 5739 Probe. (See Figure 6)

When a stirrer and probe are assembled, the stirrer agitates the sample directly in front of the sensor by means of a rotating eccentric weight which causes the spring-mounted hermetically sealed motor housing to vibrate. An impeller on the end of the motor housing flushes the media across the oxygen sensor. (See sales literature and instruction sheets for further information).

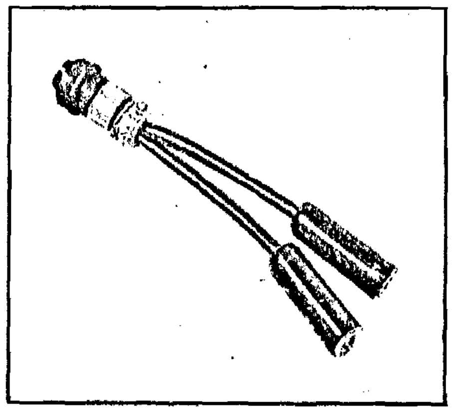


FIGURE 5

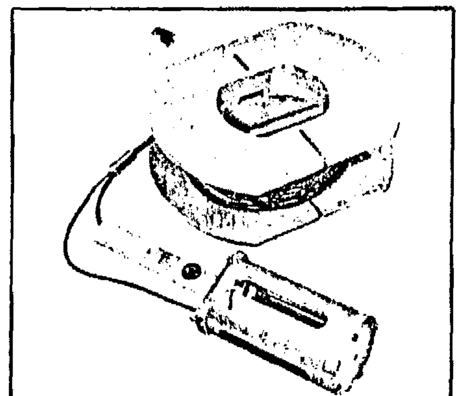


FIGURE 6

VI. YSI 5721 Battery Pack and Charger

The YSI 5721 Battery Pack and Charger is offered as an accessory to operate either the YSI 5791 or 5795 Submersible Stirrer when the stirrer is used in conjunction with the YSI Model 57 Oxygen Meter. The YSI 5721 can be purchased with the YSI Model 57 or installed at a later time. (See sales literature and instruction sheet for further information).

OPERATING PROCEDURES

I. Preparing the Probe

All YSI 5700 Series Probes have similar sensors and should be cared for in the same manner. They are precision devices relying on good treatment if high accuracy measurements are to be made. Prepare the probes as follows. (See Figure 7)

ALL PROBES ARE SHIPPED DRY — YOU MUST FOLLOW THESE INSTRUCTIONS

1. Prepare the electrolyte by dissolving the KCl crystals in the dropper bottle with distilled water. Fill the bottle to the top.
2. Unscrew the sensor guard from the probe (YSI 5739 only) and then remove the "O" ring and membrane. Thoroughly rinse the sensor with KCl solution.
3. Fill the probe with electrolyte as follows:
   - A. Grasp the probe in your left hand. When preparing the YSI 5739 probe the pressure compensating vent should be to the right. Successively fill the sensor body with electrolyte while pumping the diaphragm with the eraser end of a pencil or similar soft, blunt tool. Continue filling and pumping until no more air bubbles appear. (With practice you can hold the probe and pump with one hand while filling with the other.) When preparing the YSI 5720 and 5750 probes, simply fill the sensor body until no more air bubbles appear.
   - B. Secure a membrane under your left thumb. Add more electrolyte to the probe until a large meniscus completely covers the gold cathode. NOTE: Handle membrane material with care, keeping it clean and dust free, touching it only at the ends.
   - C. With the thumb and forefinger of your other hand, grasp the free end of the membrane.
   - D. Using a continuous motion *stretch* the membrane *UP, OVER,* and *DOWN* the other side of the sensor. Stretching forms the membrane to the contour of the probe.
   - E. Secure the end of the membrane under the forefinger of the hand holding the probe.
   - F. Roll the "O" ring over the end of the probe. There should be no wrinkles in the membrane or trapped air bubbles. Some wrinkles may be removed by lightly tugging on the edges of the membrane beyond the "O" ring.
   - G. Trim off excess membrane with scissors or sharp knife. Check that the stainless steel temperature sensor is not covered by excess membrane.
4. Shake off excess KCl and reinstall the sensor guard.
5. A bottomless plastic bottle is provided with the YSI 5739 probe for convenient storage. Place a small piece of moist towel or sponge in the bottle and insert the probe into the open end. This keeps the electrolyte from drying out. The YSI 5720 and 5750 probes can be stored in a B.O.D. bottle containing about 1" of water.

KCL solution & membranes in slit in foam: or in wood cabinet in bin

6. ...hbra... ill la... efini... depe... on u... Ave... repl... ent is 2-4 weeks. However, should the electrolyte be allowed to evaporate and an excessive amount of bubbles form under the membrane, or the membrane become damaged, thoroughly flush the reservoir with KCl and install a new membrane.
7. Also replace the membrane if erratic readings are observed or calibration is not stable.
8. "Home brew" electrolyte can be prepared by making a saturated solution of reagent grade KCl and distilled water, and then diluting the solution to half strength with distilled water. Adding two drops of Kodak Photo Flo per 100 ml of solution assures good wetting of the sensor, but is not absolutely essential.
9. The gold cathode should always be bright and untarnished. To clean, wipe with a clean lint-free cloth or hard paper. NEVER USE ANY FORM OF ABRASIVE OR CHEMICAL. Rinse the sensor several times with KCl, refill, and install a new membrane.
10. Some gases contaminate the sensor, evidenced by discoloration of the gold. If the tarnish cannot be removed by vigorous wiping with a soft cloth, lab wipe, or hard paper, return the probe to the factory for service.
11. H_2S, SO_2, Halogens, Neon, and CO are interfering gases. If you suspect erroneous readings, it may be necessary to determine if these are the cause.
12. If the probe has been operated for extended periods with a loose or wrinkled membrane the gold cathode may become plated with silver. In this event return the probe to the factory for refinishing.

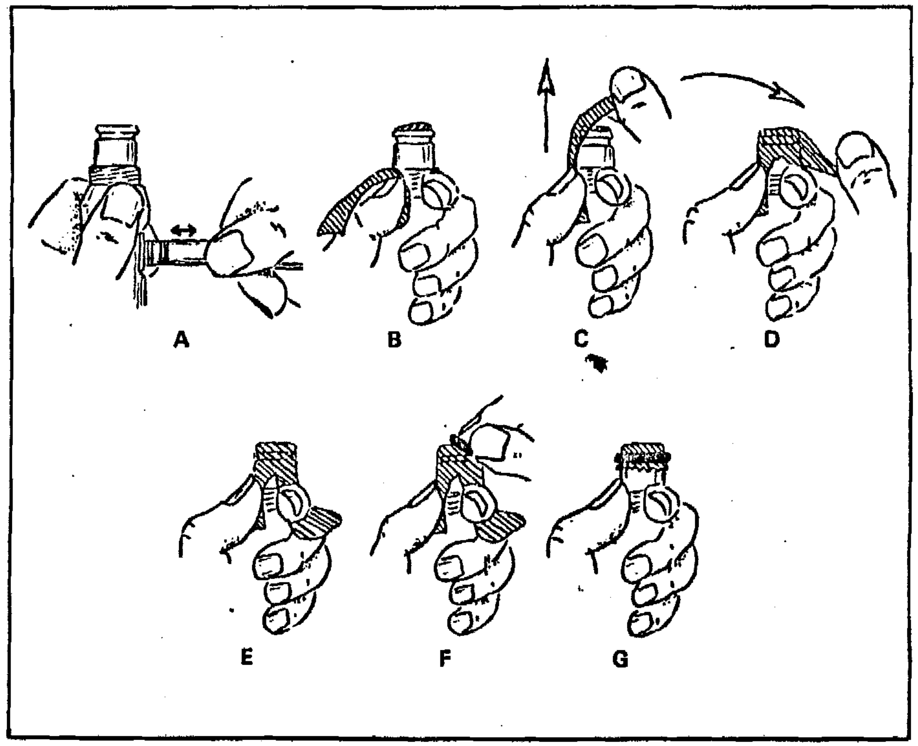


FIGURE 7

II. ...ir... e In... ent

It is important that the instrument be placed in the intended operating position vertical, tilted, or on its back — before it is prepared for use and calibrated. (See Figure 8). Readjustment may be necessary when the instrument operating position is changed. After preparing the probe proceed as follows:

1. With switch in the OFF position, adjust the meter pointer to Zero with the screw in the center of the meter panel. Readjustment may be necessary if the instrument position is changed.
2. Switch to RED LINE and adjust the RED LINE knob until the meter needle aligns with the red mark at the 31°C position.
3. Switch to ZERO and adjust to zero with zero control knob.
4. Attach the prepared probe to the PROBE connector of the instrument and adjust the retaining ring finger tight.
5. Before calibrating allow 15 minutes for optimum probe stabilization. Repolarize whenever the instrument has been OFF or the probe has been disconnected.

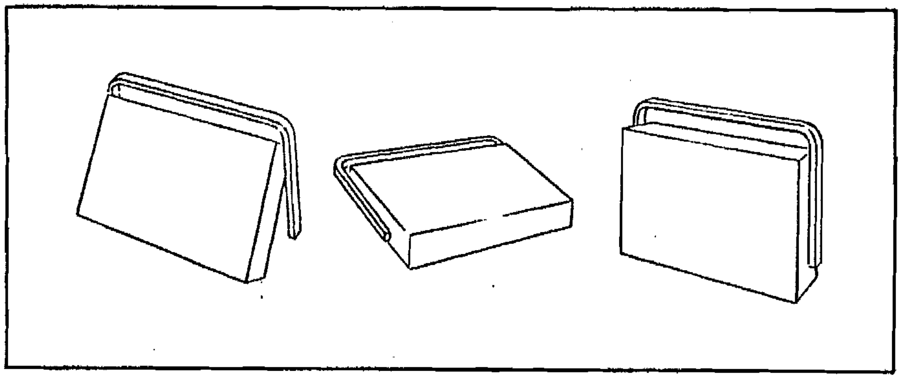


FIGURE 8

III. Calibration

The operator has a choice of three calibration methods — Winkler Titration, Saturated Water, and Air. Experience has shown that air calibration is quite reliable, yet far simpler than the other two methods. The three methods are described in the following paragraphs.

Winkler Titration

1. Draw a volume of water from a common source and carefully divide into four samples. Determine the oxygen in three samples using the Winkler Titration technique and average the three values. If one of the values differs from the other 2 by more than 0.5 ppm, discard that value and average the remaining two.
2. Place the probe in the fourth sample and stir.
3. Set the SALINITY control to zero or the appropriate salinity value of the sample.
4. Switch to desired PPM range and adjust the CALIBRATION control to the average value determined in Step 1. Allow the probe to remain in the sample for at least two minutes before setting the calibration value, and leave in the sample for an additional 2 minutes to verify stability. Readjust if necessary.

...ated ...ter

1. Air saturate a volume of water (300-500cc) by aerating or stirring for at least 15 minutes at a relatively constant temperature.
2. Place the probe in the sample and stir. Switch to TEMPERATURE. Refer to Table I for the PPM value corresponding to the temperature.
3. Determine local altitude or the "true" atmospheric pressure (note that "true" atmospheric pressure is as read on a mercury barometer. Weather Bureau reporting of atmospheric pressure is corrected to sea level). Using Table II determine the correct factor for your pressure or altitude.
4. Multiply the PPM value from Table I by the correction factor from Table II to determine the corrected calibration value for your conditions.
   EXAMPLE: Assume temperature = 21°C and altitude = 1000 feet. From Table I the calibration value for 21°C is 9.0 PPM. From Table II the correction factor for 1000 feet is about 0.96. The corrected calibration value is 9.0 PPM X 0.96 = 8.6 PPM
5. Switch to an appropriate PPM range, set the SALINITY knob to zero, and adjust the CALIBRATE knob while stirring until the meter reads the corrected calibration value from Step 4. Leave the probe in the sample for two minutes to verify calibration stability. Readjust if necessary.

Air Calibration

1. Place the probe in moist air. BOD probes can be placed in partially filled (50 mL) BOD bottles. Other probes can be placed in the YSI 5075 Calibration Chamber (refer to the following section describing calibration chamber) or the small storage bottle (the one with the hole in the bottom) along with a few drops of water. The probe can also be wrapped loosely in a damp cloth taking care the cloth does not touch the membrane. Wait approximately 10 minutes for temperature stabilization.
2. Switch to TEMPERATURE and read. Refer to Table I — Solubility of Oxygen in Fresh Water, and determine calibration value.
3. Determine altitude or atmospheric correction factor from Table II.
4. Multiply the calibration value from Table I by the correction factor from Table II.
   EXAMPLE: Assume temperature = 21°C and altitude = 1000 feet. From Table I the calibration value for 21°C is 9.0 PPM. From Table II the correction factor for 1000 ft. is about 0.96. Therefore, the corrected calibration value is 9.0 PPM X 0.96 = 8.6 PPM.
5. Switch to the appropriate PPM range, set the SALINITY knob to zero and adjust the CALIBRATE knob until the meter reads the correct calibration value from Step 4. Wait two minutes to verify calibration stability. Readjust if necessary.

The probe is now calibrated and should hold this calibration value for many measurements. Calibration can be disturbed by physical shock, touching the membrane, or drying out of the electrolyte. Check calibration after each series of measurements and in time you will develop a realistic schedule for recalibration. For best results when not in use, follow the storage procedures recommended for the various probes described under OXYGEN PROBES AND EQUIPMENT. This will reduce drying out and the need to change membranes.

Calib[illegible] Ch[illegible]r

The YSI 5075 Calibration Chamber is an accessory that helps obtain maximum accuracy when air calibrating in the field and is also a useful tool when measuring in shallow water (less than 4 ft). As shown in Figure 9, it consists of a 4-1/2 ft. stainless steel tube (1) attached to the calibration chamber (5) and the measuring ring (7). For calibration insert the solid rubber stopper (6) into the bottom of the calibration chamber (5). Push the probe (4) through the hollow rubber stopper (3) as shown in Detail A. For maximum accuracy wet the inside of the calibration chamber (5) with fresh water. This creates a 100% relative humidity environment for calibration. Insert the probe-stopper assembly in the top of the calibration chamber.

During calibration hold the calibration chamber under water and calibrate as described in the Air Calibration procedure. Keep the handle above the water at all times. After calibration the chamber can be used as a measuring aid by removing the probe-stopper assembly from the calibration chamber (5) and placing it in measuring ring (7). (See Detail C). Slowly stir the water with the wand when measuring.

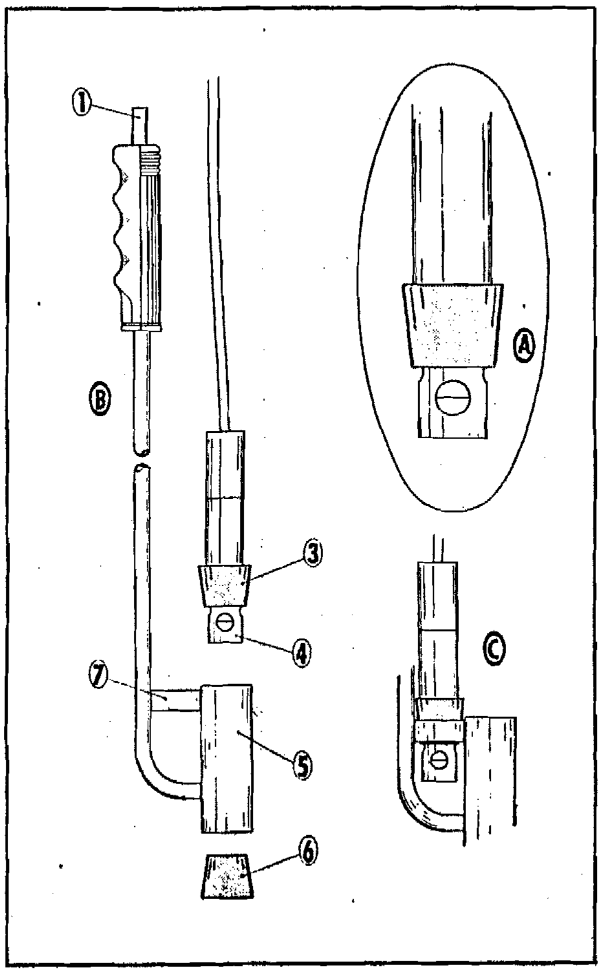


FIGURE 9

IV. [illegible]olve[illegible] [illegible]ygen [illegible]sur[illegible]t

With the instrument prepared for use and the probe calibrated, place the probe in the sample to be measured and provide stirring.

1. Stirring for the 5739 Probe can best be accomplished with a YSI submersible stirrer. Turn the STIRRER knob ON. If the submersible stirrer is not used, provide manual stirring by raising and lowering the probe about 1 ft. per second. If the 5075 Calibration Chamber is used, the entire chamber may be moved up and down in the water at about 1 ft. per second.
2. The YSI 5720 has a built-in power driven stirrer.
3. With the YSI 5750 sample stirring must be accomplished by other means such as with the use of a magnetic stirring bar.
4. Adjust the SALINITY knob to the salinity of the sample.
5. Allow sufficient time for probe to stabilize to sample temperature and dissolved oxygen. Read dissolved oxygen.

V. Calibration Tables

Table I shows the amount of oxygen in PPM that is dissolved in air saturated fresh water at sea level (760 mmHg atmospheric pressure) as temperature varies from 0° to 45°C.

Table I — Solubility of Oxygen In Fresh Water

Temperature °C	PPM Dissolved Oxygen	Temperature °C	PPM Dissolved Oxygen
0	14.6	23	8.7
1	14.2	24	8.5
2	13.9	25	8.4
3	13.5	26	8.2
4	13.2	27	8.1
5	12.8	28	7.9
6	12.5	29	7.8
7	12.2	30	7.7
8	11.9	31	7.5
9	11.6	32	7.4
10	11.3	33	7.3
11	11.1	34	7.2
12	10.8	35	7.1
13	10.6	36	7.0
14	10.4	37	6.8
15	10.2	38	6.7
16	9.9	39	6.6
17	9.7	40	6.5
18	9.5	41	6.4
19	9.3	42	6.3
20	9.2	43	6.2
21	9.0	44	6.1
22	8.8	45	6.0

Source: Derived from "Standard Methods for the Examination of Water and Wastewater."

Table [illegible] gives the correction factor that should be used to correct the calibration value for the effects of atmospheric pressure or altitude. Find true atmospheric pressure in the left hand column and read across to the right hand column to determine the correction factor. (Note that "true" atmospheric pressure is as read on a barometer. Weather Bureau reporting of atmospheric pressure is corrected to seal level.) If atmospheric pressure is unknown, the local altitude may be substituted. Select the altitude in the center column and read across to the right hand column for the correction factor.

Table II — Altitude Correction Factor

Atmospheric Pressure mmHg	or	Equivalent Altitude Ft.	=	Correction Factor
775		540		1.02
760		0		1.00
745		542		.98
730		1094		.96
714		1688		.94
699		2274		.92
684		2864		.90
669		3466		.88
654		4082		.86
638		4756		.84
623		5403		.82
608		6065		.80
593		6744		.78
578		7440		.76
562		8204		.74
547		8939		.72
532		9694		.70
517		10472		.68
502		11273		.66

Source: Derived from "Standard Methods for the Examination of Water and Wastewater."

VI. HIGH SENSITIVITY MEMBRANE

Use of high sensitivity .0005" membranes (YSI 5776) in place of standard .001" membranes (YSI 5775) when measurements are to be made consistently at low temperatures (less than 15°C). Calibration and readings will be made just as if the standard YSI 5775 membrane was being used.

The YSI 5776 High Sensitivity Membrane can also be used in certain situations to increase sensitivity at temperatures above 15°C. The ranges thus become 0.25, 0-5 and 0-10 PPM. When calibration with high sensitivity membranes is attempted at temperatures greater than 15°C the selector switch must be set to 0-20 PPM. Multiply the calculated calibration value by 2. For example: at 21°C and 1000 ft. altitude the calibration value would be 8.6 x 2 or 17.2. Remember the 0-5, 0-10 and 0-20 PPM ranges are now 0-2.5, 0-5 and 0-10 PPM, and all PPM readings must be divided by 2 for a final reading. When operating in this manner accuracy will be degraded slightly.

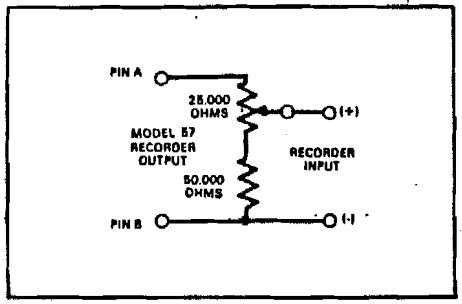
VII. [illegible]COR[illegible] OU[illegible]

Output at full scale is 114 to 136 mV.

Use a 50K or higher input impedance recorder and operate it with the terminals ungrounded. (The YSI Models 80A and 81A strip Chart recorders are compatible with this system for laboratory use).

Many recorders have an adjustable full scale sensitivity feature. When using this type, use the 100 mV range and adjust the full scale (span, range control, sensitivity, etc.) control to give full scale chart deflection with full scale oxygen meter deflection. Refer to the recorder instructions. For recorders without this feature, a simple driver network as shown below can be constructed. This is adequate to adjust the signal for full scale chart and meter deflection on the 100 mV fixed range recorders.

FIGURE 10



Recorder Output Plug

The YSI Model 57 is supplied with the necessary parts to construct a waterproof recorder plug for the YSI Model 57 Dissolved Oxygen Meter. The cable and potting materials are not included. (See Figure 11).

General purpose epoxy potting materials of medium viscosity and moderate cure rate are recommended. The two tube kits available in hardware stores are satisfactory.

1. Prepare the cable end by stripping back 3/16" (5MM) of insulation. Tin the ends with rosin core solder. If polarity is important pin "A" is the (+) terminal.
2. Disassemble the connector pieces and slide the mold, ring, extension, and coupling nut over the cable. Solder the leads to the appropriate connector pins with rosin core solder.
3. Check all connections. The two leads should show electrical continuity to the pins and should not contact the body or each other.
4. Re-assemble the pieces and hold the connector upright. Pour the epoxy mix into the plastic mold until full. Refill as the epoxy settles.
5. After the epoxy cures the plastic mold may be removed with pliers or knife.

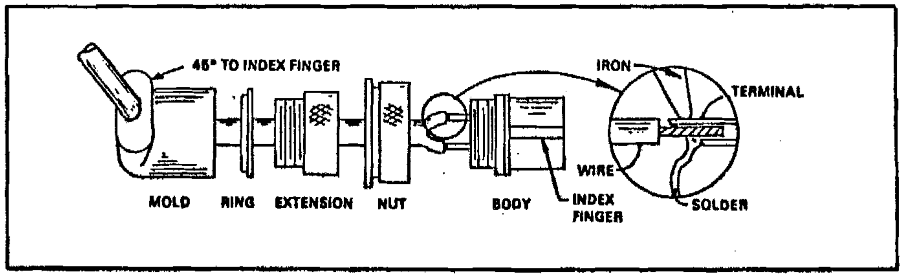


FIGURE 11

DISCUSSION OF MEASUREMENT ERRORS

There are three basic types of errors which can occur. Type I errors are related to limitations of the instrument design and tolerances of the instrument components. These are chiefly the meter linearity and resistor tolerances. Type II errors are due to basic probe accuracy tolerances, chiefly background signal, probe linearity, and variations in membrane temperature coefficient. Type III errors are related to the operator's ability to determine the conditions at the time of calibration. If calibration is performed against more accurately known conditions, Type III errors are appropriately reduced.

Individual Sources of Error

This description of sources of error can be used to attach a confidence to any particular reading of dissolved oxygen. The particular example given is for a near extreme set of conditions. As a generality, overall error is diminished when the probe and instrument are calibrated under conditions of temperature and dissolved oxygen which closely match the sample temperature and dissolved oxygen.

Type I

A. Is the error due to the meter linearity.
   Error = ±1% of full scale of the measurement range.

B. Is the error due to tolerances in the instrument when transferring a reading from one range to another.
   Error = ±1% of the meter reading if the reading is taken on a range one range away from the calibration range.
   Error = ±2% of the meter reading if the reading is taken on a range two ranges away from the calibration range.

C. Is the error due to the design and components of the instrument salinity compensation circuit.

$$\text{Error} = \pm 2.5\% \text{ of the meter reading} \times \frac{\text{sample salinity ppt}}{\text{40 ppt salinity}}$$

Type II

A. errors are due to probe background current.

$$\text{Error} = 0.5\% \left(1 - \frac{\text{meter reading ppm}}{\text{Calib. value}}\right) \times \text{calib. value, P.P.M.}$$

B. errors are due to the probe non-linearity
   Error = 0.3% of reading

C. error is caused by variability in the probe membrane temperature coefficient.
   Error = zero if readings are taken at the calibration temperature.
   Error = ± 1% of meter reading if readings are taken with 5°C of the calibration temperature.
   Error = ±3% of meter reading all other conditions.

Type III

A. errors are due to the accuracy of the instrument thermometer when used to measure the exact probe temperature during calibration.
   Error = ±1.5% of reading.

B. errors are due to the assumption of mean, barometric pressure. Daily variation is usually less than 1.7%
   Error = ±1.7% of reading.

C. [illegible] ft. when computing the altitude correction factor.
   Error = 1.8% of reading.

D. errors consider the possibility of only 50% relative humidity when calibrating the probe. If the actual relative humidity is 50% instead of 100% the errors will be as follows:

Calibration Temperature ± C	Error in Percent of Reading
0	(-) 0.3
10	(-) 0.6
20	(-) 1.15
30	(-) 2.11
40	(-) 3.60

Example of a Typical Error Calculation

The example given presumes the air calibration technique. If calibration is done with air saturated water, the relative humidity consideration (III-D) is eliminated. If the Winkler calibration method is used, Type III errors are deleted and replaced by the uncertainty attributable to the overall Winkler determination.

Data: Instrument calibrated at 25°C, elevation estimated at 2000 ft., ±500 feet, normal barometric pressure presumed, calibrated on 0-10 ppm scale at 7.8 PPM. Readings taken on 0-5 ppm range at 4.5 ppm, temperature 20°C. Salinity of 20 ppt.

Type	Description	Calculations	Error ppm
IA	Linearity	$= .01 \times 4.5$ ppm	.045
IB	Range Change	$= .01 \times 4.5$ ppm	.045
IC	Salinity	$= .025 \times 4.5 \text{ ppm} \times \frac{20 \text{ ppt}}{40 \text{ ppt}}$	.056
IIA	Probe Background	$= .005 \times \left(1 - \frac{4.5 \text{ ppm}}{7.8 \text{ ppm}}\right) \times 7.8 \text{ ppm}$	.016
IIB	Probe Linearity	$= .003 \times 4.5$ ppm	.014
IIC	Temp. Compensation	$= .01 \times 4.5$ ppm	.045
IIIA	Temp. Measure	$= .015 \times 4.5$ ppm	.068
IIIB	Pressure	$= .017 \times 4.5$ ppm	.076
IIIC	Altitude	$= .018 \times 4.5$ ppm	.081
IIID	R.H.	$= .016 \times 4.5$ ppm	.072
		Maximum possible error =	.518 ppm
		Probable Error	±.259

Considering a statistical treatment of the probable error at any time for any instrument, it is likely that the actual error in any measurement will be about 1/2 of the possible error. In this case the probable error is about ±.26 ppm out of a reading of 4.5 ppm or 5.8% of the reading.

INSTRUMENT CASE

The instrument case is water resistant when properly closed. As a precaution against damaged gaskets or loose fittings, the instrument case should be opened and inspected for moisture whenever the instrument has been subjected to immersion or heavy spray. The instrument case is opened by removing the screws on the rear cover and lifting the cover off.

INSTRUCTIONS FOR YSI 5791A AND 5795A SUBMERSIBLE STIRRERS AND YSI 5492A AND 5721 BATTERY PACKS

The YSI submersible stirrers and battery packs are accessories for YSI dissolved oxygen meters. They perform the function of stirring the sample being measured when conducting dissolved oxygen measurements in the field or in the lab.

INSTALLATION — YSI 5791A SUBMERSIBLE STIRRER

The YSI 5791A stirrer is for use with the following YSI dissolved oxygen probes: YSI 5418, 5419, 5718, 5719 and 5739.

When the stirrer and probe are assembled, the stirrer agitates the sample directly in front of the sensor by means of a rotating eccentric weight which causes the spring-mounted hermetically sealed motor housing to vibrate. An impeller on the end of the motor housing flushes the media across the oxygen sensor.

All probes are installed in the same manner by simply removing the guard from the probe and screwing the probe into the stirrer until it bottoms out, about three turns. To avoid entanglement of the probe cable, it may be helpful to twist the probe and cable three turns in the opposite direction before screwing the probe into the stirrer. This is preferable to disconnecting the cable.

The dimension between the end of the probe and the stirrer impeller is critical for proper stirring (see Figure 1). If necessary to achieve proper spacing, the diaphragm on the bottom of the stirrer can be removed and the impeller and motor assembly raised or lowered by adjusting the locknuts on the motor assembly mounting screw. The motor and housing assembly is hermetically sealed at the factory; don't tamper with it.

The probe and stirrer cables can be taped or tied together to facilitate handling.

If the stirrer is to be used in fast running streams or if the probe is being used as a depth indicator, additional weight may be desirable. A hole in the motor mounting stud is provided for attaching weights. Weights over 16 oz. are not recommended.

After completing assembly connect the stirrer cable to the YSI 5492A Battery Pack when using any of the YSI Model 51 or 54 instruments, or to the stirrer/charger connector on the YSI Model 57. (See battery pack installation elsewhere in this instruction sheet, plus the instruction manual for the instrument being used.)

INSTALLATION — YSI 5795A SUBMERSIBLE STIRRER

The YSI 5795A stirrer is for use only with the YSI 5739 probe. It differs from the YSI 5791A by offering the convenience of a single cable for both stirrer and proble instead of separate cables for each.

The probe is mounted in the stirrer and the stirrer connected to the power supply in the same manner as described for the YSI 5791A stirrer.

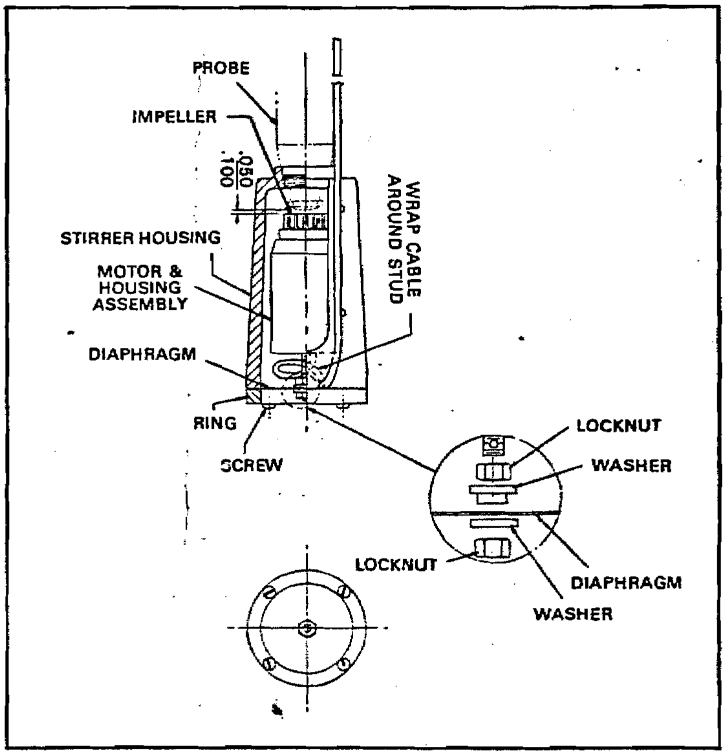


Figure 1

MAINTENANCE OF SUBMERSIBLE STIRRERS

The YSI 5791A and 5795A stirrers are made with all exposed parts fabricated from plastic or stainless steel to minimize maintenance. Some routine procedures will greatly aid in optimizing performance and stirrer life. Most important is to keep the assembly clean; sand, mud or other debris on the impeller may seriously affect stirring. Inspect occasionally and flush off as needed.

Adequate stirring can be verified by moving the operating probe-stirrer assembly up and down in the water at about 1 ft. per second. If the oxygen reading increases while this is being done, stirring speed is probably too slow. Three items to check are: impeller, diaphragm, and power supply voltage. (See battery pack instructions.) If the impeller is grossly damaged with one or more broken blades, continued use is not recommended and the motor and housing assembly should be replaced.

SUBMERSIBLE STIRRER REPLACEMENT PARTS

YSI 077512 — Motor & Housing Assembly (includes locknuts)
YSI 077519 — Case
YSI 050824 — Diaphragm Clamp
YSI 077510 — Diaphragm

INSTALLATION — YSI 5492A BATTERY PACK

The YSI 5492A Battery Pack can be attached to the case of of the Model 51 or 54 dissolved oxygen instruments to provide power for operating either of the submersible stirrers.

To install the battery pack remove the six screws and rear cover of the instrument. Sandwich the battery pack between the instrument and rear cover and fasten with the longer screws provided (See Figure 2). It is important to keep the nameplate and serial number in case questions arise concerning service or warranty. CAUTION: Disconnect battery charger before unscrewing cover of the Model 54 instrument.

Remove the batteries from the battery pack by unscrewing the knobs at the ends of the battery pack. Take off the plastic bags and reinstall the batteries so the terminals contact the battery pack terminals. Only ONE battery position will work.

The batteries provide adequate stirring until discharged to 5.25 volts under load, over 60 hours of use with a 4 hour/day duty cycle. To determine battery discharge measure the voltage across each battery under 100 mA load. If this is not feasible, adequate stirring can be verified as described in MAINTENANCE OF SUBMERSIBLE STIRRERS. If battery replacement is indicated, replace with Ray-O-Vac 941 or equal 6 volt spring terminal lantern batteries.

NOTE: When using the YSI Model 51 or 54 instruments an alternate power source, which can be used in place of the YSI 5492A Battery Pack, is any 6 VDC battery that will deliver .050 amp current. A 12 VDC battery can be used in conjunction with a resistor in series. Consult the factory for details.

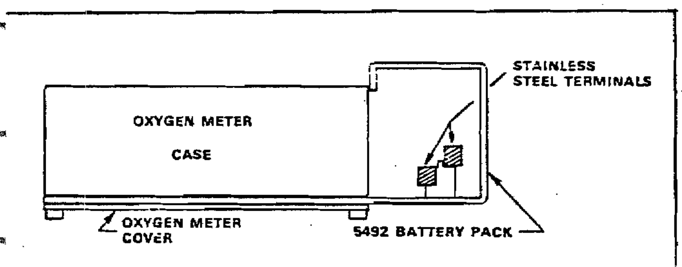


Figure 2

INSTALLATION — YSI 5721 BATTERY & CHARGER PACK

The YSI 5721 is offered as an accessory to operate either submersible stirrer when used in conjunction with the YSI Model 57 dissolved oxygen meter. The battery pack consists of nickel cadmium batteries and a line operated charger. (Specify either 117 VAC or 230 VAC input when ordering.)

The batteries fit inside the YSI Model 57 instrument case. Remove the instrument rear cover and install the five batteries with the plus (+) terminal of each battery in the red cup end of the battery holder. As shipped, the batteries are charged and proper installation can be checked by switching to the BATT CHECK position. The meter should display at least 6.0 volts on the red 0-10 PPM scale. If there is no indication the batteries should be checked for proper contact in their holders. If the reading is low, one battery may be reversed or one of all cells may require recharging. Plugging the charger into the stirrer/charger receptacle should immediately bring the meter reading to 6.0 volts or more if all cells are properly installed. (See Figure 3.)

000 75

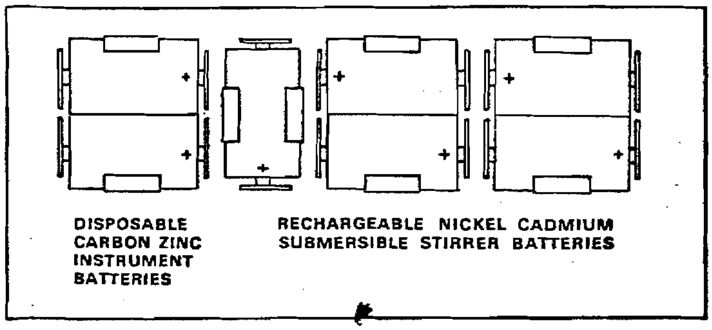


Figure 3

The rechargeable batteries should have a service life of 500 to 1000 recharge cycles, depending on variables of individual batteries and charging and discharging conditions. If the batteries will not hold a charge above 6.4 volts, one or all batteries may require replacement. To locate a defective battery fully charge the batteries and check each battery voltage with a voltmeter while operating the submersible stirrer. If an individual battery is generating less than 1.2 volts, or shows any signs of leakage, it should be replaced. Replace batteries in sets or with exact replacement types. Mixing batteries of different manufacture can shorten life of the set.

GUARANTEE AND REPAIR

All YSI products carry a one-year unconditional guarantee on workmanship and parts, exclusive of batteries. Damage through accident, misuse or tampering will be repaired at a nominal charge, if possible. If you are experiencing difficulty with a YSI product, even if the guarantee has expired, it may be returned for repair to any authorized YSI dealer or to the factory.

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INSTRUCTIONS FOR YSI 5700 SERIES DISSOLVED OXYGEN PROBES

The probes described in this instruction sheet are designed for direct use with YSI Models 51B, 54ABP, 54ARC and 57 Dissolved Oxygen Meters. The probes can also be used with discontinued YSI Models 51A, 54BP and 54RC Dissolved Oxygen Meters when the YSI 5735 Cable Adaptor is employed (See Accessories).

I. PRINCIPLE OF OPERATION

Each YSI 5700 Series Probe is a complete polarographic system in itself. A thin permeable membrane stretched over the sensor isolates the sensor elements from the environment, but allows gases to enter. When a polarizing voltage is applied across the sensor, oxygen that has passed through the membrane reacts at the cathode, causing a current to flow.

The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure under the membrane is zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the adsolute pressure of oxygen outside the membrane. If the oxygen pressure increases, more oxygen diffuses through the membrane and more current flows through the sensor. A lower pressure results in less current.

II. SPECIFICATIONS

Cathode — Gold
Anode — Silver
Membrane — .001" FEP Teflon (.0005" FEP Teflon available)
Electrolyte — Half saturated KCl
Temperature Compensation — (See instrument specifications)
Pressure Compensation — effective to 1/2% of reading over a 100 psi range (230 ft. water)
Response Time — 90% DO value in 10 seconds
Polarizing Voltage — 0.8 volts nominal
Probe Current — Air at 30°C = 19 microamps nominal
Nitrogen at 30°C = .15 microamps or less

ACCESSORIES AND REPLACEMENT PARTS

YSI 5986 — Diaphragm Kit
YSI 5775 — Membrane and KCl Kit, Standard — includes 2 each 15-membrane packets (.001" thick standard FEP Teflon membranes) and a 30 ml bottle KCl with Kodak Photo Flo.
YSI 5776 — Membrane and KCl Kit, High Sensitivity — includes 2 each 15-membrane packets (.0005" thick FEP Teflon membranes) and a 30 ml bottle KCl with Kodak Photo Flo.
YSI 5945 — "O" ring pack — contains replacement "O" rings for all YSI 5700 Series Probes.

Detachable cable:

YSI 5740-10	10' cable
YSI 5740-25	25' cable
YSI 5740-50	50' cable
YSI 5740-100	100' cable
YSI 5740-150	150' cable
YSI 5740-200	200' cable

YSI 5735 — Cable Adaptor to mate YSI 5700 Series Probes with discontinued YSI Models 51A, 54BP and 54RC Dissolved Oxygen Meters.
YSI 5486 — Beater Boot Assembly for YSI 5720 Probe.

III. YSI 5739 DISSOLVED OXYGEN PROBE

The YSI 5739 probe, with built-in lead weight, is an improved design that replaces the discontinued YSI 5418, 5419, 5718 and 5719 probes. (See Figure 1.)

The complete probe consists of the YSI 5739 probe body plus a YSI 5740 detachable cable. The detachable cable is a convenience feature that facilitates changing cable lengths and replacing damaged cables or probes. The probe and cable assembly is held together with a threaded retaining nut. The connection is not designed for casual disconnection and should only be disconnected when necessary.

To disconnect the cable unscrew the retaining nut and slide it down the cable to expose the connector. Pull gently on the cable and connector until the connector comes away from the probe body.

To reassemble, inspect the connector and "O" ring for cleanliness. If the "O" ring is frayed or damaged remove it by squeezing it in the groove causing it to bulge, then roll it out of the groove and off the connector. A replacement "O" ring is supplied with the cable.

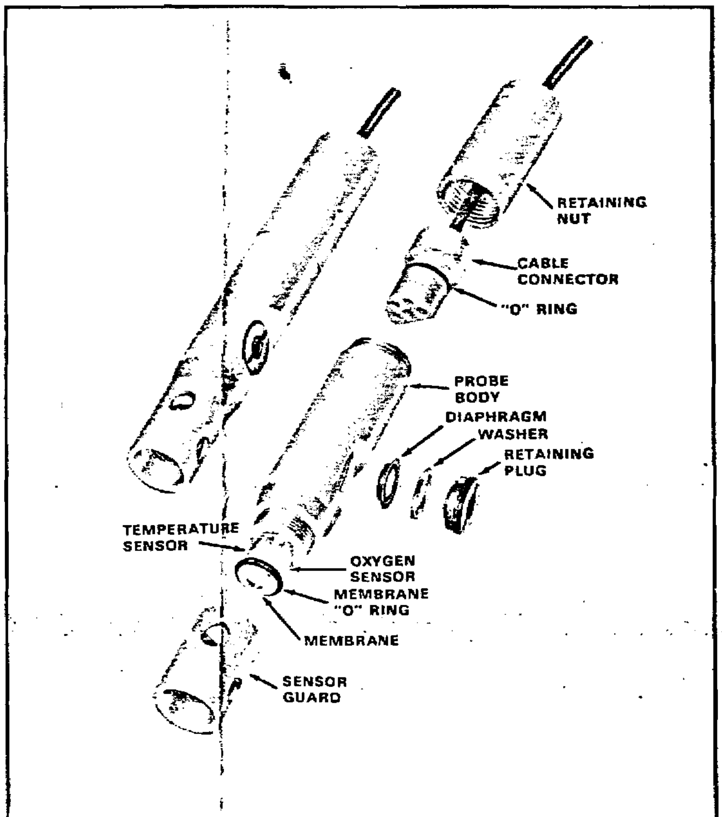

Figure 1

PRICE $1.00

Push the connector into the probe body, rotating it until the two halves mate. A light coating of vaseline or silicone grease on the "O" ring will make reassembly easier. Air trapped between the connector halves which may cause them to spring apart slightly, is normal. Screw on the retaining nut, hand tight only. NOTE: If erratic readings are experienced, disconnect the cable and inspect for water. If present, dry out and reconnect, replacing the "O" ring, if necessary.

PRESSURE COMPENSATION

The vent on the side of the probe is part of a unique pressure compensating system that helps assure accurate readings at great depths of water. Pressure compensation is effective to 1/2% of reading with pressures to 100 psi (230 ft. water). The quantity of air bubbles trapped under the membrane determines how serious the pressure error will be, which is why proper preparation of the probe is essential. The system is designed to accommodate a small amount of trapped air and still function properly, but the amount should be kept to a minimum.

The compensating system normally does not require servicing and should not be taken apart. However, if electrolyte is leaking through the diaphragm or if there is an obvious puncture, the diaphragm must be replaced. Large accumulation of salt crystals around the diaphragm plug may be due to a poorly tightened plug or dirt underneath the diaphragm. Cleaning the parts in water and retightening may be tried before diaphragm replacement. A spare is supplied with the probe. Using a coin unscrew the retaining plug and remove the washer and the diaphragm, flush any salt crystals from the reservoir, install the new diaphragm (convolution side in), replace the washer, and screw in the retaining plug.

PROBE SCHEMATIC

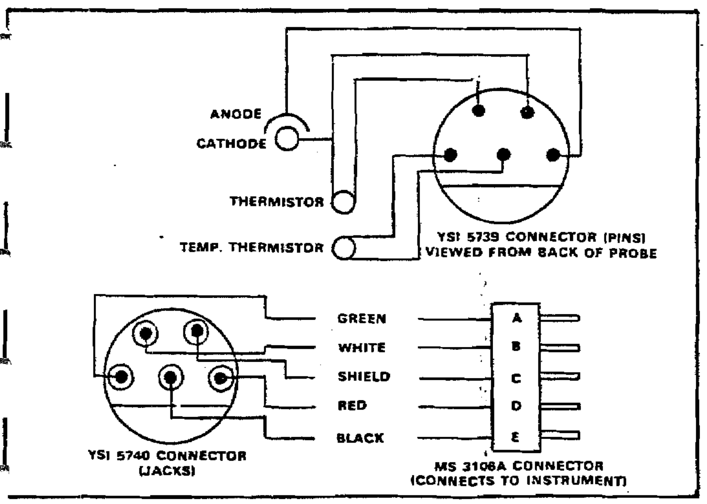

Figure 2

IV. YSI 5720 B.O.D. BOTTLE PROBE

The YSI 5720 B.O.D. Bottle Probe replaces the discontinued YSI 5420A B.O.D. Bottle Probe for measuring dissolved oxygen and temperature in standard B.O.D. bottles. It is provided with an agitator for stirring the sample solution, available in models for 117VAC (95-135VAC, 50/60 Hz) or 230VAC (190-250VAC, 50/60 Hz) operation. (See Figure 3.)

When using the probe, plug the agitator power supply into line power and the probe plug into the instrument. With the agitator turned off place the tapered probe end into the B.O.D. Bottle and switch agitator "ON" with switch on top of probe. The probe should be operated with a minimum of trapped air in the B.O.D. bottle. A slight amount of air in the unstirred region at the top of the bottle may be neglected, but no bubbles should be around the thermistor or oxygen sensor.

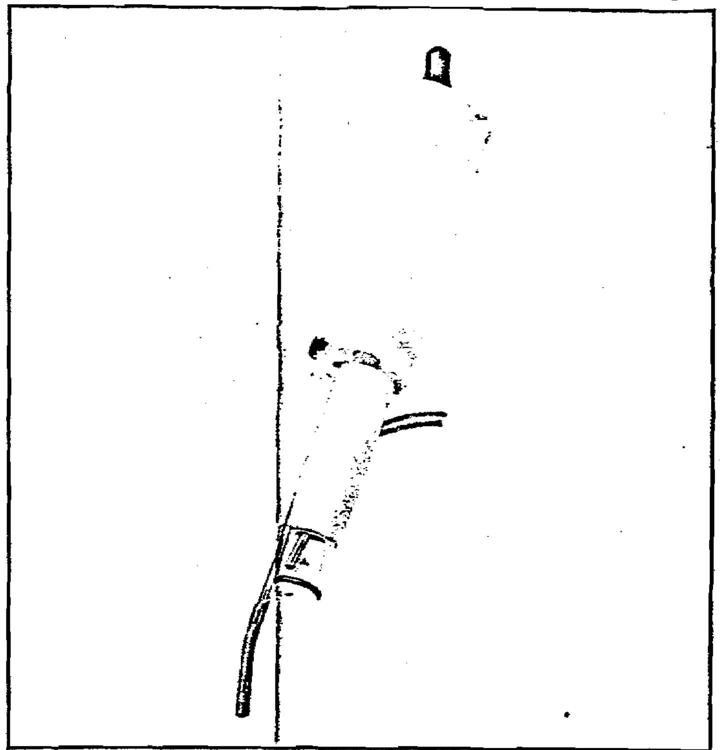

Figure 3

STIRRER BOOT

The probe uses a flexible stirring boot to transmit motion from the sealed motor housing to the sample. If the boot shows signs of cracking or other damage likely to allow leaking into the motor housing, the boot must be replaced.

In fresh water applications boot life is normally several years, but this may be shortened by exposure to hydrocarbons, moderate to strong acids or bases, ozone, or direct sunlight. For maximum life rinse the boot after use in contaminated samples. (See Figure 4.)

Boot replacement is as follows:

1. Pull off old assembly and clean shaft.
2. Slide on new assembly making sure the back spring is on the grooved area of the shaft. A small amount of rubber cement may be used.
3. Check that there is sufficient clearance between the tip and the end of the shaft to permit turning without binding.

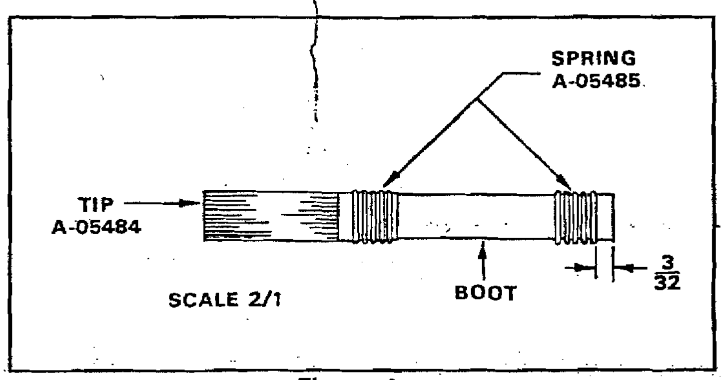

Figure 4

V. YSI 5750 B.O.D. BOTTLE PROBE

The YSI 5750 B.O.D. Bottle Probe replaces the discontinued YSI 5450 B.O.D. Bottle Probe. It is similar to the YSI 5720 B.O.D. Bottle Probe, except that it does not have a stirrer. Agitation of the sample must be provided by other means, such as a magnetic stirrer. (See Figure 5.)

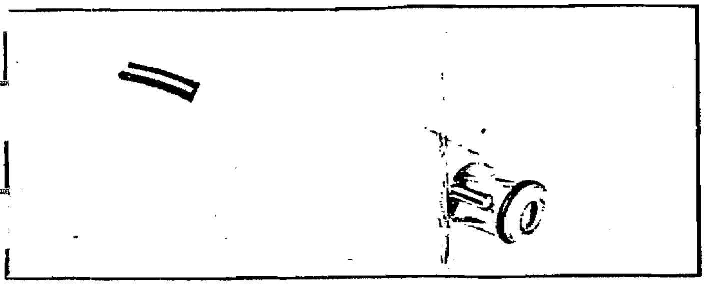

Figure 5

VI. PROBE PREPARATION AND CARE

1. Prepare the electrolyte by dissolving the KCl crystals in the dropper bottle with distilled water. Fill the bottle to the top.
2. Unscrew the sensor guard from the probe (YSI 5739 only) and then remove the "O" ring and membrane. Thoroughly rinse the sensor with KCl solution.
3. Fill the probe with electrolyte as follows:
   ALL PROBES ARE SHIPPED DRY — YOU MUST FOLLOW THESE INSTRUCTIONS.
   A. Grasp the probe in your left hand. (See Figure 6.) When preparing the YSI 5739 probe the pressure compensating vent should be to the right. Successively fill the sensor body with electrolyte while pumping the diaphragm with the eraser end of a pencil or similar soft, blunt tool. Continue filling and pumping until no more air bubbles appear. (With practice you can hold the probe and pump with one hand while filling with the other.) When preparing the YSI 5720 and 5750 probes, simply fill the sensor body until no more air bubbles appear.
   B. Secure a membrane under your left thumb. Add more electrolyte to the probe until a large meniscus completely covers the gold cathode. NOTE: Handle membrane material with care, keeping it clean and dust free, touching it only at the ends.
   C. With the thumb and forefinger of your other hand, grasp the free end of the membrane.
   D. Using a continuous motion **STRETCH** the membrane **UP, OVER,** and **DOWN** the other side of the sensor. Stretching forms the membrane to the contour of the probe.
   E. Secure the end of the membrane under the forefinger of the hand holding the probe.
   F. Roll the "O" ring over the end of the probe. There should be no wrinkles in the membrane or trapped air bubbles. Some wrinkles may be removed by lightly tugging on the edges of the membrane beyond the "O" ring.
   G. Trim off excess membrane with scissors or sharp knife. Check that the stainless steel temperature sensor is not covered by excess membrane.
4. Shake off excess KCl and reinstall the sensor guard.
5. A bottomless plastic bottle is provided with the YSI 5739 probe for convenient storage. Place a small piece of moist towel or sponge in the bottle and insert the probe into the open end. This keeps the electrolyte from drying out. The YSI 5720 and 5750 probes can be stored in a B.O.D. bottle containing about 1" of water.
6. Membranes will last indefinitely if properly installed and treated with care during use. The result of poor membrane application or damage is erratic readings. The cause of erratic behavior can be loose, wrinkled or fouled membranes (by algae for example), or bubbles in the probe from electrolyte loss. If any of these signs occur it is good practice to thoroughly flush the reservoir with new KCl and replace the membrane.
7. "Home brew" electrolyte can be prepared by making a saturated solution of reagent grade KCl and distilled water, and then diluting the solution to half strength with distilled water. Adding two drops of Kodak Photo Flo per 100 ml of solution assures good wetting of the sensor, but is not absolutely essential.
8. The gold cathode should always be bright and untarnished. To clean, wipe with a clean lint-free cloth or hard paper. NEVER USE ANY FORM OF ABRASIVE OR CHEMICAL. Rinse the sensor several times with KCl, refill, and install a new membrane.
9. Some gases contaminate the sensor, evidenced by discoloration of the gold. If the tarnish cannot be removed by vigorous wiping with a soft cloth, lab wipe, or hard paper, return the probe to the factory for service.
10. H_2S, SO_2, Halogens, Neon, and CO are interfering gases. If you suspect erroneous readings, it may be necessary to determine if these are the cause.
11. If the probe has been operated for extended periods with a loose or wrinkled membrane the gold cathode may become plated with silver. In this event return the probe to the factory for refinishing.

VII. GUARANTEE AND REPAIR

All YSI products carry a one-year unconditional guarantee on workmanship and parts, exclusive of batteries. Damage through accident, misuse, or tampering will be repaired at a nominal charge, if possible, when the item is returned to the factory or to an authorized YSI dealer.

If you are experiencing difficulty with any YSI product, it may be returned for repair, even if the guarantee has expired. YSI maintains complete facilities for prompt servicing of all YSI products.

Yellow Springs Instrument Co., Inc.
Service Department
P.O. Box 279
Yellow Springs, Ohio, 45387, U.S.A.
Phone: 513-767-7241

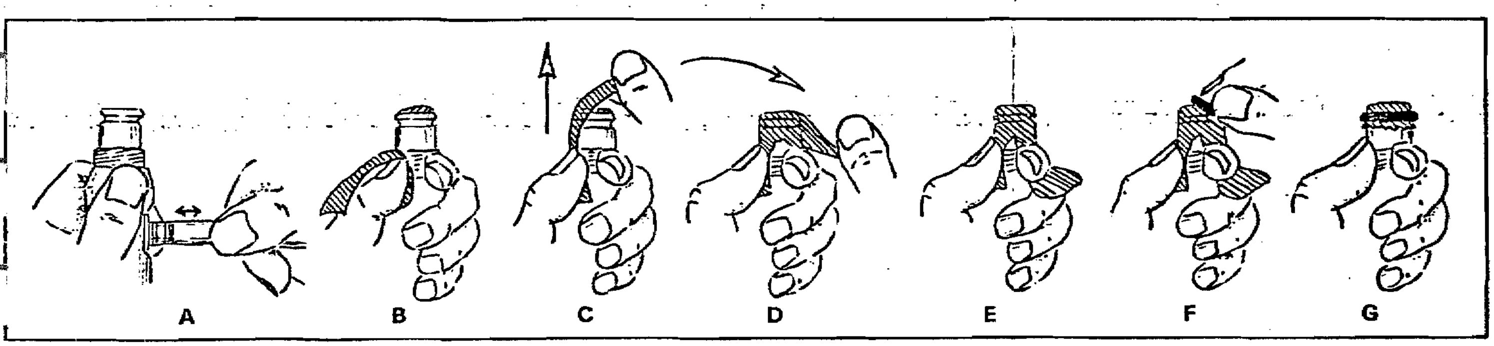

Figure 6

YELLOW SPRINGS INSTRUMENT CO., INC.
YELLOW SPRINGS, OHIO, 45387
PHONE 767-7242 (AREA CODE 513)
TELEX 20-5437

5075 CALIBRATION CHAMBER - SUPPLEMENT TO INSTRUCTIONS

When using the 5075 Calibration Chamber with the YSI oxygen probe 5739, a total immersion depth of two (2) feet is recommended. Exceeding this depth could cause errors in calibration.

If the probe is at a significantly (i.e., 5 degrees C) different temperature from the calibrating temperature, quicker calibration will be achieved by placing the probe in the water for a minute to allow it to come to calibrating temperature. Then shake the probe dry and assemble into the chamber as described in the instrument instruction manual. Proceed as usual following those instructions.

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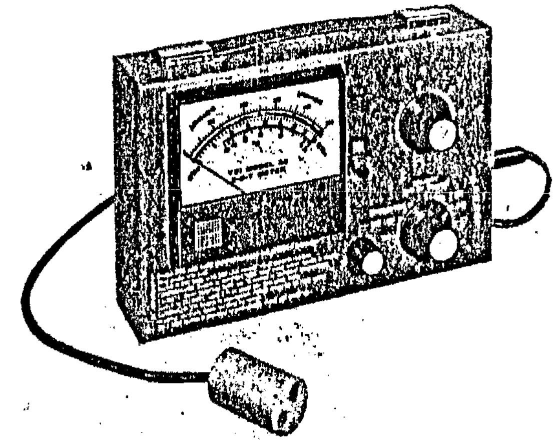
INSTRUCTIONS FOR YSI MODEL 33 S-C-T METER



Scientific Division

Yellow Springs Instrument Co., Yellow Springs, Ohio 45387

PRICE $5.00

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GENERAL DESCRIPTION

The YSI Model 33 S-C-T Meter is a portable, battery powered, transistorized instrument designed to accurately measure salinity, conductivity and temperature. It uses a probe consisting of a rugged, plastic conductivity cell and a precision YSI thermistor temperature sensor combined in a single probe.

Conductivity in umhos/cm is the measurement of electrical conductance a sample would have shown if measured between opposite faces of a 1 cm cube. Salinity is the number of grams of salt/kilogram of sample (‰ = parts per thousand). This measurement assumes the sample contains a "standard" sea water salt mixture. The sample temperature is measured in degrees Celsius.

Salinity measurements are manually temperature compensated by direct dial. Conductivity measurements are not temperature compensated, however, a temperature function is provided on the instrument to aid with calculation of corrections. Also, when just temperature and conductivity are known it is possible to calculate salinity, and when only temperature and salinity are known it is possible to calculate conductivity.

SPECIFICATIONS

Conductivity

Ranges:	0-500, 0-5,000, 0-50,000 μmhos/cm with YSI 3300 Series Probes. (Note: The "μmho" designations on the instrument are a shorthand form for "μmho/cm".)
Accuracy:	± 2.5% max. error at 500, 5,000 and 50,000 plus probe ± 3.0% max. error at 250, 2,500 and 25,000 plus probe See Error Section

Readability:	2.5 μmhos/cm on 500 μmho/cm range 25 μmhos/cm on 5000 μmho/cm range 250 μmhos/cm on 50000 μmho/cm range
Temperature Compensation:	None

Salinity

Range:	0-40 ‰ (parts per thousand) over temperature range -2 to +45°C.
Accuracy:	Above 4°C, ± 0.9 ‰ at 40 ‰ and ± 0.7 ‰ at 20 ‰ plus conductivity probe. Below 4°C, ±1.1 ‰ at 40 ‰ and ± 0.9 ‰ at 20 ‰ plus conductivity probe. See Error Section.
Readability:	0.2 ‰ on 0-40 ‰ range
Temperature Compensation:	Manual by direct dial from -2° to +45°C

Temperature

Range:	+ 50 to -2°C
Accuracy:	± 0.1°C at -2°C, ± 0.6°C at 45°C plus probe. See Error Section.
Readability:	± 0.15°C at -2°C to ± 0.37°C at 45°C.

Power Supply	Two D size alkaline batteries, Eveready E95 or equivalent, provide approximately 200 hrs. of operation.

Probe	YSI 3300 Series Conductivity/Temperature Probe Nominal Probe Constant: K =5
Accuracy:	±2% of reading for conductivity and salinity. Error of ±0.1°C at 0°C and ±0.3°C at 40°C
Instrument	
Ambient Range:	Satisfactory operation -5 to +45°C. A maximum error of ± 0.1% of the reading per °C change in instrument temperature can occur. This error is negligible if the instrument is readjusted to redline for each reading.

OPER[illegible]

1. [illegible]

[illegible] If this cannot be accomplished, replace the batteries.

(c) Plug the probe into the probe jack on the side of the instrument.

(d) Put the probe in the solution to be measured (See Probe Use).

2. Temperature

Set the switch to temperature. Read the temperature on the bottom scale of the meter in degrees Celsius. Allow time for the probe temperature to come to equilibrium with that of the water before reading.

3. Salinity

(a) Transfer the temperature reading from Step 2 to the temperature knob on the instrument.

(b) Switch the instrument to the SALINITY position and read salinity on the red 0-40 ‰ meter range.

(c) Depress the CELL TEST button. The meter reading should fall less than 2%; if greater, the probe is fouled and the measurement is in error. Clean the probe and re-measure.

4. Conductance

(a) Switch the meter to the X100 µmhos/cm range. If the reading is below 50 on the 0-500 meter scale, switch to the next [illegible] µmhos/cm [illegible] (Measure [illegible] temperature con[illegible]

Example: [illegible] reading

Reading [illegible]

Answer 2470 µmhos/cm [illegible]

(b) When measuring on the X100 and X10 ranges, depress the CELL TEST button. The meter reading should fall less than 2%; if greater, the probe is fouled and the measurement is in error. Clean the probe and re-measure.

NOTE: The CELL TEST does not function on the X1 range.

5. Error

The maximum error in a reading can be calculated by using the graphs in the following sections.

(1) Temperature

The temperature scale is designed to give the minimum salinity error when the temperature readings are used to compensate salinity measurements.

Figure 1 shows total error for probe and instrument versus °C reading.

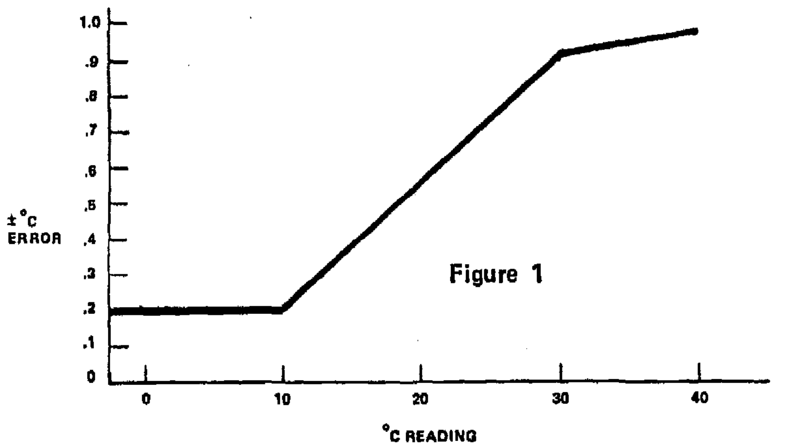


Figure 1

Example:	Reading	15°C
Total	Error	0.4°C
	Accuracy	15°C ± 0.4°C for probe and instrument combined

(2) Conductivity

Figure 2 shows the worst case conductivity error as a function of the conductivity reading for the probe and instrument combined.

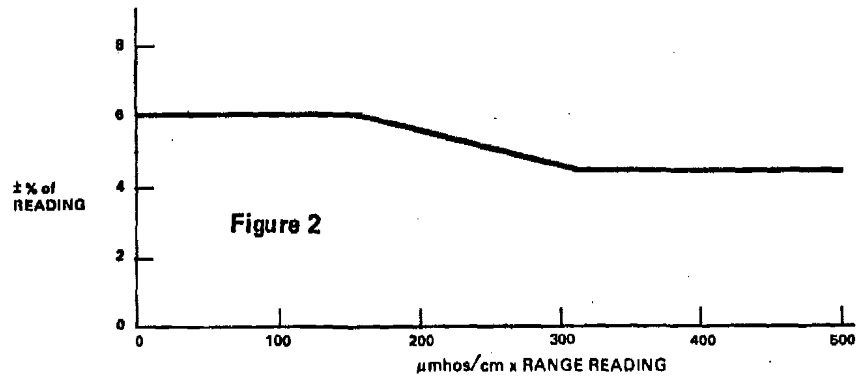


Figure 2

Example:	Reading	360 µmhos/cm
	Range	X10
	% Reading Error	± 4.5%
	Accuracy	3600 ± 162 µmhos/cm for probe and instrument

(3) Salinity

The salinity readings are a function of temperature and conductivity, therefore the accuracy is a function of both. The temperature scale and temperature control have been designed to minimize the temperature error contribution to the salinity error. The error shown in Figure 3 is the total of the temperature and conductivity probe, the temperature scale and the salinity scale errors.

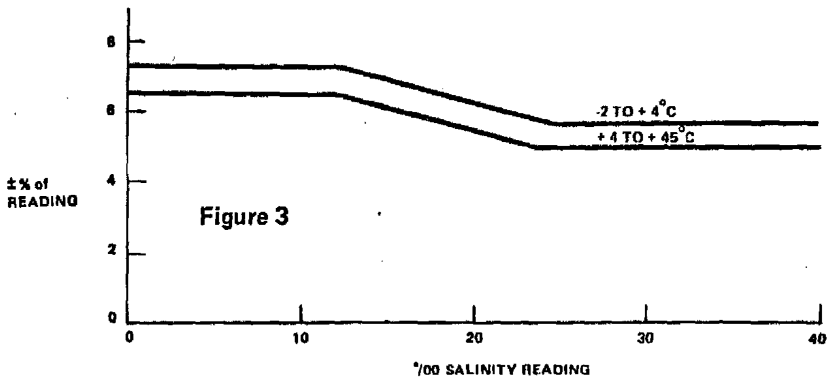


Figure 3

Example: Reading 10 part/thousand, @ 10°C

% of Reading Error	6.5%
Accuracy	10 ‰ ± 0.65 ‰ for all errors, combined worst case.

CIRCUIT DESCRIPTION, MAINTENANCE AND CALIBRATION

1. Description

The circuit is composed of two parts; a multivibrator and switching transistors. The multivibrator produces a square waveform voltage. The square wave is applied to two switching transistors. They alternately apply two batteries of opposite polarity to the probe thus providing AC power which minimizes polarization effects. The meter is in series with one battery and measures the current from it. The current from the battery is proportional to the conductance of the cell. Salinity is measured in a special range conductivity circuit which includes a user-adjusted temperature compensator. In the temperature, redline and X1 positions the multivibrator operated at 100 Hz. In the salinity, X100 and X10 positions the multivibrator operates at 600 Hz and on these ranges pushing the CELL TEST button drops the frequency to 100 Hz allowing the operator to judge the degree of probe polarization.

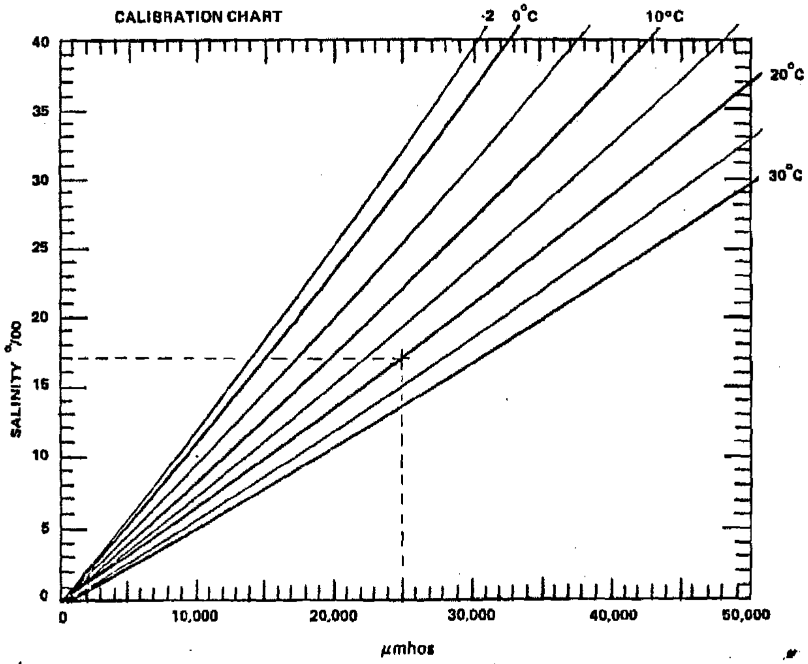
2. Maintenance

The only maintenance required is battery replacement. Two "D" size alkaline flashlight cells, such as Eveready E95 or equivalent batteries will provide 200 hrs. of operation. Accuracy will not be maintained if zinc-carbon "D" cells are used. Battery replacement is indicated when the redline adjustment cannot be accomplished.
Replace batteries every six months to reduce the danger of corrosion due to leaky batteries. To replace batteries, remove the six screws from the rear plate. The battery holders are color coded. The Positive (+ button) end must go on red.

3. Calibration

It is possible for the temperature knob to become loose or slip from its normal position. In an emergency the dial can be re-positioned. It must be emphasized that this is an emergency procedure only, and that the instrument should be returned to the factory for proper recalibration at the earliest opportunity.

(a) Read the temperature and conductance of the solution. Determine the salinity of the solution by running a line vertically on the graph from this conductance value until it intersects the appropriate °C line (interpolate as required for



temperatures between the given °C lines). From this intersection extend a line horizontally to the edge of the graph. This determines the salinity for this sample.
Example: 25000 μmhos and 20° C gives a salinity of 17.

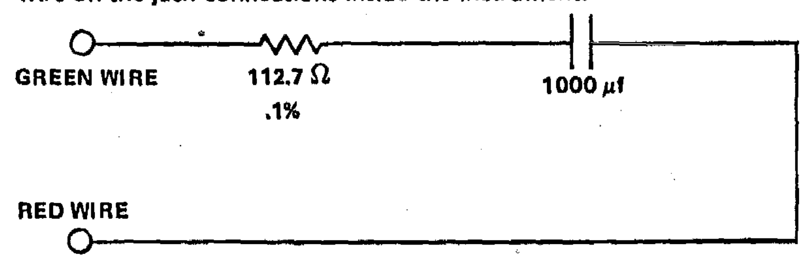
(b) Remove the °C knob, switch to SALINITY, and turn the control shaft until the meter needle indicates the salinity value determined in Step (a). In the example given, the value is 17.

(c) Switch to TEMPERATURE (Note: This temperature reading must be the same as Step (a); if not, begin again at Step (a).) Place the knob on the control shaft (without turning the control shaft) with the knob pointer at the same temperature as the meter reading and tighten both set screws securely.

At earliest opportunity recalibrate using the following procedure or return the instrument to factory for service.

(a) Set the instrument for a salinity measurement as normal.
(b) Substitute a 1000 μf capacitor and 112.7 ohm 0.1% tolerance resistor for the probe.

Connect the resistor and capacitor between the green wire and red wire on the jack connections inside the instrument.



(c) Turn the temperature dial until the meter reads redline. Now install the temperature knob with the arrow at 25°C. This is a temporary calibration only. Return the instrument to the factory for proper recalibration.

PROBE

1. Description of YSI 3300 Series Conductivity/Temperature Probe

The YSI 3300 Series Conductivity Probes are designed for field use, embodying construction and design for rugged, accurate service.

Each probe features a built-in cell constant of 5.00 ±0.1, a precision YSI thermistor temperature sensor of ±0.1°C accuracy, at 0°C and ±0.3°C at 40°C and a low capacitance cable assembly terminating in a three terminal 0.25" dia. phone type connector.

The 3310 has a 10 ft. cable and the 3311 is a 50 ft. version. Other lengths are available on special order.

The probe has a rigid P.V.C. body, platinized pure nickel electrodes, and a durable cable, providing resistance to a wide range of water-borne substances.

2. Maintenance

(a) Cleaning

When the cell test indicates low readings the probable cause is dirty electrodes. Hard water deposits, oils and organic matter are the most likely contaminants.

For convenient normal cleaning soak the electrodes for 5 minutes with a locally available bathroom tile cleaning preparation such as: Dow Chemical "Bathroom Cleaner"; Horizon Industries "Rally, Tile, Porcelain, and Chrome Cleaner"; Johnson Wax "Envy, Instant

Cleaner"; or Lysol Brand "Basin, Tub, Tile Cleaner."

For stronger cleaning a 5 minute soak in a solution made of 10 parts distilled water, 10 parts isopropyl alcohol and 1 part HC1 can be used.

Always rinse the probe after cleaning and before storage.

CAUTION: Do not touch the electrodes inside the probe. Platinum black is soft and can be scraped off.

If cleaning does not restore the probe performance, re-platinizing is required.

(b) Re-Platinizing

Equipment Required –

(1) YSI #3140 Platinizing Solution, 2 fl. oz. (3% Platinum Chloride dissolved in .025% lead acetate solution).
(2) YSI Model 33 S-C-T Meter.
(3) 50 m1 glass beaker or equivalent bottle.
(4) Distilled water.

Procedure –

(1) Clean the probe as in Section (a) — either method.
(2) Place the cell in the beaker and add sufficient solution to cover the electrodes. Do not cover the top of the probe.
(3) Plug the probe into the Model 33, switch to the X100 range to platinize the electrode. Move the probe slightly to obtain the highest meter reading and continue platinizing for the approximate time shown below:

Meter Reading (μmhos)	Time (minutes)
30,000	5
25,000	6
20,000	8
15,000	11
10,000	16

(4) After the elapsed time remove the probe and rinse in fresh water.
(5) Return the solution to its container. 2 oz. of solution should be sufficient for 50 treatments.

3. Probe Use
(a) Obstructions near the probe can disturb readings. At least two inches of clearance must be allowed from non-metallic underwater objects. Metallic objects such as piers or weights should be kept at least 6 inches from the probe.
(b) Weights are attached to the cable of the YSI 3310 and 3311 Probes. The YSI 3327 Weights are supplied in pairs with a total weight of 4 ounces per pair. Should it become necessary to add more weight to overcome water currents, we suggest limiting the total weight to two pounds (8 pairs). For weights in excess of two pounds use an independent suspension cable. In either case, weights must be kept at least 6 inches away from the probe.
(c) Gentle agitation by raising and lowering the probe several times during a measurement insures flow of specimen solution through the probe and improves the time response of the temperature sensor.

4. Cell Calibration & Standard Solutions
The YSI #3300 Series Cells are calibrated to absolute acaccuracy of ±1-1/2% based on a standard solution. Since the literature on conductivity does not indicate a consistently accepted standardization methods, we have chosen the .01 demal KCl solution method as determined by Jones and Bradshaw in 1937 as our standard. Recent textbooks, as well as the ASTM standards, concur with this choice.

The solution is prepared by diluting .745 grams of pure dry KCl with distilled water until the solution is 1 kilogram. The table below

shows the values of conductivity this solution would have if the distilled water were non-conductive. However, since even high purity distilled water is slightly conductive, the measured conductivity will be higher by an amount equal to the water's conductivity.

Temperature °C	Conductivity (Absolute Micromhos/cm^3)
15	1141.5
16	1167.5
17	1193.6
18	1219.9
19	1246.4
20	1273.0
21	1299.7
22	1326.6
23	1353.6
24	1380.8
25	1408.1
26	1436.5
27	1463.2
28	1490.9
29	1518.7
30	1546.7

The operator may use the standard solution and the table to check accuracy of a cell's constant or to determine an unknown constant. The formula is shown below:

$$K = \frac{R(C_1 + C_2)}{10^6}$$

where: K = Cell Constant
R = measured resistance in ohms
C_1 = conductivity in absolute micromhos
C_2 = conductivity in absolute micromhos of the distilled water used in making solution

R, C_1 and C_2 must either be determined at the same temperature or corrected to the same temperature to make the equation valid.

Note: For further information on conductivity and the above standard information, refer to ASTM Standards Part 23 – Standard Methods of Test for Electrical Conductivity, or Water and Industrial Waste Water – ASTM Designation D1125-64.

YSI MODEL 33 USED WITH YSI 51A, 54 and 57 OXYGEN METERS

If the Model 33 salinity measurement is to be used for salinity correction on the 51A, the reading should be converted to Chlorosity. The formula is:

$$\text{PPM Chlorosity} = \frac{\text{Salinity } ‰ - 0.03}{1.8} \times 10^3$$

For these instruments the 0.03 can be neglected so the equation simplifies to:

$$\text{PPM Cl} = \frac{\text{SS } ‰}{1.8} \times 10^3$$

S ‰	0	9	18	27	36
PPM CL	0	5,000	10,000	15,000	20,000

For salinity correction when using the Model 57 use the salinity reading direct from the Model 33. No conversion is necessary.

Model 33 salinity readings taken in conjunction with Model 54 dissolved oxygen readings can be used to correct the Model 54 for salinity and to make post measurement salinity corrections to dissolved oxygen data. Correction tables are available from the factory.

REPAIR FACILITIES

If you are experiencing difficulty with a YSI product, it may be returned to the YSI Customer Service Department for repair, even if the guarantee has expired. YSI maintains complete facilities for prompt servicing of all YSI products.

GUARANTEE

The Model 33 S-C-T Meter carries a one year unconditional guarantee on all workmanship and components. Damage through accident, misuse, or tampering will be repaired at a nominal charge when the instrument is returned to our plant. Cells are similarly guaranteed.

Note: In communications regarding this instrument, please mention model number and serial number and the type of failure experienced.

ACCESSORIES AND REPLACEMENTS

5992-20 Replacement pH Electrode for Model 5985-20 Meter

5992-50 Replacement pH Electrode for Model 5985-40 Meter

5985-05 AC Adapter for 115/230vAC operation

5977-04 pH Buffer, 4.00, vial of 12 capsules

5977-07 pH Buffer, 7.00, vial of 12 capsules

5977-09 pH Buffer, 9.00, vial of 12 capsules

5977-10 pH Buffer, 10.00, vial of 12 capsules

READY-TO-USE BUFFER SOLUTIONS

These prepared buffer solution standards offer excellence in precision and consistency. With these ready-to-use buffer solutions, you are guaranteed an accuracy of ±0.01 pH at 25°C. These buffer solutions are dated to assure freshness. Double protection against contamination -- unbreakable plastic bottles have shrink-sealed caps and are packed in individual plastic bags. Color-coded solutions.

Container Volume	pH 4.01, Red Cat. No.	pH 7.00, Green Cat. No.	pH 10.00, Blue Cat. No.
Pint	5942-20	5942-40	5942-60
Quart	5942-22	5942-42	5942-62
Gallon	5942-24	5942-44	5942-64

12-15-76

INSTRUCTIONS FOR DIGI-SENSE® pH METER

I. GENERAL RECOMMENDATIONS

Whenever transferring the electrode from one solution to another, it is essential that the electrode be thoroughly rinsed in water and any excess water should be shaken off. Doing this will prevent contamination between samples.

When immersing the electrode in sample or buffer give a moderate stirring action to the electrode. This improves electrode response and gives more accurate reading.

If you store your electrode for an extended period, put several drops of distilled water in the plastic cap and place cap on the end of the electrode.

For improved accuracy and consistency of readings it is important that buffers and samples are at the same temperature.

II. PREPARATION FOR FIELD OPERATION

Install batteries by removing the four screws from rear of pH meter and inserting batteries supplied.

BATTERY REPLACEMENT

"BAT. LOW" indicator will signal when it is time to replace batteries. Just remove the four screws from back of meter case and replace the six 1.5 volt, size "AA", alkaline batteries.

PREPARATION FOR AC OPERATION

Set the optional AC adapter, using switch on rear of adapter, to appropriate voltage (either 115 vAC or 230 vAC) then connect adapter to pH meter and power outlet. Meter is now "on" and should be calibrated by following steps in calibration procedure.

III. CALIBRATION PROCEDURE

1. Connect electrode to meter.

2. Set "temperature" knob to the temperature of the buffers.

3. Immerse electrode in buffer pH 7, press push-button "on" switch located at left side of meter, and adjust "standarize" knob to reading of 7.0.

4. Rinse electrode in water.

5. Immerse electrode in the second buffer, depress "on" switch and adjust "temperature" knob to reading of the buffer.

6. Rinse electrode in water. Your DIGI-SENSE is now ready for use.

NOTE: The "temperature" knob serves the dual purpose of both temperature compensation and meter calibration. Therefore, upon completion of the calibration procedure the temperature knob does not necessarily indicate the actual buffer temperature.

IV. TROUBLE SHOOTING

In many cases poor performance or lack of performance can be traced to causes other than instrument malfunction. Some of these are defective electrode, weak batteries, contaminated buffers, temperature difference between buffers and poor calibrating and measurement technique.

If your pH meter is not operating satisfactorily the following checks should be made:

Try a new or another set of batteries.

Check meter by recalibrating with fresh buffer solutions.

Review your calibrating procedure.

Use another electrode of assured accuracy in above checks.

The following problems and corrective action will help in locating the trouble source:

1. *Sluggish response*: use a mild detergent to remove any dirt or film on the electrode tip, and rinse thoroughly. If condition persists, replace electrode.
2. *Excessive drift*: same procedure as above.
3. *Same reading from two different buffers*: replace electrode.

NOTE: Repeated fluctuations of more than ± 0.1 pH unit is an indication that the batteries are nearing the end of their life and should be replaced.

Digi-Sense Digital pH Meter

ELECTRODE INSTRUCTIONS

Sealed Combination Electrodes - - (Ag-AgCl Reference) - - 8mm

(1) Wet entire outside of electrode, except the cap, in tap water. Carefully remove the lower rubber sleeve. NOTE: This lower sleeve is used only for storage and shipping.

(2) Use a wet paper towel and clean the wick area by wiping several times.

(3) For first time usage, or after long storage, soak the lower end of the electrode (including the wick) in tap water for five minutes. This will allow the wick to commence flowing.

(4) If air bubbles are present in the bulb area, shake downwards to fill the bulb with the solution.

pH Measurement

(5) After following the above instructions, thoroughly rinse the electrode tip in distilled water. Next insert the electrode tip in a known buffer, close to the sample to be tested.

(6) Adjust the standardize control on pH meter until meter reads the value of the buffer.

(7) Thoroughly rinse electrode with distilled water, then insert electrode in solution to be tested. NOTE: This electrode tip should be rinsed in distilled water between each measurement to prevent contamination of the next solution.

Cleaning the Electrode

(8) It is necessary to clean the wick and bulb area thoroughly before using the electrode. Improper cleaning may produce drift or slow response.

Storage

(9) Storage of the electrode for a short period, immerse the membrane in a buffer of 4 or 7. During this period, the rubber sleeve should be over the filling hole. The wick rubber sleeve should be off.

(10) For long storage (over one week) the plastic cap should be placed into position as when the electrode was received. Then place back in the box and store.

OPERATING INSTRUCTIONS for the DIGI-SENSE pH METER

Calibrate with pH buffer solutions 4.00 and 7.00 for expected readings below 7 pH; calibrate with 7.00 and 10.00 for above 7 pH. Prepare buffer solutions by emptying contents of buffer capsules supplied into clean containers and dissolving each with 100 ml of water (distilled water if available). Solutions being checked for pH should be stirred. NOTE: Cleaning probe regularly will assure maximum accuracy and probe life—frequency of cleaning should be determined by operating conditions.

FIELD OPERATION

1. Install batteries by removing the four screws from rear of pH meter and inserting batteries supplied.
2. Connect electrode to meter.
3. Set "TEMPERATURE" knob to approximate temperature of buffer.
4. Immerse electrode in buffer 7.00, press push-button "ON" switch located at left side of meter, and adjust "STANDARDIZE" knob for a digital readout of 7.0 (7.00 for four-digit model).
5. Rinse electrode in water.
6. Immerse electrode in buffer 4.00 or 10.00, depress "ON" switch, and adjust "TEMPERATURE" knob for a digital readout of 4.0 or 10.0 (4.00 or 10.00 for four-digit model).
7. Rinse electrode in water.

AC OPERATION

Set the optional AC adapter, using switch on rear of adapter, to appropriate voltage (either 115vAC or 230vAC). Then connect adapter to pH meter and power outlet. Meter is now "on" and should be calibrated following steps (2) through (6) above.

BATTERY REPLACEMENT

"BAT. LOW" indicator will signal when it is time to replace batteries. Just remove the four screws from back of meter case and replace the six 1.5 volt, size "AA", alkaline batteries.

ACCESSORIES AND REPLACEMENTS

5992-20 Replacement pH Electrode for.

5985-05 AC Adapter for 115/230vAC operation.

5977-04 pH Buffer, 4.00, vial of 12 capsules.
5977-07 pH Buffer, 7.00, vial of 12 capsules.
5977-10 pH Buffer, 10.00, vial of 12 capsules.

Digi-Sense

Digital pH Meter

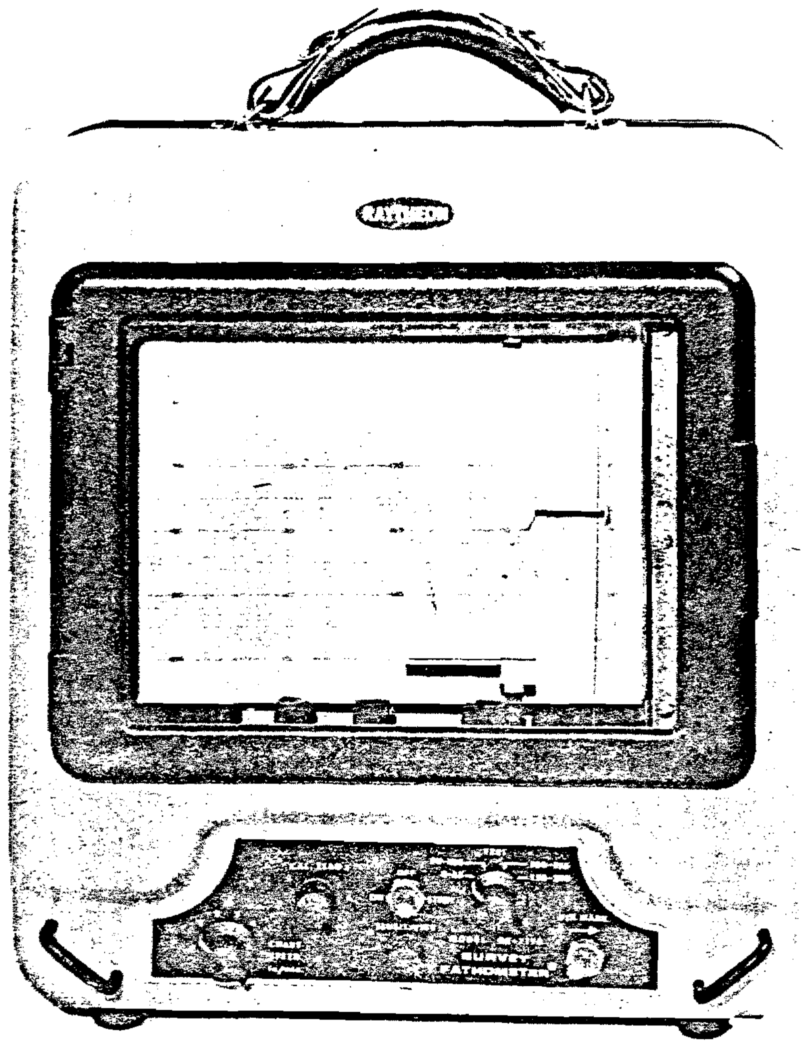
$6.00

DE-719B

FATHOMETER®

PRECISION SURVEY DEPTH RECORDER

INSTRUCTION MANUAL



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FEBRUARY 1977

RAYTHEON

Raytheon Marine

Limited Warranty

Marine Products

Raytheon Marine Company warrants all parts of each new product against defects in material and workmanship under normal use, and will repair or exchange any parts proven to be defective at no charge for a period of TWO YEARS from the date of original installation, EXCEPT AS PROVIDED BELOW.

Defects will be corrected by an authorized Raytheon Marine Company Service Station. There will be no charge for labor for a period of ONE YEAR from date of original installation, EXCEPT AS PROVIDED BELOW, and during this time Raytheon Marine Company will assume travel costs of its Authorized Service Station Representative up to a total of 100 highway miles.

WARRANTY LIMITATIONS

Raytheon Marine Company will not be responsible for equipment which has been subjected to accident, abuse, or misuse, nor any equipment on which the serial plate has been removed, altered, or mutilated.

Except where Raytheon Marine Company has performed the installation, it assumes no responsibility for damage incurred during installation.

This warranty is effective only with respect to the original purchaser from Raytheon Marine Company or an authorized Raytheon Marine Company Representative.

A validated warranty certificate and station logbook (if applicable) must be made available to the authorized Raytheon Marine Service Station Representative at the time of service.

On radar installations, the magnetron, T/R cell, klystron, and modulator tube (if applicable), and cathode ray tube are warranted for SIX MONTHS from date of original installation.

Chart paper, stylii, stylus belts, lamps, and fuses are consumable items, and are not covered by this warranty.

Any cost associated with transducer replacement, other than the cost of the transducer itself, is specifically excluded from this warranty.

Travel costs will not be accepted for products that do not require installation by an Authorized Service Station.

Raytheon Marine Company equipment or parts thereof which have been repaired or altered outside of its plant except by Authorized Raytheon Marine Company Service Stations are not warranted in any respect.

This warranty is STRICTLY LIMITED to the terms indicated herein, and no other express warranties or remedies thereunder shall be binding on Raytheon Marine Company. TO THE EXTENT CONSISTENT WITH STATE AND FEDERAL LAW: (1) ANY IMPLIED WARRANTIES SHALL BE LIMITED TO THE SAME TIME PERIODS STATED HEREIN FOR EXPRESS WARRANTIES, AND (2) RAYTHEON MARINE COMPANY SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES UNDER ANY EXPRESS OR IMPLIED WARRANTIES RELATING TO THIS EQUIPMENT.

RAYTHEON MARINE COMPANY
676 Island Pond Road, Manchester, New Hampshire 03103

66-52 (4/77)

NOTE: THE SAMPLE WARRANTY STATEMENT IS FURNISHED FOR REFERENCE ONLY. PLEASE REFER TO THE WARRANTY CERTIFICATE ISSUED WITH YOUR EQUIPMENT FOR SPECIFIC TERMS AND CONDITIONS.

PURPOSE

THIS MANUAL CONTAINS IMPORTANT INFORMATION ON THE INSTALLATION, OPERATION AND MAINTENANCE OF YOUR EQUIPMENT.

RAYTHEON MARINE COMPANY products are supported by a worldwide network of Authorized Service Representatives.

The below-listed Raytheon Marine Company Factory Service Centers will either assist you directly, or refer you to an Authorized Service Representative.

FACTORY SERVICE CENTERS

CALIFORNIA:
633 N. Marine Avenue
Wilmington, Ca. 90744
(Los Angeles)
Phone: (213) 835-0147

FLORIDA:
1107 N. Ward Street
Tampa, Fl. 33607
Phone: (813) 877-9418

LOUISIANA:
525 Jefferson Street
New Orleans, La. 70121
Phone: (504) 835-6491

NEW HAMPSHIRE:
25 Industrial Village
Londonderry, N.H. 03053
(Manchester)
Phone: (603) 668-1600

NEW YORK:
756 5th Avenue
Brooklyn, N.Y. 11232
Phone: (212) 768-2511

DENMARK:
Rayscan-Copenhagen
Siljangade 6-8 DK2300
Copenhagen S Denmark
Phone: 451-550702

TEXAS:
1203 Galveston Street
South Houston, Tx. 775
Phone: (713) 941-2700

WASHINGTON:
4800 20th Ave. NW
Seattle, Wa. 98107
Phone: (206) 782-0242
285 6543

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SECTION 1

INTRODUCTION

1.1 PRINCIPLES OF ECHO DEPTH SOUNDING

Echo depth sounding is a method of measuring water depth by computing the time interval required for sound waves to travel, at a known velocity, from a known point to a reflecting surface and return. If the time is measured between the transmission of a sound and the reception of its echo, the distance may be computed by multiplying one-half of this time interval by the velocity of sound in water.

From fresh water at the freezing point to the warmest water of the highest saline content likely to be encountered, there can be a variation in the speed of sound of from approximately 4550 to 5050 feet per second; the speed increasing with both higher temperature and salinity. The division of change is roughly three fifths for temperature and two fifths for salinity. The speed of sound also increases slightly with increasing pressure; however for water depths measured with the DE-719B equipment, the correction for pressure would be negligible and therefore will not be considered in this text.

The foregoing shows that under widely differing water conditions the sounding accuracy could be affected as much as ±5% due to the speed of sound in water variation. Under normal conditions of operation in a given area, variations of the speed of sound in water will usually be less than ±0.5%. The DE-719B equipment is calibrated for a speed of sound in water of 4800 feet per second, which is the figure commonly used for navigational purposes in salt water. However, for accurate survey work a speed of sound correction must be applied to the soundings to obtain the accuracy designed into the equipment.

1.2 EFFECTS OF FOREIGN MATERIAL, THERMAL GRADIENTS, ETC.

A hard bottom, such as rock or sand, provides the best reflecting surface for sound waves; however, strong reflection is also possible from air bubbles in the water, such as are present in the wake of another vessel. Weaker sound reflections (echoes) are generated by small fish, bits of seaweed and even by temperature variations in the water. If the sensitivity (gain) control of a depth sounder is set too high, it is sometimes possible to obtain sufficient echo return from the water itself to mark the chart to a depth of as great as one hundred feet. At a slightly lower setting of the sensitivity control, it is sometimes possible to observe thermal or salinity gradients and micro-organisms.

SECTION 2

DESCRIPTION

2.1 GENERAL

The DE-719B portable, precision, survey-type Fathometer® Depth Recorder is a complete echo depth sounder designed to provide a detailed permanent recording of underwater topography in water depths between 2 and 410 feet. Ease of set-up and operation, plus the extreme accuracy and low power consumption makes this an ideal instrument for underwater surveying.

The DE-719B Recorder is designed primarily for portability; however, it may be mounted on a bulkhead. For maximum portability, space is provided in the rear half of the case for stowing the transducer, rigging and power cable. A zippered canvas cover is provided for protection during handling and transportation.

A bracket, designed to support the recorder in an inclined position for easy viewing and operation, is built into the back portion of the case. Additional brackets and clips are incorporated in the back section for securing the transducer, cabling, and extension pipe.

The DE-719B is advance design equipment using completely solid-state circuitry, magnetic keying and electronically controlled chart speed. The equipment is housed in a splash-proof, aluminum case to assure maximum protection when operated under adverse conditions. The viewing window in the front cover is hinged to permit access to the chart paper for annotations. A safety guard covers the stylus and belt assembly to prevent accidental contact with the rotating stylus arm while entering notes and data on the chart paper.

The DE-719B provides high resolution recordings due to the narrow transducer beam width, high sounding rate, four selectable chart speeds and high signal frequency. The versatility of the DE-719B is further enhanced by a TIDE and DRAFT control, a SPEED OF SOUND control and a RANGE doubling control. Any changes in the setting of the preceding controls is permanently recorded on the chart paper for future reference. Fix marks can be inscribed on the chart by the FIX MARK switch. (A remote switch may be connected.)

The operating controls such as the power OFF/STANDBY/ON, RANGE SELECTOR, SENSITIVITY, CHART SPEED and the FIX MARK control and the RANGE X2 (doubles range on all scales) control are located inside and are accessible through the hinged front window.

The standard chart paper furnished is graduated in feet; however, chart paper graduated in meters is available as an option from the office where the DE-719B equipment was purchased.

The DE-719B equipment is designed to operate from a 12 VDC source; however, on special order it can be furnished with a built-in power converter to operate from a 115/230 volt, 50-60 Hz power source. This does not affect the ability to operate from a 12 VDC power source.

2.2 OPTIONS AVAILABLE

1. 115/230 VDC power supply, #M33105.
2. 7245A narrow beam transducer, #M396005.
3. Metric graduated chart paper, #587630-1.
4. Remote Fix Marker Switch, #7273-5010G1.
5. Maintenance spares kit, #M33125.

2.3 TRANSDUCER

The model 200T5HAD transducer is a two-way energy conversion device which functions like the combination microphone/speaker in an intercom unit. During transmission, it converts pulses of electrical energy into pulses of supersonic energy which travel through the water toward the bottom. During reception it receives the echoes of supersonic energy which are reflected from the bottom and converts them to electrical signals. Reference Section 3 for specifications.

2.4 SPARE PARTS KIT

A small spare parts kit (P/N 7430-5031G1) is furnished with each DE-719B system. The kit contains replacement fuses, stylus, brushes and chart paper.

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2.5 SPECIFICATIONS

Depth Range	0-55, 50-105, 100-155, 150-205 Feet 0-16.5, 15-31.5, 30-41.5, 45-61.5 Meters
Sounding Rate	534 Soundings per minute
Voltage Input	12 VDC
Current Input	2.5 Amperes
Accuracy	±0.5% ±1" of indicated depth
Operating Frequency	208 kHz
Tranducer	Barium titanate - Model 200T5HAD Optional Model 7245A
Transducer Beamwidth	8^{O} at the half power points
Chart Paper Speed	1,2,3,4, inches per minute
Chart Paper	7 inches x 60 feet
Recorder Dimensions	Height (including handle) - 18" Width 15-3/8" Depth 9-1/16"
Net Weight	Recorder w/transducer and rigging 47 lbs. Recorder only - 38 lbs.

000103

SECTION 3

TRANSDUCER DATA

3.1 GENERAL

The 7245A transducer has been designed for precision survey work and other applications where a very narrow beam pattern is required. Such an application requirement would result where it is necessary to accurately delineate the sides of a dredged channel, or a trench for the underwater laying of pipe or cable. The narrow beam pattern is also useful for more accurately outlining a submerged object such as a sunken vessel. The transducer is also useful for measuring wave heights, where the narrow beam can differentiate between the peak and trough of the waves. The 7245A transducer has been designed to match the electrical characteristics of the model 200T5HAD transducer supplied with the DE-719B Survey Recorder and is supplied with a cable connector for use with the DE-719B equipment. The model 7245A differs from the model 7245 in that it contains a built-in matching transformer to match a 50 ohm line impedance, which is also the transducer output impedance of the DE-719B equipment.

Because of the larger radiating area and greater directivity index, there will be at least a 6 dB improvement in echo strength compared to the smaller 200T5HAD transducer supplied with the DE-719B equipment.

3.2 SPECIFICATIONS

<u>7245A Transducer</u>

Operating Frequency:	204 to 210 kHz.
Transducer impedance:	50 ohms +J18 ±20% at operating frequency.
Transducer Beam Width:	2.75° inclusive at -3 dB points. 3.5° inclusive at -6 dB points. 4° degrees inclusive at -10 dB points.
Minor Lobes:	First lobes down at least 11 dB, peaking 4.5° either side of center; all minor lobes beyond 10° down at least 21 dB, and beyond 35° down at least 40 dB.

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7245A Transducer (Cont'd)

Cable:	Supplied with 30' of 2 conductor #18 shielded and neoprene jacked cable, having O.D. of 3/8". Supplied with Cannon type XLR-3-12C connector plug for use with DE-719B Survey Recorder. Additional cable up to 1500' in length may be used.
Housing Material:	Silicon bronze housing with sound window of polyurethane.
Mounting:	The mounting stem should be vertical within 1^{o} of the bottom for best resolution.
Beam Pattern:	Reference Figure 3-1.
Outline:	Reference Figure 5-1.

200T5HAD Transducer

Operating Frequency:	208 kHz.
Transducer Impedance:	The impedance at 200 kHz with the transducer immersed in water shall be in the range of 50 ohms $\pm 15\%$.
Transducer Beam Width:	Peak response within 2^{o} of mechanical axis. -3 dB points not more than 10^{o} apart. -10 dB points not more than 18^{o} apart.
Minor Lobes:	First sidelobes at least 15 dB below on axis response. Outside $\pm 35^{o}$ off axis, the response must be at least 20 dB below on axis at any angle including sides and rear.

200T5HAD Transducer (Cont'd)

Cable:	The cable is shielded twin with stranded copper shield, all tin plated. Each conductor is the equivalent of 16 strands of #31 AWG. The total cable length is 30' ±6".
Housing Material:	Red brass housing.
Mounting:	Same as 7245A.
Beam Pattern:	Reference Figure 3-2.
Outline:	Reference Figure 5-2.

3.3. OPERATION

The 7245A transducer with connector supplied, is plugged directly into the DE-719B transducer socket. No re-tuning of the equipment is required.

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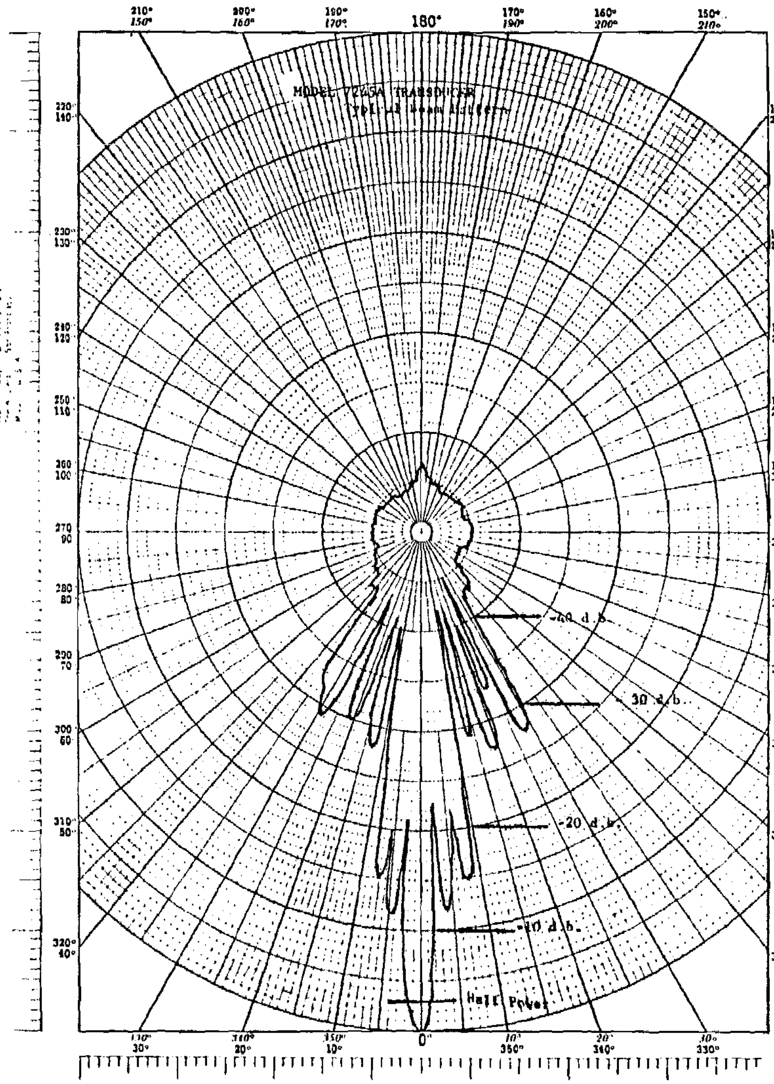

Figure 3-1 7245A Beam Pattern

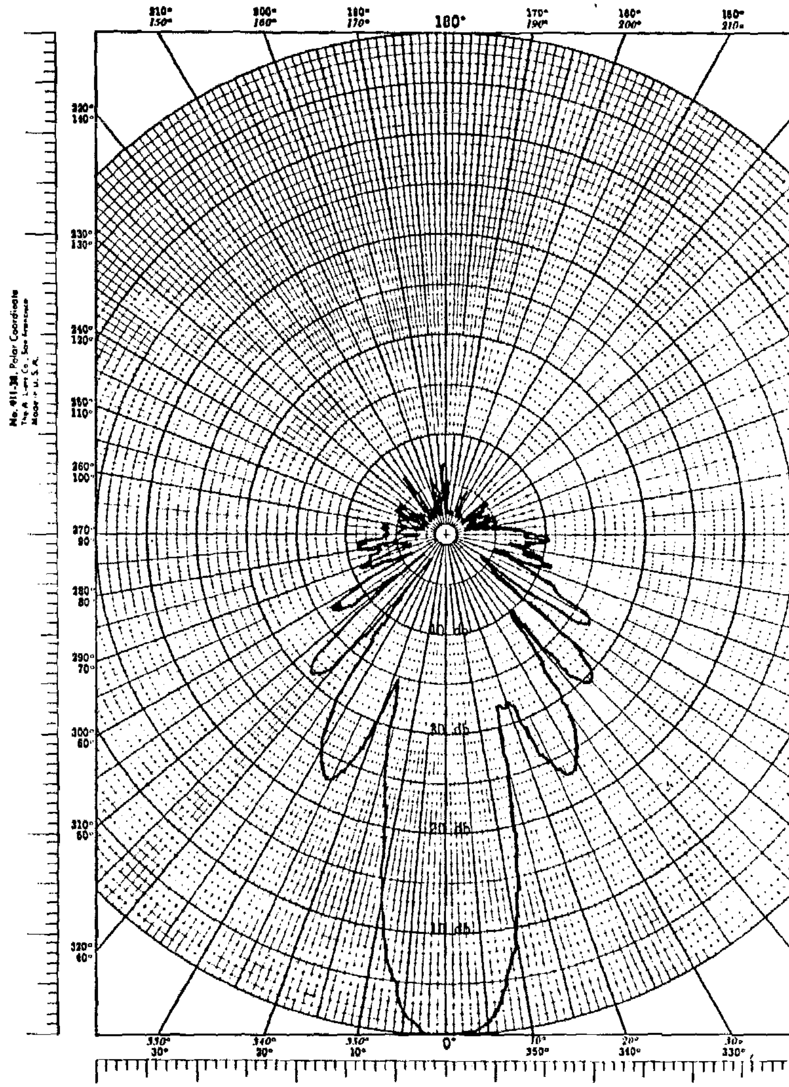

Figure 3-2 200T5HAD Beam Pattern

SECTION 4

OPERATION

4.1 OPERATOR CONTROLS AND FUNCTIONS

1. OFF/STANDBY/ON: Applies power to equipment. In standby chart drive and stylus are disabled but the equipment is warmed up and ready for instant use.

2. SENSITIVITY: Adjusts the receiver sensitivity (gain).

3. FIX MARK SWITCH: A spring loaded switch causes the stylus to inscribe a reference mark the full height of the chart paper. A remote fix-mark switch is available as an optional accessory.

4. TIDE and DRAFT: Adjustment to advance or delay the start of the transmitter pulse to compensate for tide and/or draft differences.

5. SPEED OF SOUND: Enables operator to vary stylus drive motor speed to compensate for salinity content and temperature of water.

6. RANGE X1, X2: Changes speed of stylus to multiply scale by 2 i.e. from 50 feet per phase to 100 feet per phase.

7. CHART SPEED: Selects the rate of chart paper feed; 1, 2, 3 or 4 inches per minute.

8. CAL ZERO: Enables the operator to adjust the first maker line to 0 (zero) on the chart paper. This is to compensate for stylus wear, etc.

9. FEET SWITCH: Selects the desired operating depth range.

4.2 OPERATION: INITIAL SET-UP

1. Remove the battery cable and the transducer and support tubes from the back section of the recorder case.

2. Assemble the first section of the support tubing to the transducer. Back off-on the hex nut on the transducer stem far enough to allow the keyhole slot in the tubing to slip over the screw. Tighten the hex nut with a wrench so that it seats firmly in the round part of the keyhole slot.

CAUTION

Do not turn the screw.

3. Assemble the remaining sections of the support tubing.

NOTE

Unscrew, but do not remove, each screw only as far as necessary to clear the keyhole slot. As each section is assembled tighten the screw so that it seats firmly in the circular part of the keyhole.

4. Slide the clamping ring over the full length of the transducer cable and support tubes. Secure the ring as close to the transducer as possible. Install a guy wire or line in the eye of the clamping ring. This is to provide strain relief for the support tubes when the boat is underway.

5. Clamp the assembled transducer and support tubes to the side of the boat (see Figure 4-1).

NOTE

Before immersing, wash the transducer face with a solution of liquid detergent and water. (This should be done each time the system is used.) The detergent removes any oil or other foreign matter which might prevent thorough wetting of the transducer face.

The support tube should be veritcal in the thwartship plane. In the fore and aft plane the lower end of the support tube should be tilted slightly forward. This will prevent the formation of air bubbles on the transducer face due to cavitation. Adjust the forward guy wire or line to hold this alignment.

NOTE

The transducer face or radiating surface should be submerged to a depth of at least one foot while underway.

6. Set the recorder on the seat or deck of the boat. Prop the recorder at an angle with the built-in support. (See Figure 4-2.)

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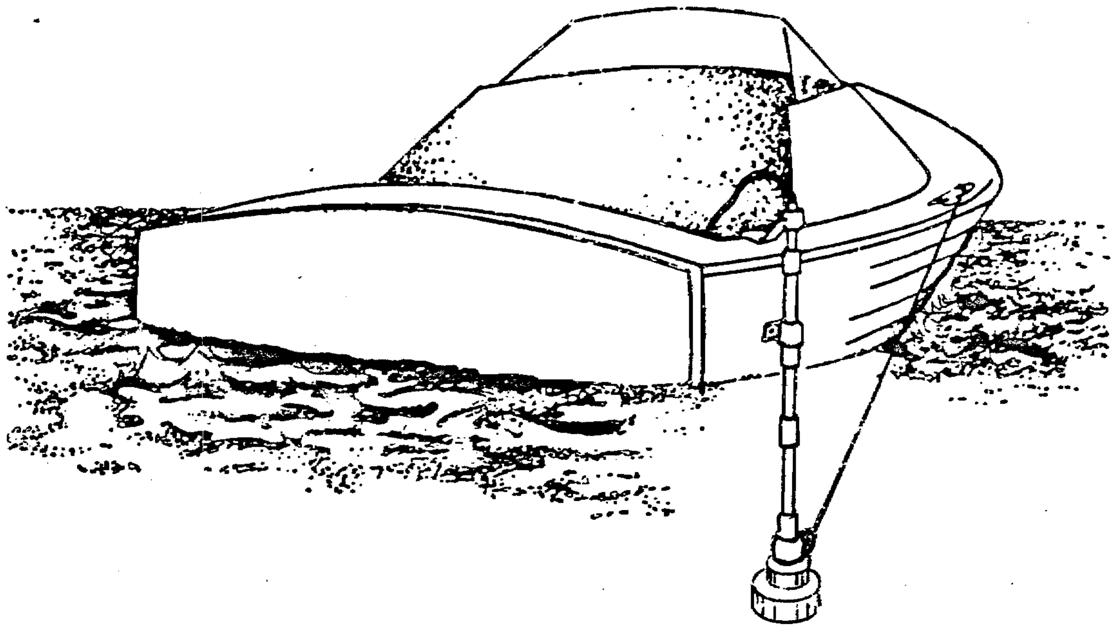

Figure 4-1 Typical Transducer Over-Side Installation

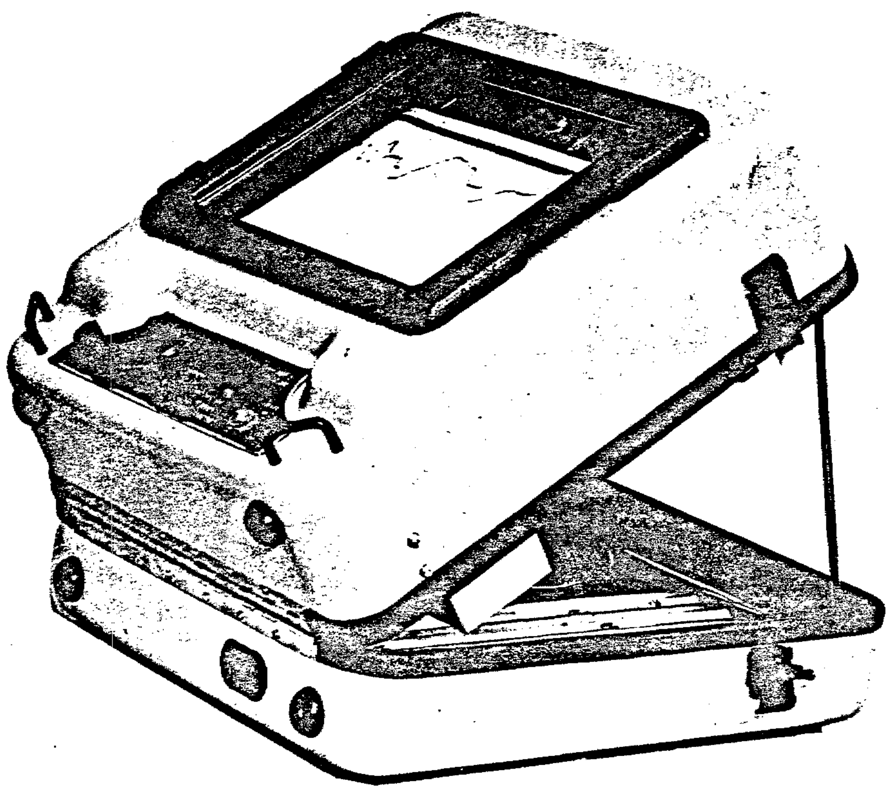

Figure 4-2 Recorder In Operating Position

7. Plug the transducer cable into the appropriate receptacle in the back of the recorder chassis.

8. Plug the battery cable into the BATTERY receptacle on the back of the recorder chassis.

9. Make sure that the OFF/STANDBY/ON control is in the OFF position. Connect the battery clips to a fully charged 12 volt storage battery. BE SURE TO OBSERVE POLARITY.

10. Set the FEET Switch to the 0-55 foot range. Set the RANGE X1, X2 control to X1 (control is located inside hinged front window).

11. Open the front cover of the recorder and rotate the stylus belt <u>counterclockwise</u> through one complete revolution by rotating the upper pulley. Check that the stylus rides in the track at the left side of the assembly and the pulleys turn smoothly. Close the front cover and latch securely.

12. Turn the OFF/STANDBY/ON control to ON. This applies power to the recorder circuitry, stylus drive motor and the chart feed motor.

13. Adjust the front panel CAL ZERO control until the "calibrate zero line" falls on the zero calibration on the chart paper.

NOTE

For this adjustment the direct transmission mark should be moved off the zero calibration by the TIDE and DRAFT control.

After the CAL ZERO adjustment is completed readjust the TIDE and DRAFT control until the direct transmission mark falls on the chart paper zero line, or as required.

14. Adjust the SPEED OF SOUND control (located inside the hinged window) until the calibrate mark falls on the CALIBRATE line near the bottom of the chart paper. This adjusts the speed of sound to 4800 feet per second.

15. Set the chart paper speed to the desired feed rate: 1, 2, 3 or 4 inches per minute.

16. Turn the FEET switch to the range which brackets the approximate depth reading.

000111

NOTE

The zero transmission mark appears only on the 0-55 foot range.

17. Advance the SENSITIVITY control slowly clockwise until the bottom echo appears. Continue advancing the control until there is no change in the depth indication. Read the upper edge of the recording for the proper depth reading.

4.3 ADDITIONAL CONTROLS

The instructions in Section 4.2 outline the steps required to place the DE-719B in operation. The following controls may be used as required to further utilize the versatility built into this unit.

4.3.1 CHART SPEED

There are four distinct chart paper speeds available; 1, 2, 3 and 4 inches per minute. The higher the paper feed the greater the bottom detail.

4.3.2 FIX-MARK Switch

This switch when pressed to the right will inscribe a mark on the chart paper for time and/or position reference. Annotations can be made adjacent to the fix mark by opening the hinged window in the front of the recorder. A guard prevents accidental contact with the rotating stylus and belt assembly.

4.3.3 TIDE and DRAFT Adjustment

This adjustment permits the operator to advance or delay the transmitter pulse to compensate for tide and/or draft variations. The latitude of adjustment is from a minus 5 feet to plus 30 feet.

4.3.4 SPEED OF SOUND Compensation

This control allows the operator to compensate for variations in the temperature and salinity content of the water. Adjustment of this control permits the accuracy of the recorded depth reading to be calibrated to a "check-bar" reading. A calibration marker, indicating the amount of compensation, is permanently recorded on the chart for future reference.

4.4 HOW TO INTERPRET RECORDINGS

A basic factor to be considered when interpreting bottom conditions is that a hard bottom will reflect an echo more strongly than a soft bottom. To obtain bottom readings, set the SENSITIVITY control to the minimum position that produces a good consistent record.

A flat bottom composed of rock, sand or packed mud usually results in a fairly thin dark trace on the chart paper. This type of bottom creates multiple echoes in shallow water caused by the signal bouncing back and forth between the bottom and the surface. These echoes show as multiples of the actual depth which is always the shallowest reading.

A soft mud bottom produces a broad echo of light intensity. The broad echo is caused by the reflection of the transmitted signal from the top of the mud and the hard surface beneath the mud. The thickness of the soft mud layer can often be determined by a split in this type of echo.

Another indication of the type of bottom is the the relative setting of the SENSITIVITY control required to obtain recordings at various depths. The strongest echoes are generally obtained from the air-water interface. Rock, sand, metal, wood, fish and plankton return echoes in a diminishing order of strength. The air-to-water transistion may occur when passing over your own or another vessels wake.

During deep water soundings, the conical sound beam propagated from the transducer is reflected from a large area of the bottom resulting in a wide echo; whereas in shallow water the sound wave is reflected from a smaller area and produces a narrower echo.

4.5 OPERATOR REPLACEMENTS

4.5.1 Chart Paper Removal Procedure (Figures 4-3, 4-5)

1. Disconnect power from the equipment.

2. Release case latches and swing front cover down.

3. Rotate drive pulley (13) slowly counterclockwise to position recording stylus (8) off paper.

4. Rotate take-up knob (16) to wind chart paper onto the paper take-up roll (20). Guide paper by hand to avoid fouling.

5. Release quick-lock (1) and swing platen assembly (14) to the right.

6. Grasp paper take-up roll (20) in left hand, lift up spring loaded paper take-up arm (17) with right hand to disengage upper end cap.

00113

7. Grasp paper take-up roll (20) in left hand, lift up spring loaded paper take-up arm (17) with right hand to disengage upper end cap.

8. Lift and tilt the paper take-up roll (20) to disengage it from lower end cap (21), and remove the roll.

4.5.2 Chart Paper Installation Procedure

1. Disconnect power from the equipment.

2. Rotate drive pulley (13) slowly counterclockwise to position recording stylus (8) off paper.

3. Release quick-lock (1) and swing platen assembly (14) to the right.

4. Pull up knurled, spring-loaded paper supply knob (27), tilt paper supply roll shaft (26) away from the platen.

5. Remove the empty chart paper spool from the paper supply roll shaft (26) and install it in position on paper take-up roll (20) by raising paper take-up arm (17), taking care to engage spool end slots with key projections on end caps (19) and (21).

6. Hold paper retard spring (25) to one side and slide new roll of chart paper down over paper supply roll shaft (26), taking care to engage slotted end of chart paper spool with key projections on end cap (22). Release paper retard spring (25).

7. Tilt paper supply roll shaft (26) back to normal position, pull up paper supply knob (27) so it clears the frame. Release paper supply knob (27), making sure that it seats securely in its frame socket. Check position of paper retard spring (25) against paper supply roll.

8. Thread leading end of chart paper to the left around paper feed roller assembly (24), under the stylus guide block (10).

9. Swing platen assembly (14) to the left to its normal position.

10. Draw the loose end of the chart paper across the platen assembly (14) to the live roller assembly (15).

11. Swing platen assembly (14) to the right to its open position while continuing to draw chart paper around live roller assembly (15), threading paper between frame and paper take-up roll.

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12. Attach loose end of chart paper to spool with the tape supplied with the new roll.

13. Rotate the take-up knob (16) to wind two or three layers of paper onto the paper take-up roll (20), guiding the paper by hand so it aligns properly. When all the slack is removed from the paper, it should lie flat and wrinkle-free on the platen assembly (14).

14. Swing the platen assembly (14) to the left and fasten the quick-lock (1).

15. Rotate the drive pulley (13) counterclockwise and check the recording stylus (8) for straight and smooth travel over the chart paper.

16. Raise the front cover up into the closed position and secure the latches.

17. Operate the equipment at maximum chart speed to check chart paper travel and stylus function.

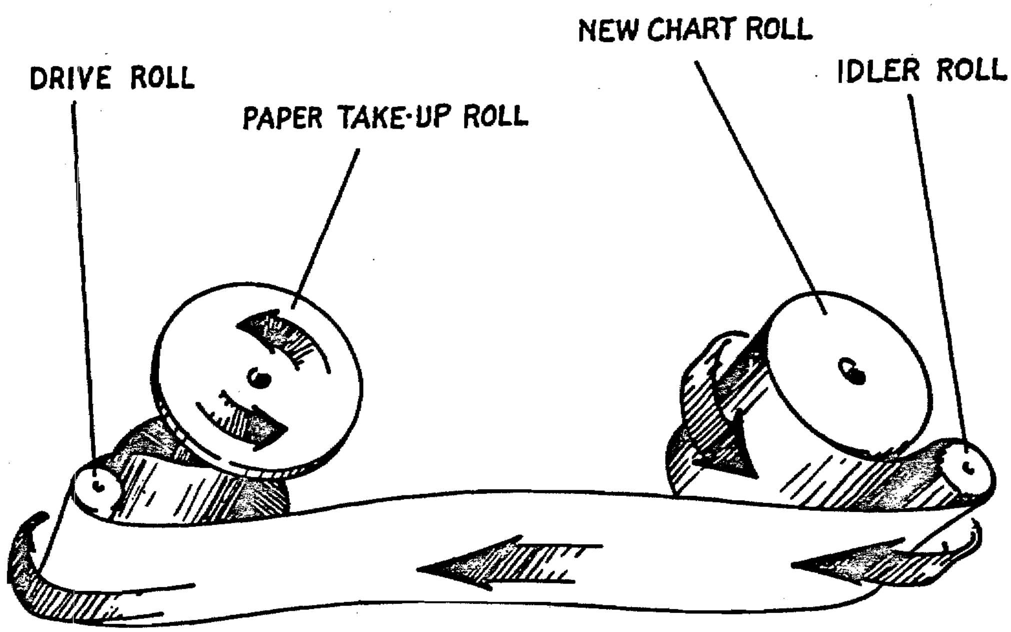

Figure 4-3 Chart Paper Threading

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4.5.3 Recording Stylus Removal Procedure (Figures 4-4 and 4-5)

1. Disconnect all power from the equipment.

2. Release the latches and lower the front cover.

3. Rotate the drive pulley (13) slowly counterclockwise to position the recording stylus (8) off the paper.

4. Remove stylus from holder by compressing the ends sufficiently to clear the holder hooks. Push down lightly to compress the sponge pad and permit disengagement from the center hooks.

4.5.4 Recording Stylus Installation Procedure

1. Disconnect all power from the equipment.

2. Release latches and lower the front cover.

3. Rotate drive pulley (13) slowly counterclockwise to position recording stylus (8) off paper.

4. Engage center loop of new stylus with center hook on stylus holder. The sponge pad must be depressed to permit insertion of the stylus ends into the end hooks. *NOTE - Hooked end of stylus must be toward the guide.*

5. Rotate drive pulley (13) counterclockwise to insure that one end of the stylus engages the trolley (11) Vee groove, and the other end maintains full contact with the guide rail and the chart paper throughout the full length of travel down the chart paper.

6. Raise the front cover up into the closed position and secure latches.

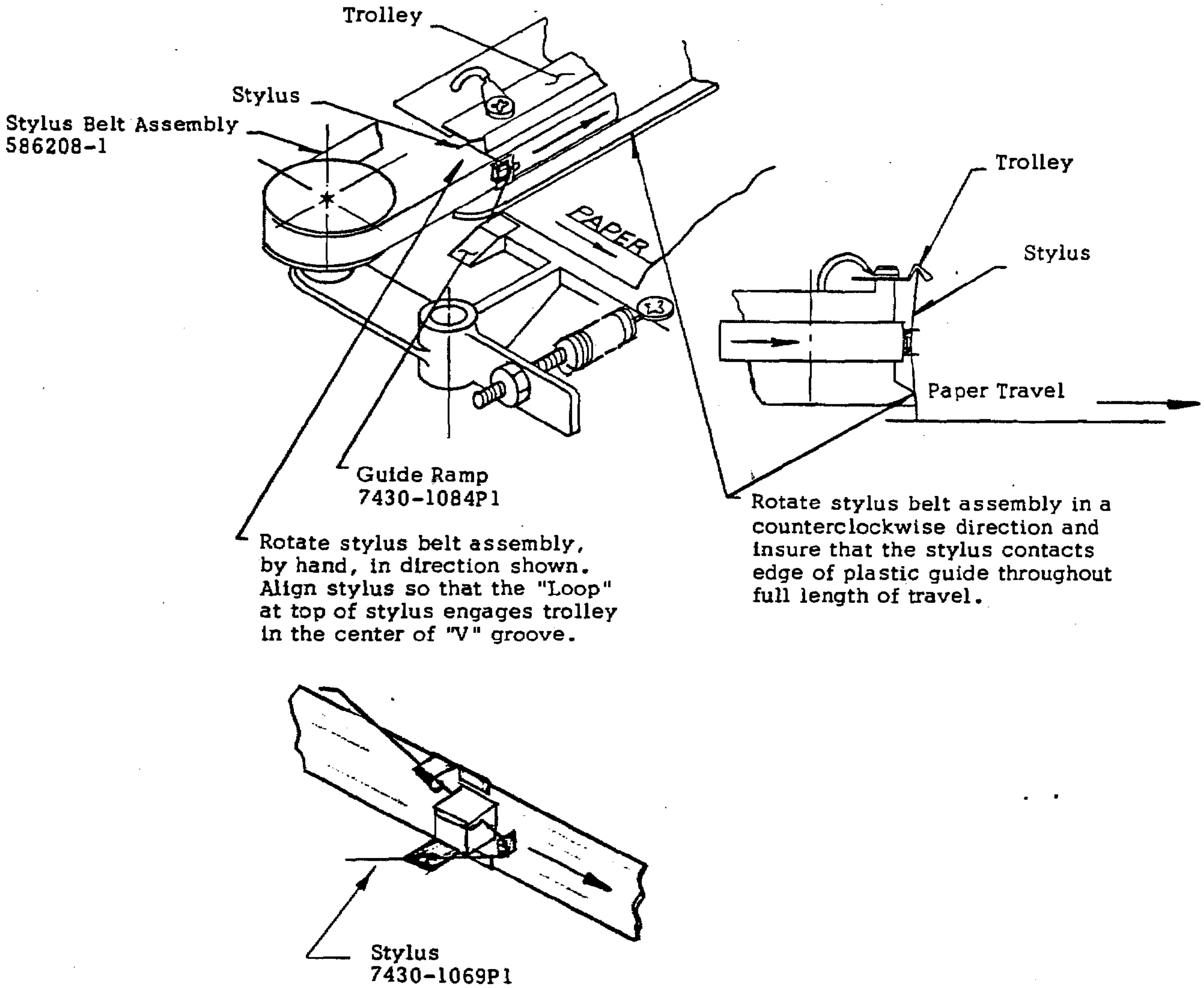
7. Restore power, turn the equipment on and allow to operate for approximately five minutes, or until the recording stylus (8) inscribes a smooth, straight line when the FIX MARK switch is actuated.

4.5.5 Stylus Belt Removal Procedure (Figures 4-4 and 4-5)

1. Disconnect all power from the equipment.

2. Release latches and lower front cover.

3. Rotate drive pulley (13) slowly counterclockwise to position the stylus off the paper.



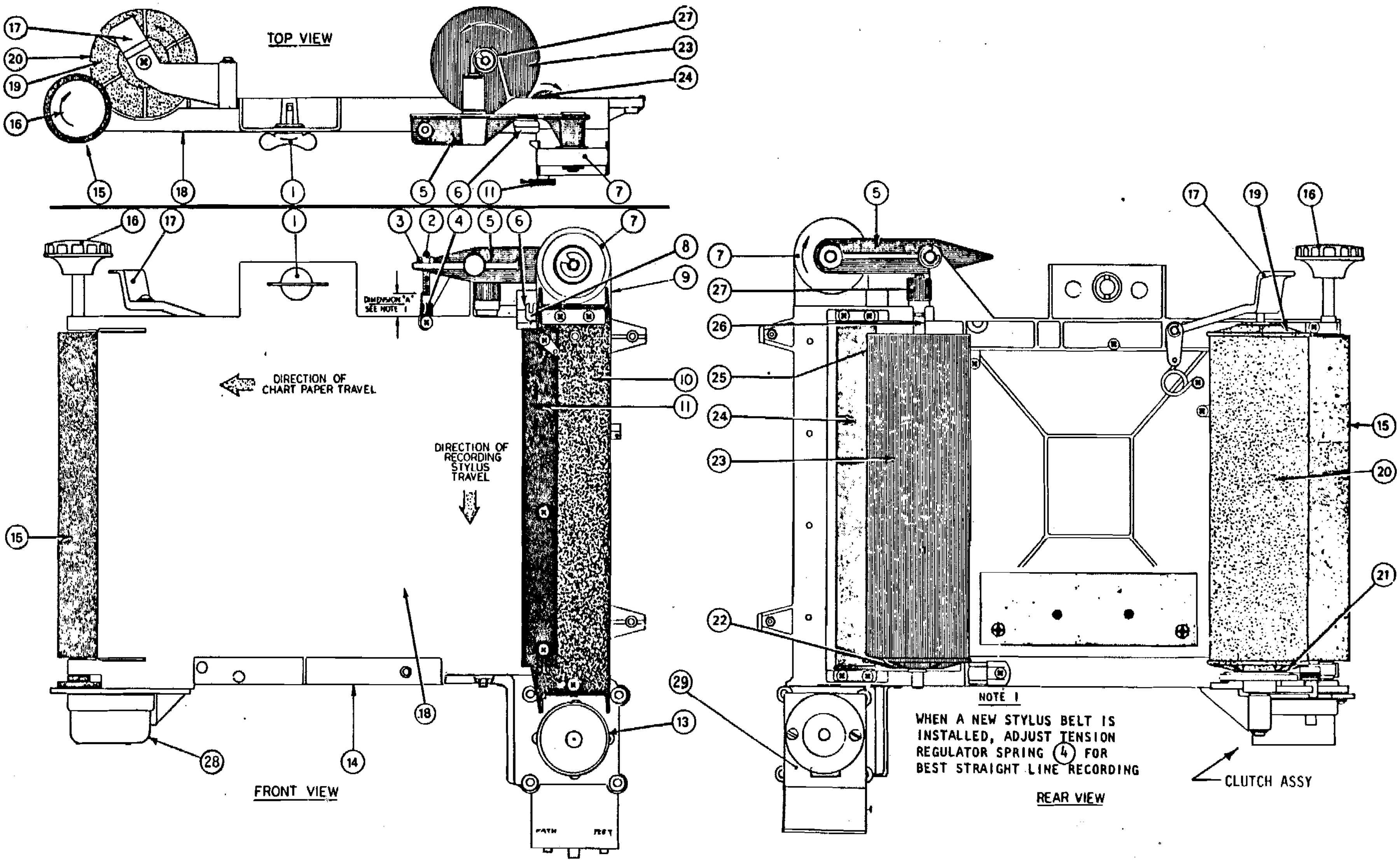
NOTE:

1. When a new stylus is installed, operate the equipment on the X1 RANGE for approximately five minutes, or until the stylus draws a straight line when the FIX MARK switch is actuated. This "break-in" period is necessary to remove any burrs which might be present on the writing end of the stylus.

2. When a new stylus belt is installed, adjust the belt tension for optimum straight line recording. Install stylus and observe mark inscribed on chart paper when FIX MARK is actuated. If mark fluctuates more than 1/16 inch from side to side, increase tension until "track" ceases to fluctuate.

Figure 4-4 Belt and Stylus Replacement

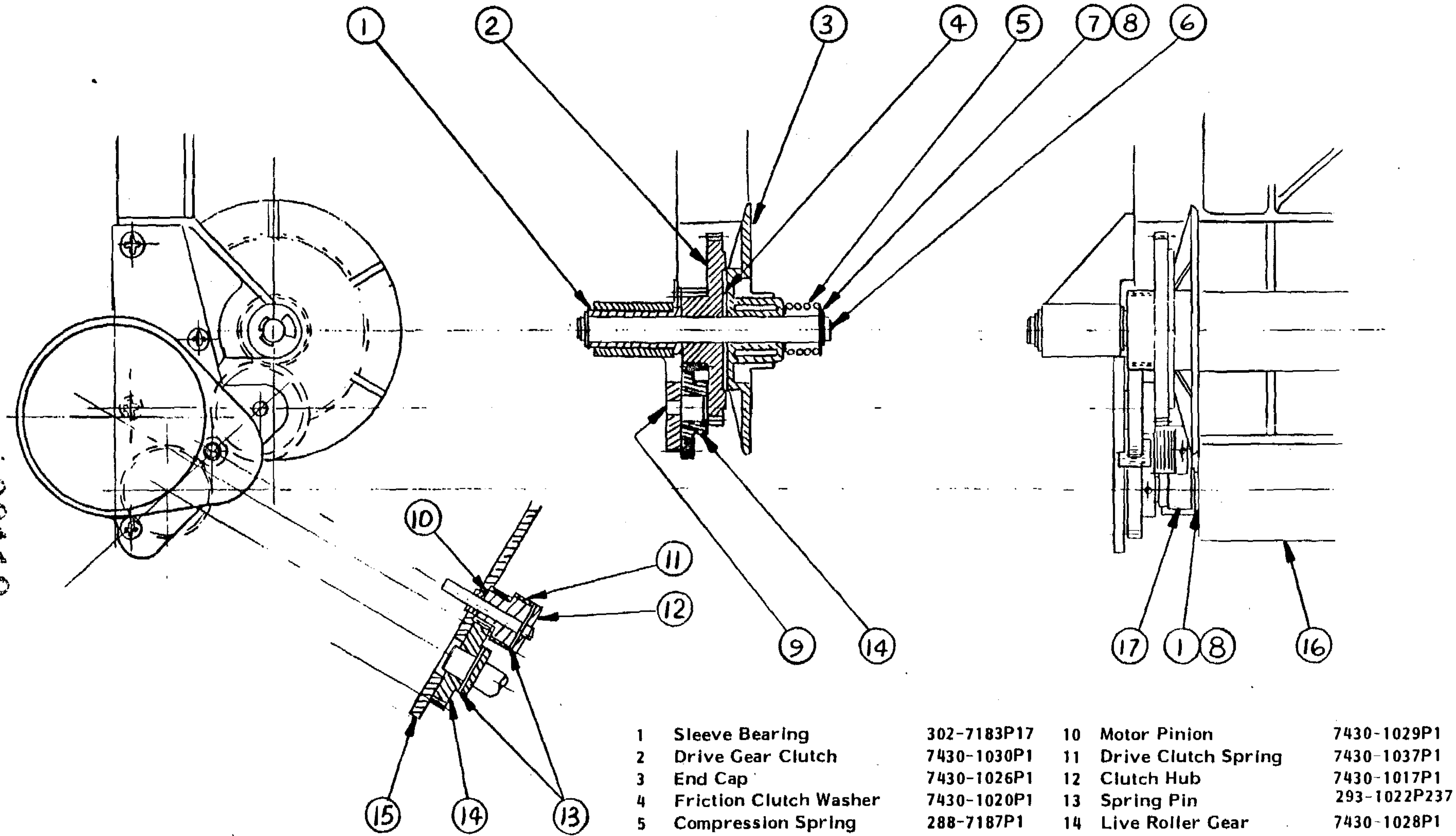
00117



1	Quick Loc	373-7188P1	11	Trolley	7430-1068P1	22	End Cap	7430-1025P1
2	Tension Req Screw	7430-1067P1	13	Drive Pulley	7430-1076G2	23	Paper Supply Roll	7430-1013P1
2	Self Loc-Nut	203-1011P47	14	Platen Assy	7430-5013G1	24	Paper Feed Roller Assy	7430-1079G1
4	Reg Tension Spring	7275-1016P1	15	Live Roller Assy	7430-1078G2	25	Paper Retard Spring	7430-1062P1
5	Tension Arm	7430-1006G1	16	Take Up Knob	231-7184P1	26	Paper Supply Shaft	7430-1007P2
6	Stylus Guide Ramp	7430-1084P1	17	Paper Take Up Arm	7430-1008P1	27	Paper Supply Knob	7430-1014P1
7	Idler Pulley	7430-1076G3	18	Platen	586090-2	28	Chart Motor	315-7228P2
8	Recording Stylus	7430-1069P1	19	End Cap, Paper Take	7430-1026P1	29	Stylus Motor	315-7223P1
9	Stylus Belt Assy	586208-1	20	Paper Take Up Roll	7430-1007P4			
10	Stylus Guide Block	586166-1	21	End Cap (Lower)	7430-1026P1			

Figure 4-5 Platen Assembly

600118



1	Sleeve Bearing	302-7183P17	10	Motor Pinion	7430-1029P1
2	Drive Gear Clutch	7430-1030P1	11	Drive Clutch Spring	7430-1037P1
3	End Cap	7430-1026P1	12	Clutch Hub	7430-1017P1
4	Friction Clutch Washer	7430-1020P1	13	Spring Pin	293-1022P237
5	Compression Spring	288-7187P1	14	Live Roller Gear	7430-1028P1
6	Take-Up Drive Shaft	7430-1007P4	15	Drive Train Assy	7430-1036P1
7	Retaining Ring	362-7176P17	16	Live Roller Assy	7430-1078G2
8	Shim Washer	236-7174P8	17	Bearing Retainer	7430-1087P1
9	Idler Stud	7430-1016P1			

Figure 4-5A Platen Clutch Assembly

4. Release tension on stylus belt assembly (9) by pressing down on spring-loaded tension arm (5) while slipping the belt off the idler and drive pulleys.

4.5.6 Stylus Belt Installation Procedure

1. Disconnect all power from the equipment.

2. Release latches and lower front cover.

3. Depress the stylus belt tension arm (5) and loop the new belt assembly (9) over the idler pulley (7) and drive pulley (13) so that the recording stylus (8) is in the position illustrated in Figure 4-4; Front View.

4. Rotate the drive pulley (13) counterclockwise by hand to check the belt for proper tracking around the pulley.

5. Check for straight line recording at maximum chart speed. Adjust as required.

6. Install a new stylus as described in Section 4.5, paragraph 4.

7. Restore power to the equipment, turn on and observe the mark inscribed on the chart paper when the FIX MARK switch is actuated. If the mark fluctuates from left to right, increase tension of regular spring (4) until the mark does not deviate.

4.6 OPERATOR ADJUSTMENTS

4.6.1 Calibration Marker Adjustment (Standard Chart Paper)

The speed of the stylus drive motor can be varied by the operator to compensate for variations in the speed of sound in water using a "check bar" or the calibration marks generated within the DE-719B, as a reference.

The fixed reference marks are generated by a stable time base circuit which produces two sharp pulses spaced exactly 20.833 milliseconds apart. These pulses are electrically superimposed on the analog output to the recording stylus and will fall exactly 50 feet apart on the chart paper when the stylus drive motor speed is adjusted to the speed of sound in water of 4800 feet per second. The sharp line inscribed on the chart by the transmitted pulse is adjustable to the zero depth calibration on the chart by the CAL ZERO control and the line initiated by the second pulse will fall on the 50-foot chart "calibrate" line.

For each one percent change in the speed of the stylus drive motor (from a base speed or 4800 feet/second) the calibrate mark will change position by one-half foot. For example, if the stylus drive motor speed was increased by two percent the calibrate mark would move from the 50-foot "calibrate" line to the 51-foot graduation. Conversely, if the motor speed was decreased by four percent the mark would move from the "calibrate" line to the 58-foot graduation.

The "calibrate" line is also used to indicate the recording phase in use. The line is intermittently broken into a series of one, two, three or four short dashes to indicate the first, second, third or fourth phase.

Adjust as follows:

1. Be sure that the stylus drive motor speed is adjusted to 3350 RPM.

2. Adjust the CAL ZERO control until the calibrate zero line falls directly on the chart paper zero line.

   NOTE

   The direct transmission pulse can be moved off the zero line by the TIDE and DRAFT control while makeing the calibrate zero adjustment.

3. Adjust potentiometer R210 until the second calibrate pulse falls exactly on the chart paper "calibrate" line.

   NOTE

   Adjustment of the SPEED OF SÔUND control, R305, varies the position of the 50-foot calibration line by plus and minus three feet. The calibrate lines (at zero and 50 feet) are not present when operating on the X2 range.

4.6.2 Calibration Marker Adjustment (Metric Paper)

When your DE-719B is ordered from the factory with metric chart paper installed, the unit will be factory calibrated for metric scales.

If your DE-719B is calibrated for use with the standard chart paper and it is desired to change to the metric chart paper, it will be necessary to re-calibrate the built-in marker calibrate circuit. This is necessary since the 50-foot calibration line does not agree with

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an even number in meters and the actual calibration point for the metric paper has been set at 15 meters for ease in reading. The ratio between 50 feet and 15 meters is 0.9821 and the calibration marker adjustment (internal) must be changed by this amount.

The adjustment procedure is as follows:

1. With the standard chart paper (feet) installed, adjust the SPEED OF SOUND control so that the calibration marker lines fall at exactly 0 and 50 feet on the chart paper.

2. Remove the plastic cover from the "Motor Control" printed circuit board and adjust potentiometer R210, in the upper right hand corner, until the 50 foot calibrate line falls at 49.1 feet on the chart paper.

3. Remove the standard chart paper and install the metric chart paper. Make certain that the original 50-foot calibrate mark on the standard chart paper now falls at 15 meters on the metric chart paper.

CAUTION

DO NOT READJUST THE "SPEED OF SOUND" CONTROL DURING THIS OPERATION.

NOTE

If metric paper (P/N 587630-1) will be used only occasionally it will not be necessary to recalibrate, merely bear in mind that the calibrate mark will fall at 15.27 meters instead of 15 for a speed of sound of 4800 feet per second.

When the DE-719B is calibrated for metric operation the drive motor speed will be 3290 RPM rather than the 3350 RPM called out in the manual. In the X2 range the motor speed for metric operation will be 1645 RPM rather than 1675 RPM as specified in the manual.

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SECTION 5

INSTALLATION

5.1 RECORDER

Although the DE-719B recorder is designed for portable use it may be installed permanently. The slotted key holes in the back of the case permit bulkhead mounting. The battery input power cable (or AC power cable) and the transducer cable enter the case via the two holes in the back. The holes are of sufficient size to provide clearance for the power and transducer cable plugs.

If desired, the recorder may be mounted at a 45° angle for easy viewing and operation. Installing the recorder with the right side toward the bow of the vessel will make the recording naturally assume the correct correlation with the over-the-bottom travel of the vessel.

5.2 TRANSDUCER

The type 200T5HAD transducer (furnished with the DE-719B) may be installed temporarily as described in the Operation section or it may be permanently installed.

5.2.1 Permanent Transducer Installation

1. Select a location which is close to the keel and will not be subject to turbulent water passing across the transducer face. The transducer must be completely immersed when the boat is underway; also the radiating surface must be as nearly parallel to the water line as possible.

2. Leave sufficient space within the hull for tightening the nut on the transducer stem and for routing the cable to the recorder.

3. Remove the screw and locknut from the side of the transducer sleeve (see Figure 5-2).

4. At the selected location bore a 1-1/16 inch hole through the blocks as shown.

5. The block outside the hull should be streamlined to conform to the shape of the transducer to reduce the possibility of water turbulence.

6. The filler block inside the hull must be thick enough so that the nut/washer does not seat against the top of the transducer sleeve before tightening against the filler block.

000123

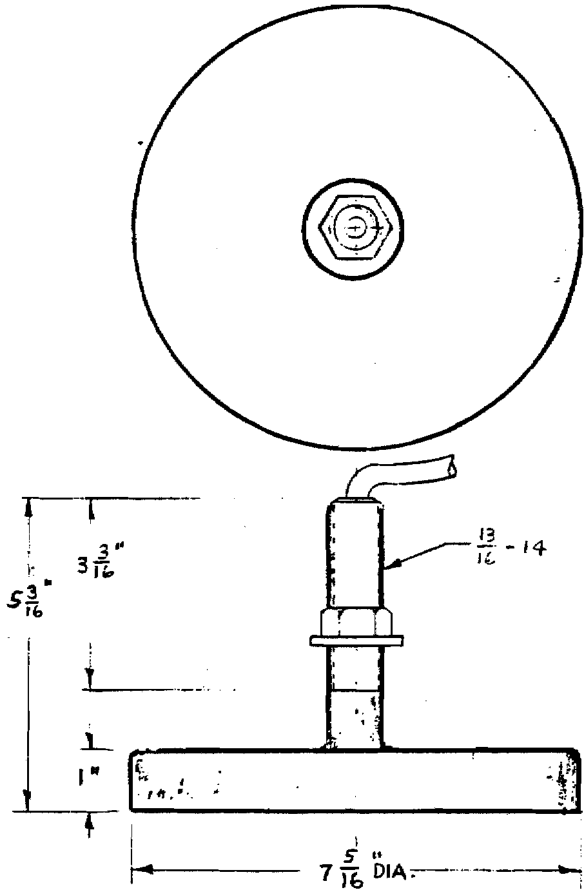

Figure 5-1 7245 Outline

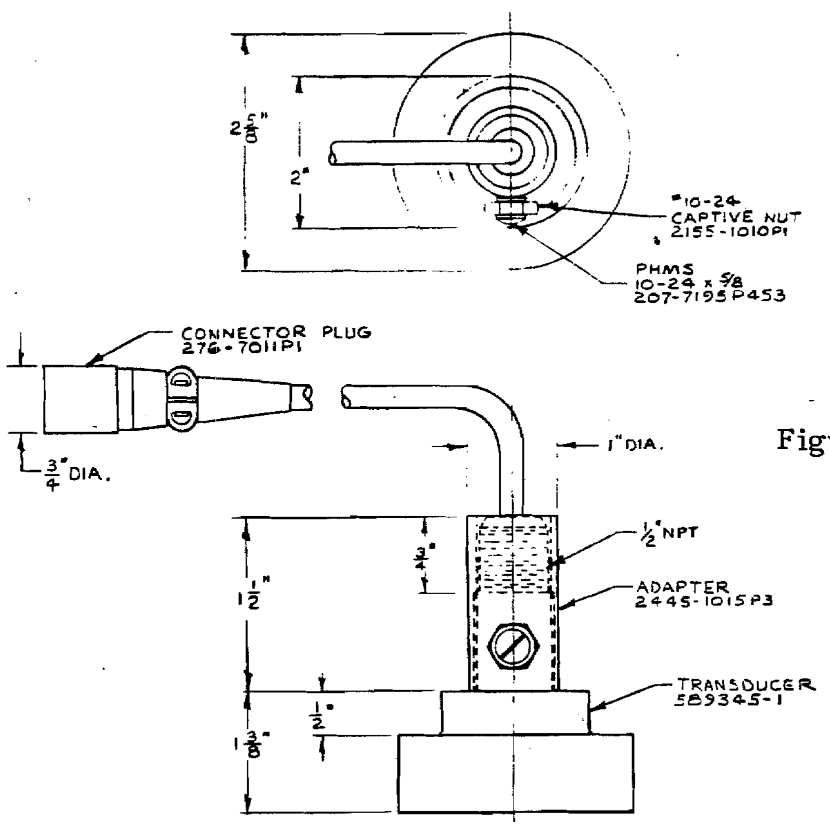

Figure 5-2 200T5HAD Outline

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7. Remove the plug from the cable; do not cut the cable.

8. Coat the inner and outer fairing blocks with a good quality seam filler or bedding compound.

9. Thread the cable through the hole in the outer fairing block and the hole in the hull.

10. Insert the transducer stem up through the outer block and the hull.

11. Before launching the boat, wash the face of the transducer with a solution of liquid detergent and water.

5.2.2 Cable Installation

1. Inside the vessel, thread the cable through the hole in the fairing block, canvas washer (well coated with white lead), and the bronze nut/washer.

2. Place the above, in the order listed, over the protruding stem of the transducer, and tighten nut/washer securely.

3. If the cable end becomes wet with bilge water, wash with fresh water and dry thoroughly.

4. Route the transducer cable to the recorder location by the most direct path keeping the cable as far as possible from ignition wiring.

5. If the cable is too long, coil it and store it out of the way do not cut as this would impair operation.

6. Reinstall the plug.

5.3 115/230 VAC POWER SUPPLY INSTALLATION

The AC power supply is designed to mount on the main chassis below the platen assembly as shown in Figure 5-3.

To install:

1. Remove the plastic plug from the hole in the main chassis marked J303.

2. Mount the power supply chassis as shown in the photograph.

3. Connect the black lead to the bottom terminal on TB303.

4. Connect the red lead to the second from the top terminal on TB303.

5. Connect the jumper straps on TB301 for 115 or 230 VAC depending on power source. The strapping diagram is shown on the back of the main chassis panel. (Ref. Figure 7-3.)

6. Connect the AC power to the connector J303.

7. The OFF/STANDBY/ON switch on the front panel will control the application of power to the equipment.

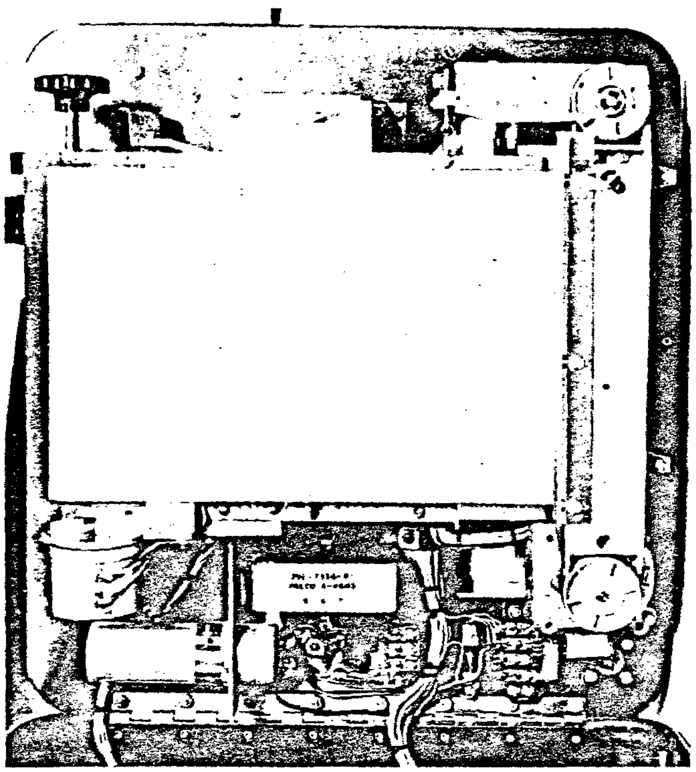

Figure 5-3 115/230 VAC Power Supply-Installed

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SECTION 6

THEORY OF OPERATION

6.1 TRANSMITTER

The transmitter circuitry is basically a Master-Oscillator Power-Amplifier configuration operating at a frequency of 208 kHz. Transistor Q102 operates as a pulsed oscillator normally in a cut-off state. When a positive-going signal is received at the base of Q102 from the TIDE and DRAFT ADJUST circuit, it oscillates at the frequency determined by the collector tuned circuit. The length of the pulse is determined by the build-up time of the RC network in the emitter of Q102; this is approximately 200 microseconds in both the X1 and X2 modes of operation. The secondary of the oscillator transformer is coupled to the base of Q103 which functions as a class "C" amplifier with the collector tuned to the oscillator frequency by the primary of T102 and the transducer capacity. Operating voltage for the transmitter amplifier is furnished by the built-in inverter. The inverter consists of a 150 kHz oscillator the output of which is rectified and filtered and clamped to 40 VDC by zener diode CR101. The inverter oscillator operates from the 12.6 VDC supply voltage and is tuned to 150 kHz by C101, C102 and L102.

6.2 RECEIVER

The transmitted pulse and the returning echo pulses are coupled to the receiver by the secondary of transformer T102. The receiver consists of two transformer-coupled stages, Q102 and Q103, tuned to 208 kHz. A factory set internal gain control, R112, determines the maximum sensitivity of the receiver. The front panel SENSITIVITY control permits the operator to vary the receiver to the desired gain level. The output of the receiver is rectified and filtered to remove the 208 kHz component. The resultant DC pulses supply the collector of Q106, the stylus oscillator, which is Colpitts configuration tuned to approximatley 22 kHz. The output from T105 is fed to Q107, an emitter follower, and in turn, to Q301 the power amplifier. The output of Q301 is fed to the stylus by the step up cupcore transformer T301.

6.3 MOTOR SPEED CONTROL

The stylus drive motor is a series wound DC motor; the speed is variable and is controlled electronically as follows: Speed sensing coil L305, which is wound on a small permanent magnet, is positioned such that a toothed disc, mounted on the motor shaft, is in the magnetic field of the coil. When the motor shaft and toothed disc rotate, a frequency directly proportional to the speed of the motor is generated in L305. The voltage developed is fed to the base of Q207 where it is amplified and fed to a one-shot multivibrator,

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Q208 and Q209. The multivibrator is triggered at a rate determined by the speed of the motor. Capacitor C217, in the base circuit of Q210, functions as an integrator; therefore the input to Q210 is a DC voltage which is inversely proportional to the speed of the motor (the voltage fed to the base of Q210 is maximum when the motor is stationary). Q210 compares the voltage on C217 with a zener voltage at CR207; when the output falls below the zener level Q210, Q211 and Q302 decrease conduction and maintain the motor at the proper speed. Zener diodes CR206 and CR208 limit the square wave signals from the multivibrator to the same amplitude irrespective of power supply variations. The voltage being compared is a result of frequency only, rather than of possible amplitude variations.

Transistor Q302 and the drive motor are supplied power from an unregulated source which will vary with the ship's power line variations. The drive motor circuitry is designed so that motor speed changes are slight regardless of large line voltage excursions. Diode CR301, connected across the motor, prevents the voltage on Q302 from rising too high when the transistor cuts off and opens the winding. The motor speed is governed in the same manner for both the X1 and X2 scales by merely changing the Rep Rate of the multivibrator with the Range X1, X2 control S302 and associated components. R305, the Speed of Sound control, permits the operator to vary the motor speed to compensate for variations of the speed of sound in water of various density and temperatures.

6.4 CHART DRIVE MOTOR CIRCUITRY

The chart drive mechanism is advanced by a stepping motor at the rate of 1, 2, 3 or 4 inches per minute; the speed is selected by the front panel control switch S304.

The electronics circuitry supplying power to the stepping motor consists of the following: A unijunction transistor Q212 with a repetition rate determined by C221 and a resistor selected by S304. Four different repetition rates are necessary to produce the 1,2, 3, and 4 inch per minute paper feed. The repetition rates are factory set by adjustment of R241, R242, R243 and R244.

The theory of operation of the drive motor circuitry is as follows: each time the unijunction Q212 fires, a positive pulse is developed across R247 which controls a flip-flop circuit consisting of transistors Q213 and Q214. The pulse cuts off whichever transistor is on and in turn biases the other transistor on. The positive square wave outputs from the collectors of the flip-flop transistors are coupled via emitter followers Q215 and Q216 to the base of the stepping motor transistors Q217 and Q218. This causes Q217 and Q218 to alternately turn on and supply power to the stepping motor. From the above explanation it can be readily seen that with a faster unijunction rep. rate the stepping motor will turn faster.

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6.5 TIDE AND DRAFT ADJUSTMENT CIRCUITRY

The positive-going pulse from the keying pick-up coil (L301-L304, depending on which phase is in use) is coupled to Q108, amplified and fed to the base of Q109 which is the first transistor of a single-shot multivibrator. This pulse is negative and cuts off Q109. The length of time Q109 is off and Q110 is on is determined by the RC discharge time of C127, R135 and the setting of potnetiometer R303 (Tide and Draft adjustment). The output of the transistor Q110 is differentiated and coupled to the base of Q102, the 208 kHz transmitter oscillator, turning it on.

6.6 SPEED CHECK MARKER

The Speed Check Marker circuitry, which operates only on the X1 mode, causes two fixed marks, 20.833 milliseconds apart, to appear constantly on the chart paper. The first of these two marks is adjusted by the CAL ZERO control, R307, to appear on the zero line of the chart paper at all times; the second mark automatically appears on the CALIBRATE line near the bottom of the chart. The second mark (calibrated) will be interrupted periodically to indicate the phase on which the recording was made. For example, two interruptions with one solid mark indicates operation on phase 1 (0-55 feet); three interruptions with 2 solid marks indicates operation on phase 2; etc. The primary purpose of the Speed Check Marker is to indicate the speed of the stylus drive motor. Should the motor speed vary the operator will be alerted; for example, should the motor run too fast the second mark will be below the calibrate line, and conversely if the motor is running too slow the second mark will be above the calibrate line. The "Speed of Sound" control allows the operator to vary the motor speed in accordance with local operating conditions.

The electronics circuitry for the Speed Check Marker operates as follows: Pickup coil L301 is connected through a coupling capacitor C201 to the base of Q201 which amplifies the positive going pulse impressed across the pickup coil. The amplifier pulse (now negative) is coupled to the base of Q202, the first transistor of a single-shot multivibrator, turning it off. The length of time this stage remains off is determined by the RC discharge time of C205, R207 and R307. The output of Q203, the second transistor of the multivibrator, is differentiated and its positive going pulse is fed to the base of Q204 which in turn conducts and turns on the unijunction Q205. This disrupts the normal repetition rate of the unijunction circuitry, the normal rate being determined by C208, R211 and the Rep. Rate adjust potentiometer R210. It is this trigger pulse that appears on the zero line of the chart paper. The purpose of this multivibrator is to permit the operator to either advance or delay this trigger pulse with the front panel control until it coincides with the zero line on the chart paper. After Q204 restarts the unijunction, it reverts back to its normal Rep. Rate. The initial pulse of this Rep. Rate, which is factory set by R210, shows on the "calibrate" mark on the chart paper. Both the "zero" and "calibrate" marks are coupled to the Colpitts Oscillator in the receiver via Q206 the pulse amplifier.

The interruptions in the "calibrate" mark (to indicate Phases 1, 2, 3 and 4) are obtained by mechanically grounding the base of Q206 through C225 and S303 to obtain the proper number of dashes which corresponds with the particular phase in use.

SECTION 7

MAINTENANCE

7.1 GENERAL

A routine maintenance schedule should be initiated to assure that your DE-719B equipment is kept in peak condition and ready for instant use. A program of regular maintenance can go far toward preventing major breakdowns and unnecssary downtime.

The recorder interior should be protected from excessive moisture. The recorder is designed to withstand dampness, but severe drenchings could render it inoperative and lead to costly repairs. Condensation of water vapor (due to lowering temperature when humidity is high) could cause malfunction; therefore, the equipment should be stored in a dry, well-ventilated location.

The unit should be checked periodically to be sure that all hardware is tight and the cabinet (inside and outside) should be kept clean. Carbon dust will collect inside the recorder case as a result of the recording process. The recorder interior should be cleaned with a soft brush and rag; the frequency of the cleaning operation will be largely determined by the amount of usage.

7.2 LUBRICATION

The DE-719B is constructed with oilite and ball-type bearings which are designed to provide many hours of trouble-free operation. The bearings are pre-lubricated at the factory and will not require further lubrication for the life of the bearing. The drive gears are nylon, therefore do not require lubrication. All hinges and hasps should be periodically lubricated with a light oil to prevent seizure, especially when the equipment is used around salt water.

7.3 INTERNAL CONTROLS (FACTORY SET)

The following controls are preset at the factory and should not be readjusted without the proper test equipment.

Control	Function
R112, Internal gain	Sets receiver gain to 40-microvolt maximum
R210, Marker circuit	Sets rep. rate of unijunction Q205
R227, Scale X2 speed adj.	Trim potentiometer, sets stylus motor speed on scale X1

Control	Function
R241, Paper feed adj.	Sets rep. rate of unijunction Q212 to feed chart paper at 1" per minute
R242, Paper feed adj.	Sets rep. rate of unijunction Q212 to feed chart paper at 2" per minute
R243, Paper feed adj.	Sets rep. rate of unijunction Q212 to feed chart paper at 3" per minute
R244, Paper feed adj.	Sets rep. rate of unijunction Q212 to feed chart paper at 4" per minute

7.4 ALIGNMENT PROCEDURE

7.4.1 Equipment Required

1. Calibrated oscilloscope
2. Signal generator capable of covering from 190 to 220 kHz with 10 ohms output impedance.
3. Accurate Strobotac
4. 200T5HAD transducer (to be the same transducer which will be used with the DE-719B).

7.4.2 Stylus Drive Motor Speed Adjustment

The recording mechanism is designed for operation with a drive motor speed of 3350 RPM to coincide with the calibration for the speed of sound in water of 4800 feet per second when operating in the X1 (normal) mode. In the X2 mode the motor speed is reduced to 1675 RPM. The exact motor speed can be determined by an accurate Strobotac or an electronic frequency counter connected to measure the frequency generated by the "tone wheel" mounted on the motor shaft. (The number of teeth has been selected to provide a direct RPM count.)

To adjust:

1. Set the RANGE X1, X2 switch (S302) to the X1 mode.
2. Set the SPEED OF SOUND control (R305) to midposition.

3. Using an accurate Strobotac set the stylus drive motor speed to 3350 RPM (±15) by carefully adjusting R229.

4. Set the RANGE X1, X2 switch to the X2 mode and adjust R227 until the motor speed is 1675 RPM ±15. Return RANGE switch to the X1 position.

NOTE

An accurate strobe reading can be obtained by triggering a frequency counter from the Strobotac.

7.4.3 Calibration Marker Adjustment

1. Be sure that the stylus drive motor speed has been adjusted to 3350 RPM.

2. Adjust the CAL ZERO control (R307) until the calibrate zero line falls directly on the chart paper zero line.

NOTE

The direct transmission pulse can be moved off the zero line by the TIDE and DRAFT control while making the calibrate zero adjustment.

3. Adjust R210 until the second calibrate pulse falls exactly on the 50-foot line on the chart paper.

NOTE

Adjustment of the SPEED OF SOUND control, R305, will vary the position of the 50-foot calibrate line by plus and minus three feet.

4. The calibrate lines (at zero and 50 feet) will not be present when operating on the X2 range.

7.4.4 Tide and Draft Adjustment

1. While operating on the X1 range, adjust the TIDE and DRAFT control until the mark inscribed by the direct transmission falls on zero.

2. Switch to the RANGE X2 mode and adjust R304 until the direct transmission mark is on the zero line on the chart paper. (Do not alter position of TIDE and DRAFT control while making the above adjustment.

7.4.5 Chart Paper Advance Adjustments

The chart paper drive mechanism is driven by a stepping motor whose armature advances 15° each time a pulse is alternately applied to the two field coils. A gear reduction of 45:1 is built into the motor and an external gear reduction of 3.11:1 is incorporated between the drive motor and the chart paper drive roller. The square wave pulses which drive the stepping motor are generated by controlling a flip-flop circuit (Q218 and Q214) from a unijunction (Q212) time base circuit. The time constant of the unijunction is controlled by the four position CHART SPEED switch (S304). A separate trim-pot for each of the four speeds is provided for close adjustment. The output of the flip-flop is followed by two stages of push-pull amplification to drive the stepping motor.

To adjust the trim-pots proceed as follows:

1. Connect a calibrated scope to pins X and N of the motor control printed circuit board and observe square wave pulses of approximately 12 volts amplitude with transient leading edge reaching above 20 volts. Set the CHART SPEED switch (S304) to the one inch per minute position. Adjust R241 for a pulse length of 53.6 milliseconds ±3%.

2. Set the CHART SPEED switch to the 2 inches per minute position. Adjust R242 for a pulse length of 26.8 milliseconds ±3%.

3. Set the CHART SPEED switch to the 3 inches per minute position. Adjust R243 for a pulse length of 17.87 milliseconds ±3%.

4. Set the CHART SPEED switch to the 4 inches per minute position. Adjust R244 for a pulse length of 13.4 milliseconds ±3%.

NOTE

The vertical timing lines on the chart paper are one inch apart.

7.4.6 Transceiver PC Board Adjustments

The transceiver is tuned, at the factory, to match the particular 200T5HAD transducer furnished with the equipment. If the transducer or a transceiver component is replaced, a slight retuning of the transmitter and/or receiver section may be required. Proceed as follows:

1. Place the transducer in the water and plug it into the equipment. Connect the oscilloscope across the transducer terminals and turn the equipment on . Observe the direct transmission (transmitted pulse) and the first echo return.

2. The DC voltage across the transducer should be 40 volts ±10%.

3. Adjust the tuning slug in T101 for maximum first echo return. The transmission pulse should be at least 80 volts peak-to-peak and 100 to 200 microseconds in length.

4. To tune the receiver; suspend the transducer in air two feet from a hard flat surface. Connect the oscilloscope between the secondary of T104 and ground. Set the gain control to maximum and tune T103 and T104 for the maximum number of multiple echoes. If feed-through from the 40-volt inverter is present, tune L102 until minimum feed-through is seen.

5. Connect the signal generator in series with the cold transducer lead (generator hot lead to transducer and generator ground to DE-719B ground). Set the signal generator output level to 100 microvolts, 50% modulated, tune generator for maximum receiver response. Maximum should fall at 208 kHz ±7%.

6. Reduce the signal generator output to 40 microvolts, adjust the internal gain trim-pot, R112, until the receiver output level results in a medium gray recording on the chart with the CHART SPEED set at 1 inch per minute and the RANGE switch set on the X1 mode.

7.4.7 Notes

1. Actuating the FIX MARK switch should cause a straight, dark fix-mark line on the chart paper. The line should be straight within 1/32 inch. Note that when a new stylus is installed, it may take several minutes of "run-in" before a straight fix-mark line is obtained.

2. The life expectancy of a new stylus is approximately 40 hours when operated in the X1 mode. Double this life should be expected when operating in the X2 mode.

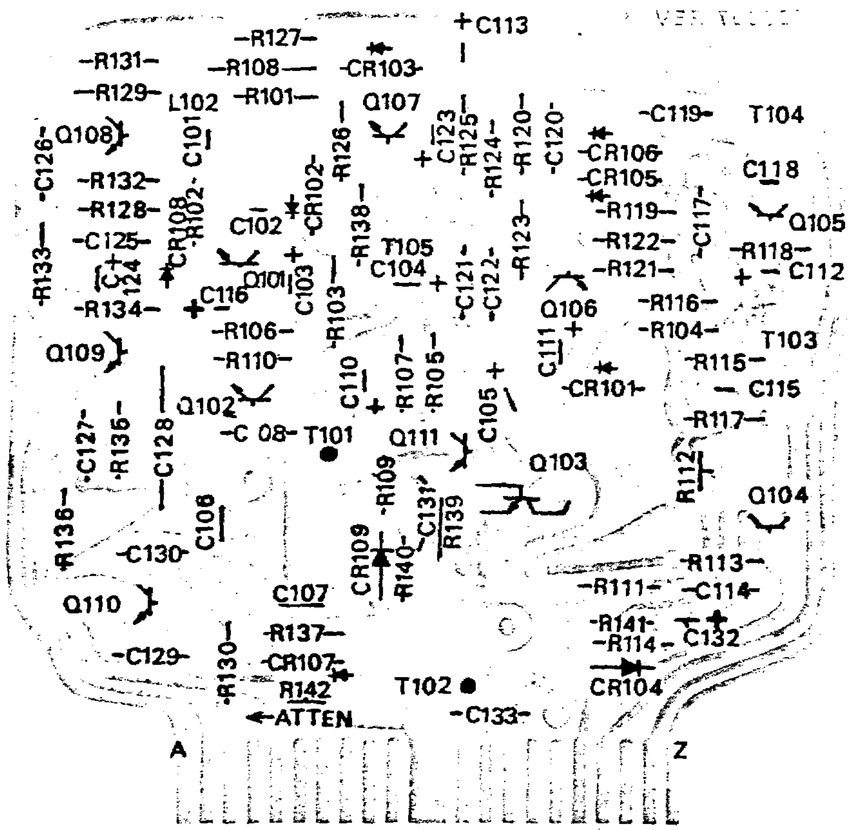

Figure 7-1. Transceiver PC Board

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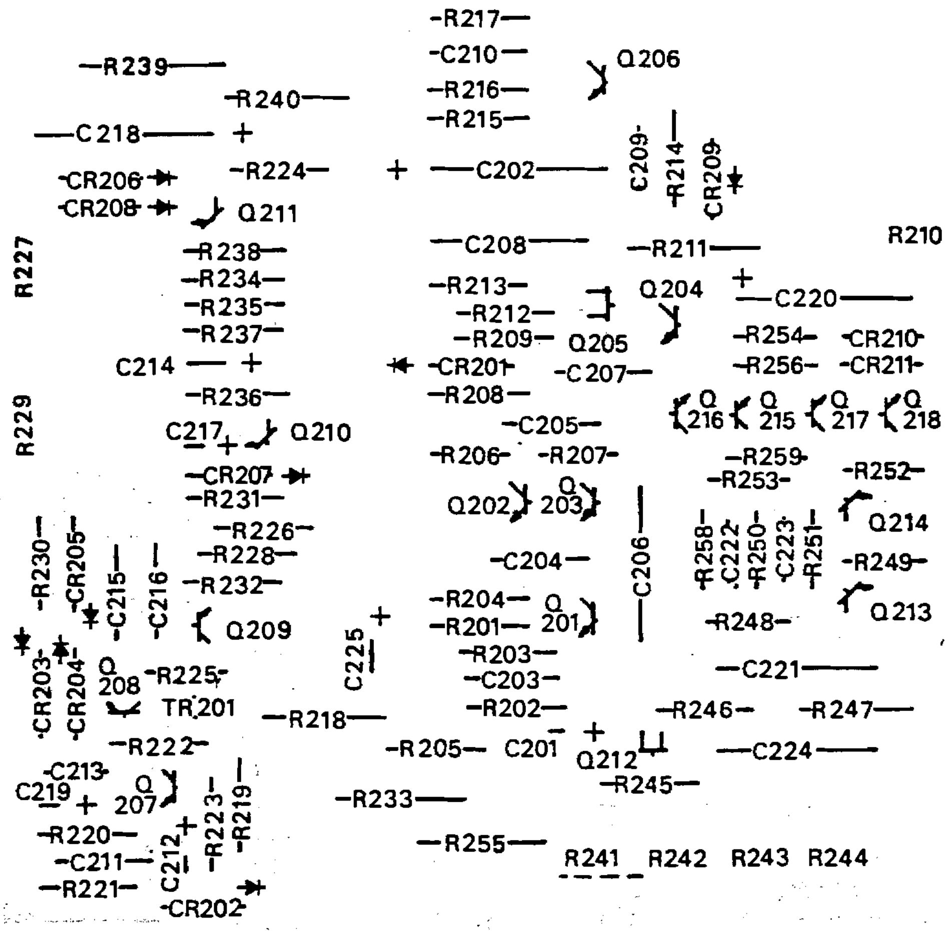


Figure 7-2. Motor Control PC Board

CC136

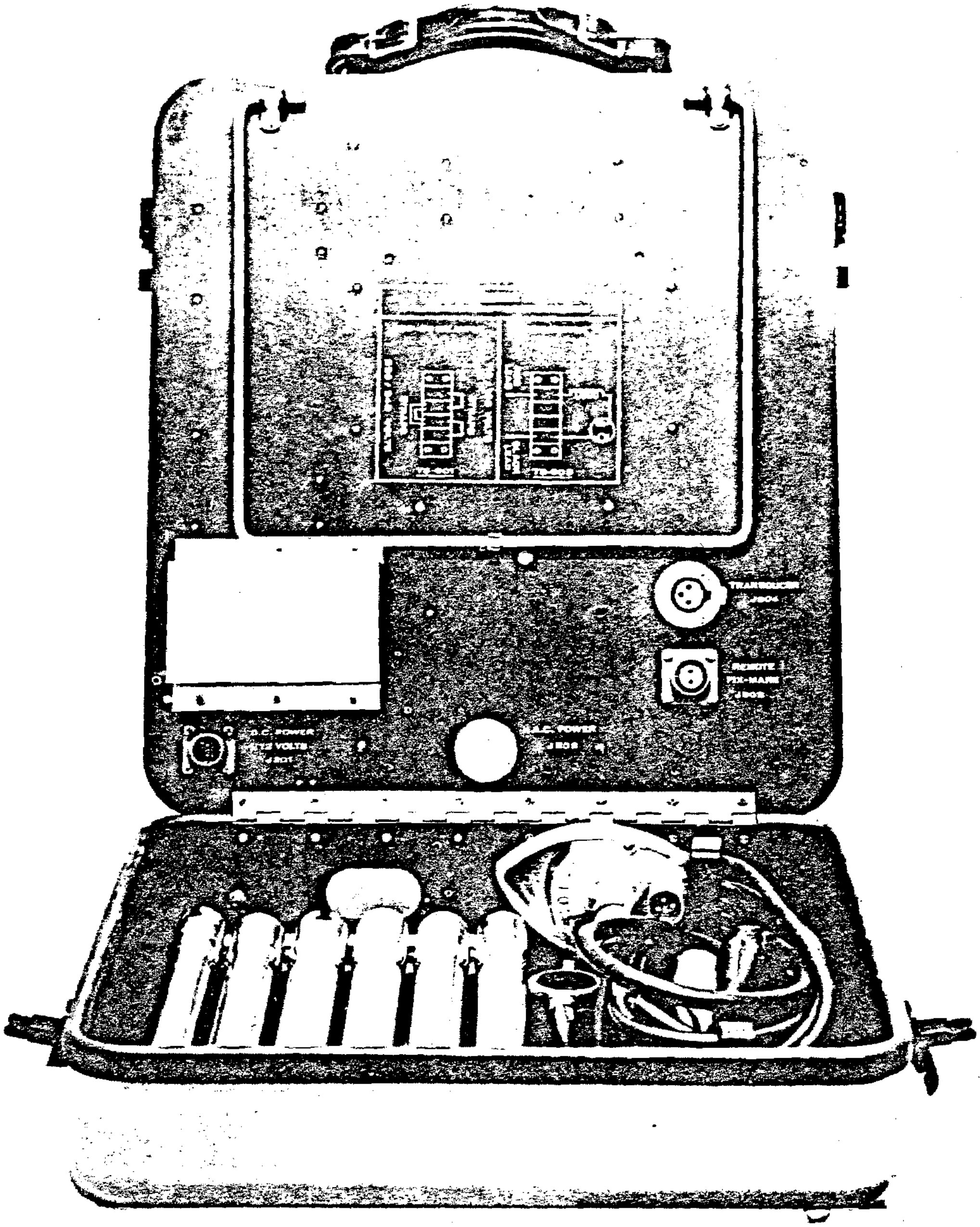


Figure 7-3. Chassis Plate - Rear View


FIGURE 6


FIGURE 7


FIGURE 8


FIGURE 9

your unit. If it reads correctly, the unit will perform distance measurements at all distances within its capability, accurately. If, for instance, the distance is 120 and the unit reads 135, an adjustment will be necessary. DO NOT ADJUST THE UNIT UNNECESSARILY.

If you must adjust the unit, follow these steps:

1. Note that the tape-knob has two sections in it.
2. Grasp the smaller section and hold it firmly. (Fig. 7)
3. Grasp the larger section and separate it slightly from the smaller section and turn it until the proper footage reading appears opposite the red-line on the tape indicator. (Fig. 8)
   Final adjustment may be necessary.
   If the red line indicator does not line up perfectly with the correct distance, push down on the read-out window and slide it sideways until the red line is over the correct distance. (Fig. 9)
4. Make the measurement again to check the accuracy of the reading and make any final adjustments necessary using the same steps (1 through 3).

IMPORTANT: To obtain optimum accuracy with your unit, please follow these suggestions:

1. In making readings, always come from the lower end of the read-out scale up to the distance you are measuring. In other words, if you are measuring a distance known to be approximately 150, make sure that you are moving the tape from a lower reading such as 150, up to the 170 reading. Never take readings by moving the tape from a higher reading to a lower one.
2. Select a conspicuous target which has good contrast.
3. Do not take readings through glass windows or doors.
4. You must spend some time training your eye to recognize when the images are in perfect coincidence. With practice your readings will become very accurate.

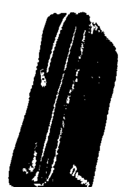
Product Warranty (Limited)

Ranging products are warranted to the original purchaser for two years from the date of purchase. Any product defective in material or workmanship will be repaired or replaced, without charge, when returned with the shipping charges paid to RANGING INC., Service Department, 90 Lincoln Road North, East Rochester, New York 14445.

Exceptions and Exclusions:

To the extent that any or all of the following exclusions are prohibited by the law of any state or municipality and cannot be pre-empted, they shall not be applicable.

1. *There are no warranties covering consequential damages, incidental damages, and incidental expenses, including injury to property.*
2. *There are no other warranties except as set out above and the implied warranties are limited in duration to that of the express warranties.*
3. *This warranty gives you specific legal rights and you may have other rights that vary from state to state.*

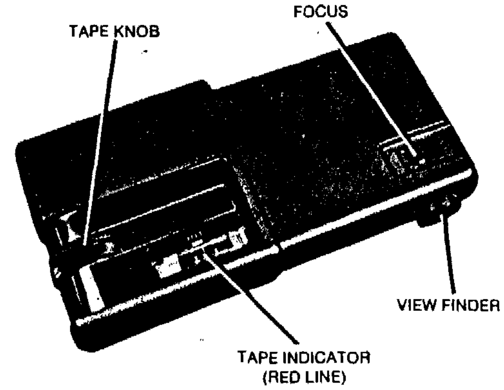


A padded vinyl carrying case is available for $11.95. The model number is 33-600. If your dealer is out of stock, send your check or money order to RANGING INC., 90 North Lincoln Road, East Rochester, New York 14445, and the case will be delivered to you promptly.

RANGING INC.
Measuring Systems
90 Lincoln Road North
East Rochester, New York 14445

OPERATING INSTRUCTIONS
Ranging 600, 610 & 620

This unit may need adjustment before you can expect it to give accurate readings. If you find your first readings to be inaccurate, refer to page 4 for "adjustment instructions."



How it works

Step 1. Pick an object the distance to which you want to measure. Examples: tree, bush, rock, window frame, fence post, building corner, roof corner or peak or sign. You may use any distinct object as the target.

Step 2. Look at the object through the viewfinder. The object will appear as a double image. Focus eyepiece until what you see is sharp. (Note: Focusing the eyepiece will not bring the double image together.)

Step 3. Hold unit steady and turn tape-knob until a single sharp image of the object is observed. (Note: If you do not observe a double image of the object check to be sure that your fingers are not obstructing either front window.)

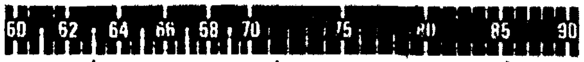
Step 4. Read distance at the red line on the tape indicator. You have now measured the distance from the front of unit to the object.

RANGING
Measuring Systems

You have now learned the technique of measuring with a rangefinder. A little practice and you'll make accurate measurements, quickly, easily, safely, with a minimum of effort. Apart from the obvious advantage of requiring only one operator, measurements are made on line of sight and are not affected by tape sag, obstructions, or undulations in terrain.

Reading the tape

The tape read-out employs a computer plotted system. Read-out characters change as distance increases. Here are examples of the tape read-out:



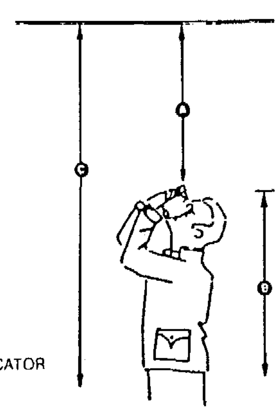
600 (FEET) 63' 71.5' 85.5'

610 (YARDS) 32y. 39.5y. 46.5y.

620 (METERS) 31m. 36m. 48.5m.

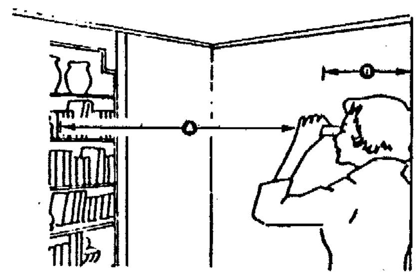
Methods of measuring

Heights—Stand beneath the object the height of which you want to measure. Make measurements by sighting up at the object and turning tape-knob. Read the distance on the tape indicator. Now add your height to the distance indicated.



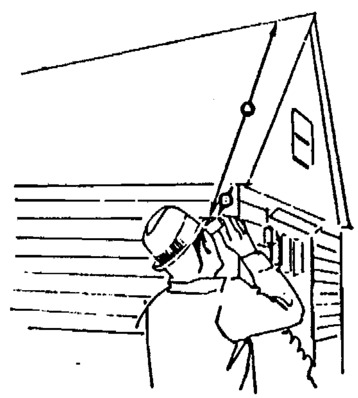
A DISTANCE ON TAPE INDICATOR
B YOUR HEIGHT
C A PLUS B EQUALS C
HEIGHT OF OVERHEAD WIRE

Room Sizes—If possible, stand at door jamb to make these measurements. When this is not possible, stand against the wall opposite a prominent target on the other wall. Place the back of your head against the wall and measure across the room. Add one foot or 30.5 cm. to the reading you get, as the unit will be located this distance from the wall as you are making the measurement. Move to another wall and take the other dimension in the same manner.



A DISTANCE ON TAPE
B DISTANCE FROM WALL TO
TAPE MEASURE (ONE FOOT OR 30.5 CM.)
A PLUS B EQUALS WALL TO
WALL DIMENSION

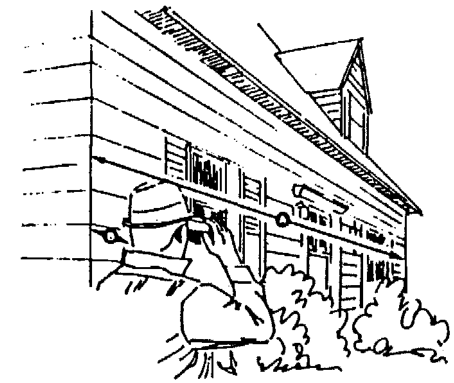
Roof Sizes—Stand at a corner of the roof and move away from the building so that the roof corner and peak are roughly in the same plane of vision. Measure distance to the peak. Measure distance to the corner. Subtract to obtain the proper dimension. Example: Measurement to peak of roof minus measurement to corner = width.



A DISTANCE TO PEAK
B DISTANCE TO CORNER
A MINUS B EQUALS WIDTH OF ROOF

Distance to peak (158 minus 67 = 91)
Measure side of building or house to get length of roof.

Building Dimension—Stand close to one corner of the building. Look at the other corner in the viewfinder. Turn knob until single image of corner is seen.
Distance indicated is the dimension for that side of structure. Note: error slightly increases as you move away from the corner of the building. For best measurements, stay as close to the building as possible.



A LENGTH OF BUILDING
B STAY CLOSE TO CORNER

Adjustments

What to do if the two images seen in the viewfinder are not on the same plane

1. To adjust, place a small screwdriver in the access hole on the bottom of the unit marked—ADJ.

2. Hold the unit to your eye. Keep it perfectly level and look through the viewfinder at an object. Turn the screw until you bring both images of the object into line. (Fig. 6)

What to do if the distance readings are wrong

Distance measurements are made from the front of the unit to the object. Although your unit has been calibrated at the factory, you will probably want to check to be sure that it is measuring accurately. To accomplish this, pick an object at a known distance. Something from 100 to 150 away is ideal. Carefully measure the distance with

See page 7.

HP-32E
Advanced Scientific Calculator

Fold Out

Statistical

[Q] Computes area under the standard normal distribution curve to the left of x.

[Q⁻¹] Computes x, given the area under the standard normal distribution curve to the left of x.

[ŷ] Linear estimate. Computes estimated value of y for a given value of x.

[x̂] Linear estimate. Computes estimated value of x for a given value of y.

[L.R.] Linear regression. Computes y-intercept and slope for linear function approximated by x and y values accumulated using [Σ+]. The value of the y-intercept is placed in the X-register; the value of the slope is placed in the Y-register.

[r] Correlation coefficient. Computes "goodness of fit" between the x and y values accumulated using [Σ+] and the linear function which they approximate.

[x̄] Computes means (averages) of x and y values accumulated using [Σ+].

[s] Computes standard deviations of x and y values accumulated using [Σ+].

[Σ+] Accumulates statistical data in storage registers $R_{.0}$ through $R_{.5}$ using numbers in X- and Y-registers.

[Σ-] Subtracts from statistical data in storage registers $R_{.0}$ through $R_{.5}$ using numbers in X- and Y-registers.

CLEAR [Σ] Clears statistical storage registers ($R_{.0}$ through $R_{.5}$).

Mathematical

[√x] Computes square root of number in displayed X-register.

[x²] Computes square of number in displayed X-register.

[1/x] Computes reciprocal of number in displayed X-register.

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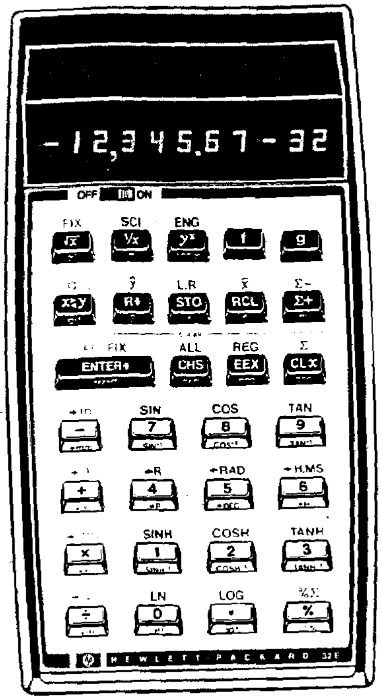
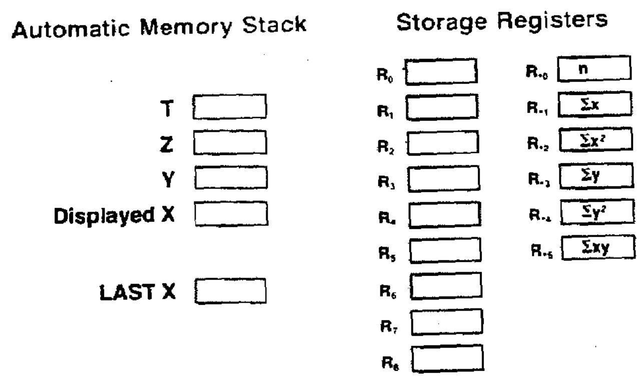
The HP-32E
Advanced Scientific Calculator





Function Index

OFF [ ] ON
Power switch.

[f] Pressed before function key, selects gold function printed above key.

[g] Pressed before function key, selects blue function printed on lower face of key.

CLEAR [PREFIX] Cancels the following keystrokes or sequences of keystrokes when pressed after them: [f], [g], [STO], [RCL], [STO][•], [RCL][•], [STO][+], [STO][−], [STO][×], [STO][÷], [STO][+][•], [STO][−][•], [STO][×][•], [STO][÷][•], [FIX], [SCI], [ENG].

Digit Entry

[0] through [9] Digit keys.

[•] Decimal point.

[ENTER↑] Enters a copy of number displayed in X-register into Y-register. Used to separate numbers.

[CHS] Changes sign of mantissa or exponent in displayed X-register.

[EEX] Enter exponent. Digits keyed in immediately following this key comprise the exponent.

Display Control

[FIX] Fixed point display. Followed by a digit key, specifies fixed point notation display.

[SCI] Scientific display. Followed by a digit key, specifies scientific notation display.

[ENG] Engineering display. Followed by a digit key, specifies engineering notation display.

[MANT] Mantissa. Temporarily displays all 10 digits of the mantissa of the number in the X-register.

Number Manipulation

[x⇄y] Exchanges contents of X- and Y-registers.

[R↓] Rolls down contents of stack for viewing in displayed X-register.

[CLx] Clears contents of displayed X-register.

CLEAR [ALL] Clears contents of stack registers (X, Y, Z, and T), LAST X register, and all storage registers (R_0 through R_8, and $R_{.0}$ through $R_{.5}$).

Storage

[STO] Store. Followed by a digit key 0 through 8 or by a decimal point and a digit key 0 through 5, stores displayed number in specified storage register. Also used to perform storage register arithmetic.

[RCL] Recall. Followed by a digit key 0 through 8 or by a decimal point and a digit key 0 through 5, recalls value from specified storage register into the displayed X-register.

CLEAR [REG] Clears contents of storage registers R_0 through R_8.

[LST x] Recalls number displayed before previous operation back into displayed X-register.

Statistical

[Q] Computes area under the standard normal distribution curve to the left of x.

[Q⁻¹] Computes x, given the area under the standard normal distribution curve to the left of x.

[ŷ] Linear estimate. Computes estimated value of y for a given value of x.

[x̂] Linear estimate. Computes estimated value of x for a given value of y.

[L.R.] Linear regression. Computes y-intercept and slope for linear function approximated by x and y values accumulated using [Σ+]. The value of the y-intercept is placed in the X-register; the value of the slope is placed in the Y-register.

[r] Correlation coefficient. Computes "goodness of fit" between the x and y values accumulated using [Σ+] and the linear function which they approximate.

[x̄] Computes means (averages) of x and y values accumulated using [Σ+].

[s] Computes standard deviations of x and y values accumulated using [Σ+].

[Σ+] Accumulates statistical data in storage registers $R_{.0}$ through $R_{.5}$ using numbers in X- and Y-registers.

[Σ−] Subtracts from statistical data in storage registers $R_{.0}$ through $R_{.5}$ using numbers in X- and Y-registers.

CLEAR [Σ] Clears statistical storage registers ($R_{.0}$ through $R_{.5}$).

Mathematical

[√x] Computes square root of number in displayed X-register.

[x²] Computes square of number in displayed X-register.

[1/x] Computes reciprocal of number in displayed X-register.

[π] Places value of pi (3.141592654) into X-register.

[n!] Factorial. Computes $n \cdot (n-1) \ldots 3 \cdot 2 \cdot 1$, where n is number in X-register.

[+], [−], [×], [÷] Arithmetic operations.

Trigonometric

[SIN] [COS] [TAN] Computes sine, cosine, or tangent of number in displayed X-register.

[SIN⁻¹] [COS⁻¹] [TAN⁻¹] Computes arc sine, arc cosine, or arc tangent of number in displayed X-register.

[RAD] Sets radians mode for argument of trigonometric functions.

[GRD] Sets grads mode for argument of trigonometric functions.

[DEG] Sets decimal degrees mode for argument of trigonometric functions.

[→RAD] Converts decimal degrees to radians.

ZhI000

→DEG Converts radians to decimal degrees.

→H.MS Converts decimal hours or degrees to hours, minutes, seconds or degrees, minutes, seconds.

→H Converts hours minutes, seconds or degrees, minutes, seconds to decimal hours or degrees.

Hyperbolic

SINH COSH TANH Computes hyperbolic sine, hyperbolic cosine, or hyperbolic tangent of number in displayed X-register.

SINH⁻¹ COSH⁻¹ TANH⁻¹ Computes inverse hyperbolic sine, inverse hyperbolic cosine, or inverse hyperbolic tangent of number in displayed X-register.

Logarithmic and Exponential

y^x Raises number in Y-register to power of number in displayed X-register.

LN Computes natural logarithm (base e, 2.718281828) of number in displayed X-register.

e^x Natural antilogarithm. Raises e (2.718281828) to power of number in displayed X-register.

LOG Computes common logarithm (base 10) of number in displayed X-register.

10^x Common antilogarithm. Raises 10 to power of number in displayed X-register.

Polar/Rectangular Conversion

→P Converts rectangular (x,y) coordinates in X- and Y-registers to polar (r,θ) coordinates.

→R Converts polar (r,θ) coordinates in X- and Y-registers to rectangular (x,y) coordinates.

Metric Conversion

→in Converts millimeters to inches.

→mm Converts inches to millimeters.

→°F Converts degrees Celsius to degrees Fahrenheit.

→°C Converts degrees Fahrenheit to degrees Celsius.

→lbm Converts kilograms to pounds (mass).

→kg Converts pounds (mass) to kilograms.

→gal Converts liters to gallons (U.S.).

→ltr Converts gallons (U.S.) to liters.

Percentage

% Computes x percent of y.

Δ% Computes percent difference between number in Y-register and number in X-register.

%Σ Computes percent that x is of the number (Σx) in storage register $R_{.1}$.

Solving Problems With Your Hewlett-Packard Calculator

ENTER↑

It's the "key" to solving problems with ease and confidence. It's part of the RPN logic system in your new Hewlett-Packard calculator. A logic system so amazing in its simplicity and power that, once you've tried it, you'll never be content with any other system.

This book describes the Hewlett-Packard RPN logic system. If you're new to HP calculators, taking the time to read it thoroughly will be the second best investment you've made (the first was purchasing your new HP calculator). Even if you already own another HP calculator, you may find some new features you're not familiar with.

If you're like most people who buy a new calculator, you can't wait to get started using it. We don't blame you. In fact, that's just what we want you to do. That's why we wrote this book. It's not very long and, when you've worked your way through it with your new calculator, you'll be well on your way to being an RPN expert like other HP owners. And, you'll wonder why anybody makes a scientific calculator without an ENTER↑ key. We wonder too.

So, turn the page and get started.

Getting Started

Power On

To begin working with your HP calculator, set the power switch to ON. If your calculator has a PRGM RUN switch, set it to RUN.

Operating Power

Your Hewlett-Packard calculator is shipped fully assembled, including a battery pack. You can run the calculator on battery power alone, or you can connect the battery recharger and use the calculator while the battery is charging. If you want to use the calculator on battery power only, charge the battery first (refer to Battery Charging in your owner's handbook). Whether you operate from batteries or from the recharger, *the battery pack must be in the calculator.*

Self Check Routine

Your new Hewlett-Packard calculator is loaded with features that help you operate it with ease and confidence. The self check routine, a feature found on many sophisticated electronic instruments and computers, was designed for just this reason. We don't expect you to ever have a problem with your calculator, but if you think that it isn't operating properly, try this:

Keystrokes	Display
[STO] [ENTER↑]	-8,8,8,8,8,8,8,8,8,8,

The display shown above will appear if the self check determines that your calculator is operating properly. Press any key to clear the display. If the display shows *Error 9*, the self check routine has determined that your calculator is not operating properly. You should then send it in for service (refer to Shipping Instructions in your owner's handbook). Pressing any key will replace the *Error 9* in the display with a number that tells a Hewlett-Packard service engineer which circuit in the calculator is at fault. That's right. The calculator not only tells you it's having

problems, it tells us where the problem is, so we can fix it as quickly and inexpensively as possible and return it to you without delay.

> **Note:** Using the self check may cause memory and the registers to be cleared, depending on which calculator model you have.

Keying In Numbers

Key in a number by pressing the digits in sequence, as though you were writing on paper. A decimal point must be keyed in if it is part of the number.

Example: Key in 10912.45 (the depth in meters reached by the Bathyscaphe *Trieste* in the Marianas Trench on January 23, 1960.)

Keystrokes	Display
10912.45	10,912.45

The resulting number 10,912.45 is seen in the display. Notice that commas are automatically inserted for you. Answers can be read quickly and easily, with less chance for error.

Negative Numbers

To key in a negative number, key in the digits, then press [CHS] *(change sign)*. The number, preceded by a minus (−) sign, will appear in the display.

Example: Change the sign of the number now in the display:

Keystrokes	Display
[CHS]	-10,912.45

You can change the signs of negative or positive numbers in the display. Change the sign of -10,912.45 now in the display.

Keystrokes	Display
[CHS]	10,912.45

Clearing

Any number that is in the display can be cleared by pressing [CLX] *(clear X)*. This key erases the displayed number and replaces it with zero.

Keystrokes	Display
[CLX]	*0.0000*

If a mistake is made while keying in a number, press [CLX] to clear the entire number. Then key in the correct number.

> **Note:** The number shown in the display is always designated by x on the function key.

Functions

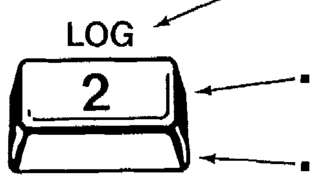
Keyboard

Most keys on the keyboard perform two or more functions. One function is indicated by the symbol on the flat face of the key, another by the symbol on the slanted key face, and a third by the symbol written above the key on the calculator case.

To select the function printed on the flat face of the key, press the key.

To select the function printed above the key, first press the prefix key [f], then press the function key.

To select the function printed on the slanted face of the key, first press the prefix key [g], then press the function key.



- To select the function printed in gold above the key, first press the gold prefix key [f], then press the function key.
- To select the function printed on the flat face of the key, press the key.
- To select the function printed in blue on the slanted face of the key, first press the blue prefix key [g] then press the function key.

Some keystroke sequences in this handbook require the use of prefix keys to make them applicable to your calculator. Check your calculator keyboard for proper execution sequences.

One-Number Functions

One-number functions are functions that require only one number present in order for an operation to be performed, such as [1/x], [LOG], or [SIN].

To execute one-number functions:

1. Key in the number.
2. Press the function key (or press the applicable prefix key, then the function key).

To use the one-number function [1/x] (reciprocal) key, key in the X-number then press [1/x].

Example: Calculate $^1/_8$.

Keystrokes	Display	
8	*8.*	Key in X-number.
[1/x]	*0.1250*	Press function key for answer.

> Remember: *First key in the number, then press the function key.*

Try these other one-number function problems:

Keystrokes	Display	
1/35	*0.0286*	Use the [1/x] key.
$\sqrt{3500}$	*59.1608*	Use the [√x] key.
log 16.40291	*1.2149*	Use the [LOG] key.

Two-Number Functions

Two-number functions are functions that must have two numbers present in order for an operation to be performed. The [+], [−], [×], and [÷] keys are examples of two-number function keys.

Two-number functions work the same way as one-number functions—operations are performed only when the function key is pressed. Therefore, *both numbers must be in the calculator before the function key is pressed*.

To place two numbers into the calculator and perform an operation:

1. Key in the first number.
2. Press [ENTER↑] to separate the first number from the second.
3. Key in the second number.
4. Press the function key to perform the operation.

All arithmetic functions are performed the same way:

To perform	Keystrokes	Display
13 + 2	13 [ENTER↑] 2 [+]	*15.000*
13 − 2	13 [ENTER↑] 2 [−]	*11.0000*
13 × 2	13 [ENTER↑] 2 [×]	*26.0000*
13 ÷ 2	13 [ENTER↑] 2 [÷]	*6.5000*

The [y^x] key is also a two-number operation. Used to raise a number to a power, it works in the same simple way as every other two-number function key:

1. Key in the first number (y).
2. Press [ENTER↑] to separate the first number from the second.
3. Key in the second number (power).
4. Perform the operation (if applicable, press the *prefix key*, then [y^x]).

When working with any function key (including [y^x]), remember, the number shown in the display is always designated by x on the function key on the calculator.

Example: Calculate 7^8.

Keystrokes	Display	
7	*7.*	
[ENTER↑]	*7.0000*	
8	*8.*	8 is designated by X.
[y^x]	*5,764,801.000*	The answer.

Try the following problems using the [y^x] key. Keep the simple rules for two-number functions in mind.

15^3	(15 to the third power)	=	*3,375.0000*
72^2	(72 squared)	=	*5,184.0000*
$601^{.5}$	(601 to the $^5/_{10}$ power)	=	*24.5153*
3^{18}	(3 to the 18th power)	=	*387,420,489.0*

Chain Calculations

The simplicity and power of the Hewlett-Packard RPN logic system becomes very apparent during chain calculations. Even during extremely long calculations, you still perform only one operation at a time. The automatic memory stack stores up to four intermediate results until you need them, then inserts them into the calculation. Thus, working through a problem is as natural as if you were working it out with pencil and paper—except the calculator takes care of the hard part.

Example: Solve (13 + 2) × 5.

If working the problem with pencil and paper, you would first calculate the intermediate result of (13 + 2)...

15
~~(13 +~~ 2) × 5 =

...then you would multiply this intermediate result by 5.

15
~~(13 +~~ 2) × 5 = 75

You work through the problem the same way with your calculator—one operation at a time. Solve for the intermediate result first...

(13 + 2)

Keystrokes	Display	
13	*13.*	
[ENTER↑]	*13.0000*	
2	*2.*	
[+]	*15.0000*	Intermediate result.

...and then solve for the final answer. The intermediate result is automatically stored inside the calculator when you key in the next number. To continue...

Keystrokes	Display	
5	5.	Intermediate result from preceding operation is automatically stored when you key in this number.
[×]	75.0000	Pressing the function key gives you the final answer.

Try these problems. Notice that you have to press [ENTER↑] to separate numbers only when they are being keyed in one immediately after the other. A calculated *result* and a new number are automatically separated.

Solve:	Keystrokes	Display
$\frac{(2+4)}{12}$	2	2.
	[ENTER↑]	2.0000
	4	4.
	[+]	6.0000
	12	12.
	[÷]	0.5000
$(18-6)\times 3$	18	18.
	[ENTER↑]	18.0000
	6	6.
	[−]	12.0000
	3	3.
	[×]	36.0000
$\frac{13+6+4-5}{8}$	13	13.
	[ENTER↑]	13.0000
	6	6.
	[+]	19.0000
	4	4.
	[+]	23.0000
	5	5.
	[−]	18.0000
	8	8.
	[÷]	2.2500

Even more complicated problems are solved in the same simple manner—using automatic storage of intermediate results.

Example: Solve $(3 + 4) \times (5 + 6)$.

Solving with pencil and paper, you would:

$$(3 + 4) \times (5 + 6)$$

First calculate for the result of these parentheses... ...then for these parentheses...

...and then you would multiply the two intermediate answers together.

The problem is solved the same way using your calculator.

First add 3 and 4:

Keystrokes	Display
3 [ENTER↑] 4 [+]	7.0000

Then add 5 and 6:

Since another *pair of numbers* must be keyed in, one immediately after the other, before you can perform a function, you must use the [ENTER↑] key again to separate the first number from the second. There is no need to press [ENTER↑] before you key in the 5. The intermediate result is stored automatically.

Keystrokes	Display
5 [ENTER↑] 6 [+]	11.0000

Then multiply the intermediate answers together for the final answer:

Procedure	Keystrokes	Display	
(7) × (11)	[×]	77.0000	The two intermediate results are multiplied together.

Notice that your calculator automatically stored the intermediate answers and brought them out when it was time to multiply. You didn't have to write down or key in the immediate answers from inside the parentheses before you multiplied.

Remember, the ENTER↑ key is used only for separating the first number from the second in any operation requiring the entry of two numbers. The calculator knows that after it completes a calculation, any new digits keyed in are part of a new number.

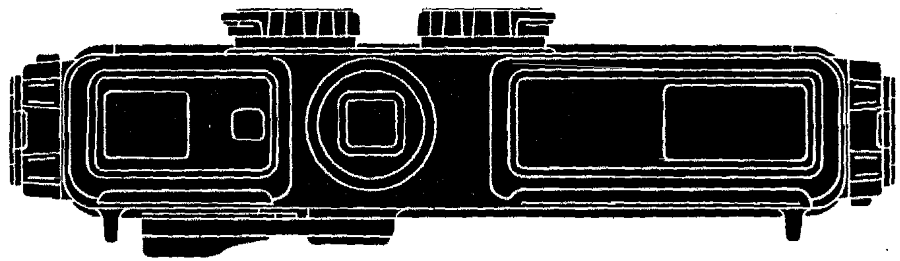
Now that you've done some calculating, you can begin to fully appreciate the benefits of the Hewlett-Packard logic system.

Here are just a few of the benefits of RPN:

- *You never have to work with more than one function at a time.* Your HP calculator cuts problems down to size instead of making them more complex.
- *Intermediate results appear as they are calculated.*
- *Pressing a function key executes that function immediately so each step can be checked as you go.*
- *Intermediate results are handled automatically.* There is no need to write down long intermediate answers when working on a problem.
- *You calculate in the same order as you do with pencil and paper.* Thinking the problem through ahead of time is unnecessary.

Now, continue on through the book to learn more about your calculator and the power of RPN.

MINOLTA WEATHERMATIC-A



OWNER'S MANUAL

E

000149

Your new Minolta Weathermatic-A is the ideal do-anything, go-anywhere photographic traveling companion. It is just as at home in a backpack on top of a mountain or skiing down one as it is at the beach or around the pool.

Its rugged watertight construction and 110 format conveniences, such as drop-in cartridge film loading, built-in electronic flash, and compact size makes taking quality photos simple and easy in even the most adverse conditions.

Please read this manual carefully all the way through and follow the simple instructions for the best results and longest service with your camera. Then keep it for later reference as needed.

IMPORTANT SAFEGUARDS

When using your camera, the specific cautionary notices in the owner's manual should always be observed and complied with, as well as basic precautions, including the following:

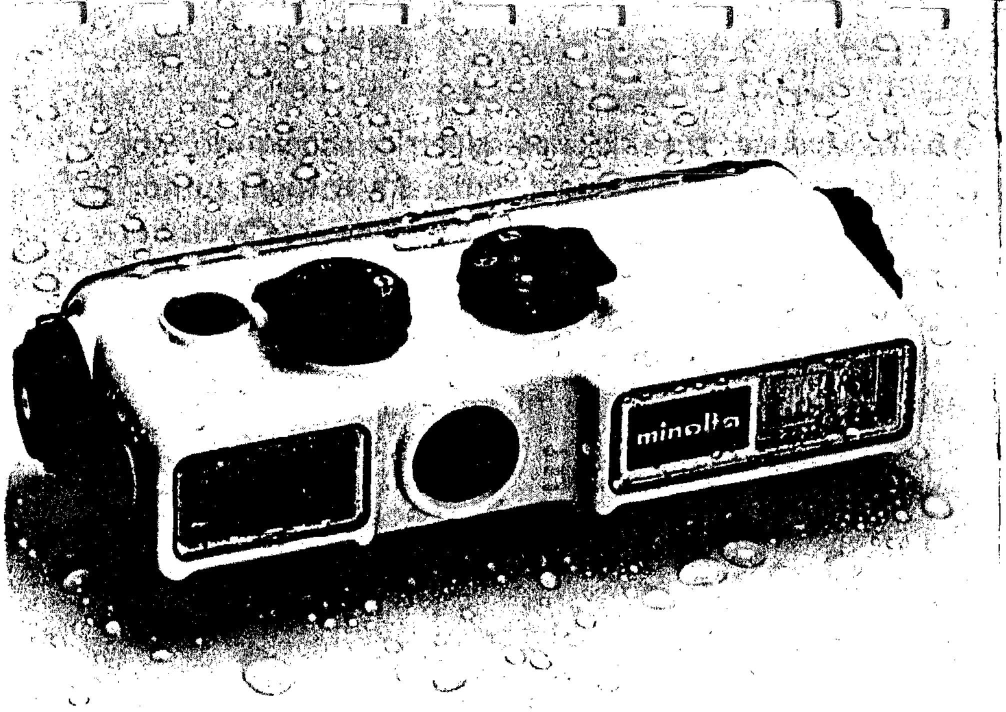
1. Read and understand all instructions.
2. Close supervision is necessary when the camera is used by or near children. Do not leave the camera unattended while in use.

CCO/5C

3. Do not operate the camera if it has been dropped or damaged – until it has been examined by an authorized Minolta service facility.
4. To protect against electrical shock hazards, do not immerse the camera in water or other liquids while the camera's back cover is open. Also do not open the back cover while in or under the water, or while the camera is wet.

5. To reduce the risk of electric shock, do not disassemble this camera, but take it to an authorized Minolta service facility when some service or repair work is required. Incorrect reassembly can cause electric shock when the camera is subsequently used.

SAVE THESE INSTRUCTIONS



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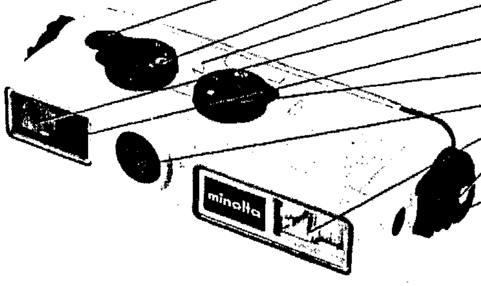
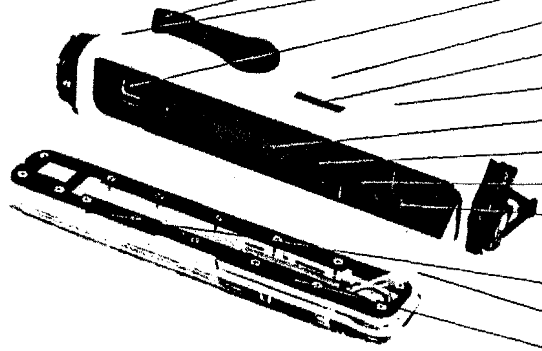
NAMES OF PARTS

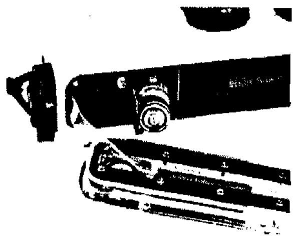


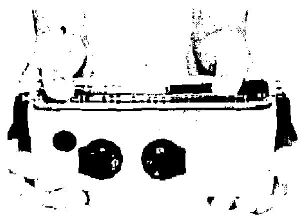


SUMMARY OF OPERATION

The steps pictured on this page outline use of your Weathermatic-A in normal "on-land" conditions. They give a general idea of how very easy it is to get properly exposed pictures with this camera and are keyed to corresponding sections of this manual for ready reference.

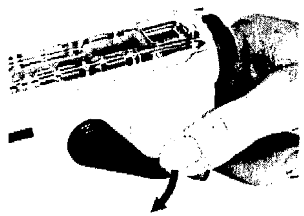
1. Make sure camera is *completely* clean and dry.
2. Lift back-cover release tabs, twist back-cover release knobs and open back cover (p. 10).
3. After installing and checking battery (p. 13), insert film cartridge (p. 15), and press back cover securely in to place and lock it (p. 12).

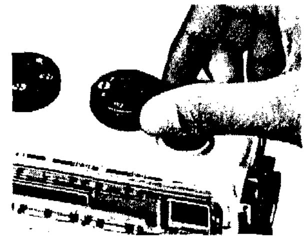


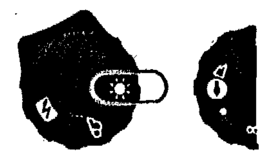


This brief guide may also be useful as a quick refresher for good results after you have not used your camera for some time. *It is not, however, a substitute for the detailed instructions in the rest of this manual,* which should be thoroughly studied for best results.

4. Operate film advance lever repeatedly until first exposure locks in place and the lever will not move (p. 16).
5. Check and/or clean lens cover glass and set focus for your subject (p. 19).
6. Look through eyepiece and compose subject in viewfinder (p. 18). Depress shutter release slightly; if red lamp in finder lights at ☀ sun symbol, turn control to ☁ cloud symbol. If it lights at cloud symbol, turn to ⚡ flash symbol and take picture within flash range when lamp begins to pulsate (p. 24). Always squeeze shutter release smoothly.







Opening and closing the back cover

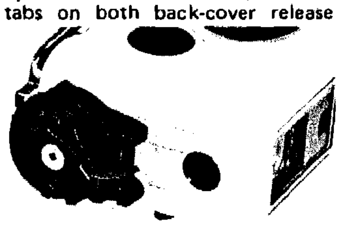
IMPORTANT INSTRUCTIONS FOR PROPER USE OF THIS CAMERA

The back cover of your Weathermatic-A is equipped with an O-ring that forms a watertight seal when the cover is properly fitted to the camera body. This enables the camera to be used under conditions (such as rain, snow, and in or underwater) where use of conventional cameras is either not recommended or impossible.

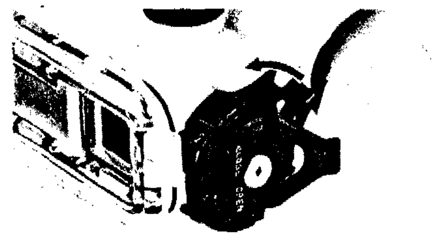
IT IS OF UTMOST IMPORTANCE TO ALWAYS BE SURE YOUR WEATHERMATIC-A IS COMPLETELY CLEAN AND DRY BEFORE OPENING THE BACK COVER. ALSO THAT THE BACK COVER'S O-RING IS CLEAN AND IN GOOD CONDITION BEFORE THE BACK COVER IS CLOSED. BY DOING THIS YOU WILL OBTAIN THE FULL SERVICE LIFE INTENDED FOR THIS SEAL.

Opening the back cover:

1. Hold the camera with the back cover facing you and lift the back-cover release tabs on both back-cover release knobs. Then turn the back-cover release knobs counterclockwise in the direction of the arrows until the back cover opens.



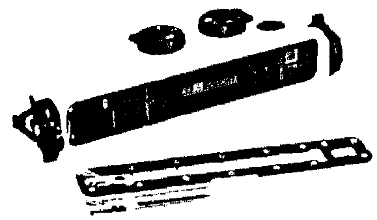
2. Lift the back cover away from the camera body. You can let the back cover hang from the back-cover connector strap or remove it completely for cleaning by disengaging the strap from the pin on the back cover.



NOTE

Be sure never to crease or twist the connector strap.

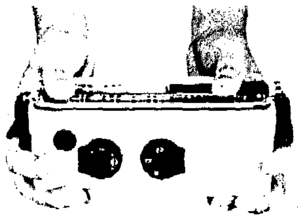
ONCE THE BACK COVER IS OPEN THE CAMERA IS NO LONGER WATERTIGHT AND MAY BE DAMAGED IF WATER OR SAND ENTERS THE CAMERA.

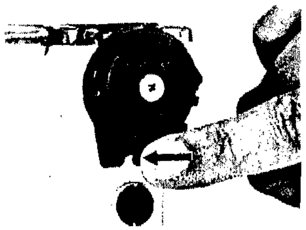


Closing the back cover

1. Make sure that the inside lip of the camera body and back cover's O-ring are clean and wiped by a soft clean cloth and that the back-cover release knobs are at "OPEN". Then align the back cover with the camera body.
2. Press both ends of the back cover with your thumbs as shown. Then, with the palm of your hand, press down on the center of the cover to assure a proper seal.
3. Turn the back-cover release knobs in the direction of the arrows all the way to "CLOSE" and push the back-cover release tab's locking pins into the holes in the knobs.

NOTE
Be sure the back cover is attached to the connector strap before closing.





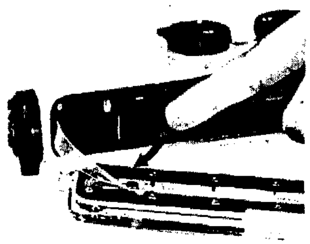
Installing the battery

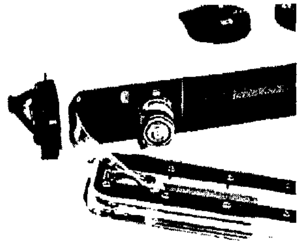
Your camera's built-in flash and exposure warning system are powered by one 1.5v AA-(penlight) size alkaline-manganese (Eveready E91 or equivalent), sealed carbon-zinc or nickel-cadmium battery.

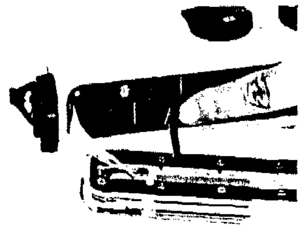
To install this:

1. With the back cover open, lift the battery-chamber cover as shown.
2. Insert a battery as specified with the plus end out as indicated inside the chamber, then close and latch the cover.

NOTE
The battery can be installed or replaced at any time without damage to loaded film.



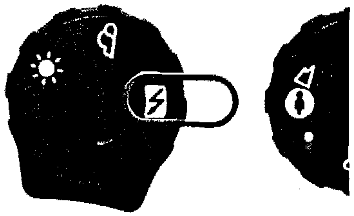


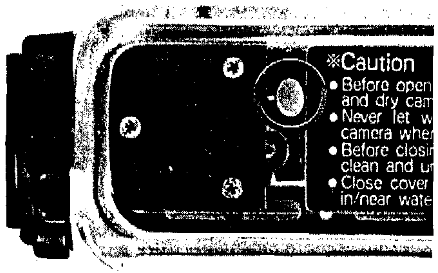


Checking the battery

The battery should be checked immediately after installing and from time to time thereafter, especially before starting on trips or taking especially important pictures. To do this, turn on the built-in flash by moving the exposure/function control knob to the (flash) symbol. If the finder/monitor lamp lights and begins to pulsate in approximately 10 seconds, the battery is serviceable. If these signals do not light within 30 seconds make sure a fresh battery is properly inserted or replace an exhausted battery as soon as it is convenient. To save battery power, **be sure to turn the exposure/function control knob to either the sun or cloud symbol after checking the battery.**

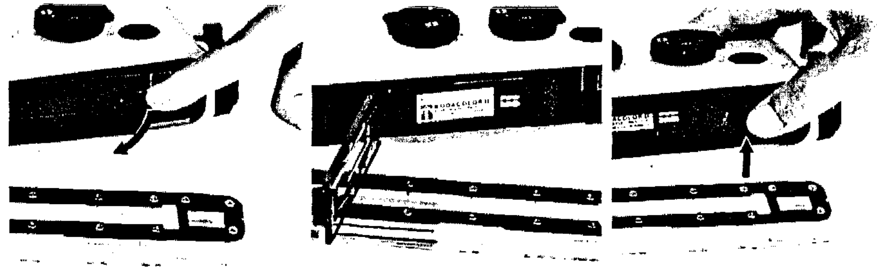
- For taking pictures without battery, see the note on page 23.



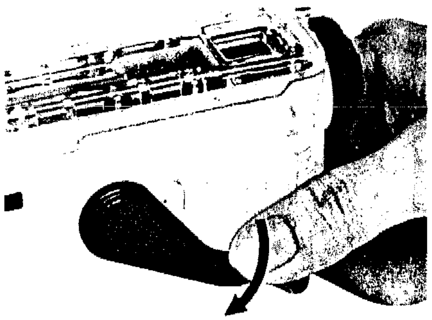


Loading and advancing film

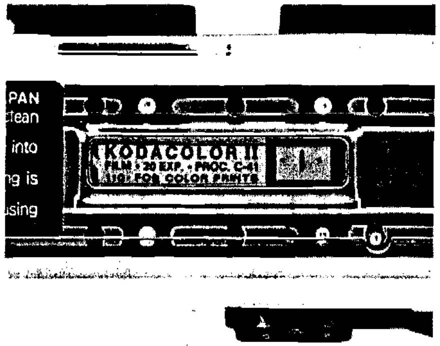
1. With the back cover open, lift the tab near the finder eyepiece as shown to open the film-chamber cover.
2. Insert the film cartridge into the camera
3. Close the film-chamber cover and push in on it until it clicks shut.



4. Close and latch the camera's water-tight back cover as described on page 12.



5. Use your right thumb to operate the film advance lever repeatedly until it locks (about three full strokes). A series of 1's should be visible in the film data window to indicate the first exposure.

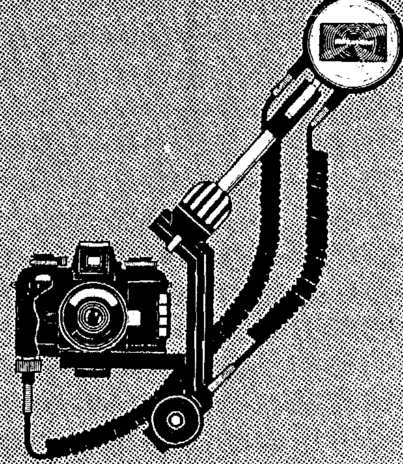


- The shutter release cannot be depressed unless the film advance has been operated until it locks.
- Film speed settings are automatically adjusted when a film cartridge is loaded. However use of high speed films under extremely bright conditions such as beach or snow scenes is not recommended.
- Load and unload film in subdued light, never in direct sunlight.
- When used in cold weather or if the camera is not used for a long period of time, the winding lever may not return all the way when the film is advanced. If this happens, push the lever back to its rest position with your thumb.
- If the film advance lever should stop before winding is complete and there is still unexposed film in the cartridge, push the lever with your thumb until it moves all the way to its advance stop. This will free the mechanism and return to operation.
- If a series of diagonal lines or the film's black paper backing appears in the film-data window while advancing the film, do not wind any farther as the film cartridge will be difficult to remove.

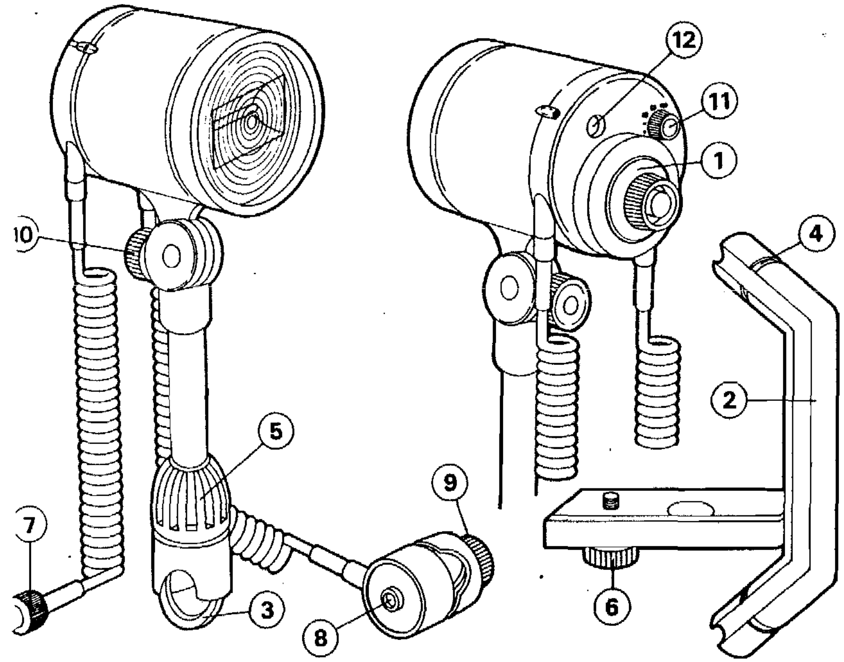
TOSHIBA UNDER WATER ELECTRONIC FLASH UNIT

Toshiba

TOSHIBA TM-II



Instruction Manual



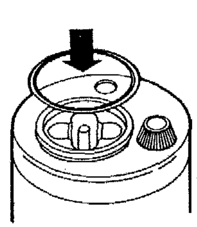


Fig./Abb. 1

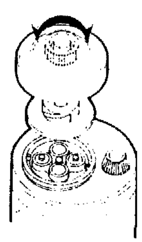


Fig./Abb. 2

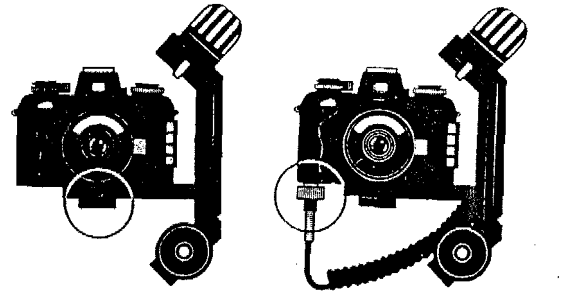


Fig./Abb. 3

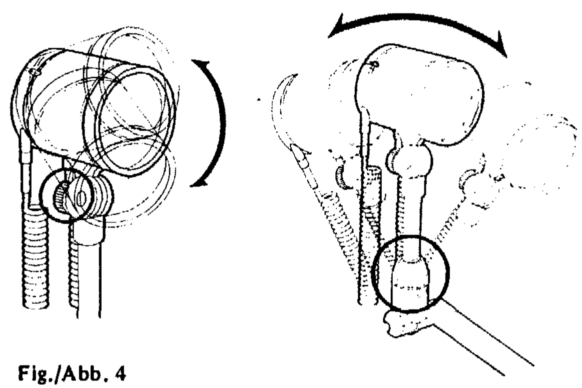


Fig./Abb. 4

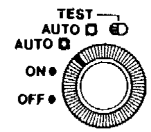


Fig./Abb. 5

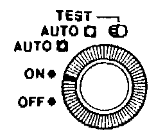


Fig./Abb. 6

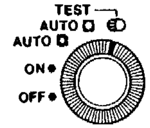


Fig./Abb. 7

Before taking pictures

1. Precautions for use

(1) Apply a thin layer of grease to the O-rings of the synchro connector and battery compartment cover before use.

(2) Do not detach the flash unit's synchro connector from the camera underwater. This unit is constructed so that it is made completely waterproof only when mounted on the camera. If detached, you may not be able to use both the camera and the flash unit's synchro connector again.

(3) This unit has an watertight structure designed to withstand water pressures at depths of 60 meters. Do not use it at any greater depths.

(4) After use, wash the flash unit still attached to the camera in fresh water and then allow to dry. After drying, separate the flash unit from the camera.

(5) Apply a thin layer of grease for storage to the O-rings of the locations where mounting/demounting operations are relatively frequent (battery compartment cover, synchro connector). This is also to safeguard against damage.

2. When opening the battery compartment after use

(1) Handle this unit with perfectly dry hands. Take care that no water leaking from the arms of your underwater suit falls onto the unit.

(2) Wipe away all the water around the battery compartment cover.

(3) The inside electrical circuit parts do not take kindly to drops of water and so if any are allowed inside the battery compartment, remove them immediately with a dry cloth.

(4) Check that the O-ring has not been marked and no foreign matter has adhered to it. Otherwise complete waterproofness cannot be guaranteed.

(5) Apply just the right amount of grease to the O-ring.

l ....
for use:
l to 8 inclusive.
S ....
ploi
es 9 jusqu'à 16 inclus.
....
weisung
7 bis 24.
....
de uso:
as 25 hasta 32 incl.
....
l'uso:
vedere da pag. 33 a pag. 40.

torage after use

/ash the unit in fresh water, keeping it attached to the camera for this operation.
\llow the unit to dry. (Do not bring the unit into direct contact with flames or heat for drying.)
:emove all the connection parts.
\pply grease to the O-rings and then store.

:eplacement period and method for O-rings (Fig. 1)

be of grease for the O-rings, an O-ring for the synchro connector and O-ring for the battery compartment r are supplied as accessories.
e are for replacement since the O-rings are liable to become marked or develop cracks with frequent nting and demounting.
eplace, first remove the marked or cracked O-ring from the battery compartment cover, apply a thin · of grease to the accessory O-ring and then mount it onto the battery compartment cover.

)ther handling precautions

:e sure to replace the O-ring if it has become marked.
'he capacitor discharges completely when the flash unit is not used for a long period of time. This is why : takes time for charging when you first use the unit.
/hen you do not intend to use the unit for a long period of time, remember to recharge the battery about ·nce a month and emit flashers. This will keep the capacitor in peak working order.

Loading the batteries (Fig. 2)

(1) The battery compartment cover (1) can be removed by rotating the knob to the left (counterclock until it becomes loose.
(2) Remove the cover and then take out the inside battery clamp.
(3) Load four (size "AA") batteries into the battery compartment as indicated inside.
(4) Once the batteries have been covered by the clamp, replace the battery compartment cover and rotat knob to the right (clockwise) until it will go no further.

Caution
Align the polarities of the batteries properly. Improper alignment can result in a malfunction.

* Hints on using the batteries

(1) Between taking pictures and after use, remember to set the switch to OFF.
(2) Replace the batteries with fresh units if the neon lamp does not light even after 30 seconds from the the switch was set to ON.
Use the same type of battery for all four units and make sure that they are all new.
(3) Remove the batteries from the unit when it is not being used in order to safeguard against battery lea which may cause a malfunction.

ring to take pictures

unting flash unit onto camera (Fig. 3)

mount the flash unit and bracket (2) together, align the bracket anchoring ring (3) and the ring's ove (4) and then tighten with the anchoring knob (5).
camera is then secured using the camera set screw (6) on the bracket.
unt the synchro connector (7) onto the camera.
le the auto sensor (8) into the bracket's anchoring ring groove and secure by tightening up the knob
.
en using the Nikonos IV-A, set the shutter dial to "M" (*mechanical* 1/90th sec.). If the camera allows ıchro contact selection, set the contact to "X" and then set the shutter speed to the value designated the flash unit. (For details, check the camera's operating instructions.)
n
n mind that the flash unit properly mounted on the camera yields both synchronization and a water- construction and that improper mounting may result in a malfunction which may render the camera ıit unusable.
ıto sensor must be pointed in the direction of the subject.

ljusting the flash direction (Fig. 4)

ash unit allows the flash direction to be varied just as preferred.
e unit's flash section moves to the front or back when the flash rotary knob (10) is rotated counter- ıckwise. Once the flash direction has been set, rotate the knob clockwise to secure it.
e flash position can be varied just as preferred using the bracket anchoring knob.
ghting is easily provided when taking pictures in a vertical position if the bracket is removed with the choring ring and the flash section is mounted at the bottom of the bracket.
ount the auto sensor onto the anchoring groove on the top of the bracket with the flash section already ounted at the bottom of the bracket.

Taking pictures

1. Auto mode operation (*Fig. 5*)

When using this flash unit in the auto mode, the f-number can be set to one of two values in line with objective in mind (camera to subject distance, depth of field).

(1) Set the switch (11) to AUTO ■ or AUTO □ in line with the objective in mind.
If you are using an ASA100 *film*, the f-number is:
fll at AUTO ■
f4 at AUTO □
Once this f-number has been set on the camera, the only other thing that has to be done is focus camera.

– F-numbers with "auto" mode photography –

Film speed (ASA)		25	50/64	100	200	400
F-number	AUTO ■	5.6	8	11	16	22
	AUTO □	2	2.8	4	5.6	8

(2) The automatic flash coverage does not depend on the film speed (ASA).
This coverage is between 0.5 and 2.5 m (1.6 and 8 ft) on land for AUTO ■.
between 1 and 7 m (3.3 and 23 ft) on land for AUTO □.

ıual mode operation (Fig. 6)

the switch to the ON (manual) mark

ting the exposure

ɔending on the transparency of the water and the conditions affecting the subject, the exposeure will y even though the light source emits a constant amount of light.

: following formula can be used to calculate the f-number from the quide number on condition that transparency is good:

(2/3 · 1/2) Guide number/Camera distance = f-number

netimes the optimum exposure cannot be calculated from this formula, in which case the exposure ·ditions should be changed and the desired pictures taken.

: guide number for taking pictures on land is 28 (ASA 100 m) and so use this to determine the optim exposure.

Optimum f-number = Guide number ÷ Camera distance

t method (Fig. 7)

e ready to test the flash as soon as you set the switch to TEST after the neon lamp (12), that indicates :teries are sufficiently charged, lights. This test is conducted at the AUTO ◘ position. If the switch is the TEST position after the test flash, AUTO ◘ operation results.

other test flash, return the switch to AUTO ◘ and then set it again to TEST.

: is no flash with the unit mounted on the camera, short the synchro connector using a piece of metal. sh results, there is nothing wrong with the flash unit.

: is a flash at "open flash," but none at the synchro connector, either the synchro cord has a disconı or the camera is malfunctioning. To remedy this, either replace the synchro cord or have the camera d.

Performance

Guide number	On land:	28 (ASA 100 m), 46 (ASA 25 ft)
Coverage range	AUTO ◘:	Approx. 0.5 to 2.5 m (1.6 to 8 ft) on land
	AUTO ◘:	Approx. 1 to 7 m (3.3 to 23 ft) on land
Power requirements:	4 (size "AA") alkaline dry batteries	
	4 (size "AA") Ni-Cd dry batteries	
	(Unicad TN-3U batteries)	
Recycling time	Auto:	Approx. 0.5 to 7 sec. with alkaline dry batteries
		Approx. 0.5 to 4 sec. with Unicad batteries
	Manual:	Approx. 7 sec. with alkaline dry batteries
		Approx. 4 sec. with Unicad batteries
Number of flashes	Auto:	Approx. 130 to 900 with alkaline dry batteries
		Approx. 40 to 300 with Unicad batteries
	Manual:	Approx. 130 with alkaline dry batteries
		Approx. 40 with unicad batteries
Light distribution	35 mm lens coverage with 35 mm camera	
Light quality	Same as sunlight	
Dimensions	Flash section:	93 x 140 mm
	Auto sensor:	50 x 34 mm
Weight	Approx. 1,200 g (main unit only)	
Accessories	O-ring for battery compartment cover, O-ring for synchro connector, grease fc O-rings	

* Recycling time, number of flashes
  The recycling time is defined as the time required for the neon lamp to light next after continuous flashing for 30 seconds using new batteries. The number of flashes is defined as the number of flashes emitted until the recycling time reaches 30 seconds.
* In the auto mode, the recycling time and number of flashers vary depending on the camera distance.
* The coverage range varies in water depending on the water's transparency, its quality and the effect of objects floating in the water.

5'11/000

E G F S

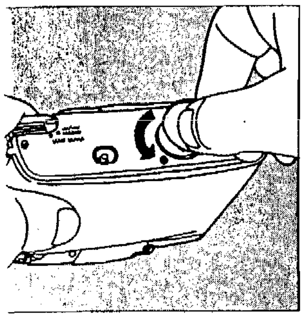
OLYMPUS XA2

■INSTRUCTIONS ■BEDIENUNGSANLEITUNG
■MODE D'EMPLOI ■INSTRUCCIONES

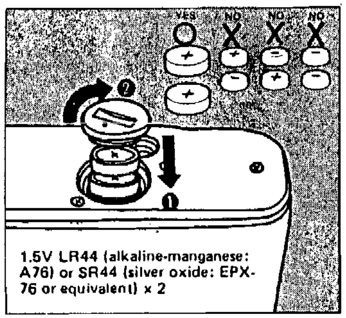
000 1166

REPARATION VORBEREITUNG
réparation Preparación

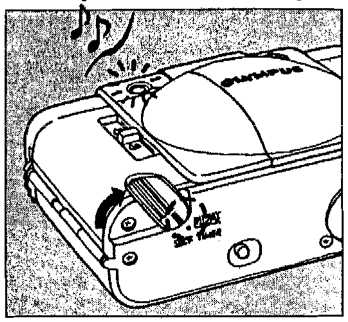
Jncap the battery chamber.
iatteriefachdeckel öffnen.
)uvrir le compartiment à piles.
\bra el compartimento de pilas.



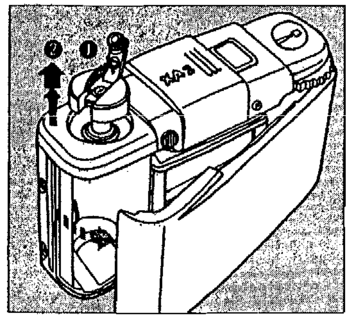
2. Insert batteries.
2. Batterien einsetzen.
2. Introduire les piles.
2. Inserte las pilas.



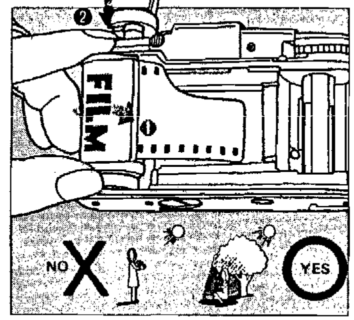
3. Check the batteries.
3. Batterien kontrollieren.
3. Contrôler les piles.
3. Compruebe la carga de las pilas.



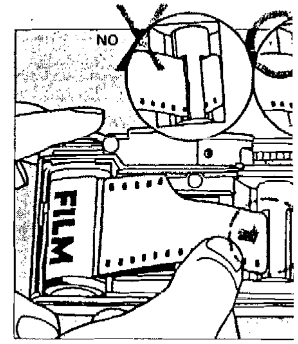
4. Open the camera back.
4. Kamerarückwand öffnen.
4. Ouvrir le dos de l'appareil.
4. Abra la tapa posterior.



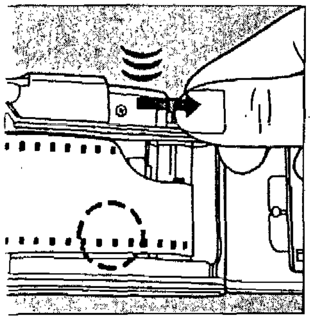
5. Load the film cartridge.
5. Filmpatrone einsetzen.
5. Charger le film.
5. Inserte la pelicula.



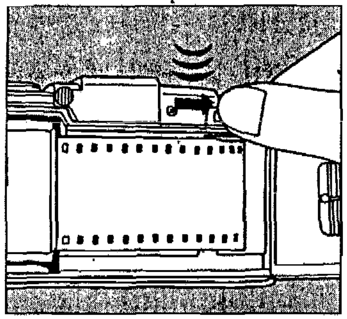
6. Insert the film leader.
6. Filmanfang einfädeln.
6. Introduire l'amorce du fil
6. Inserte el guia de la pelicu



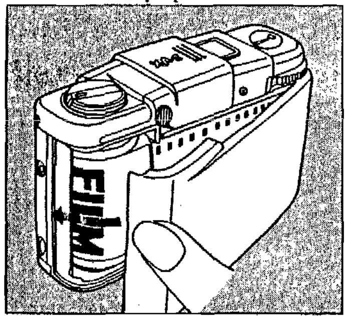
Engage film on sprocket teeth.
Walzenzähne in Filmperforation eingreifen.
Engager les perforations du film.
Engrane las perforaciones de la película en los dientes.



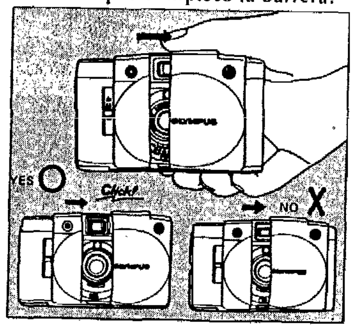
8. Tighten the film.
8. Film straff ziehen.
8. Tendre le film.
8. Tense bien la película.



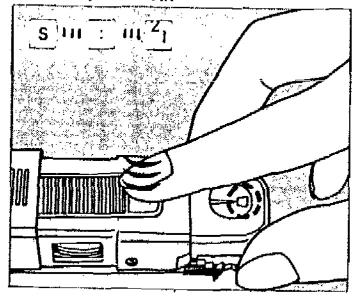
9. Close the camera back.
9. Kamerarückwand schließen.
9. Refermer le dos de l'appareil.
9. Cierre la tapa posterior.



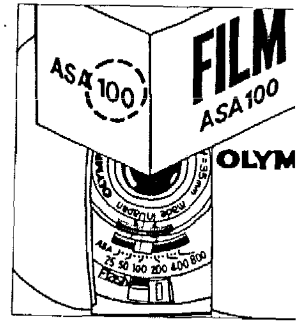
10. Open the Dust Barrier fully.
10. Staubschutz voll öffnen.
10. Ouvrir à fond le protecteur.
10. Abra por completo la barrera.



11. Press the shutter button and advance the film until "1" appears.
11. Blindaufnahmen machen, bis "1" im Bildzählwerk erscheint.
11. Armer et déclencher jusqu'à ce que le "1" apparaisse.
11. Haga tomas en blanco hasta que el "1" se vea.

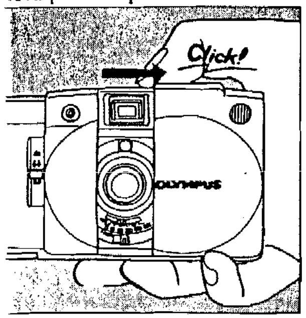


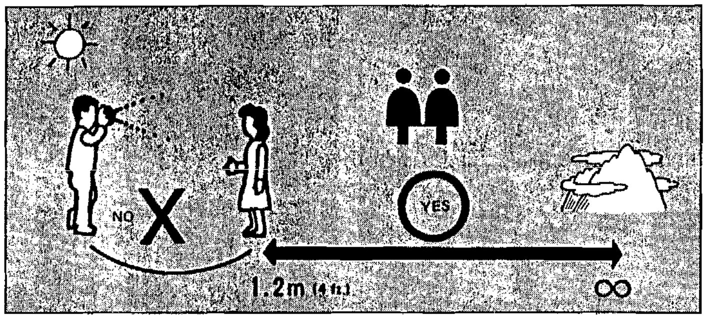
12. Set the ASA film speed.
12. ASA-Filmempfindlichke stellen.
12. Afficher la sensibilité AS
12. Ajuste la sensibilidad AS



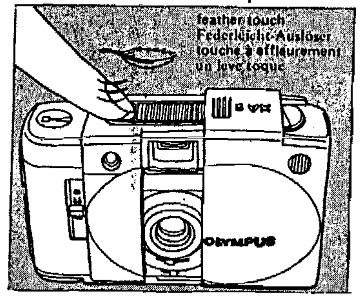
NAPSHOTS SCHNAPPSCHUSSE
nstantanés Las instantáneas

)pen the Dust Barrier fully.
itaubschutz voll öffnen.
)uvrir à fond le protecteur.
\bra por completo la barrera.

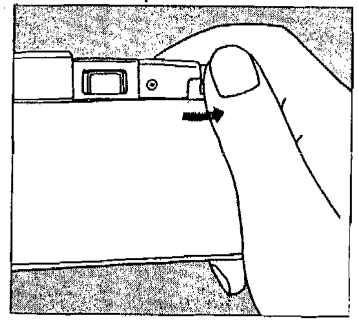




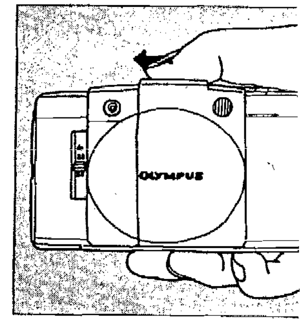
2. Hold the camera steady and lightly press the shutter release.
2. Kamera ruhig halten und Auslöser weich betätigen.
2. Tenir fermement l'appareil et appuyez sur le déclencheur.
2. Sostenga la cámara y oprima levemente el botón disparador.



3. Wind the film.
3. Film weiterschalten.
3. Bobiner le film.
3. Bobine la película.

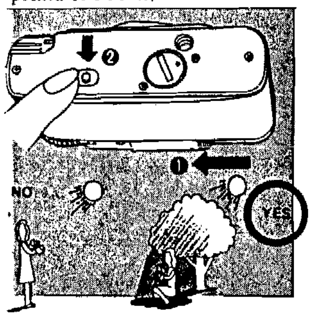


4. Close the Dust Barrier.
4. Staubschutz schließen.
4. Fermer le protecteur.
4. Cierre la barrera contra el

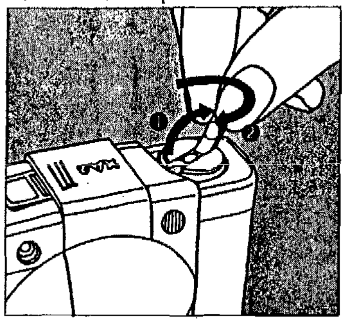


NLOADING THE FILM HERAUSNEHMEN
échargement du film Cómo extraer la película

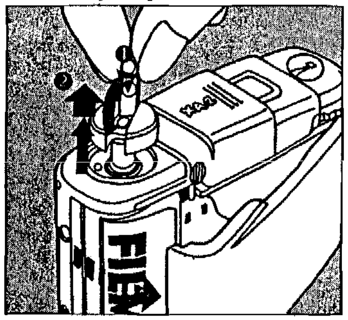
ress the rewind release button.
ückspul-Freilaufknopf drücken.
ppuyer sur le bouton.
prima el botón.



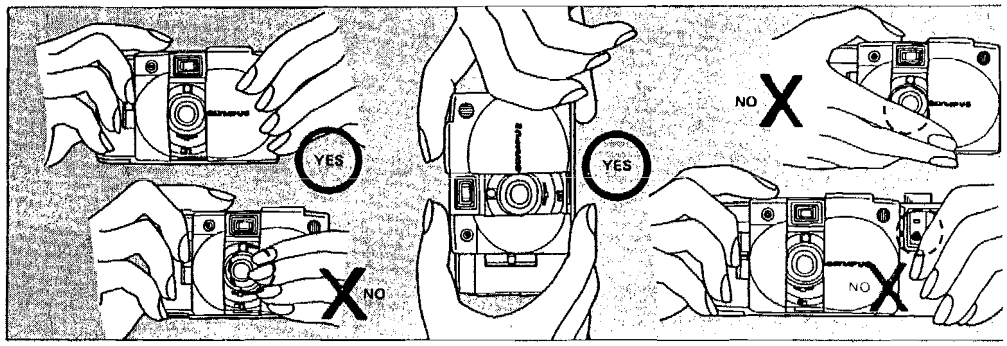
2. Rewind the film.
2. Film zurückspulen.
2. Rebobiner le film.
2. Rebobine la película.



3. Remove the film.
3. Film herausnehmen.
3. Retirer la cartouche.
3. Extraiga la película.

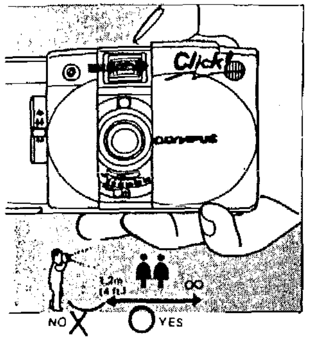


HOLDING THE CAMERA
HALTEN DER KAMERA
Tenue de l'appareil
Cómo sostener la cámara



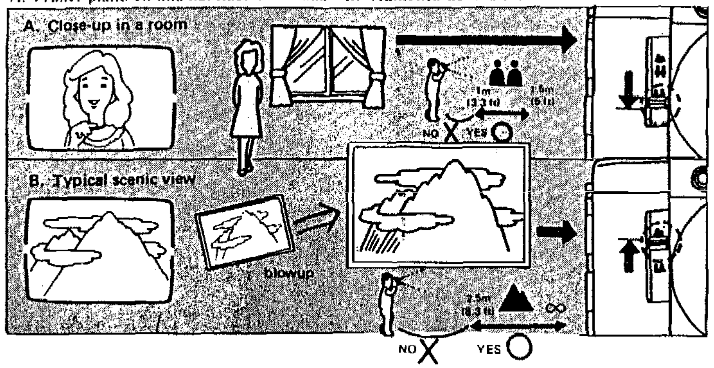
HOTOGRAPHING IN SPECIAL SITUATIONS AUFNAHMEN UNTER BESONDEREN VERHALTNISSEN
hotographie de sujets particuliers La fotografia de temas especiales

pen the Dust Barrier fully.
taubschutz voll öffnen.
uvrir à fond le protecteur.
bra por completo la barrera.



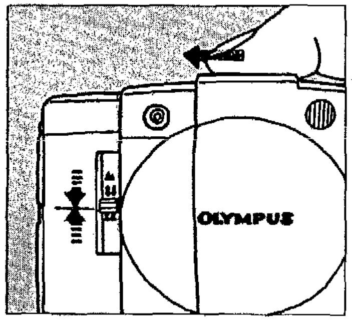
2. A. Nahaufnahme im Zimmer
   A. Photographie rapprochée en intérieur,
   A. Primer plano en una habitación cerrada

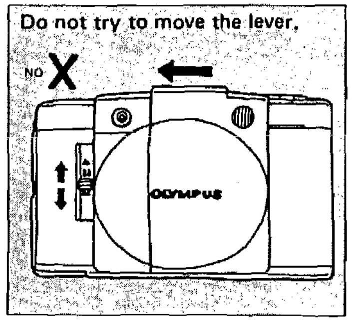
B. Fernsicht
B. Grandissement de l'image
B. Aumento de una toma

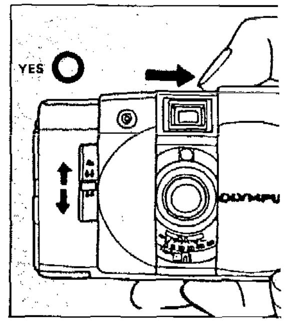


3. Close the Dust Barrier. The zone focusing lever resets itself to 👥.
3. Staubschutz schließen. Der Entfernungs-Einstellhebel stellt sich automatisch zurück auf 👥.

3. Fermer le protecteur. Le levier de zone de mise au point revient de lui-même sur 👥.
3. Cierre la barrera. La palanca de enfoque vuelve a su posición 👥 automáticamente.



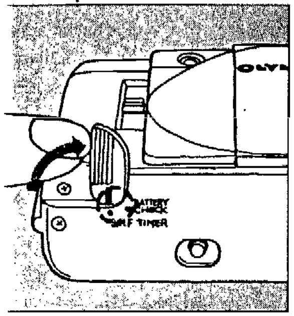


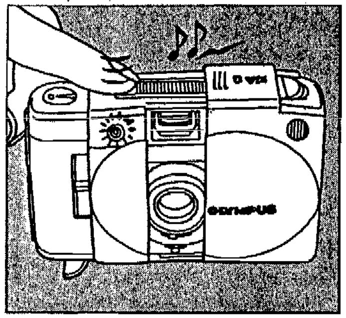


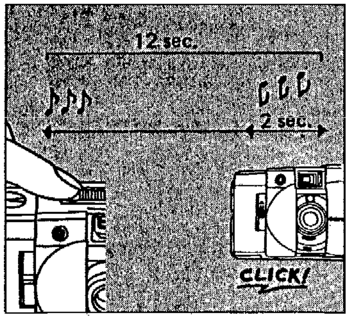
LF-TIMER SELBSTAUSLÖSER
clencheur à retardement Autodisparador

:t the lever to SELF TIMER.
:bel herausschwenken.
:tionner le levier.
uste la palanca.

2. Release the shutter.
2. Auslöser betätigen.
2. Déclencher l'obturateur.
2. Dispare el obturador.

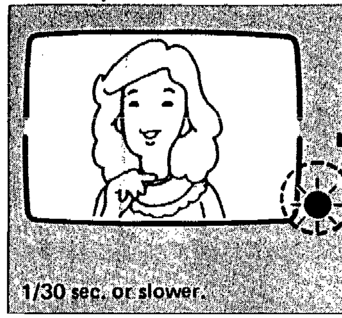




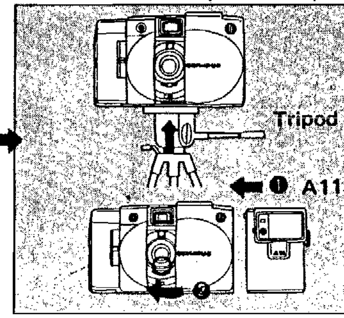


PREVENTING THE CAMERA SHAKE VERWACKELTE AUFNAHMEN VERMEIDEN
Indicateur de vibration Cómo evitar la vibración de la cámara

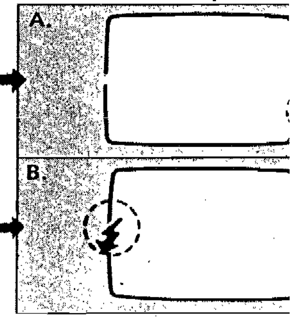
When the warning appears:
Die Langzeit-Warnung erscheint:
Lorsque le signal apparaît:
Cuando aparece la señal:



A. Long exposure
A. Langzeit-Belichtung
A. Exposition longue
A. En exposiciones prolongadas

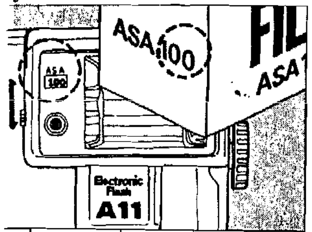


B. Flash photograp
B. Blitzaufnahme
B. Photographie au
B. En fotografía co



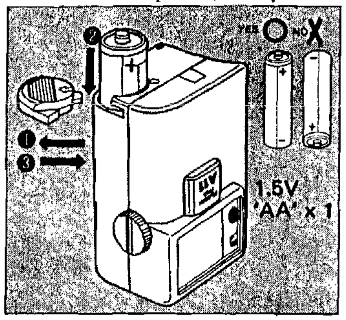
TOMATIC FLASH PHOTOGRAPHY WITH A11 BLITZAUFNAHMEN MIT DEM A11
otographie au flash automatique avec le A11 Cómo fotografiar con el flash automático A11

et the ASA film speed.
SA-Filmempfindlichkeit ein-tellen.
fficher la sensibilité ASA.
juste la sensibilidad ASA.

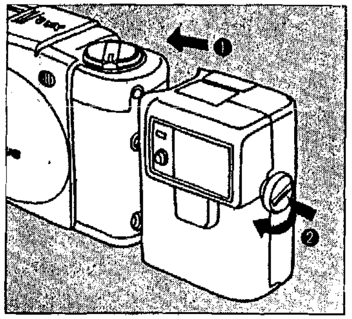


·11	ASA Film	DIN		
0	80, 100, 125	20, 21, 22	1m–1.5m–2.8m	
0	400	27	1m–1.5m–5.6m	

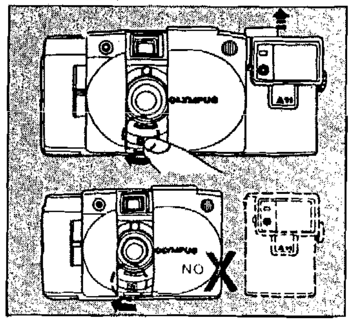
2. Load one 1.5V AA size battery.
2. Mignonbatterie einsetzen.
2. Charger une pile 1,5V type AA.
2. Inserte una pila 1,5V tipo AA.



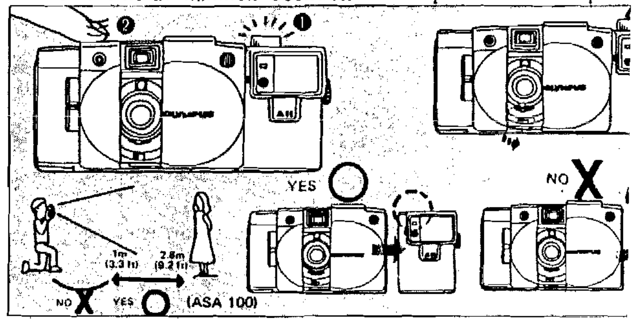
3. Attach the A11.
3. Blitzgerät A11 befestigen.
3. Fixer le Flash A11.
3. Monte el A11.



4. Set the flash lever to 'Flash.'
4. Schalter auf Blitzsymbol stellen.
4. Régler le levier sur le repère flash.
4. Ajuste la perilla en la posición de flash.



5. After the lamp glows, release the shutter. Depress the lamp after flash exposure to turn off A11.
5. Nach Aufleuchten der Bereitschaftslampe Verschluss auslösen. Lampe niederdrücken, wenn Blitzaufnahmen beendet.
5. Lorsque la lampe s'allu clencher l'obturateur. le lampe après la exposi
5. Una vez que la lámpa cienda, dispare el ol Oprima la lámpara hac después de la exposic



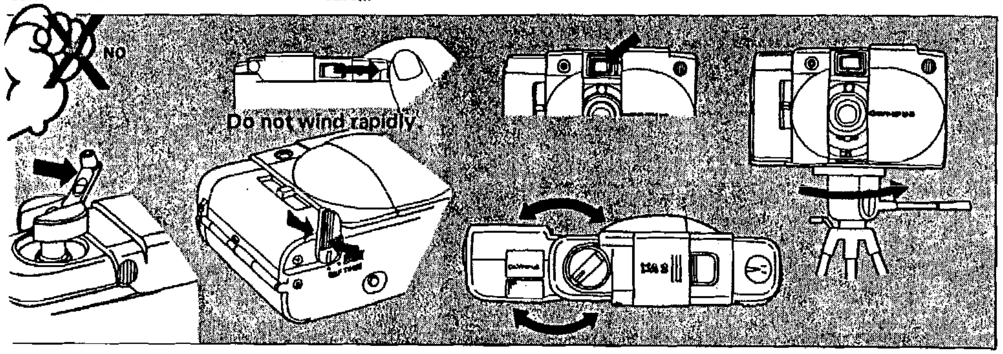
'ENTION >

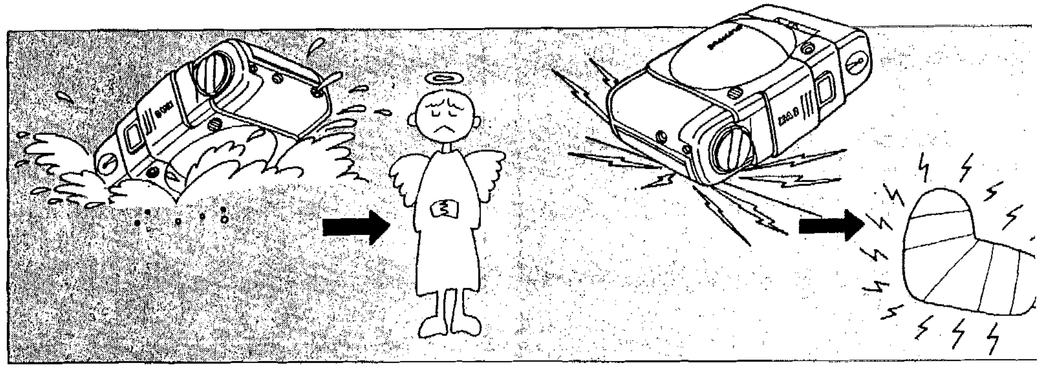
ıot apply unnecessary pres-

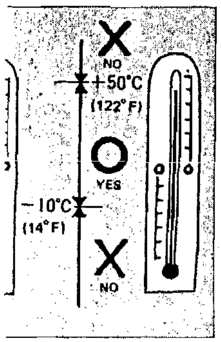
unnötige Kraftanwendung 'ermeiden.

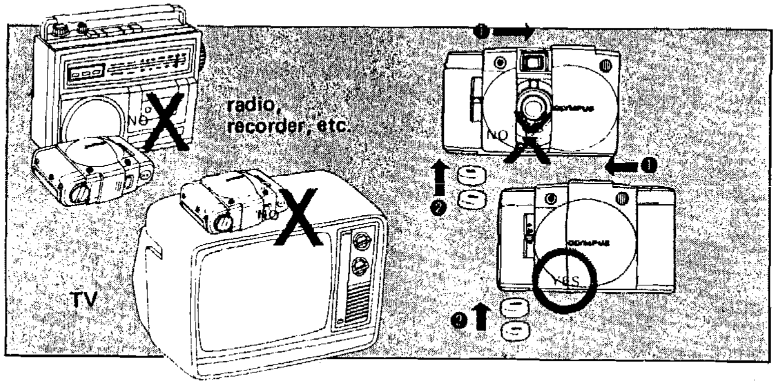
• N'appliquez pas une pression exagérée.

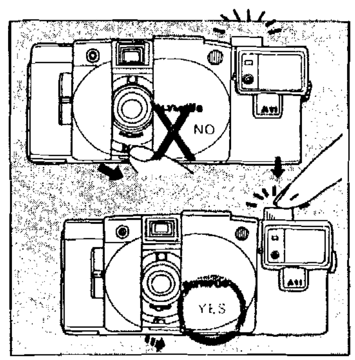
• No haga más presión que la necesaria.







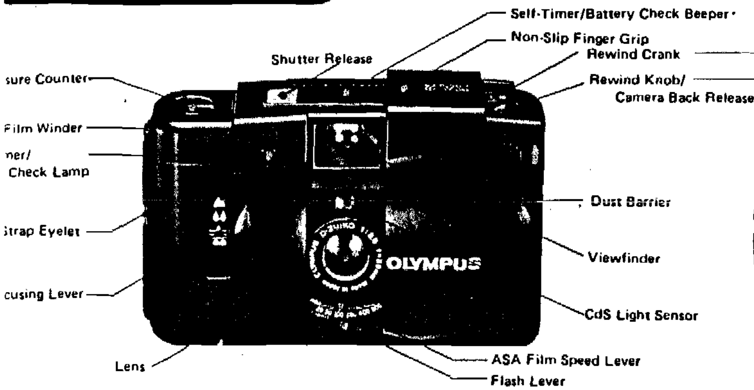


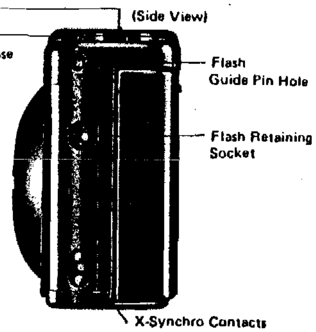


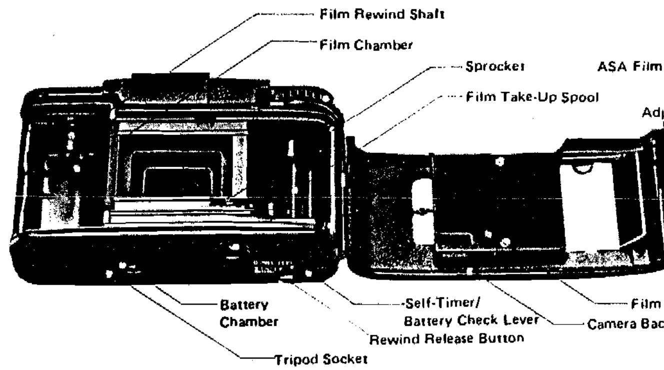
The long-exposure warning signal goes out after 90 seconds. It turns on again when the Dust Barrier is closed and opened.
Do not use "FULL" setting as the XA2 doesn't permit free selection of lens aperture.(when A11 is in use).
Die Langzeit-Warnung erlischt nach 90 Sekunden und leuchtet erneut auf, wenn der Staubschutz geschlossen und wieder geöffnet wird.
Bei Benutzung des "A11" an der XA2 niemals auf "FULL" stellen, weil die Belichtungsautomatik der XA2 die Vorwahl beliebiger Blendenwerte nicht erlaubt.

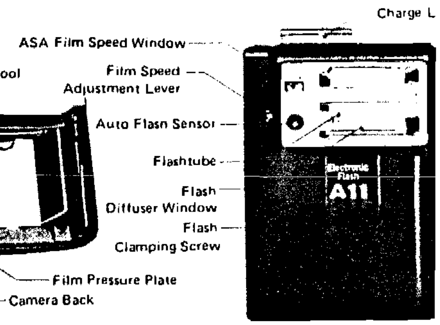
Le signal de exposition longue te après 90 sec. l'ouvrir à no lorsque protecteur est fern ouvert.
Ne pas utiliser "FULL", car vc pouvez pas choisir exacte l'ouverture que vous désirez.
La señal de exposición prolo se apaga luego de 90 segundos. do la barrera contra el polvo a abrirse o cerrarse, la señal ciende otra vez.
No utilice el ajuste en "F porque la XA2 no permite e la abertura libremente.

DESCRIPTION OF CONTROLS





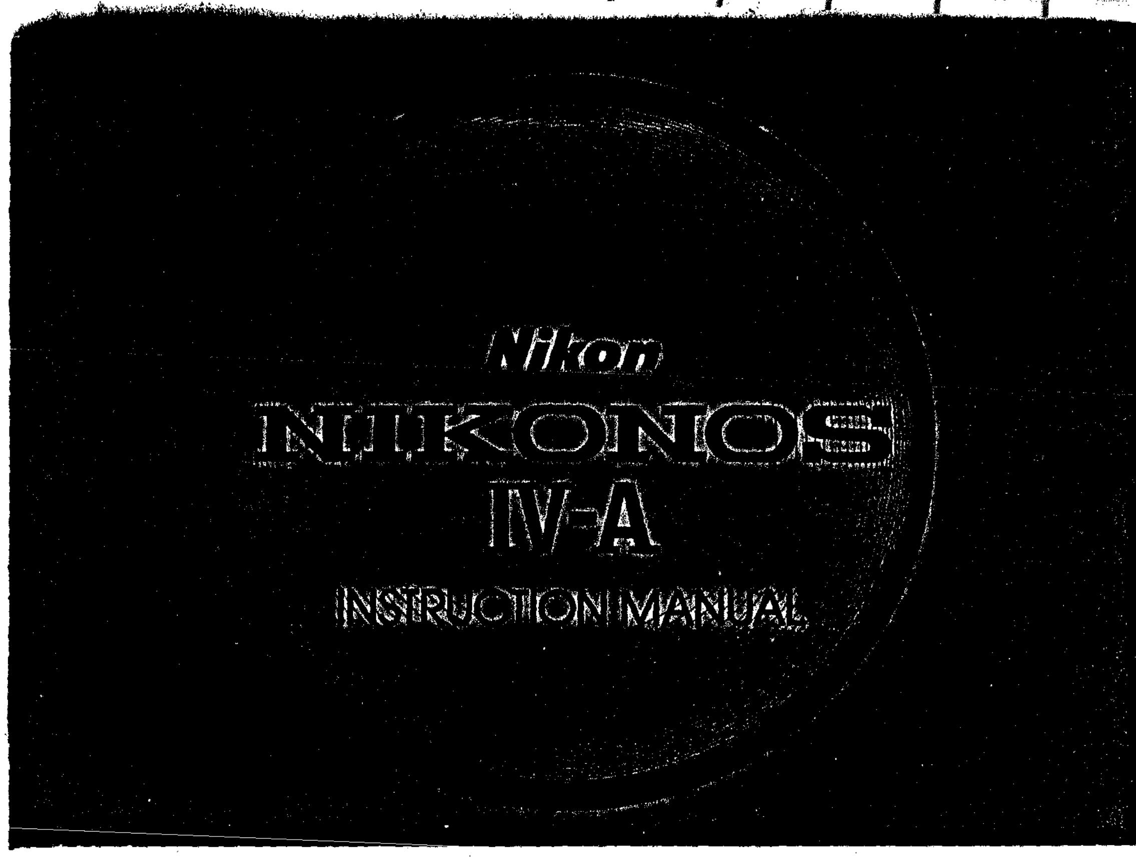




MAIN SPECIFICATIONS

Camera type: 35mm electronic lens-shutter camera.
Film format: 35mm standard cassette (24 x 36mm).
Lens: D. Zuiko 35mm F3.5, 4 elements in 4 groups.
Shutter: Programmed between-lens shutter.
Viewfinder: Bright frame finder, 0.5x. Long exposure warning and flash mark visible in finder.
Focusing: Three zone indicators.
Exposure control: Programmed shutter. Automatic exposure range 2 sec. (F3.5) — 1/750 sec. (F14).
Film speed range: ASA 25 ~ 800.
Film advance: Rear winding thumbwheel (360°).
Exposure counter: Progressive type with automatic reset.
Film rewind: Crank type with rewind release button.
Shutter release: Electromagnetic shutter release.
Self-timer: Electronic self-timer with 12 second delay. Blinking LED and electronic beeper (Piezoelectric Ceramic Vibrator) during self-timer operation.

Battery check: Via self-timer/battery check lever. Continuous LED and PCV.
Flash mounting: Exclusive automatic Electronic Flash A11 attaches to (or detaches from) the camera in seconds.
Setting camera's flash lever to flash symbol switches the A11 on, and sets the XA2 for autoflash.
Lens/finder barrier: Sliding cover. When the cover is opened, power is switched on and shutter release unlocks. When the cover is closed, power is switched off and shutter release locks.
Power source: Two 1.5V alkaline-manganese batteries LR44 (A76) or silver oxide batteries SR44 (Eveready EPX-76 or equivalent).
Dimensions: 102 (W) x 65 (H) x 40 (D) mm. (4" x 2.6" x 1.6").
Weight: 200 grams or 7.1 oz. (less batteries).



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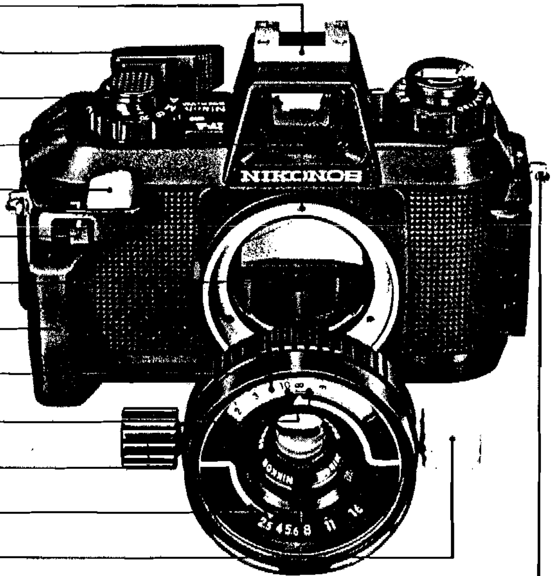
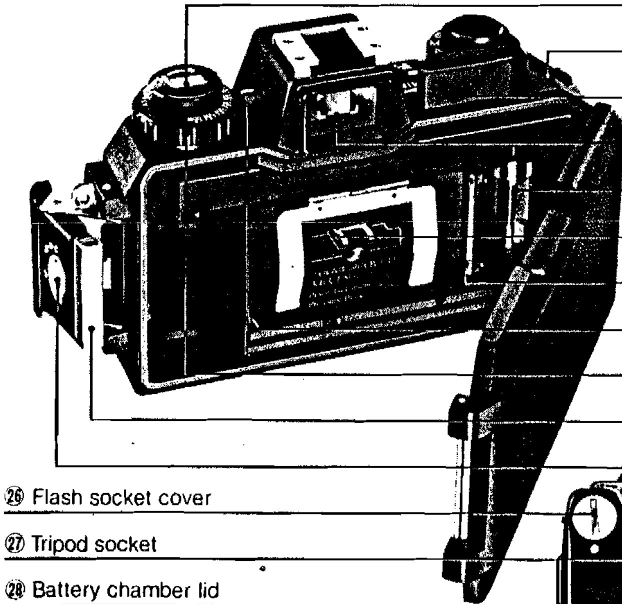
)MENCLATURE

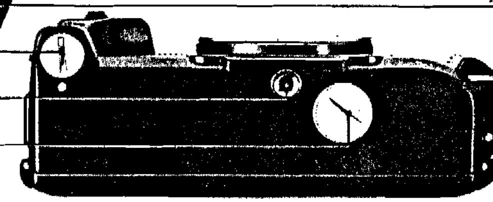
:essory shoe
ıtter speed index
ıtter speed dial
s sealing slot
tter release button
tter release button lock
s seating pin
tomical grip
ance scale
th-of-field indicators
; aperture knob
rture scale
; focusing knob
kstrap eyelets





Film rewind knob with crank
Frame counter
Film advance lever
Viewfinder
Film takeup spool
Hinged pressure plate
Film advance sprockets
ASA/ISO film speed dial index
ASA/ISO film speed dial
Camera back latch
O-C key

26 Flash socket cover
27 Tripod socket
28 Battery chamber lid



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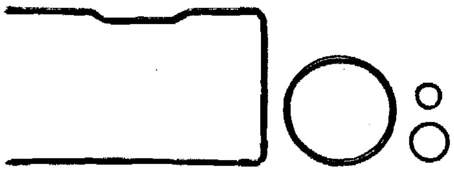
FOREWORD

The Nikonos IV-A is the world's only 35mm underwater camera capable of going down to depths of 50 meters (160 feet) and withstanding pressure of 6kg/cm²(85 lb/in²) without a special underwater housing. Because of this ruggedness, you can use the Nikonos in situations where regular cameras would dare not go. Carry it to the beach, use it on your boat, even take it mountain climbing without worrying about camera care.
And now with automatic exposure control, picture-taking has been made easier than ever. Just set a shooting aperture, and the camera adjusts the shutter speed to give you the correct exposure AUTOMATICALLY.
The Nikonos IV-A has a large, high-eyepoint viewfinder allowing you to see the entire field of view from up to 40mm away while wearing a diver's mask or goggles. In addition, its swing-open camera back and large shutter release button and film advance lever allow the Nikonos to be operated in the same manner as regular 35mm cameras.
Even though this camera is very easy to use, yo should still familiarize yourself with its prepa ration and basic operation as presented in th first two sections of this manual. For more de tailed information, please refer to "CONTROLS I DETAIL" and "TIPS ON UNDERWATER SHOOTING. A few minutes wisely invested now will pay o later in years of rewarding photographi experiences.

?EPARATION

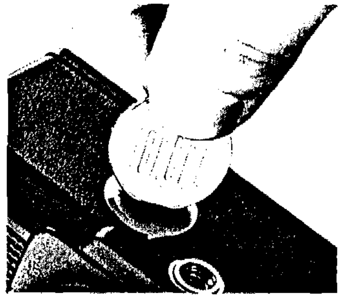
· to using the Nikonos IV-A, check to see that)-rings are not scratched and that there is no sand ther foreign matter attached to the rings. Then, nust lubricate the four O-rings shown in red using tube of lubricant provided. Lubrication makes camera back easy to open and the lens or other ; easy to attach; it also protects the O-rings from ssive wear. Apply the lubricant sparingly, yet e sure there are no gaps between areas of appli- n. It is recommended that lubricant be applied n necessary to ensure the longest possible service ne Nikonos IV-A. An extra set of O-rings, plus a of lubricant, is supplied with the camera.

O-rings



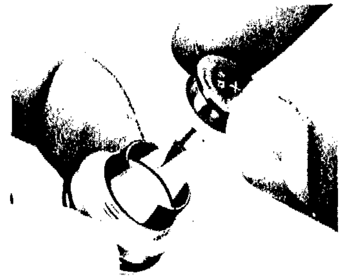
O-ring lubricant

BASIC OPERATION



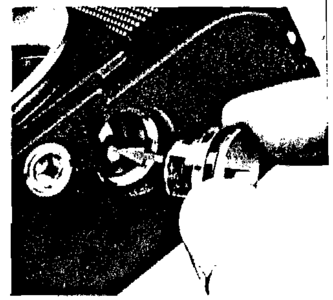
1. Remove the battery chamber lid 28.

Use a coin to twist the lid counter-clockwise to unscrew it.



2. Install the batteries.

Insert the two 1.5V silver-oxide batteries supplied with the camera, making sure that the "+" signs are up.

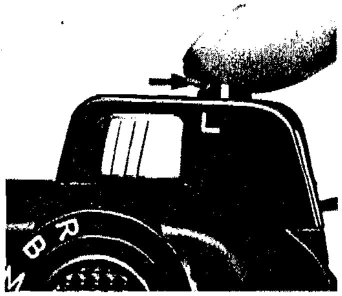


3. Replace the battery chamber lid.

Slip the battery clip back into the camera body and screw the lid tightly into place.

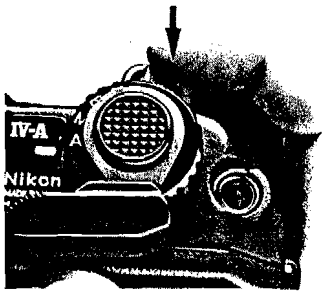
Set the camera for automatic ration.

te the shutter speed dial (3) the "A" is opposite the white (2).



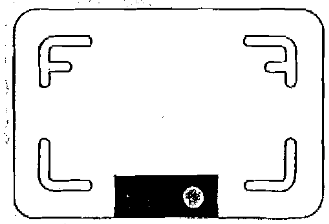
5. Unlock the shutter release button.

Move the shutter release button lock (6) off the "L" position.



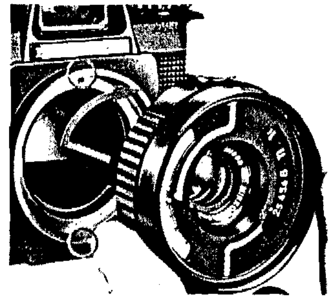
6. Depress the shutter release button (5) halfway.

This activates the exposure meter. The meter stays on for approx. 20 seconds after you take your finger off the button and turns itself off automatically to conserve battery power.



7. Check battery power.

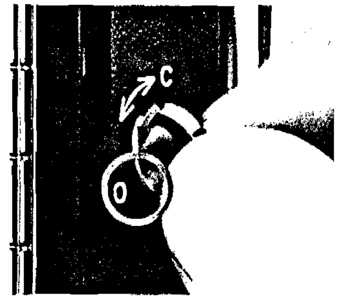
Look through the viewfinder (18). A red LED at the bottom of the frame should be displayed to show that the batteries have been properly installed and their power is adequate. If not, recheck the orientation of the "+" "−" symbols, and if necessary, replace both batteries with a fresh set.



8. Mount the lens on the camera.

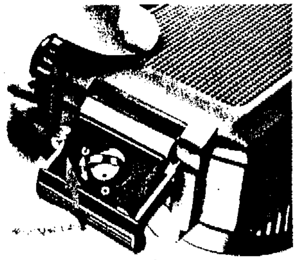
With the white lens focusing knob W positioned vertically in front of the viewfinder, push the lens firmly into the camera'd bayonet mount. Twist the lens 90° clockwise until the seating pins (7) click and lock into position in the slots (4). Now the camera and lens assembly are completely watertight.

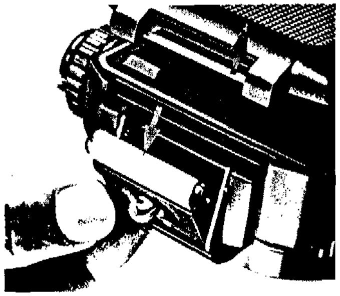
Note: *Mounting the lens upside down may make it easier to read the aperture and distance scales from above the camera.*



9. Unlock the camera back.

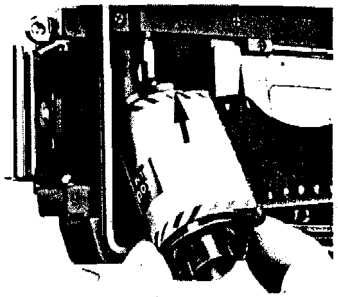
Turn the O-C key (25) to the "O" position.





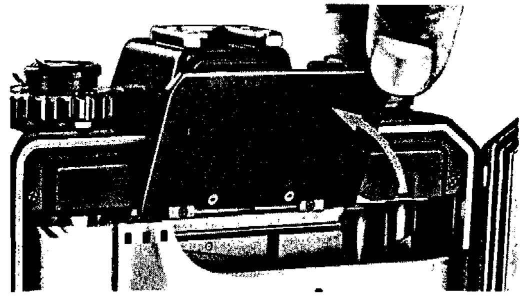
), Open the camera back.

Press, your thumb against the camera back as you lift up the ·ra back latch ㉔. Release thumb pressure, and the camera back ɔen.

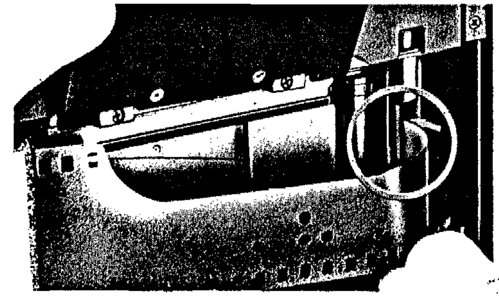


11. Install the film cartridge.

Slip the cartridge into the film cartridge chamber, so that the top of the cartridge engages the film rewind fork . Then push the bottom of the cartridge until it is fully seated in the chamber.

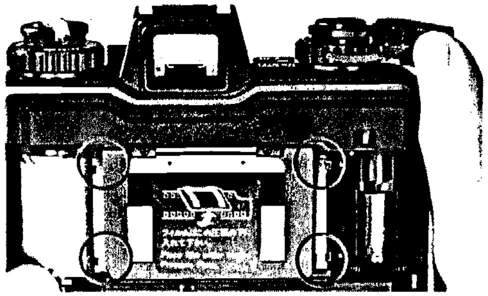


12. Lift up the pressure plate ⑳.



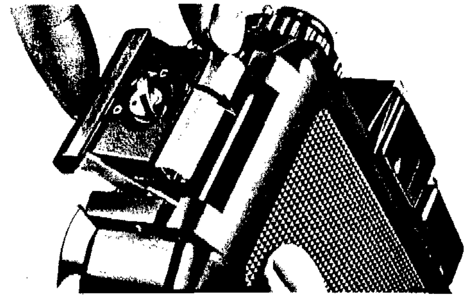
13. Insert the film leader in the takeup spool ⑲.

While holding the pressure plate in the "up" positior pull the leader across the camera and insert it into onı of the slots in the film takeup spool. Then push thı pressure plate back down until it locks into place.



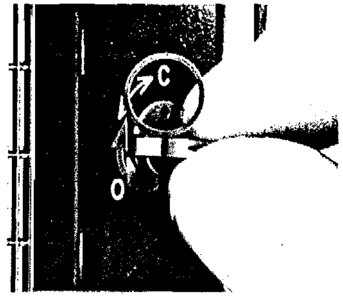
4. Wind the film advance lever [17] to advance film onto the eup spool.

ress the shutter release button and wind the film ance lever until the film sprockets [21] engage the orations on both edges of the film.



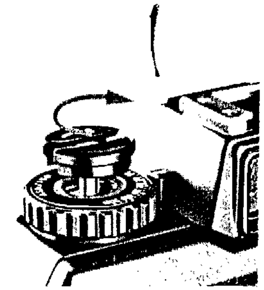
15. Close the camera back.

Make sure the bottom of the cartridge is still fully seated in the chamber and the O-ring fits snugly in the groove around the camera back before swinging the camera back shut. Then, while pressing the camera back against the camera body, rotate the camera back latch to the rear. Push the back of the latch in so that the claw hooks onto the pin on the camera back. Finally, push the latch forward to clamp the camera back into place.



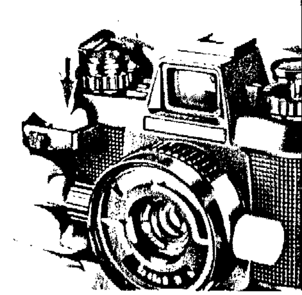
16. Lock the camera back.

Return the O-C key to the "C" position to prevent the camera back from being accidentally opened during picture-taking.



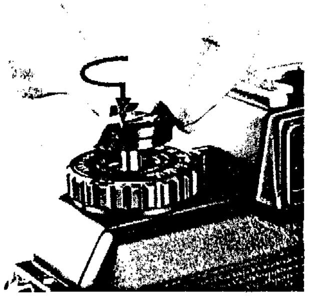
17. Take up the film slack.

Fold out the film rewind crank [15]. Rotate the film rewind knob in the direction of the arrow as you lift it up. Then with the knob in the raised position, rotate it in the same direction until you feel slight tension.



18. Make blank exp sures until the frame counter shows "1."

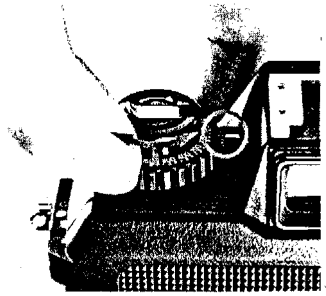
Continue to depress the shut release button and wind the f advance lever until the fra counter [16] shows "1." While ma ing blank exposures, watch the wind knob to see that it rotat This indicates that the film h been loaded correctly and is be advanced.



9. Push the rewind knob back down.

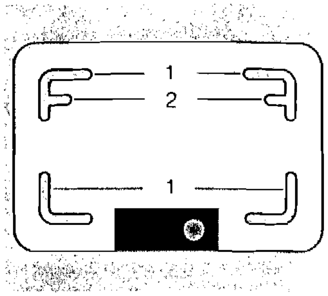
d the crank back in. Then rotate · knob slightly in the opposite ɜction of the arrow while push- : down. The knob will return to normal position.

ution: Before you actually dive into water, make sure the rewind knob ˀn the "down" position. Otherwise, ·er might get inside the camera.



20. Set the ASA/ISO film speed.

Lift up the film speed dial ㉓ and rotate it in either direction until the ASA/ISO film speed is opposite the white index ㉒. This programs the camera's exposure meter so that it may provide a proper exposure for the speed of film in use.

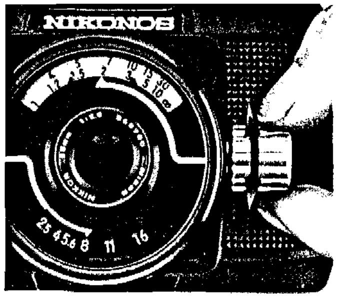


21. Frame the subject in the viewfinder.

The frame lines built into the viewfinder show the field of view for the normal 35mm lens. For proper framing, place your subject within the outlined area. When shooting subjects at distances as close as 0.8m (2.75ft), use the parallax correction marks for framing.

Inside the viewfinder

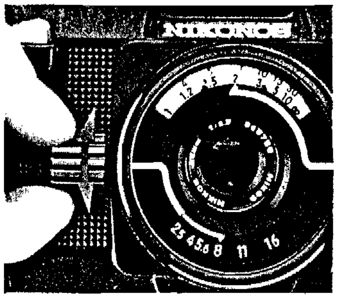
1. Frame lines showing the field of view for the normal 35mm lens
2. The parallax correction marks



22. Set the distance on the lens.

Estimate or measure* the camera-to-subject distance. Turn the white lens focusing knob until the estimated camera-to-subject distance in meters or feet is lined up with the index on the front of the lens.

*Refer to page 36 for more details.



23. Set the lens aperture.

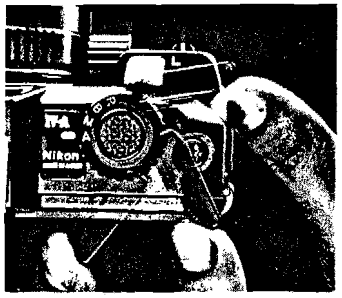
Turn the black aperture knob ⑪ until the desired f/number is opposite the index mark on the front of the lens.

The pincer-type depth-of-field indicators ⑩, coupled with the focusing knob, open or close to show the range of distances which will be in focus in the final photograph.*

*Refer to the example pictures on page 27.

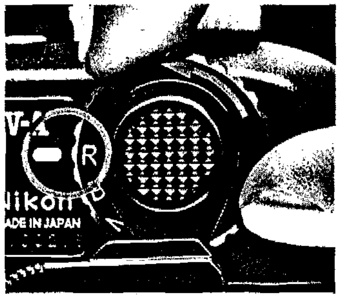
24. Take the picture

Look through the vi finder, and depress the shu release button halfway. If the L doesn't blink, depress the but all the way to take the picture. shutter speed automatically lected is between approx. 1 sec. and 1/1000 sec. If the L does blink, readjust the apert until it stops blinking.



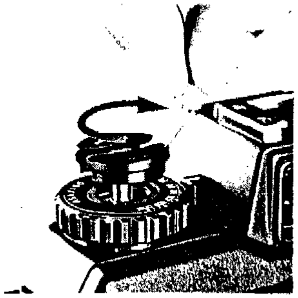
25. Advance the film.

Stroke the film advance lever to transport the film to the next frame and get the camera ready for the next shot.



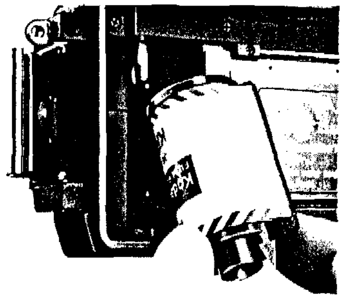
26. Set the shutter speed dial to "R."

After the last exposure has been made, the film advance lever will stop working. You must then rewind the exposed film back into its cartridge. To do this, first turn the shutter speed dial to "R" to disengage the film sprocket drive.



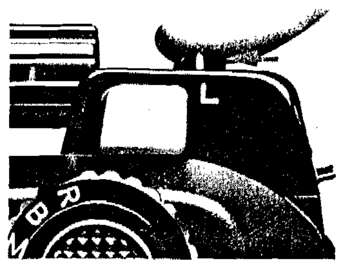
27. Rewind the film.

Fold out the film rewind crank. Rotate the film rewind knob in the direction of the arrow as you lift it up. Then with the knob in the raised position, rotate it in the same direction to rewind the film. When you feel the tension lessen, continue winding one or two more turns so that the film leader is rewound completely back into the cartridge.



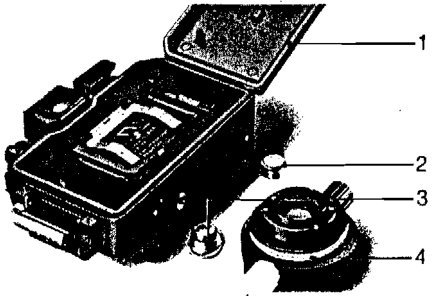
28. Remove the film cartridge.

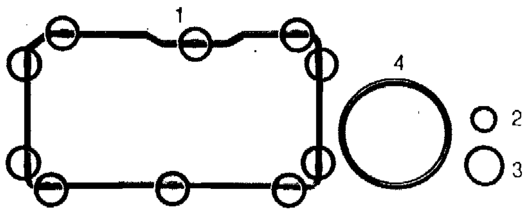
Open the camera back and take out the film cartridge.



29. Lock the shutter release button.

Return the shutter speed dial to the "A" position to make the camera ready for loading the next roll of film. Finally, set the shutter release button lock to the "L" position. This prevents the shutter release button from being depressed and causing inadvertent battery drain.





ngs

urpose of using O-rings on the Nikonos IV-A is to ıll joints making the camera completely water- As explained in the "PREPARATION" section, hould apply lubricant to the O-rings whenever ;sary to insure smooth operation and long life. ɘ make sure to clean all sand and foreign matter ese parts. If you find a ring difficult to clean, /e it completely making certain not to scratch it. ısure watertightness, replace all O-rings when ›ecome scratched or worn.

move the O-rings, except the one around the ra back, grasp the ring between your thumb and ηger. Pinch you fingers together as you slide in the direction of the arrow to create slack in the O-ring. Then grasp the slack portion with your other hand and pull the ring off (Fig. 1). The O-ring around the camera back can be removed by inserting a pointed object under the ring and pulling up to lift it out (Fig. 2). However, make sure not to scratch the O-ring in doing so.

To install a new O-ring, insert one side of the ring into the groove and hold it in position while rolling the other side of the ring into place (Fig. 3). When inserting the O-ring into the groove in the camera back, first place it over the groove; then press it down in the groove making certain that the ten points having small winged-shaped projections (as circled in red above) are fully seated into the ten pairs of slots (Fig. 4).

Fig. 1

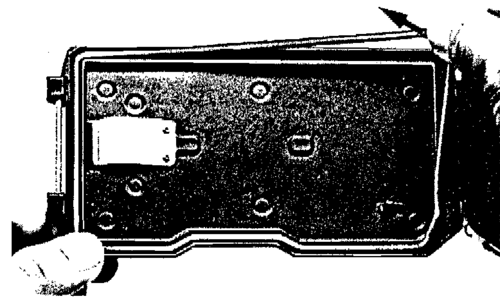


Fig. 2

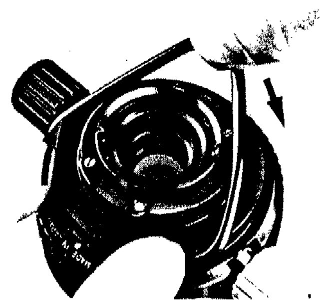


Fig. 3

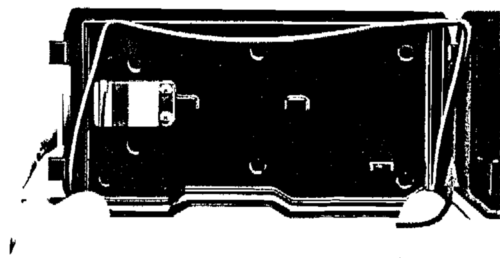
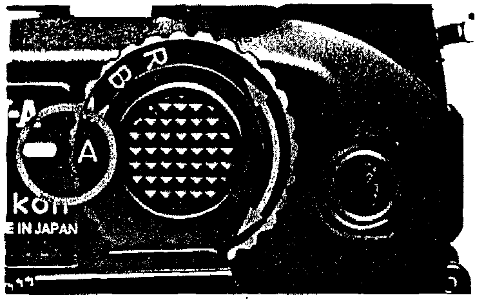


Fig. 4

ƆNTROLS IN DETAIL—continued



ıtter speed dial ③

shutter speed dial on the Nikonos IV-A has four ngs: A, M, B and R.

ıe A (AUTO) setting

ın the dial is set to "A," the shutter speed is auto-cally set to match the ASA/ISO film speed setting, lens aperture setting, and the scene brightness. the meter on, and an LED inside the viewfinder ıs when the shutter speed is within the "safe" ıe of approx. 1/30—1/1000 sec. However, if the ter speed is outside this range, the LED blinks as ırning. In this case, turn the lens aperture knob to her setting. If you are unable to stop the LED from king after all possible settings, then the subject is too bright or too dim for automatic exposure control. If the subject is too bright, use a neutral density filter or change the film to one with a lower ASA/ISO; if the subject is too dim, use a speedlight or faster film. With the Nikonos Speedlight SB-101, the shutter speed is automatically switched to 1/90 sec. for proper electronic flash synchronization. To speed up film loading, the shutter fires at approx. 1/1500 sec. for blank shots until the frame counter reaches "1."

***Note:** The UW-Nikkor 15mm f/2.8 cannot be used for automatic exposure. When using it, set the dial to "M" and estimate the exposure or use an underwater exposure meter instead.*

At the M (MECHANICAL) setting

This setting provides a backup mechanical speed of 1/90sec. in case the batteries become weak or exhausted or there are none loaded in the camera. This setting should also be used when speedlights other than the Nikonos Speedlight SB-101 are used.

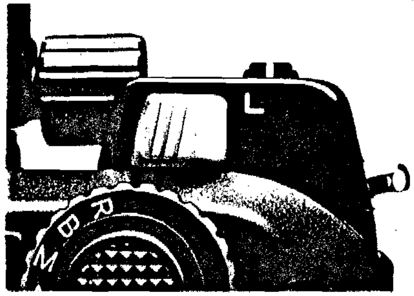
At the B (BULB) setting

At "B," the shutter remains open for as long as you keep the shutter button depressed, allowing you to make time exposures or create "stroboscopic" effects by firing the flash repeatedly with the shutter open. "B" is also a mechanical setting.

At the R (REWIND) setting

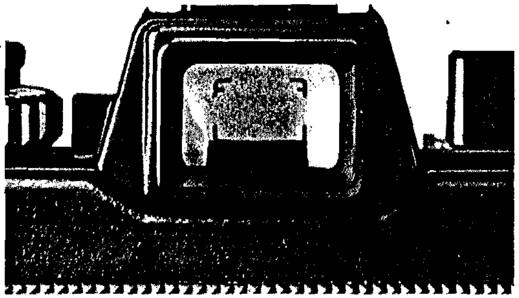
To disengage the film sprocket drive for rewinding, the dial to "R." At this setting, the shutter rele button cannot be operated.

8810002



utter release button ⑤ (with lock ⑥)

ated at the top of the anatomical grip, the large tter release button on the Nikonos IV-A provides venient operation either above or below the water. ı the shutter speed dial set at "A," the shutter on serves as a meter-ON switch when depressed way; the meter then stays on for approx. 20sec. r you take your finger off the button, turning itself automatically to conserve battery power. When d in conjunction with the LED in the viewfinder, shutter release button can be used as a battery ck. When you release the shutter at "A" in a very ‹ place or with the front lens cap on, the shutter tain may remain open. If this happens, turn the tter speed dial to either "B" or "M" to close the shutter. A shutter release button lock is provided to prevent wasting a frame or causing inadvertent battery drain in case the shutter release button is accidentally depressed while the camera is not in use.

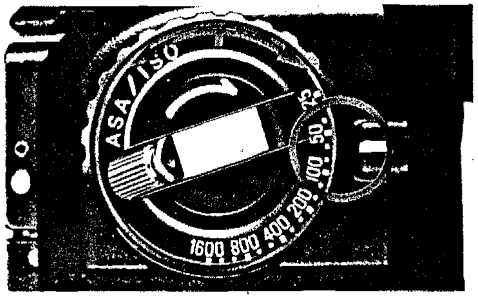


Viewfinder 18

The high-eyepoint viewfinder in the Nikonos IV-A allows you to place your eye up to 40mm away from the eyepiece, so that the entire field of view can be seen while wearing a diver's mask, goggles, or safety glasses. The built-in frame lines indicate the area of coverage for the normal 35mm lens; the parallax correction marks should be used to frame the subject when shooting at the closest focusing distance of 0.8m (2.75ft).

At the bottom of the viewfinder, there is an LED wh glows when the shutter speed is between approx. 1 and 1/1000 sec. and blinks when the speed is outs this range. In addition, a flash ready-light in the fo of a red lightning bolt appears when the Nikon Spe light SB-101 is charged up and ready to fire

ONTROLS IN DETAIL—continued



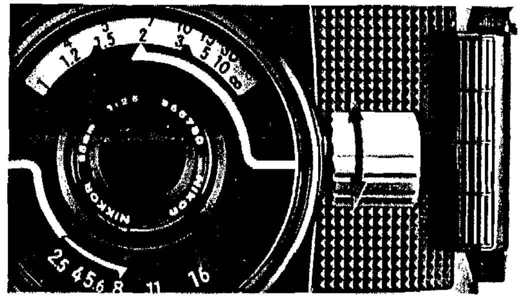
\/ISO film speed dial 23

ding ASA/ISO settings from 25 to 1600, the film d dial is set by lifting up the knurled ring and ng until the desired speed is opposite the white . When the ring is released, it locks into place. dial can be rotated even underwater without fear iter getting inside the camera.
et the correct exposure when shooting backlit cts or for creating special effects, you can reset dial for exposure compensation. If you're using ISO 100 film, turn the dial from 100 to 50 and the picture will be one f/stop overexposed; reset the rom 100 to 200, and the final photograph will be one f/stop underexposed. The right amount of exposure compensation can be determined through trial and error.

ASA/ISO film speed scale

25 50 100 200 400 800 1600
32 40 64 80 125 250 500 1000
160 320 640 1250

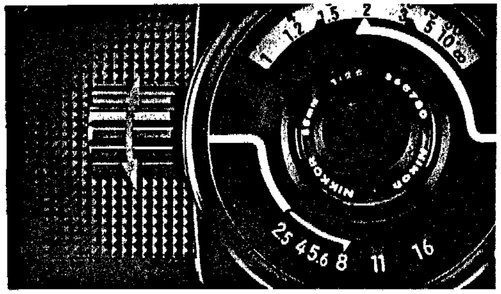
***Note:* Make sure to return the ASA/ISO dial to the correct setting after you have finished making exposure compensation.**



Lens focusing knob 13

The Nikonos IV-A does not offer through-the-lens focusing, nor is it equipped with a rangefinder. Therefore, you must focus by either estimating or actually measuring the camera-to-subject distance and then setting it on the lens. To focus the lens, turn the white focusing knob until the desired distance in meters or feet is opposite the white focusing index. In addition, a pair of pincer-type depth of field indicators shows the exact distance from near to far that will be in sharp focus in the final photograph.

***Note:** When you actually measure the distance underwa you must modify this distance before setting it on the lens. more information, refer to "Tips on Underwater Photograp on page 36.*



›ns aperture knob 11

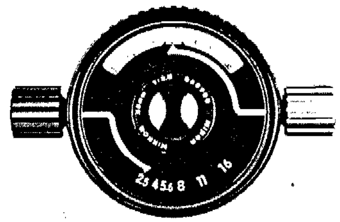
turning the black lens aperture knob, you change › size of the lens aperture letting more or less light ss through the lens. At the same time the pincer-›e depth-of-field indicators expand or contract, ile the aperture scale moves in relation to the arrow :ex. By adjusting the aperture, the automatically ected shutter speed can be controlled. Choose a de aperture (smaller f/number), and you let in more it thus increasing the shutter speed. On the other nd, by selecting a small aperture (larger f/number), › light is reduced resulting in a slower shutter speed. addition to controlling the shutter speed, the size of · aperture also determines depth of field. Depth of d is to the zone of acceptable foucs extending in front of, and behind, the plane of sharpest focus and is indicated clearly by the depth-of-field indicators. Within this zone, image blur is negligible and everything can be considered as being in sharp focus. Three factors control depth of field: the focal length of the lens in use, the camera-to-subject distance, and the shooting aperture.

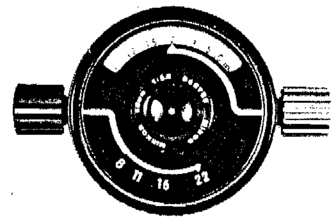
At wide apertures, depth of field is very shallow. But, as the lens is stopped down, depth of field increases proportionally. Please refer to the following examples for details.

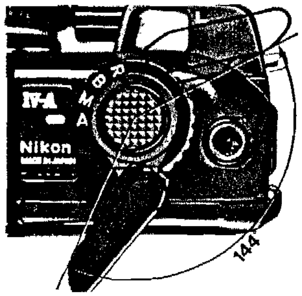
Note: *To cover any error you might have made in focusing, use the smallest aperture possible. Alternately move farther away from the subject or use a lens with shorter focal length.*

f/2.5—Shallow depth of field

f/22—Deep depth of field

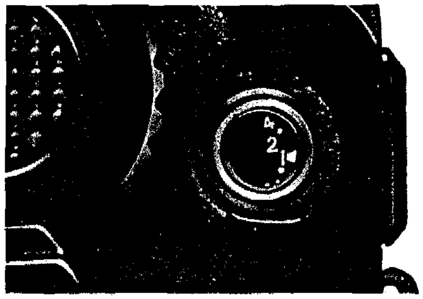






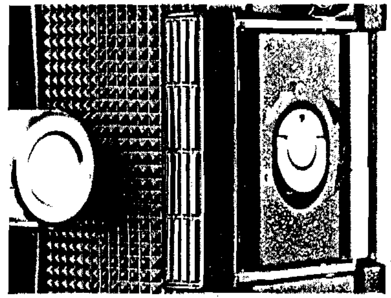
ı advance lever 17

ılm advance lever on the Nikonos IV-A operates ɘ same manner as a regular 35mm camera. ɘ the lever in the direction of the arrow to cock hutter and advance the film to the next frame. ɘver is ratcheted, so it may be operated in one ıuous stroke or a series of shorter ones. In on, the lever is hinged for compact storage in the ›osition. The angle of throw is 144°.



Frame counter

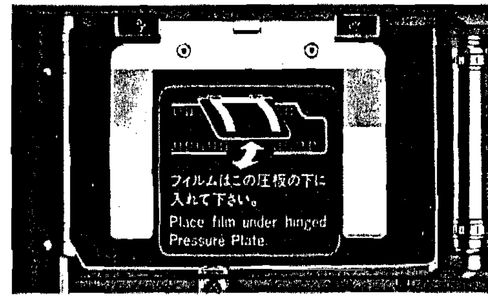
To accommodate all commercially available film cartridges, the Nikonos IV-A frame counter goes up to 36. The "S" appears automatically as soon as the camera back is opened and signifies the "START" position. Then there are two dots between "S" and "1." After "1," even numbers are listed with odd numbers indicated by dots in between. All indications are in white against a black field for maximum legibility. On "AUTO," until the frame counter reaches "1," the shutter speed is approx. 1/1500 sec. for blank shots to facilitate film loading.



Camera back latch 24 (with O-C key 25)

New to the Nikonos IV-A is its swing-open type camera back. This design allows quick and easy film loading in the normal 35mm camera way.

To allow the camera back to be opened or closed in a minimum amount of time, a quick-release camera back latch is employed. It can be opened after turning the O-C key to the "O" (OPEN) position. After loading film, to prevent the camera back from being accidentally opened and to insure complete watertightness, you must turn the O-C key to the "C" (CLOSED) position. It goes without saying that you should never attempt to load or unload the camera underwater or in situations where water might get inside the camera.



Pressure plate 20

Instead of being attached to the camera back, t Nikonos IV-A's pressure plate is attached to the ins of the camera and is hinged.

This style pressure plate uses a safety catch to ke the film flat, and to protect the shutter curtains fr accidental splashes or foreign matter when open the camera back.

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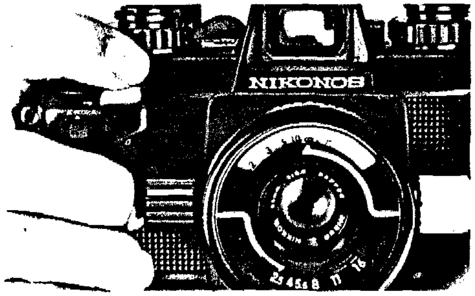
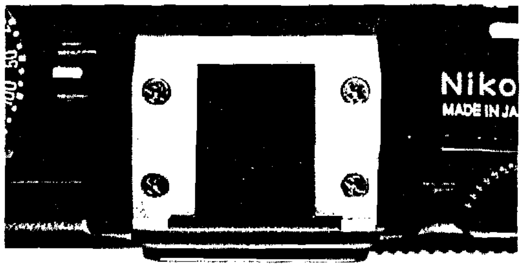
ƆNTROLS IN DETAIL—continued



ıtomical grip 8

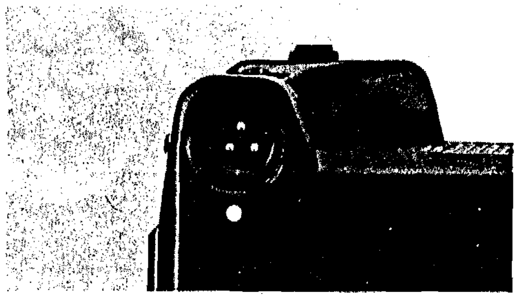
ɘacing your right forefinger on the shutter release n with the thumb behind the film advance lever, other fingers just naturally wrap around the ɔmical grip. With this comfortable and secure you can change rapidly from horizontal to vertical- ıt shooting with a minimum of fumbling. One of ɔiggest causes of unsharp pictures is camera ɘ. When you release the shutter, support the ɘra with both hands and gently squeeze the er release button instead of jabbing it. Under- r, weightlessness makes steady camera holding more difficult. Concentrate on steadiness even ı using fast shutter speeds.



Accessory shoe ①

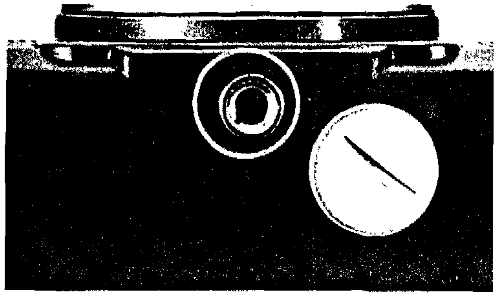
Built into the top of the viewfinder, the Nikonos IV-A's accessory shoe accepts the following accessories:

1. Two plastic frame finders, one for the UW-Nikkor 28mm f/3.5 and the other for the W-Nikkor 35mm f/2.5 or the Nikkor 80mm f/4.
2. Three optical viewfinders, one for the UW-Nikkor 15mm f/2.8, another for the 28mm lens, and the third for the 80mm for use on land.
3. The Sensor Unit SU-101 for the Nikonos Speedlight SB-101 as well as regular direct-mounting speedlights for non-underwater use.



Flash socket 26

The flash socket is located in the camera's baseplate just below the anatomical grip. Use a coin to unscrew the flash socket cover. Like the battery chamber cover, it has an O-ring to insure absolute watertightness. Once the cover is removed, electrical connection between the camera and the Nikonos Speedlight SB-101 can be made via the coiled sync cord. Since the Nikonos IV-A's flash socket provides X-sync only, a flash unit utilizing flashbulbs *cannot* be used. A special Flash Unit Adapter is also available allowing other electronic flash units to be used for non-underwater photography with Nikonos IV-A.



Tripod socket 27

A standard tripod socket is located in the camera baseplate for attachment of the bracket for th Nikonos Underwater Speedlight SB-101. A regul tripod can also be used for shooting on land at slo shutter speeds or when making time exposures.

TIPS ON CAMERA CARE

1. After using the camera in salt water, and whenever dirty, rinse it thoroughly in fresh running water to remove any residue. Then dry with a soft cloth before opening. Never dry the camera by heating.
2. Do not submerge the camera in water with the flash socket cover removed. And whenever using the Nikonos Speedlight, make sure that the sync cord and sensor cord plugs are securely attached before entering the water.
3. Should the lens or body be accidentally dropped in salt water during loading (or at any other time when the interior is exposed), rinse immediately in fresh water and take the unit to a Nikon Service Center or your dealer as soon as possible.
4. Do not attempt to adjust the focusing knob or aperture knob past the end limits of travel; forcing these knobs will result in damaging the lens mechanism.
5. Never attempt to change lenses, open the camera, or load/unload film underwater.

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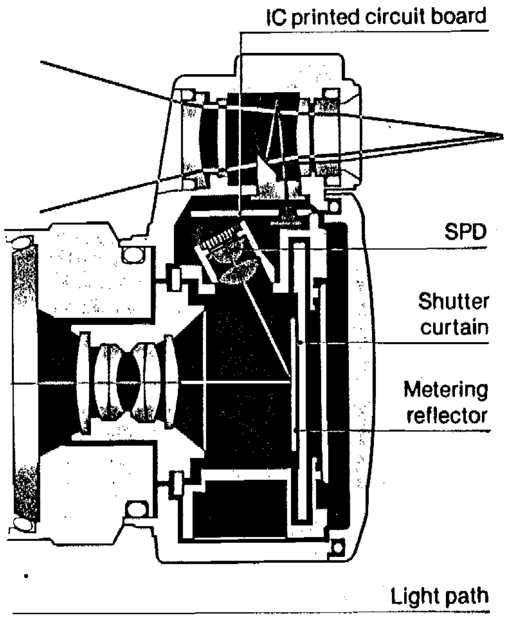
:CHNICAL INFORMATION



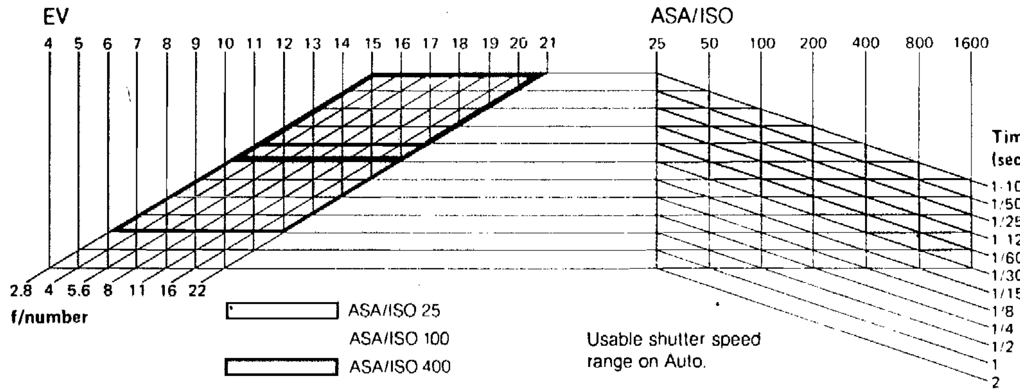
Automatic Exposure Control System

The Nikonos IV-A features a highly advanced automatic exposure control system. A fast-reacting silicon photo diode (SPD) used for metering is located just below the viewfinder and faces downward and toward the rear. Light from the subject passes through the lens, strikes a special metering reflector in front of the shutter and then is reflected back to the SPD. The intensity of the light, in addition to the setting on the ASA/ISO film speed dial, is translated into exposure information by an IC printed circuit board at the top of the camera. Processed in record time, the correct shutter speed is selected for proper exposure. At the instant of exposure, the electromagnetically controlled shutter stays open for precisely the required amount of time. Speeds are infinitely variable between approx. 1/30 and 1/1000 sec.

EV Chart

At ASA/ISO 100, the exposure range of the Nikonos IV-A is from EV8 (1/30 sec. at f/2.8) to EV19 (1/1000 sec. at f/22). The ranges at various ASA/ISO's are shown in the chart. For example, the range at ASA/ISO 100 is in pink; the range at ASA/ISO 25 is indicated by blue lines, while ASA/ISO 400 is in black.

EV is an abbreviation of Exposure Value. The expos value is a number representing all the combinatic of shutter speeds and f/stops which will give exac the same amount of exposure. For instance, EV represents 1/30 sec. at f/5.6, but it can also me 1/60 sec. at f/4 or 1/125 sec. at f/2.8.



OPTIMUM BATTERY PERFORMANCE

1. New batteries: Between manufacturing and first use, all batteries exhibit some drain. Therefore, care should be taken to purchase the newest (and freshest) ones possible. To help you do this, some manufacturers stamp the date of manufacture on the bottom of each battery. Ask your camera dealer for assistance in interpreting the codes.
2. Temperature: Battery life ratings are based on operation at around 20°C (68°F). At other temperatures, battery life is shortened. At 0°C, for instance, battery life is shortened by as much as 2/3. Spare batteries should therefore be kept available if operation in low temperatures is anticipated.
3. Continuous use: Batteries are drained much more quickly by continuous use than by intermittent use.
4. Storage: When not in use, the batteries should be removed to prevent damage from leakage. To minimize drain during the period of disuse, store the batteries in a cool, dry place.
5. Battery brands: Do not use mixed brands of batteries, nor batteries with different model numbers. Also, avoid mixing new and old batteries since proper performance will not be obtained and battery leakage into your Nikonos IV-A may occur.
6. Disposal: Do not dispose of batteries by throwing them in a fire. For safety's sake, never disassemble batteries.
7. Polarity: When installing batteries, observe the voltage polarities carefully. Reversal of the positive (+) and negative (–) terminals will result in leakage. If leakage should occur, clean carefully or take your Nikonos IV-A to your dealer.

›ECIFICATIONS

e of camera	35mm amphibious camera
ıstruction	Body made of die-cast aluminum alloy and reinforced plastic; all joints sealed by means of O-ring gaskets to insure absolute water-tightness; camera able to with-stand pressures up to the 6kg/cm² (85 lb/in²) at depths down to 50m (160 ft)
:ure format	24mm × 36mm (standard 35mm film format)
s mount	Nikonos bayonet type
ses	W-Nikkor 35mm f/2.5 as standard; three additional lenses from super-wideangle to tele-photo available
tter	Vertical-travel metal focal-plane type
tter speeds	A (AUTO): Electronically con-trolled stepless speeds from 1/30 to 1/1000 sec.; M (MANUAL): Mechanical speed of 1/90 sec.; B (BULB): Mechanical setting for long exposures; R (REWIND): Setting used when rewinding film
Shutter release	Via button at top of anatomical grip; initial pressure on button switches on meter, meter then stays on for approx. 20 sec. after finger is taken off button; shutter release lock incorporated
Exposure control	Aperture-priority automatic exposure with mechanical speeds at M and B; through-the-lens stopped-down metering via silicon photo diode (SPD) with center-weighted metering pattern
Film speed range	ASA/ISO 25 to 1600
Metering range	EV 8 to EV 19 at ASA/ISO 100 with f/2.8 lens
Accessory shoe	Provided; built into top of viewfinder
Flash synchronization	X-sync only via flash socket in camera's base; with Nikonos Speedlight SB-101, shutter speed is automatically switched to 1/90 sec. with shutter speed dial at "A"; with other electronic flash units, shutter speed dial is manually set to "M"
Viewfinder	Inverted Galilean type Albada finder built into camera for use with standard 35mm lens; bright frame lines show approx. 85% field of view; 0.55X magnifi-cation; diopter 0.9; high eyepoint allows viewing with eye 40mm away from finder; parallax correction marks provided; accessory optical viewfinders or frame finders available for various lenses
Viewfinder display	Large red LED in lower part of viewfinder glows when shutter speed is between approx. 1/30 to 1/1000 sec.; blinks if shutter speed is outside this range; red LED lightning bolt lights up when Nikonos Speedlight SB-101 is recycled and ready to fire; on automatic control, the lightning bolt glows only when the meter-ing circuit is on
Film advance lever	Wound in single stroke or series of strokes; 144° winding angle; hinged for compact storage; shutter speed automatically set to approx. 1/1500 sec. until frame "1" for fast film loading
Frame counter	Additive type; self-resetting
Film rewind	Manual via film rewind crank
Camera back	Hinged with camera back latch and O-C key
Pressure plate	Hinged-type attached to camera body; locking catch provided
Batteries	Two 1.5V silver-oxide cells (Eveready EPX76, D76, or equivalent)
Battery check	LED inside viewfinder lights up i[f] batteries are loaded properly an[d] their voltage is approx. 2.6V or above
Dimensions (without lens)	149mm(W) × 99mm(H) × 58mm(D)
Weight (without lens)	Approx. 740g

Model [illegible]

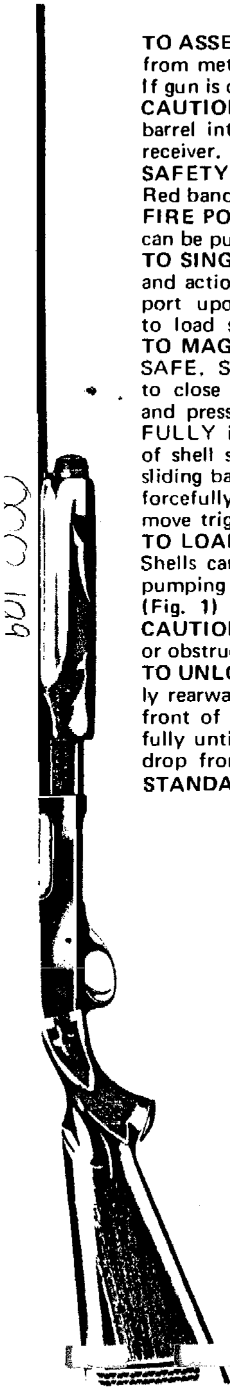
Pump Action Shotgun

12, 20 Gauges

28, 410 & 20 Ga. [illegible]

Owner's Manual

Remington®



MODEL 870 12-20
PUMP ACTION SHOTGUN 28-410 & 20 GA. LW

Wingmaster®

TO ASSEMBLE GUN – Gun is shipped taken down. Before assembling, clean lubrication from metal parts and bore of barrel. Remove magazine cap and cardboard packing ring. If gun is cocked press action bar lock and slide fore-end half way back.
CAUTION: Do not pump action or pull trigger repeatedly with barrel removed. Place barrel into receiver with barrel guide ring over magazine tube. Seat barrel firmly into receiver. Do not jam barrel against ejector. Replace and tighten magazine cap.
SAFETY (Fig. 1) – Before loading or unloading gun, push safety to ON SAFE position. Red band on safety will not show.
FIRE POSITION – Push safety to FIRE position. Red band marking will show. Trigger can be pulled to fire gun.
TO SINGLE LOAD – Push safety ON SAFE. Pull fore-end fully to rear. If gun is cocked and action locked closed, press in action bar lock **(Fig. 1).** Place shell into open ejection port upon carrier. Slide fore-end forward to load shell and lock action.

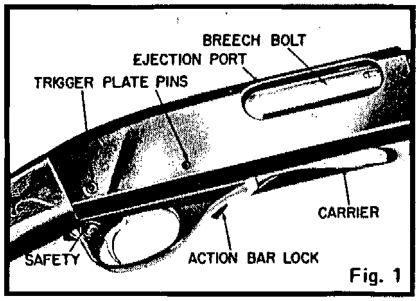


Fig. 1

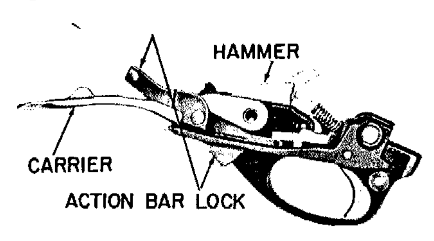
TO MAGAZINE LOAD – Push safety ON SAFE. Slide fore-end completely forward to close action. Turn gun bottom upward and press shell against carrier then forward FULLY into magazine. Make sure that rim of shell snaps past shell latch to avoid shell sliding back over carrier. Should this occur, forcefully open action or, if necessary, remove trigger plate assembly to remove shell.
TO LOAD CHAMBER from MAGAZINE – Shells can be fed from loaded magazine by pumping fore-end. Press in action bar lock (Fig. 1) if gun is cocked. Pump fore-end back and forth to open and close action.
CAUTION: Before firing make sure barrel bore is clean and free of any grease, heavy oil or obstruction.
TO UNLOAD GUN – Push safety ON SAFE. Press in action bar lock; pull fore-end slowly rearward until front end of shell from barrel is even with ejection port in receiver. Lift front of shell outward and remove from ejection port. Continue pulling fore-end back fully until next shell releases from magazine. Roll gun sideways to allow released shell to drop from ejection port. Close action. Continue until magazine and gun are empty.
STANDARD MODEL (12 – 20 GAUGE) – Barrel chambered for 2¾" shells in light or heavy modern factory loads or 2¾" MAGNUM.
(28 – 410 GAUGE) – Barrel is chambered for 2¾" shell in 28 ga. and 3" and 2½" shell in 410 ga.
3 INCH MAGNUM MODEL – Barrel is chambered for 3 inch Magnum shell.
NOTE: 3" MAGNUM shells cannot be fired in standard guns designed for 2¾" shells.
CAPACITY – Gun capacity is five (5) shells – one in chamber and four (4) in magazine. When using 3" shells, capacity of 410 ga. gun is reduced to four (4) shells. The Federal Migratory Bird Treaty Act, and some state laws, require that the maximum magazine capacity does not exceed two (2) shells so that overall gun capacity is not more than three (3) shells. Check magazine capacity of your state and for game you plan to hunt. **12, 16 & 20 gauge** field grade guns and 12 & 20 gauge Magnum grade guns are shipped from factory with a suitable plug installed in magazine. To remove plug unscrew magazine cap. Remove magazine spring retainer from front of magazine tube by placing screw driver under inside rim of retainer and prying free. **Remove carefully. Retainer is under compression of spring.** Remove plug. Reassemble spring and retainer into tube. **IMPORTANT** – Place retainer into magazine tube, cup inward, and tap firmly until flat on retainer is flush with end of tube.
BARREL CLEANING – Push safety ON SAFE. Open action and make certain no shells remain in chamber or magazine. Unscrew magazine cap and remove barrel. Replace magazine cap to end of magazine tube. Clean barrel with cleaning rod and lightly oiled cloth. If necessary, scrub bore with powder solvent. Wipe clean and re-oil very lightly.
ACTION CLEANING – A petroleum solvent can be used. Take necessary prec[illegible]s. A[illegible] mech[illegible] s rem[illegible] lean [illegible] long[illegible] r sh[illegible] if lubrication is used sparingly.

DISASSEMBLY of Model 870 for cleaning or service of action parts should be done as follows:

TRIGGER PLATE ASSEMBLY (Fig. 2) – Push safety ON SAFE Open action and make certain no shells remain in chamber or magazine. Cock action. Tap out front and rear trigger plate pins. Lift rear of trigger plate from receiver, then slide rearward to remove from gun. If necessary to clean, brush with solvent. Clean as a unit. Wipe dry and re-oil very sparingly. To replace trigger plate assembly, close action and carefully insert assembly (carrier first) into receiver. Adjust until trigger plate is aligned in opening. Push downward on rear of trigger plate until assembly enters receiver freely. Adjust to align holes and tap in front and rear trigger plate pins. Open action and push up carrier until action bar lock is visible. Top of action bar lock should ride along and not over-ride bottom edge of action bar.

NOTE: Do not allow hammer to snap forward with trigger plate assembly removed from gun. In reassembling trigger plate mechanism, always be sure that end of action bar lock is below end of connector, left. Otherwise, gun will not function properly (Fig. 2).

FORE–END ASSEMBLY UNIT – Push safety ON SAFE. Open action and make certain no shells remain in chamber or magazine. Close action and remove magazine cap and barrel. Reach into bottom of receiver and press left shell latch inward. Slide fore-end off magazine tube. NOTE: Top right edge of slide may bind on bottom front of ejection port in receiver. To free slide, push front end of bolt downward.

Fig. 2


After fore-end assembly is removed from gun, breech bolt parts and slide may be lifted from ends of action bars. Not necessary to disassemble bolt parts. Brush with solvent to clean.
NOTE: Gun must be cocked when reassembling fore-end parts. During reassembly of fore-end assembly unit, place slide in correct position on ends of double action bar. Place breech bolt assembly (includes attached locking block assembly) over slide on bars. Insert end of action bars into matching receiver grooves. Move fore-end gently rearward into receiver until contact is made with front end of right shell latch (See exploded view). Press front of right shell latch into side of receiver. Move fore-end past right shell latch until contact is made with left shell la[illegible] Press f[illegible] of lef[illegible] latch[illegible] d to allow fore-end assembly to pass and reassemble freely into receiver. Reassemble barrel and tighten firmly with magazine cap.

BELOW FREEZING WEATHER – Special attention should be taken that oil is removed from action parts. If a lubricant is desired – use dry graphite or similar non-congealing lubricant. Take care to prevent rusting from condensation and wetness (cold weather to warm room temperature) on action parts and barrel bore, barrel chamber.

HANDLING – Outside of gun should be wiped with oil to prevent rust. Invisible "prints" of moisture can cause rusting unless removed. Exposure to unfavorable weather or moisture from condensation also require additional care.

MAINTENANCE – Gun should be checked periodically by a competent gunsmith to ensure proper inspection and any necessary replacement of worn or damaged parts.

IMPORTANT – Remington firearms are designed, manufactured and proof tested to standards based on factory loaded ammunition. Improperly loaded handloads can be dangerous. Remington Arms Company, Inc., cannot assume responsibility for damages or injury caused by handloads or reloaded ammunition.

This gun has been manufactured to Remington specifications and shipped from the factory suitable for use. Remington does not recommend and is not responsible for any alteration or modification to the gun not made by Remington factory personnel, nor the replacement of worn or damaged parts with those not of Remington manufacture.

SHOOTING GLASSES. Smart shooters, who don't normally wear corrective lenses, always hunt and shoot wearing good, impact–resistant shooting glasses in order to protect their eyes against unanticipated ricochet, possible powder blowback, or branch and twig whiplash. In addition to eye safety, green or gray glasses keep the eyes fresh and untired on bright, glary days, while yellow lenses aid in spotting game in dim or fading light. So for safety, comfort and better shooting – both in the field and on the target range – shooting glasses are a real "must".

EAR PROTECTION – Proper ear protection in the form of ear plugs or hearing guards should be worn whenever practical.

PUMP ACTION SHOTGUN

NOTE: SEE INSTRUCTIONS FOR ORDERING PARTS.

View No.	Part No.	NAME OF PART	List Price
	NOTE	**Field Grade 12, 20 Gauge listed below. See added page for other grades.**	
1	18849	Action Bar Lock	
2	19622	Action Bar Lock Spring	
	NOTE	**All Barrels (same gauge) interchangeable without adjustment. Prices furnished upon application. Also give choke and barrel length needed.**	
3		Barrel Assembly, 12 Ga., PLAIN	
		Barrel Assembly, 20 Ga., PLAIN	
		Barrel Assembly, 12 Ga., VENT RIB	
		Barrel Assembly, 20 Ga., VENT RIB	
4	18545	Breech Bolt, 12 Ga.	
	20016	Breech Bolt, 20 Ga.	
	22860	Breech Bolt Assembly, 12 Ga.	
	22862	Breech Bolt Assembly, 20 Ga.	
7	18584	Carrier	
	20060	Carrier Assembly	
8	15480	Carrier Dog	
9	17416	Carrier Dog Follower	
10	17415	Carrier Dog Follower Spring	
11	18781	Carrier Dog Pin	
12	18760	Carrier Dog Washer	
13	17417	Carrier Pivot Tube	
14	17419	Connector, Left (Restricted)	
15	17551	Connector, Right (Restricted)	
16	17420	Connector Pin	
17	25431	Ejector, 12 Ga.	
	24447	Ejector, 20 Ga.	
18	18646	Ejector Rivet, Front	
19	18647	Ejector Rivet, Rear	
20	18648	Ejector Spring	
21	16176	Extractor	
22	17432	Extractor Plunger	
23	17433	Extractor Spring	
24	17436	Firing Pin	
25	18623	Firing Pin Retaining Pin	
26	17437	Firing Pin Retractor Spring	
	20088	Fore-end (Wood only) 12 Ga.	
	20089	Fore-end (Wood only) 20 Ga.	
27	27552	Fore-end Assembly, 12 Ga.	
	27553	Fore-end Assembly, 20 Ga.	
28	20065	Fore-end Tube Assembly	
29	18634	Fore-end Tube Nut	
30	18673	Front Sight (Plain Barrel)	
	18796	Front Sight (Vent Rib) Steel Bead	
	15660	Front Sight Retaining Pin (for use on Vent Rib Steel Sight)	
31	18015	Grip Cap	
31a	14943	Grip Cap Spacer	
32	25380	Grip Cap Screw	
33	18749	Hammer	
34	16600	Hammer Pin	
	15809	Hammer Pin Washer	
35	17465	Hammer Plunger	
36	19014	Hammer Spring	
37	22325	Locking Block Assembly	
	24075	Locking Block Assembly (oversize)	
39	25375	Magazine Cap	
40	17451	Magazine Cap Detent	
41	16791	Magazine Cap Detent Spring	
42	32350	Magazine Follower, 12-20 Ga.	
43	18097	Magazine Plug, 3-Shot, Wood	
44	19479	Magazine Spring	
45	16949	Magazine Spring Retainer	
46	20030	Receiver Assembly, 12 Ga. (Restricted)	
	20032	Receiver Assembly, 20 Ga. (Restricted)	
47	18551	Receiver Stud	
47a	14620	Recoil Pad	
47b	25410	Recoil Pad Screw	
47c	14944	Recoil Pad Spacer	
48	25115	Safety	
49	23223	Safety Detent Ball	
50	17514	Safety Spring	
51	17515	Safety Spring Retaining Pin	
52	18750	Sear	
53	17463	Sear Pin	
54	17518	Sear Spring	
55	20040	Shell Latch, Left, 12 Ga.	
	20042	Shell Latch, Left, 20 Ga.	
56	20045	Shell Latch, Right, 12 Ga.	
	20047	Shell Latch, Right, 20 Ga.	
57	14543	Slide Assembly	
58	14577	Stock Assembly	
59	19993	Stock Bearing Plate	
60	18571	Stock Bolt	
61	18572	Stock Bolt Lock Washer	
62	18573	Stock Bolt Washer	
63	25370	Trigger (Restricted)	
	20610	Trigger Assembly (Restricted)	
64	17533	Trigger Pin	
65	25035	Trigger Plate, R.H. Safety	
	25036	Trigger Plate. L.H. Safety	
	22985	Trigger Plate Assembly, R.H. (R.H. Safe)	
	22986	Trigger Plate Assembly, (L. H. Safe)	
66	20601	Trigger Plate Pin, Front	
67	20606	Trigger Plate Pin, Rear	
68	17541	Trigger Plate Pin Bushing	
69	17539	Trigger Plate Pin Detent Spring, Front	
70	17540	Trigger Plate Pin Detent Spring, Rear	

DELIVERIES ARE F.O.B. ILION, N. Y. PRICES AND PARTS SUBJECT TO CHANGE WITHOUT NOTICE

28-410 GA. MODEL 870 PUMP ACTION SHOTGUN PARTS LIST

NOTE: SEE INSTRUCTIONS FOR ORDERING PARTS.

See 12 & 20 Gauge List For Parts Not Listed Below.

Part No.	NAME OF PART	List Price
18849	Action Bar Lock	
19622	Action Bar Lock Spring, 28 Ga.	
14706	Action Bar Lock Spring, 410 Ga.	
	Please list choke needed	
30020	Barrel Assembly, 28 Ga., 25" Vent Rib	
30025	Barrel Assembly, 410 Ga., 25", Vent Rib	
14439	Breech Bolt, 28 Ga.	
14440	Breech Bolt, 410 Ga.	
30040	Breech Bolt Assembly, 28 Ga.	
30041	Breech Bolt Assembly, 410 Ga.	
20615	Butt Plate	
25410	Butt Plate Screw (2)	
15387	Butt Plate Spacer	
29795	Carrier, 28 Ga.	
14741	Carrier, 410 Ga.	
30130	Carrier Assembly, 28 Ga.	
30131	Carrier Assembly, 410 Ga.	
14280	Ejector, 28 Ga.	
14452	Ejector, 410 Ga.	
14721	Ejector Rivet	
14678	Ejector Rivet, Front, 410 Ga.	
14441	Extractor 28 Ga.	
91222	Extractor 410 Ga.	
14742	Extractor Plunger 410 Ga.	
14806	Extractor Spring 410 Ga.	
14297	Firing Pin Retaining Pin	
15702	Firing Pin Retractor Spring	
30050	Fore-end (wood only), 28 Ga.	
30051	Fore-end (wood only), 410 Ga.	
29810	Fore-end Assembly, 28 Ga.	
29811	Fore-end Assembly, 410 Ga.	
29815	Fore-end Tube Assembly.	
14276	Fore-end Tube Nut	
18796	Front Sight (for Vent Rib) Steel Bead	
15660	Front Sight Retaining Pin (for Vent Rib Steel Sight)	
14295	Hammer	
29920	Locking Block Assembly	
14279	Magazine Cap	
14961	Magazine Follower, 28 Ga.	
14960	Magazine Follower, 410 Ga.	
90497	Magazine Plug (3-Shot Wood) 28 Ga.	
14878	Magazine Plug (3-Shot Wood) 410 Ga.	
17496	Magazine Spring, 28 Ga.	
14901	Magazine Spring, 410 Ga.	
17501	Magazine Spring Retainer	
30081	Receiver Assembly, 28 Ga.	(Restricted)
30080	Receiver Assembly, 410 Ga.	(Restricted)
20041	Shell Latch, 28 Ga., Left	
30931	Shell Latch, 28 Ga., Right	
31661	Shell Latch, 410 Ga., Left	
30930	Shell Latch, 410 Ga., Right	
31660	Slide Assembly	
30085	Stock Assembly	
19621	Stock Bearing Plate	
31280	Trigger Plate, R.H. Safety	
31281	Trigger Plate, L.H. Safety	
29930	Trigger Plate Assembly, 28 Ga., R.H. Safety	
29931	Trigger Plate Assembly, 410 Ga. R.H. Safety	
29936	Trigger Plate Assembly, 28 Ga., L.H. Safety	
29935	Trigger Plate Assembly, 410 Ga., L.H. Safety	
20602	Trigger Plate Pin, Front	
20607	Trigger Plate Pin, Rear	

The Match-Weight Skeet Cap is adjustable to suit individual shooters. Weight of cap will vary from eleven ounces when empty to one pound two ounces when filled with the maximum amount of shot.

To adjust, unscrew and remove from gun and remove magazine cap. Loosen lock nut and turn rod counter clockwise to increase depth of shot chamber. Fill with number 8 or 9 shot and tighten locknut. Replace magazine cap and reassemble Match-Weight Skeet Cap to gun.

ACCESSORY (Added Cost)

Part No.	NAME OF PART	List Price
31285	Match-Weight Skeet Cap	

SKEET GRADE

NOTE: For Parts Not Listed, see Field Grade, 28 & 410 Gauge.

Part No.	NAME OF PART	List Price
31285	Match-Weight Skeet Cap Assembly, 28 and 410 Ga.	
30615	Barrel Assembly, Skeet Grade, 28 Ga., 25", Vent Rib	
30616	Barrel Assembly, Skeet Grade, 410 Ga., 25", Vent Rib	
31675	Fore-end Assembly, 28 Ga. SA Grade	
31676	Fore-end Assembly, 410 Ga. SA Grade.	
31590	Stock Assembly, 28 & 410 Ga. SA Grade	

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ADDITIONAL GRADES

MODEL 870 PUMP ACTION SHOTGUN

PARTS LIST

NOTE: SEE INSTRUCTIONS FOR ORDERING PARTS.

Parts Not Listed Below Same As Field Grade.

Part No.	NAME OF PART	List Price
19465	Action Bar Lock, TC	
	Barrel Assembly, PLAIN, 12 Ga. 3" MAGNUM	
	Barrel Assembly, PLAIN, 20 Ga. 3" MAGNUM	
	Barrel Assembly, VENT RIB, 12 Ga. 3" MAGNUM	
	Barrel Assembly, VENT RIB, 20 Ga. 3" MAGNUM	
	Barrel Assembly, BRUSHMASTER, 12 Ga.	
	Barrel Assembly, BRUSHMASTER, 20 Ga.	
	Barrel Assembly, RIFLE SIGHT (20 inch) 12 Ga. only	
	Barrel Assembly, POLICE Grade, 12 Ga. only.	
	Barrel Assembly Police Grade (18") 12 Ga. only.	
	Barrel Assembly, SKEET Grade, VENT RIB, 12 Ga.	
	Barrel Assembly, SKEET Grade, VENT RIB, 20 Ga.	
	Barrel Assembly, SKEET Grade, VENT RIB COMP., 12 Ga.	
	Barrel Assembly, SKEET Grade, VENT RIB COMP., 20 Ga.	
	Barrel Assembly, TB — TC Grade, VENT RIB	
18851	Ejector, MAGNUM Grade (12 Ga.)	
18852	Ejector, MAGNUM Grade (20 Ga.)	
18855	Ejector Spring, MAGNUM Grade	
25450	Fore-end, (Wood only), POLICE Grade	
27457	Fore-end, (Wood only), TB Grade, 12 Ga.	
21818	Fore-end, (Wood only), SC Grade, 12 Ga.	
21819	Fore-end, (Wood only), SC Grade, 20 Ga.	
15665	Fore-end, (Wood only), TC Grade 12 Ga.	
22570	Fore-end Assembly, POLICE Grade	
22571	Fore-end Assembly, Standard Deer Gun and AP Grade	
27557	Fore-end Assembly, TB Grade, 12 Ga.	
21823	Fore-end Assembly, SC Grade, 12 Ga.	
21824	Fore-end Assembly, SC Grade, 20 Ga.	
21151	Fore-end Assembly, TC Grade.	
91482	Front Sight (Rifle Sight) 12 Ga.	
91481	Front Sight (Rifle Sight) 20 Ga.	
18918	Front Sight (Ivory Bead) VENT RIB	
18771	Grip Cap, TB—TC—SC Grade	
25385	Grip Cap Screw, TB—TC—SC Grade	
19626	Magazine Spring, POLICE Grade	
18052	Middle Sight	
32523	Rear Sight Assembly Brushmaster, 12 Ga.	
32520	Rear Sight Assembly Brushmaster, 20 Ga	
91483	Rear Sight Aperture	
32500	Rear Sight Base	
28505	Rear Sight Base Screw	
90905	Rear Sight Slide	
90906	Elevation Screw	
90904	Windage Screw	
22975	Receiver Assembly, MAGNUM Grade, 12 Ga.	
22976	Receiver Assembly, MAGNUM Grade, 20 Ga.	
21413	Receiver Assembly, TB Grade, 12 Ga.	
20033	Receiver Assembly, TC Grade, 12 Ga.	
21385	Recoil Pad, TB—TC Grade (Red)	
22990	Stock Assembly, POLICE, DEER GUN, AP Grade	
27441	Stock Assembly, TB Grade	
15669	Stock Assembly, TB Grade, Monte Carlo	
21812	Stock Assembly, SC Grade.	
21136	Stock Assembly, TC Grade	
15672	Stock Assembly, TC Grade, Monte Carlo	

SPECIAL ACCESSORIES

Part No.	NAME OF PART	List Price
30855	Sling Strap Assembly only, 7/8" Plain	
	To Complete for Mounting add:	
20435	Sling Strap Hooks (2). (Each)	
18593	Stock Swivel Screw	
20150	Swivel Front Assembly, 12 and 20 Ga.	
25565	Sling Strap Assembly and Mountings Complete	
21350	Magazine Plug Assembly (12 Ga. only) Vari-Weight, 3-Shot, Steel	

20 GA. LW — MODEL 870 PUMP ACTION SHOTGUN — PARTS LIST

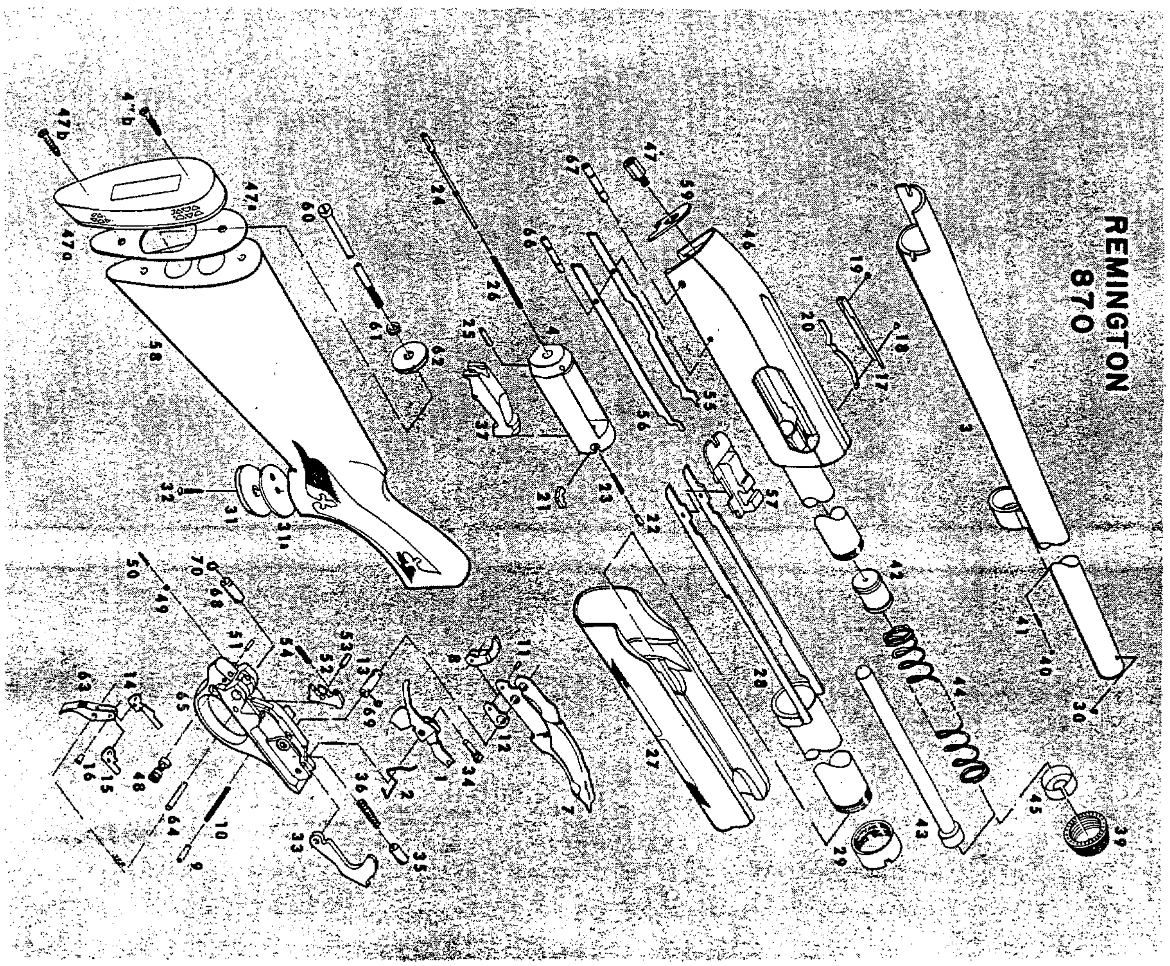
NOTE: SEE INSTRUCTIONS FOR ORDERING PARTS

Part No.	NAME OF PART	List Price
Note:	**Parts not listed below same as 12 Ga.**	
14595	Action Bar Lock	
Note:	**20 Gauge LW barrels are not interchangeable with regular 20 Gauge Barrels. Prices furnished upon application. Please give choke and barrel length needed.**	
	Barrel Assembly, 20 Ga. LW, PLAIN, 26"	
	Barrel Assembly, 20 Ga. LW, PLAIN, 28"	
	Barrel Assembly, 20 Ga. LW, PLAIN, 28" MAGNUM Grade	
	Barrel Assembly, 20 Ga. LW, VENT RIB, 26"	
	Barrel Assembly, 20 Ga. LW, VENT RIB, 28"	
	Barrel Assembly, 20 Ga. LW, VENT RIB, 28" MAGNUM Grade	
14778	Breech Bolt	
32305	Breech Bolt Assembly	
29796	Carrier	
30132	Carrier Assembly	
32050	Ejector	
32051	Ejector, MAGNUM Grade	
18647	Ejector Rivet (2), Rear	
30052	Fore-end (Wood only)	
29812	Fore-end Assembly	
29816	Fore-end Tube Assembly	
15999	Fore-end Tube Nut	
27730	Front Sight (Plain Barrel)	
14295	Hammer	
29921	Locking Block Assembly	
32296	Magazine Cap Assembly	
15995	Magazine Cap	
14448	Magazine Cap Plug	
14962	Magazine Follower	
90497	Magazine Plug, 3 – Shot, wood	
17496	Magazine Spring	
14281	Magazine Spring Retainer	
30082	Receiver Assembly	(Restricted)
30083	Receiver Assembly, MAG. Grade	(Restricted)
30140	Slide Assembly	
30932	Shell Latch, Left	
20049	Shell Latch, Right	
30086	Stock Assembly	
19621	Stock Bearing Plate	
29932	Trigger Plate Assembly, R. H. Safety	
29937	Trigger Plate Assembly, L. H. Safety	
31280	Trigger Plate, R. H. Safety	
31281	Trigger Plate, L. H. Safety	
20602	Trigger Plate Pin, Front	
20607	Trigger Plate Pin, Rear	

DELIVERIES ARE F.O.B. ILION, N. Y. — PARTS AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE

Send all guns for factory service and inquiries on service and parts to
REMINGTON ARMS COMPANY, INC.
Arms Service Division
Ilion, New York 13357

All other inquiries are to be addressed to
REMINGTON ARMS COMPANY, INC.
Bridgeport, Connecticut 06602



MODEL 870
PUMP ACTION SHOTGUN

OLYMPUS STEREO MICROSCOPES

INSTRUCTION MANUAL

MODELS VMF, VMT & VMZ

OLYMPUS

This instruction manual has been written for the use of the Olympus Stereo Microscopes Models VMF, VMT and VMZ. It is recommended that you read the manual carefully in order to familiarize yourself fully with the use of the microscope so that you can obtain optimum performance.

IMPORTANT

■ Operation

1. Always handle the microscope with the care it deserves and **avoid abrupt motions.**
2. Avoid exposure of the microscope to **direct sunlight, high temperature, high relative humidity, dust** and **vibration.**

■ Maintenance

1. Lenses must always be kept clean. Fine dust on lens surfaces should be blown or wiped off by means of an air blower or gauze. Carefully wipe off oil or fingerprints deposited on the lens surfaces, with gauze moistened with a **small** amount of xylene, alcohol or ether.
2. Do not use organic solutions to wipe the surfaces of various components. Plastic parts, especially, should be cleaned with a neutral detergent.
3. **Never disassemble** the microscope for repair.
4. The microscope should be stored in its container immediately after use. If this is not possible, it should be covered with the vinyl dust cover provided. It is best to keep lenses in a desiccator, containing silica gel.

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I. MAIN CHARACTERISTICS

The VM Series Stereo Microscopes include three types of stereomicroscope bodies —— VMF, VMT and VMZ. The Model VMF is provided with one objective pair built into the binocular stereomicroscope body, and the Model VMT with two parfocal objective pairs in a turret built in the microscope body, while the Model VMZ features a continuously variable zoom system objective control in the body.

1. Model VMF

Microscope body	Objective
VMF-1	1X
VMF-2	2X
VMF-4	4X

2. Model VMT

Microscope body	Objective
VMT-2	1X – 2X
VMT-4	1X – 4X

3. Model VMZ

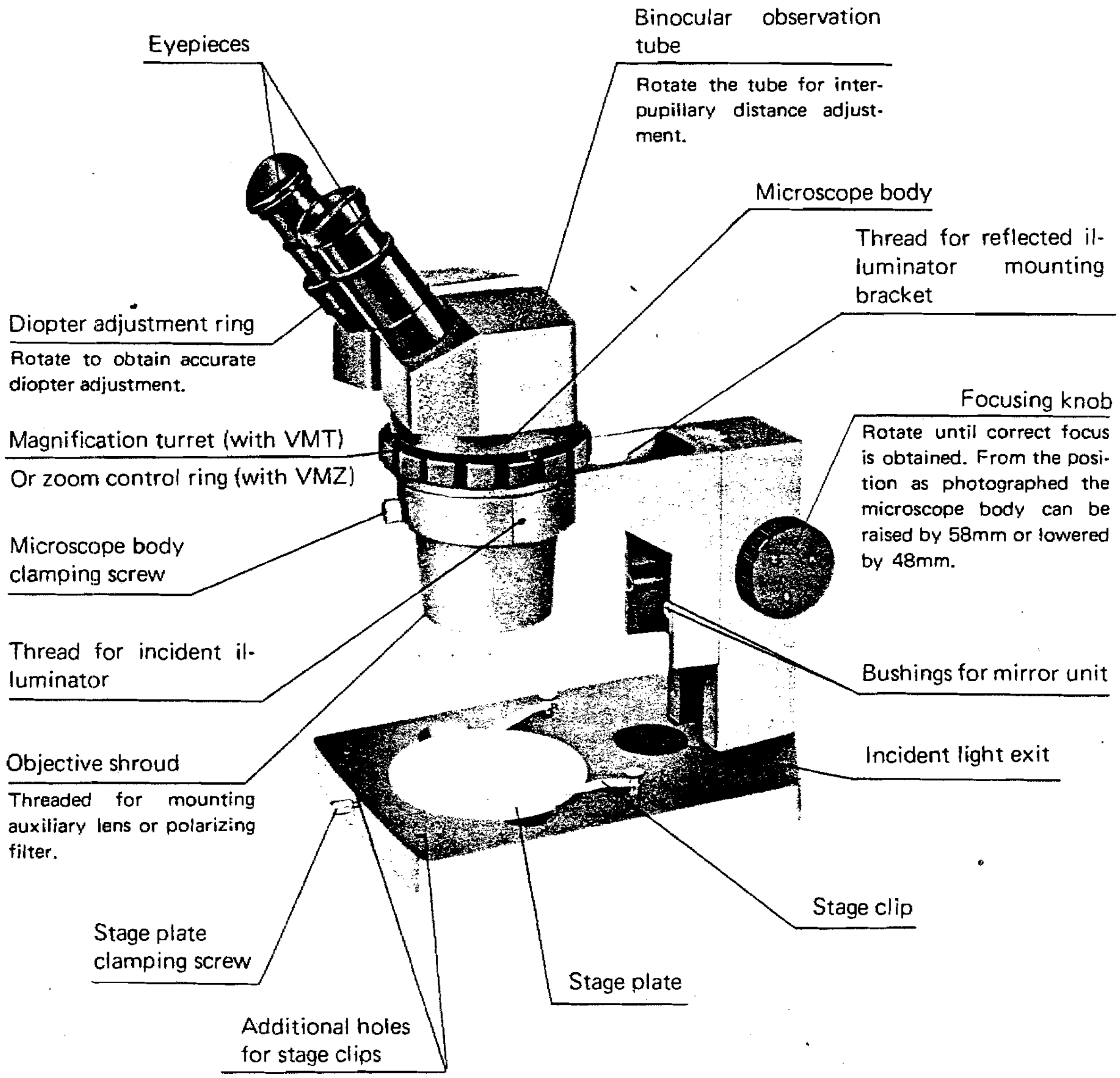
Microscope body	Objective in zoom system
VMZ-4	1X – 4X

II. STANDARD EQUIPMENT

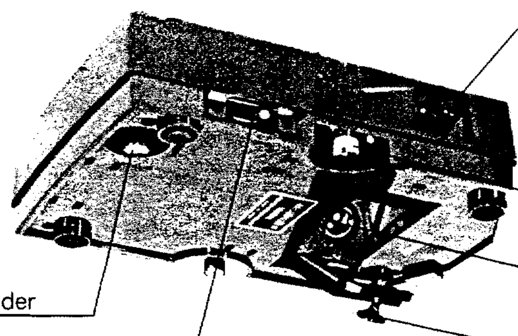
Component		VMF-						VMT-				VMZ-	
		1-S	1-SA	2-S	2-SA	4-S	4-SA	2-S	2-SA	4-S	4-SA	4-S	4-SA
Binocular stereomicro-scope body	with built-in objective 1X VMF-1	○	○										
	with built-in objective 2X VMF-2			○	○								
	with built-in objective 4X VMF-4					○	○						
	with objectives 1X–2X in turret VMT-2							○	○				
	with objectives 1X–4X in turret VMT-4									○	○		
	with zoom system objective 1X–4X VMZ-4											○	○
Standard stand VM-STA		○	○	○	○	○	○	○	○	○	○	○	○
Widefield eyepieces GW10X, paired		○	○	○	○	○	○	○	○	○	○	○	○
Stage plates	Clear glass plate	○	○	○	○	○	○	○	○	○	○	○	○
	Black and frosted white plastic plate	○	○	○	○	○	○	○	○	○	○	○	○
Stage clips, paired		○	○	○	○	○	○	○	○	○	○	○	○
Eyeshields, paired		○	○	○	○	○	○	○	○	○	○	○	○
Reflected and transmitted illumination base VM-ILA			○		○		○		○		○		○
Vinyl dust cover		○	○	○	○	○	○	○	○	○	○	○	○

III. IDENTIFICATION AND FUNCTION OF VARIOUS COMPONENTS

The photo below shows the Model VMT-2-S.

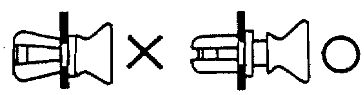


Reflected and Transmitted Illumination Base VM-ILA



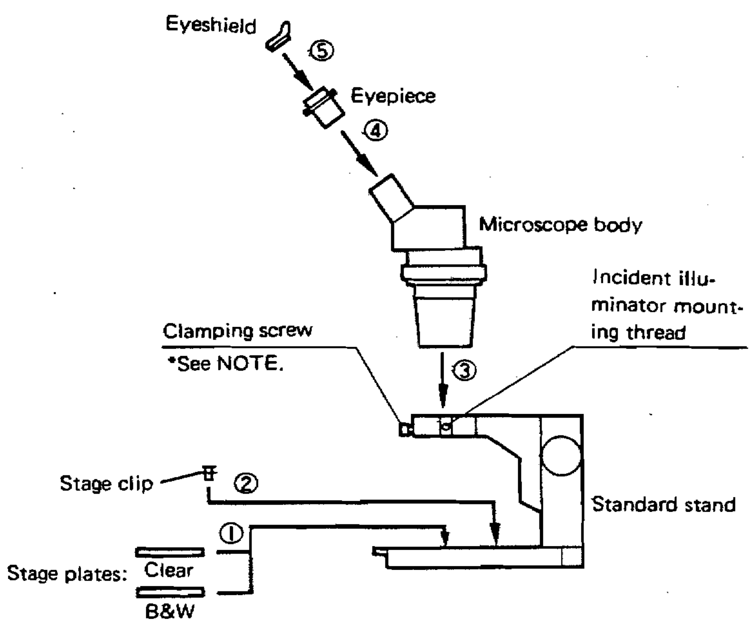
The lamp housing cover can be opened by pulling down the knob; or closed by pushing it up until it snaps in place. Before pushing, ascertain that the knob is positioned as shown in the picture below right, marked with circle.

Mirror unit



IV. ASSEMBLY

The picture below illustrates the sequential procedure of assembly. The numbers indicate the assembly order of various components.



*NOTE:
As this screw can also be used at the incident illuminator mounting thread, you can choose a better position for mounting the incident illuminator so that it does not block your smooth operation.

V. OPERATION

The stage plates fit into the circular opening in the base. The clear plate can be used for both reflected and transmitted illumination. Colored background can be achieved by placing suitable material beneath the plate, for contrast, etc. The frosted plate is used with reflected illumination. The plate is frosted white on one side, and black on the other. If the specimen is white or brightly colored, use the black side of the plate to increase image contrast by darkening the background. For dark or black specimens, reverse the plate with the white frosted side facing the objective.

1. Tension Adjustment of Focusing Knobs

This focusing mechanism makes its motion freely adjustable for either heavy or light movement depending on the observer's preference. To adjust the tension hold the two focusing knobs with both hands and slightly rotate them in the opposite directions, at the same time. (Fig. 1)

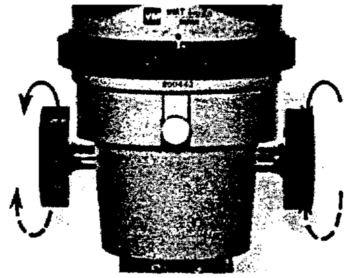


Fig. 1

2. Specimen on the Stage Plate

Place a specimen in the center of the stage plate and clamp it with the stage clips, if necessary. (Fig. 2)

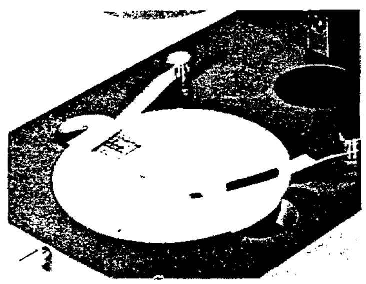


Fig. 2

3. Interpupillary Distance Adjustment

Hold the right and left eyepiece tubes with both hands and push or pull the tubes in the arrow directions until perfect binocular vision is obtained. (Fig. 3)

4. Diopter Adjustment

a) Looking through the right eyepiece with your right eye, focus on the specimen with the focusing knobs.

NOTE: In case of the Model VMT or Model VMZ, ascertain that the high magnification objectives are used for this adjustment.

b) Look at the image through the left eyepiece with your left eye, and rotate the diopter adjustment ring ① to focus on the specimen, without using the focusing knobs. (Fig. 4)

NOTE: If accurate interpupillary distance and diopter adjustments are not accomplished, prolonged observation would put considerable strain on the observer's eyes.

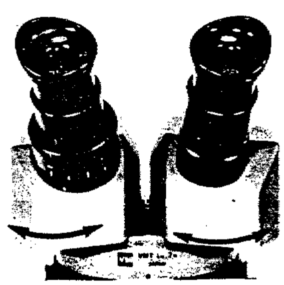


Fig. 3

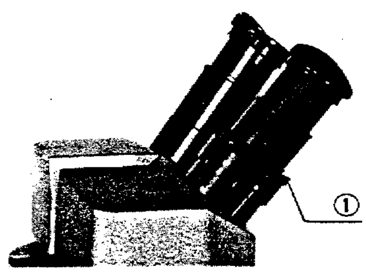


Fig. 4

5. Objective Changes

The Model VMT is provided with two objective pairs. Rotate the turret until the objective pair of your choice is engaged.

In case of the Model VMZ, rotate the zoom control ring until you obtain the desired magnification within the magnification range.

6. Use of Eyeshields

Eyeshields are recommended to prevent glare and loss of contrast caused by ambient light hitting the eye.

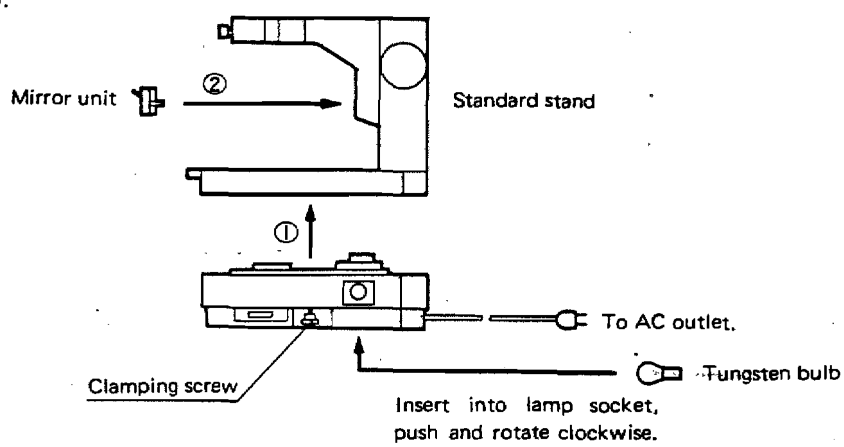
7. Use of the Reflected and Transmitted Illumination Base VM-ILA

a) Water sealed light exits on the base prevent damage from water spills.

b) It provides even illumination with all objective powers except the auxiliary lens VM-AL 0.5X.

c) If light intensity is too high, it can be reduced by placing a 45mm-diameter ND filter on the light exit on the base.

d) Setup.



e) Use.

1) Activate the on-off switch ① .

2) Set the light path selector switch ② .

T: Transmitted light. Use clear stage plate.

R: Reflected light via mirror unit. Adjust the mirror ③ so that the light hits the center of the stage plate.

$\frac{R}{T}$: Combination reflected and transmitted light.

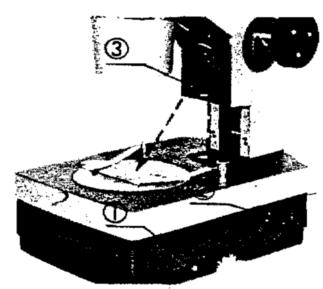


Fig. 5

VI. OPTICAL DATA

■ Models VMF and VMT

Objectives		Eyepieces							
		GW10X (Field number 22)		*GWH10X(23)		G15X(13)		G20X(12.2)	
				Optional					
		*Total magnif.	*Field of view	Total magnif.	Field of view	Total magnif.	Field of view	Total magnif.	Field of view
1X	*W.D. 90mm	10X	22mm	10X	23mm	15X	13mm	20X	12.2mm
2X		20X	11mm	20X	11.5mm	30X	6.5mm	40X	6.1mm
4X		40X	5.5mm	40X	5.75mm	60X	3.25mm	80X	3.05mm

■ Model VMZ (Data below are obtained at zoom magnification setting positions)

Objective (Zoom magnif. 1X to 4X)		Eyepieces							
		GW10X (Field number 22)		*GWH10X(23)		G15X(13)		G20X(12.2)	
				Optional					
		*Total magnif.	*Field of view	Total magnif.	Field of view	Total magnif.	Field of view	Total magnif.	Field of view
1X	*W.D. 90mm	10X	22mm	10X	23mm	15X	13mm	20X	12.2mm
2X		20X	11mm	20X	11.5mm	30X	6.5mm	40X	6.10mm
3X		30X	7.33mm	30X	7.67mm	45X	4.33mm	60X	4.07mm
4X		40X	5.5mm	40X	5.75mm	60X	3.25mm	80X	3.05mm

*REMARKS

GWH10X: Widefield high eyepoint eyepiece.

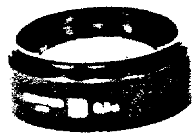
W.D.: Working distance between specimen and objective front lens.

Total magnification = Objective power x Eyepiece power

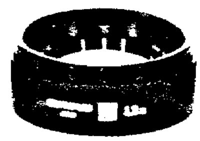
$$\text{Field of view diameter} = \frac{\text{Field number of eyepiece}}{\text{Objective power}}$$

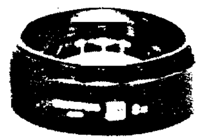
VII. USE OF OPTIONAL ACCESSORIES

A. Auxiliary Lenses VM-AL 0.5X, VM-AL 0.75X, VM-AL 1.5X and VM-AL 2X


VM-AL 0.5X


VM-AL 0.75X


VM-AL 1.5X


VM-AL 2X

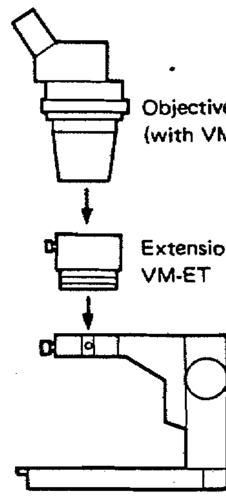
When threaded into the objective shroud, each of these auxiliary lenses permits change of total magnification without changing objective or eyepiece.

Auxiliary lens	*VM-AL 0.5X	VM-AL 0.75X	VM-AL 1.5X	VM-AL 2X
W.D.	156mm(6.14")	101mm(4")	43mm(1.7")	29mm(1.14")

Total magnification = Objective power x Eyepiece power x Auxiliary lens power

$$\text{Field of view diameter in mm} = \frac{\text{Field number of eyepiece}}{\text{Objective power x Auxiliary lens power}}$$

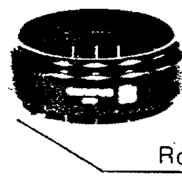
***NOTE:** The VM-AL 0.5X requires an extension tube (VM-ET) in conjunction with the standard stand because of its considerably long working distance. After screwing the VM-AL 0.5X into the objective shroud, attach the extension tube in position between the objective shroud and the standard stand as illustrated right:



B. Simple Polarizing Filter Set VM-POL

This unit enables observation of birefringent material in transmitted light.


Polarizer

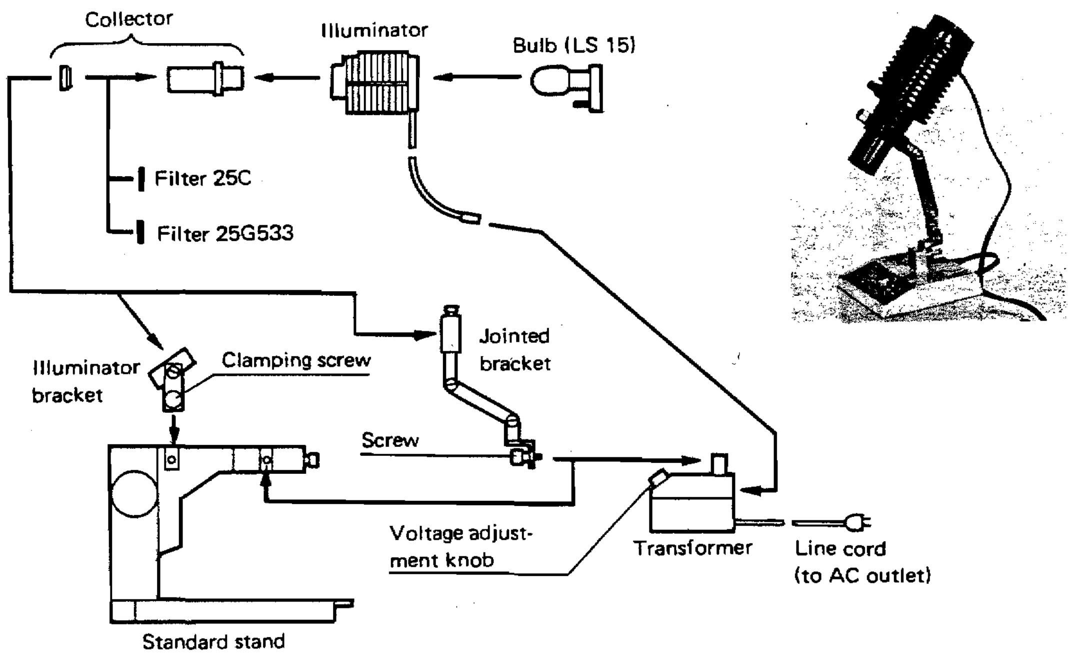


Insert the polarizer into the base opening beneath the stage plate, aligning the white dot to the recess in the opening edge, and screw the analyzer into the threaded objective shroud. Rotate the analyzer rotation knob, looking through the eyepieces, until extinction is achieved.

C. Incident Illuminator VM-LSG

The Model VM-LSG is connected to the transformer TL and can be inserted into the microscope stand or clamped to the transformer by means of a jointed bracket for incident illumination.

a) Setup.

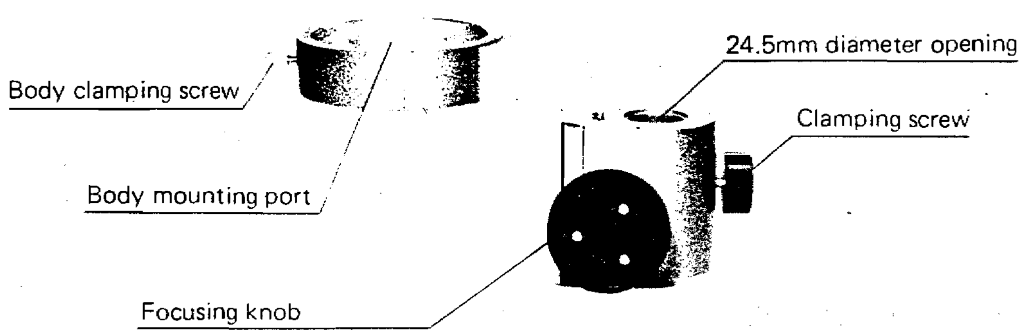


b) The light intensity of the incident illuminator is adjusted by means of the voltage adjustment knob on the transformer.

c) A daylight filter 25C and a green contrast filter 25G533 are provided.

D. Mounting Bracket VM-STI

Permits mounting of the microscope body to the universal table stands Models VS-4, VS-5 or on a custom mounting post on any machine or instrument you own or manufacture, through the 24.5mm diameter opening.



Tension adjustment identical to standard stand.
Focusing range: 58.5mm.

12343-08

LABORATORY TURBIDIMETER
Model 2100A

1-15-80-12ED

MANUAL CHANGE NOTICE

The turbidity standard ampule supplied for the 1.0-NTU range is a 0.61-NTU chlorobenzene solution rather than the 1.0-NTU polymer suspension specified in the manual. Please make the changes described below. This change notice applies to the 11th edition of the Model 2100A Laboratory Turbidimeter Instruction Manual dated 5-1-78.

Page 8, Standardization—change to read as follows:

> Instrument standardization is achieved with the aid of four liquid turbidity standards, one for each range except the lowest. The turbidities of all four standards are based on Formazin dilutions. The standards (furnished with the instrument) are rated at 0.61, 10, 100 and 1000 NTU and are contained in sealed glass tubes. The first (0.61) is a liquid chlorobenzene solution and the last three are liquid latex solutions. When placed in the instrument, the standards scatter an amount of light proportional to the NTU ratings specified on the tubes. Standardization is accomplished by selecting the desired range, placing the appropriate standard in the instrument and, with the light shield in place, adjusting the STANDARDIZE control to obtain a meter reading equal to the NTU value of the standard. When standardizing the 100 and 1000-NTU ranges, the cell riser must be used. *See Figure 3.*
>
> These four standards are secondary standards and are not stable indefinitely. When flocculation begins they should be replaced.
>
> **Caution: Chlorobenzene is flammable and may be a skin irritant.**

Page 13, first Step 3—change to read as follows:

3. Remove the cell riser and repeat the procedure with the 10 and 0.61-NTU standards. Determine if range adjustment is necessary.

Page 13, Step 8—change to read as follows:

8. With the cell riser out of the instrument, insert the 0.61 chlorobenzene turbidity standard tube, cover with the light shield and set the range selection switch to 1.0. Adjust the 1.0-NTU range trimmer potentiometer to obtain a 0.61-NTU reading on the 1.0 meter scale.

Page 22, Parts List—change the turbidity standards kit to read as follows:

Kit, turbidity standardization	12684-00
0.61-NTU chlorobenzene standard	2479-00
10-NTU latex standard	2480-00
100-NTU latex standard	2481-00
1000-NTU latex standard	12652-00

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SPECIFICATIONS

ACCURACY

Within ± 2% of full scale

REPRODUCIBILITY

Within ± 2% of full scale

SENSITIVITY

Better than ± 0.5% of full scale

STANDARDIZATION

Turbid solutions with known turbidity values

CALIBRATION

Formazin

STRAY LIGHT

Less than 0.04 NTU equivalent on low ranges
Less than 0.5 NTU equivalent on 0 - 100 and 0 - 1000 ranges

DARK CURRENT

Less than 1.0% of full scale

VOLTAGE STABILITY

No change in specification from 95 - 135 V or 190 - 270 V

RANGES

0 - 0.2 NTU
0 - 1.0 NTU
0 - 10 NTU
0 - 100 NTU
0 - 1000 NTU

RESPONSE TIME

Less than one second

SAMPLE REQUIRED

25 ml on all ranges

WEIGHT

Net: 17 lbs
Shipping: 23 lbs

POWER REQUIREMENTS

Manually adjustable for 95 - 135 V ac, 50 - 60 Hz, 35 W, or 190 - 270 V ac, 50 - 60 Hz, 35 W

CASE CONSTRUCTION

Heavy gauge steel with corrosion-resistant painted finish
Black case with blue front

DIMENSIONS

9" high (without light shield) x 12" wide x 8½" deep

Model 2100A, complete with all accessories

4 sample cells, 25 mm
1 cell riser and retriever tool
4 turbidity standards, in case
1 focusing template
1 dust cover
1 light shield
1 instruction manual

The Model 2100A Turbidimeter is a true nephelometer used for the measurement of turbidity in liquids.

PRINCIPLE OF OPERATION

The 2100A operates on the principle that light, passing through a substance, is scattered by particulate matter suspended in the substance. In the 2100A, a strong light beam is sent upward through a cell containing a sample. As the beam passes through the turbidity particles, an amount of light (proportional to turbidity present) is scattered at a 90° angle to the beam and is received by a photomultiplier tube. *See Figure 1.* This light energy is, in turn, converted to an electrical signal which is measured by the instrument's panel meter.

SAMPLE CELLS

The turbidimeter is furnished with four sample cells *(see Figure 2)* which should be maintained in a clean condition. The instrument is sensitive to fingerprints or dirt, particularly in the 0 - 1 or 0 - 0.2 NTU ranges. Before each use, clean all sample cells, inside and out, with a good soap or other cleaning solution and rinse in demineralized water. Wipe the outside of the cell with a lens tissue or towel that will not leave an oil film.

CELL RISER

When measuring turbidities on the 0 - 100 and 0 - 1000 NTU ranges, a cell riser is inserted into the cell holder assembly to raise the sample cell. *See Figure 3.* The riser decreases the light path length which results in increased linearity in the measurement of high turbidities. A foam and plastic retriever tool is included with the accessories to remove the cell riser from the instrument.

The cell riser must not be used when measuring turbidities on the 0 - 0.2, 0 - 1 and 0 - 10 ranges. Use of the cell riser on these lower turbidity ranges will result in a significant measuring error.

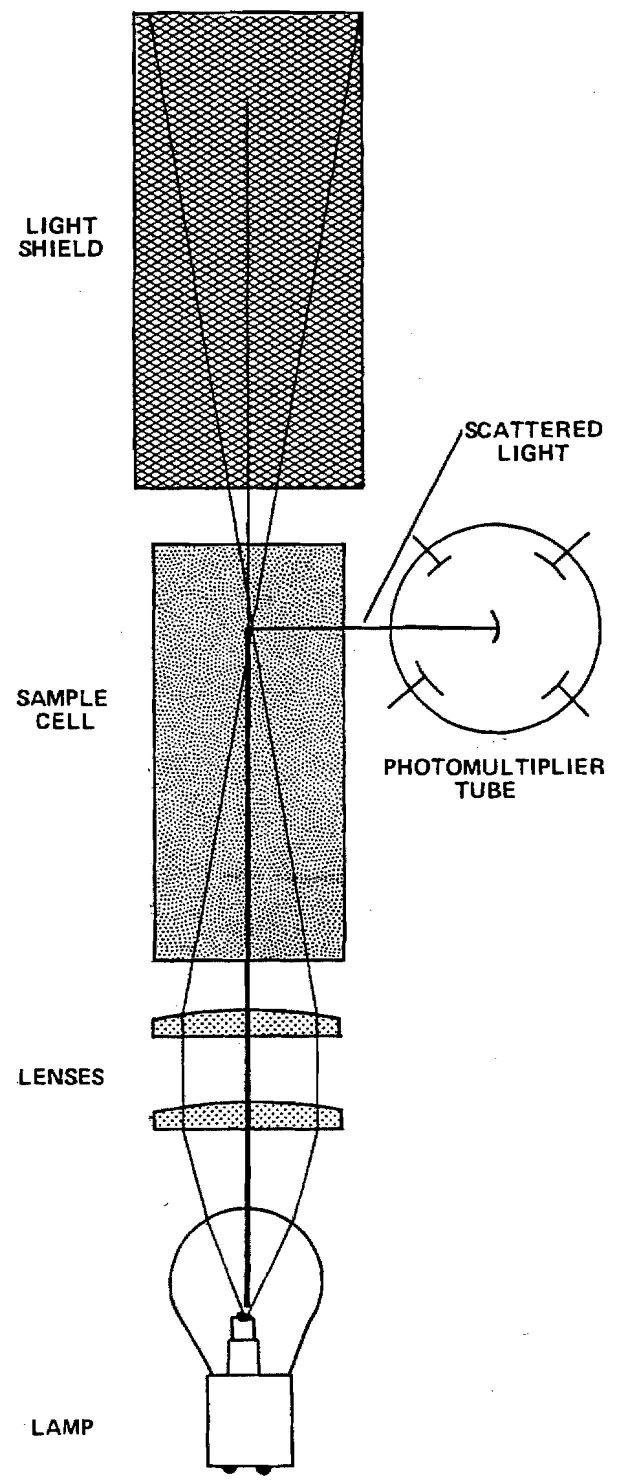

FIGURE 1 LIGHT PATH DIAGRAM

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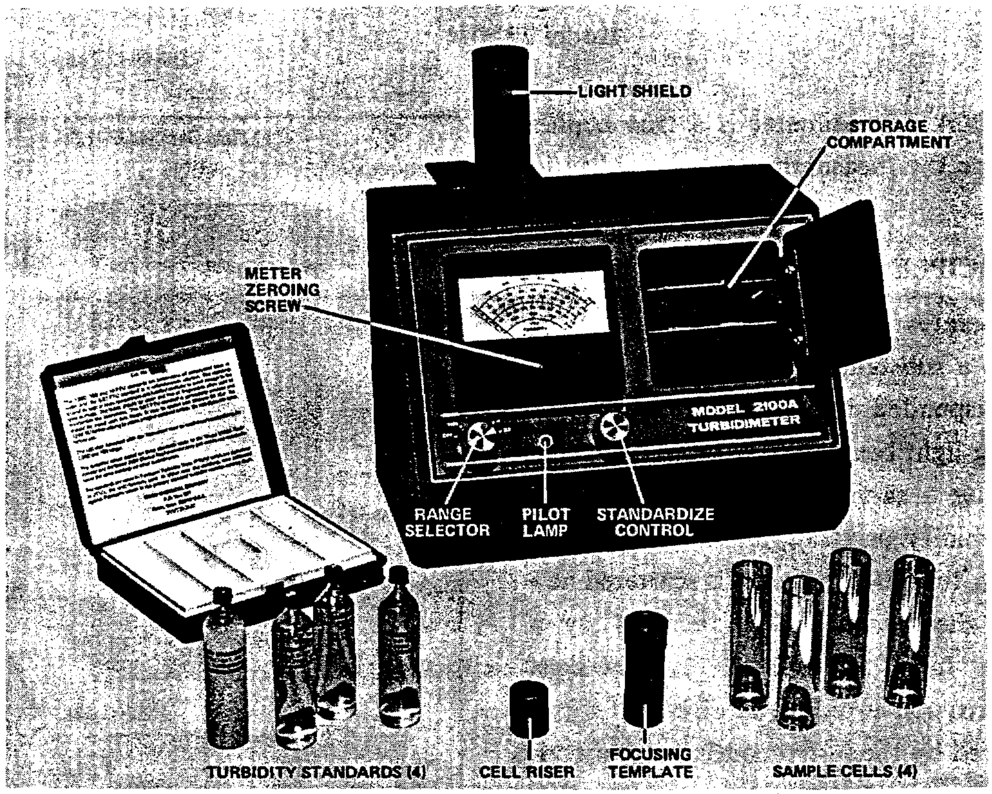

FIGURE 2 **FEATURES AND ACCESSORIES**

CALIBRATION

Calibration of this instrument is based on Formazin, a material that can be made by synthesis and reproduced repeatedly within one percent. When properly mixed, it is uniform in the number, size and shape of its particles, thus making it an ideal turbidity standard. The unit of measure used in this instrument is the Nephelometric Turbidity Unit (NTU).

The following formula for preparing a Formazin stock suspension rated at 4000 NTU is provided for those investigators who may wish to work with other turbidity units or who may want to check their turbidity standards.

PREPARATION OF FORMAZIN STANDARD

(See Parts List for ordering chemicals)

1. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($N_2H_4 \cdot H_2SO_4$) in about 400 ml of distilled water.
2. Dissolve 50.000 grams of pure hexamethylenetetramine in about 400 ml of distilled water.
3. Pour the two solutions into a one-liter volumetric flask and dilute to volume with distilled water.
4. Allow the solution to stand for 48 hours at 20° - $22^{\circ}C$ (68° - $72^{\circ}F$). During this time the suspension will develop.

The following table gives the relationship between dilutions of the stock suspension prepared per preceding instructions and NTU's. When diluting the suspension, use "turbidity-free" distilled or demineralized water. Be sure to adequately mix the stock suspension prior to removing a portion for dilution.

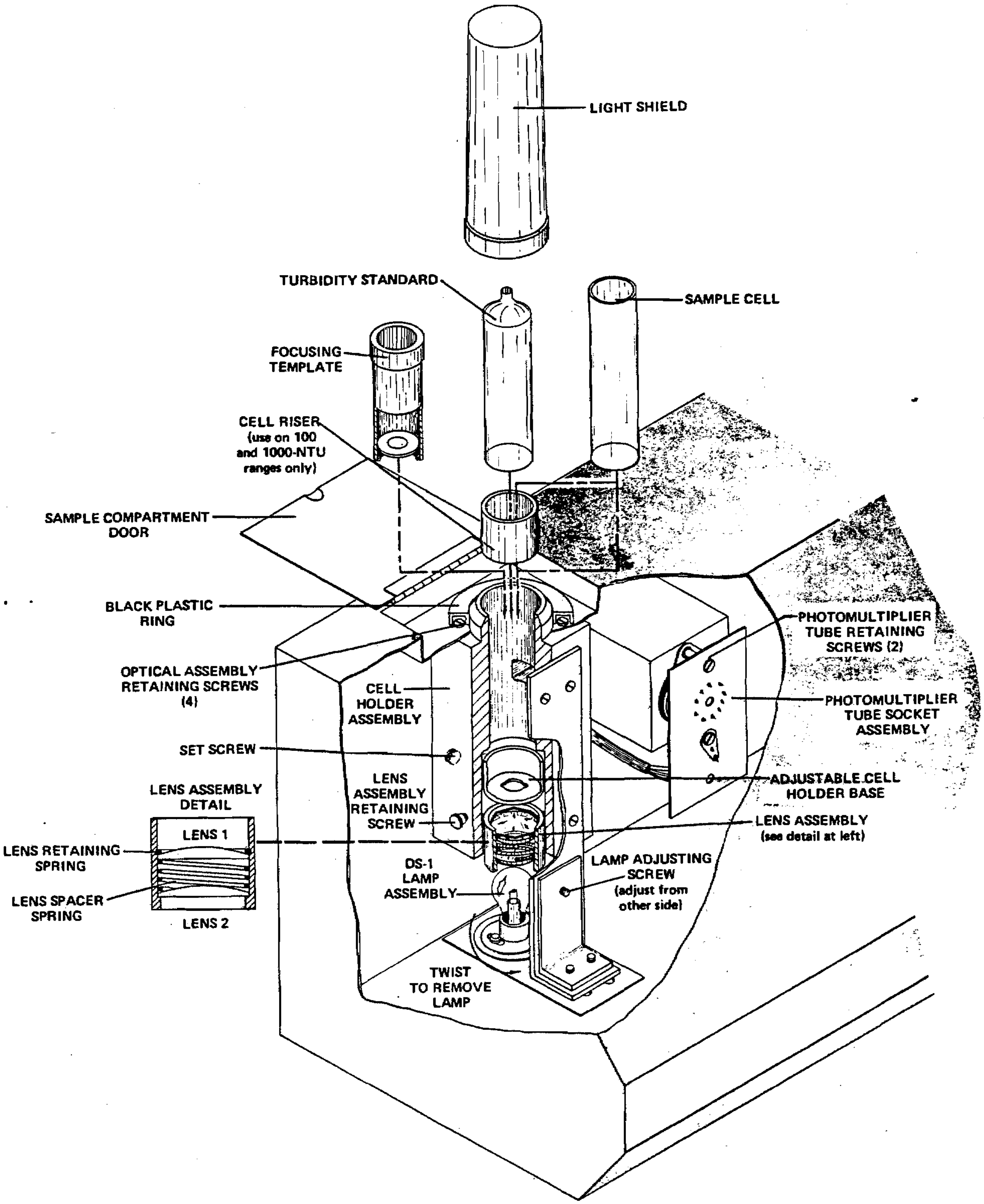

FIGURE 3 OPTICAL ASSEMBLY DIAGRAM

NTU's	ml of Stock Suspension Diluted to 1.000 liter with "Turbidity-free" Water
1000	 250
500	 125
100	 25
50	. . . . 12.5
10	. . . . 2.5
5	. . . . 1.25
1	. . . . 0.25

The Formazin stock suspension is stable for 6 to 12 months, whereupon it should be discarded. The diluted samples are stable for no more than two days.

STANDARDIZATION

Instrument standardization is achieved with the aid of four liquid turbidity standards, one for each range except the lowest. The turbidities of all four standards are based on Formazin dilutions. The standards (furnished with the instrument) are rated at ~~1.0~~ 0.61, 10, 100 and 1000 NTU and are contained in sealed glass tubes. The first ~~(1.0)~~ 0.61 is a ~~high molecular weight polymer dissolved in water and the other~~ liquid chlorobenzene solution the rest three standards are liquid latex solutions. When placed in the instrument, the standards scatter an amount of light proportional to the NTU ratings specified on the tubes. Standardization is accomplished by selecting the desired range, placing the appropriate standard in the instrument and, with the light shield in place, adjusting the STANDARDIZE control to obtain a meter reading equal to the NTU value of the standard. When standardizing the 100 and 1000-NTU ranges, the cell riser must be used. *See Figure 3.*

These four standards are secondary standards and are not stable indefinitely. When flocculation begins they should be replaced.

Caution: Chlorobenzene is flammable and may be a skin irritant.

STRAY LIGHT

In the design of optical instruments, the matter of minimizing stray light in the optical system is important. In the 2100A Turbidimeter, the amount of stray light has been determined to be 0.035 to 0.040 NTU on the 0-0.2, 0-1 and 0-10 ranges. This is significant only on the 0-0.2 range and it is recommended that 0.04 be subtracted from the reading when using this range.

START-UP

1. The instrument is normally wired for 115 V, 50/60 Hz operation. If desired, it can be ordered for 220 V, 50/60 Hz. The operating voltage can be changed manually in the field by changing the jumper arrangement on TB–1. *See Figure 4. Refer to the note on the instrument schematic for the appropriate jumpering.* After it has been determined that the instrument is connected for the proper voltage, it should be plugged into a grounded outlet.
2. Before turning the instrument on, note whether the meter needle is at the zero point. If it is not, zero the instrument by turning the small screw located on the meter. *See Figure 2.*
3. Turn the power switch on. The amplifier and power supplies in the instrument are stable with line voltage and temperature changes. However, due to the inherent characteristics of photomultiplier tubes, maximum accuracy will be achieved if the instrument is allowed to operate for approximately 12 hours before it is standardized and readings are taken.
4. Check the instrument for proper focusing. Vibrations during shipment may cause lamp movement. *Refer to Lens and Focus paragraph on page 10.*

OPERATIONAL NOTES

1. The sample size for all turbidity measurements should be 25 (± 1 ml). Variations in sample volume can affect the accuracy of the determinations.

NOTE ↑

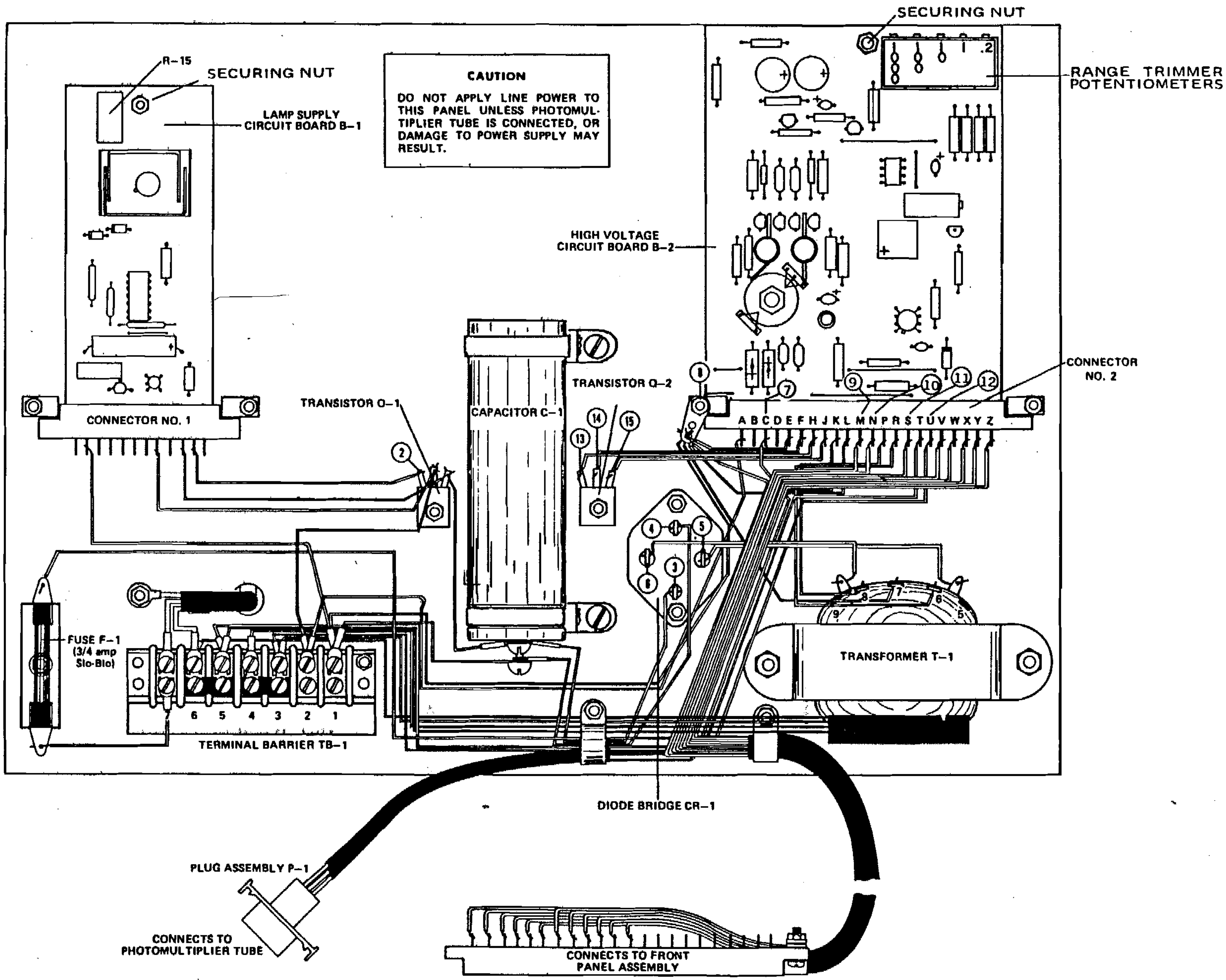

FIGURE 4 **BACK PANEL PICTORIAL**

2. When measuring the lower ranges (0-10, 0-1 and especially 0-0.2 NTU), air bubbles in the sample will cause false high readings. Before covering the cell with the light shield, observe the sample in its cell. If finely divided air bubbles are present, five minutes may be required before the bubbles can rise past the photomultiplier tube so that a valid reading can be taken. Bubbles may be eliminated rapidly and completely by dipping the end of the filled sample cell into an ultrasonic cleaning bath. When measuring the turbidity of viscous or thick solutions, it may be necessary to use a centrifuge to remove entrapped air from the sample. If a centrifuge is used, place rubber cushions in the centrifuge cups and fill the cups with water prior to inserting the turbidimeter sample cells. This will reduce the possibility of damage to the sample cells.

3. If a water sample being tested is supersaturated with oxygen, air bubbles may appear on the sides of the sample cell in sufficient numbers to prevent turbidity measurement. This problem can be corrected by placing a drop of membrane-filtered Triton X-100® Solution in the cell before filling with the water sample.

4. When measuring high amounts of turbidity, it may be necessary to dilute the sample in order to bring it within the range of the instrument. If the sample is extremely turbid or highly colored, the meter may read less than the actual amount of turbidity present. When a sample appears to contain more turbidity than the meter reads, the sample should be diluted with another portion of sample that has been filtered. Diluting with distilled or deionized water may dissolve some of the turbidity. The remeasured turbidity of the diluted sample should then be multiplied by the dilution factor to obtain the turbidity of the original sample. If the accuracy of the reading is still questionable, further dilutions should be conducted.

5. When through with the measurements, best performance will be gained from the photomultiplier tube by 1) removing the sample cell from the cell holder, 2) closing the sample compartment door, and 3) leaving the range switch in the 1000 or 100 position. **The instrument is designed to run continually and leaving it on will improve the performance of the lamp and multiplier tube.**

6. The liquid standards supplied with the instrument should be stored in their case and kept at room temperature. Excess light and/or heat will affect their stability. Use care when handling the standards to avoid scratching or otherwise marring the glass surfaces. When in use, they must be clean and free of fingerprints.

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RANGE SELECTION

The sensing range of the turbidimeter is changed by turning the range selection switch on the front panel. Each range has been factory calibrated and readjustment should not be necessary except in some cases when either the photomultiplier tube or the high voltage circuit board is replaced.

CLEANING THE LENSES

Unplug the power cord and open the back panel of the turbidimeter. The lens assembly is held in place by a brass retaining screw on the side of the cell holder assembly. *See Figure 3.* Before removing the lens assembly, be sure to mark its original position in the cell holder so that the factory focusing of the instrument is not changed when the unit is reassembled. Wipe each lens with a tissue or towel that will not leave an oil film.

LENS AND FOCUS

Each cell holder assembly is focused at the factory with the aid of the focusing template furnished with the instrument. Inside the template is a

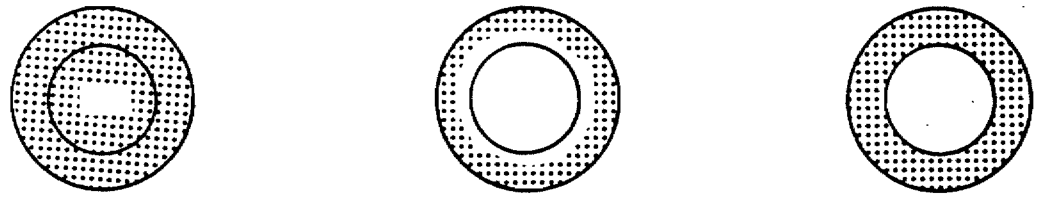


FIGURE 5 INSTRUMENT FOCUSING

translucent plastic disc engraved with a circle. When the template is placed in the cell holder assembly, the instrument is properly focused if the image of the lamp completely fills the circle but does not extend beyond it. *See Figure 5.* If the image is off-center, or too small or large, readjustment should be made as follows:

Caution: This adjustment must be made with power applied to the instrument. Do not apply power unless photomultiplier tube is connected, or damage to power supply may result.

1. Open the back panel of the instrument.

2. View from above, through the sample cell holder opening. The lamp image must be centered in the circle of the focusing template. If it is not, loosen the lamp adjusting screw directly above and behind the lamp. *See Figure 3.*

3. Position the lamp bracket to center the lamp image, then retighten the lamp adjusting screw.

4. If the lamp image still does not completely fill the circle, or if it is larger than the circle, the lens assembly needs to be adjusted. Loosen the brass lens assembly retaining screw and adjust the assembly up or down until the image just fills the circle on the focusing template. Be careful not to get fingerprints on the lens.

LAMP REPLACEMENT

1. Unplug the power cord, unscrew the back panel fastener and open door.

2. Remove the transparent plastic cover over terminal barrier TB–1.

3. Locate and remove the pair of lamp assembly lead wires attached to terminals 1 and 2 on TB-1. *See Figure 4.*

4. Remove the lamp by twisting approximately 1/8 of a turn counterclockwise (looking down on bulb). *See Figure 3.*

5. Lift the lamp up and pull the lead wires through the center of the lamp socket.

6. After lamp replacement, the parts should be reassembled in reverse order and the lens focus checked, using the focusing template included.

Caution: Do not apply line power to the instrument unless photomultiplier tube is connected, or damage to power supply may result.

PHOTOMULTIPLIER TUBE REPLACEMENT

1. Disconnect the power cord and open the back panel of the instrument.

2. Open the sample compartment door on top of the instrument and carefully remove the black plastic ring inside. *See Figure 3.*

3. While holding the cell holder assembly, turn out the four screws concealed beneath the black plastic ring.

4. Carefully remove the cell holder assembly, with photomultiplier tube mounting block attached, from the case.

5. Remove the cable clamp retaining screw that secures the cable to the photomultiplier tube mounting block.

6. The photomultiplier tube is retained in the plastic block by the two screws which also secure the socket assembly circuit board. Remove the two screws and slide the photomultiplier tube out.

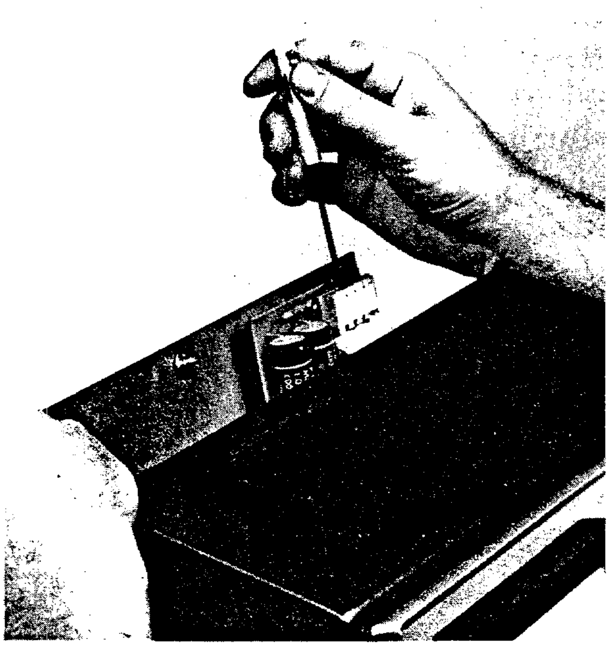
7. Remove the photomultiplier tube from its socket assembly and insert a new tube.

8. Slide the photomultiplier tube in the black plastic mounting block. Be sure that the fine wire grid of the tube faces the cell holder and the photomultiplier tube shield is placed so that it does not block light to the tube.

9. Replace the two retaining screws and cable clamp and reinstall the cell holder assembly in reverse order of disassembly.

Caution: Do not apply power to instrument unless photomultiplier tube is connected, or damage to power supply may result.

10. Because of the inherent characteristics of new photomultiplier tubes, a conditioning period is required before recalibration and routine usage. To condition the newly installed photomultiplier tube, turn the instrument on, set the range selector knob to the 0.2 range, insert the focusing template into the cell holder (to block the light) and place the light shield in place. Allow the instrument to condition the photomultiplier tube for 72 hours.



RANGE TRIMMER
FIGURE 6 POTENTIOMETER ADJUSTMENT

11. After 72 hours of conditioning, check the standardization and tracking from range to range using the liquid standards. If the instrument will not standardize and/or track from range to range, perform range adjustments as described in the following procedure.

12. Select the 1000 range and place the cell riser in the cell holder.

13. Place the 1000-NTU turbidity standard in the cell holder, cover with the light shield and verify an exact reading of 1000. Adjust the STANDARDIZE control if necessary.

14. With the instrument still in the 1000 range, substitute the 100-NTU standard in the cell holder and verify a reading of 100. If the reading is high or low, the adjustable cell holder base is not set properly. Open the rear panel and loosen the allen head set screw securing the base adjustment. Insert the tool provided into the top of the cell holder and slightly rotate the base clockwise if the reading is too low or counterclockwise if too high. Repeat Steps 13 and 14 until the proper setting is attained and tighten the set screw.

RANGE ADJUSTMENT

The calibration of each sensing range is set by five trimmer potentiometers located on circuit board assembly B-2 (at the top of the back panel assembly). *See Figures 4 and 6.* These are factory adjusted for accurate readings on all ranges and should not normally require readjustment. In case the photomultiplier tube or high voltage circuit board is replaced, range adjustment may be required. From time to time, it is advisable to check the range adjustment settings by using the four turbidity standard tubes as follows:

Caution: This adjustment must be made with power applied to the instrument.

1. Place the cell riser in the cell holder and insert the 1000-NTU standard. Standardize the turbidimeter to give a 1000 reading on the 1000 range.
2. Place the 100-NTU standard in the cell holder and select the 100 range. A 100 (± 2) reading should be obtained. If the reading is in error, range adjustment is required.
3. Remove the cell riser and repeat the procedure with the 10 and ~~1.0~~ 0.61-NTU standards. Determine if range adjustment is necessary.

If range adjustment is required, the following procedure should be used:

1. If the instrument has been on for several days proceed to Step 3. If not proceed as follows: turn the instrument on and adjust to range 0.2. Fill a sample cell with tap water, place it in the sample cell holder and cover with the light shield. Allow the instrument to stand for at least 12 hours.
2. Remove the sample cell.
3. Turn the range select knob to 1000, place the cell riser in the cell holder, insert the 1000 NTU standard and cover with the light shield.
4. Turn the STANDARDIZE control on the front panel fully counterclockwise and note the meter reading. Then turn control clockwise until twice this reading is obtained. Leave the STANDARDIZE control in this position for calibrations of all ranges except the 0-0.2 range.
5. Adjust the 1000 range trimmer potentiometer to obtain an exact full-scale meter reading. To do this, open the back panel with one hand and adjust the 1000 potentiometer with the other hand. *See Figure 6.* (The 1000-NTU range must always be adjusted first.)
6. With the cell riser still in place, insert the 100-NTU latex standard tube, cover with the light shield and set the range selector switch to 100. Adjust the 100-NTU range trimmer potentiometer to obtain an exact full-scale reading.
7. Remove the cell riser and insert the 10-NTU latex standard tube, cover with the light shield and switch the range selector to 10. Adjust the 10-NTU range trimmer potentiometer to obtain an exact full-scale meter reading.
8. With the cell riser out of the instrument, insert the ~~1.0 polymer~~ 0.61 chlorobenzene turbidity standard tube, ~~into the cell holder assembly,~~ cover with the light shield and set the range selection switch to 1.0. Adjust the 1.0-NTU range trimmer potentiometer to obtain a ~~1.0~~ 0.61-NTU reading on the 1.0 meter scale.
9. Obtain some water that contains less than 1 NTU turbidity. Tap water may be adequate. With the cell riser out of the instrument, place a sample tube of this water in the cell holder. Cover with the light shield and adjust the STANDARDIZE control to obtain a reading of 0.20 NTU on the 1.0-NTU range. (This may not be possible if the water is too turbid to reach this value. In this case, it will be necessary to dilute the turbid sample with very clear water in a proportion so that a reading of 0.20 can be obtained by adjusting the STANDARDIZE control.) With the STANDARDIZE control adjusted to give a reading of 0.20 on the 1.0 range, turn the range selector to 0.2. Adjust the 0.2 trimmer potentiometer to obtain an exact full-scale meter reading. This completes the range adjustment. A recheck may be made of the adjustments if desired.
10. Restandardize the instrument using the appropriate turbidity standard.

TROUBLESHOOTING

Introduction

This section contains troubleshooting procedures to facilitate the isolation and repair of the instrument circuits. Standard procedures and practices for repair of electronic equipment must be exercised when testing and replacing parts.

When a malfunction is detected, all connectors and cables should be checked first to insure proper connection. Each printed circuit board should also be checked to insure proper mating with its associated connector. Other basic checks for such items as defective indicating lamps and fuses should also be performed prior to checking the internal circuits.

Test Equipment

The Simpson Model 260 Volt-Ohmmeter (VOM) (or equivalent) is recommended for maintenance and troubleshooting. This is a 20,000 ohms/V dc, 5,000 ohms/V ac meter.

Disassembly

Access to all electrical components in the instrument is possible by simply opening the door on back of the case.

Caution: All checks made with power on must be made with photomultiplier tube connected or damage to power supply may result.

Symptom I - Instrument functions but will not standardize with STANDARDIZE control turned fully clockwise.

A. Select the 100 range and rotate the STANDARDIZE control fully counterclockwise.

B. Insert the cell riser and 100-NTU standard in the cell holder. Install the light shield.

C. Open the back panel and rotate the 1000 range potentiometer *(see Figure 6)* fully clockwise or until a 70-NTU reading is obtained, whichever is first. A clicking sound will be audible when the potentiometer reaches the adjustment end stop.

D. Restandardize the instrument by using the STANDARDIZE control. If the instrument still will not standardize and the STANDARDIZE control is fully clockwise, continue to Step E.

E. Check the lamp voltage and adjust if necessary for 4.5 V dc as described in *Step C of Symptom III.* If lamp voltage is correct, check the photomultiplier tube assembly to make sure that the shield is not blocking part of the light to the tube. *Refer to Photomultiplier Tube Replacement.* If the shield is not at fault, replace the photomultiplier tube.

Symptom II - Instrument measures turbidity, but pilot lamp does not illuminate.

A. Check for loose wires.

B. Pilot lamp DS–2 is defective and should be replaced.

Symptom III - Instrument will not measure turbidity, but pilot lamp is on.

A. Open back panel to see if lamp DS–1 is on. If it is not, replace.

B. If the new lamp does not illuminate, proceed to Step D.

C. If the new lamp lights, but appears to be very bright:

1. Turn instrument off and unplug power cord.
2. Remove the clear plexiglass cover over the fuse and terminal barrier TB–1.
3. Set VOM to measure dc volts. Connect the positive lead to pin 2 on terminal barrier TB–1 and the negative lead to pin 1.
4. Plug power cord in and turn instrument on. Reading should be 4.5 + 0.2 V dc.

5. If the correct voltage is not read, adjust potentiometer R–15 on circuit board B–1 until voltage is correct. *See Figure 4.*

6. If adjusting potentiometer R–15 has no effect on the voltage reading, check transistor Q–1 and circuit board B–1 as follows:

   a. Turn off instrument and unplug power cord.

   b. Disconnect circuit board B–1 from its connector (remove nut and pull board from its socket).

   c. Plug power cord in and turn instrument on.

      1) If lamp lights, transistor Q–1 is defective and should be replaced.

      2) If lamp does not light, the circuit board B–1 is defective and should be replaced.

   d. Reconnect circuit board B–1.

D. If new lamp does not illuminate, check transistor Q–1 as follows:

1. Turn instrument off.

2. Disconnect circuit board B–1 from its connector (remove securing nut and pull from socket).

3. Turn the VOM to the Rx100 range.

4. Connect the negative lead to point 2 on transistor Q–1 and the positive lead to point 3 on diode bridge CR–1. Resistance should be between 400 and 900 ohms. Now connect positive lead to pin 2 of TB–1. Resistance should again be 400 to 900 ohms.

5. Reverse the connections. Connect the positive lead of VOM to point 2 on transistor Q–1. Connect the negative lead to point 3 on diode bridge CR–1 and then to pin 2 on TB–1. The VOM should read infinite for both checkpoints. Disconnect DS–1 lamp lead from pin 2 on TB–1. Next, connect positive lead to pin 2 on TB–1 and negative lead to point 3 on diode bridge CR–1. The reading should be infinite.

6. If checks in Steps 4 and 5 are satisfactory, proceed to Step 7. If not satisfactory, transistor Q–1 is defective and should be replaced.

7. Check diode bridge CR–1.

   a. Set VOM to measure dc volts.

   b. Connect the positive lead to point 3 and negative lead to point 4 on diode bridge CR–1.

   c. Turn instrument on. Reading should be 12 + 1 V dc.

   d. If the voltage is correct, circuit board B–1 is defective and should be replaced.

   e. If the voltage is not correct:

      1) Turn instrument off.

      2) Set VOM to measure ac volts. Connect leads to points 5 and 6 on diode bridge CR–1.

      3) Turn instrument on. Reading should be 8.5 + 1.0 V ac.

      4) If voltage is correct, diode bridge CR–1 is defective and needs replacement.

      5) If voltage is not correct, transformer T–1, or the wiring to or from transformer T–1, is defective.

8. Reconnect circuit board B–1 to its connector.

Symptom IV - Instrument will not measure turbidity, but pilot lamp DS–2 is on and lamp assembly DS–1 is on.

A. Open back panel to make certain that the lamp DS–1 is on. If it is not, *see Symptom II.*

B. Turn power off, unplug power cord and check for a loose wire, plug or meter terminal connection.

C. Check the high voltage as follows:

1. Turn the instrument off.
2. Connect the positive lead of VOM to point 8 and the negative lead to point 7 of connector No. 2.
3. Be very careful not to short your leads to other pins while making these measurements or components on the circuit board may be damaged.
4. Turn instrument to the 1000-NTU range. Voltage should be from 200 to 350 V dc.
5. If the voltage is correct, proceed to Symptom IV, Step D, amplifier check. If voltage is not correct:
   a. Turn instrument off, unplug power cord and disconnect circuit board B–2 from its connector.
   b. Set the VOM to the Rx100 range. Be sure to zero VOM.
   c. Connect negative lead to point 13 and the positive lead to point 14 of transistor Q–2. Then, connect the positive lead to point 15. Both readings should be 400 to 900 ohms.
   d. Connect the positive lead to point 13 and the negative lead to point 14 and then to point 15. These two readings should be infinite.
   e. Connect positive lead to point 14 and negative lead to point 15. This reading should also be infinite.
      1) If readings in c, d and e are correct, circuit board B–2 is defective and should be replaced.
      2) If readings in c, d and e are not correct, transistor Q–2 is defective and should be replaced.
6. Reconnect circuit board B–2.

D. Check amplifier.

1. Make sure instrument is off and circuit board B–2 is in its connector.
2. Set the VOM to the 1000-V dc range.
3. Connect the positive lead to point 11 and the negative lead to point 7 on connector No. 2.
4. Turn STANDARDIZE knob completely counterclockwise.
5. Turn instrument on.
6. The instrument meter M–1 should read from 50 to 90 percent of full scale.
7. Turn the STANDARDIZE control slightly clockwise. Instrument meter should go to full scale.
8. If Steps 6 and 7 check satisfactory, the photomultiplier tube is defective, or the wiring to and from the tube has a bad connection.
9. If Steps 6 and 7 do not check satisfactory, measure ac voltage at pins 6 and 8 on transformer T–1. Voltage should be 21 ± 3 V ac.
10. If voltage is not correct, transformer T–1 is defective and should be replaced.
11. If voltage is correct, check meter M–1 as follows:
    a. Turn instrument off and disconnect power cord.
    b. Set the VOM to the next range above Rx1 or the meter movement may be damaged.
    c. Connect the positive lead to point 9 on connector No. 2 and the

negative lead to point ⑧. The instrument meter should deflect upscale and the VOM should read 43 ± 9 ohms.

d. If the reading is not correct, the meter, or the wires connected to it, are defective.

e. If the reading is correct, check standardization potentiometer (Step 12).

12. Connect VOM leads to points ⑩ and ⑪ on connector No. 2.

a. Turn the STANDARDIZE control on the front panel. The reading on the VOM should vary from 0 to 500 k ohms.

b. If the reading is not correct, the standardization potentiometer, or the wires connected to it, are defective.

c. If the reading is correct, circuit board B–2 is defective and should be replaced.

Symptom V - Instrument meter stays pegged past full scale or reads abnormally high.

A. Set range switch to 1000 NTU and turn STANDARDIZE control completely counterclockwise. If meter is still pegged, or reads very high, turn instrument off. If meter still reads high, tap it to see if needle comes down. If not, replace meter.

B. If the meter needle returns to zero with instrument off, check the high voltage following the instructions in Step C, Symptom IV. **If correct voltage is read in Step C4, do not proceed to Step C5; instead, continue with Step C, below.**

C. If high voltage is correct, remove photomultiplier tube from its socket. *(Refer to Photomultiplier Tube Replacement.)*

1. With photomultiplier tube out of its socket, turn instrument on and observe reading on instrument meter.

2. If meter still reads the same, circuit board B–2 is defective and should be replaced.

3. If meter does not read the same but goes to zero, the photomultiplier tube is defective and should be replaced.

Symptom VI - Instrument reading varies or is unsteady.

A. Turn instrument off and open back panel.

B. Set the VOM to measure dc volts.

C. Connect the positive lead to point ③ and the negative lead to point ④.

D. Turn instrument on and record voltage.

E. Turn instrument off and unplug power cord.

F. Unscrew the terminal (to which red wires are attached) on capacitor C–1. (In order for the lamp to turn on, the two lugs on the screw must be attached to each other. Be careful that they don't short to anything else.)

G. Plug instrument power cord in, turn instrument on and record voltage reading.

H. If the Step D reading (capacitor connected) does not exceed the Step G reading (capacitor disconnected) by 2 volts or more, capacitor C–1 is defective and should be replaced. (Reconnect red wires to capacitor C–1).

I. If the Step D reading (capacitor connected) does exceed the Step G reading (capacitor disconnected) by 2 volts or more, check the high voltage as follows:

1. Turn instrument off.

2. Set the VOM to a high dc voltage range.

3. Connect the positive lead to point ⑧ and the negative lead to point ⑦ on connector No. 2. **Be very careful not to short meter connections because of high voltage.**

4. Turn instrument on and observe reading.

a. If reading varies, circuit board B–2 is defective and should be replaced.

b. If the reading does not vary, the photomultiplier tube is defective

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and should be replaced. *See Photomultiplier Tube Replacement.*

Symptom VII - Instrument does not work properly and a sound similar to arcing is heard.

A. Turn instrument off and unplug power cord.

B. Check for loose wiring connections, especially at plug P–1.

C. Disconnect circuit board B–2 (remove nut and pull from socket).

D. Set VOM to measure resistance. Connect leads to point 7 and point 12. Resistance should be approximately 560 k ohms.

E. If the reading is correct, circuit board B–2 is defective and should be replaced.

F. If the resistance reading is not correct:

1. Check wire connections on photomultiplier tube socket.

2. If the connections are all right, one (or more) of the resistors on the photomultiplier tube socket assembly is defective. Replace photomultiplier tube socket assembly.

Symptom VIII - Instrument is turned on but is completely inoperative.

A. Make certain the instrument is plugged in.

B. If instrument is plugged in but still does not work, unplug it.

C. Open back panel and check for blown fuse.

1. If fuse is not blown, proceed to Step D.

2. If fuse is blown, proceed to Step E.

D. If fuse is not blown:

1. Set VOM to measure ac volts.

2. Connect leads across terminals 6 and 7 on terminal barrier TB–1.

3. Plug instrument in. Normal line voltage of 115 or 220 V ac should be present.

a. If voltage is correct, the range switch on the front panel, or the wires leading to it, are defective.

b. If voltage is not correct, there is either a blown circuit breaker or fuse in the electrical service, or the instrument power cord is defective.

E. If fuse is blown, make the following checks before replacing it:

1. Look for broken wire connections or foreign material that may be causing a short.

2. Check capacitor C–1 as follows:

a. Using a screwdriver (or some other metal object), short across the positive and negative terminals of C–1.

b. Unscrew the terminal to which the red wires are attached.

c. Set VOM to the Rx1 range.

d. Connect the positive lead to the terminal unscrewed in Step b above, and the negative lead to the other terminal on C–1. The VOM should deflect upward toward zero ohms, then return to infinity.

e. Reverse the connections. The VOM should again deflect upward toward zero ohms, reaching a low reading 5 to 10 ohms before returning to infinity.

1) If the VOM does not deflect upward in Steps d and e, the capacitor C–1 is defective and should be replaced.

2) If the VOM does deflect upward in Steps d and e, proceed to Step F to check diode bridge CR–1.

F. **Before checking the diode bridge, make sure the red wires which were disconnected from capacitor C–1 are separated from each other and are not touching anything else.**

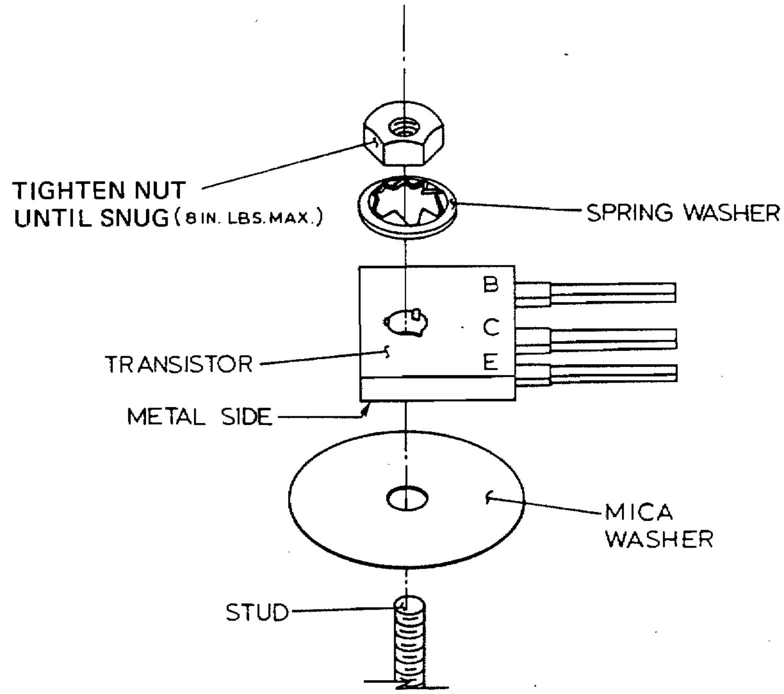


FIGURE 7 **TRANSISTOR ASSEMBLIES**

1. Remove circuit boards B–1 and B–2 from their connectors.

2. Set VOM to the Rx100 range. (Be sure VOM has been zeroed properly.)

3. Connect the positive lead to point ③ and the negative lead to point ⑥ on diode bridge CR–1. VOM should read infinite resistance.

4. Reverse the VOM connections. It should now read 350 to 750 ohms.

5. Continue with the remaining diodes in the bridge by checking the adjacent terminals and reading 350 to 750 ohms in one direction and infinite resistance in the opposite direction.

   a. If the reading for any of the diodes is not correct, diode bridge CR–1 is defective and should be replaced.

   b. If the readings are all correct, proceed to Step G.

G. Check transistor Q–1 as follows: (circuit boards B–1 and B–2 still disconnected)

1. Remove lamp lead from pin 2 on terminal barrier TB–1.

2. Turn the VOM to the Rx100 range. Connect the positive lead to point ⑧ and the negative lead to pin 2 on TB–1. Reading should be infinite resistance.

3. If the reading is correct, proceed to Step 5.

4. If the reading is less than infinite:

   a. Unscrew the nut that holds Q–1 on the back panel. Lift transistor.

   b. Check the mica washer to be sure that it has not been broken or penetrated by some object, thus causing the transistor to short to the back panel. *See Figure 7.*

   c. Remove obstruction and/or replace washer. Be certain to put washer on first, then transistor.

   d. Tighten nut until snug, but do not overtighten.

5. Reconnect the lamp lead to its proper

terminal at pin 2 on terminal barrier TB–1.

6. Reconnect the red wires to capacitor C–1.
7. Plug circuit boards B–1 and B–2 into their proper connectors.
8. Make sure plug P–1 is connected.
9. Replace fuse F–1, plug instrument power cord in and turn instrument on.
   a. If fuse blows again, transformer T–1 is defective and should be replaced.
   b. If fuse does not blow, the first fuse was faulty.

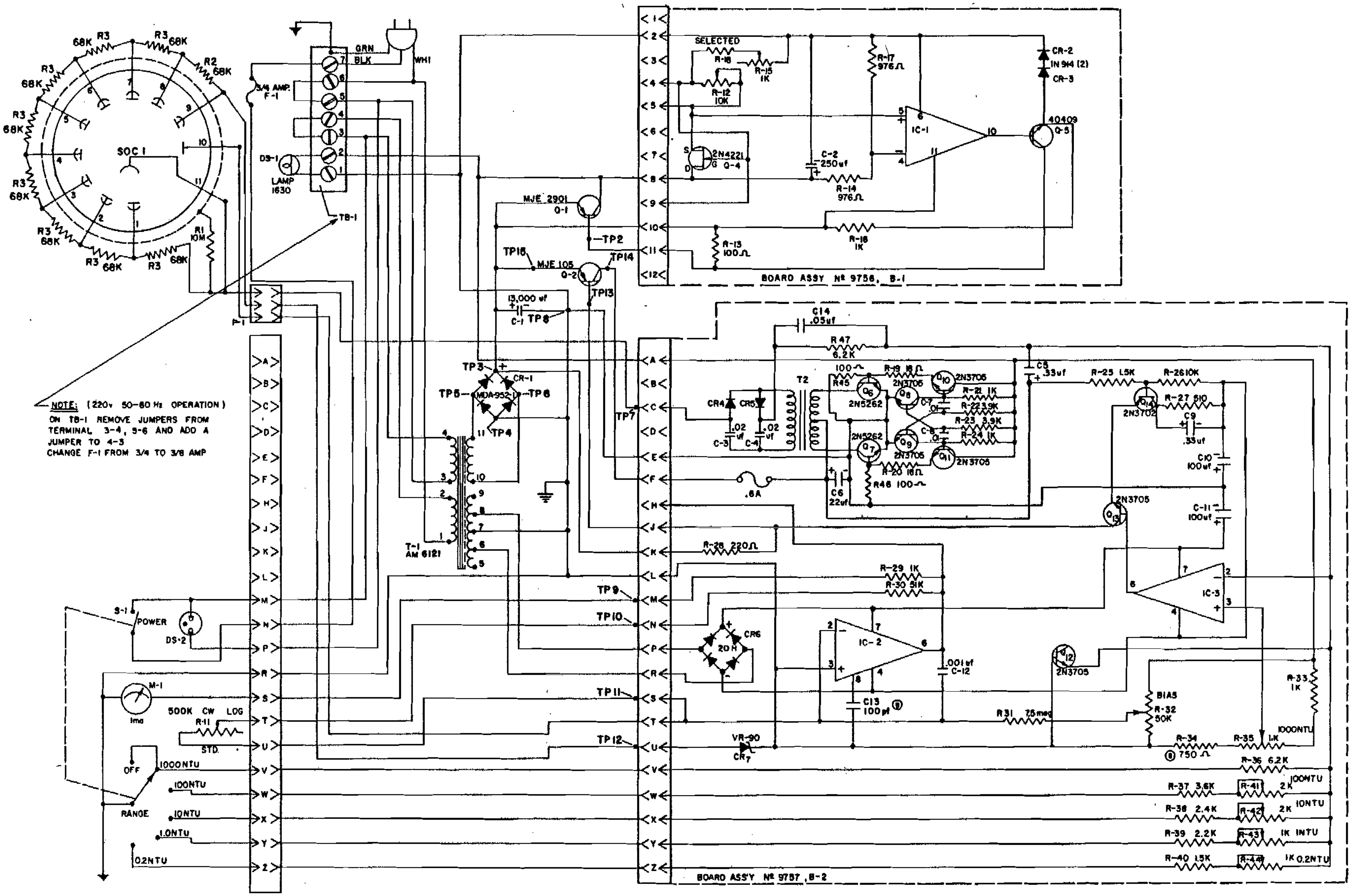
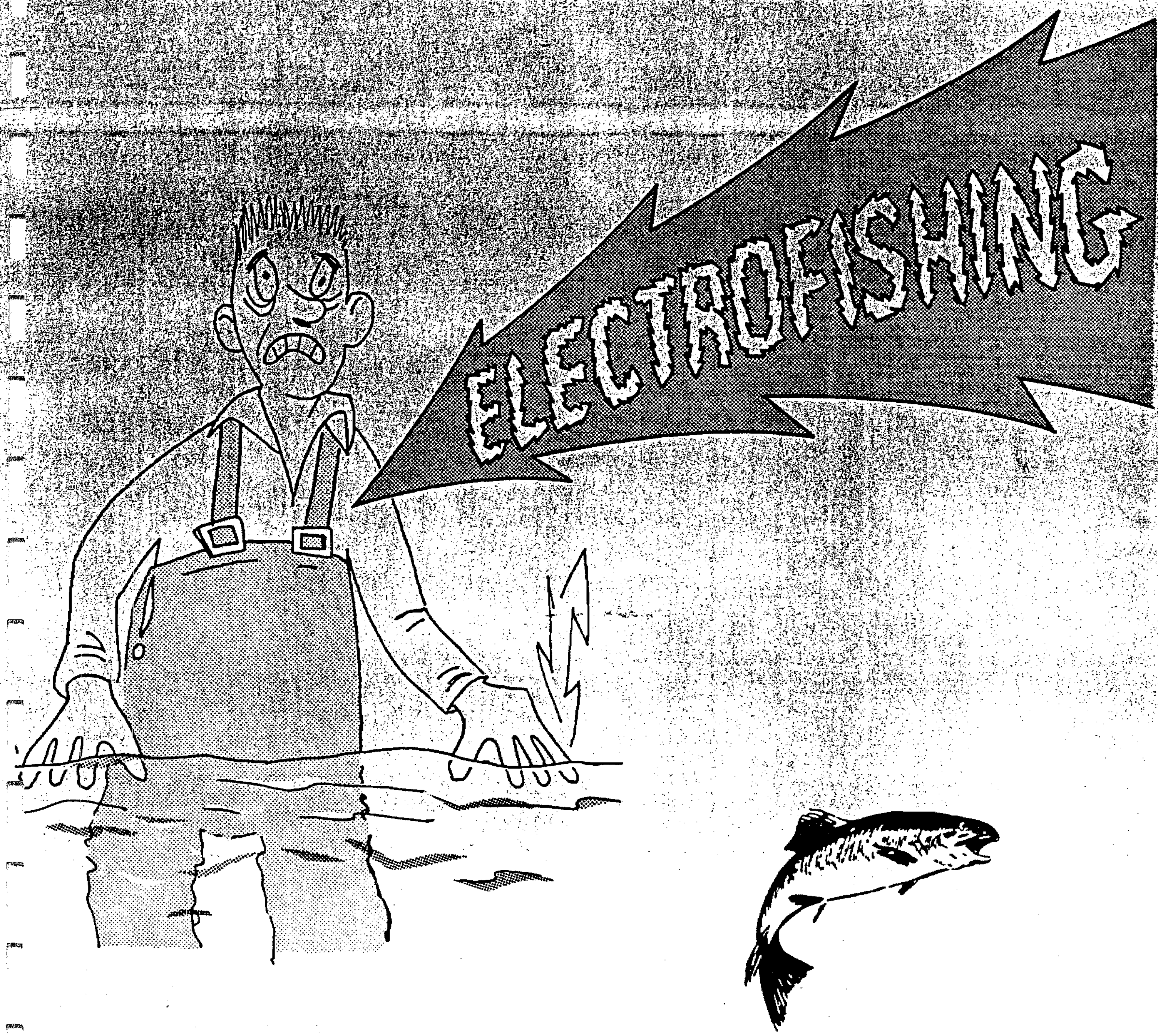


FIGURE 8 SCHEMATIC

Some shocking facts about...



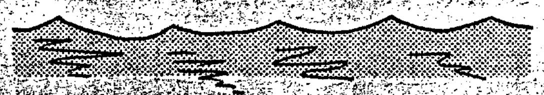
Coffelt Electronics

LEADERS IN ELECTROFISHING EQUIPMENT

FACTS AND SAFETY TIPS ON ELECTROFISHING

Let's start with the basic elements:

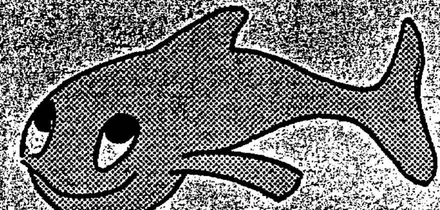
WATER



COMES HARD OR SOFT, CAN RUN FAST (STREAMS) OR BE DEEP (LAKES).

The first thing you need is some water. It comes in all types from fast running mountain streams to deep rivers and lakes. It seems almost every location has some different water problem for the electrofisher. The hardness [number of dissolved particles] determines the conductivity of the water, or how well it will carry an electrical current. The conductivity of water is measured by ohms per centimeter. The higher the ohms number the softer the water. Water temperature is another variable affecting the electrofisher.

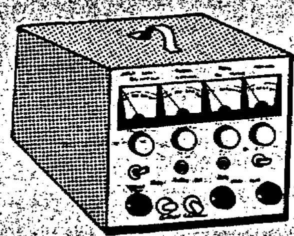
FISH



COMES LARGE AND SMALL AND IN DIFFERENT KINDS.

Fish come large-small-fat-skinny-handsome-ugly, etc. Various species of fish react differently to electro-shocks. For instance large fish are influenced more quickly and by relatively smaller voltages. Fish also have different densities of flesh which means that conductivity can vary from species to species.

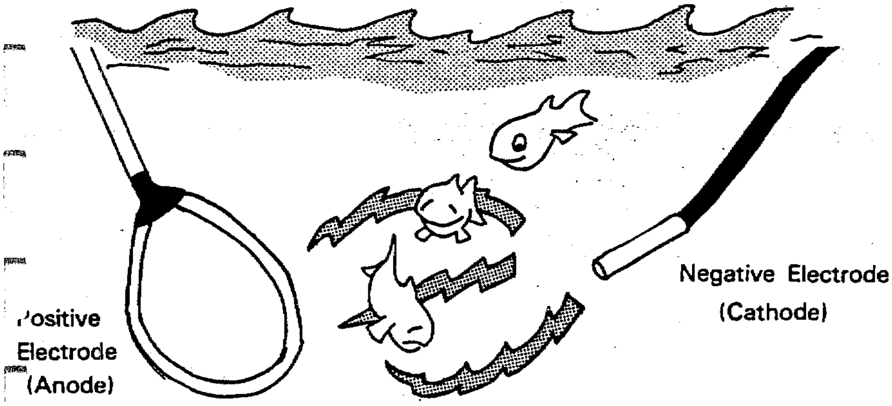
ELECTROSHOCKER



COMES IN A VARIETY OF SHAPES AND SIZES TO DO DIFFERENT JOBS.

Our first suggestion is to use an electronic unit which is designed and tested for electrofishing. Home-made units can be very dangerous. Electroshockers basically are designed to put electricity into water. The more control you have over the types of electric current, the more successful you're going to be in dealing with the variables involved. The two basic types of electricity used are AC or DC. [More about that later.] Choose the unit that best suits the physical surroundings, type of water and fish you are going after.

Put them all together and they spell ZAP!

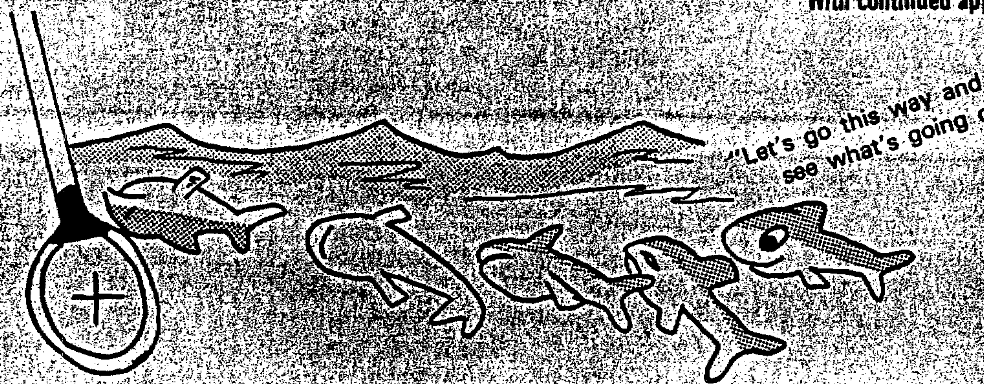


Electricity needs positive and negative electrodes to complete a circuit. In boat electrofishing the negative electrode [cathode] usually hangs over the boat's side. The positive electrode [anode] can dangle from a boom or be hand maneuvered. You put them into the water, aim at the fish, turn on the juice [after following all safety and proper operating procedures] and the result is a bunch of surprised fish.

AC or DC? How the fish react:

DC

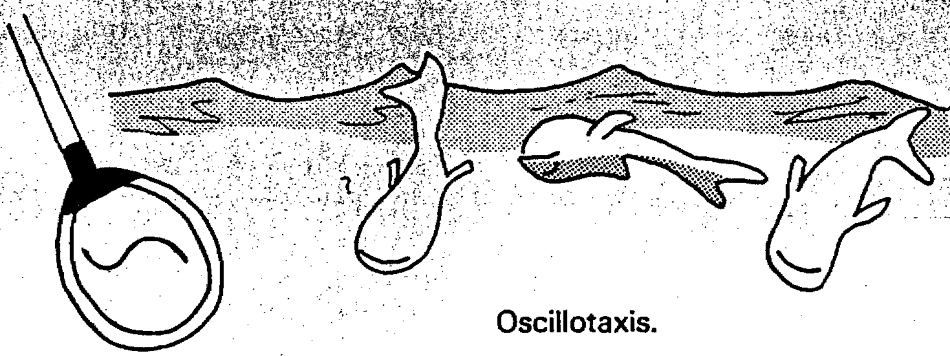
When Direct Current [DC] is applied, fish react in three basic phases. With initial electrical introduction fish line up with the direction of electrical current. Then fish which are parallel with the current start to swim toward the anode. Fish in other positions line up parallel to the current, preparing for their trip to the anode. With continued application of current, all fish start to swim to the anode. This reaction is called galvanotaxis. When the fish get close to the anode their ability to move is reduced and they may turn belly up and go into a state called galvanonarcosis. In this condition they are easily caught. When the electric current is switched off they recover and swim away [provided they are put back into the water, of course.]



All this is called Electrotaxis.

AC

When fish are zapped with Alternating Current [AC] they don't swim anywhere. They take a posture transverse to the current in such a way as to receive a minimum of voltage. This is called oscillotaxis. The electrical effect is more violent so greater care must be taken to lessen harm to the fish. Also, with AC the reaction lasts longer - a kind of knock-out punch. If time of application is not too great, fish may recover and swim away.



Oscillotaxis.

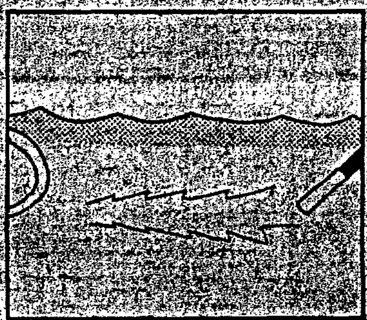
Again we say the heart of electrofishing is the electroshocking unit. The more control over the voltages and currents the more successful your efforts are going to be.

PULSED CURRENT:

When you use interrupted current, depending on the type of pulse and the number per second, you have a greater control over fish reaction. Fish recovery is quicker with a pulsed current, and with a low pulse rate and a narrow width the required electrical energy is reduced.

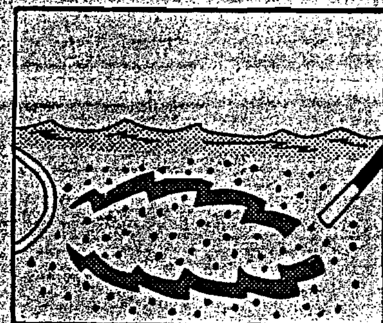
It's the variables that make electrofishing interesting:

Water Conductivity:



LOW CONDUCTIVITY - HARD TO GET ELECTRICITY FROM POS. TO NEG.

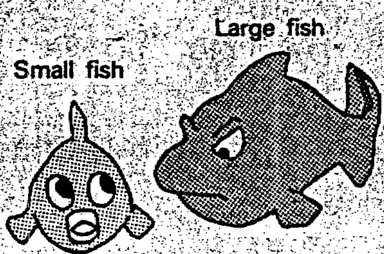
The amount of dissolved solids in the water determines its conductivity. The fewer the dissolved solids the harder it is to pass electrical current from positive to negative electrodes. For instance, distilled water is actually an insulator. Hard water, with lots of dissolved solids is a good conductor and current passes readily between anode and cathode.



HIGH CONDUCTIVITY - EASY TO PASS CURRENT FROM POS. TO NEG.

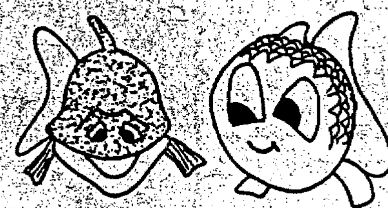
You might think that high water conductivity automatically means really good electrofishing. Not necessarily so. This is where the size of fish and the density of their flesh is important. As an example salt water has very high conductivity, but fish have relatively less conductivity in their bodies and the electrical current sort of slides around them requiring more voltage for a reaction.

When the conductivity of the water is lower than the conductivity of the fish, electrofishing conditions are more favorable. Electrical force lines are drawn to the fish with a resultant satisfactory reaction. Again control of current, pulse, etc. is essential for best results.



LARGE FISH REACT TO CURRENT MORE THAN SMALL FISH.

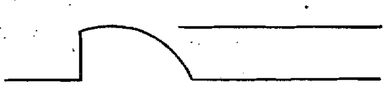
Larger fish receive a greater voltage in the water than smaller fish and are influenced more quickly and by relatively smaller voltages. Furthermore, the conductivity of fish flesh varies from species to species and environment to environment.



FISH FLESH OF DIFFERENT SPECIES CAN HAVE DIFFERENT CONDUCTIVITIES.

Variable shocking waves & currents help match the right shocking to the water conditions

AC-60 hz. Sine wave form.

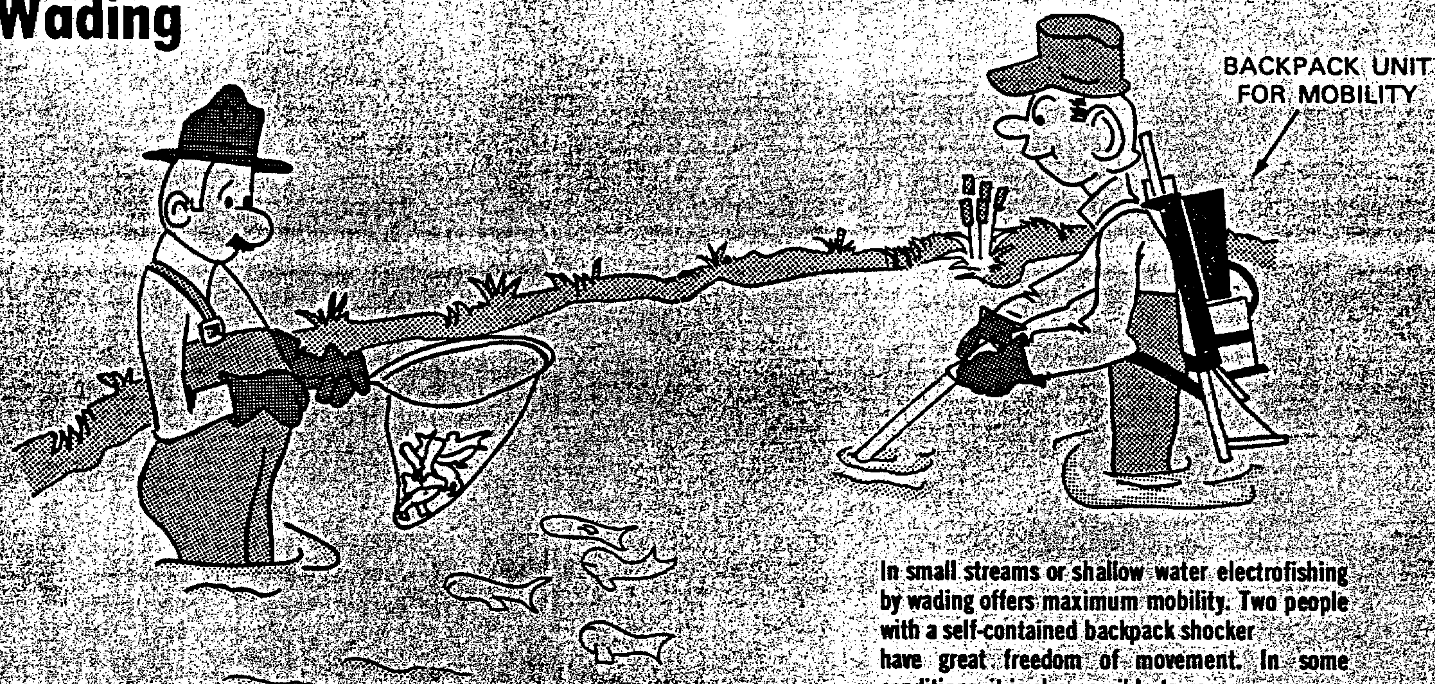


Square wave form. DC Pulse.

As we've suggested, the more control over the type of current and pulse rate, etc. the better the chances for successful electrofishing. It's not our intention to get too technical, but to give you some idea of the basic principles of electrofishing. In summation, you can introduce continuous Alternating or Direct currents into the water, or you can break the current by pulsing a certain number of times per second. This is extreme simplification and for more detailed consideration there is an abundance of technical data available.

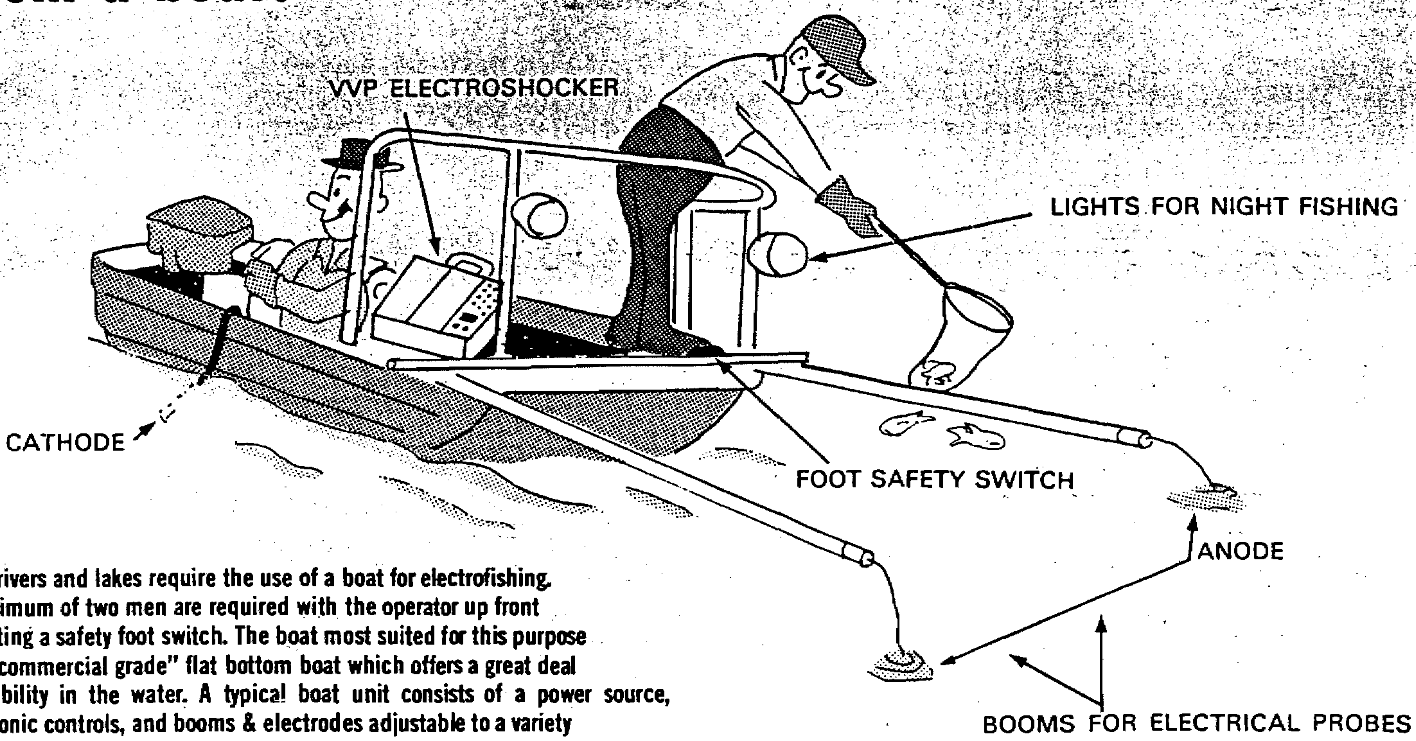
A couple of popular electrofishing set ups:

Wading



In small streams or shallow water electrofishing by wading offers maximum mobility. Two people with a self-contained backpack shocker have great freedom of movement. In some conditions, it is also possible to use probes connected by long cables to an electrofishing unit on the bank or in a boat.

From a boat:



Most rivers and lakes require the use of a boat for electrofishing. A minimum of two men are required with the operator up front operating a safety foot switch. The boat most suited for this purpose is a "commercial grade" flat bottom boat which offers a great deal of stability in the water. A typical boat unit consists of a power source, electronic controls, and booms & electrodes adjustable to a variety of conditions.

A suitable holding tank should be available to contain fish. Several sizes of boat are available with the component equipment outfitted to individual needs.

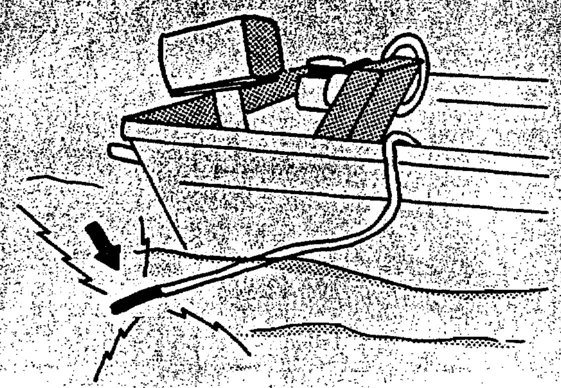
Don't be shocked - Some

1. WEAR THE PROPER SAFETY ITEMS:

Three basic safety items must be worn by those involved in electrofishing. 1. LIFE JACKET - Even if you are an excellent swimmer or working in shallow water your life may at some time depend on a life jacket. Don't be without it! 2. WADERS - High waders are preferrable. Make sure there are no leaks. [If you have leaks, you'll probably find them when the juice is turned on]. 3. RUBBER GLOVES - The easily slipped on gauntlet type are best. Always watch what you touch when working with electricity.

2. NEVER TOUCH THE ANODE OR CATHODE:

Since the business end of an electrofishing unit is its probes, it should be clear they are not to be touched under any circumstances. Make sure you are aware of their location at all times. Also make sure you do not operate any conductive equipment near the probes.

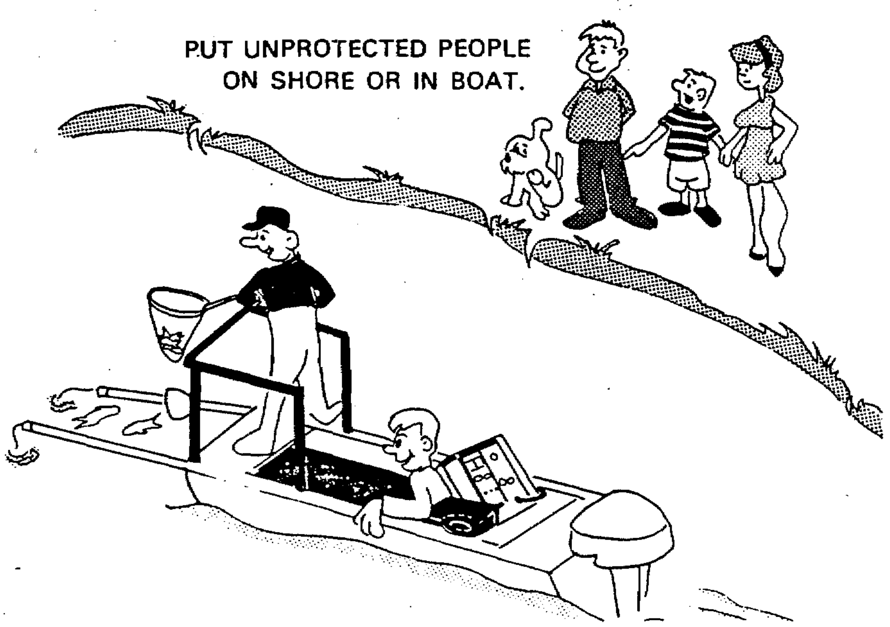


3. KEEP BOOTS AND GLOVES DRY:

If you have leaks in your boots or gloves you run the same risk as the fish. Maintain all protective clothing in a waterproof, shockproof condition. Make sure you are thoroughly dry during an electrofishing operation.

4. KEEP OTHER PEOPLE CLEAR OF AREA:

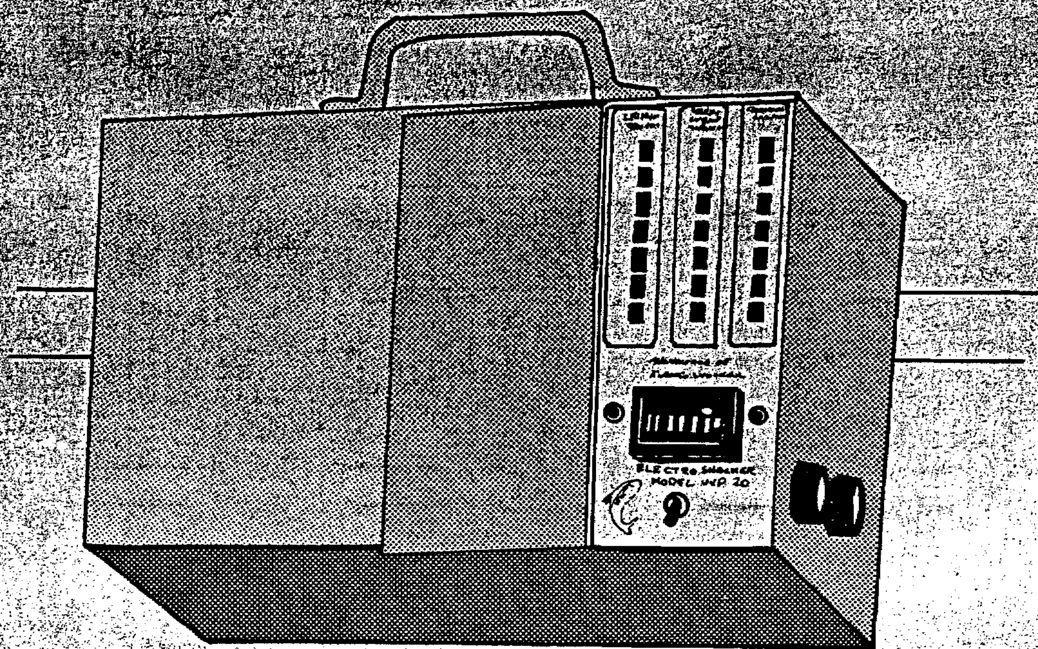
Before starting an electrofishing operation make sure that everybody, including pets, is in a safe place. Everyone on shore should be kept at a safe distance and only authorized people should participate in the operation. Remember you are using a very powerful force which can be lethal to unprotected persons or animals.



important safety tips:

5. USE PROPER EQUIPMENT:

As suggested before - make sure you use the appropriate equipment. Commercially designed units have every possible safety feature built into them in the testing stages. Don't take chances with poorly designed, home-made equipment. It just isn't worth the risk!



6. FOLLOW MFRS. OPERATION INSTRUCTIONS:

Reliable professionally designed equipment comes with complete operating, safety and hookup instructions. Even if you think equipment operation is perfectly obvious, read and understand every step; then read it again. It is very important to you.

7. KNOW PROPER FIRST AID PROCEDURES:

If trouble should occur, your life or someone elses may depend on adequate knowledge of first aid. Keep on hand a well equipped kit and check it often. Be especially familiar with the proper techniques for mouth-to-mouth resuscitation.

When all safety and proper operating procedures are followed, electrofishing is a safe operation. Don't allow yourself to be narcotized with the fish by foolishly ignoring basic safety rules and procedures.

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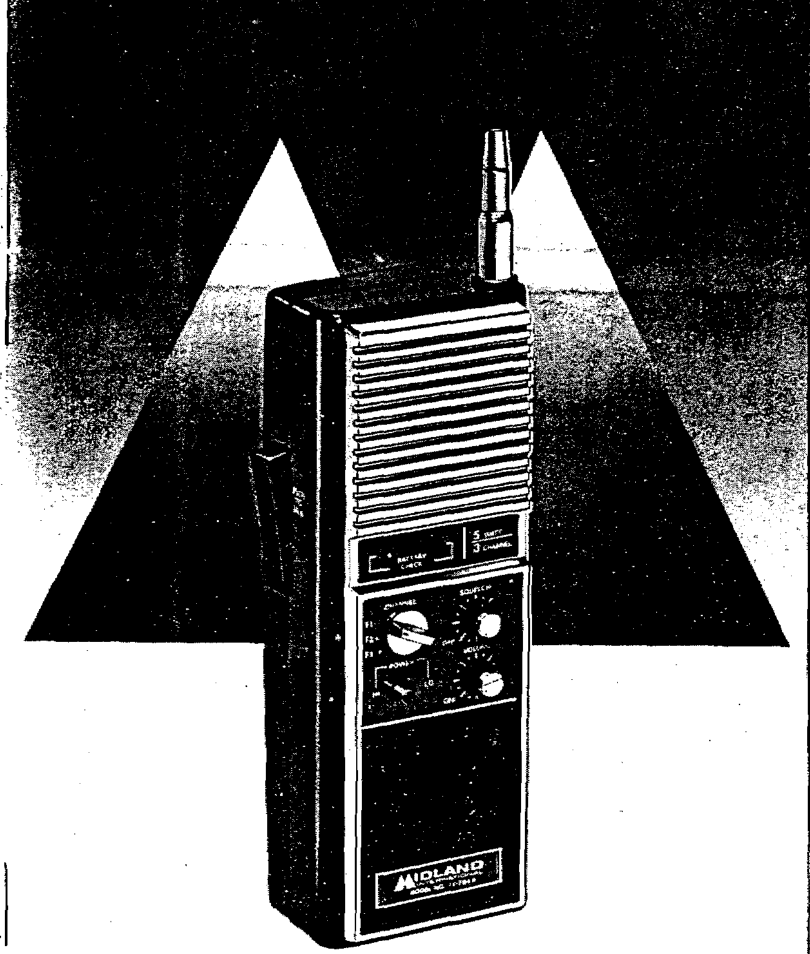
MIDLAND



OWNER'S MANUAL

5-WATT 3-CHANNEL TRANSCEIVER

MODEL 75-764B

Midland 75-764B

Your 75-764B is a versatile, professional quality transceiver and we suggest that you read this Owner's Guide carefully before operation so that you may receive full benefit from its many features.

For your protection, the spaces below are provided for you to record the FCC Data and Serial Number of this product. Both are located on the identification plate attached to the rear cabinet panel. After recording these numbers, keep this record for future reference. *When contacting Midland for service or parts information, the FCC Data Number and Serial Number must be referred to in order to expedite your request.*

FCC Data: ______________________________

Serial Number ______________________________

FCC requirements for CB users.

Your new Midland Hand-Held CB is a combination receiver/transmitter (transceiver) designed and built for licensed Class D operation on any of the 40 frequencies designated for citizens band use by the Federal Communications Commission.

You are required to have or have ordered a current copy of Part 95, Subpart D, of the FCC rules and regulations (a current copy as of the date of manufacture is included with your new CB) prior to operation of this unit.

You are also required to complete FCC Form 505 (also included with your CB) and submit it to the **FCC, Gettysburg, PA 17326** in order to obtain your license to operate this unit.

(Disregard the above paragraph if you have a current CB license less than 5 years old.)

FCC regulations will be violated if you transmit with this unit without complying with procedures explained on FCC temporary license, Form 555-B, which is included as well.

You may use Form 555-B as a temporary permit while your regular Form 505 application is being processed by the FCC.

The technical information diagrams and charts provided in this manual are supplied for the use of a qualified holder of a first or second class radio-telephone license. It is the user's responsibility to see that this unit is operating at all times in accordance with FCC Citizens Band Radio Service regulations.

If you install your own transceiver, do not attempt to make any transmitter or receiver tuning adjustments. These adjustments are prohibited by the FCC unless you hold a first or second class radio-telephone license. A Citizens Band or Amateur license is not sufficient.

When service is performed by an authorized and licensed person, care must be taken that only authorized replacement parts are used in order not to void the type acceptance or certification of this model.

Midland International Corporation hereby certifies that this unit has been designed, manufactured, FCC type accepted and certified in accordance with Part 95 and Part 15, Subpart C, of the current FCC rules and regulations as of the date of manufacture.

General CB information.

In 1958, The Federal Communications Commission approved the use of 23 channels by duly licensed Citizens Band radio operators. The authorization was expanded to 40 channels in 1977.

A simple, basic means of communication, CB requires no more skill or knowledge than the operation of a standard AM or FM receiver.

Still, there are certain facts, procedures and "rules of the road" you'll need to know in order to make the most of your CB experience.

Make it "short and sweet." When using your CB, get on and off the air as quickly as possible. Never use profanity — which is against the law and subject to heavy penalties. Follow the FCC rules outlined in Part 95.

Use Channel 9 in emergencies only. Emergency channel 9 is designated for this purpose and this purpose alone.

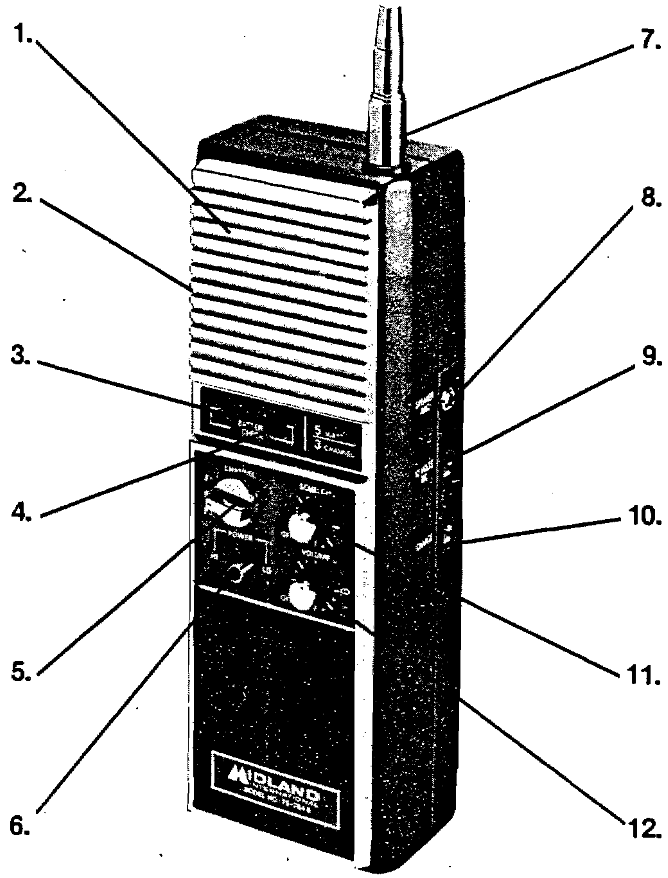
The FCC has given public safety agencies various "call signs" including "0911" numbers, coinciding with the "911" phone numbers these agencies use in telephone communications.

The call signs for state-level agencies use 3 letters and 4 numbers, with the second and third letters being the official Post Office state abbreviation, e.g., "KS" for "Kansas."

Frequency-channel number chart.

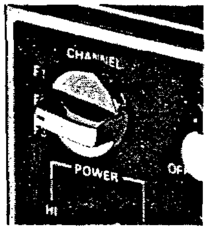
Frequency	Channel	Frequency	Channel
26.965 MHz	1	27.215 MHz	21
26.975 MHz	2	27.225 MHz	22
26.985 MHz	3	27.255 MHz	23
27.005 MHz	4	27.235 MHz	24
27.015 MHz	5	27.245 MHz	25
27.025 MHz	6	27.265 MHz	26
27.035 MHz	7	27.275 MHz	27
27.055 MHz	8	27.285 MHz	28
27.065 MHz	9	27.295 MHz	29
27.075 MHz	10	27.305 MHz	30
27.085 MHz	11	27.315 MHz	31
27.105 MHz	12	27.325 MHz	32
27.115 MHz	13	27.335 MHz	33
27.125 MHz	14	27.345 MHz	34
27.135 MHz	15	27.355 MHz	35
27.155 MHz	16	27.365 MHz	36
27.165 MHz	17	27.375 MHz	37
27.175 MHz	18	27.385 MHz	38
27.185 MHz	19	27.395 MHz	39
27.205 MHz	20	27.405 MHz	40

MIDLAND 75-764B operating controls.

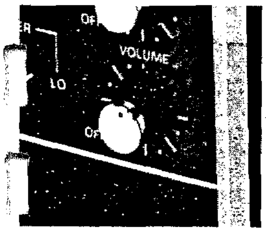


1. Speaker/Microphone
2. Push-To-Talk Bar
3. L.E.D. Battery Indicator
4. Battery Check Button
5. Channel Selector
6. Power Output Switch
7. Telescopic Antenna
8. Speaker/Mic Jack
9. 12 Volts DC Jack
10. Battery Charge Jack
11. Squelch Control
12. On/Off Volume Control

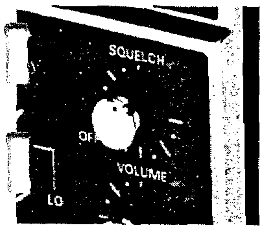
Operating controls, connectors: Their functions and uses.



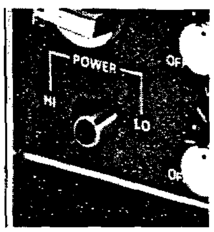
Channel Selector. Controls both transmitter and receiver frequencies simultaneously. This transceiver is capable of 3 channel operation. One set of Channel 11 crystals are installed in the "F1" position. Additional crystals may be installed (see crystal installation) in the open channels. To operate, turn the switch to the desired channel.



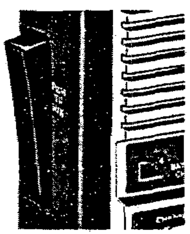
Volume-On/Off. Turns the set on and controls the sound output from the speaker when receiving. The volume control does not affect transmitting output. To turn the unit on and increase volume, rotate this control clockwise.



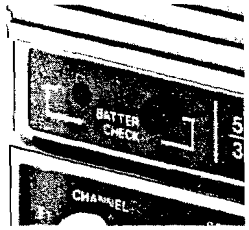
Squelch. Quiets the receiver when signals are not being received. It functions only in the receive position and does not affect the receiver volume when signals are being received. To adjust: When no signals are present, rotate the squelch control clockwise until the receiver is quieted. Incoming signals will automatically release the squelch, enabling you to receive normally. Careful adjustment is necessary as settings too far to the right will not allow weaker signals to release the squelch.



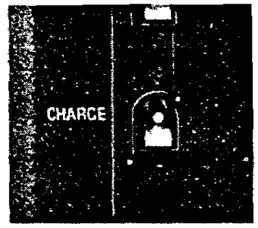
Power Output Switch. To extend battery life, use the unit with the "Power" switch to "Lo" position for short range communications. For long range use, place the switch in the "Hi" position.



Push-To-Talk Bar; Speaker/ Microphone. This controls both transmitter and receiver. To transmit, press and hold the bar, to receive, release it.

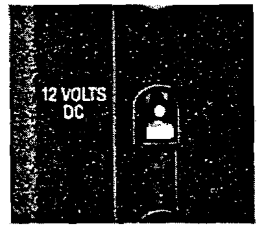


Battery Check. Your new Model 75-764B uses an L.E.D. (Light Emitting Diode) to monitor battery condition. To check battery condition press the battery check button. A bright L.E.D. indicates high battery current. A dim or unlit L.E.D. indicates batteries should be replaced, or recharged if nickel cadmium batteries are being used.

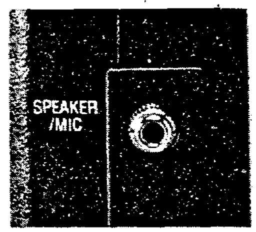


Charge (Battery Charger Jack) (Coaxial). This jack allows charging of rechargeable batteries without removing the batteries from the unit.

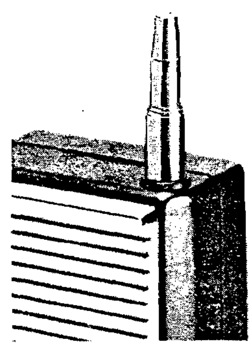
CAUTION: Do not try to charge the conventional non-rechargeable batteries. Use only nickel-cadmium batteries for recharging. Carbon-zinc, mercury, and alkaline batteries may be used to operate the transceiver, but **do not attempt** to recharge these types because leakage or battery damage may occur. A regulated battery charger and not an AC power supply should be used for recharging purposes.



12 Volts DC Jack (Coaxial). This jack allows the use of an external 12 volt DC power source such as a 12 V DC adaptor or your car battery.



External Speaker/Microphone Jack. This will be used for connection of an optional Speaker/Microphone , which allows you to transmit without holding and moving the transceiver to your mouth at every transmission. Connecting the external Speaker/ Microphone will automatically cut off the built-in speaker/microphone.

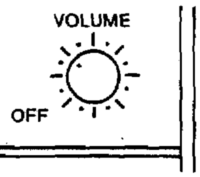


Telescopic Antenna. The telescopic antenna must be fully extended. Simply pull it out to its maximum length.

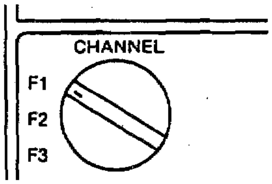
Midland 75-764B Operating Instructions.

Step 1: Extend the antenna to its full length.

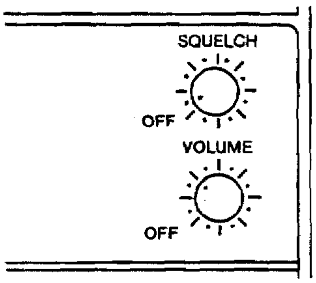
NOTE: Transmitting without extending antenna may cause damage to the output transistors and void your warranty.



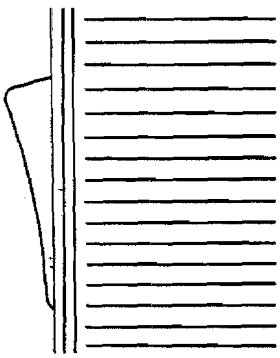
Step 2: Rotate the Volume/On-Off control clockwise to turn unit "on".



Step 3: Set the channel selector to the desired channel (F1 position if you have not installed other crystals).



Step 4: Adjust the volume and squelch controls.



Step 5: To transmit, press and hold the push-to-talk bar and talk into the microphone. Use a normal tone of voice and hold the unit about 2 to 3 inches from your mouth. To receive, release the push-to-talk bar.

For best transmission and reception, model 75-764B should be held in a vertical position and the telescoping antenna must be fully extended.

NOTE: This unit is designed to operate properly with any standard 12V DC system. Voltages other than 12V may cause damage to the unit or result in poor operation.

Operating Range.

The operating range will vary from ½ to several miles depending upon terrain, obstacles, climatic conditions and the other transceiver used.

Battery condition also affects range and fresh batteries will provide far better range than weak ones.

When the 75-764B is used with a base or mobile unit the range will generally be increased.

Battery Installation.

This unit operates on 8 "AA" size 1.5 volt batteries or 10 "AA" 1.2 volt rechargeable nicad batteries. Standard types may be used, but alkaline or rechargeable batteries are desirable.

NOTE: Only nickel-cadmium batteries can be used for recharging purposes. Nickel-Cadmium Batteries with 500mA capacity are recommended.

To install: Remove the rear of the case and carefully remove the battery holder. It is not necessary to remove the wire connected to the battery holder and care should be taken not to break it. Insert the batteries observing the polarities marked on the holder. Make sure the batteries are properly seated and replace the holder and rear cover plate. Two dummy batteries are included. These should be removed when using rechargeable nickel-cadmium batteries.

Crystal Installation.

In order to insure proper operation, only crystals designed for this unit should be used. Crystal specifications are included on page 10 in this manual for your convenience.

This unit has been adjusted for maximum performance in the middle of the citizens band channels and will operate properly across the entire band without further adjustment. If you desire, this unit may be readjusted for maximum performance at either the high or low end of the band. This will, however, result in reduced performance at the opposite end. All adjustments of this type MUST be made by a qualified and **LICENSED technician.** Refer to Crystal Specifications, page 10.

NOTE: FCC regulations specify transmitter crystals must be installed by or under the supervision of a person holding a first or second class radio-telephone license.

Specifications.

Semiconductor Complements .... 14 Transistors, 6 Diodes, 2 Zener, 1 Varistor, 1 LED and 1 transistor used in squelch circuit

Transmit and Receive Frequency .... 3 Channel available, Channel 27.085 MHz plug-in crystals factory installed in number F1 position

Receiving System .... Superheterodyne

Intermediate Frequency .... 455 KHZ

Transmitter .... 3 channel, crystal controlled system

Modulation System .... AM maintained between 90 & 100%

RF Input Power .... 5 Watts

Frequency Tolerance .... ± 0.005%

Receiver Sensitivity .... 1 µV at 10 dB (S + N)/N

Antenna .... Telescopic 13 section, 60¾" extended

Power Source .... 12-Volts DC (8 penlight batteries self-contained or external 12 Volt DC source)

Speaker/Microphone .... Extra sensitive 2¼" dynamic 16 Ohm

Controls & Switches .... 3-channel selector switch, ON-OFF volume controls, full variable squelch control, Hi-Lo Power Output switch, Push-To-Talk switch, Battery Check.

Accessory Jacks .... External SPKR/MIC, AC Adaptor Battery Charger

Dimensions .... 8-7/8"(H) x 3-1/4"(W) x 2-3/16"(D)

Crystal Specifications.

Receiver

Holder HC-25

Resonance .... Parallel

Oscillation .... 3rd Overtone

Load Capacitance 20pf

Drive Level 1mW

Equivalent Resistance .... 32 ohms (Series)

Frequency Tolerance .... ± 20 ppM

Temperature Range .... − 10° C to + 60° C

Frequency Calculation .... Channel Frequency minus 455 KHZ = Crystal Frequency

Transmitter

Holder HC-25

Resonance .... Parallel

Oscillation .... 3rd Overtone

Load Capacitance 5pf

Drive Level 1mW

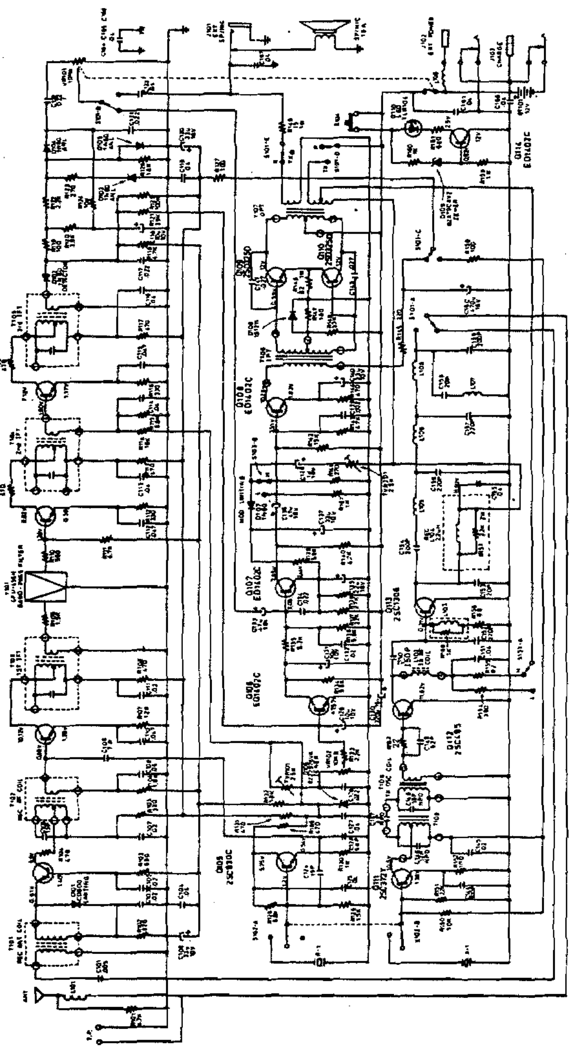
Equivalent Resistance .... 32 ohms (Series)

Frequency Tolerance .... ± 20 ppM

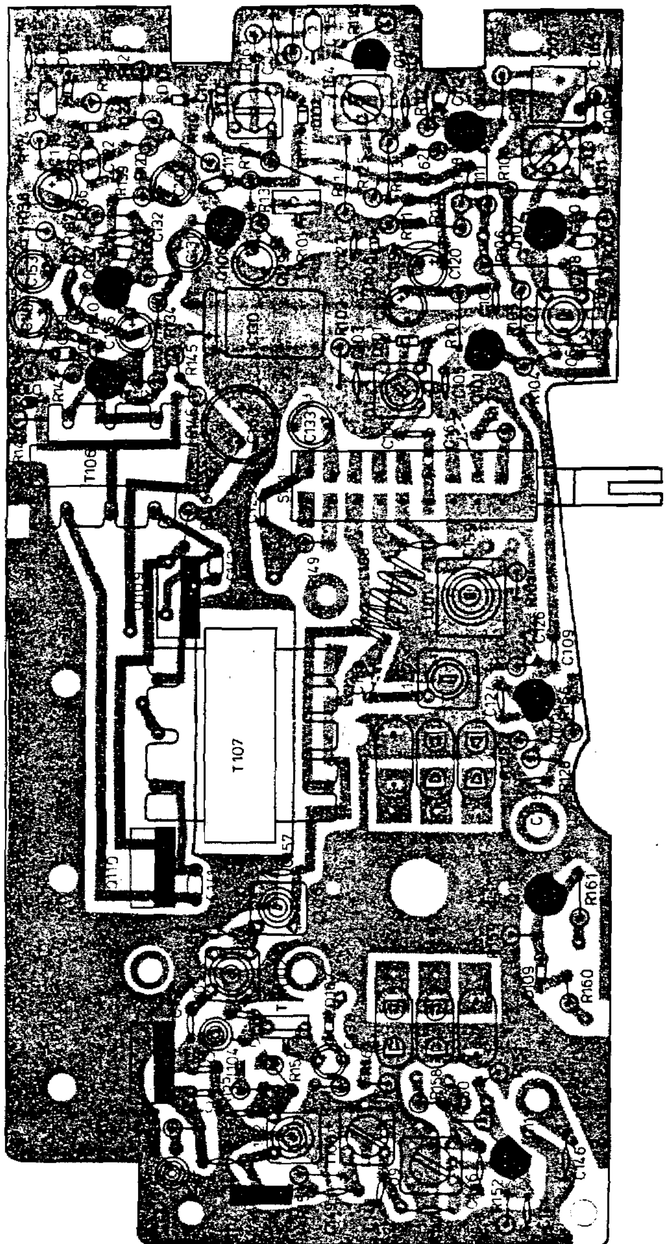
Temperature Range .... − 10° C to + 60° C

Frequency Calculation .... Channel Frequency = Crystal Frequency

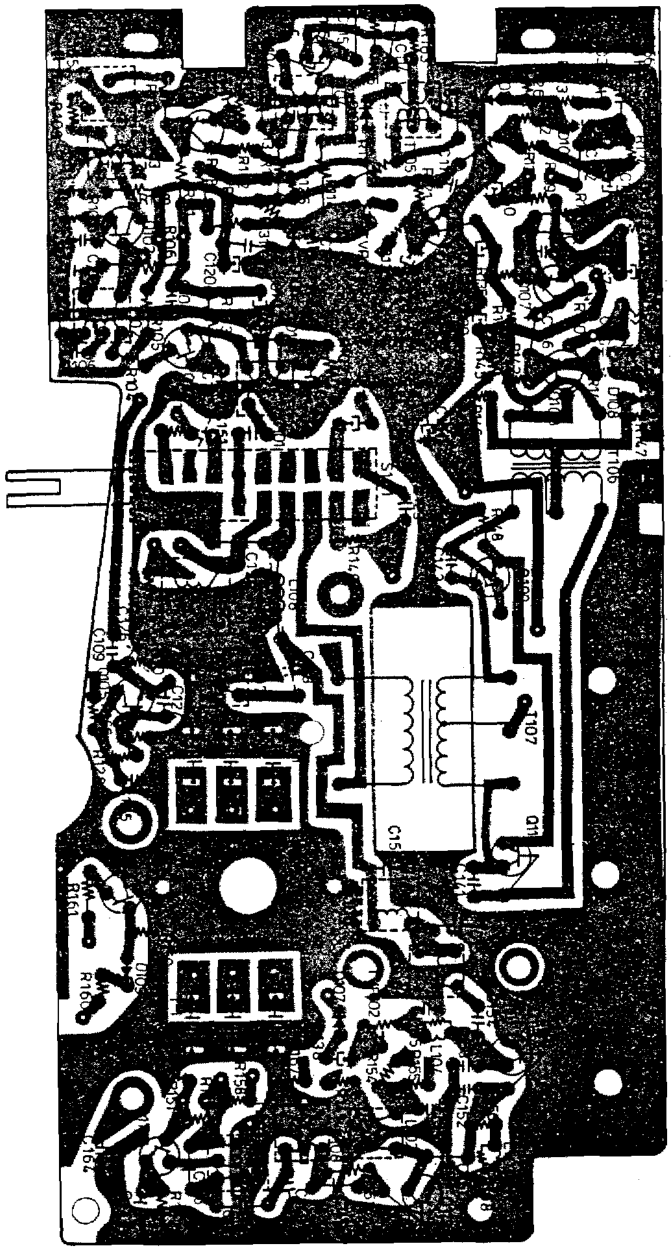
Schematic Diagram.



Circuit Board Assembly.



Top View



Bottom View.

Limited Warranty.

Midland International Corporation will repair or replace, at its option, without charge, any Hand-Held Midland Citizens Band transceiver rated at an input power of 2 watts or greater, which fails due to a defect in material or workmanship within 90 days following the initial consumer purchase.

This warranty does not include any carrying cases, earphones, or telescoping antennas which may be a part of or included with the warranted product.

Performance of any obligation under this warranty may be obtained by returning the warranted product, freight prepaid, along with proof of the purchase date, to Midland International Corporation, Warranty Service Department, 1690 North Topping, Kansas City, Missouri 64120, to any "Midland Authorized Warranty Service Station," or to the place of purchase (if a participating dealer.)

Warranty information and the location of the nearest "Midland Authorized CB Warranty Service Station," may be obtained by writing Midland International Corporation, Warranty Service Department.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

NOTE: The above warranty applies only to merchandise purchased in the United States of America or any of its territories or possessions or from a U.S. military exchange. For warranty coverage on merchandise purchased elsewhere, consult the supplemental warranty information included with this product or ask your dealer.

Please be sure to fill out and mail the Customer Registration Card included with this Owners Manual. Failure to return this card will not affect your rights under the above warranty.

The Midland tradition of electronic excellence.

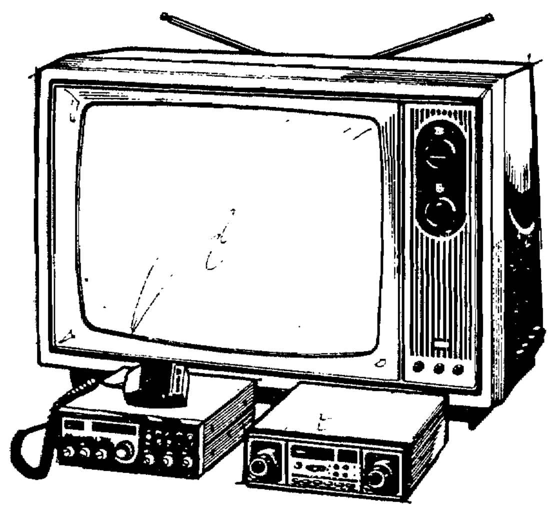
Outstanding CB performance and dependability are only two ways Midland electronic excellence will brighten your life.

The same expertise, skill and dedication that's engineered into your Midland CB also go into every product in the long, versatile line of Midland car stereo receivers, tape players and accessories.

Including widely-acclaimed, exclusive Midland Micro-Precision™ AM/FM/MPX electronic tuning. The 100% electronic signal-search system that locates and locks on stations with microprocessor precision.

And keep your eyes and ears on the popular line of Midland television sets.

The color and black-and-white sets that give you the quality and features you want at some of the most attractive prices in the industry.



DIGITAL THERMISTOR THERMOMETER

Models 8522-10
and 8522-20

Cole-Parmer Instrument Co.
7425 North Oak Park Avenue
Chicago, Illinois 60648

A-1299-94
Edition 1180

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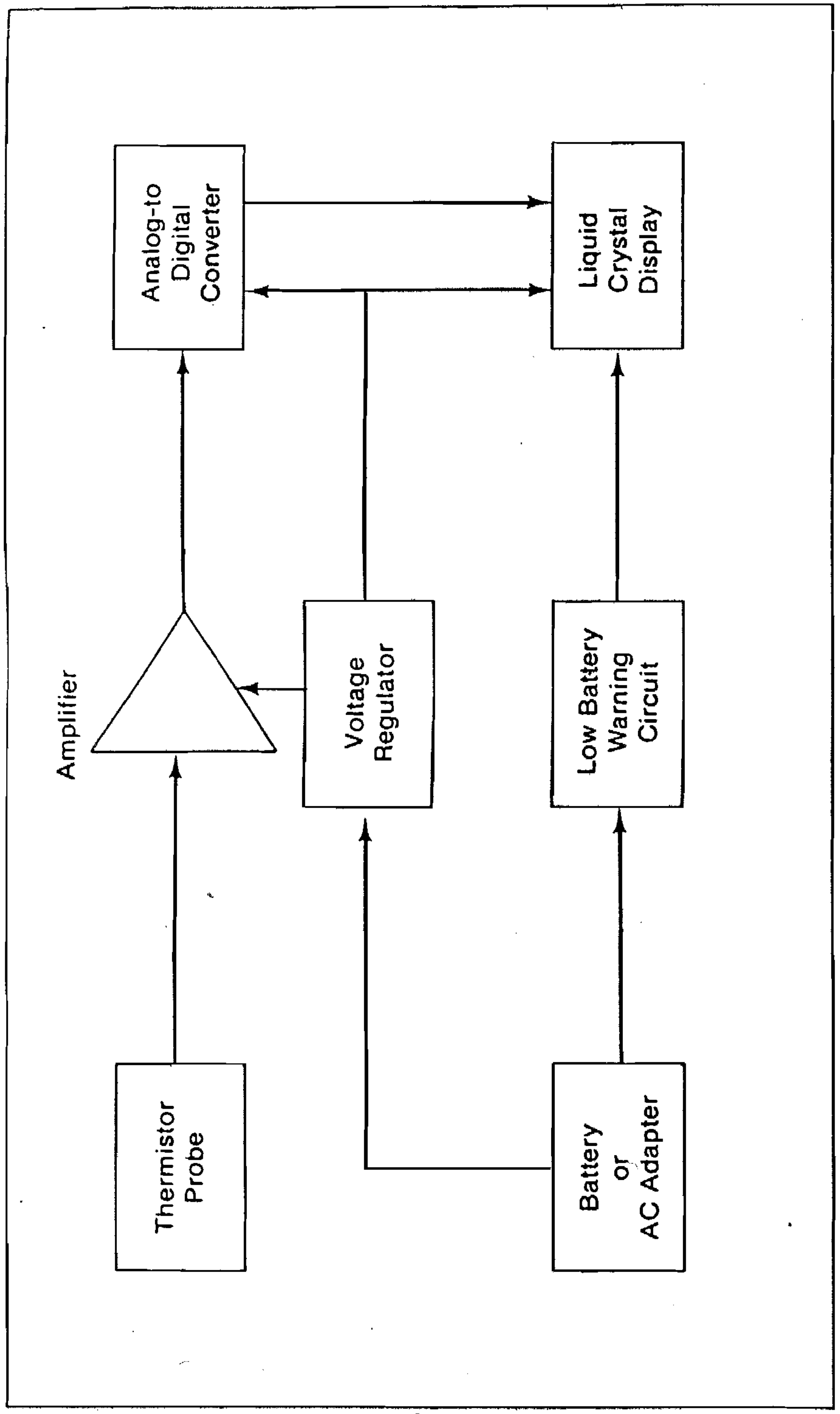


Circuit Block Diagram

1. INTRODUCTION

1A. General Description

The 8522 series of Thermistor Thermometers incorporate all solid state circuitry to provide reliability and minimum maintenance. An "LCD" readout provides easy viewing with a minimum of power consumption. Two versions exist: the 8522-20 and the 8522-10, which provide Fahrenheit (°F) and Celsius (°C) temperature readouts, respectively. The 8522-20 unit has two ranges selected by a switch (the low range provides improved resolution). Either unit can be operated with their internal batteries or an AC line adapter.

1B. Theory of Operation

The instrument consists of several sub-systems. They are the power supply, amplifier, analog-to-digital converter and display. The electrical signal developed by the thermistor is amplified and presented to the analog-to-digital converter which contains all the necessary circuitry to convert the signal into a digital display.

1C. Quality Control Tests

To insure trouble free operation, the instruments are extensively tested. After calibration, every unit is subjected to a "burn in" where the ambient is cycled from hot to cold while the unit is operating. This allows marginal components to be discovered and replaced, minimizing field failures. The units are then re-calibrated and inspected before shipping.

2. INITIAL PREPARATION

2A. Unpacking

The carton will contain the thermometer, a package of batteries and the manual. Carefully inspect during unpacking. If any damage is present, report it to the carrier and enter a claim.

2B. Battery Installation

The battery module consists of six AA size batteries. They were fresh at the time of packing; however, as a precaution, carefully inspect before installation. Discard any that show signs of cracks or leakage. To install, hold the instrument in one hand with the rear battery compartment door facing you. Pull down at the roughened surface of the door and slide it out. Observe the polarity while inserting the batteries. **CAUTION: Failure to observe the correct polarity could result in instrument malfunction or damage.** Carefully align the door into position and slide back into place; the door tangs will snap in place and hold the door closed.

2C. Operating Instructions

Select a thermistor probe which is appropriate for the medium to be measured: air, liquid, or solid (see Probe Usage Section). Insert the probe plug into the socket in the top of the instrument. Depress and release the push button switch once and the instrument will turn on and display the temperature. Depressing the switch again will turn the unit off.

3. INSTRUMENT FEATURES

3A. Display

A Liquid Crystal Display (LCD) has been chosen due to its low current drain, and hence long battery life.

3B. Power Switch

To operate the instrument with its internal batteries, depress once to turn the unit on and depress again to turn off. To operate with the AC adapter, plug it into the instrument and turn the unit on and off with the switch.

3C. Low Battery Indicator

A portion of the instrument's circuitry continuously monitors the battery voltage when the unit is on. If the "Lo Bat" notation is present (the left side of the display), the batteries should be replaced, to maintain the units accuracy.

3D. AC Line Adapter

This optional piece of equipment permits the instrument to be operated from an AC power source. When inserted into the unit, the batteries are disconnected. The adapter only powers the unit; it does not recharge the batteries. Two adapters are available. Use the 5985-10 for 115V, 50-60Hz, and the 5985-15 for 230V, 50-60Hz line voltage.

3E. Probe Connection

The probe socket is a two conductor phone jack located above the display. Only "series 400" thermistor probes should be used (see pages 8 and 9).

3F. Battery Replacement

To maintain the instrument accuracy, the batteries will have to be replaced periodically. The useful life of a set of alkaline batteries is approximately 40 hours. See paragraph 2B for installation instructions.

4. INSTRUMENT SPECIFICATIONS

Accuracy:		±0.2% of full scale
Readability:		8522-10: 0.1 degree
	(low range)	8522-20: 0.1 degree
	(full range)	8522-20: 1.0 degree
Display Update Rate:		2.5/second
Temperature Range:		8522-10: -50°C to +125°C
	(low range)	8522-20: -60°F to +199.9°F
	(full range)	8522-20: -60°F to +260°F
Ambient Limits:		-10°C to +50°C
Thermistor probes:		Series 400
Physical Dimensions:		size: 6"L x 3"W weight: 11 ounces
Storage Limits:		-4°F to +149°F -20°C to +65°C
Digit Size:		0.5" high

5. INSTRUMENT CALIBRATION

As discussed in the Theory of Operation, the different sub-systems have to be carefully calibrated for the instrument to make an accurate measurement. Under normal usage, the instrument will not need re-calibration. If the unit has been accidentally damaged, the manufacturer will recalibrate it, for a nominal charge.

6. PRECAUTIONS

6A. Batteries

When installing new batteries, proper polarity must be observed. The instrument is designed to tolerate improper battery connection but it will not function. However, even momentary improper insertion will reduce battery life.

6B. Handling

Although the instrument is ruggedly designed, severe blows, shocks, or vibration should be avoided if possible. A fall from a table or bench could result in permanent damage.

6C. Storage

For prolonged storage, it is suggested that the batteries should be removed to eliminate the possibility of instrument damage due to battery acid leakage.

800 256

7. PROBE USAGE

Accurate temperature measurement requires the proper selection and use of the appropriate probe. The probes displayed in this manual indicate the large variety that is available. The following notes should assist in selecting the proper probe.

7A. Liquid Measurement

To prevent inaccurate readings due to stratification, the liquid should be stirred continuously. Due to a loss of heat along the probe sheath, the depth of probe immersion is important. A suggested rule to follow is to immerse the probe a minimum distance equal to 10 times the sheath diameter.

7B. Air/Gas Measurement

The small mass of the air probe allows small temperature fluctuations to be monitored. Some general purpose probes, such as those designed for liquid measurement, contain too much mass for them to follow small temperature changes.

7C. Surface Measurement

Several possible configurations exist. Probes having a flat surface can be taped or cemented onto the surface (use a thermally conductive cement).

7D. Interior Mass Measurement

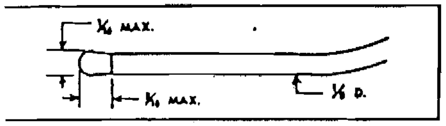
Small thermistors can be inserted into a mixture while it is still in a liquid state and allowed to harden in place. Probes having a pointed tip can be used for deep insertion into semi-solids such as fruit or soil.

7E. Probe Time Constant

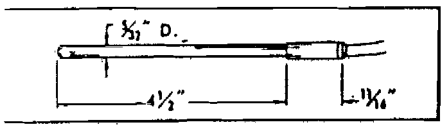
The term "time constant" is a standard method of expressing the response time to a temperature change. "One time constant" is the time required for a given probe to indicate 63% of a sudden temperature change. All probes, except the air temperature probe, were subjected to the same test conditions. The probe was transferred from a water bath at +68° F to another bath at +108° F. The time to respond to 63% of the change (25.2° F) was recorded as its time constant. A probe will indicate approximately 99% of the total change after 5 time constants. The 8442-00 probe could be used as an example. It has a time constant of 1.1 seconds. Therefore, in 5.5 seconds (5 times 1.1), it will indicate 99% of the temperature it is subjected to. This provides a suggested minimum length of time for the operator to wait before recording a temperature reading.

Series 400 Thermistor Probes

The following probes are completely interchangable without recalibrating the thermometer. The recommended temperature range of each probe is given. The minimum temperature limit is -110°F (-80°C). Each probe is provided with a permanently attached 10 foot vinyl covered lead terminating in a plug (unless otherwise noted). Extra long cables and extension cables are available.

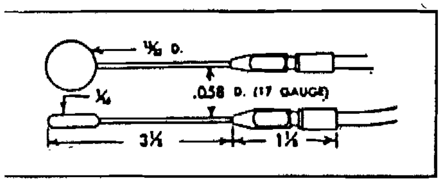


430-00 General purpose esophageal-rectal ·robe for body temperatures of humans and ırger lab animals. Can be used with long ·ads for deep water temperatures or buried ır sub-soil readings. Our most rugged, least ·xpensive probe. Vinyl covered wire and tip. ime constant 7 seconds. Temp range −40 to 212°F (−40 to +100°C).

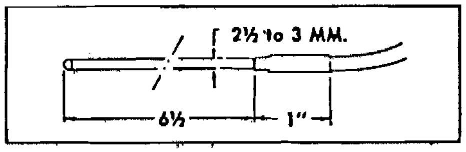


434-00 Liquid immersion applications, ery fast response. Also for oral and rectal ·ork. Made of stainless steel. Immersible nly to cap unless waterproofed. Time con- ·ant 3.4 seconds. Temp range −40 to 300°F (−40 to +150°C). . . . .

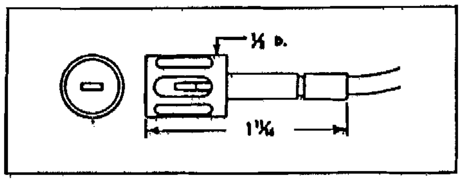
436-00 Liquid immersion, same as above ·xcept probe diameter is $^1/_8$".



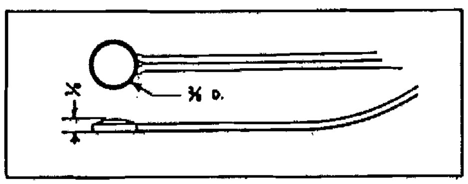
440-00 Surface "Banjo" type, for skin, flat ırfaces, oral and axillary temperatures, soil ırfaces. Suitable anywhere a handle on a ·obe is needed. Stainless steel construction. ıme constant 0.6 seconds. Temperature ınge −40 to +300°F (−40 to +150°C).



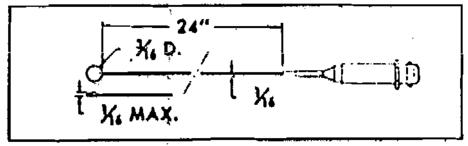
8432-00 Small flexible vinyl for rectal temperatures in small animals and esophageal temperatures of infants. Vinyl sheath and tip. Time constant 3.2 seconds. Temp range −40 to +212°F (−40 to +100°C).



8438-00 Air temperature for test rooms, incubators, remote air temperature tests, gas stream temperatures. All stainless steel. Time constant 3.2 seconds. Temp range −40 to +300°F (−40 to +150°C).

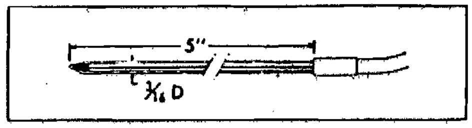


8442-00 Surface for skin temperatures or any flat surface. Easy to tape in place. Used for heat loss on piping or compression efficiency studies. Epoxy-backed stainless steel disc. Vinyl covered parallel leads. Time constant 1.1 seconds. Temp range −40 to +212°F (−40 to +100°C).



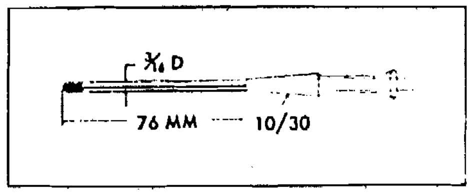
8443-00 Small surface, autoclavable. Similar to 8442-00 but smaller with faster response. 24" Teflon covered flexible wire. Time constant 0.3 seconds. . . . .

8443-20 Small surface, non-autoclavable. Similar to 8443-00 above but with 8432-00 type connector.

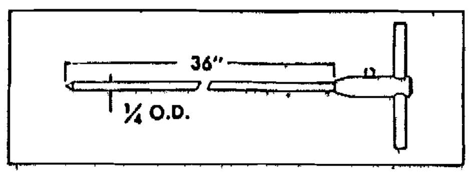


8446-00 Liquid Immersion, Pyrex glass. Use this chemically inert probe for thermometric titrations and general lab readings. Time constant 4.2 seconds. Temp range −40 to +300°F (−40 to +150°C). . . . .

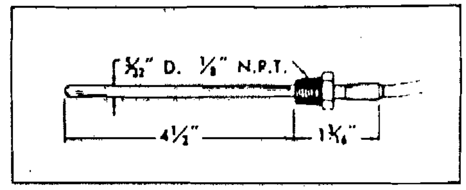
8448-00 Liquid Immersion, same as above but 15" length for use in larger vessels.



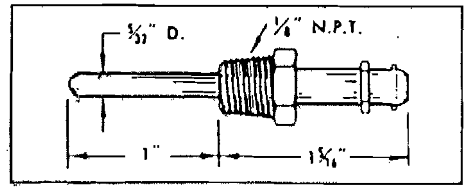
8480-00 Ground glass joint for temperature monitoring or control in all-glass systems. Made entirely of glass with 10/30 ground joint. Time constant 4.2 seconds. Temp range −40 to +300°F (−40 to +150°C).



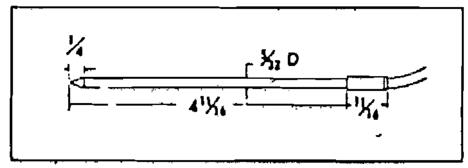
8482-00 Semi-solid Insertion with pointed tip for deep insertion into semi-solids or liquids. Has detachable lead wire and convenient handle. Time constant 4.3 seconds. Temp range −40 to +300°F (−40 to +150°C).



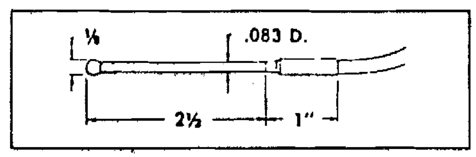
8444-00 Tubular with pipe fitting for temperature readings in closed pipes or vessels. Probe and fitting are stainless steel. Time constant 3.4 seconds. Temp range −40 to +300°F (−40 to +150°C).



8449-00 Tubular with pipe fitting, similar to 8444-00 but with detachable lead and autoclavable probe. Useful with biological apparatus. Stainless steel probe and fitting. *Not electrically insulated.*



8481-00 Semi-solid Insertion with pointed tip for deep insertion into semi-solids such as fruit, soil, tobacco, etc. All stainless steel. *Not electrically insulated.* Time constant 3.7 seconds. Temp range −40 to +300°F (−40 to +150°C).



8484-00 Small flexible nylon, for frozen food packages, hand-held small animals, and cuvettes. Nylon and epoxy tip. Time constant 3.0 seconds. Temp. range -110 to +212°F (-80 to +100°C)

8. TEMPERATURE CONVERSION

Fahrenheit to Celsius
(°F - 32) x 5/9 = °C

Celsius to Fahrenheit
(°C x 9/5) + 32 = °F

The above formulas will provide an accurate conversion between the two forms of temperature measurement. As a quick alternate method, consult the table below.

°F	°C	°F	°C
-58	-50	977	525
-13	-25	1022	550
+32	0	1067	575
77	+25	1112	600
122	50	1157	625
167	75	1202	650
212	100	1247	675
257	125	1292	700
302	150	1337	725
347	175	1382	750
392	200	1427	775
437	225	1472	800
482	250	1517	825
527	275	1562	850
572	300	1607	875
617	325	1652	900
662	350	1697	925
707	375	1742	950
752	400	1787	975
797	425	1832	1000
842	450	1877	1025
887	475	1922	1050
932	500	2012	1100

9. MAINTENANCE

The outside of the instrument case can be wiped clean with a soft, lint free cloth dampened (not dripping wet) with a mild detergent. Do not attempt to use solvents on either the case or LCD lens. Periodically examine the batteries. Replace any that show signs of cracking or leakage. Aside from the batteries, these instruments do not contain user repairable components.

10. WARRANTY

The warranty card must be properly filled out and returned. The manufacturer warrants this product to be free from defects in material and workmanship for a period of six months. If repair or adjustment is necessary and has not been the result of abuse or misuse within the six month period, please return, freight prepaid, and correction of the defect will be made without charge. (see note on return of items). Out-of-warranty products will be repaired for a nominal charge.

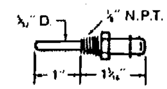
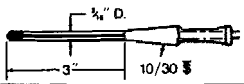
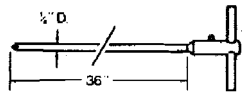
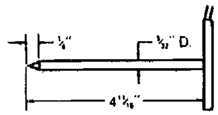
11. RETURN OF ITEMS

Authorization must be obtained from our Customer Service Department before returning items for any reason. When applying for authorization, please include data regarding the reason the items are to be returned. A 15% restocking charge will be made on all returns resulting from customer errors in ordering.

For your protection, items being returned must be **carefully packed** to prevent damage in shipment and insured against possible damage or loss. We will not be responsible for damage resulting from careless or insufficient packing.

12. NOTE

We reserve the right to make improvements in design, construction, and appearance of our products without notice.

Probe No.	Description	Time Constant	Configuration
416	TUBULAR-AUTOCLAVABLE. Like YSI 410, but with detachable lead. Useful in biological apparatus such as heart-lung, heat exchanger, etc. Stainless steel. Fitting withstands 500 psi. Useable to 150°C (300°F). Not electrically isolated.	3.4 sec.	
404	TUBULAR-GLASS. Chemically inert for liquid immersion use. Thermometric titration. Freezing point determination. Pyrex, 5" long. Useable to 150°C (300°F).	4.2 sec.	
415	TUBULAR-LONG GLASS. Same as YSI 404 but with a length of 15". Pyrex. Useable to 150°C (300°F).	4.2 sec.	
417	GROUND GLASS JOINT. For temperature monitoring and control in all-glass systems. Pyrex. Useable to 150°C (300°F)	4.2 sec.	
418	TUBULAR-POINTED METAL. To pierce semi-solids such as meat, fruit, soil, tobacco, etc. Stainless steel. Useable to 150°C (300°F).	3.7 sec.	
419	TUBULAR-LONG POINTED METAL. Similar to YSI 418, but longer for deep insertion in semi-solids. Has handle and detachable lead. Stainless steel. Useable to 150°C (300°F). Not electrically isolated.	4.3 sec.	
433	TUBULAR-POINTED METAL. Stainless steel. For piercing semi-solids. Useful in processing of food products. Pointed tip useable to 150°C (300°F). High temperature Teflon lead wire useable to 260°C (500°F).	3.7 sec.	

Time Constant Time constant, the standard measure of probe response time, is the time required for a probe to read 63% of a newly impressed temperature change. YSI time constants are obtained by transferring the probe from a well stirred water bath at 68°F to a like bath at 108°F. Approximately five "time constants" are required for a probe to read 99% of the total change. Time constants are representative values and subject to variation due to small differences in location of the thermistor component within the probe.

Probe Leads Supplied with 10' vinyl covered shielded leads with plug; may be subjected to 100°C (212°F). Standard extensions are available as follows, junctions are not water resistant:
YSI 4010 — 10' YSI 4025 — 25' YSI 4050 — 50'

Probe Modifications The following probe modifications will be quoted on request:
- YSI 402 — Length to 24"; Teflon instead of vinyl
- YSI 403, 410, 416, 418 — Lengths to 36"; bends to 90° with 3/8" to 1/2" radius
- YSI 404 — Lengths from 1" to 5"
- YSI 405 — Probe without case; longer probe stem to 12"
- YSI 406 — Same as YSI 403, except 1/8" to 3/8" bend radius
- YSI 408 — Bends to 90°; probe length to 12"
- YSI 415 — Length from 5" to 24"
- YSI 419 — Lengths from 6" to 60"
- YSI 409A, 421, 427 — Teflon covered lead to 60" (consult factory for possible temperature error); epoxy encapsulated thermistor without stainless steel disc
- YSI 423 — Length to 5"

Special probes manufactured to customer specifications, including waterproof probes utilizing marine cable for deep water applications.

WARRANTY

All probes carry a one-year warranty on workmanship and components. Damage through accident, misuse or tampering is not covered. Probe life will vary from a few months to many years depending mainly on the amount of cable flexing. Normal life exceeds one year

Scientific Division
Yellow Springs Instrument Co., Inc.
Yellow Springs, Ohio 45387 • Phone 513-767-7241 • Telex 20-5437

ITEM 005311 P/N A40738L February 1981

PRICE INCLUDING HANDLING $1.0

INSTRUCTIONS FOR YSI SERIES 40 TEMPERATURE PROBE

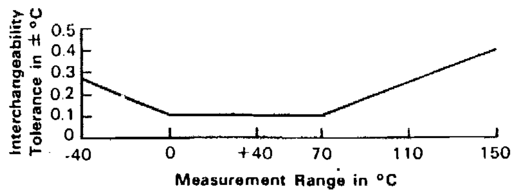
Maximum Operating Temperature: 100°C (212°F) or 150°C (300°F) depending on probe design (see the individual probe descriptions). The vinyl covered lead wires and the phone jacks may not be exposed to temperatures above 100°C.

CONSTRUCTION

Standard YSI Series 400 probes consist of a thermistor temperature sensing element housed in a probe and attached to a plasticized vinyl jacketed shielded lead wire terminated with a phone plug.

Except as indicated in the individual probe descriptions, probes are constructed with the thermistor sensing element electrically isolated from the outer probe surfaces to prevent an accidental ground path or shock from other instruments when the probes are used in contact with the body.

YSI Series 400 probes offer the feature of true interchangeability between probes. The thermistor temperature sensing elements are manufactured by a unique patented method for producing thermistors with matching temperature/resistance characteristics. All probes are warranted to remain within the interchangeability tolerances shown by the following curve for a period of one year.



APPLICATION

YSI Series 400 probes are recommended for use with YSI Tele-Thermometers and temperature controllers for direct temperature measurement.

STEM EFFECT

"Stem Effect" refers to the potential inaccuracy of measurement caused by heat transfer through the lead of a probe. The leads of some probes are relatively more massive for the sake of ruggedness; such leads introduce potentially greater stem effects. These effects may be lessened by minimizing the difference between probe tip temperature and lead temperature by means of appropriate insulation, isolation or immersion as each application dictates. Stem effect is negligible on probes with very light leads — though at the expense of ruggedness.

TEMPERATURE/RESISTANCE CHARACTERISTICS

The following table lists the temperature/resistance characteri tics for YSI Series 400 probes with standard 10' leads. Probe with leads hundreds of feet long can be provided, but whe length exceeds 100' it may be necessary to consider errors intr duced by lead resistance. Generally, this is only significant high temperatures. On request, YSI will provide temperature co rection data for probes with long leads

Temp. °C	Res. Ohms	Temp. C	Res. Ohms	Temp. °C	Res. Ohms	Temp. C	Res. Ohms
−40	75.79K	12	4075	32	1668	60	560.7
−35	54.66K	13	3887	33	1599	65	469.4
−30	39.86K	14	3708	34	1534	70	394.9
−25	29.38K	15	3539	35	1471	75	333.5
−20	21.87K	16	3379	36	1412	80	283.1
−15	16.43K	17	3226	37	1355	85	241.3
−10	12.46K	18	3082	38	1301	90	206.5
− 5	9534	19	2944	39	1249	95	177.5
0	7355	20	2814	40	1200	100	153.2
1	6990	21	2690	41	1153	105	132.7
2	6645	22	2572	42	1108	110	115.4
3	6319	23	2460	43	1065	115	100.6
4	6011	24	2354	44	1024	120	88.1
5	5720	25	2253	45	984.2	125	77.4
6	5444	26	2156	46	946.6	130	68.2
7	5184	27	2065	47	910.6	135	60.2
8	4937	28	1977	48	876.2	140	53.4
9	4704	29	1894	49	843.2	145	47.4
10	4483	30	1815	50	811.7	150	42.3
11	4273	31	1740	55	672.9		

STORAGE

When not in use, probes and leads should be formed into loc loops. If wires are stretched or wrapped tightly around inst ment cases, sheathing may become permanently indent creating stresses sufficient to cause mechanical failure. St probes at temperatures below 50°C, preferably at room te perature.

CAUTION

Use only with instruments designed for YSI Series 400 prob In the presence of high intensity RF energy sources, local he ing, temperature errors and probe damage may occur. In medi use, unplug the probe or remove it from patient contact befo activating electro-surgical apparatus or other direct-coupled f energy source.

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CLEANING CAUTIONS

Several precautions must be observed when cleaning and sterilizing probes; as they are easily destroyed with improper handling.

NEVER BOIL OR AUTOCLAVE THE VINYL JACKETED LEAD WIRE. The vinyl may safely be exposed to temperatures up to 100°C, but above 90°C the vinyl softens and can be deformed permanently by mechanical stress. Handle gently while hot.

Avoid contact with strong, aromatic, chlorinated, ketone, ether or ester solvents. Prolonged immersion in alcohols or mild organic solvents, detergent solutions or highly alkaline solutions will cause the vinyl to lose flexibility. In medical applications, the user must determine that a probe is suitable and sufficiently flexible for esophageal or rectal use.

During cleaning or sterilization, probes should be handled gently. When wiping clean, hold the probe in one hand at the sensing tip and wipe the probe and lead wire toward the plug end. If excessive pressure is used, the covering will be stretched, which may break the internal wires and destroy the probe.

Continued flexing of lead wires in use and cleaning will break the internal wires and cause failure. Failure from this cause is not covered by the warranty.

DISINFECTION

Probes may be disinfected and sanitized by washing with 3% hydrogen peroxide or 70% isopropanol. 70% ethanol is nearly as effective, but 100% alcohols are less germicidal. Dakin's solution (sodium hypochlorite in neutral buffer) is also suitable. Brief immersion in detergent solutions is not harmful.

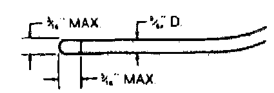
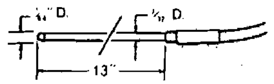
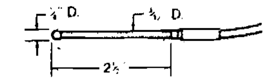
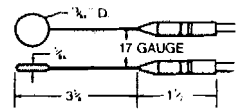
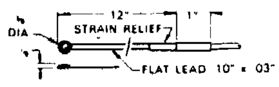
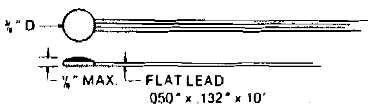
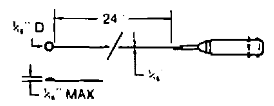
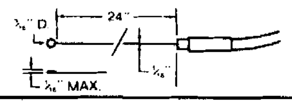
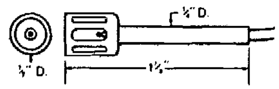
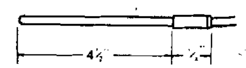
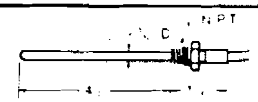
Phenol disinfectants, such as hexachlorophene, should be avoided because the disinfectant may be absorbed by the vinyl.

STERILIZATION

The detachable probe portion of the YSI 416 and 421 probes may be autoclaved, but should never be boiled. NEVER BOIL OR AUTOCLAVE ANY YSI SERIES 400 TEMPERATURE PROBE EXCEPT FOR THE DETACHABLE PORTION OF YSI 416 OR YSI 421. On other probes, autoclaving may cause the insulation to fail and may also cause the probe to give inaccurate temperature readings.

Ethylene oxide sterilization does not damage the probe, but the gas is highly irritating and is absorbed by the plastic parts. Directions given by the manufacturer of the sterilizer must be followed; and before handling or use, probes must be safely and thoroughly ventilated according to the sterilizing apparatus manufacturer's instructions. Biological indicators should be employed to assure that sterility has been achieved.

YSI Series 400 Probe Styles Available

Probe No.	Description	Time Constant	Configuration
401	GENERAL PURPOSE: Esophageal or rectal temperature in humans and animals. Used for water temperatures (short term), and often buried for sub-soil readings. Used for air where fast response is not required. Most rugged probe. Vinyl tip and lead. Useable to 100°C (212°F).	7.0 sec.	
402	SMALL FLEXIBLE VINYL. Rectal temperatures of small animals. Esophageal temperatures of infants. Cuvette temperatures. Vinyl sheath and tip. Useable to 100°C (212°F).	3.2 sec	
423	SMALL SEMI-FLEXIBLE NYLON. Frozen food package temperatures. Esophageal and rectal readings. Cuvette temperatures. Nylon with epoxy tip. Useable to 100°C (212°F).	1.4 sec.	
408	"BANJO" SURFACE TEMPERATURE. Skin, oral, axillary, water bath, and flat surface temperatures. Excellent for many air temperature applications. Handle aids in probe use. Stainless steel. Useable to 150°C (300°F)	0.6 sec	
409A	ATTACHABLE SURFACE TEMPERATURE. Stainless steel cup, epoxy backed with teflon-covered flexible wire. Easy to tape on flat surfaces. Good for heat loss or compression efficiency study of piping. Useable to 150°C (300°F).	1.1 sec	
409B	ATTACHABLE SURFACE TEMPERATURE. Tape on skin or flat surfaces. Good for heat loss and compression efficiency study of piping systems. Similar to 409A but less flexible and more rugged with 10' vinyl covered parallel lead with right angle phone plug termination. Stainless steel cup, epoxy backed. Useable to 100°C (212°F).	1.1 sec	
421	SMALL SURFACE TEMPERATURE. Cuvette, water bath, leaf and other surfaces. 24" Teflon*-covered flexible wire. Stainless steel disc with epoxy back. Can be autoclaved. Useable to 150°C (300°F). Probe head electrically isolated, connector not isolated. Detachable lead.	0.3 sec.	
427	SMALL SURFACE TEMPERATURE. Like YSI 421, but with YSI 402 type juncture. Non-detachable lead, non-autoclavable. Useable to 150°C (300°F)	0.3 sec	
405	AIR TEMPERATURE. Test rooms, incubators, remote air readings, gas streams, etc. Stainless steel cage around epoxy encapsulated thermistor. Useable to 150°C (300°F).	0.6 sec	
403	TUBULAR. For rugged duty in liquid immersion. Fast response oral or rectal. Stainless steel 5/32" dia. Useable to 150°C (300°F).	3.4 sec.	
406	THIN TUBULAR. Same as YSI 403, except diameter is 1/8" and probe is less rugged, but response is faster. Useable to 150°C (300°F).	2.5 sec	
410	TUBULAR WITH FITTING. For readings in pipes or closed vessels. Stainless steel. Fitting withstands 500 psi. Useable to 150°C (300°F)	3.4 sec	

000 260

of the moving car is determined for each run by making an independent measurement of the distance it travels during the time that the revolutions of the rotor are electrically counted. A scale graduated in feet and tenths of a foot is used for this purpose. Eight pairs of runs are usually made for each current meter. A pair of runs consists of two traverses of the basin, one in each direction, at approximately the same speed. Practical considerations usually limit the ratings to velocities ranging from 0.1 fps to about 15 fps, although the rating car can be operated at lower speeds. Unless a special request is made for a more extensive rating, the lowest velocity used in the rating is about 0.2 fps, and the highest is about 8.0 fps.

For convenience in field use, the data from the current-meter ratings are reproduced in tables, a sample of which is shown in figure 11. The velocities corresponding to a range of 3 to 350 revolutions of the rotor within a period of 40 to 70 seconds are listed in the tables. This range in revolution and time has been found to cover general field requirements. To provide the necessary information for extending a table for the few instances where extensions are required, the equations of the rating table are shown in the spaces provided in the heading. The equation to the left of the figure in parentheses (2.28 in fig. 11) is the equation for velocities less than 2.28 fps and the equation to the right is for velocities greater than 2.28 fps. The 2.28 fps is the velocity common to both equations.

It should be noted that the equations given are those of the rating table, and not necessarily those of the actual rating. If a rating table already on file matches a rating within tolerances, that table is selected in preference to preparing a new one. Those tolerances are listed below.

Revolutions of rotor per second	*Tolerance, in percent*
0.0	1.0
1.0 and above	.5

Sounding equipment

Sounding (determination of depth) is commonly done mechanically, the equipment used depending on the type of measurement being made. Depth and position in the vertical are measured by a rigid rod or by a sounding weight suspended from a cable. The cable is controlled either by a reel or by a handline. A sonic sounder is also available, but it is usually used in conjunction with a reel and a sounding weight.

Sounding equipment used by the Geological Survey is described in the following categories: wading rods, sounding weights, sounding reels, handlines, and sonic sounder.

Wading rods

The two types of wading rods commonly used are the top-setting rod and the round rod. The top-setting rod is preferred because of the convenience in setting the meter at the proper depth and because the hydrographer can keep his hands dry. The round rod can be used in making ice measurements as well as wading measurements, and has the advantage that it can be taken down to 1-foot lengths for storing and transporting.

The top-setting wading rod has a ½-inch hexagonal main rod for measuring depth and a ⅜-inch diameter round rod for setting the position of the current meter. (See fig. 12.)

The rod is placed in the stream so the base plate rests on the streambed, and the depth of water is read on the graduated main rod. When the setting rod is adjusted to read the depth of water, the meter is positioned automatically for the 0.6-depth method. (See fig. 13 and p. 32.) The 0.6-depth setting might also be described as the 0.4-depth position up from the streambed. When the depth of water is divided by 2 and this new value is set, the meter would be at the 0.2-depth position up from the streambed. When the depth of water is multiplied by 2 and this value is set, the meter would be at the 0.8-depth position up from the streambed. These two positions represent the conventional 0.2- and 0.8-depth positions in reverse. (See p. 32.)

The round wading rod consists of a base plate, lower section, three or four intermediate sections, sliding support, and a rod end (not essential). (See fig. 14.) The parts are assembled as shown in figure 15. The meter is mounted on the sliding support and is set at the desired position on the rod by sliding the support.

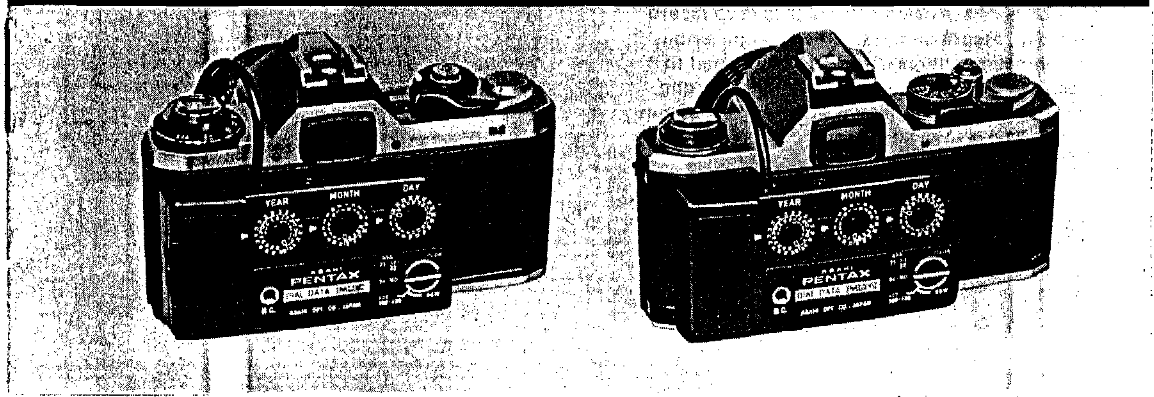
The round rod is also used in making ice measurements. Intermediate sections of the round rod are screwed together to make an ice rod of desired length. (See fig. 16.) The most convenient length for an ice rod is about 3 feet

326-253 O—69——3

ccd 261

ASAHI
PENTAX

DIAL DATA ME
DIAL DATA MX



CCO 262

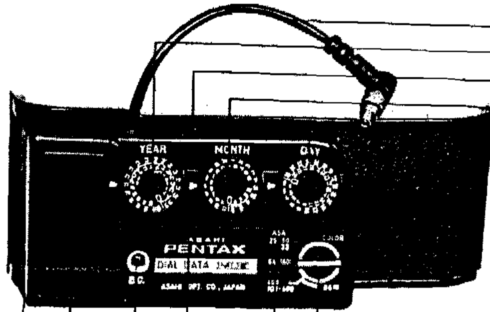
:ATURES

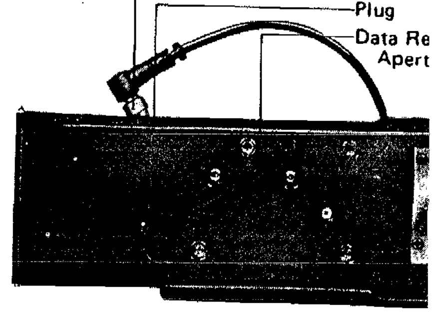
The dial backs for the Pentax ME and MX ıeras—Dial Data ME and Dial Data MX—are dy devices for imprinting a variety of useful ırmation directly onto the corner of your ıtographs. There are three integral dials on back of the data backs, one each to record day, month and year. And used in various ıbinations, these dials can also be used to ırd exposure data such as aperture setting, ıtter speed, focal length of lenses (for 35mm ıes and below) and magnification ratios. habet letters from A – O are also included coding information.

With a little imagination and by employing various codes, virtually unlimited uses can be found for home picture taking, for schools, in industry, police work and science. Index specimens, product catalogues, aircraft; record progress on construction sights. These are just some of the many uses for the Dial Datas.

Both Dial Data MX & ME are exactly the same functionally, although the backs on which they are mounted differ in size because of the differences in the ME and MX cameras; the other difference is that sync cords connect in a different manner.

DESCRIPTION OF PARTS





000263

PECIFICATIONS

lounting:	Both backs interchange with standard ME & MX back covers. ME sync cord connects with ME's X-sync terminal; MX sync cord with MX's FP terminal.	
ecording System:	Internal recording lamp projects the data onto the reverse side of the film.	
ata on Each Dial:	**Year Dial**	
	3 groups	77 – 88 (Years 1977 – 1988) F-numbers (F1.2, F1.4, F1.7, F2, F2.4, F2.8, F3.4, F4, F4.8, F5.6, F6.7, F8, F9.5, F11, F13.5, F16, F19, F22, F27, F32, F45, F1.8, F2.5, F3.5, F4.5) Blank –□
	Month Dial	
	4 groups	12 months of the year (1 – 12) Shutter speeds (AUTO, 1000, 500, 250, 125, 100, 60, 30, 15; months 8, 4, 2, & 1 double as shutter speeds) Letters A – O (B doubles as "B" shutter speed setting) Blank –□
	Day Dial	
	3 groups	days (1 – 31) Numbers (0 – 36) Nos. 15, 17, 18, 20, 24, 28, 30, 35 doubl focal lengths for lenses Blank –□

ASA Film Speed Settings:

Color	25 – 50	64 – 160	400
B & W	32		100 – 400

Power Source:	Three 1.5V silver oxide batteries
Battery Checker:	LED indicator lights when battery check button is pressed.
Number of Recordings:	Approx. 10,000 recordings (at Color ASA 64 – 160 setting) or approx. 1 y
Recording Confirmation:	LED indicator lights when internal recording lamp is functioning.
Joint Use with Motor Drives:	Records data in sequence on each frame at the respective operating speeds c Winder ME, Winder MX and Motor Drive MX.

000 264

her Features:	Mounts without interfering with use of flash, tripod and other camera accessories (except 250-frame bulk film back).	
nensions and ight:	Dial Data MX:	139.5mm (length) x 54.5mm (height) x 28mm (depth) max. dimensions; 130g. (with batteries)
	MX Body + Dial Data MX:	Depth increases to 59mm (length & height remain the same)
	Dial Data ME:	134.5mm (length) x 54.5mm (height) x 30.5mm (depth) max. dimensions; 130g (with batteries)
	ME Body + Dial Data ME:	Depth increases to 59mm (length & height remain the same)

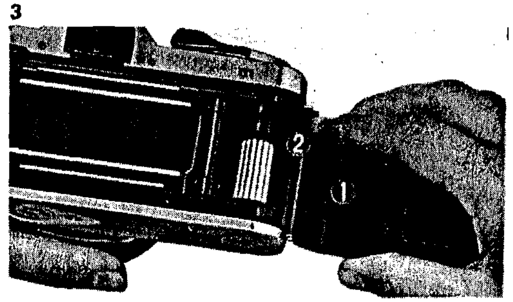
OCO 265

MOUNTING

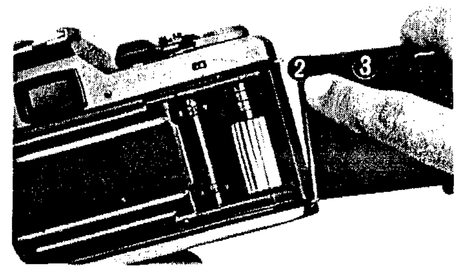
Illust. 3 Open the standard camera back (1). Depress the pin which protrudes from hinge (2) and pull outward at the top of the hinge until the back comes loose.

Illust. 4 Procedure is the reverse of the abc mounting the data backs. First insert the bo of the hinge into the mount at the base of t camera, then, depress the protuding pin (2) align the top of the hinge with the top mou Release the protuding pin when properly al to spring the back into place.

3



4

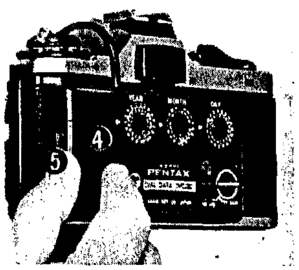


ATTERIES

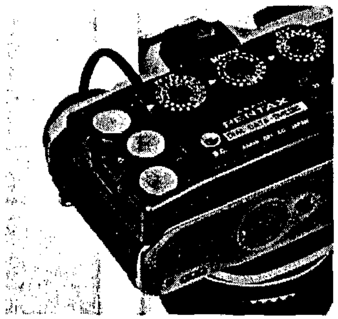
TALLATION

st. 5 Lift out on the battery compartment h (5) until the cover (4) comes off.
st. 6 Insert three 1.5V silver oxide batteries ı the (+) signs facing outwards.

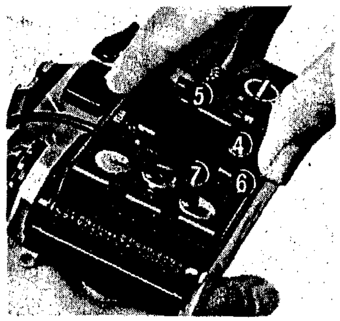
Illust. 7 To replace the battery compartment cover (4), insert the two tabs (6) into notches at the right side of the battery compartment and close the latch (5).



6



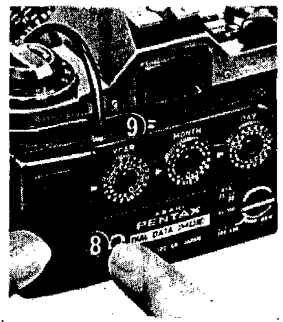
7



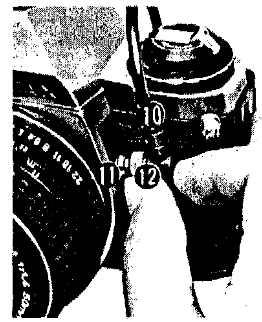
CHECKING BATTERIES

Illust. 8 Press the battery check button (8) marked "BC." The LED indicator will light if the circuit is functioning properly. If the indicator fails to light, make sure that batteries have been inserted properly. When the LED indicator no longer lights,

8



9



it is time to replace the batteries. Repl three batteries together as standard per cannot be assured when batteries are m

BATTERY LIFE

The 1.5V silver oxide batteries are gen sufficient for 10,000 data recordings; i used at all they will last for approx. 2 y

SYNC CORD HOOK-UP

Illust. 9 For Dial Data ME, connect the cord to the ME's X-sync terminal (11). Data MX connects to the FP terminal o After aligning the sync cord, turn the c screw (12) clockwise to lock in place.

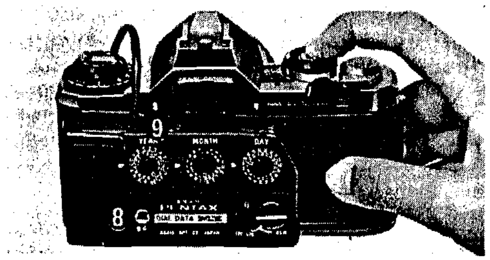
PERATION

NCTION TEST

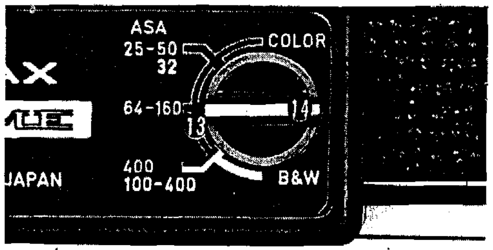
ıst. 10 After the sync cord is hooked up, ‧ase the shutter once before loading film in camera. If the LED indicator (9) lights ıultaneously with releasing the shutter, the ‧jection bulb inside the unit is functioning perly.

ıe LED indicator fails to light, although batteries still fairly new, check whether the sync cord been connected properly, batteries have been ‧rted properly, etc. If you still can not find the se of the trouble, it may be internal function and the unit should be taken to the rest Pentax service outlet.

10



11



PRECAUTIONS WITH BATTERIES

When batteries are low and when temperatures are below freezing the LED indicator (9) will not light. This indicates that the recording lamp inside the unit is also not lighting and data will not record. If low temperature is the cause, the batteries or battery compartment should be warmed. When batteries are warm, battery performance returns to normal.

• The battery check button (8) will light even in low temperatures unless the batteries are extremely low. However, the unit will not function unless the LED indicator lights.

• When the LED indicator produces only a faint glow, exposure may not be sufficient enough to record data. In this instance, exposure compensation can be made by lowering the ASA film speed setting on the data back's ASA film speed dial (next paragraph). With ASA 100 color film, for example, set the dial to ASA 25 - 50.

USING THE ASA FILM SPEED DIAL

Illust. 11 The following settings circle the / film speed dial (13).

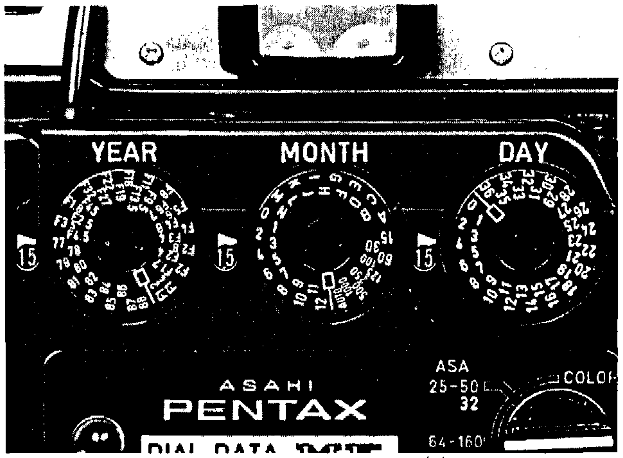
Color Film	25 - 50 64 - 160	400
B & W	32	100 - 40(

To set the dial, turn the knob (14) until aligns with the setting which covers the film Each setting covers a wide range of film spee latitude is rather wide. For example, with A color film, which is to be push processed at 360, the Color 64 - 160 setting will be suffi Although the 64 - 160 setting is also used fc 64 color film, when the subject is brightly li figures can be made to stand out brighter by lowering the dial to 25 - 50.

:TTING THE DATA DIALS

ust. 12 Rotate the appropriate dial ıtil the desired figure lines up with e index mark (15) on the left side the dial. When you desire that :ertain dial not record, the blank tting (—▭) must be used. For ımes when you do not wish to :ord any data at all, either rotate all ree dials to the blank settings, or sconnect the sync cord.
l shutter speed settings on both meras (except the "L" setting on e ME) may be used to record data. ıe various information on each dial listed laterally in the specifications age 4 – 6).

12



SHOOTING POSTURE

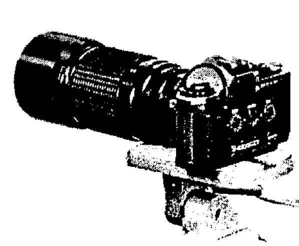
Dial Data ME & MX are designed so as to permit easy viewing while hand holding the camera. When holding the camera vertically and viewing with the right eye, the camera should be held so as the shutter button is above eye level as shown in Illust 14.

Illust. 15 Both ME and MX Dial Data ba securely to the camera when it is used wit a tripod.
Illust. 16 A special soft camera case whic encloses both the camera and the data bac available as an accessory.

13

14

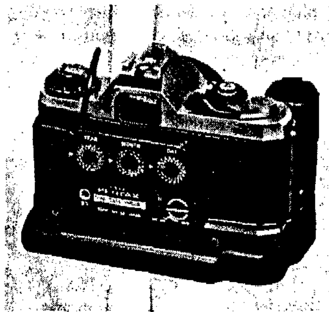
15

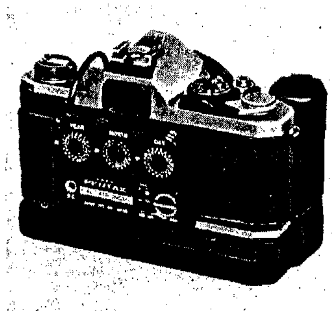


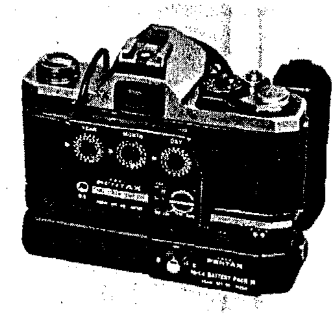
16

USE WITH OTHER PENTAX ACCESSORIES Winder ME, Winder MX, Motor Drive MX

When used with winder and motor drive units both data backs record data on each frame in unison with the motor drive unit's operation speed.


ME + Dial Data + Winder ME

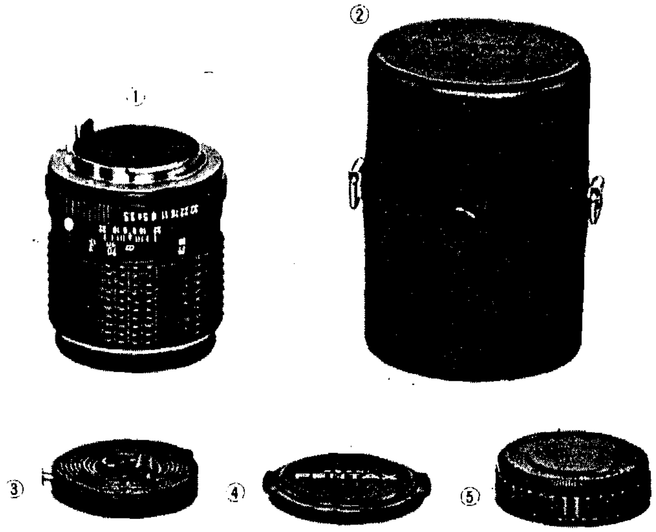

MX + Dial Data + Winder MX


MX + Dial Data + Motor Drive MX and Ni-Cd Battery Pack M

000270

HANDLING LENSES

1



The SMC Pentax lens is furnished with a lens cap (4) and a rear lens cap (5), both of which protect the lens from dust, dirt and moisture; be sure to keep these caps on the lens, while not in actual use. It is a good practice to place these caps, whenever removed from the lens, in the leather lens case so that they will not be lost. The lens case is large enough to hold a lens with a filter (except for a polarizing one) attached; in this case, the focusing ring has to be set at infinity to minimize the length of the lens. When the lens has been removed from the camera body, place it front-element down as shown in Fig. 1. Don't place the lens on its side because it may roll. Never place the lens rear-element down, for to do so may cause damage to the protruding automatic diaphragm lever or may cause the lens to topple over.

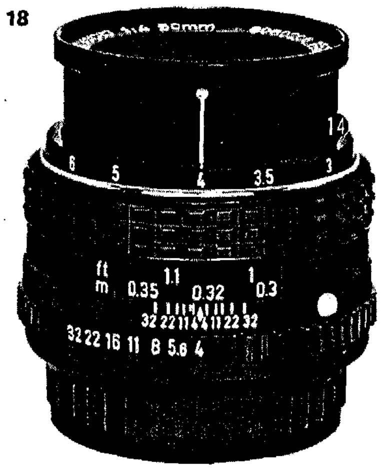
A standard lens, when removed from the camera body, should be kept in a standard lens case for protection. This case is available as an optional accessory.
Be careful never to touch the lens surface with your fingers. Lens stains such as fingerprints are difficult to wipe off.

MACRO LENSES

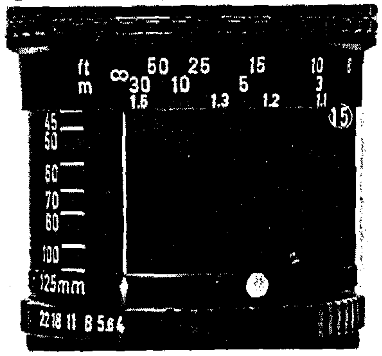
When the magnification index ⑭ indicates '4', it means that the image on the film is 1/4 as large as the real object. For macrophotography, simply set the desired magnification on the index and then focus by moving the entire camera back and forth. When using an SMC Pentax-M Macro lens no particular exposure determination is required. For exposure, you can depend on the meter built into the Pentax cameras. You also need not worry about exposure increase factors for close-up work.

Life-size magnification is possible with the SMC Pentax-M Macro 50mm f/4 lens when it is combined with the No. 3 Auto Extension Tube K, or with the SMC Pentax Bellows 100mm f/4 lens when it is used with the Auto Extension Tubes K50mm.

18



19



Close-up Lenses

An optional attachment lens for close-ups is available for the SMC Pentax Zoom 45–125mm f/4 lens. The attachment lens screws to the front of the lens to permit photographing the subject closer than the lens' normal minimum focusing distance will permit. When the attachment lens and the zoom lens are used together, focusing is via the zoom lens' close focusing scale ⑮ (i.e., the bottom roll of white figures in Fig. 19). Close focusing range for the 45–125mm zoom lens is 1.5 to 0.9 meter. In the case of the SMC Pentax Zoom 135–600mm f/6.7 lens, a close-up attachment is furnished as an accessory. With the close-up lens attached, focusing range is from 7–3.35 meters. A close focusing scale is provided on the zoom lens.

Focusing

Once in focus, the SMC Pentax Zoom lenses maintain the focus setting even while zooming. It is a good practice to focus at the maximum focal length, i.e. with the largest possible image, and then zoom back to the desired focal length. This ensures maximum focusing accuracy.

Filters

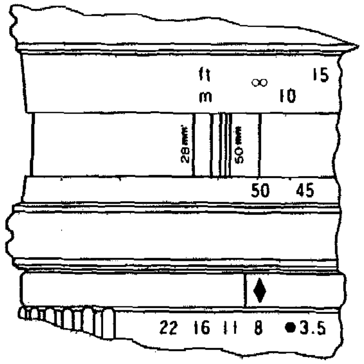
Refer to the chart on pages 16 and 17 to determine which filters to use with zoom lenses.

Depth of Field Scales/Infrared Photography

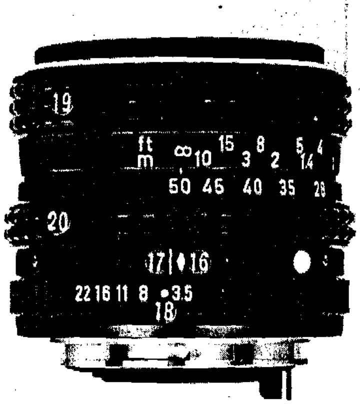
Depth-of-field scales and compensation markings for infrared focusing are not provided with zoom lenses. For most of the lenses, however, indications as to how to determine these are given in the charts on pages 32–41.
The focal shift required for infrared photography with the 28–50mm lens is indicated in the diagram at the right. If an aperture of f/8 is used, however, focal compensation is not required as the depth-of-field will adequately cover the amount of shift.

Distortion

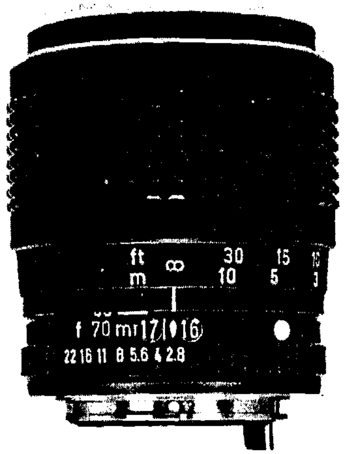
By nature, zoom lenses give rise to slightly greater distortion (alterations in the shape or proportion of objects) then fixed focal length lenses. The amount of distortion varies according to the focal length of the lens. The zoom lens is, therefore, not recommended for situations where proportional accuracy is crucial.



20 28–50mm f/3.5–f/4.5



21 35–70mm f/2.8–F3.5



Variable Aperture Zoom Lenses

The SMC Pentax Zoom 28mm–50mm f/3.5–f/4.5 (Fig. 20) and Zoom 35mm –70mm f/2.8–f/3.5 (Fig. 21) both feature variable maximum aperture which depends upon the focal length setting in use. Likewise both have two aperture index marks: a ♦ ⑯ which indicates the maximum aperture at the shortest focal length setting, and a green line ⑰ (which indicateds the maximum aperture at the longest focal length). Thus, with the 28–50mm lens, the ♦ index gives the f/3.5 maximum aperture with the lens at 28mm; while the green index indicates the f/4.5 maximum aperture of the lens when it is set at 50mm. Similarly, the f/2.8 maximum aperture of the 35–70mm lens when used at 35mm focal length is indicated by the ♦ index. while the green index indicates the f/3.5 maximum aperture of the lens when it is used at 70mm setting.

When using inbetween focal lengths, the exact aperture lies partway between both indexes. However, the aperture scale features half stops, permiting adjustment to the closest index, depending upon which focal length setting is in use. For example, with the 28–50mm lens, you should adjust the ring one click in the direction of the diamond index when at 35mm, and one-click in the direction of the green index at 40mm.

The 40–80mm f/2.8–f/4 zoom pictured on page 30 has three indexes: use the ♦ index for focal lengths in the vicinity of 40mm; use the white line when the focal length is closer to 60mm, and use the green line when closed to 80mm.

Approx. Apertures for Midway Focal Lengths

For flash photography and other special shooting applications its handy to know the approximate f-number at the midway focal length settings of the above three lenses; these are as follows.

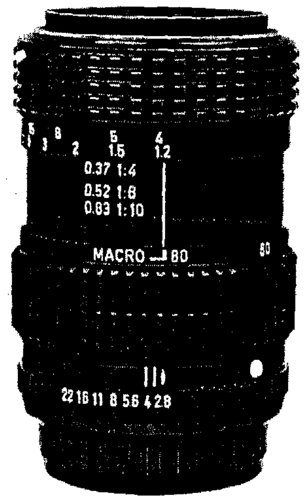
Lens	Setting	Approx. f-number
28–50mm	35mm	f/4
35–70mm	50mm	f/3.1
40–80mm	60mm	f/3.4

Dual Control Zooms
While most of the SMC Pentax Zoom lenses feature a combined zoom/focus collar, the following three feature separate zooming and focusing rings: 24–35mm, 28–50mm and 40–80mm. With all three lenses, focusing is performed with the front ring, and zooming is accomplished with the back ring.

MACRO Setting of the 40–80mm Lens
The 40–80mm zoom lens pictured in Fig. 22 features a clickstop at the 80mm setting. To engage the macro override system turn the zooming ring beyond the click-stop to the MACRO setting as shown in Fig. 23 and extend the focusing ring. When it's extended all the way, the magnifica-

22 40mm–80mm f/2.8 – f/4

23



tion ratios 1:10, 1:6 and 1:4 will be visible; these represent magnifications approximately 1/10X, 1/6X and 1/4X the actual object size. The figures to the left of the ratios (i.e., 0.83, 0.52 and 0.37) are the corresponding focusing distances for the given magnification. Thus, when the macro override system is engaged and the focusing ring is extended all the way, the approximate magnification will be 1/4X at a distance of 0.37 meter from the subject (although the focusing index will still read 1.2 meters).
When you wish to shoot at one of the premarked magnifications, align the focusing ring just above the desired magnification ratio and focus by moving the camera closer or further from the subject, as required. If you focus by turning the focus ring, the magnification will be altered.
Infrared compensation is not required with this lens at apertures of f/5.6 or smaller (depth of field adequate covers infrared focal shift at these apertures).

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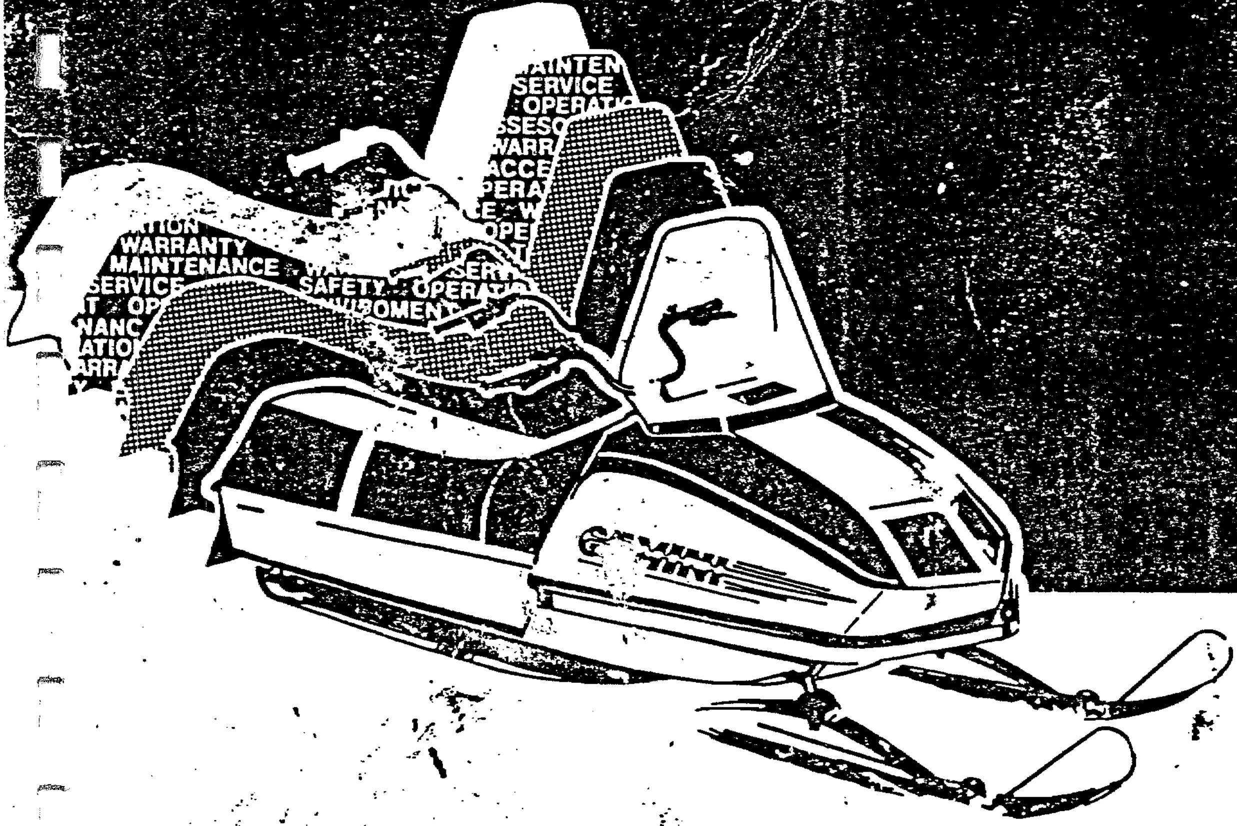
OWNER'S MANUAL



Polaris

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CAUTION: **ATTENTION:**

BEFORE STARTING ENGINE: CHECK THROTTLE AND BRAKE FOR PROPER OPERATION. CHECK TO SEE THAT HOOD IS SECURELY LATCHED. CHECK SURROUNDINGS TO VERIFY CLEAR OPERATION AREA. DETERMINE THAT STEERING IS FREE AND FUNCTIONAL.
ALWAYS: BE SEATED AND IN POSITION TO CONTROL VEHICLE. STOP ENGINE BEFORE ATTEMPTING ADJUSTMENTS. KNOW THE LIMITATIONS OF THE VEHICLE AND YOUR SKILLS AS A DRIVER. UNDERSTAND YOUR OWNERS MANUAL. WEAR CLOTHING DESIGNED FOR SNOWMOBILING. REMOVE IGNITION KEY WHEN LEAVING MACHINE.

AVANT LA MISE EN MARCHE: S'ASSURER DU BON FONCTIONNEMENT DE L'ACCÉLÉRATEUR ET DU FREIN. S'ASSURER QUE LE CAPOT EST VERROUILLÉ. S'ASSURER QU'IL N'Y A PAS D'OBSTACLE AUX ALENTOURS. S'ASSURER QUE LE GUIDON NE SOIT PAS BLOQUÉ.
EN TOUT TEMPS: ÊTRE ASSIS DANS UNE POSITION PERMETTANT LE CONTRÔLE DU VÉHICULE. ARRÊTER LE MOTEUR AVANT DE PROCÉDER À DES RÉGLAGES. BIEN CONNAÎTRE LES LIMITES DE TOLÉRANCES DU VÉHICULE ET VOS CAPACITÉS DE CONDUCTEUR. BIEN COMPRENDRE LE MANUEL DE L'UTILISATEUR. PORTER DES VÊTEMENTS CONCUS POUR LA MOTONEIGE. ENLEVER LA CLÉ DE CONTACT QUAND VOUS LAISSEZ VOTRE VÉHICULE.

The symbol is a warning symbol and is meant to be just that. Instruction decals bearing this symbol have been placed on your snowmobile to remind you of particularly important items, and each of these decals is explained below.

CAUTION – Although your Polaris has been designed to provide you with a safe, reliable snowmobile, much of its safety depends on the operator. Improper use of this snowmobile or failure to maintain it in good operating condition can result in injury. To reduce this possibility, read the important safety items below.

Before Starting Engine

A. "CHECK THROTTLE AND BRAKE FOR PROPER OPERATION"

Keep in mind that the throttle and brake are the primary controls of your snowmobile. If either should malfunction, a serious loss of control could result.

When checking the throttle, make sure that the control lever will compress evenly and smoothly. When the lever is released, it should immediately return to the idle position without binding or hesitation. If the throttle doesn't function smoothly, do not attempt to start the engine.

The need for a properly functioning brake is obvious. Your Polaris is equipped with the highest quality hydraulic disc brake system available and operates directly on the drive system. Two operating characteristics of the brake must always be checked before starting the engine to assure proper performance:

1. Lever Travel – When the brake handle is depressed, it should move no closer than 1/2" from the handgrip. Excessive travel indicates low fluid level, air in ~~hydraulic system~~, or improper adjustment. If the lever travel is excessive, refer to section on brake adjustment.

2. Lever Feel – A hydraulic system multiplies the force of your hand squeeze just as the hydraulic system on a car. It depends on an adequate and air-free supply of hydraulic fluid in the system for proper operation. If the lever feels "spongy" when squeezed, both the fluid level and presence of air in the system must be checked, as shown in this manual.

B. "CHECK FOR PROPER OPERATION OF STEERING SYSTEM"

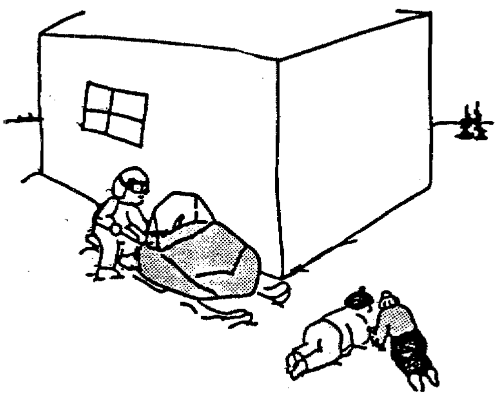
Check for proper operation of the steering system by manually turning the skis completely to the right and to the left. If difficulty is encountered, check for ice and snow buildup that may be obstructing the steering linkage. Ensure adjustable handlebars are locked securely.

C. "CHECK TO SEE THAT THE HOOD IS SECURELY LATCHED"

The hood of your snowmobile protects the operator from moving parts as well as aiding in sound emission controls and various other functions. Under no circumstances should your snowmobile be operated with the hood open or removed.

D. "CHECK SURROUNDINGS TO VERIFY CLEAR OPERATING AREA"

It is most important to assure yourself that you ıave a clear area all around your snowmobile, ıncluding an area clear of bystanders. Remember that the possibility always exists of some sideways ɾehicle slippage, or a little more throttle than ıntended, or debris can be thrown up by the track. If you are assured of a clear area surrounding you ɔefore you start, you can give your full attention o operating the snowmobile.



After Starting Engine

\. "LIGHTING CHECK"

Check headlight, high and low beam, taillight, and ɔrake light for operation.

B. "AUXILIARY SHUT—OFF SWITCH"

Check auxiliary shut-off switch for proper operation.

\lways

A. "BE SEATED AND IN POSITION TO CONTROL VEHICLE"

Improper operator position on the snowmobile can ɔe the source of serious injury. Remember that ɔperating a snowmobile does require skill and ɔalance for proper control, and an improper ɔosition can seriously reduce your ability to control your snowmobile. The style of positioning will vary from person to person as they become more skilled, but under most conditions the proper ɔosition is to be seated, feet on the running boards, ɔnd in a comfortable position for proper throttle, brake, and steering control.

⚠ *CAUTION — Your snowmobile is propelled by a revolving track which must be partially exposed for proper operation. Serious injuries may be caused by operator carelessness, resulting in hands, feet, or clothing becoming entangled in the track. Be alert. Remember, being properly seated with feet on the running boards keeps you clear of the track.*

B. "STOP ENGINE BEFORE ATTEMPTING ADJUSTMENTS"

Your snowmobile's engine compartment contains moving parts. Shields and guards have been provided, but it is still possible to carelessly get your hands or fingers into a moving belt or a rotating shaft. For this reason, NEVER attempt adjustments with the engine running. The proper method is to turn off the ignition, raise the hood, make the adjustment, secure the hood, then restart the engine to check its operation. The same is true of track alignment. If the track must be re-aligned, it is recommended that this service be performed by your dealer.

C. "REMOVE IGNITION KEY"

There are two important reasons for this warning. Naturally, we don't want you to have your machine stolen. But more important, DO NOT tempt a child to start your snowmobile by leaving the key in the ignition.

D. "KNOW THE LIMITATIONS OF THE MACHINE AND YOUR SKILLS AS A DRIVER"

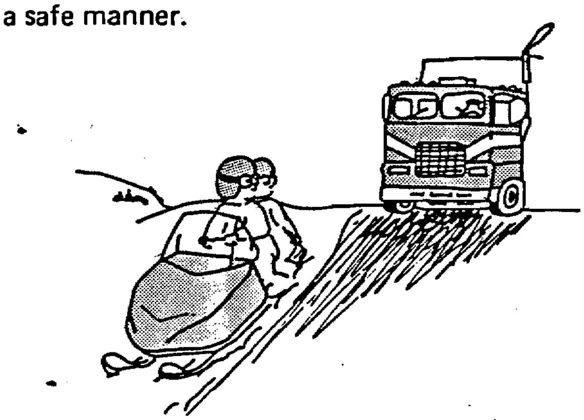
For the purpose of this Owners Manual we would like to make several important points for you to remember.

Your snowmobile is not a toy. It is a well engineered and constructed recreational vehicle. The following suggestions are provided to aid you in its safe operation:

1. Observe state and local laws governing snowmobile operation. They have been set up for your protection.

2. Traveling at night requires extra caution. Check both headlight and taillights to ensure their proper operation. Do not "over-drive" your headlight beam. A good rule to follow is to be able to bring your machine to a stop in the distance illuminated by the headlight. High speed driving at night is unwise and dangerous.

3. When traveling with a passenger aboard, it is the driver's responsibility to operate his machine in a safe manner.

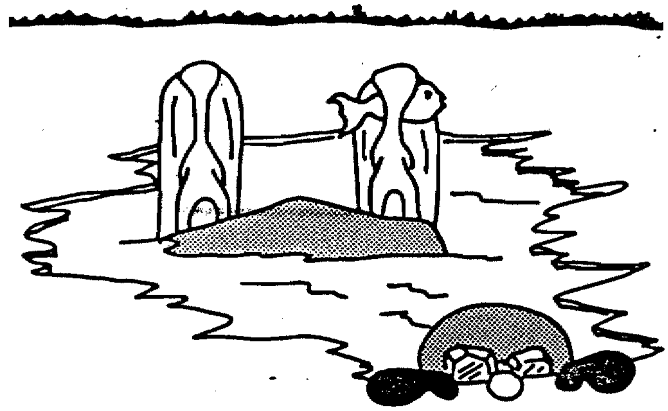


⚠ *CAUTION – Always make certain the passenger remains seated, facing forward, with both feet placed firmly on running boards. Be particularly careful to avoid "jumping" your snowmobile.*

<u>NOTE:</u> Some Polaris model snowmobiles are designed for a single occupant only; a decal on the console of these models indicates single occupant operation. Machines designated as double occupant should never be operated with more than two people on board.

4. Wire fences are a serious hazard, and unless you are thoroughly familiar with an area, you should always be on the alert for fences. Single strands are especially dangerous, since there can be a great distance between posts. Guy wires on utility poles also are difficult to distinguish. Reduce speed when traveling near poles, posts, or hidden obstacles. BE ESPECIALLY ALERT IF YOU ARE SNOWMOBILING AFTER DARK.

5. When traveling on lakes and streams that are strange to you, always check with local residents or authorities for general information on conditions. Thin ice, open water, and snowmobiles are not compatible. Use good common sense judgment at all times.

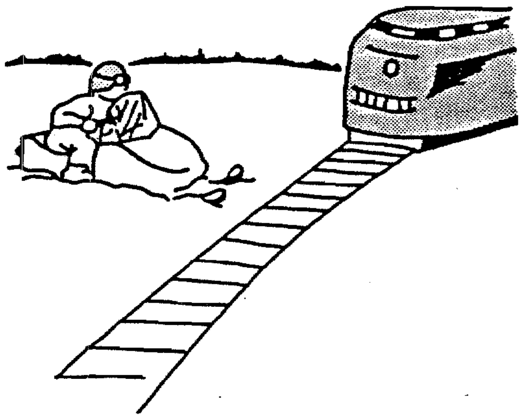


6. As with an automobile, defensive driving when traveling in a group of snowmobiles is an important factor in avoiding accidents. Don't tailgate. Allow ample stopping distances.

7. When teaching youngsters to operate your Polaris, set up a nearby pre-determined course. Make sure they know how to drive and control the snowmobile before you allow them to make longer distance runs. Teach them proper snowmobile courtesy. Enroll them in a driver's training and safety course sponsored by local or state organizations.

8. Remember, the sound of your machine will drown out the sound of approaching vehicles. Look ahead, behind, and to the sides before turning or crossing railroad crossings or highways. Steep

embankments may also hide your view. Always leave yourself a "way out." MAKE SURE BEFORE YOU CROSS.



E. "ALWAYS WEAR CLOTHING DESIGNED FOR SNOWMOBILING"

Clothing designed for snowmobiling is warm, comfortable, and safe.

CAUTION – Always wear an approved helmet and eye protection. Don't wear loose clothing or long scarves because such items can easily become entangled in moving parts. Also, be aware of the weather forecast and especially the wind chill. A table is given below for your reference. Be prepared; be warm and comfortable.

F. "READ AND UNDERSTAND YOUR OWNERS MANUAL"

And that's hopefully what you're doing right now. Read it all now and then re-read it from time to time. We have attempted to give you as much information as possible to alert you to the safety requirements of snowmobiling.

CELSIUS/FAHRENHEIT CONVERSION TABLE

C-Centigrade F-Fahrenheit

C	F	C	F	C	F	C	F
-40	-40	-20	-4	0	32	20	68
-39	-38	-19	-2	1	34	21	70
-38	-36	-18	0	2	36	22	72
-37	-35	-17	1	3	37	23	73
-36	-33	-16	3	4	39	24	75
-35	-31	-15	5	5	41	25	77
-34	-29	-14	7	6	43	26	79
-33	-27	-13	9	7	45	27	81
-32	-26	-12	10	8	46	28	82
-31	-24	-11	12	9	48	29	84
-30	-22	-10	14	10	50	30	86
-29	-20	-9	16	11	52	31	88
-28	-18	-8	18	12	54	32	90
-27	-17	-7	19	13	55	33	91
-26	-15	-6	21	14	57	34	93
-25	-13	-5	23	15	59	35	95
-24	-11	-4	25	16	61	36	97
-23	-9	-3	27	17	63	37	99
-22	-8	-2	28	18	64	38	100
-21	-6	-1	30	19	66	39	102

WIND CHILL CHART

ESTIMATED WIND SPEED IN MPH	ACTUAL THERMOMETER READING (°F.)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	EQUIVALENT TEMPERATURE (°F.)											
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-21	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-36	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-124
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(wind speeds greater than 40 mph have little additional effect)	LITTLE DANGER (for properly clothed person)				INCREASING DANGER			GREAT DANGER				
					Danger from freezing of exposed flesh							

SAFETY WARNING DECALS

CAUTION – When working in the engine compartment, we must again remind you that no adjustments are to be made with the engine running. Please note the decal on the clutch guard; it should remind you to always use care and caution when servicing your machine.

WARNING	AVERTISSEMENT
DO NOT OPERATE ENGINE WITH HOOD REMOVED. DO NOT ATTEMPT ADJUSTMENT WITH ENGINE RUNNING. DO NOT OPERATE ENGINE WITH THIS GUARD REMOVED. NEVER RUN ENGINE WITH DRIVE BELT REMOVED. NEVER SERVICE CLUTCHES YOURSELF – – SEE YOUR DEALER.	N'OPÉREZ PAS LE MOTEUR LORSQUE LE CAPOT EST OUVERT. N'EFFECTUEZ AUCUN AJUSTEMENT LORSQUE LE MOTEUR EST EN MARCHE. NE FAITES PAS FONCTIONNER LE MOTEUR LORSQUE LA COURROIE D'ENTRAÎNEMENT EST ENLEVEE. NE RÉPAREZ JAMAIS L'EMBRAYAGE VOUS-MÊMES, VOIR VOTRE CONCESSIONNAIRE.

A. "DO NOT OPERATE ENGINE WITH THIS GUARD REMOVED"

The clutch guard is designed to protect the operator from metal parts in the event the clutch should fail. Although the chance of failure is extremely remote, don't defeat the purpose of the guard by removing it. It is there for <u>your</u> safety.

B. "NEVER RUN ENGINE WITH DRIVE BELT REMOVED"

Operation of the engine with the belt removed can result in a serious overspeed condition. Any servicing which requires operation without a belt must be done by your dealer.

C. "NEVER SERVICE CLUTCHES YOURSELF – SEE YOUR DEALER"

This warning means exactly what it says. Your clutch is a complex mechanism which operates at high rotational speeds. Each clutch is dynamically balanced before installation on your Polaris. Any tampering by the owner, with the exception of periodic lubrication, may disrupt this precision balancing and create an unstable condition.

WARNING	AVERTISSEMENT
STAY CLEAR OF TRACK.	DEMEUREZ Ã L'ÉCART DE LA CHENILLE.

D. "STAY CLEAR OF TRACK"

When "warming up" the engine or "clearing" the track and related components, no person should be standing in front of, in back of, or to the side of the snowmobile.

CAUTION...
ATTENTION...

DO NOT OPERATE WITH INTAKE SILENCER REMOVED.

NE PAS OPÉRER LORSQUE LE SILENCIEUX DE LA PRISE D'AIR EST ENLEVÉ.

E. "DO NOT OPERATE WITH INTAKE SILENCER REMOVED"

When operating engine with intake silencer removed, damage to the engine may occur.

Each time you operate your Polaris, or whenever you allow someone else to use it, keep these precautions in mind. You have purchased a well designed and engineered product which will give you many seasons of enjoyment. Remember though that safe snowmobiling is your responsibility.

OCC237

OPERATING INSTRUCTIONS – ADVERSE CONDITIONS

Sub-Zero Weather

Whenever the machine has been parked for some length of time, especially overnight, always shake loose the skis and track before attempting to put the machine into motion. The throttle should always be opened with enough authority to put the machine into motion, staying within safety limits with respect to passengers on the machine.

Powder Snow

Your Polaris is designed to operate best on unpacked snow. Maneuverability is attained by the steering skis and by shifting your body weight. Maximum control will be attained after practice on trial runs.

CAUTION: DO NOT OPERATE FOR PROLONGED PERIODS ON BLACKTOP, GRAVEL, OR GLARE ICE. It is essential that your machine be operated under conditions with adequate snow cover, as snow provides the only lubrication for the power slide suspension. Failure to do so will result in excessive wear and damage to the slide rail.

If the machine becomes stuck in snow, free the running board area, and step down the snow forward of the machine so that when the throttle is opened the machine will be able to climb up and over. The operator can then mount the machine and continue.

NOTE: Ability of the machine to travel in adverse conditions will improve as the operator gains experience.

Packed Snow

Maneuverability will be lessened under packed snow or icy conditions. Reduce your speed in these conditions and when turning.

Glare Ice

It is dangerous to operate at full throttle on glare ice or under slippery conditions. If ice is unavoidable, use caution and operate at slow speeds. Never attempt an abrupt change of direction on a slippery surface, for the chance of "spin-out" increases under these conditions.

Hilly Terrain

On hilly terrain, cut throttle speed to enable the Torque-Balance Drive System to gear down and provide maximum power. Always "zig-zag" up or down steep slopes. Do not go straight up or down long, steep hills.

Responsible Driving

To summarize, if you operate your snowmobile improperly, you will cause situations which will exceed your driving skills. Each snowmobile is a little different, and even if you are a seasoned driver, it is strongly recommended that you spend some time getting the feel of this particular machine before you attempt any ambitious maneuvers. If you are new to snowmobiling, take enough time to acquaint yourself with the machine and what it will and won't do under varying conditions.

1. As mentioned above, get the feel of your machine before you attempt ambitious maneuvers. Your snowmobile depends on your body position for proper balance in executing turns, traversing hills, and so forth. It's best to start on a smooth, level area to build your operating experience.

2. ⚠ *CAUTION – Driving your snowmobile requires your full attention. DON'T drink or use drugs or medications while driving as they will reduce your alertness and slow your reaction time. In most states and provinces, to drive while intoxicated or under the influence of drugs is prohibited by law.*

3. ⚠ *CAUTION – Before you let someone else use your snowmobile, ensure that you know the extent of their operating skills. Be especially careful in letting children operate your machine. Check to see if they have taken a snowmobile safety course and have an operator's certificate. For your own children's protection, as well as yours, make sure they take a snowmobile safety course. Adults also can benefit from the course.*

4. ⚠ *CAUTION – Don't "jump" your snowmobile. "Jumping" can injure your back because of spinal compression. The seat and suspension of your snowmobile have been designed and constructed to give you protection, but they too have their limits. Your snowmobile is <u>not intended</u> for this kind of use.*

PRESERVATION OF OUR ENVIRONMENT

Polaris recommends that you drive your snowmobile with consideration given to the protection and preservation of our environment. As the number of snowmobilers have increased in the past few years, so have the critics, challenging snowmobilers on the seeming lack of concern for the very environment they claim is theirs to enjoy.

Noise Level

Probably the most publicized subject with regard to snowmobiles is noise. Sound, which is measured in decibel by electronic instrumentation, is generally determined by what is known as the dB "A" scale. The Society of Automotive Engineers (SAE), the standard-making organization for both snowmobiles and passenger cars, has recommended that snowmobiles conform to prescribed sound levels. Their recommended standard is achieved by recording the sound level of the snowmobiles at a distance of fifty feet. Your Polaris conforms to or better than the SAE standards.

It is important to point out that all regulations, to be meaningful, require the cooperation of the snowmobile driver. Muffling systems, designed to reduce noise levels, must not be removed, and snowmobile owners must become increasingly aware that they have a public responsibility to operate their snowmobiles not only for their own pleasure, but with concern for the interest of others as well. As a snowmobile operator, you may not realize that the sound of your snowmobile does annoy some non-snowmobilers. We, as a manufacturer, are attempting to do our part through the manufacture of quieter machines. But we also ask that you help in the effort to further reduce the impact of noise.

Air Pollution

As part of Polaris' plan for the snowmobile's compatability within the environment, Polaris engineers are investigating various ways to further reduce emission levels of two-stroke engines. Research is underway . . with regard to the possibilities of low or non-leaded gasolines. We are also working with various fuel-to-oil ratios and hope that our efforts will soon lead to a reduction in the amount of oil required to be mixed with gasoline, thus leading to a significant reduction of potential air pollution.

In addition to technological research, we have also suggested that governmental agencies, manufacturers, distributors, dealers, ecologists, and all interested parties join together in helping to develop comprehensive research data on environmental topics. Polaris has always expressed a willingness to participate in this type of study so that some day we may find the answers to these and other difficult problems.

Environmental Protection

As part of the continuing environment education campaign, Polaris is encouraging state and provincial governments across the snowbelt to adopt strenuous safety training programs to give impetus for protection of our environment. We ask that you join with us in protecting wild life and vegetation. We recommend that you encourage and participate in projects designed for the preservation of all aspects of our environment. Snowmobile clubs and other organizations are working for the protection of our environment. It is important that we not only participate ourselves, but that we also encourage others.

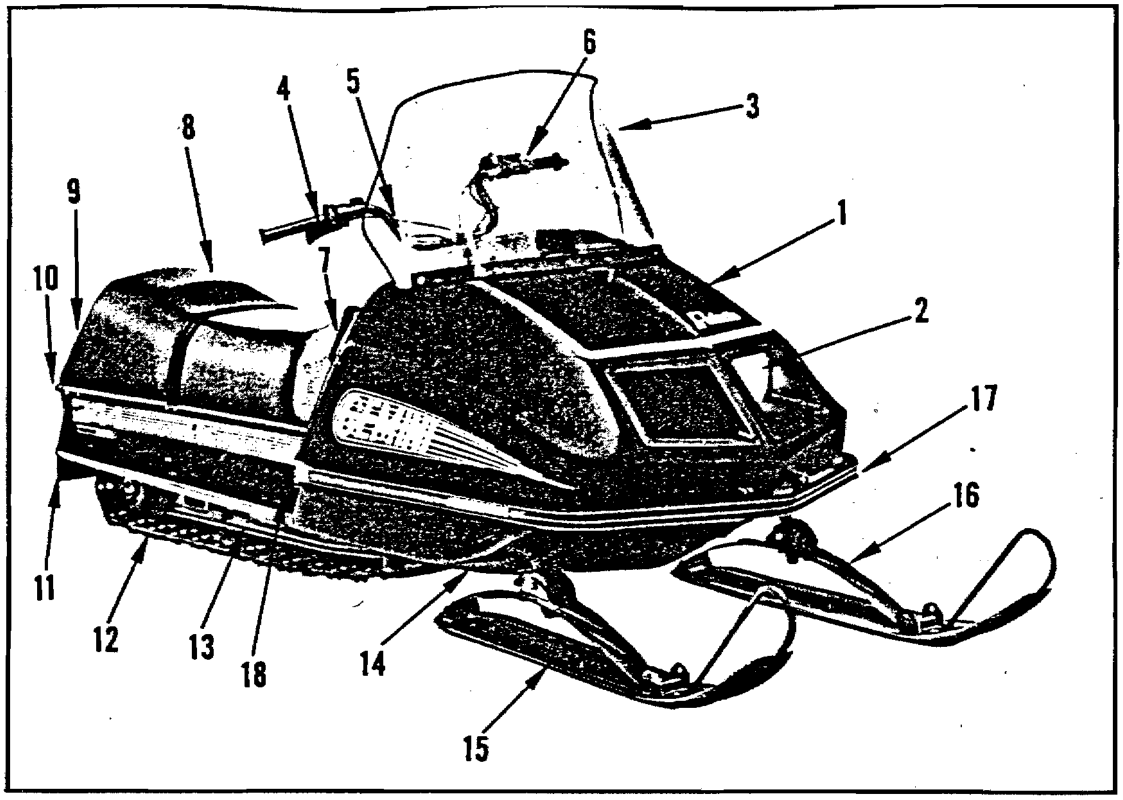
RESPECT YOUR SNOWMOBILE

RESPECT OUR ENVIRONMENT

AND YOU WILL EARN THE

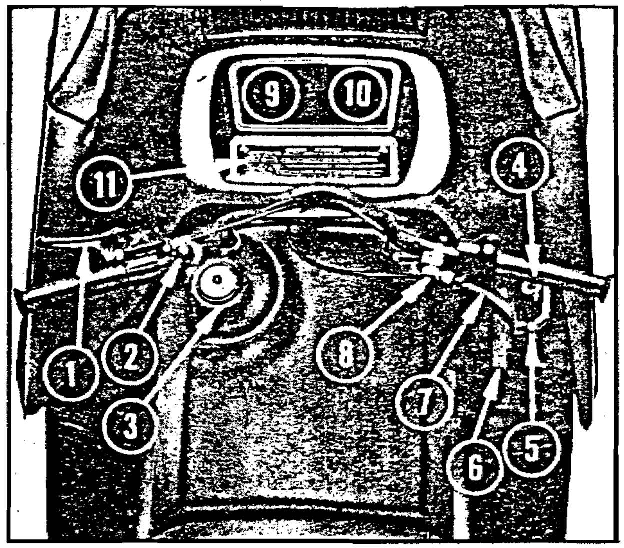
RESPECT OF EVERYONE

MODEL IDENTIFICATION
GEMINI



Right Side View of Polaris Gemini — Model 811025 (244cc single)

1. Hood
2. Headlight
3. Windshield
4. Throttle
5. Handlebar
6. Brake Lever
7. Gas Tank
8. Seat
9. Taillights
10. Bumper
11. Snow Flap
12. Track
13. Suspension
14. Nosepan
15. Ski
16. Ski Spring
17. Bumper
18. Vehicle Identification Number (Front right side of tunnel)



1. Brake Control
2. Headlight Dimmer Switch – 2 position (Hi/Lo)
3. Fuel Filler Cap (Gauge Optional)
4. Ignition Switch
5. Choke Control
6. Recoil Starter Handle
7. Throttle Control
8. Auxiliary Shut-Off Switch – 3 position (Off/On/Off)
9. Speedometer – Odometer (Optional)
10. Tachometer (Optional)
11. Safety Decals

SPECIFICATIONS AND CONDENSED SERVICE DATA

Engine	Gemini 244 EC25PS
Model Number	0811025
Weight (Dry)	355 lbs., 161kg.
Height w/Windshield	39.5", 100.3cm
Length w/Skis	101.75", 258.4cm
Track Bearing Area	1,058 sq. in., 6,826 sq. cm
Ski Center Distance	24", 60.96cm
Track Width	15", 38.1cm
Track Length on Ground	42", 106.68cm
Track Type	Rubber, Steel Cleats, Molded Ice Growsers
Suspension	Stamped Steel
Ski Shock	Accessory
Stable Ski Insert	Accessory
Fuel Capacity	7.3 U.S. gal., 27.60l
Brake	Hydraulic Disc
Gas Gauge	Accessory
Cooling	Fan Air
Number of Cylinders	1
Cylinder Displacement	244cc
Bore	72mm
Stroke	62mm
Carburetor Type & Model	Mikuni VM30SS
Main Jet	120H
Pilot Jet	60
Ignition Type	Mech. Pt.
Spark Plug	NGK BR8ES
Spark Plug Gap	.020", .5mm
Fuel	Regular Leaded or Premium Unleaded
Recommended Oil	Polaris
Recommended Oil/Gas Mixture*	40:1

* 20:1 break-in mixture for first tank-full of fuel.

Long term summer storage of your snowmobile will require you to take some preventative measures to assure against deterioration and to prolong the useful life of many components.

CLEANING AND PRESERVATION OF HOOD, CHASSIS, AND TRIM

Proper storage starts by cleaning, washing, and waxing the hood, chassis, upholstery, and plastic parts. Clean and touch up with paint any rusted or bare metal surfaces. Ensure that all corrosive salt and acids are removed from surfaces before beginning preservation with waxes and rust inhibitors (grease, oil, or paint).

If the machine is equipped with electric start, disconnect the battery cables and clean the cables and battery post. Remove and store the battery in a cool dry place.

The machine should be stored in a dry garage or shed out of the sunlight and covered with a fabric snowmobile cover.

CONTROLS AND LINKAGE

All bushings, spindle shafts, and tie rod ends should be coated with a light coat of oil or grease. Throttle controls and cables should be lubricated with light oil or Polaris clutch lubricant. Force a small amount of lubricant down cable.

ELECTRICAL CONNECTIONS

Separate electrical connector blocks and clean corrosive build-up from connectors. Lubricate or pack connector blocks with petroleum jelly and re-connect. Replace worn or frayed electrical wire and connectors.

CLUTCH AND DRIVE SYSTEM

Remove drive belt and store in cool dry location. Lubricate surface faces, shaft, and ramps of drive and driven clutches with light oil (oil must be cleaned off before installing belt for service). A generous amount of Polaris clutch lubricant should be sprayed through the three windows on the drive clutch cover and onto the rollers and weight pins. Replace chaincase lubricant with new oil. Spray lubricant on steel drive shafts, etc., to reduce rusting.

TRACK AND SUSPENSION

Under normal conditions moderate track tension should be maintained during summer storage. The rear of the machine should be supported off the ground to allow free hanging of track.

ENGINE AND CARBURETOR

There are two methods of properly preparing an engine for storage. The best method is to keep your machine in an area where you can run the engine for about five minutes twice a month. This gives the crankshaft bearings and cylinder walls a fresh coat of oil. Run the engine at about 3,000 RPM and stop it by pulling the choke. This method will prevent rusting of the cylinder walls and prevent the formation of varnish from evaporated fuel in the carburetor.

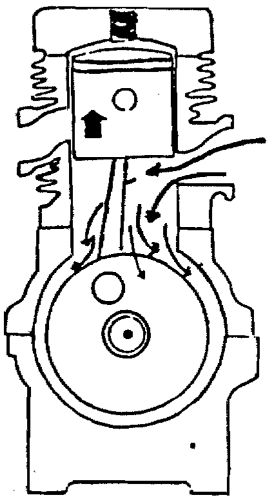
However, this approach to summer storage is not always feasible, and if not suitable, the following method of engine storage can be used. The fuel tank, fuel lines, and carburetor should be completely drained of gasoline. The engine should be run until it stops to eliminate any gas remaining in the carburetor. Remove the spark plug or plugs and apply a small amount of oil in each cylinder to prevent rusting. Run the pistons up and down several times to ensure coverage of the cylinder walls.

Added crankshaft protection can be obtained by injecting a small amount of Polaris engine oil into each of the carburetor intakes just as the engine is beginning to run out of fuel. Petroleum based oils only should be used in the preparation of the snowmobile engine for summer storage.

FALL TUNE–UP

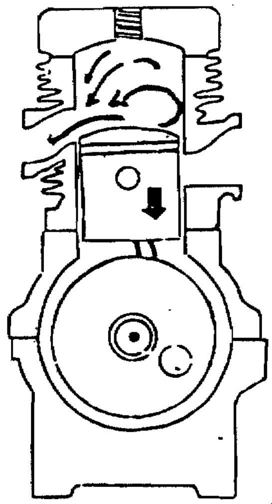
To obtain maximum performance and use from your snowmobile, Polaris encourages you to arrange for a fall service tune-up with your Polaris dealer. He has an experienced and trained service technician who is very interested in keeping your machine in peak operating condition.

TWO–CYCLE ENGINE THEORY AND OPERATION



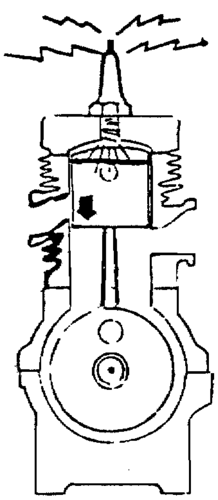
INTAKE

A basic component of the two-cycle engine is the piston. When the piston moves upward in the cylinder (1st stroke), it draws fuel into the crankcase while also compressing fuel in the combustion chamber. The spark plug then ignites the fuel, which expands and forces the piston downward.



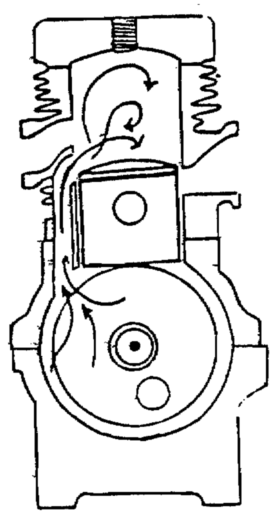
EXHAUST

Actually, several functions take place simultaneously during the exhaust phase. When the piston moves downward far enough to expose the exhaust port, most of the burned exhaust gases are expelled from the cylinder - - complete exhaust takes place after the piston drops low enough to expose the transfer ports which completes one cycle.



POWER

Immediately after the piston starts downward, peak combustion pressure from the burning gases is applied against the piston, driving it downward with maximum force. This vertical motion is transmitted through the connecting rod to radial motion by the crankshaft. The force of combustion continues until the piston is further down in the cylinder when the exhaust port becomes exposed.



FUEL TRANSFER

The down-stroke provides the power which turns the crankshaft. It also compresses the fuel in the crankcase, clears the transfer ports, and releases a new supply of fuel through the ports and into the combustion chamber. This forces the burned gases out through the exhaust ports.

Your Polaris snowmobile is equipped with a dependable, high-performance two-cycle engine. Treat it right . . . give it reasonable care. The first step is to have a basic comprehension of the mechanics involved in its operation. Understanding your two-cycle engine and how it functions will enable you to better maintain your engine, resulting in longer and better performance and life at less cost to you.

When you realize that at 6,000 RPM the crankshaft is rotating 100 revolutions a second, you can appreciate the importance of proper lubrication, fuel mixture, and carburetor adjustments.

Lubrication

Oil provides the only lubrication your engine gets. Keep in mind the manufacturer's recommendations:

1. The use of Polaris 40:1 oil is the only oil recommended. This oil has been specially formulated for use in Polaris snowmobiles. If a regular grade of snowmobile oil is used, follow the oil manufacturers mixing recommendations. <u>Engine warranty may be affected with the use of oils other than Polaris 40:1 oil.</u>

2. Always mix them in proper proportions — thoroughly — and in a clean container. For the first tank full of fuel, mix two (2) pints of Polaris 40:1 oil to five gallons of gasoline.

3. Keep surplus fuel tightly capped to prevent evaporation, loss of volatility and power.

Too little oil means inadequate lubrication; too much oil means spark plug fouling, rapid carbonization, and overheated pistons, all which may lead to engine damage and costly repairs.

Carburetion

The carburetor feeds the gas-oil mixture to the engine, mixing fuel and air to obtain the correct volatile mixture, thus providing fuel for combustion, a lubricant, and a coolant for internal surfaces.

Proper carburetor adjustment is crucial, as too "lean" a mixture (too much air, too little fuel) will result in overheating of the plugs causing pre-ignition of the fuel. This results in piston burning, bearing failure, or complete engine failure. A lean mixture can also be the result of fuel line restrictions, foreign matter in the carburetor, clogged fuel filters, etc. Too "rich" a mixture (too much fuel, too little air) is also hazardous, as it can foul plugs or retard heat dissipation of the pistons, causing overheating.

Carburetor adjustments are a job for your dealer, as these fine adjustments require technical equipment, knowledge, and experience.

Gasoline Antifreeze

To eliminate the possibility of fuel system icing, we advise the use of gas line antifreeze or methyl alcohol at an approximate rate of three to four ounces per five gallons of fuel.

Spark Plugs

Your spark plugs provide the spark which ignites the fuel-air mixture. Again, manufacturer's recommendations should be observed to obtain top performance.

Spark plug fouling is usually one of two types:

Carbon deposits appear in the plug gap. Remove these deposits and re-install the plug. Excessive deposits necessitate replacement of the plug.

Wet fouling is usually the result of a flooded engine or a very low octane grade of regular gasoline. Always carry spare plugs. Avoid prolonged idle speeds as plug fouling will result. Idle speed should be approximately 1,000 RPM less than clutch engagement speed.

With a basic understanding of how your machine works, and with close attention to maintenance tips, you will be ready to go. Keep in mind these recommendations and those covered elsewhere in this manual.

OPERATION

Break-In Period

No single action on your part is as important to long engine life as rigid adherence to proper break-in of the engine. Follow these procedures closely:

1. All carburetors have been pre-set at the factory for adequate fuel supply. Higher altitude operation may require different adjustments and settings. Consult your dealer.

2. During initial break-in, use two (2) pints of Polaris 40:1 oil to five (5) gallons of gasoline. The resulting 20:1 mixture should be used for the first tank full of fuel.

3. Do not operate engine at prolonged full throttle for the first three hours of operation; vary speed at 1/3 to 3/4 throttle during this period.

Pre-Starting

⚠ Before starting engine, always refer to all fety p[illegible]ions.

Th[illegible] ost important safety items are:

1. Throttle system.
2. Brake system.
3. Steering system.

These three systems must be checked each time, before starting engine. Incorrect adjustments, damage, or excessive wear, if neglected, could result in personal injury and damage to the snowmobile.

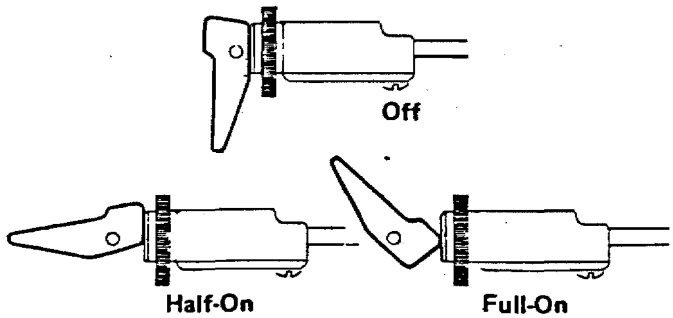
Starting

NOTE: A manual starter is standard equipment on all models. If for any reason your machine cannot be started electrically, follow the manual starting procedure or check the troubleshooting chart.

COLD ENGINE

1. Turn key to on position.
2. Flip choke toggle to "full on" position, as shown in photo.
3. Grasp starter handle and pull slowly until recoil engages, then pull to start.
4. Do not depress throttle until engine starts.
5. After engine starts it can be warmed up with choke toggle in the "half on" position.

NOTE: Do not pull the starter rope to its full extended position or allow it to snap back into the housing as damage can result.



WARM ENGINE

1. Turn key to on position.
2. Grasp starter handle and pull slowly until recoil engages, then pull to start.

Emergency Starting

When you purchased your snowmobile, you received an emergency tool kit consisting of a screwdriver, an 18mm plug ~~wrench, a 10mm wrench,~~ a 14mm wrench, a wrench handle, and a rope. If the primary starter recoil or rope should fail, the engine may be re-started as follows:

Using the 10mm wrench end, remove the recoil (figure 1).

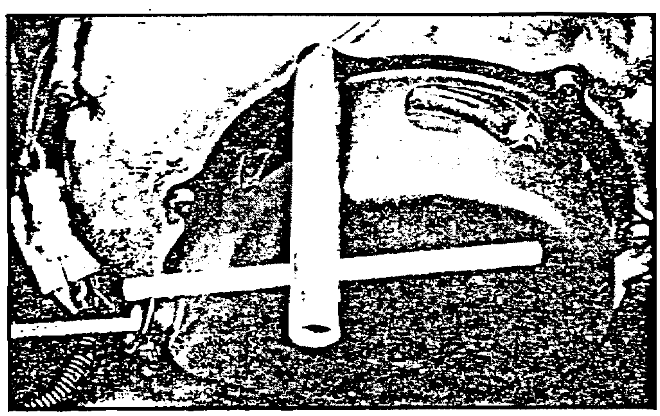


Figure 1

NOTE: On some models the muffler must also be removed.

⚠ *Next, using rope end and wrench handle, wind rope onto starter cup as shown in figure 2. Rope end must not be tied to the starter cup.*

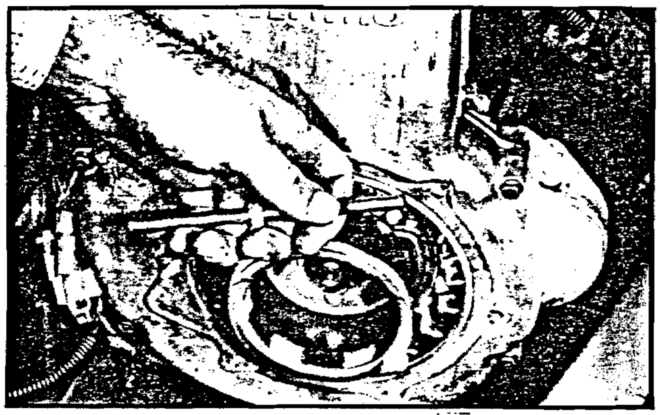
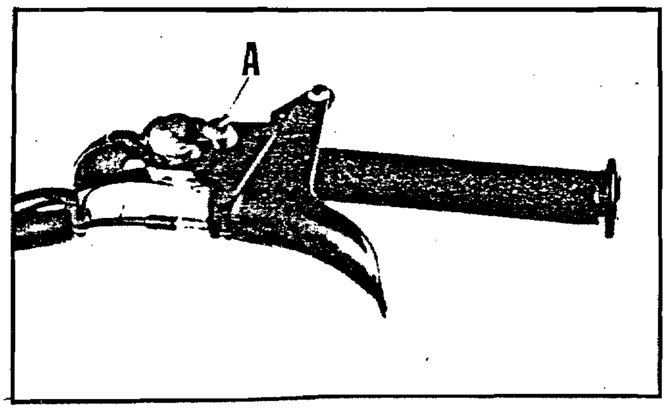


Figure 2

⚠ *Pull sharply up on the starter rope ensuring that the rope fully unwinds and disengages from the starter cup.*

Emergency Stopping



AUXILIARY ENGINE SHUT–OFF SWITCH

⚠ *To stop engine in an emergency, move switch (A) up or down from center position.*
This will ground out the ignition and bring the engine to a quick stop. To re-start engine the switch must be returned to the center position.

FUEL MIXTURE

All Polaris snowmobiles are equipped with two-cycle engines. Therefore, oil must be premixed with gasoline for proper engine lubrication and internal engine cooling. It is recommended that a good grade of leaded regular, leaded premium or unleaded premium gas with an 88 octane minimum rating and 40:1 Polaris oil be used. Polaris oil is specially formulated to meet the lubrication requirements of the Polaris Star engine because it burns more completely and results in less carbon build-up.

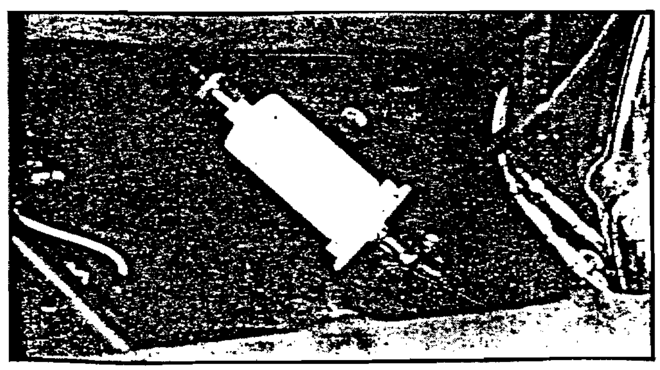
NOTE: The use of regular Polaris petroleum base snowmobile oil is recommended. The use of oils other than Polaris 40:1 oil may affect your engine warranty.

Mix fuel in a clean container. Pour about one-half of the gasoline into a container. Add all of the oil and mix well. Then add remainder of gasoline and mix thoroughly. Use a funnel with strainer to fill tank.

NOTE: Never pour raw oil or gasoline into fuel tank unless mixed. Do not use low grade, multi-viscosity oils. Excess oil will cause carbonization of pistons, spark plugs, ports, and exhaust systems, which leads to loss of power. Too little oil may cause piston seizure, over-heating, and rod and bearing failure.

⚠ *CAUTION — Never add fuel while snowmobile is running. Gasoline is dangerous, even when mixed with oil. Avoid fires due to smoking or careless maintenance practices.*

A methanol-base additive may be used to prevent gas line freeze-up. Use a maximum of four ounces per five gallons of gasoline.



⚠ *CAUTION — The inline fuel filter shown should be checked periodically for sediment. A visual inspection only is necessary as sediment and ice can be seen clearly.*

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When adding fuel to the tank always use a funnel with a fine screen. This will aid in the removal of moisture and sediment from the fuel mixture. The funnel will also control spillage during refueling.

TOWING

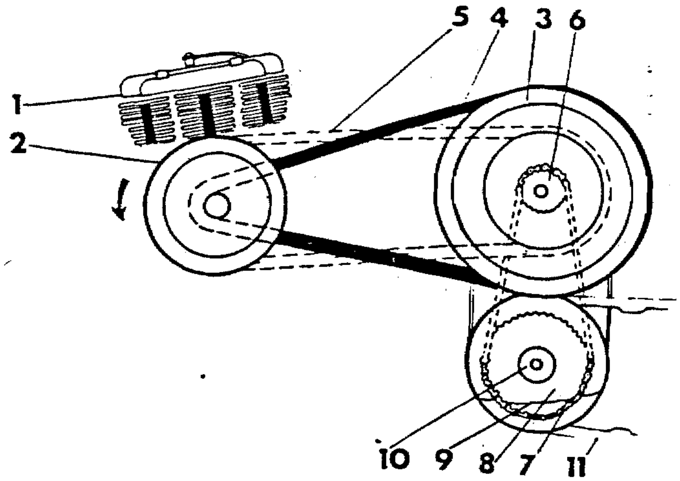
For your safety, the proper function of a tow hitch must be understood before attempting its use. DO NOT tow toboggans, sleds, saucers, or any type of vehicle with a rope. No braking power can be applied to an object being towed with a rope. Only a stiff metal pole connecting the towed object and tow hitch on the snowmobile should be used. If passengers are to be towed on a toboggan or sled, ensure that the stiff connecting pole is at least four feet long to prevent any possibility of contact between the vehicle track and a person riding in the towed object.

IMPORTANT: Always remove drive belt from a disabled snowmobile before towing to prevent serious damage to the engine and drive system.

FUNCTION OF ENGINE AND DRIVE TRAIN

As the throttle lever is compressed, the engine RPM increases causing the weights and spring combination in the drive clutch to engage. This moves the sheaves of the drive clutch together, forcing the belt to move upward in the clutch and simultaneously forcing the sheaves apart on the driven clutch. The result is a continuous change in the ratio of the two clutches which causes acceleration and forward movement of the machine. The engine RPM on most models must be between 2800 and 4500 before clutch engagement will occur.

Power is transferred to the track through the chaincase and drive shaft. Utilizing the proper sprocket gear ratio between the upper and lower chaincase sprockets and the drive chain, the snowmobile will attain its designed speed.



1. Engine
2. Torque Converter (Drive Clutch)
3. Driven Clutch
4. Drive Belt (Neutral Position)
5. Drive Belt (Full Upshift Position)
6. Upper Chaincase Sprocket
7. Chain
8. Lower Chaincase Sprocket
9. Chaincase Oil Level
10. Drive Shaft
11. Track

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POLARIS OWNER RECOMMENDED MAINTENANCE PROGRAM

Your Polaris snowmobile has been engineered and manufactured to the highest degree of performance and reliability possible by skilled Polaris personnel. In order to maintain this high degree of performance and reliability your Polaris must be given regular service and maintenance inspections.

We are interested in ensuring your continued enjoyment in snowmobiling with Polaris. To assure you of trouble-free enjoyment, the Polaris Owner Maintenance Program has been developed. If the recommended regular maintenance and service checks are followed, you will be doing your part in keeping your snowmobile in excellent operating condition at all times.

The recommended maintenance schedule on your snowmobile calls for a service and maintenance inspection at 150 miles, 500 miles, and 1200 miles. These inspections should be performed by a qualified service technician. **All necessary replacement parts and labor incurred, with the exception of authorized warranty repairs, becomes the responsibility of the original registered owner.**

If during the course of the warranty period parts failures occur as a result of owner neglect in performing the recommended periodic maintenance, the cost of such repairs shall be borne by the original owner. Please consider the recommended maintenance program illustrated on the following pages as a preventive maintenance program designed to maintain the performance and reliability of your snowmobile in the years to follow.

150 MILE INITIAL MAINTENANCE INSPECTION

X= Passed inspection
O= Required repair or adjustment.
(When completing checklist, refer to Master Repair Manual for specific data.)

____ 1. Torque cylinder heads (cold).
____ 2. Engine timing; ______ Observed BTDC
______________ Corrected BTDC.
____ 3. Synchronize carburetor throttle slide valves.
____ 4. Adjust choke plungers.
____ 5. Adjust engine idle RPM.
____ 6. Adjust carburetor pilot air screw.
____ 7. Torque converter offset (9/16").
____ 8. Torque converter center distance.
____ 9. Inspect engine rubber mounts.
____ 10. Torque engine mounting plate to chassis bolts.
____ 11. Ski alignment.
____ 12. Torque tierod ends, steering arm bolts, ski saddle bolts and handlebar bolts.
____ 13. Torque suspension mounting bolts.
____ 14. Adjust and align track - inspect cleats.
____ 15. Remove chaincase cover, flush chaincase, inspect and adjust chain, install new cover gasket, refill with Polaris chaincase oil.
____ 16. Brakes —
The following checks are suggested to keep the brake system in good operating condition. Frequency will depend largely on the severity of the service encountered.
A. Keep the fluid level in the master cylinder reservoir to within 1/8" from the top at all times.
B. Check system for fluid leaks.
C. Check brake for excessive travel or spongy feel.
D. Check the friction pads for wear, damage, and looseness.
E. Check security and surface condition of the disc.
____ 17. Headlights, Hi-Lo beam.
____ 18. Taillights.
____ 19. Brake light.
____ 20. ~~Auxiliary shut-off~~ and ignition switch.

150 MILE INITIAL MAINTENANCE INSPECTION

Authorized Polaris Servicing Dealer______________

Servicing Technician______________

Date______________ Mileage______________

500 MILE EXTENDED MAINTENANCE INSPECTION

X= Passed inspection
O= Required repair or adjustment
(When completing checklist, refer to Master Repair Manual for specific data.)

____ 1. Synchronize carburetor throttle slide valves.
____ 2. Adjust engine idle RPM.

___ 3. Adjust carburetor pilot air screw.
___ 4. Change fuel filter.
___ 5. Remove drive clutch from engine and inspect:
 A. Weights.
 B. Rollers.
 C. Buttons - using compressed air, blow clutch clean and lubricate weight and roller pins with appropriate lubricants.
 D. Torque spider and clutch to engine as specified.
___ 6. Remove driven clutch, disassemble and clean parts with a suitable parts solvent, inspect ramp buttons and bushing for wear, replacing as necessary.
___ 7. Torque converter offset (9/16").
___ 8. Torque converter center distance.
___ 9. Inspect engine rubber mounts.
___10. Torque engine mounting plate to chassis bolts.
___11. Inspect drive belt, replace if narrower than 1-3/16" across top.
___12. Ski alignment, inspect skags, replace if worn to one half original diameter.
___13. Torque tierod ends, steering arm bolts, ski saddle bolts and handlebar bolts.
___14. Torque suspension mounting bolts.
___15. Adjust and align track - inspect cleats.
___16. Remove chaincase cover, flush chaincase, inspect and adjust chain, install new cover gasket, refill with Polaris chaincase oil.
___17. Brakes —
The following checks are suggested to keep the brake system in good operating condition. Frequency will depend largely on the severity of the service encountered.
 A. Keep the fluid level in the master cylinder reservoir to within 1/8" from the top at all times.
 B. Check system for fluid leaks.
 C. Check brake for excessive travel or spongy feel.
 D. Check the friction pads for wear, damage, and looseness.
 E. Check security and surface condition of the disc.
___18. Install new spark plugs.
___19. Headlights, Hi-Lo beam.
___20. Taillights.
___21. Brake light.
___22. Auxiliary shut-off and ignition switch.

500 MILE EXTENDED MAINTENANCE INSPECTION

Authorized Polaris Servicing Dealer____________

Servicing Technician____________

Date____________ Mileage____________

1200 MILE EXTENDED MAINTENANCE INSPECTION

X= Passed inspection
O= Required repair or adjustment
(When completing checklist, refer to Master Repair Manual for specific data.)

___ 1. Remove cylinder heads, decarbonize combustion chamber, re-install with new head gaskets - torque head bolts (cold).
___ 2. Synchronize carburetor throttle slide valves.
___ 3. Adjust engine idle RPM.
___ 4. Adjust carburetor pilot air screw.
___ 5. Change fuel filter.
___ 6. Remove drive clutch from engine and inspect:
 A. Weights.
 B. Rollers.
 C. Buttons - using compressed air, blow clutch clean and lubricate weight and roller pins with appropriate lubricants.
 D. Torque spider and clutch to engine as specified.
___ 7. Remove driven clutch, disassemble and clean parts with a suitable parts solvent, inspect ramp buttons and bushing for wear, replacing as necessary.
___ 8. Torque converter offset (9/16").
___ 9. Torque converter center distance.
___10. Inspect engine rubber mounts.
___11. Torque engine mounting plate to chassis bolts.
___12. Inspect drive belt, replace if narrower than 1-3/16" across top.
___13. Remove ski spindles, clean and lubricate, change bushings if worn or spindle fit is loose.
___14. Ski alignment, inspect skags, replace if worn to one half original diameter.
___15. Torque tierod ends, steering arm bolts, ski saddle bolts and handlebar bolts.

___ 16. Remove suspension, lubricate front and rear torque arm shafts, inspect rear idler wheels and assembly frame. Inspect slide rail for wear, replace if less than 3/16" remaining.
___ 17. Torque suspension mounting bolts.
___ 18. Adjust and align track - inspect cleats.
___ 19. Remove chaincase cover, flush chaincase, inspect and adjust chain, install new cover gasket, refill with Polaris chaincase oil.
___ 20. Brakes –
The following checks are suggested to keep the brake system in good operating condition. Frequency will depend largely on the severity of the service encountered.
  A. Keep the fluid level in the master cylinder reservoir to within 1/8" from the top at all times.
  B. Check system for fluid leaks.
  C. Check brake for excessive travel or spongy feel.
  D. Check the friction pads for wear, damage, and looseness.
  E. Check security and surface condition of the disc.
___ 21. Install new spark plugs.
___ 22. Headlights, Hi-Lo beam.
___ 23. Taillights.
___ 24. Brake light.
___ 25. Auxiliary shut-off and ignition switch.

1200 MILE EXTENDED MAINTENANCE INSPECTION

Authorized Polaris Servicing Dealer______________

Servicing Technician______________________

Date______________ Mileage ______________

FURTHER MAINTENANCE

For continued maximum machine performance and component life, it is recommended the foregoing checks be rescheduled, using the 500 and 1200 mile checklists at 600 mile intervals.

WEEKLY MAINTENANCE CHECK

⚠ Safety Emblem

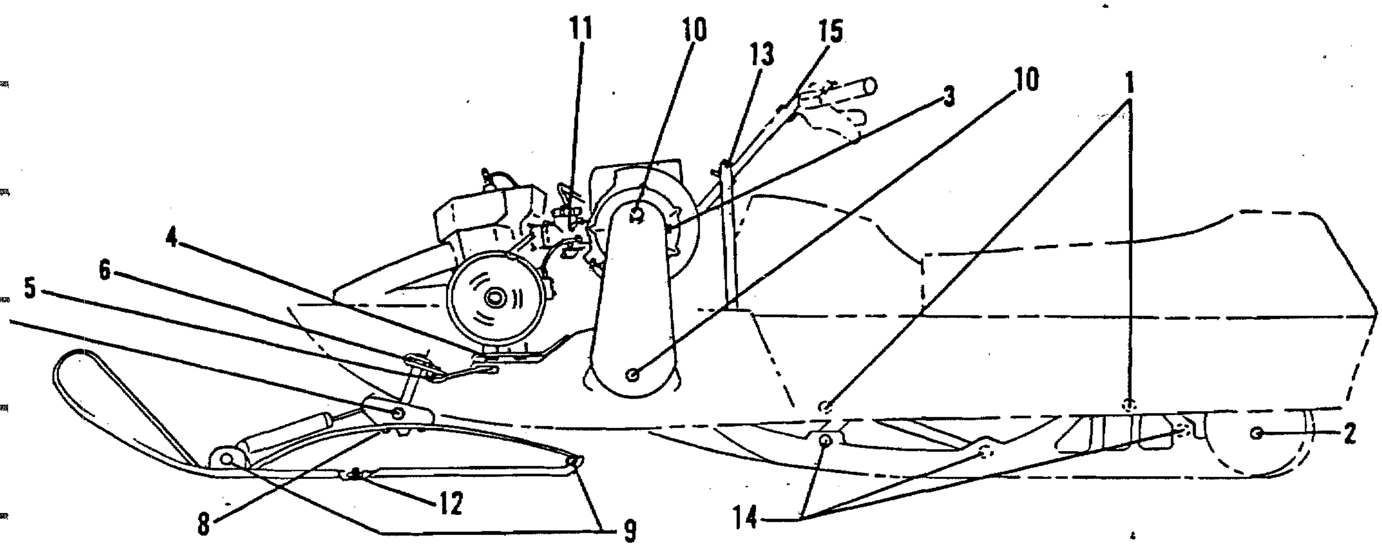
For best machine performance and safe operation, check these points weekly or before any long distance trip.

1. Track alignment and adjustments
2. Chaincase oil level
3. Drive chain tension
4. Drive belt condition
5. Brake operation and adjustment
6. Headlights, tail and stop light
7. Emergency shut off switch operation
8. Suspension mounting bolts (tighten)
9. Steering arm and tie rod ends for play or looseness
10. Ski saddle and spindle bolts (tighten)
11. Lubricate drive clutch (bi-weekly)

MAINTENANCE AND ADJUSTMENTS

You, as a snowmobile owner, have the responsibility of performing preventive maintenance and periodic adjustments. Many of the items listed in this section can be performed by you; however, at times your snowmobile may need service that requires special tools and technical skills. In these situations Polaris recommends that you contact your Polaris dealer.

CAUTION – Loose nuts and bolts can reduce your snowmobile reliability and cause needless repairs and down time. Before beginning any snowmobile trip, a quick inspection of these areas will uncover potential problem areas.



1. Suspension Mounting Bolts
2. Rear Idler Bolt
3. Chaincase Bolts
4. Engine Mounting Bolts
5. Steering Tie Rod End
6. Steering Arm
7. Ski to Spindle Bolt
8. Ski Saddle Bolts
9. Ski Spring Pin and Retaining Cotter Key
10. Chaincase Oil Level and Check Plugs
11. Carburetor Mounting and Air Silencer
12. Ski Skag Nut
13. Steering Post Bolts
14. Pivot Arm Bolts
15. Handlebar Adjustment Bolts

SPARK PLUG SELECTION

Original equipment parts or their equivalent should always be used. However, the heat range of the particular spark plug is of utmost importance, because a spark plug with a heat range which is too high will cause engine damage; one with a heat range which is too low will cause excessive fouling and malfunction. In selecting a spark plug heat range for production, a manufacturer is forced to assume that the engine is going to be operated under extreme heavy-duty conditions. This protects the engine from internal damage in the event that the purchaser actually does operate the engine in this manner. This selection, however, could cause the customer who normally operates the engine under medium or light duty to have spark plug failure.

⚠*CAUTION — A plug with a heat range which is too high will ALWAYS cause engine damage if the engine is operated in conditions more severe than that for which the spark plug was intended. Also, a new engine will usually cause temporary spark plug fouling even though the heat range is proper due to the preservative that has been added during assembly of the engine to combat rust and corrosion. AVOID PROLONGED IDLE SPEEDS, AS PLUG FOULING AND CARBONIZATION WILL RESULT.*

NOTE: Incorrect fuel mixture can often cause a spark plug to appear to be too dark or too light in color. Before changing spark plug heat ranges, be sure the correct main jet is installed in the carburetor(s).

To check for plug spark, remove spark plug and reconnect spark plug wire to plug. Lay the plug on the engine shroud. Do not hold the plug or plug wire in your hand. Pull the starter rope and check for spark. Replace plug if spark is weak.

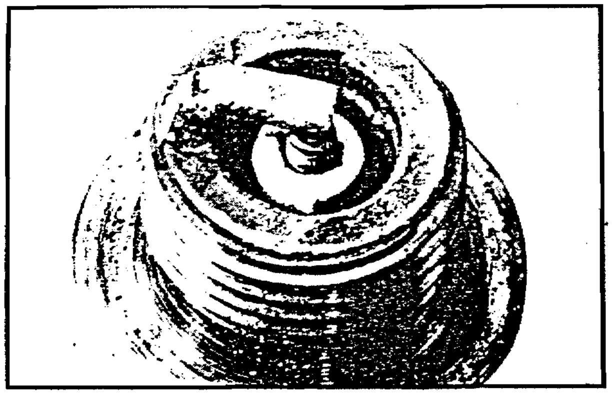
GENERAL CARBURETOR AND SPARK PLUG INFORMATION

Original Equipment Carburetor Jetting

The number size stamped in the end of the main jet banjo bolt indicates the jet size that was installed at the time of manufacture.

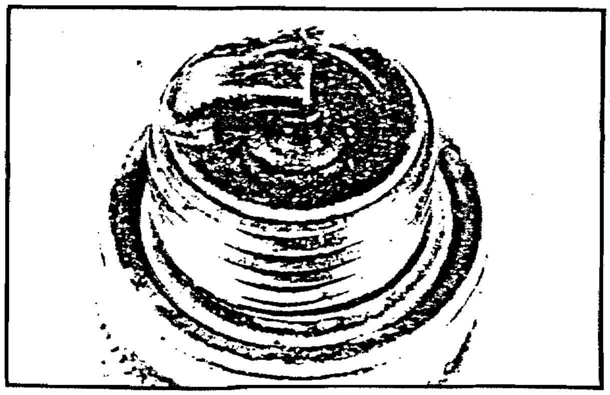
The installed main jet is not necessarily correct for a given area of altitude.

It is the dealer's responsibility to insure that the correct main jets are installed in each machine for your area of operation. To determine correct main jetting, operate machine at near full throttle for a few seconds, then, immediately, check spark plug for correct color.



1. Normal:
The insulator tip is gray, tan, or light brown. There will be few combustion deposits and the electrodes are not burned or eroded.

   This indicates the proper type and heat range for the engine and the service.



2. Wet Fouled:
The insulator tip is black. A damp oily film covers the firing end. There also may be a carbon layer over the entire nose. Generally the electrodes are not worn.

   General causes are excessive oil or use of a non-recommended oil in the fuel, excessive idling, idle too low or too rich. Weak ignition output can also cause wet fouling.

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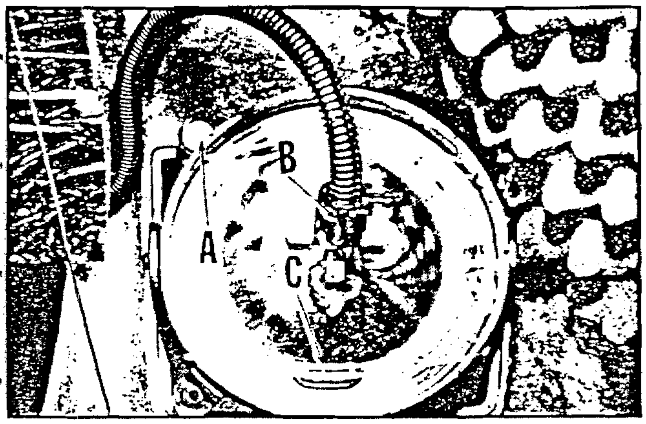
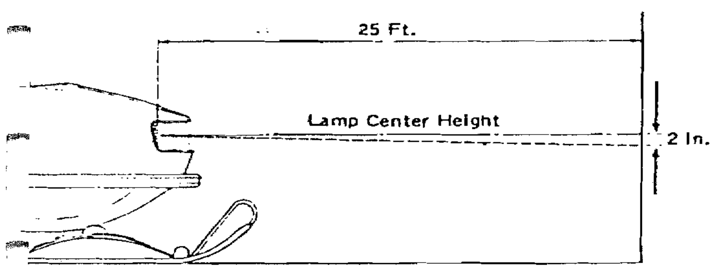
HEADLIGHT ADJUSTMENTS

Headlights on all models can be adjusted to raise or lower the light beam by adjusting the lamp according to the specifications below. Turn adjusting screw (A) clockwise to lower headlight beam; turn counterclockwise to raise headlight beam.

HEADLIGHT REPLACEMENT

Disconnect receptacle (B). Remove wire retainer (C) from slot in headlight ring. Remove sealed beam.





STEERING INSPECTION

⚠ *The steering assembly of the machine should be checked periodically before operation for loose nuts and bolts (figure 1, A, B and C).*

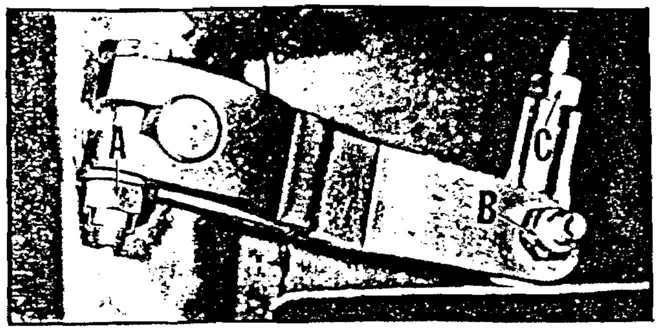


Figure 1

NOTE: Skis should be parallel at points A and B (figure 2). With the handlebars at the straight-ahead position, measure from the straight edge of the ski. Skis must not toe-in. If they are misaligned, have your dealer correct it.

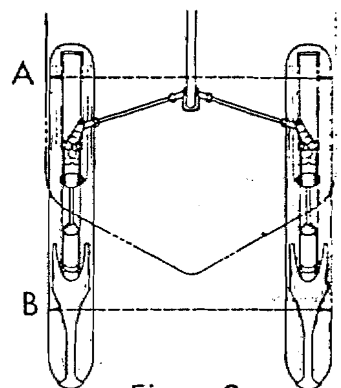
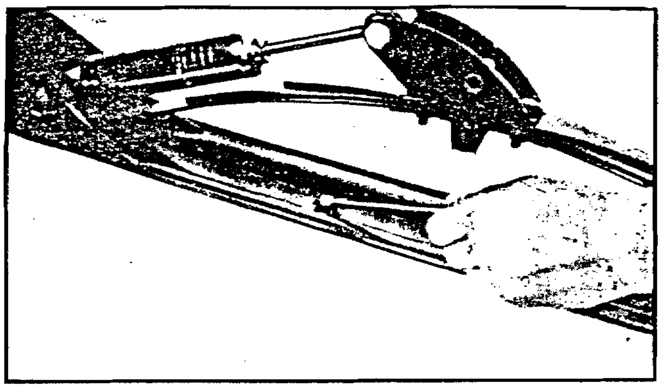


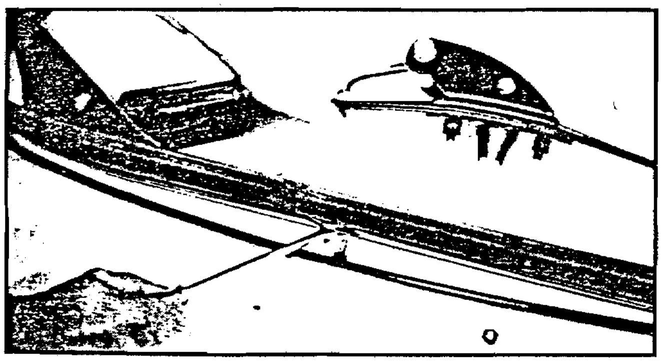
Figure 2

SKI SKAGS

The skag is a replaceable bar attached to the underside of the ski. The purpose of the skag is to assist in turning the snowmobile, to prevent the wearing away of the ski caused by contact with roads and other bare terrain, and to maintain good steering control. If the snowmobile is operated mostly in snow, ski skag wear will be minimal. However, skag wear will be excessive if the snowmobile is operated on roads and other terrain where snow cover is light. Therefore, Polaris recommends that the skags be checked once a week to prevent excess wear and to maintain positive steering characteristics. Skags must be replaced when worn to half their original diameter.

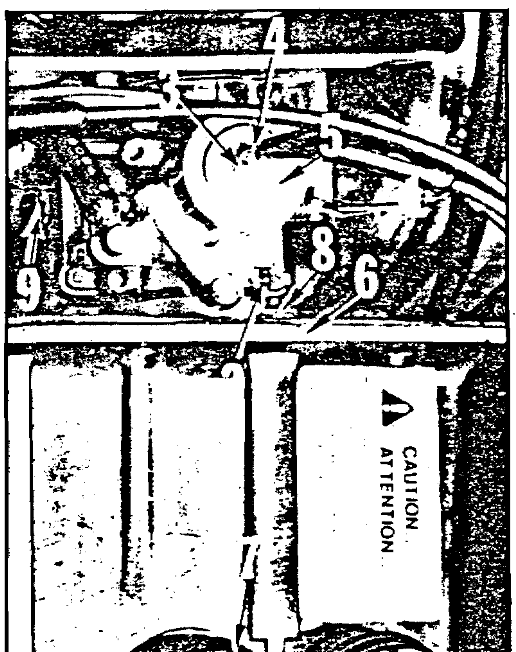


To remove the ski skag, first remove retaining nut as shown. Then push bolt down through ski.



Pull the rear of the skag from the ski, as shown, then the skag is free to be pulled from the ski.

MIKUNI CARBURETOR ADJUSTMENT PROCEDURES



Carburetor and Air Silencer Identification

1. Idle Adjustment Screw
2. Air Idle Screw
3. Throttle Adjustment Jam Nut
4. Throttle Adjustment Nut
5. Slide Valve Cap
6. Air Silencer
7. Air Silencer Inlet Hoses
8. Air Silencer Hold-down Clamp
9. Main Jet Banjo Bolt

The Mikuni carburetor is a float type, fixed jet carburetor. It has four systems: starter system, which is called the choke; pilot system, which consists of a pilot jet for low speed or idle; main system, which consists of a main jet that meters fuel at one-half to full throttle; and the float system, which maintains the fuel level in the float bowl. All systems work together in maintaining a constant even flow of fuel air mixture at various speeds of operation.

CAUTION – Improper carburetion adjustments can result in engine component failure or carburetor system malfunction.

Choke Adjustment

With the dash mounted choke control toggle flipped to full off position, the choke plunger must be seated on fuel passage-way in carburetor. If plunger is not seated on passage-way, the engine will flood or run too rich, causing plug fouling and very poor engine performance.

To check your choke adjustment, idle the engine and flip the choke toggle over center to full on position. The engine should become rich and stop running. If the engine does not stop, this indicates that your chokes are not properly adjusted. If the engine will not start easily, this may be a sign that the choke may not be functioning properly and needs adjustment. The proper free play of the choke lever is shown in figure 1.

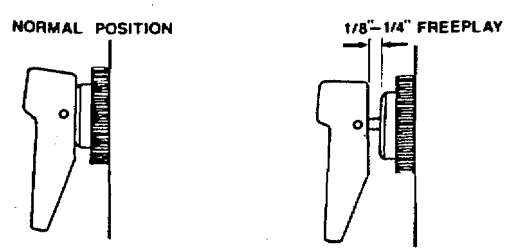


Figure 1

If there is no free play, the starter plungers may not be seating in the carburetor causing flooding or plug fouling. This adjustment may be achieved by loosening jam nut (C) (figure 2) and rotating adjusting nut (D) in the direction required to achieve proper free play as shown in figure 1. Proper free play is approximately 1/8" - 1/4".

Throttle Adjustment

1. Remove air silencer.

NOTE: Improper silencer installation or carburetor obstruction may cause less air to enter carburetors resulting in flooding or plug fouling. If silencer is not attached properly to the carburetor (hoses and connections secured), a lean mixture could occur resulting in engine seizure.

2. With the engine shut off, squeeze the throttle to wide open position and hold. Place your finger up into the slide chamber to check slide valve clearance. The slide valve must clear the carburetor venturi. Both slide valves must raise evenly when the throttle is depressed. Synchronizing may be achieved by balancing slide valve movement. This is done by loosening jam nut (A) (figure 2) and rotating throttle cable adjustment nut (B) in direction desired. Re-tighten jam nut.

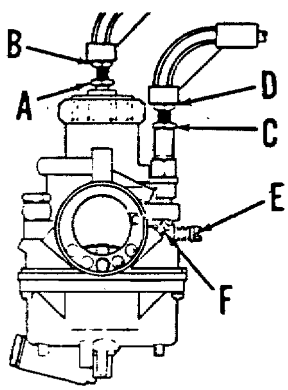


Figure 2

3. Start engine and adjust idle speed to desired RPM (1,000 RPM below drive clutch engagement). Turn idle adjusting screws (E) alternately raising RPM until it reaches the desired speed.

4. Adjust idle air mixture screw (F) one turn counterclockwise from full seated position.

NOTE: Do not run engine when adjusting carburetor. To become thoroughly familiar with the foregoing procedures, ask your dealer. DO NOT TAMPER WITH ADJUSTMENTS UNLESS YOU UNDERSTAND THEM EXACTLY.

Main Jetting

Jetting charts have been prepared for all altitudes and temperatures. For proper jetting application, always consult your dealer to prevent possible engine damage.

CHANGING DRIVE BELT

To remove drive belt from ramp style clutch, grasp one side of clutch in each hand and rotate in opposite directions (figure 1). Force unit open, allowing sufficient slack for belt to be slipped over driven clutch (figures 2 and 3). The air silencer hold-down bolts must be removed and the silencer moved over slightly (A) (figure 4).

To replace belt, reverse procedures. Ask your dealer for more specific information.

NOTE: Replacement of drive belt is recommended if width is less than 1 3/16" at outside surface.

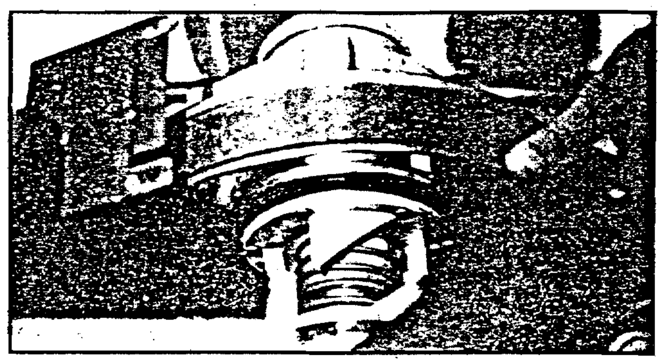


Figure 1

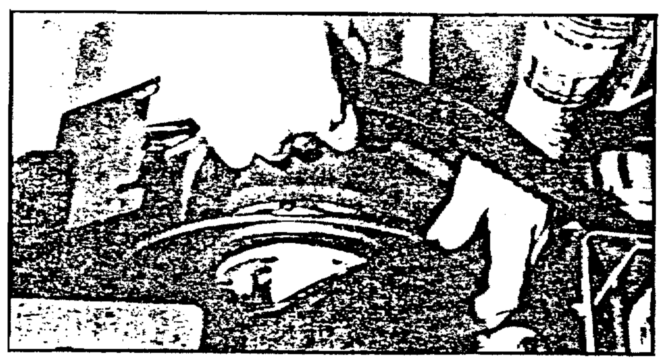


Figure 2

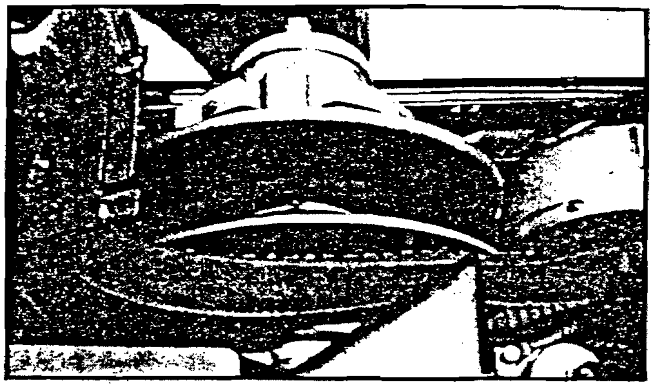


Figure 3

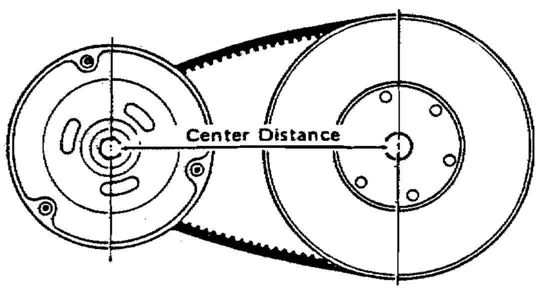
CLUTCH ALIGNMENT AND OFFSET

The primary drive belt is a very important part of the drive train. Proper adjustment of the two clutches (torque converter assembly) is necessary to obtain proper belt life. The information on this page is most important in maintaining proper tolerances. Should you desire more information, consult your dealer.

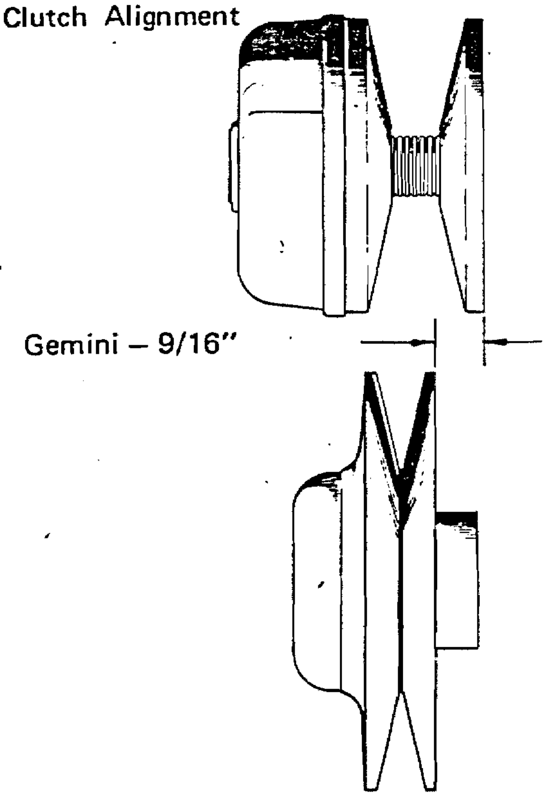
Clutch Center Distance

Recommended center distance:

Gemini model – 11.1"



Clutch Alignment

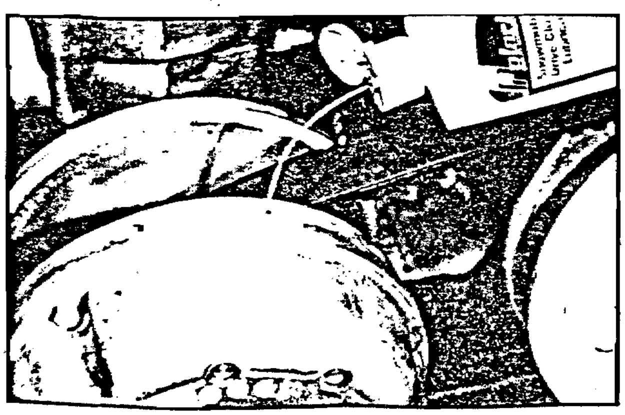


The recommended offset between the drive and driven clutches with the belt removed is 9/16" on the Gemini.

CLUTCH LUBRICATION

The lubrication of the drive clutch shift weights and rollers should be performed bi-weekly by the snowmobile operator. Lubrication of the drive clutch can be performed by spraying a small amount of Polaris clutch lubricant through the three (3) access holes in the movable face.

NOTE: Drive clutch removal for lubrication is not required. Do not overspray on the drive belt or drive clutch sheave surfaces.



⚠ *CAUTION – All clutch maintenance and repairs must be performed by an Authorized Polaris Servicing Dealer.*

⚠ *CAUTION – If you become aware of higher than normal engagement, an unusual vibration, or an unusual shift pattern, immediately contact your dealer. Do not operate the machine until corrections have been made.*

INSPECTING BRAKES

At reasonably frequent intervals, the brakes should be inspected for brake lever reserve. This is done by measuring the clearance between the lever and handlebar grip. Inspection should be made with the lever firmly depressed. Lever reserve should not be less than 1/2" (A) (figure 1).

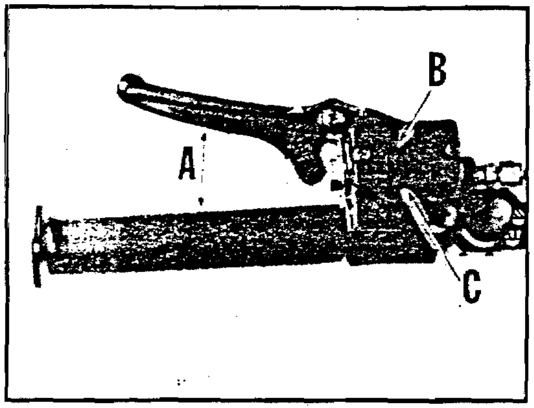


Figure 1

Replace brake pads when allen adjusting screw (A) (figure 2) makes contact with locknut (B). Brake pads should be replaced in pairs. See your dealer for replacements.

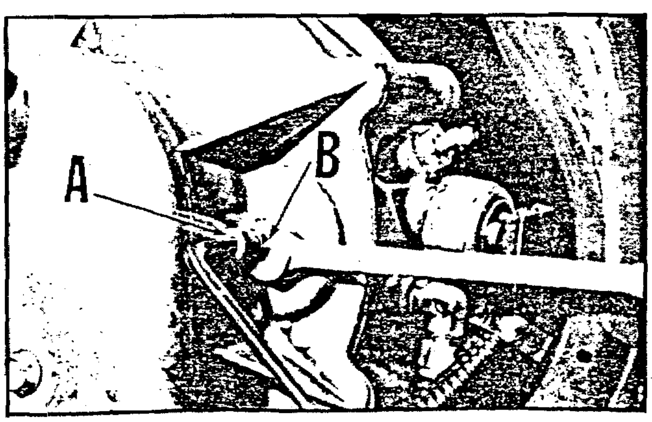


Figure 2

TROUBLESHOOTING BRAKE PROBLEMS

Excessive Lever Travel

1. Excessive Brake Pad Clearance – Loosen allen screw adjuster locknut. Turn adjuster screw clockwise until pads are tight against disc, then back off screw 1/2 turn counterclockwise and re-tighten locknut (figure 2). There should be a minimum of .015" clearance between the brake pads and the brake disc.

2. Fluid Reservoir – If master cylinder reservoir is empty or low, remove cover (B) (figure 1), add fluid as required to bring level 1/8" below lip of reservoir opening.

NOTE: See your dealer for recommended brake fluid.

Air in Hydraulic System

Air in hydraulic system will cause a springy or spongy action of brake lever. A bleeding operation is necessary to remove air from system.

1. Fill master cylinder reservoir (C) (figure 1) and replace cover and gasket.

2. Slip a rubber tube over ball of bleeder valve (A) (figure 3) and direct flow of fluid into a container. (DO NOT RE–USE FLUID.)

3. Squeeze brake lever a full stroke, unscrew bleeder valve (B) (figure 3) 3/4 of a turn to release air. Close bleeder valve, then release brake lever. Repeat this procedure until fluid flows from bleeder valve in a solid stream that is free of air bubbles. Refill reservoir after bleeding operation.

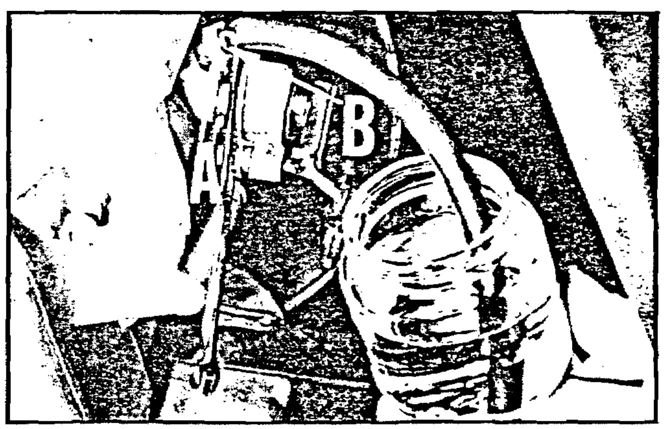


Figure 3

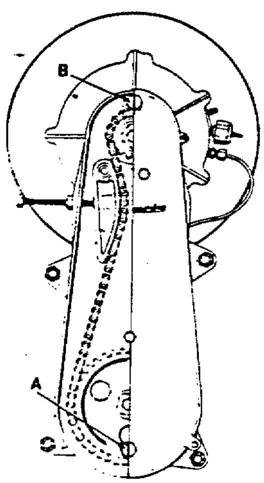
4. Frequently check master cylinder reservoir to make sure that it contains fluid.

⚠ *CAUTION – Maintain the brake handle position as level as possible. The hydraulic fluid reservoir must be in this position to minimize the possibility of air entering the system through the reservoir vent.*

CHAINCASE

Chaincase Oil Level

The Gemini 244 single has a roller type chain which is continuously immersed in oil. Proper oil level is determined by removing check plug (A) with machine placed on a level surface. If oil does not appear when this plug is removed, it will be necessary to add oil at top plug (B). Maintain oil level with Polaris chaincase oil.

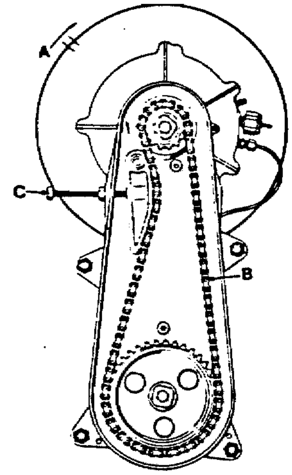


Gemini

Drive Chain Tension

To obtain correct chain tension, tip machine on its side and remove the chaincase cover. With a slight reverse tension on the chain by turning driven clutch as indicated (A) there should be approximately 3/8" deflection on the chain at point (B). Chain adjustment is achieved by loosening the adjusting bolt locknut and turning adjusting bolt (C) until correct chain deflection is obtained. Lock the adjusting bolt locknut while holding a wrench on the adjusting bolt at the same time to prevent it from turning. Install the chaincase cover and add Polaris chaincase oil.

<u>NOTE: It is the owner's responsibility to maintain proper lubrication of the chaincase.</u>



Gemini

TRACK ALIGNMENT AND ADJUSTMENT

Track Tension

Lift the rear of the machine and support it off the ground. Proper free play of track can be determined by noting the distance between the outer surface of track belt and slide rail (C) (figure 1). Dimensions for the Gemini is 1/2".
If the track needs adjustment, loosen locknuts (A) and tighten or loosen the track adjusting screws (B) as necessary to provide equal adjustment on both sides of the track.

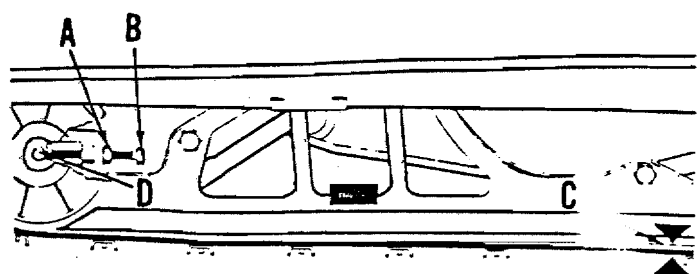
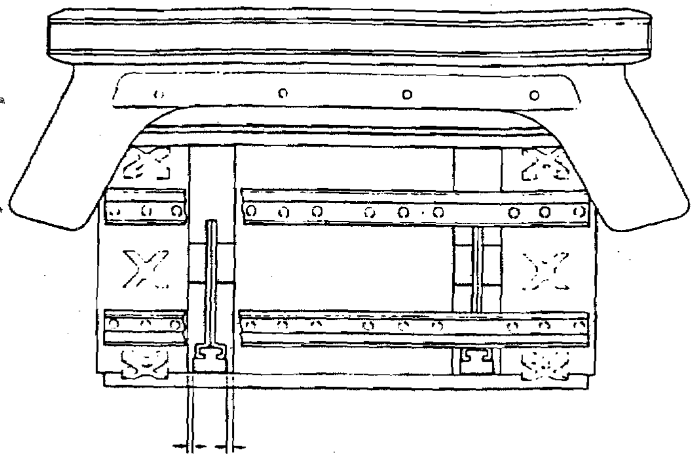


Figure 1

Track Alignment

A periodic check should be made to determine that the track is centered and running evenly on the slide rails. Misalignment will cause excessive wear to the track and the slide rail. Check by supporting the rear of the machine with the track off the ground. Start the engine and accelerate <u>slowly</u> to turn the track. If the track runs to the left, loosen left locknut (A) (figure 1) and tighten left adjusting screw (B). If to the right, adjust right-hand bolts accordingly. After adjustments are completed, be sure to tighten locknuts.

NOTE: It is necessary to loosen the rear idler shaft (D) (figure 1) to make this adjustment.



⚠ *CAUTION – When performing above checks or adjustments, stay clear of all moving parts.*

Track Maintenance

With the rear of your Polaris snowmobile supported off the ground, rotate the track by hand to check for broken, bent, or missing cleats. Replace as soon as possible to avoid damage to track or suspension system. Make it a periodic practice to check for loose bolts and nuts on the suspension system. NEVER make this maintenance check with the engine running.

NOTE: The slide rail is designed to operate in conditions with adequate snow cover to provide sufficient lubrication. Excessive wear indicates insufficient lubrication. In the event you wish to install additional non-standard cleats or ice growsers, first contact your dealer for advice.

NOTE: During overnight storage, support the rear of your snowmobile off the ground. This will prevent the track from freezing to the ground and causing any belt damage during next day start up.

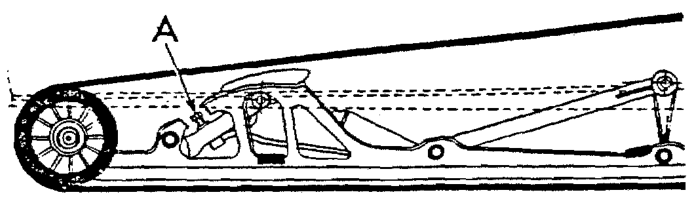
⚠ *CAUTION – Before operating your snowmobile, it is recommended that the drive belt and track be "warmed" up. This may be accomplished by carefully accelerating the snowmobile while the rear of the sled is securely positioned off the ground. This procedure will prevent possible damage to the drive belt and clutch. Be certain the track has stopped by applying the brake prior to lowering the rear of the snowmobile.*

SUSPENSION MAINTENANCE AND ADJUSTMENTS

As the hi-fax wears, the track tension must be maintained. When the hi-fax has worn down to 3/16" in thickness, it is recommended that it be replaced.

Ride Adjustment

Compensating adjustments for heavy or light passenger loads can be made by turning the cap screw (A). For a firmer ride and less weight transfer during acceleration, turn the cap screw counterclockwise. For a softer ride resulting in more ski lift and weight transfer, adjust the screw clockwise.



PROBLEM	PROBABLE CAUSE	SOLUTION
ENGINE DOES NOT TURN	1. Seized Engine	In case of a seized engine, contact your dealer. Seizure is a direct result of poor lubrication or inadequate fuel supply.
	2. Hydrostatic Lock (Fuel has entered the crankcase while vehicle was standing or being transported)	Drain plug(s) located on lower crankcase for emergency draining, however dealer should be contacted to correct cause of hydrostatic lock.
ENGINE TURNS OVER BUT FAILS TO START	1. Faulty Ignition	Remove spark plug(s) and replace with new plug(s). If engine still fails to start, check for spark; and if no spark, CONTACT YOUR DEALER.
	2. No Fuel To Engine	a. Check tank level and fill up with correct fuel-oil mixture.
		b. Ice in fuel line, filter, or fuel pump – On the standard Polaris carburetor, the choke will not function with the throttle depressed. See Item No. 2 under "Probable Cause" of "Engine Continually Backfires."
	3. Flooded Engine (Normal situation caused by too much choking)	Hold throttle open, crank engine several times (may be necessary to change plugs, however, the plugs may operate satisfactorily when dried out).
	4. Poor Engine Compression	Running with too lean a mixture (too small main jets will cause seizure resulting in loss of power). CONTACT YOUR DEALER.
ENGINE DOES NOT START	1. Wire Connections	CONTACT YOUR DEALER.
ENGINE LACKS POWER	1. Fouled or Defective Spark Plug	Change and test operation.
	2. Carburetor and Fuel Pump	There is no adjustment that will change power output – CONTACT YOUR DEALER.
	3. Fuel Filter (Loss of high RPM power)	Check fuel filter flow – Disconnect hose and drain about 1/2 cup. Fuel flow should be steady and encompass the entire diameter of fuel line. If not, replace filter.
ENGINE CONTINUALLY BACKFIRES	1. Faulty Plug(s)	Change plug(s).
	2. Carburetor	Dirt or ice in fuel system. (De-icer should be added to fuel mixture at all times for assurance against fuel line icing.)

CAUTION: *Unless you have experience and training in two-cycle engine repair, it is advisable for your benefit that you see your dealer if technical problems arise.*

TROUBLESHOOTING PROCEDURES

PROBLEM	PROBABLE CAUSE	SOLUTION
MACHINE FAILS TO MOVE	1. Clutch Jammed	Belt twisted, spring broken, weights stuck, lubricate, CONTACT YOUR DEALER.
	2. Track Jammed	Foreign object caught, broken or bent cleat, hi-fax damaged, CONTACT YOUR DEALER.
	3. Chaincase Sprocket or Chain Jammed or Broken	Chain is loose or broken, chain tightener is loose. CONTACT YOUR DEALER.
DRIVE BELT TURNS OVER	1. Wrong Belt for Application	Replace.
	2. Clutch Alignment Out of Spec	Adjust alignment offset.
	3. Engine Mount Broken or Loose	Inspect/adjust or replace. CONTACT YOUR DEALER.
ERRATIC ENGINE OPERATING RPM DURING ACCELERATION OR LOAD VARIATIONS	1. Drive Clutch Binding	a. Disassembly of drive clutch required to inspect shift weights for wear and free operation. CONTACT YOUR DEALER.
		b. Clean and polish stationary shaft hub.
	2. Driven Clutch Malfunction	a. Replace ramp buttons. CONTACT YOUR DEALER.
		b. Inspect movable sheave for excessive bushing clearance/replace. CONTACT YOUR DEALER.
HARSH DRIVE CLUTCH ENGAGEMENT	1. Drive Belt Worn or Too Narrow	Replace.
	2. Excessive Belt/Sheave Clearance	Perform belt/sheave clearance adjustment with shim washers beneath spider. CONTACT YOUR DEALER.
NOISE IN DRIVE SYSTEM	1. Broken Drive Clutch Components	CONTACT YOUR DEALER.
	2. Bearing Failure/Chaincase, Jackshaft, or Front Drive Shaft	CONTACT YOUR DEALER.
	3. Drive Chain Loose or Worn, Sprocket Teeth Broken	Inspect/adjust or replace.
	4. Drive Belt Surface Flat Spots	Inspect/replace.

SERVICE AND WARRANTY

OBTAINING SERVICE AND WARRANTY ASSISTANCE

Read carefully and understand the service data and the Polaris Warranty contained in this manual. Contact your Polaris dealer in matters pertaining to replacement parts, service, or warranty. He is constantly kept up to date on changes, modifications, and tips on snowmobile maintenance which may supersede information contained in this manual. He is familiar with our policies and procedures and will be happy to assist you.

When writing about parts, service, or warranty, always include the following information:

1. Serial Number
2. Model Number
3. Dealer Name
4. Date of Purchase
5. Details of trouble experienced
6. Length of time and conditions of operation
7. Indicate previous correspondence

Use this space to record the model and serial numbers of your machine and engine.

MACHINE ______________________

Model No. ______________________

Serial No. ______________________

ENGINE ______________________

Model No. ______________________

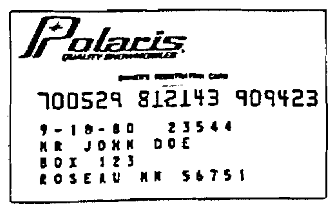
Serial No. ______________________

The companies listed on the following pages a
regional Polaris distributors who should be co
tacted for local assistance in resolving questio
and problems involving your dealer or service a
warranty information on your Polaris snowmobi
Before contacting Polaris directly, please attem
to resolve your problems by contacting the regio
distributor. (Check with your dealer first to det
mine the responsible distributor because yo
distributor's area may encompass more than o
state or a partial state.)

REGISTRATION

At the time of sale, the Warranty Registratio
Form (sample below) must be completed by yo
dealer and submitted to Polaris within ten day
Upon receipt of this registration Polaris w
prepare and mail directly to you an Owner Re
istration Card which must be presented to a deal
whenever warranty service is requested. If yo
have not signed the original registration a
received the "customer copy," or if you have n
received your Owner Registration Card, plea
contact your dealer immediately.

Initial dealer preparation and set-up of your sno
mobile is very important in ensuring trouble-fr
operation. Purchasing a machine in the crate
without proper dealer set-up will void your wa
ranty coverage.



MODEL # | ENGINE SERIAL NO.

Polaris TEXTRON

Polaris E-Z-Go Division of Textron Inc

0 | MACHINE SERIAL NUMBER

WARRANTY REGISTRATION FORM

THIS WARRANTY REGISTRATION CARD MUST BE COMPLETED BY THE SELLING DEALER AND SUBMITTED TO POLARIS WITHIN TEN DAYS FROM DATE OF SALE FOR WARRANTY ENTITLEMENT. YOUR COPY OF THIS REGISTRATION FORM IS YOUR PROOF OF WARRANTY ENTITLEMENT UNTIL YOU RECEIVE YOUR PLASTIC OWNER'S CARD.

USE ADDRESSOGRAPH IMPRINTER

MAIL MANUFACTURER'S COPY TO: POLARIS WARRANTY DEPT.
1225 NORTH COUNTY ROAD 18
MINNEAPOLIS, MN. 55427

MO. DAY YEAR

DATE OF SALE

OWNER'S PHONE NUMBER

OWNER'S NAME

ADDRESS

CITY

STATE OR PROVINCE

ZIP OR POSTAL CODE

THE DEALER NAMED AT LEFT HAS INSTRUCTED ME ON THE OPERATION, MAINTENANCE, SAFETY FEATURES AND WARRANTY POLICY, ALL OF WHICH I UNDERSTAND

OWNER'S SIGNATURE ______________________ DATE

LIMITATION OF WARRANTY

Polaris E-Z-Go Division of Textron Inc. gives a LIMITED ONE YEAR WARRANTY on all components on the Polaris Gemini model that fail because of a defect in material or workmanship. This warranty will begin on the date of purchase. A warranty registration must be completed by your dealer and submitted to Polaris by him within ten days of purchase. Be sure that you receive your copy of the Warranty Registration Form from your dealer as this is your entitlement to warranty repairs until you receive your Owner's Registration Card. UNLESS YOUR SNOWMOBILE IS REGISTERED WITH POLARIS NO WARRANTY COVERAGE WILL BE ALLOWED.

WHAT YOUR WARRANTY COVERS

Polaris warrants, to the first purchaser, that each snowmobile shall be free from defects in material and workmanship for the period specified above. This warranty coverage includes all parts and components with the exception of those components and conditions listed below:

1. Light Bulbs
2. Spark Plugs
3. Ignition Breaker Points and Condensers (if used)
4. Brake Pads
5. Suspension Slides and Ski Wear Bars
6. Drive Belts
7. Component Failure Due to Normal Wear or Abuse

Any of the following conditions will void your warranty and no repairs or replacements will be provided by Polaris under the warranty policy:

1. Failure to provide proper and periodic maintenance as stated in your Owners Manual.
2. Performance of repairs by someone other than a factory authorized repair service.
3. Use of non-standard parts or components, and modifications in your snowmobile.
4. Use of your snowmobile during any period in which there is not adequate snow cover.
5. Preparing for or using your snowmobile for racing in a competitive event, or use for commercial purposes.

HOW TO OBTAIN WARRANTY SERVICE

After you have purchased your snowmobile and your dealer has sent Polaris your warranty registration, you will receive an Owners Registration Card. You must present this card when requesting warranty service. If your snowmobile requires warranty service, you must take it to an Authorized Polaris Servicing Dealer. (THE COST OF TRANSPORTATION TO AND FROM THE DEALER IS YOUR RESPONSIBILITY.) Polaris suggests that you use your original selling dealer; however, you may use any Authorized Polaris Servicing Dealer to perform warranty service.

Polaris will repair or replace, at its option, any material or components which are defective in materials or workmanship.

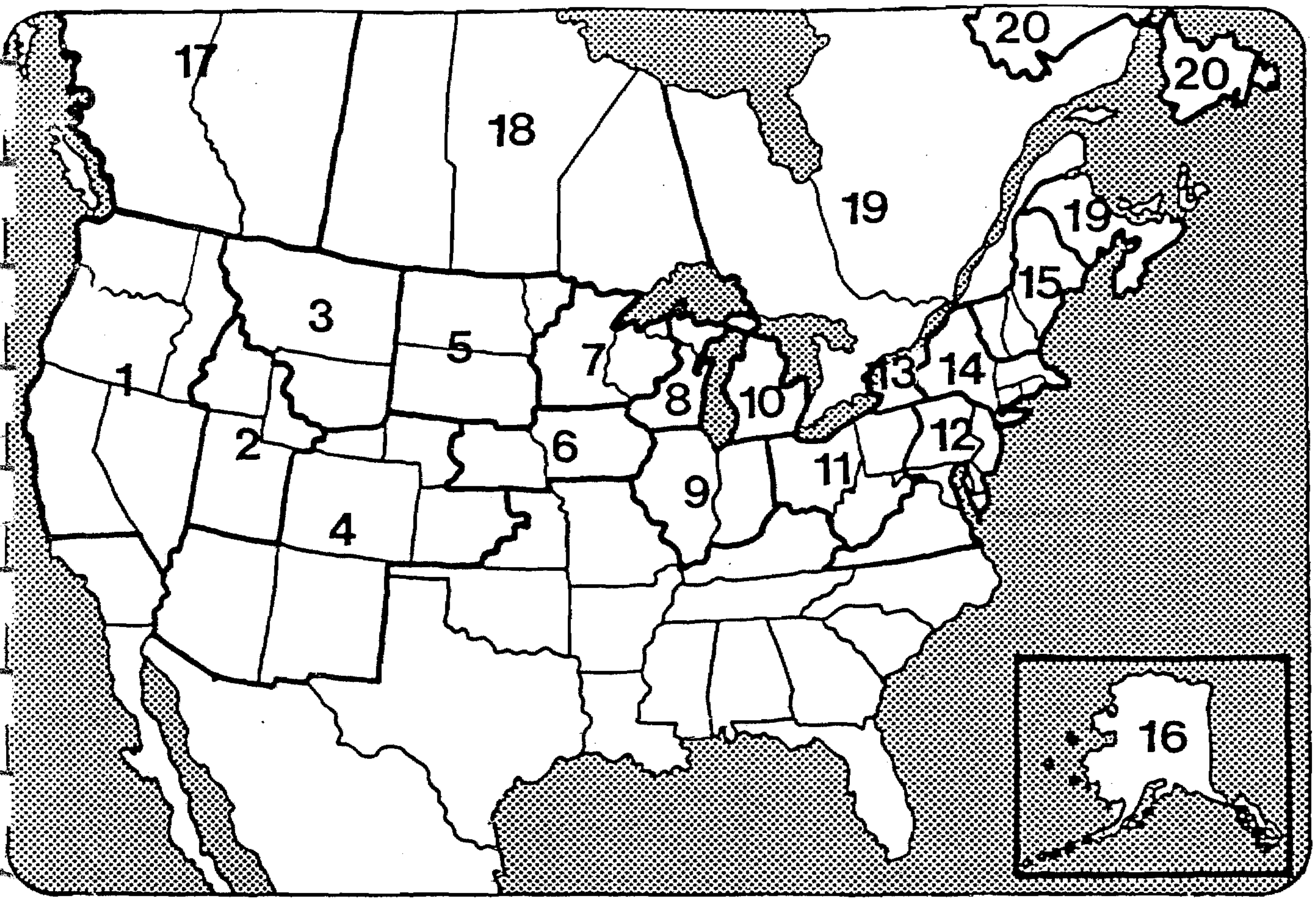
If you have questions or problems you cannot resolve with your dealer, please contact the Polaris distributor for your area listed in the back of this manual. If you have further questions still unresolved, you may contact Polaris directly.

LIMITATION OF WARRANTY

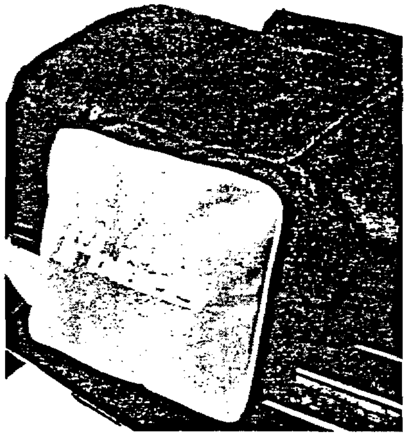
This warranty will provide for repair or replacement, at Polaris' option, of those items listed which are proven defective in material or workmanship for the period specified.

POLARIS SNOWMOBILES ARE INTENDED FOR RECREATIONAL PURPOSES ONLY AND ARE NOT INTENDED FOR ANY OTHER USE. THEREFORE, POLARIS WILL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES RESULTING FROM ANY BREACH OF ANY WRITTEN OR IMPLIED WARRANTY FOR ITS PRODUCTS. THE DURATION OF ANY IMPLIED WARRANTIES SHALL BE THE SAME AS FOR EXPRESSED WARRANTIES. THE REMEDIES STATED ABOVE ARE THE ONLY REMEDIES AVAILABLE UNDER THIS WARRANTY. NO PERSON CAN CHANGE OR EXPAND THIS WRITTEN WARRANTY.

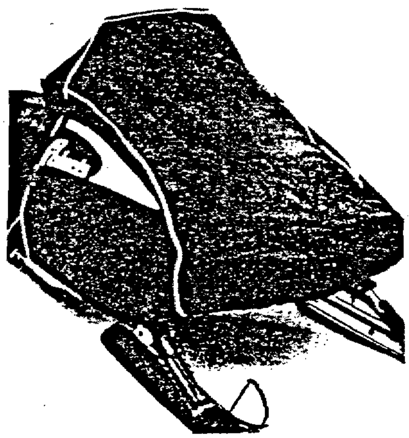
This warranty gives you specific legal rights, and you may also have other rights which vary from state to state. Some states do not allow a limitation on how long an implied warranty lasts, so the above limitation may not apply to you. If any of the above terms are void because of state law, all other warranty terms will remain in effect.



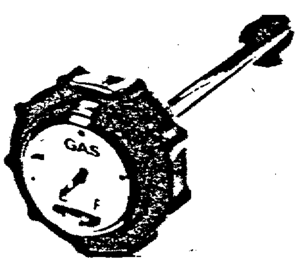
1. Western Power Sports, Inc.
2. Wilson Supply, Inc.
3. Midland Implement Company
4. Polaris E-Z-Go Denver
5. Polaris North Central
6. Harold H. Luiken & Sons, Inc.
7. Larsen-Olson Company
8. R. L. Ryerson Company, Inc.
9. Polaris E-Z-Go Chicagoland
10. Polaris E-Z-Go Michigan
11. Albert H. Buehrle Company
12. Stull Equipment Company
13. Eaton Equipment Company
14. Polaris E-Z-Go Northeast
15. Nelson & Small, Inc.
16. Polar Equipment Company, Inc.
17. Polaris Canada West
18. Polaris Canada Manitoba
19. Polaris Canada East
20. Domac Enterprises, Ltd.



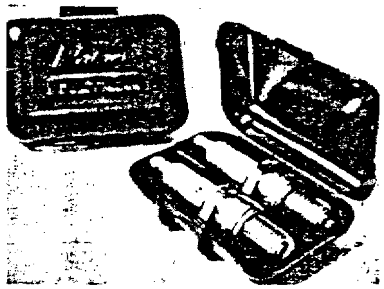
Saddle Bag
Specially designed durable canvas bag with heavy-duty side zippers.



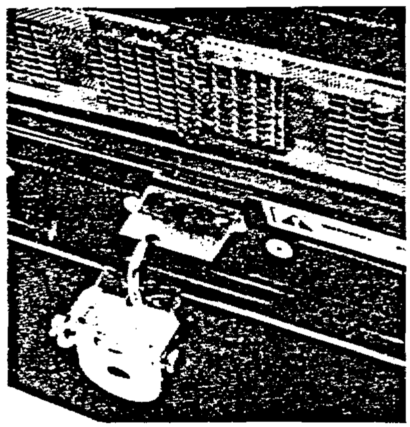
Covers
Snug-fitting covers custom tailored for each specific model. Made of durable canvas in Polaris midnight blue.



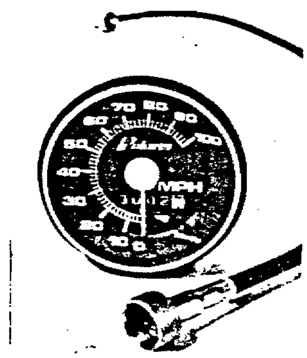
Gas Gauge
Indicates gas level at a glance.



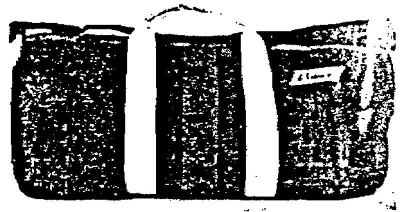
Spark Plug Case
Protects reserve spark plugs from damage while being stored in machine storage compartment.



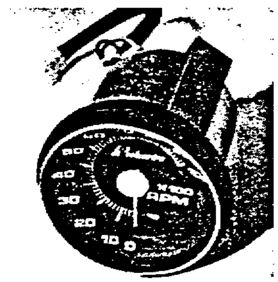
Trailer Hitches
Custom designed for each specific model, to help you pull extra loads.



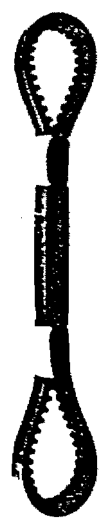
Speedometer Kit
Gives a clear, accurate reading of machine speed and miles traveled.



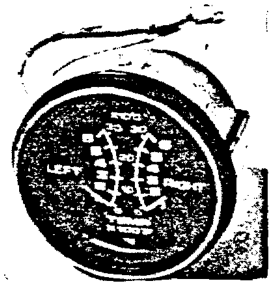
Duffel Bag
Specially designed durable canvas duffel bag.



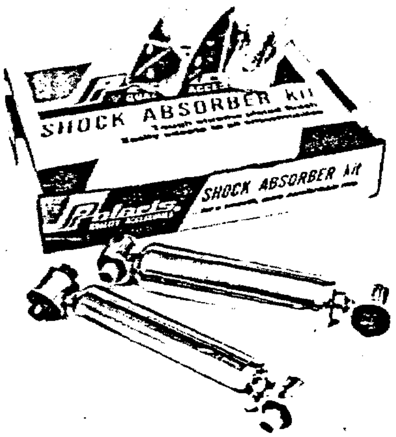
Tachometer Kit
Gives a precise reading of engine RPM's, indicating engine performance.



Drive Belt Holder
The perfect way to store that extra drive belt that you bring along.

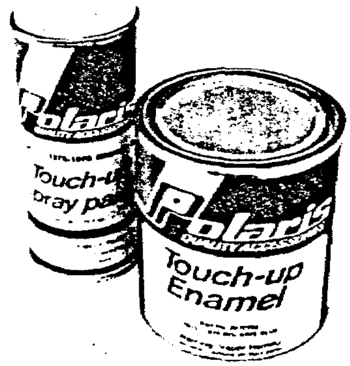


Temperature Gauge
Provides temperature reading on an illuminated dial. Dual indicators for twin cylinder models.



Shock Absorbers
Provide a smoother, more comfortable ride. Give driver more control. Give springs and skis longer life.

Quartz Halogen Headlight
High-intensity light for maximum nighttime visibility. (Designed for single-headlight models.)

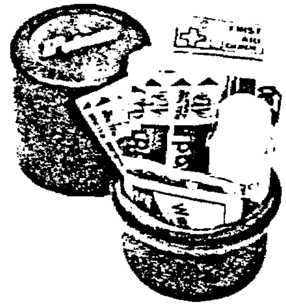


Touch-up Paint
Perfect match for original Polaris colors. Available in quarts and 12 ounce spray cans.

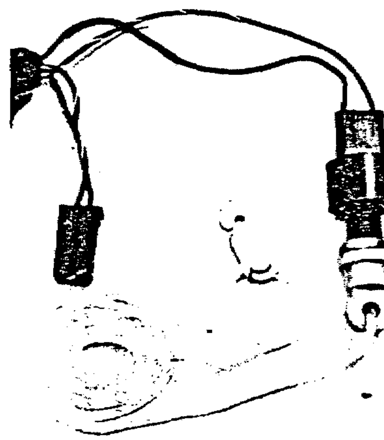
Snowmobile Oil
Special ashless blend for air-cooled snowmobile engine. Prediluted to readily mix with gasoline at low temperatures. Prolongs engine and spark plug life, minimizes piston varnish, sticky rings and blow-by.

Gas Can
Five gallon capacity. Made of durable 26-gauge galvanized steel.

Funnel
Heavy-duty polyethylene funnel, with built-in brass filter screen.



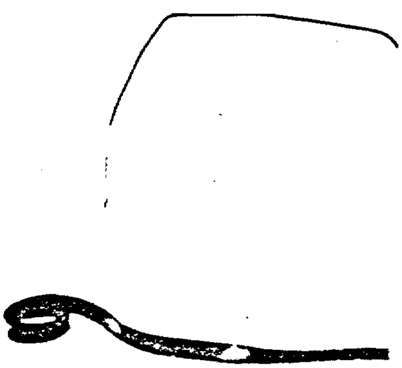
First Aid Kit
Emergency kit consisting of telfa pads, alcohol, first aid cream, matches, and knife with bottle opener.



Tether Switch
Safety switch originally designed for racers, now available for anyone. Power is shut off instantly when snap-off cap is released.

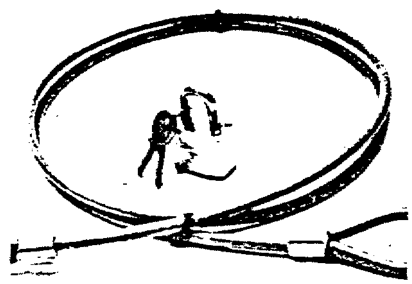
Silicone Brake Fluid
Specially formulated to perform dependably in both warm and cold conditions.

Electric Start Kit
For the discriminating Galaxy owner, a turn of the key and you are ready to ride.



High Windshield
Effectively shields driver from wind while traveling at higher speeds. Resists breaking or cracking, even at low temperatures.

Chaincase Oil
Contains anti-rust and anti-oxidation inhibitors, plus special penetrating ingredients which reduce chain wear.



Lock and Cable Set
A 6 foot security cable and lock to give your snowmobile that added protection.

Polaris Clutch Lubricant
Lubricates, helps eliminate rust and sticky clutch weights and rollers.

Polaris Suspension Lubricant
Designed to lubricate and reduce wear on suspension shafts.

Polaris
Traction/Action
Headquarters

The addition of all traction products will change the handling characteristics of a snowmobile.

All the traction equipment you need to give a snowmobile deep-digging traction and superior steering response. Items available:

Carbide Trail Skags.

Specially designed for the saf and control demands of trail ridi

Carbide Racing Skags.

Sharp carbide inserts which rea dig into snow and ice for safe, c trolled maneuvering on the r track.

Snow Biter 1.

Wide stance studs that give bro pressure and better clearing in snow. Improve traction almost where — on ice, hardpack, soft sn or slush.

Snow Biter 2.

Best stud for pure acceleration; a enhances cornering abilities.

Snow Biter 3.
The best stud to run in non-pack or powder snow conditions.

Snow Biter 4.

Carbide tipped studs that prov exceptional penetration on ice a hardpack. Longer wear than regu steel snow biters.

Also offered, but not part of Tr tion/Action Headquarters:

Ski Spreader.

Designed to give a snowmobile m imum stability and steer-ability.

TOOL KIT AND PUBLICATIONS

Included with your machine is a supply of tools for your convenience. These tools should be carried with your machine at all times. A description of the tools is as follows:

1. Tubular Socket – 10MM and 12MM
2. Tubular Socket – 14MM and 21MM
3. Phillips Screw Driver
4. Rope
5. Tubular Socket Handle

Uses of Tubular Socket

10MM – Used to remove engine recoil starter. Should recoil fail, it can be removed to allow access to emergency rope starter cup.

12MM – Used on engine head bolts.

14MM – Used on crankcase drain plugs.

21MM – Spark Plug Wrench

In the event of loss, a replacement kit, PN 2870257 may be purchased through your local Authorized Polaris Dealer.

REMEMBER – <u>ALWAYS</u> KEEP TOOLS WITH MACHINE.

AVAILABLE SERVICE MATERIAL

For customers who desire more detailed service information and procedures, the following printed material is available.

1. Master Repair Manual, part number 9910493
   This manual contains service and repair information for models from 1972-1979. The hard cover five-ring binder features sectional dividers with tabs for quick reference.
   Price: $24.50

2. 1980 Master Repair Manual Update Packet, part number 9910620
   Includes all service information and specifications pertinent to 1980 models. Individual pages are five-hole punched and numbered by sections for placement into the Master Repair manual binder.
   Price: $5.00

3. 1981 Master Repair Manual Update Packet, part number 9910692
   Includes all service information and specifications pertinent to 1981 models. Individual pages are five-hole punched and numbered by sections for placement into the Master Repair manual binder.
   Price: $9.00

This material can be ordered by sending a check or money order to:

POLARIS E–Z–GO
Division of Textron Inc.
1225 North County Road 18
P. O. Box 1284
Minneapolis, MN 55440
Attn.: Parts Department

1981

Polaris TEXTRON
Polaris E-Z-Go
Division of Textron Inc.

GEMINI ASSEMBLY INSTRUCTIONS AND PRE-DELIVERY CHECKLIST

The contents of the hardware package and part numbers are as follows:

Model 0811025 and 0811225 Gemini 244 Single

1.	Ski pivot bushing (2)	PN 5010059
2.	No. 8–32x3/4 screw (5)	PN 7511839
3.	No. 8 speednut (5)	PN 7670026
4.	3/8–24x2 3/4 bolt (1)	PN 7515417
5.	3/8–24 hex locknut (1)	PN 7542403
6.	Starter rope (1)	PN 2870388
7.	Ignition key (1)	PN 4110012
	Hardware Package (Complete)	PN 2254044

Assembly Instructions/Pre-Delivery Checklist

⚠ Observe all safety precautions when assembling snowmobiles. Avoid contact with moving parts.

Check box as each item on the checklist is completed.

☐ 1. Lubricate the ski pivot bushings with Polaris suspension lubricant and install into spindles. Install the skis with ski saddle bolts. Torque ski bolts to 36 ft./lbs.

☐ 2. With the handlebars in a straight ahead position, check ski alignment. The skis should be parallel with no more than 3/8" (0.95cm) toe-out. Skis must not toe-in. Be certain that the steering system works freely to full left and right turns and no binding is present. Lubricate as required.

☐ 3. Install the windshield and windshield band to the hood. Secure with the windshield screws and speednuts.

☐ 4. With the machine on its side, remove the chaincase cover and adjust chain tension to approximately 3/8" free play. Reinstall the cover and add Polaris chaincase oil (PN 2870464) through the upper filler plug until oil appears at lower check plug.

☐ 5. Remove the drive belt and check for 9/16" clutch alignment.

☐ 6. Check for correct center distance. Refer to the Master Repair Manual, Section VII.

☐ 7. Remove air silencer; check the throttle slide and choke for correct adjustment. Check for correct jet (120H). Refer to the Master Repair Manual, Section VI.

☐ 8. Check brake adjustment. Insure the adjustment screw is properly adjusted for adequate clearance and that the brakes are not binding. Check master cylinder fluid level, it should be 1/8" below the top surface of the master cylinder.

- [ ] 9. Pour a 20:1 mix of regular leaded or premium unleaded gas and Polaris oil in the tank. Start the engine, setting the idle at 1500–2000 RPM.
NOTE: The use of other than Polaris oil will void engine warranty.

- [ ] 10. Check to insure auxiliary shut-off switch, ignition and headlight dimmer switch operate smoothly and correctly.

- [ ] 11. Check to insure all hand controls (brake lever and throttle lever) operate smoothly and correctly.

- [ ] 12. With the rear of the machine safely suspended, align the track. Check track tension. Correct tension is 1/2". Refer to Master Repair Manual, Section IX. Adjust suspension and ride to individual rider preference.

- [ ] 13. With machine completely assembled, hood securely latched and with machine sitting on a level surface, adjust the headlight. With a rider on machine and headlight on high beam, the center of the brightest spot should have a 2" drop from center of the headlight at 25 ft. Refer to the Master Repair Manual, Section III.

- [ ] 14. Check ignition timing. Proper static timing is .014" BTDC. Refer to the Master Repair Manual, Section IV.

- [ ] 15. Check all nuts and bolts throughout entire machine for proper torque.

- [ ] 16. Test ride machine (if possible) to insure proper operation of steering assembly, throttle and brake controls and clutch engagement and operation.

This snowmobile has been assembled and inspected by myself or a qualified employee on my behalf.

______________________________ ____________
Dealer Signature Date

The above mentioned dealer has instructed me on the operation, maintenance safety features and warranty policy, all of which I understand. He has also thoroughly explained the owner's manual to me.

______________________________ ____________
Customer Signature Date

Machine Serial Number ____________________ Engine Serial Number ____________________

NOTE: Dealer is to retain this form and file it with his copy of the machine Registration.