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Document Number

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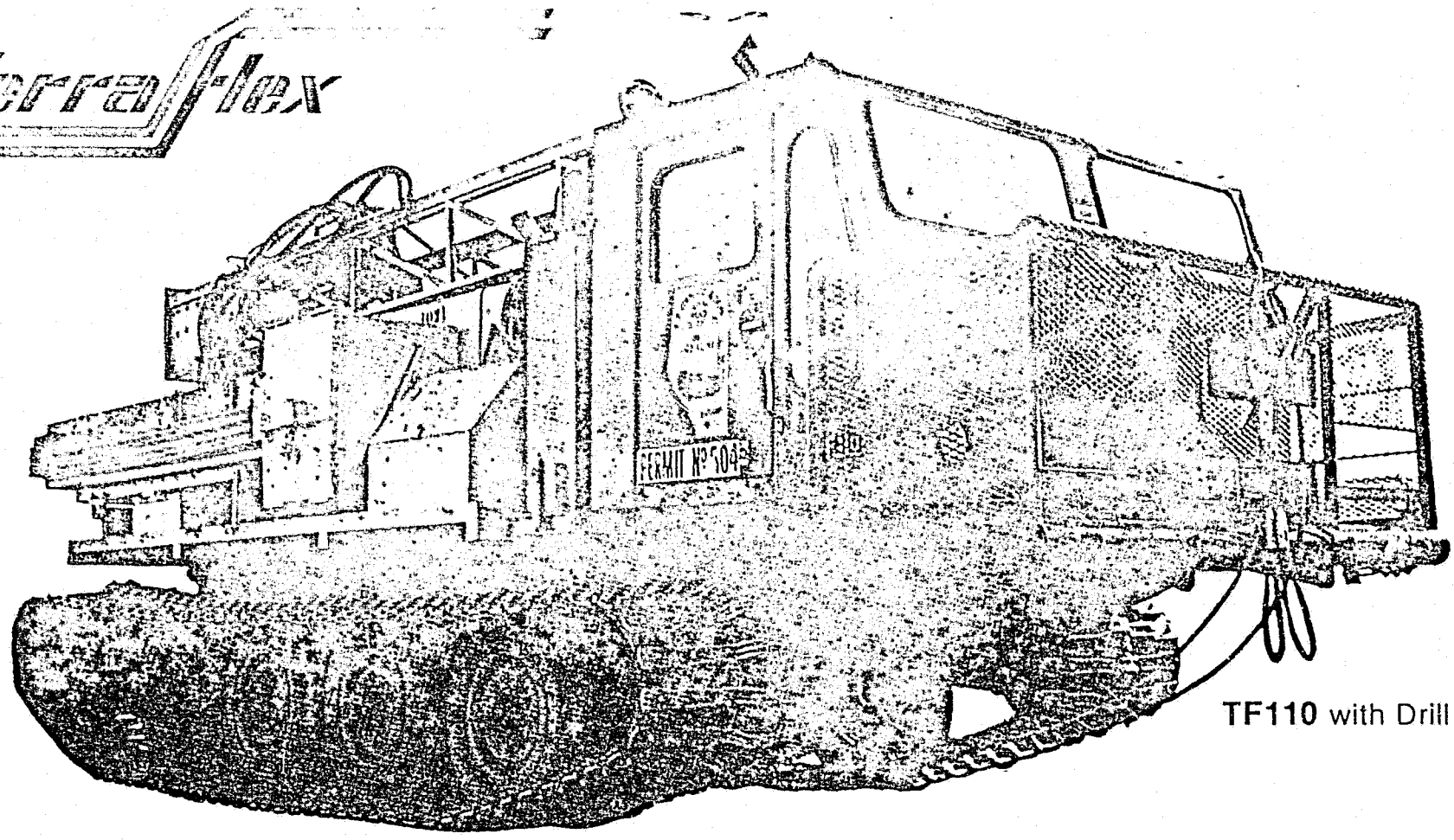
WINTER 1982 HAMMER DRILLING
TERRAFLEX CARRIERS
DRILL SYSTEMS HAMMER DRILL
MANUFACTURERS LITERATURE

ACRES

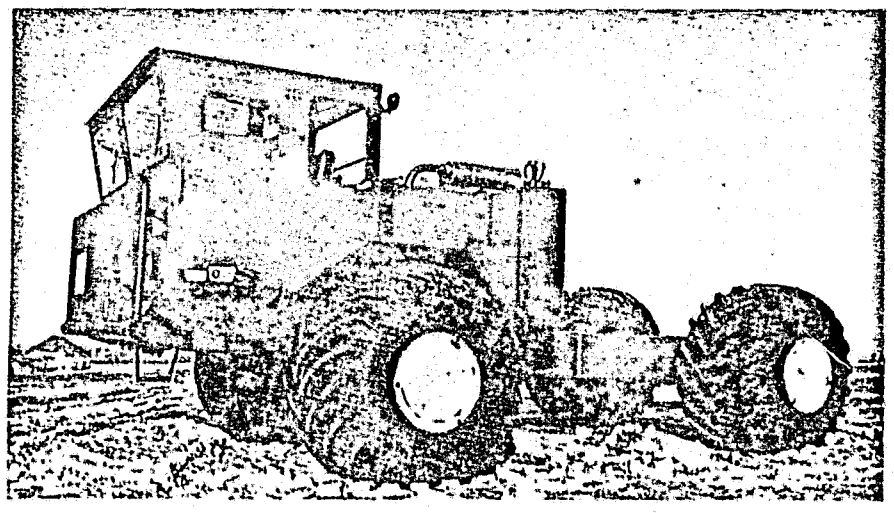
Acres American Incorporated
1000 Liberty Bank Building
Main at Court
Buffalo, New York 14202
Telephone (716) 853-7525

Terra-flex

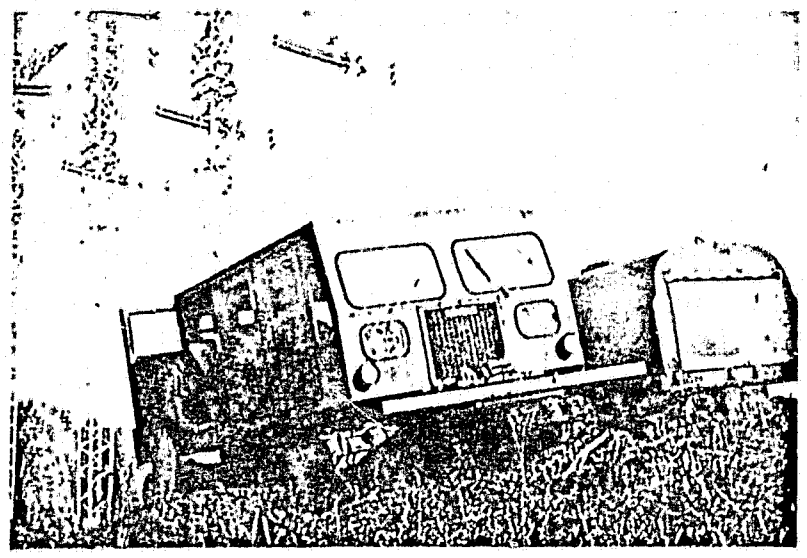


TF110 with Drill

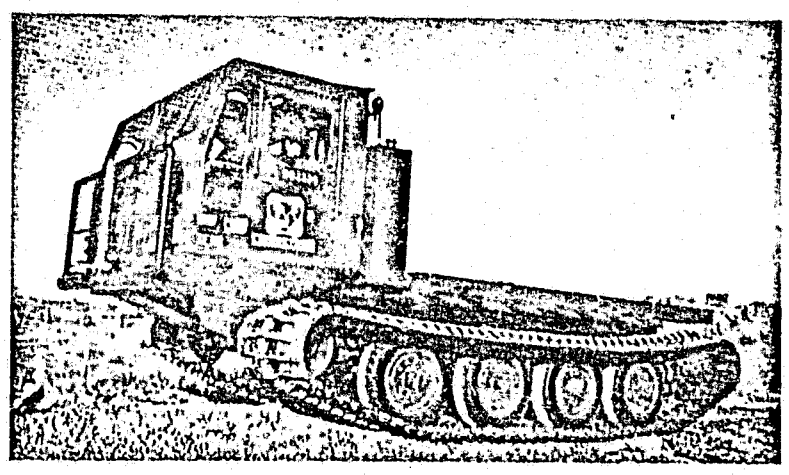
When highway vehicles fail to perform, construction of temporary roads or the use of hellicopters and fixed wing aircraft are costly alternatives to solve transportation problems. Many times, all terrain vehicles provide the most **cost effective** solution.



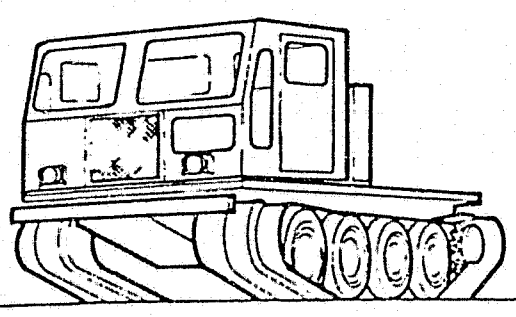
TT100



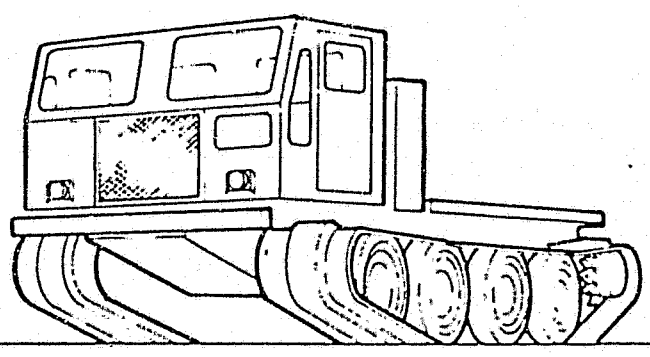
Track Trailer



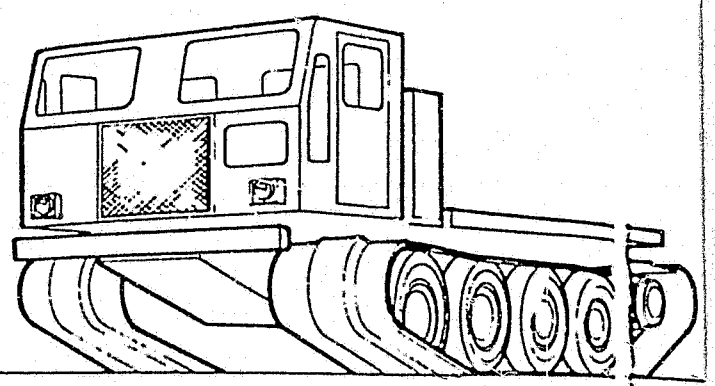
TF110



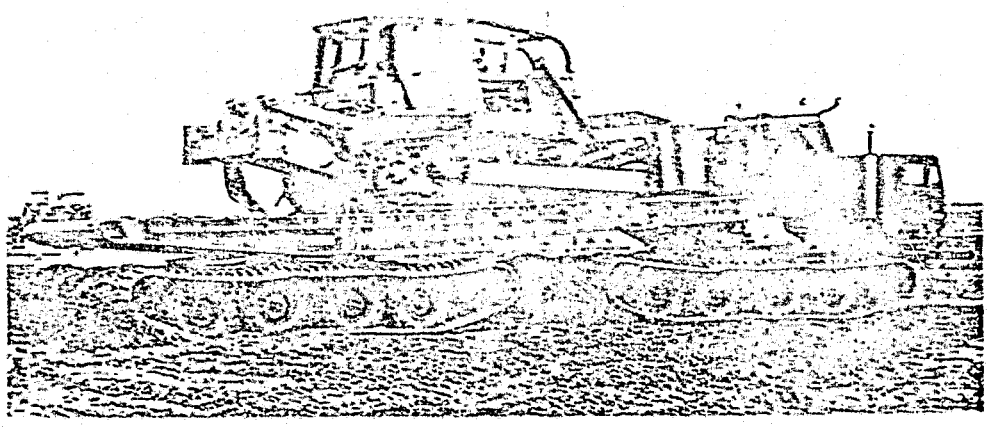
TF20/45 Payload 2,000/4,500 lb. Available as Floater



TF60 Payload 8,000 lb.



TF110 Payload 16,000 lb.



TF900 carrying D8 Cat

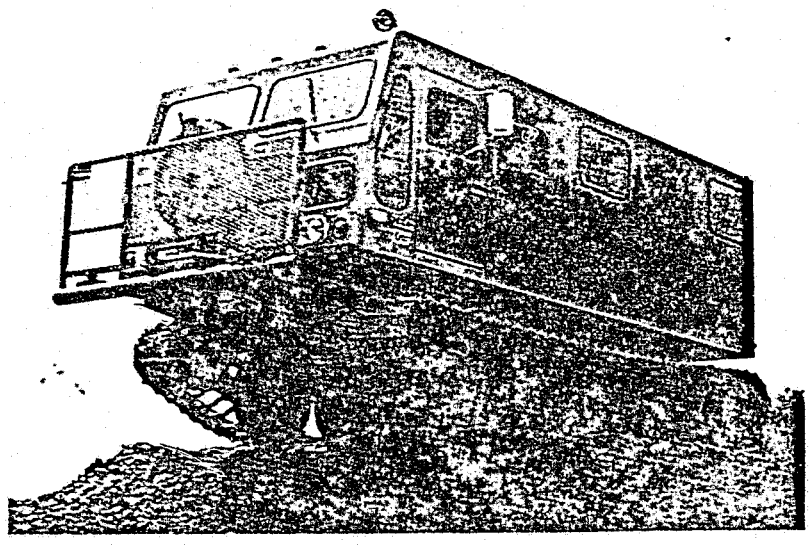
— Terra-Flex emphasizes ruggedness of construction and simplicity of design -providing dependable performance, extended machine life, and ease of maintenance.

— Terra-Flex's product package includes a standard warranty and comprehensive "start-up" and maintenance/operator training program.

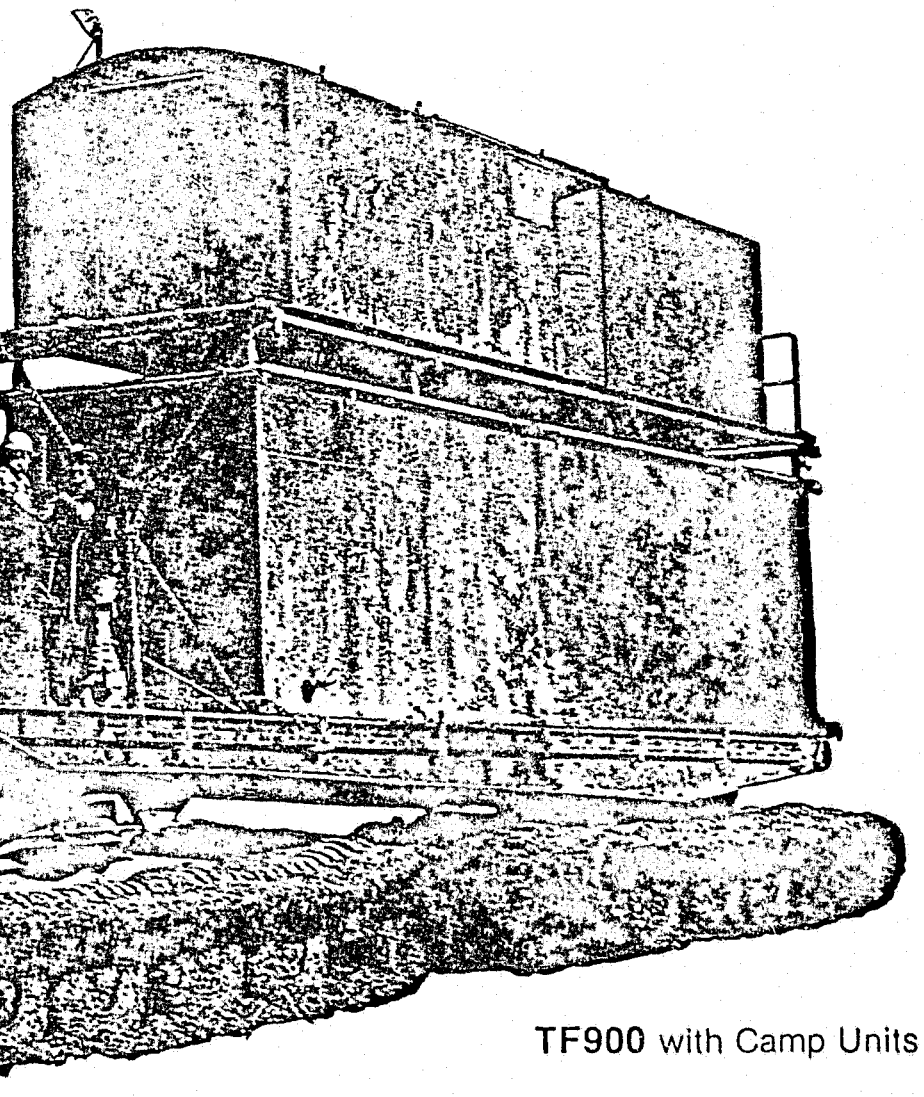
— Maximum use of standard components in product design simplifies maintenance requirements.

— Terra-Flex products have been designed with air transportability in mind. All Terra-Flex units fit - or are easily broken down into modules which fit Hercules aircraft.

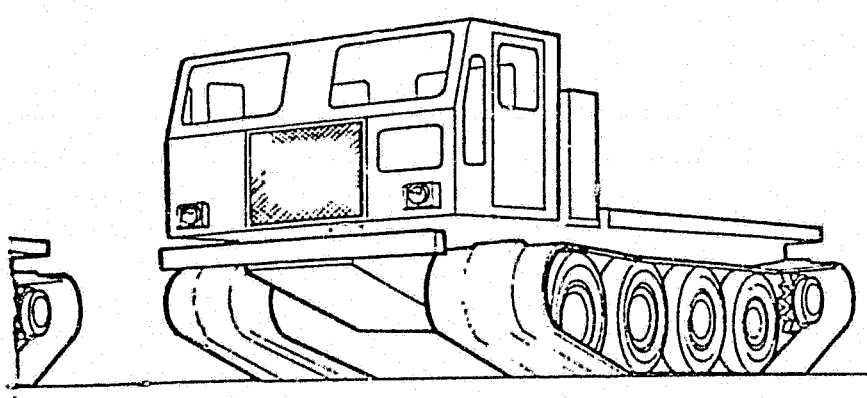
— Terra-Flex offers a wide variety of tracked and terra tired trailers with proven capability.



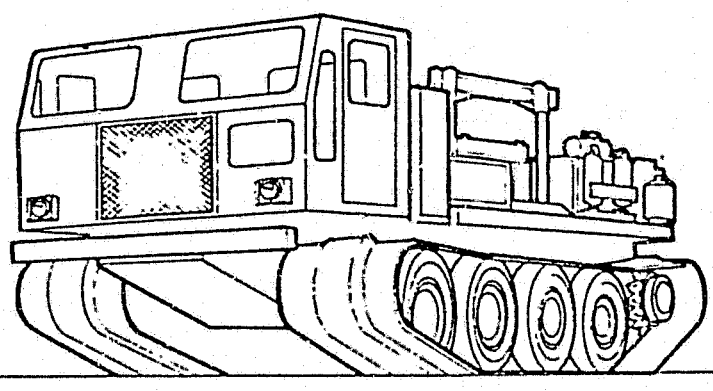
TF60 Personnel Carrier



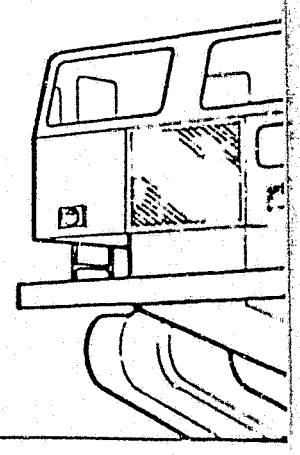
TF900 with Camp Units



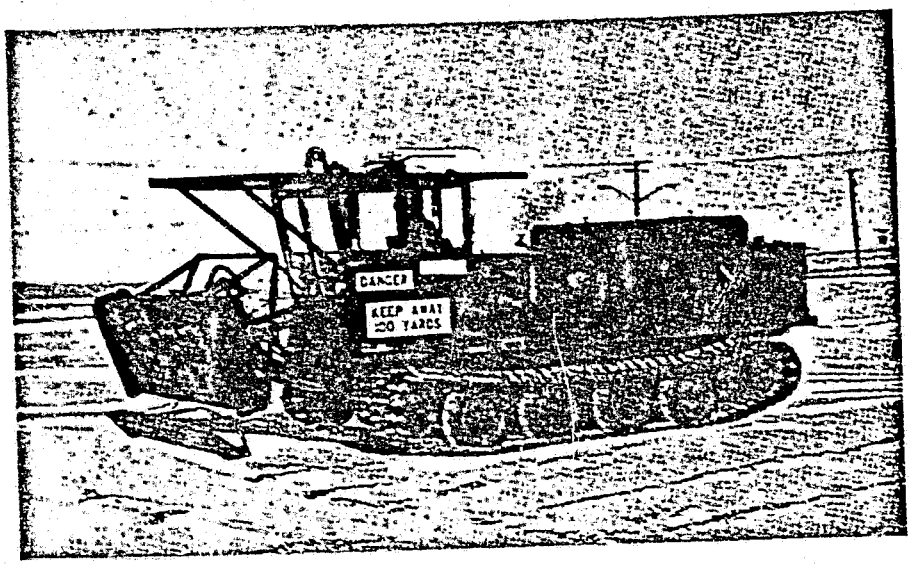
TF300 Payload 30,000 lb.



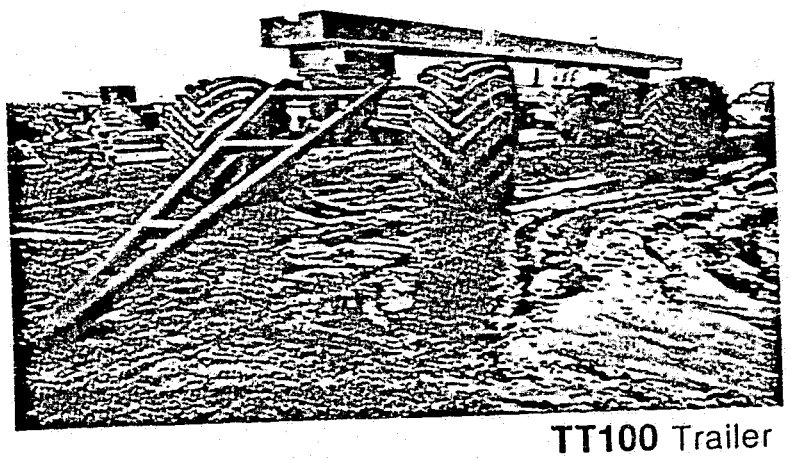
SEISMIC VIBRATOR



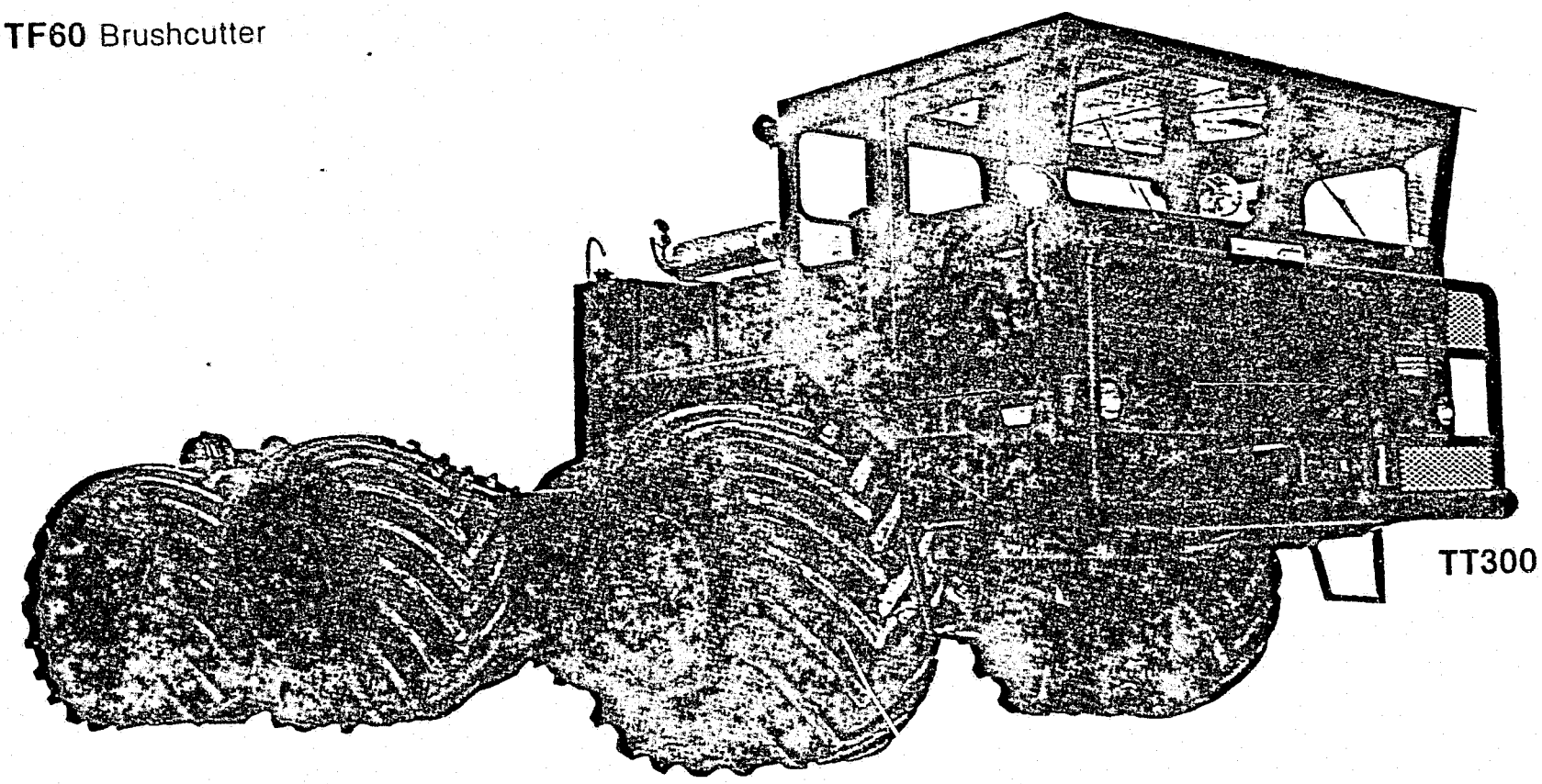
TF3(



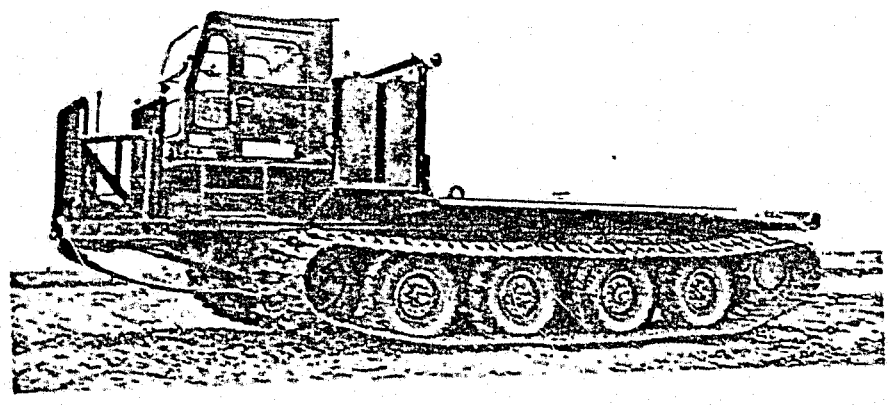
TF60 Brushcutter



TT100 Trailer



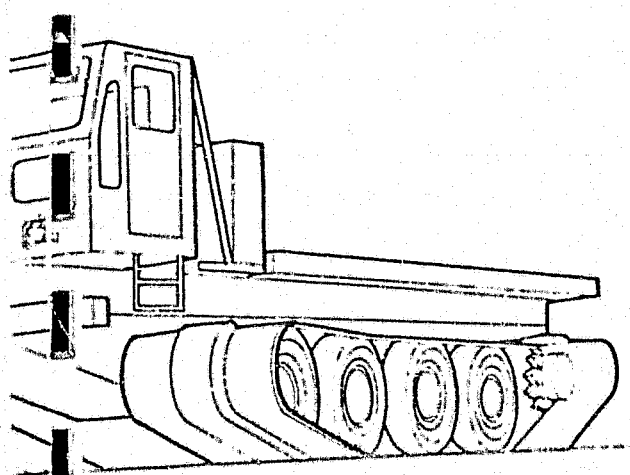
TT300



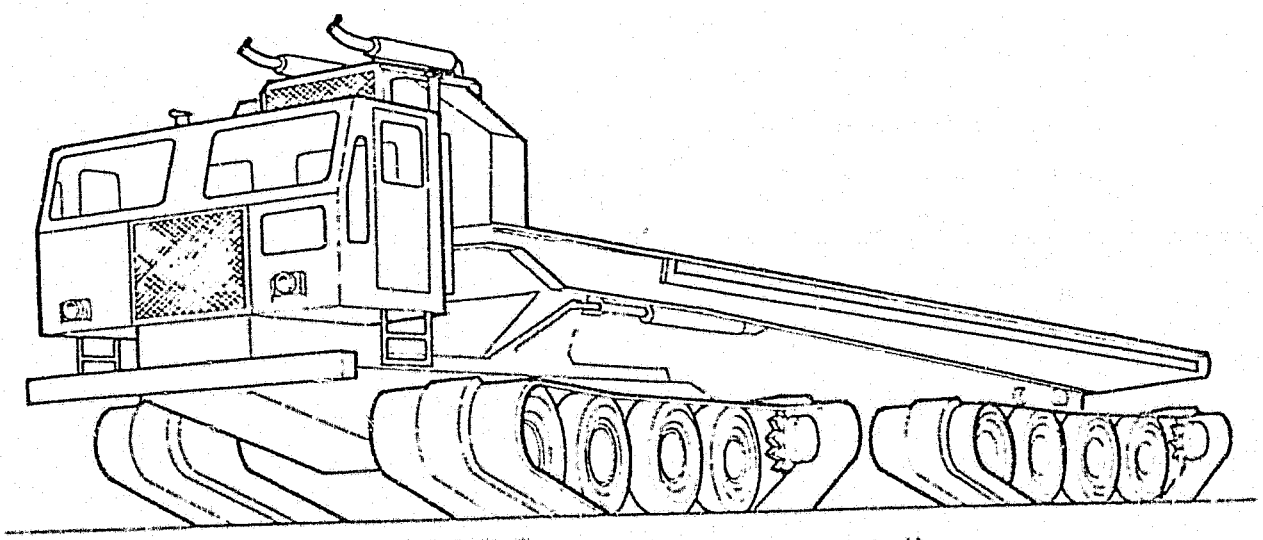
TF360 with Oilfield Deck

Terra-Flex products are versatile workhorses. They can be adapted to carry a wide range of operating accessories from backhoes to drills to cranes to seismic vibrators to transmission line tensioners and pullers.

We've designed products for a wide range of industrial needs from firefighters to brush cutters to floating personnel carriers.



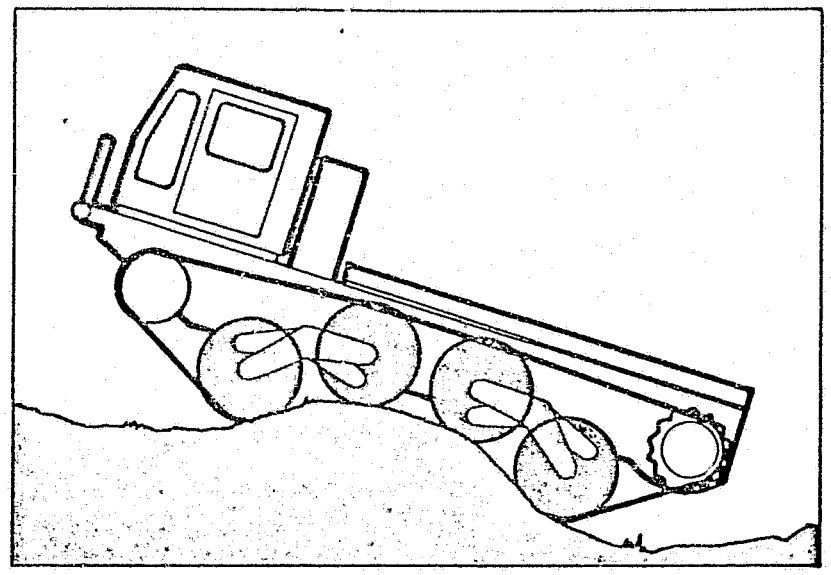
360 Payload 42,000 lb.



TF900 Payload 90,000 lb.

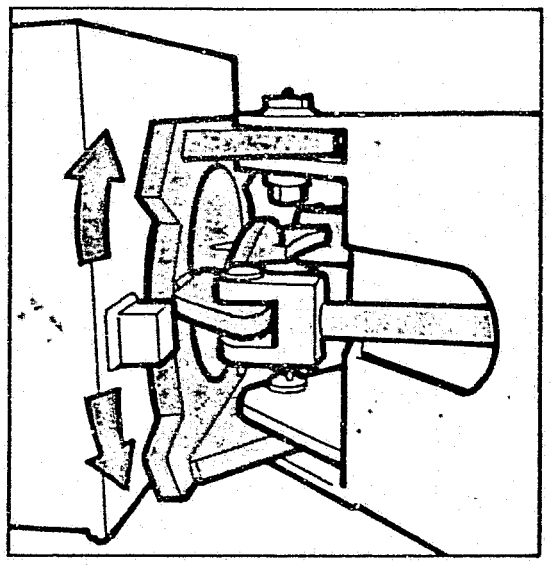
Terra-Flex designs represent the culmination of two decades of continuous evolution in all terrain vehicle technology. Our large, experienced engineering group keeps us in the forefront in the development of innovative products to satisfy all terrain transportation requirements around the world.

We've recently designed, manufactured, and proven the TF900, the world's largest, commercially available tracked transport - the most advanced product of its kind. Through utilization of walking beam suspension, 60 inch tracks, and full articulation between front and rear tracks, the "900" provides unsurpassed mobility at payloads up to 50 tons.



Walking Beam Suspension

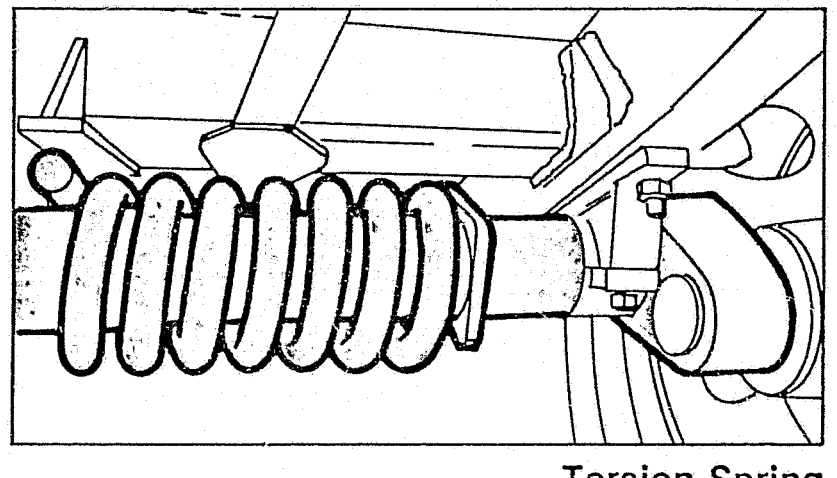
Where terrain conditions require maximum load distribution, we lead the industry in the use of walking beam suspension, expecially in the area of heavy tracked vehicles. The walking beam principle enables pairs of wheels to oscillate independently of each other and maintain equal tire loading on the tracks.



Articulated Roll Joint

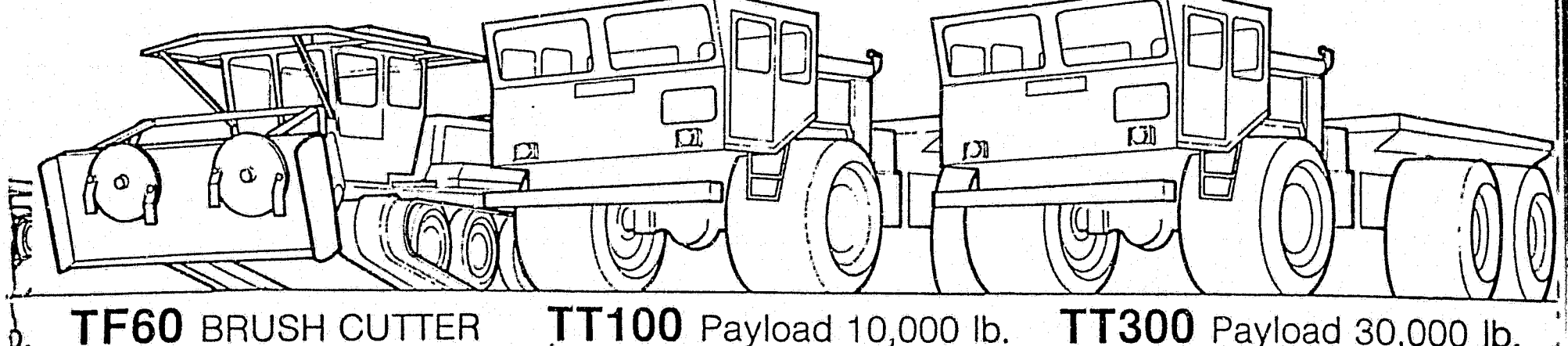
Terra-Flex's wheeled product line features a unique articulated roll joint which significantly reduces twisting forces on the frame while traversing irregular terrain - without affecting overall stability.

Our in-depth understanding of the operational effects of the relationship between vehicle width and contact track length has allowed us to pioneer the design of two-track vehicles with payloads in excess of 20 tons. Our "360" (a 20 ton capacity two-tracked carrier) has a proven record of dependability and performance while providing substantially more useful deck space and a significantly smaller turning radius within shorter overall dimensions than its four tracked equivalents.



Torsion Spring

When loads consist of personnel or fragile, sophisticated equipment, we provide the required speed and smoothness of ride through the use of Terra-Flex's proven torsion spring suspension system.



TF60 BRUSH CUTTER **TT100** Payload 10,000 lb. **TT300** Payload 30,000 lb.

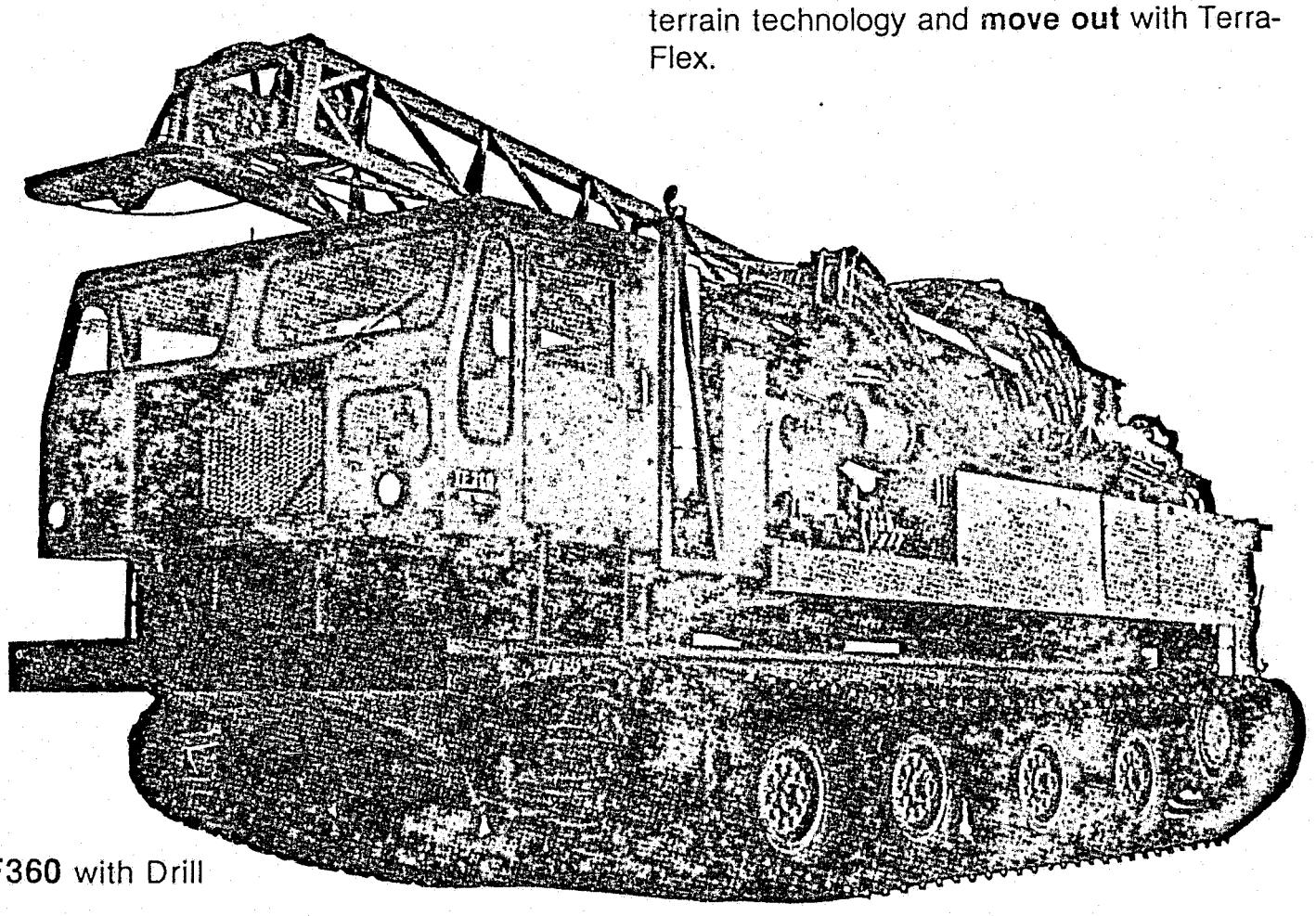
Terra-Flex is a name synonomous with excellence in the all terrain transportation business.

Terra-Flex is managed by people who have "grown-up" in the tracked/terra tired vehicle business. Since the inception of the "soft-tracked" transporters in the early 1950's, our people have been designing, producing, marketing, and servicing a wide spectrum of all terrain vehicles to satisfy a multitude of client's needs - all over the world. When it comes to solving all terrain transportation problems, we know what we're doing - we've been doing it successfully for over 20 years - and we're proud of our reputation for providing creative solutions to the world's toughest all terrain transportation problems.

Fundamental to our success is our experienced, highly qualified engineering group. Our diverse product line and ability to modify or originate designs in accordance with customer needs is a direct result of this emphasis on engineering excellence.

An integral component of our business philosophy is the maintenance of a superior after sales service program. We fully understand the importance of keeping our products performing under trying conditions and in remote areas. From our headquarters in Calgary we supply parts and service, on an international scale - 24 hours per day.

If you're operating in sand, mud, snow, or rough terrain - where conventional vehicles fail to perform - move up to the most modern all terrain technology and **move out** with Terra-Flex.



TF360 with Drill

Terra-Flex

8335a - 52nd Street S.E.
Calgary, Alberta, Canada
Telex 038-25756

P.O. Box 787, Station "T"
Calgary, Alberta, Canada
T2H 2H3

DEALER

TerraFlex
A DIVISION OF BOMBARDIER INC.

P.O. Box 787, Station "T", Calgary, Alberta T2H 2H3
Phone (403) 279-7271 Telex 038-25756

TF-20

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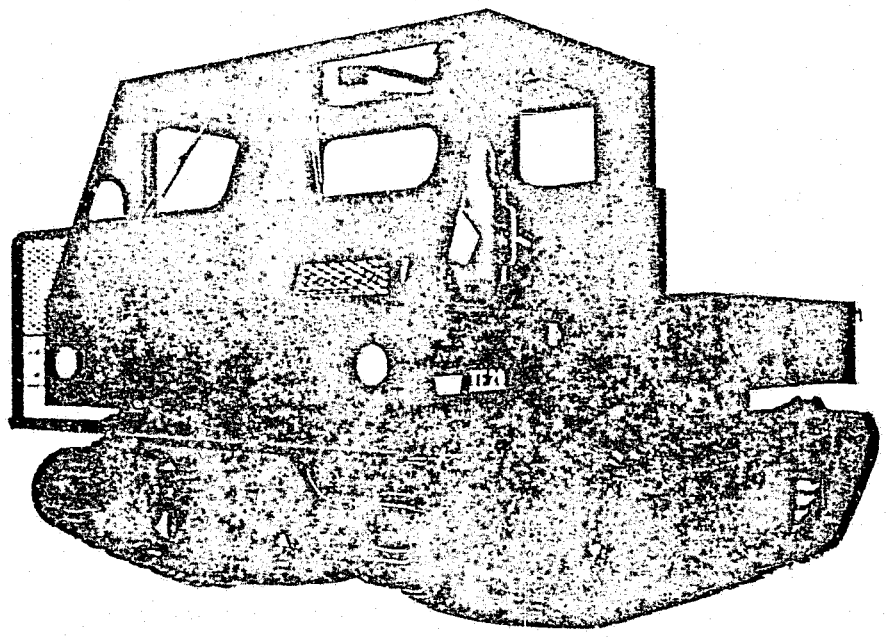


OPTIONAL GRILL GUARD SHOWN

PERFORMANCE DATA

Weight - basic vehicle	6500	lbs	2948	kg
Payload	2500	lbs	1134	kg
Gross vehicle weight	9000	lbs	4082	kg
Track area at 6" penetration	6550	sq in	4.2	sq m
Ground pressure - unloaded	0.99	psi	0.069	kg/sq cm
Ground pressure at GVW	1.4	psi	0.098	kg/sq cm
Overall width	95	in	241	cm
Width - tracks removed	78	in	198	cm
Overall height	89	in	226	cm
Overall length	167	in	425	cm
Maximum speed	27	mph	43	km/h
Ground clearance	12	in	30	cm
Turning radius - inside	100	in	254	cm
Fording depth	32	in	81	cm
Climbing ability - grade	60%			
Sidehill ability - grade	40%			

MISCELLANEOUS STANDARD EQUIPMENT

Front Bumper
Pintle Hook
Maintenance & Parts Manual
Special Tools
Antifreeze

POWER TRAIN

Engine	Ford 300 CID - 6 cylinder, industrial, gasoline
Transmission	New Process 435L - reverse & 4 forward gears
Clutch	13" single plate, hydraulic control
Final Drive	Controlled differential (5.85:1)
Brakes	Drive line parking brake, hydraulic power steering brakes at differential

GENERAL SPECIFICATIONS

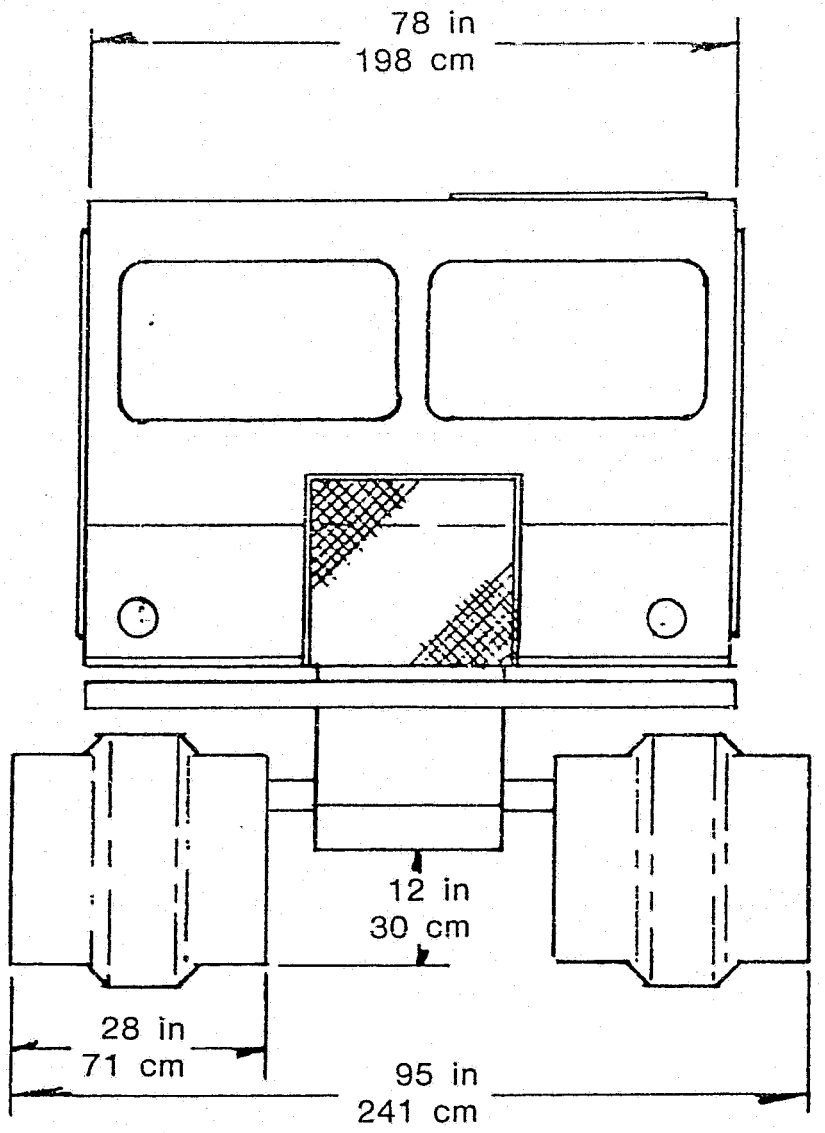
Steering	Lever controlled - hydraulic
Electrical	Alternator—45 amp 12 volt Battery—90 amp/hr H.D.
Suspension	Maintenance free, independent rubber suspension at each load wheel
Load wheels	Rims—13 x 6.5 Tires 6.50—13 x 6 PR.
Tracks	Rubber belts (PN200) and spring steel, drop centre grousers
Sprockets	Steel with replaceable urethane drive elements
Elevated front idlers	Solid rubber
Cab	Two-man, steel, roll-down windows, escape hatch, dome head, and panel lights, windshield wipers, heaters and defrosters, lined and insulated
Fuel	Single tank - 35 imp gallons (159 litres)
Instruments	Engine oil pressure, coolant temperature and fuel gauges; hourmeter and tachometer, ammeter
Color	Standard—International Orange or customer choice (single color)

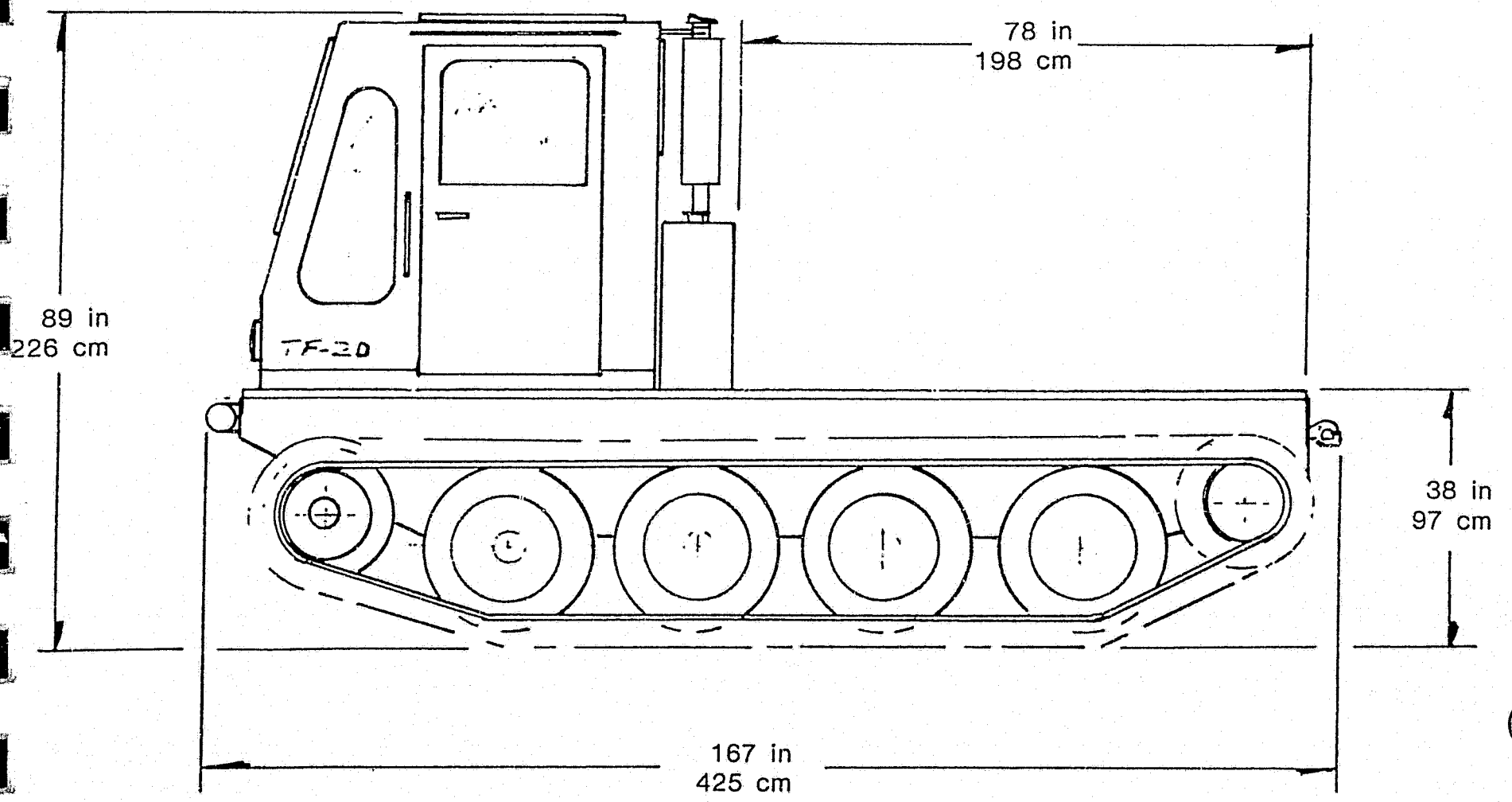
OPTIONS AVAILABLE

Options Available: include alternate engines and transmissions, tilt cabs, 5-man crew and personnel bodies, Tundra tracks, load decks in various widths and lengths, grill guards, front and/or rear winches.

DEALER STAMP

TF-20


78 in
198 cm
12 in
30 cm
28 in
71 cm
95 in
241 cm


78 in
198 cm
89 in
226 cm
TF-20
38 in
97 cm
167 in
425 cm

Terra flex
A DIVISION OF BOMBARDIER INC.

P.O. Box 787, Station "T", Calgary, Alberta T2H 2H3
Phone (403) 279-7271 Telex 038-25756

TF-60

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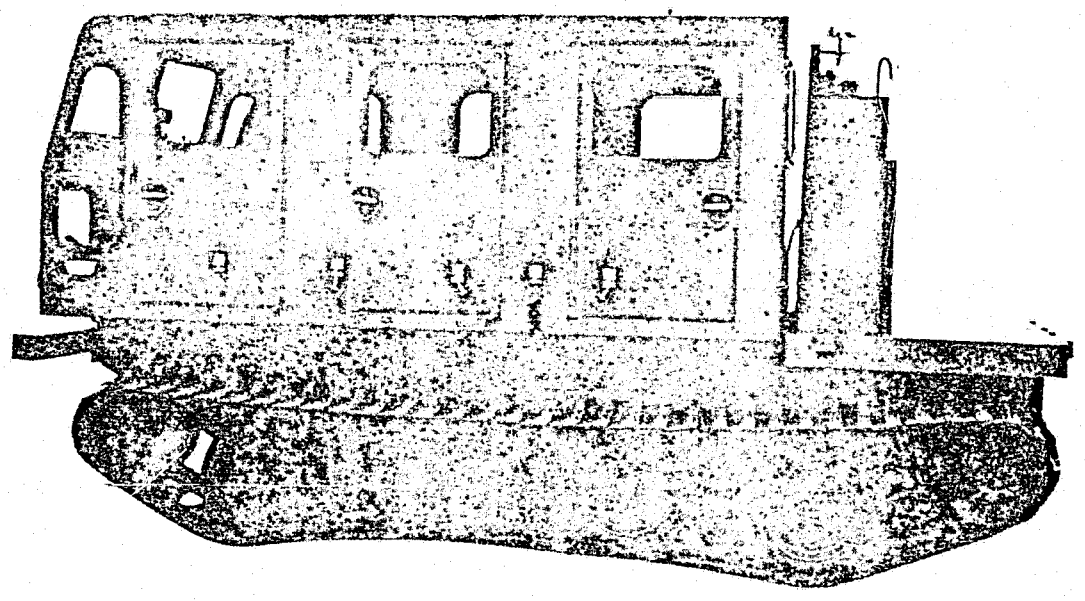

OPTIONAL CREW CAB SHOWN

PERFORMANCE DATA

Weight - basic vehicle	10400	lbs	4717	kg
Payload	8000	lbs	3628	kg
Gross vehicle weight	18400	lbs	8345	kg
Track area at 6" penetration	8958	sq in	5.78	sq m
Ground pressure - unloaded	1.16	psi	0.08	kg/sq cm
Ground pressure at GVW	2.05	psi	0.14	kg/sq cm
Overall width	96	in	244	cm
Width - tracks removed	84	in	213	cm
Overall height	98	in	249	cm
Overall length	196	in	498	cm
Maximum speed	12.2	mph	19.5	km/h
Ground clearance	15	in	38	cm
Turning radius - inside	104	in	264	cm
Fording depth	42	in	107	cm
Climbing ability - grade	60%			
Sidehill ability - grade	40%			

SPRUNG SUSPENSION VERSION MODEL TF-60S

All features as for Model TF-60 except:
- Engine - Detroit Diesel 4-53
- Transmission - Spicer CM5052-B
- *Auxiliary Transmission - Rockwell 223
- Overall Length - 202 in (513 cm)

*FOR HIGH SPEED VERSION (UP TO 20 MPH-32 KM/H)

MISCELLANEOUS STANDARD EQUIPMENT

- Front Bumper
- Pintle Hook
- Maintenance & Parts Manual
- Special Tools
- Antifreeze
- Removeable Under Pans

POWER TRAIN

Engine	Ford 300 CID - 6 cylinder, industrial, gasoline
Transmission	New Process 435L - 1 reverse & 4 forward gears
Clutch	13" single plate, hydraulic control
Final Drive	Controlled differential (5.85:1) with oil cooling reservoir. Outer planetaries (3.1:1)
Brakes	Drive line parking brake, hydraulic power steering brakes at differential

GENERAL SPECIFICATIONS

Steering	Lever controlled - hydraulic
Electrical	Alternator—45 amp 12 volt Battery—90 amp/hr H.D.
Suspension	Walking beams, replaceable wear bushings
Load wheels	Rims 16 x 5.50—6 Stud—2 pc rim Tires 6.00—16 x 10 PR—smooth
Tracks	Rubber belts (PN200) and spring steel, drop centre grousers
Sprockets	Steel with replaceable urethane drive elements
Elevated front Idlers	Solid rubber
Cab	Two-man, steel, roll-down windows, escape hatch, dome head and panel lights, windshield wipers, heaters and defrosters, lined and insulated
Fuel	Saddle tanks, 2 x 60 Imp. gallons (545 litres)
Instruments	Engine oil pressure, coolant temperature and fuel gauges; hourmeter and tachometer, ammeter
Color	Standard—International Orange or customer choice (single color)

OPTIONS AVAILABLE

Options Available: include alternate engines and transmissions, tilt cabs, 5-man crew and personnel bodies, Tundra tracks, load decks in various widths and lengths, grill guards, front and/or rear winches.

DEALER STAMP

TerraFlex
A DIVISION OF BOMBARDIER INC.

P.O. Box 787, Station "T", Calgary, Alberta T2H 2H3
Phone (403) 279-7271 Telex 038-25756

TF-60S
PERSONNEL CARRIER

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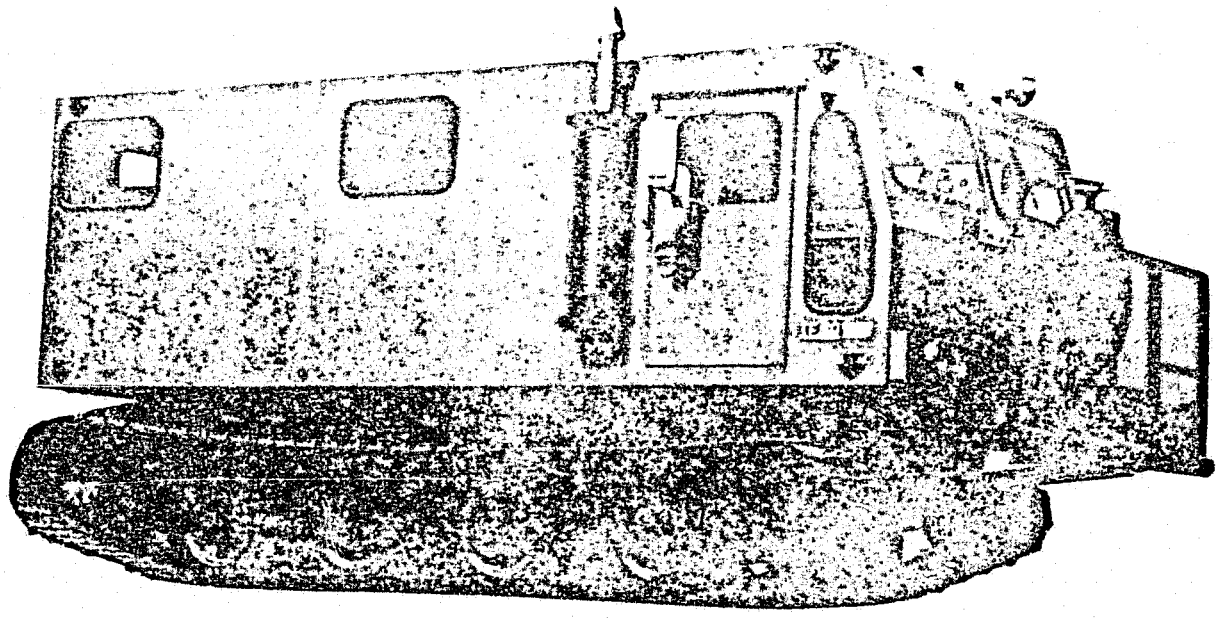


PERFORMANCE DATA

Weight - basic vehicle	18,000	8,165 kg
Payload	3,500	1,588 kg
Gross vehicle weight	21,500	9,752 kg
Track area at 6" penetration	8,958 sq in	5.78 sq m
Ground pressure - unloaded	1.9 psi	0.13 kg/sq cm
Ground pressure at GVW	2.4 psi	0.17 kg/sq cm
Overall width	95.5 in	243 cm
Width - tracks removed	84 in	213 cm
Overall height	100 in	254 cm
Overall length - over winch	220 in	559 cm
Maximum speed	20 mph	32 km/h
Ground clearance	15 in	38 cm
Turning radius - inside	104 in	264 cm
Fording depth	42 in	107 cm
Climbing ability - grade	60%	
Sidehill ability - grade	60%	

MISCELLANEOUS STANDARD EQUIPMENT

- Grill Guard
- Rear Pintle Hook & Front Tow Shackles
- Tie Down Rings for Shipping
- Maintenance & Parts Manual
- Radiator Shutters
- 110v Heaters for Battery, Coolant & Oil Pan
- 20,000# Front Mounted Winch
- Special Tools & Tool Box
- Spare Tire & Wheel
- Antifreeze
- Cold Weather Start Aid
- Removable Under Pans

POWER TRAIN

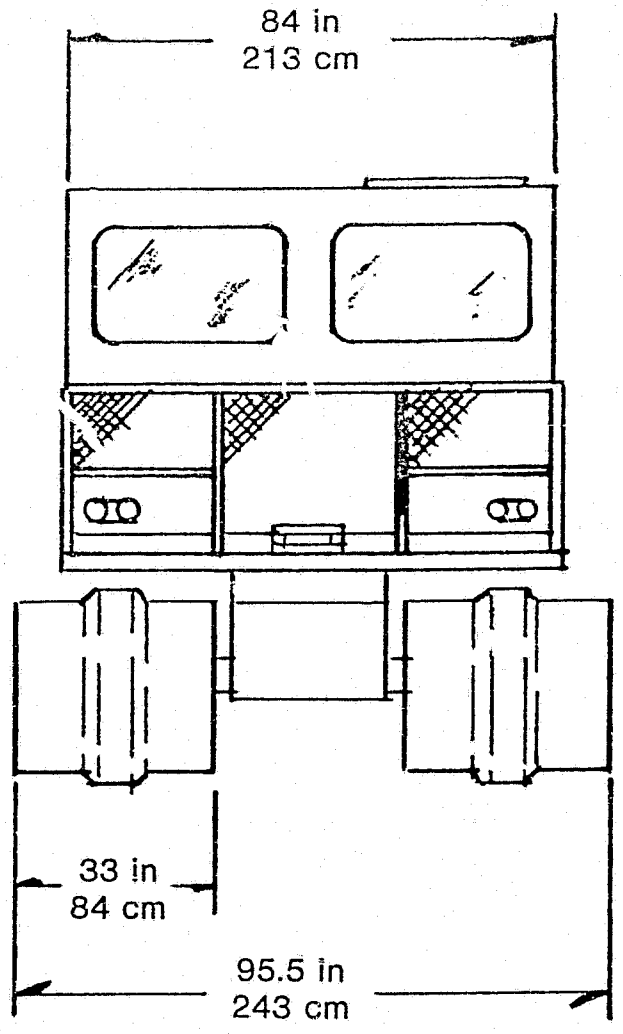
Engine	145 hp Diesel
Transmission	Powershift, 1 reverse & 4 forward speeds
Final drive	T16 controlled differential (3.89:1) with oil cooling reservoir Napco outer planetaries (3.1:1)
Brakes	Drive line parking brake at transmission. Hydraulic steering brakes at differential.

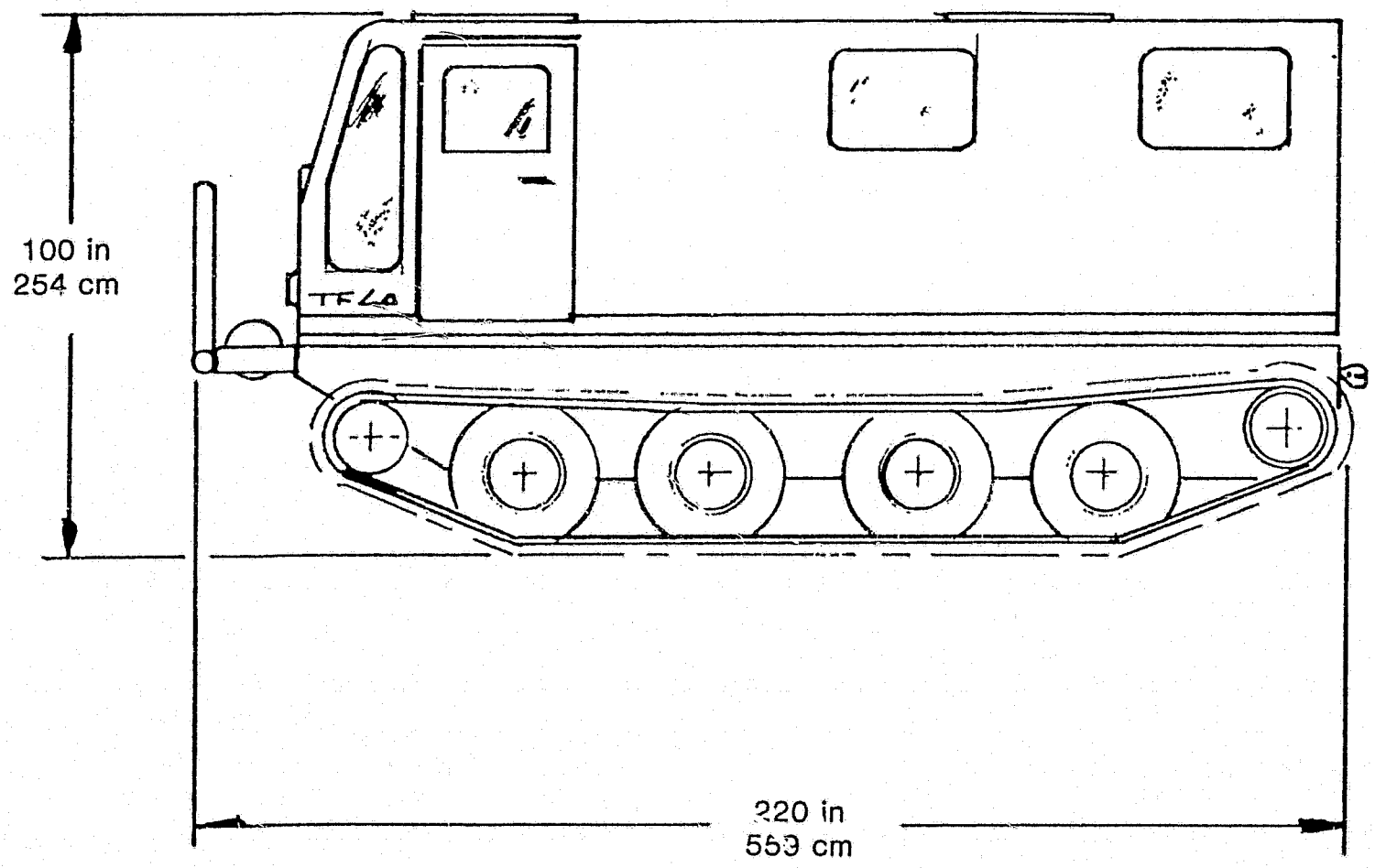
GENERAL SPECIFICATIONS

Steering	Lever controlled - hydraulic
Electrical	Alternator - 85 amp. 12 volt Battery - 200 amp/hr. H.D.
Suspension	Crank arm with torsion coil springs
Load Wheels	Rims - 16 x 5.50 - 6 stud - 2 pc rim Tires - 6.00 - 16 x 10 PR - smooth, pneumatic
Tracks	Rubber belts (PN200) and spring steel, drop centre grousers. 'Winter/Summer' type track with hydraulic track tensioners
Sprockets	Steel with replaceable urethane drive elements
Elevated front idlers	Solid rubber
Personnel body	Twelve-man, roll-down windows, escape hatches; dome, head & panel lights, windshield wipers, heaters and defrosters, lined and insulated, cargo tie down rings, full length rear doors
Fuel	Saddle tanks, 2 x 20 Imp gallons (182 liters)
Instruments & Controls	Engine oil pressure, coolant temperature and fuel gauges; hourmeter and tachometer, ammeter, hand operated locking throttle, key type ignition switch.
Color	Standard - International Orange or customer choice (single color)

DEALER STAMP

TF-60S





BOMBARDIER

Terra Flex

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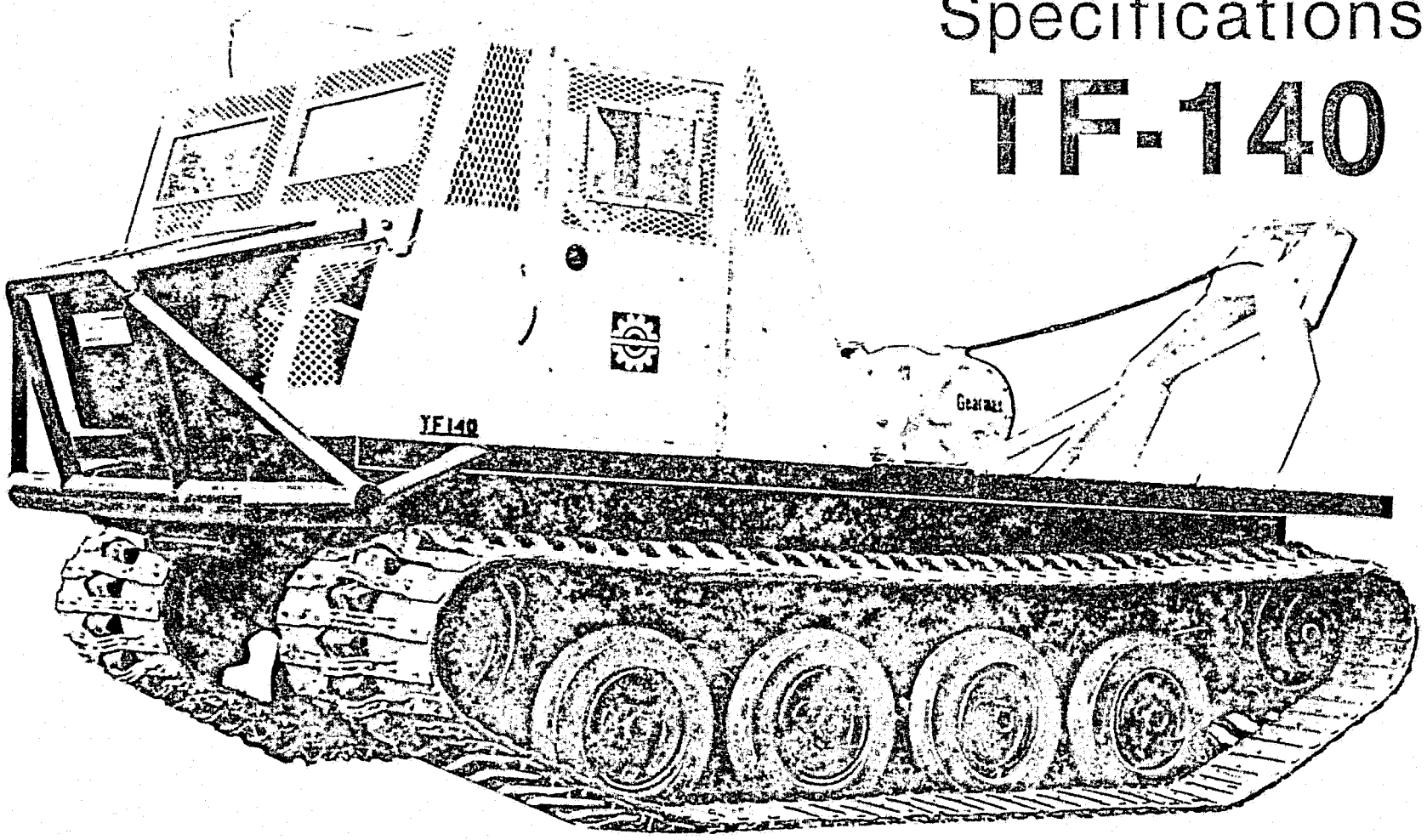
Specifications:

TF-140



DIMENSIONS:

Overall Length	252"
Overall Width	119"
Overall Height	106"
Ground Clearance	18-1/2"
Shipping Weight (Basic Vehicle)	25,000 lbs.
Width (without Tracks)	96"

OPERATIONAL:

Load Capacity	12,000 lbs.
Maximum Speed	10 MPH
Ground Pressure (at 6" Penetration)	2.74 P.S.I.
Maximum Gradeability:	
(Uphill)	60%
(Sidehill)	40%

POWER TRAIN:

Transmission Type	Funk 1000 serie Power shift 2.66:1 (with Independent Cooler)
Differential	M24 Planetary controlled
Transfer Case	Bombardier
Planetaries	Franklin F-185
Sprocket	Steel Hub with replaceable Urethane (Segment)
Front Idlers	Steel Hub with replaceable Urethane (Segment)
Tracks width	40"

STEERING:

Air operating through the controlled Differential

ENGINE:

Make	Detroit Diesel
Model	4.53
No. of Cylinders	4
Displacement	3.47 L 212.3 cu. in.
Horsepower-Brake	120 HP @ 2500 RPM
Governed RPM	2500 RPM
Torque	339 N.m 250 ft. lb.

SUSPENSION:

Heavy Duty - Walking Beams
Urethane Bushed Complete with Spindle
Oil Type - Logging Hub Cap

CAB:

Two seats - H.D. protective - Cross beam sheet metal - Expanded metal and lexan
Safety windshield

INSTRUMENTS:

Hourmeter - Temperature gauge - Ammeter
Oil gauge - Fuel gauge - Tachometer
Automatic low oil or high water temp. shutdown.
Shutdown stop cable - Emergency shutdown

FUEL TANK:

60 gals imp. - 75 U.S. gals

WHEELS:

Rims - 5:50 x 16 ten stud split
Tires - 6:00 x 16 smooth 10 ply
Urethane fill 10 ply

FAIRLEAD:

H.D. logging type

WINCH:

Gearmatic or Franklin – 20,000 lbs bare drum

MISCELLANEOUS STANDARD EQUIPMENT:

Muffler - Antifreeze - Special tools
Bumper with splash guard
Parts manual - Operator manual

The manufacturer reserves the right to change specifications at all times and without notice.

BOMBARDIER

BOMBARDIER INC.
Industrial Equipments Division
Valcourt, Québec, Canada J0E 2L0
*Trademark of Bombardier Limitée
Telex 05-832552

Terra-Flex
8335a - 52nd Street S.E.
Calgary, Alberta, Canada
Telex 038-25756

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TF-110M

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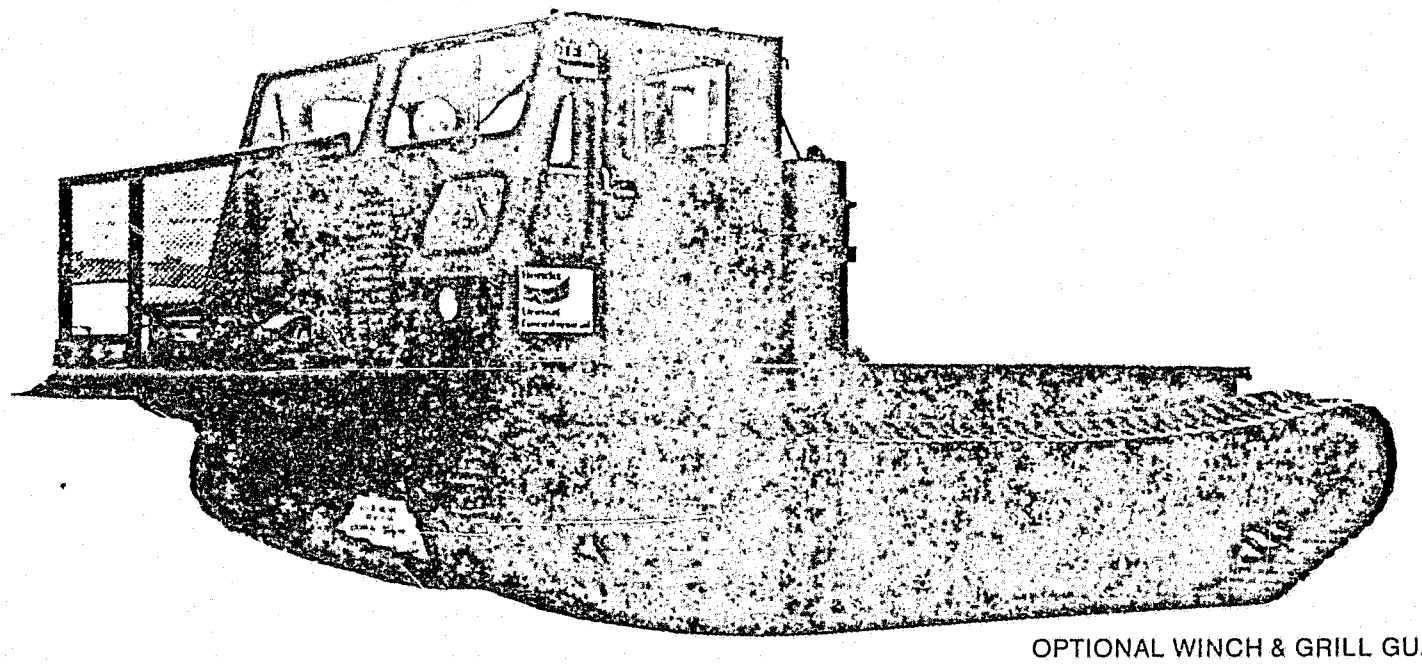


OPTIONAL WINCH & GRILL GUARD SHOWN

PERFORMANCE DATA

Weight - basic vehicle	22000	lbs	9979	kg
Payload	16000	lbs	7257	kg
Gross vehicle weight	38000	lbs	17237	kg
Track area at 6" penetration	12000	sq in	7.74	sq m
Ground pressure - unloaded	1.83	psi	0.13	kg/sq cm
Ground pressure at GVW	3.16	psi	0.23	kg/sq cm
Overall width *	119	in	302	cm
Width - tracks removed	95	in	241	cm
Overall height*	110	in	280	cm
Overall length	262	in	665	cm
Maximum speed	11.5	mph	18.4	km/h
Ground clearance	19	in	48	cm
Turning radius - inside	103	in	262	cm
Fording depth	48	in	122	cm
Climbing ability - grade	60%			
Sidehill ability - grade	40%			

*NOTE: Model TF-110MH is available with overall width of 115.5 in (293 cm) and height of 106 in (269 cm) to permit 'Hercules' aircraft loading.

MISCELLANEOUS STANDARD EQUIPMENT

Front Bumper
Pintle Hook
Maintenance & Parts Manual
Special Tools
Antifreeze

POWER TRAIN

Engine	Detroit Diesel 4-53
Transmission	Spicer CM5052-B, 1 reverse, 5 forward gears
Auxiliary transmission	Fuller 2-A-62
Clutch	13" single plate, hydraulic control
Final drive	Controlled differential (2.62:1) with oil cooling heat exchanger. Outer planetaries (3.6:1)
Brakes	Spring brake for parking, pneumatic power steering brakes at differential

GENERAL SPECIFICATIONS

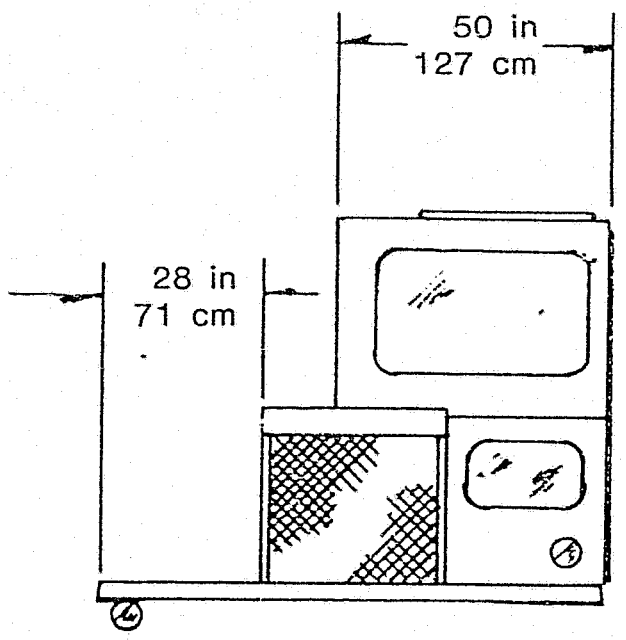
Steering	Lever controlled - pneumatic power
Electrical	Alternator—85 amp, 12 volt Battery—200 amp/hr H.D.
Suspension	Crank arm with torsion coil springs
Load wheels	Rims 20 x 6.50—10 stud—3 pc rim Tires 7.50—20 x 16 PR—smooth
Tracks	Rubber belts (PN200) and spring steel, drop centre grousers
Sprockets	Steel with replaceable urethane elements.
Elevated front idlers	Solid rubber
Cab	Two-man, steel, roll-down windows, escape hatch, dome head, and panel lights, windshield wipers, heaters and defrosters, lined and insulated
Fuel	Saddle tanks, 2 x 60 imp gallons (545 litres)
Instruments	Engine oil pressure, coolant temperature and fuel gauges; hourmeter and tachometer; ammeter.
Color	Standard—International Orange or customer choice (single color)

OPTIONS AVAILABLE

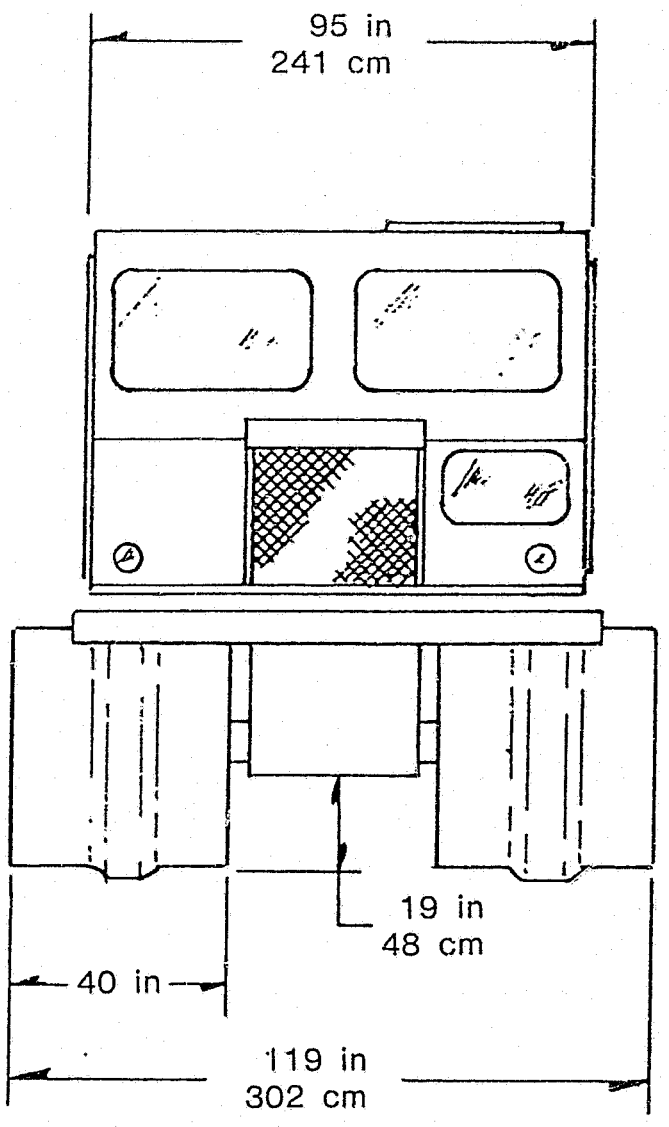
Options Available: include alternate engines and transmissions, tilt cabs, 5-man crew and personnel bodies, Tundra tracks, load decks in various widths and lengths, grill guards, front and/or rear winches.

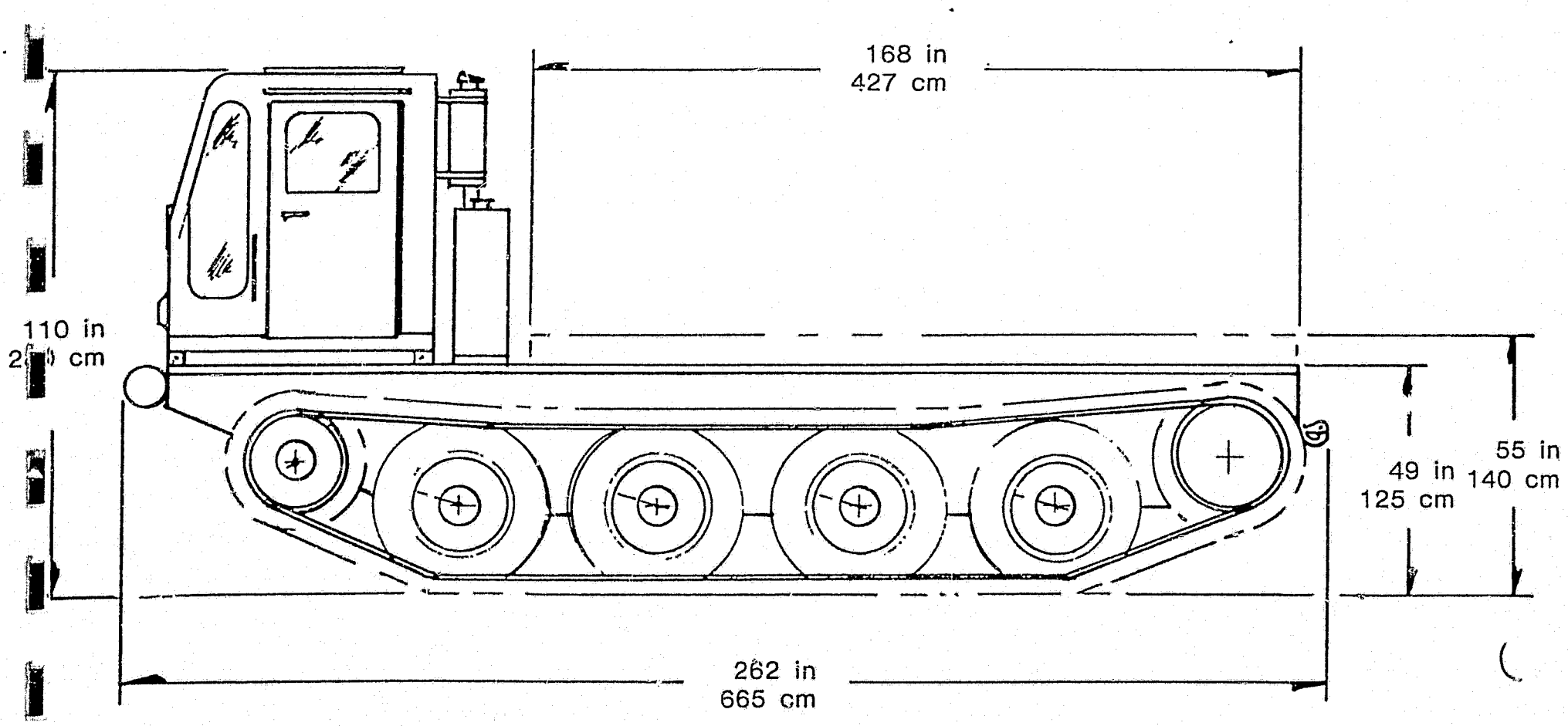
DEALER STAMP

TF-110M



OPTIONAL ONE-MAN CAB
AND SIDE DECK





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TF-110 S.R

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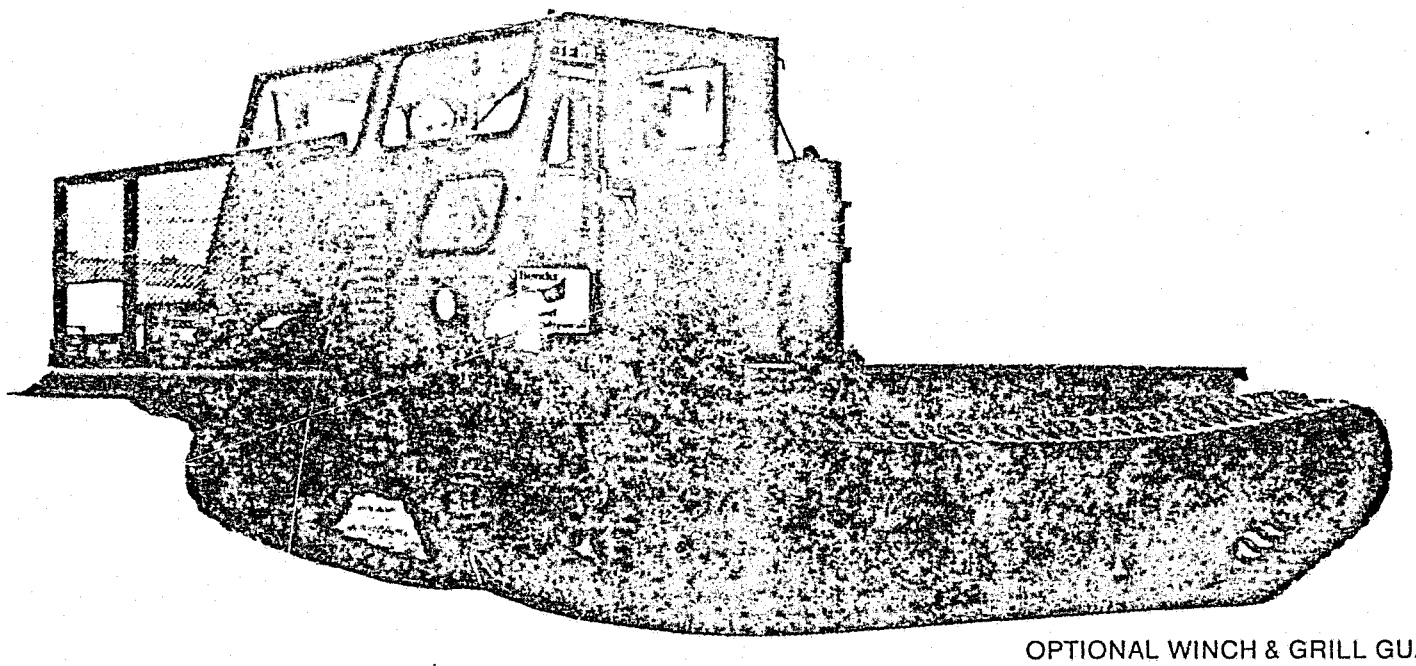


OPTIONAL WINCH & GRILL GUARD SHOWN

PERFORMANCE DATA

Weight - basic vehicle	22750	lbs	10319	kg
Payload	16000	lbs	7257	kg
Gross vehicle weight	38750	lbs	17577	kg
Track area at 6" penetration	12000	sq in	7.74	sq m
Ground pressure - unloaded	1.89	psi	0.13	kg/sq cm
Ground pressure at GVW	3.23	psi	0.23	kg/sq cm
Overall width	119	in	302	cm
Width - tracks removed	95	in	241	cm
Overall height	110	in	280	cm
Overall length	262	in	665	cm
Maximum speed	11.5	mph	18.4	km/h
Ground clearance	19	in	48	cm
Turning radius - inside	103	in	262	cm
Fording depth	48	in	122	cm
Climbing ability - grade	60%			
Sidehill ability - grade	40%			

MISCELLANEOUS STANDARD EQUIPMENT

Front Bumper
Pintle Hook
Maintenance & Parts Manual
Special Tools
Antifreeze

POWER TRAIN

Engine	Detroit Diesel 4-53
Transmission	Spicer CM5052-B, 1 reverse, 5 forward gears
Auxiliary transmission	Fuller 2-A-62
Clutch	13" single plate, hydraulic control
Final drive	Controlled differential (2.62:1) with oil cooling heat exchanger. Outer planetaries (3.6:1)
Brakes	Spring brake for parking, pneumatic power steering brakes at differential

GENERAL SPECIFICATIONS

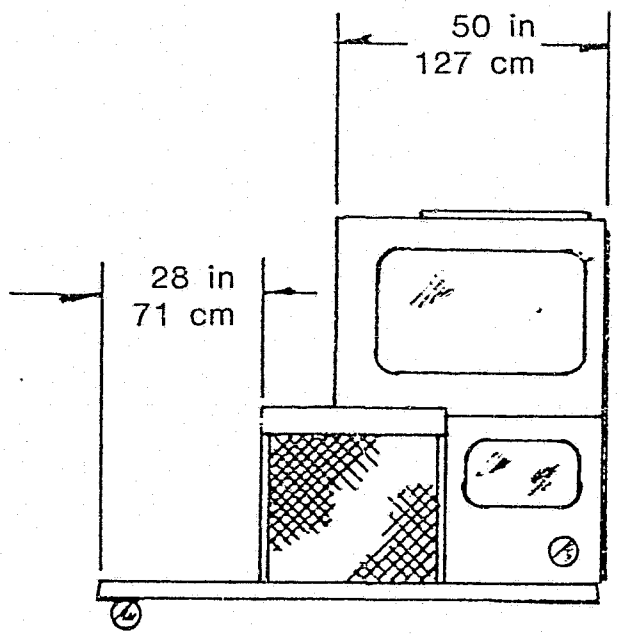
Steering	Lever controlled - pneumatic power
Electrical	Alternator—85 amp, 12 volt Battery—200 amp/hr H.D.
Suspension	Crank arm with torsion coil springs
Load wheels	Rims 20 x 6.50—10 stud—3 pc rim Tires 7.50—20 x 16 PR—smooth
Tracks	Rubber belts (PN200) and spring steel, drop centre grousers
Sprockets	Steel with replaceable urethane elements.
Elevated front idlers	Solid rubber
Cab	Two-man, steel, roll-down windows, escape hatch, dome head, and panel lights, windshield wipers, heaters and defrosters, lined and insulated
Fuel	Saddle tanks, 2 x 60 imp gallons (545 litres)
Instruments	Engine oil pressure, coolant temperature and fuel gauges; hourmeter and tachometer; ammeter.
Color	Standard—International Orange or customer choice (single color)

OPTIONS AVAILABLE

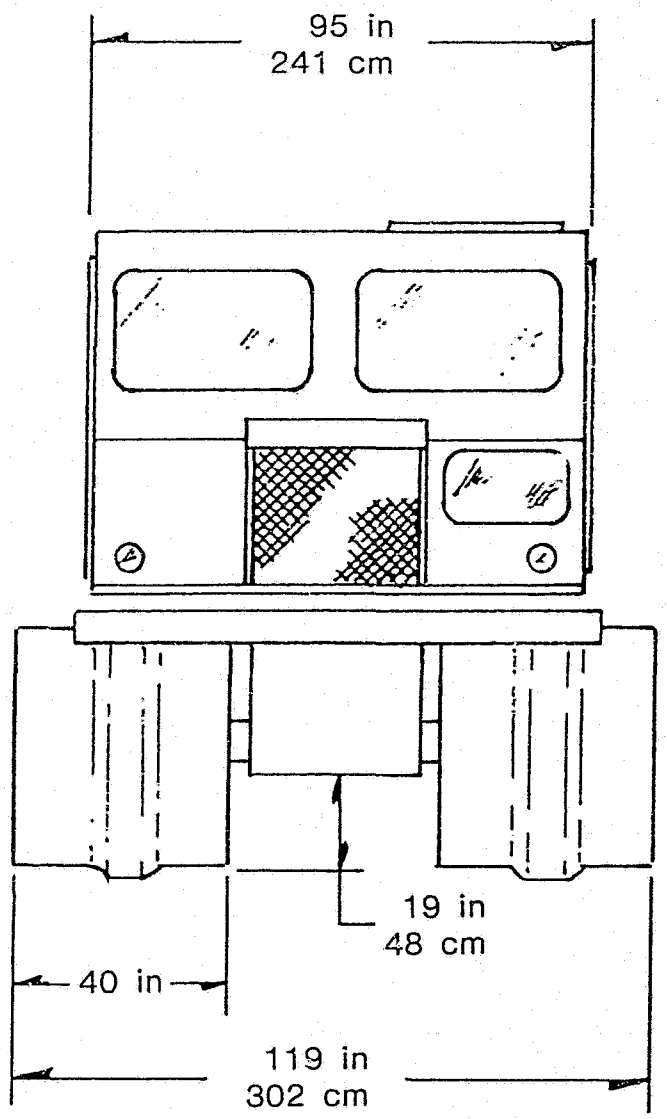
Options Available: include alternate engines and transmissions, tilt cabs, 5-man crew and personnel bodies, Tundra tracks, load decks in various widths and lengths, grill guards, front and/or rear winches.

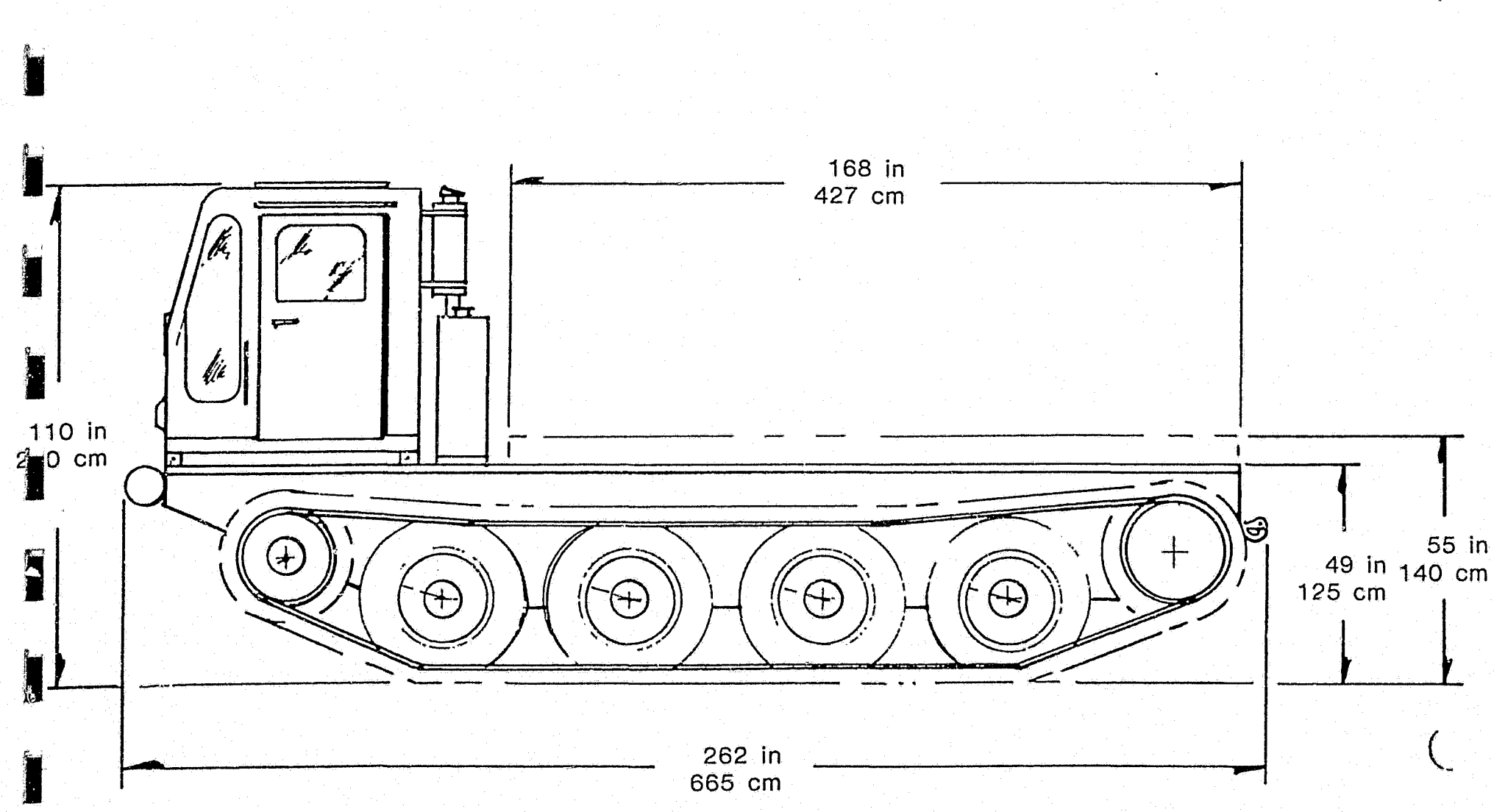
DEALER STAMP

TF-110 S.R



OPTIONAL ONE-MAN CAB
AND SIDE DECK





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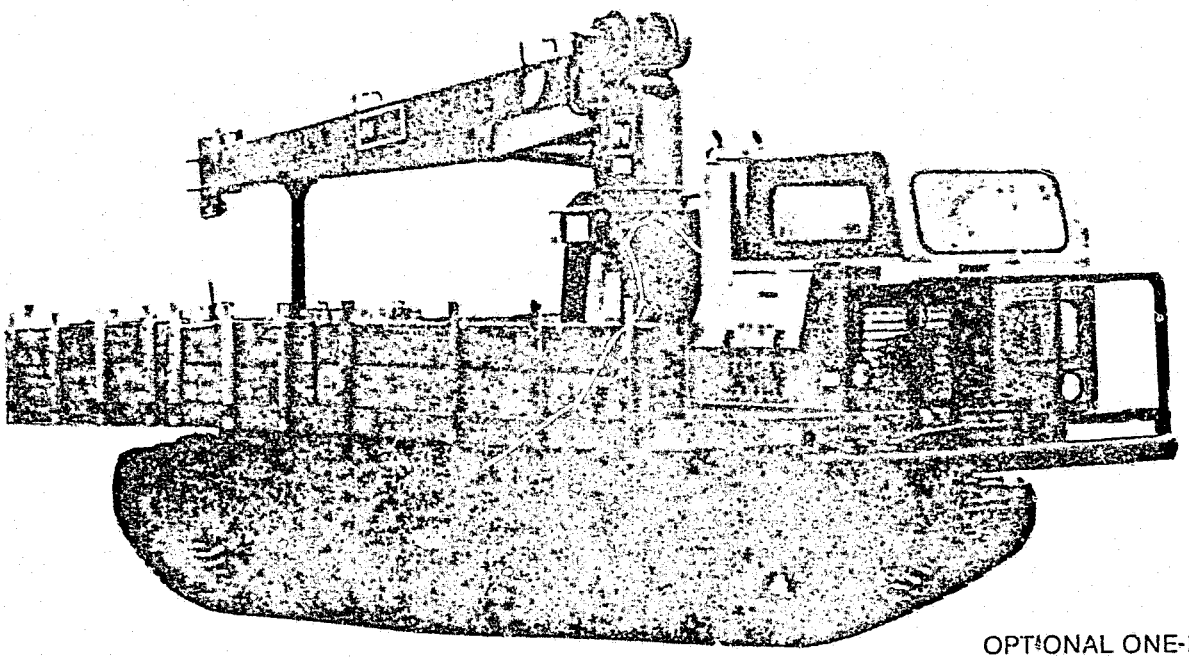


OPTIONAL ONE-MAN CAB & CRANE SHOWN

PERFORMANCE DATA

Weight - basic vehicle	23000	lbs	10432	kg
Payload	16000	lbs	7257	kg
Gross vehicle weight	39000	lbs	17689	kg
Track area at 6" penetration	13320	sq in	8.6	sq m
Ground pressure - unloaded	1.73	psi	0.12	kg/sq cm
Ground pressure at GVW	2.92	psi	0.21	kg/sq cm
Overall width	119	in	302	cm
Width - tracks removed	95	in	241	cm
Overall height	112	in	284	cm
Overall length	280	in	711	cm
Maximum speed	10	mph	16	km/h
Ground clearance	20	in	51	cm
Turning radius - inside	108	in	274	cm
Fording depth	48	in	122	cm
Climbing ability - grade	60%			
Sidehill ability - grade	40%			

MISCELLANEOUS STANDARD EQUIPMENT

Front Bumper
Pintle Hook
Maintenance & Parts Manual
Special Tools
Antifreeze
Removeable Under Pans

POWER TRAIN

Engine	Detroit Diesel 4-53
Transmission	Spicer CM5052-B - 1 reverse, 5 forward gears
Auxiliary transmission	Fuller 2-A-62
Clutch	13" single plate, hydraulic control
Final Drive	Controlled differential (2.62:1) with oil cooling heat exchanger. Outer planetaries (3.6:1)
Brakes	Spring brake for parking, pneumatic power steering brakes at differential

GENERAL SPECIFICATIONS

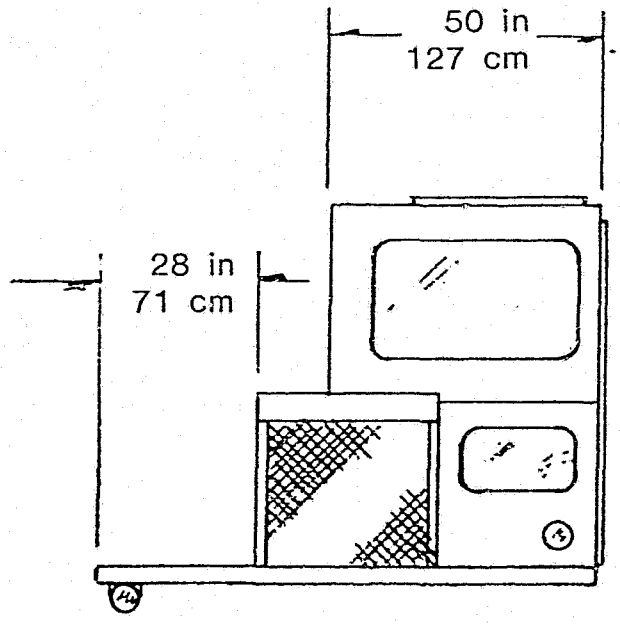
Steering	Lever controlled - pneumatic power
Electrical	Alternator—85 amp 12 volt Battery—200 amp/hr H.D.
Suspension	Walking beams, replaceable wear bushings
Load wheels	Rims 20 x 6.50—10 stud—3 pc rim Tires 7.50—20 x 16 PR—smooth
Tracks	Rubber belts (PN200) and spring steel, drop centre grousers
Sprockets	Steel with replaceable urethane drive elements
Elevated front idlers	Solid rubber
Cab	Two-man, steel, roll-down windows, escape hatch, dome head and panel lights, windshield wipers, heaters and defrosters, lined and insulated.
Fuel instruments	Saddle tanks, 2 x 60 imp. gallons (545 litres) Engine oil pressure, coolant temperature and fuel gauges; hourmeter and tachometer, ammeter.
Color	Standard—International Orange or customer choice (single color)

OPTIONS AVAILABLE

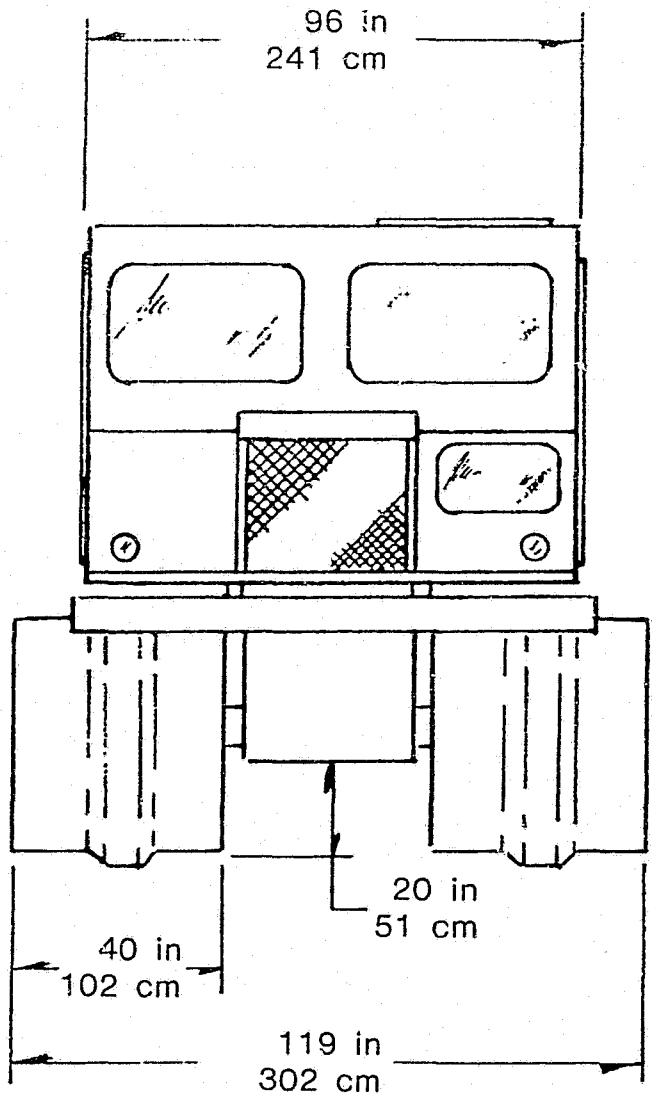
Options Available: include alternate engines and transmissions, tilt cabs, 5-man crew and personnel bodies, Tundra tracks, load decks in various widths and lengths, grill guards, front and/or rear winches.

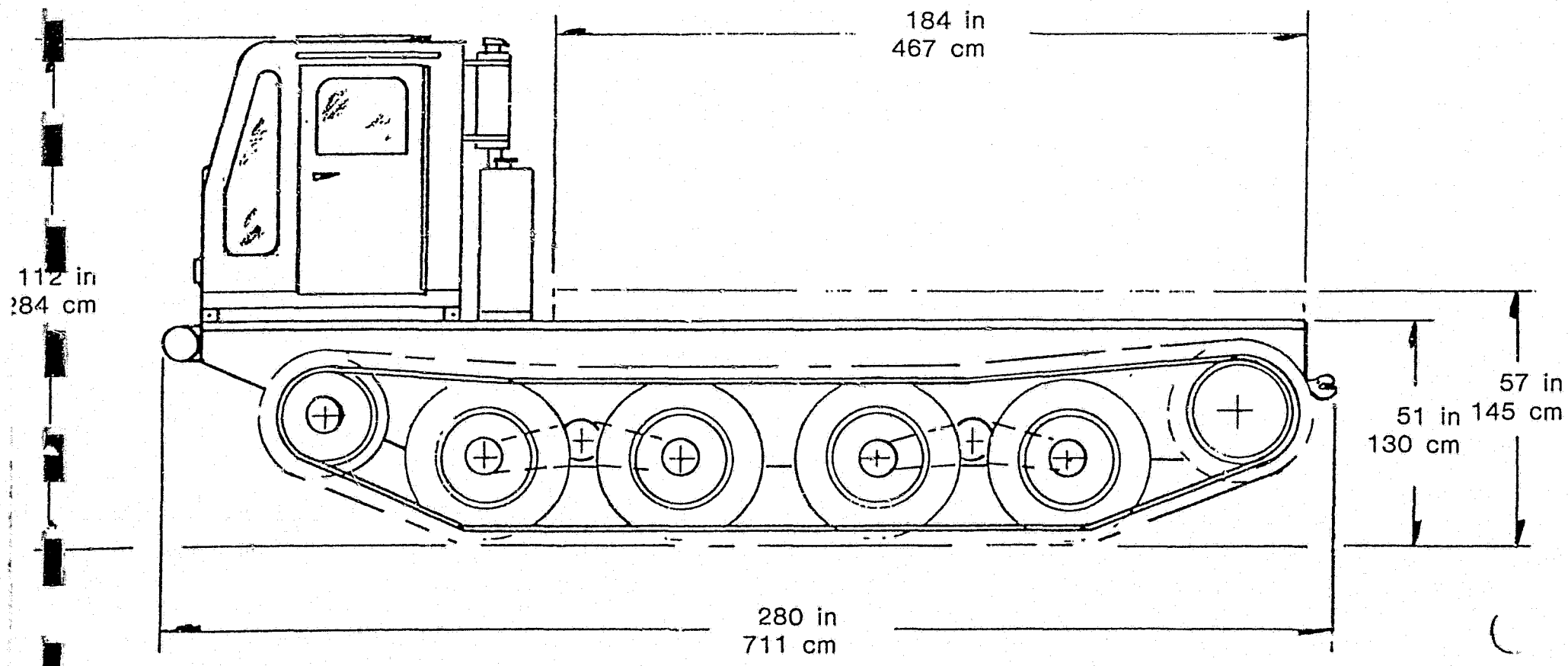
DEALER STAMP

TF-160



OPTIONAL ONE-MAN CAB
AND SIDE DECK





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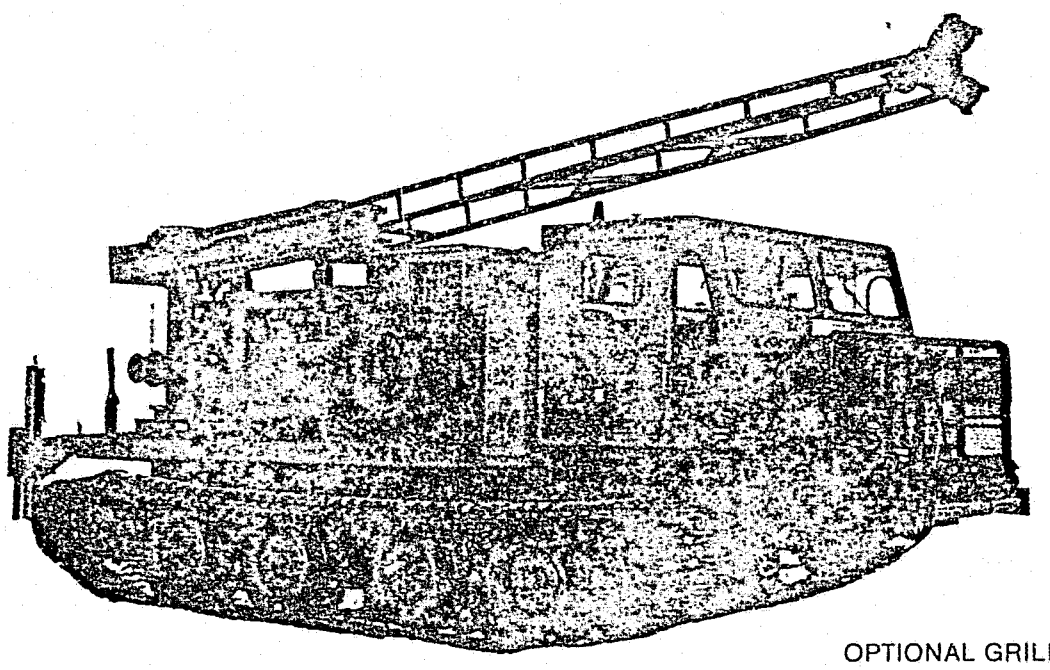


OPTIONAL GRILL GUARD & DRILL SHOWN

PERFORMANCE DATA

Weight - basic vehicle	23500	lbs	10659	kg
Payload	24000	lbs	10886	kg
Gross vehicle weight	47500	lbs	21545	kg
Track area at 6" penetration	13320	sq in	8.6	sq m
Ground pressure - unloaded	1.76	psi	0.12	kg/sq cm
Ground Pressure at GVW	3.56	psi	0.25	kg/sq cm
Overall width	119	in	302	cm
Width - tracks removed	95	in	241	cm
Overall height	112	in	284	cm
Overall length	280	in	711	cm
Maximum speed	10	mph	16	km/h
Ground clearance	20	in	51	cm
Turning radius - inside	108	in	274	cm
Fording depth	48	in	122	cm
Climbing ability - grade	60%			
Sidehill ability - grade	40%			

MISCELLANEOUS STANDARD EQUIPMENT

Front Bumper
Pintle Hook
Maintenance & Parts Manual
Special Tools
Antifreeze
Removeable Under Pans

POWER TRAIN

Engine	Detroit Diesel 6V-53
Transmission	Spicer CM6052-B, 1 reverse, 5 forward gears
Auxiliary Transmission	Fuller 2-A-62
Clutch	14" single plate, hydraulic control
Final Drive	Controlled differential (2.62:1) with oil cooling heat exchanger. Outer planetaries (3.6:1).
Brakes	Spring brake for parking, pneumatic power steering brakes at differential

GENERAL SPECIFICATIONS

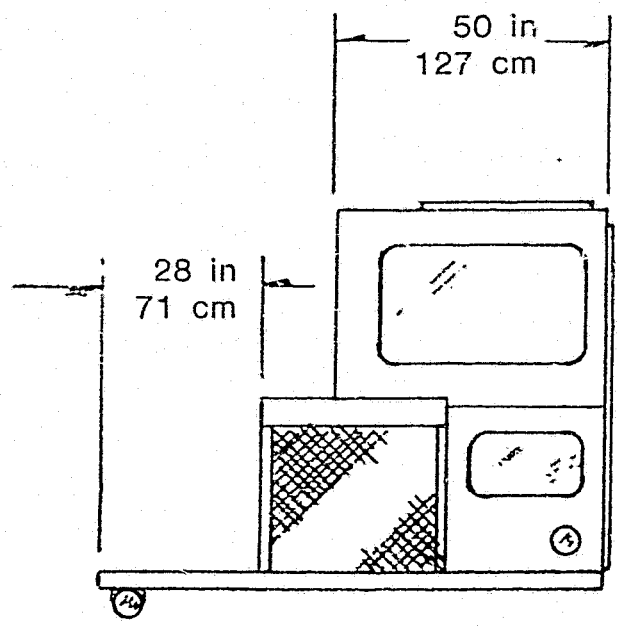
Steering	Lever controlled - pneumatic power
Electrical	Alternator—85 amp. 12 volt Battery—200 amp/hr H.D.
Suspension	Walking beam, replaceable wear bushings
Load wheels	Rims 20 x 6.50—10 stud—3 pc rim Tires 7.50—20 x 16 PR—smooth
Tracks	Rubber belts (PN200) and spring steel, drop centre grousers
Sprockets	Steel with replaceable urethane drive elements
Elevated front idlers	Solid rubber
Cab	Two-man, steel, roll-down windows, escape hatch, dome head, and panel lights, windshield wipers, heaters and defrosters, lined and insulated.
Fuel	Saddle tanks, 2 x 60 imp. gallons (545 litres)
Instruments	Engine oil pressure, coolant temperature and fuel gauges; hourmeter and tachometer, ammeter.
Color	Standard—International Orange or customer choice (single color)

OPTIONS AVAILABLE

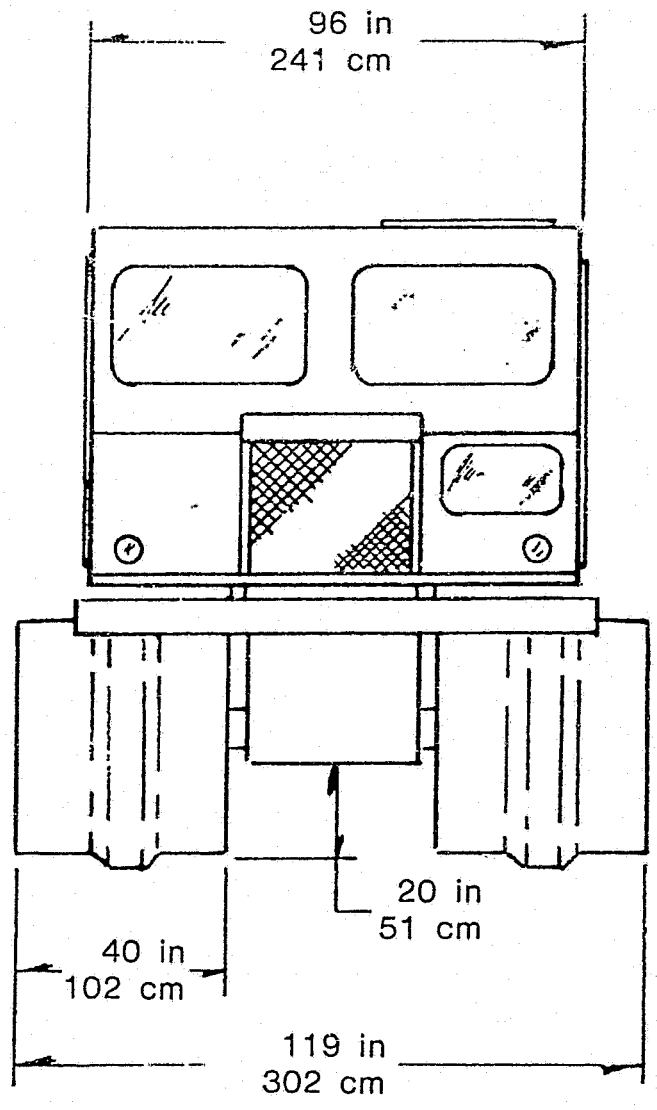
Options Available: include alternate engines and transmissions, tilt cabs, 5-man crew and personnel bodies, Tundra tracks, load decks in various widths and lengths, grill guards, front and/or rear winches.

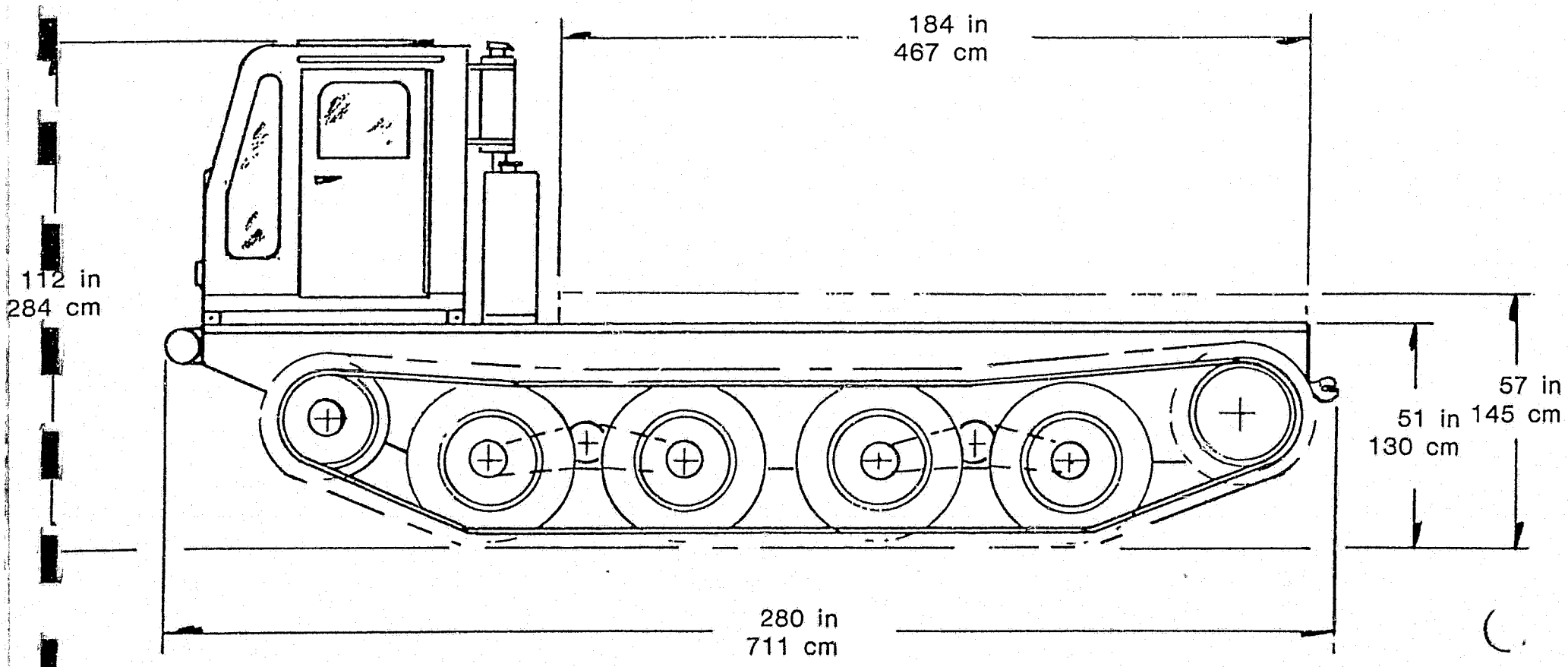
DEALER STAMP

TF-240



OPTIONAL ONE-MAN CAB
AND SIDE DECK





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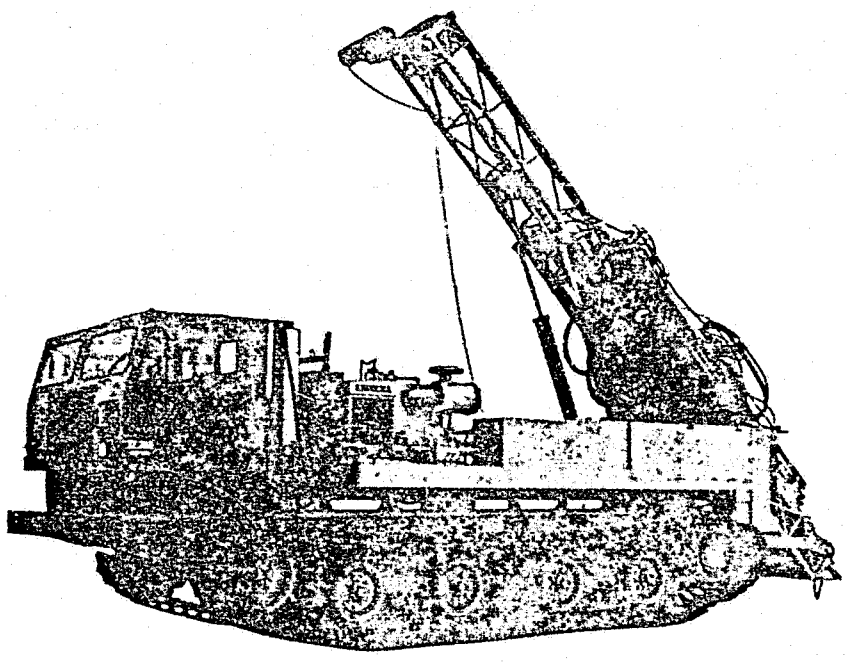


OPTIONAL DRILL SHOWN

PERFORMANCE DATA

Weight - basic vehicle	38000	lbs	17236	kg
Payload	42000	lbs	19050	kg
Gross vehicle weight	80000	lbs	36286	kg
Track area at 6" penetration	19224	sq in	12.4	sq m
Ground pressure - unloaded	1.97	psi	0.14	kg/sq cm
Ground pressure at GVW	4.16	psi	0.29	kg/sq cm
Overall width	151	in	384	cm
Width - tracks removed	114	in	290	cm
Overall height	126	in	320	cm
Overall length	323	in	820	cm
Maximum speed	12	mph	19	km/h
Ground clearance	18	in	46	cm
Turning radius - inside	108	in	274	cm
Fording depth	56	in	142	cm
Climbing ability - grade	60%			
Sidehill ability - grade	40%			

MISCELLANEOUS STANDARD EQUIPMENT

Front Bumper
Pintle Hook
Maintenance & Parts Manual
Special Tools
Antifreeze
Removeable Under Pans

POWER TRAIN

Engine	Detroit Diesel 8v-71
Transmission	SST-1062-C 1 reverse, 6 forward gears
Clutch	15½" 2-plate, hydraulic control
Final drive	Controlled differential (2.62:1) with oil cooling heat exchanger. Outer planetaries (3.6:1).
Brakes	Spring brake for parking, pneumatic power steering brakes at differential

GENERAL SPECIFICATIONS

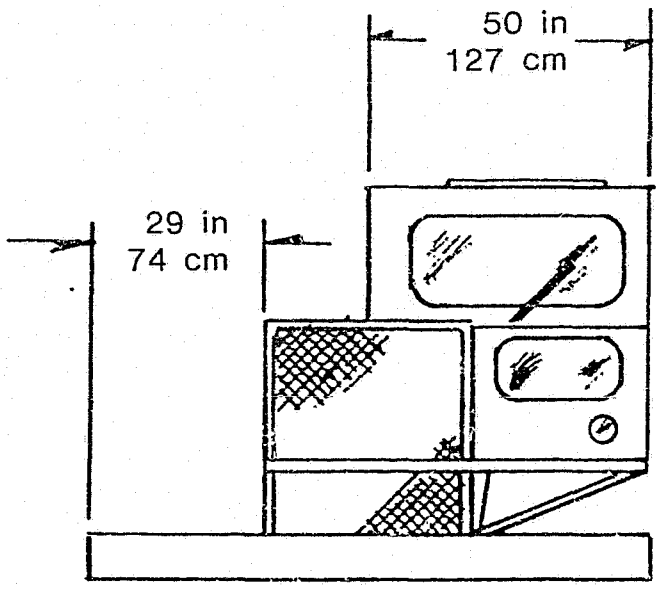
Steering	Lever controlled - pneumatic power
Electrical	Alternator—85 amp 12 volt Battery—200 amp/hr H.D.
Suspension	Walking beams, replaceable wear bushings
Load wheels	Rims 20 x 8.00—10 stud (1-⅛" dia:) 3 pc rim Tires 11.00—20 x 14 PR—Rockgrip
Tracks	Rubber belts (PN200) and spring steel, drop centre grousers
Sprockets	Steel with replaceable urethane elements.
Elevated front idlers	Solid rubber
Cab	Two-man, steel, roll-down windows, escape hatch, dome head and panel lights, windshield wipers, heaters and defrosters, lined and insulated.
Fuel	Saddle tanks, 2 X 60 imp gallons (545 litres)
Instruments	Engine oil pressure, coolant temperature and fuel gauges: hourmeter and tachometer, ammeter.
Color	Standard—International Orange or customer choice (single color)

OPTIONS AVAILABLE

Options Available: include alternate engines and transmissions, tilt cabs, 5-man crew and personnel bodies, Tundra tracks, load decks in various widths and lengths, grill guards, front and/or rear winches.

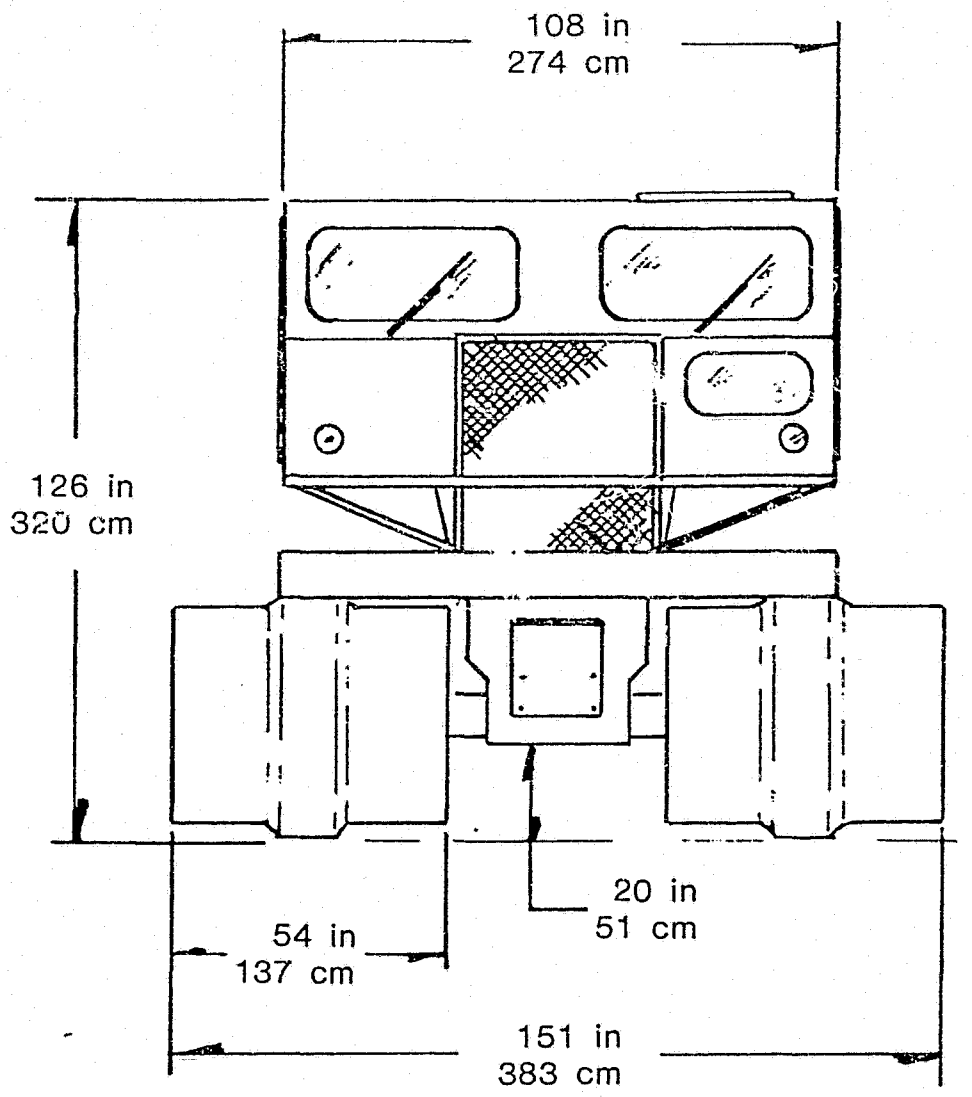
DEALER STAMP

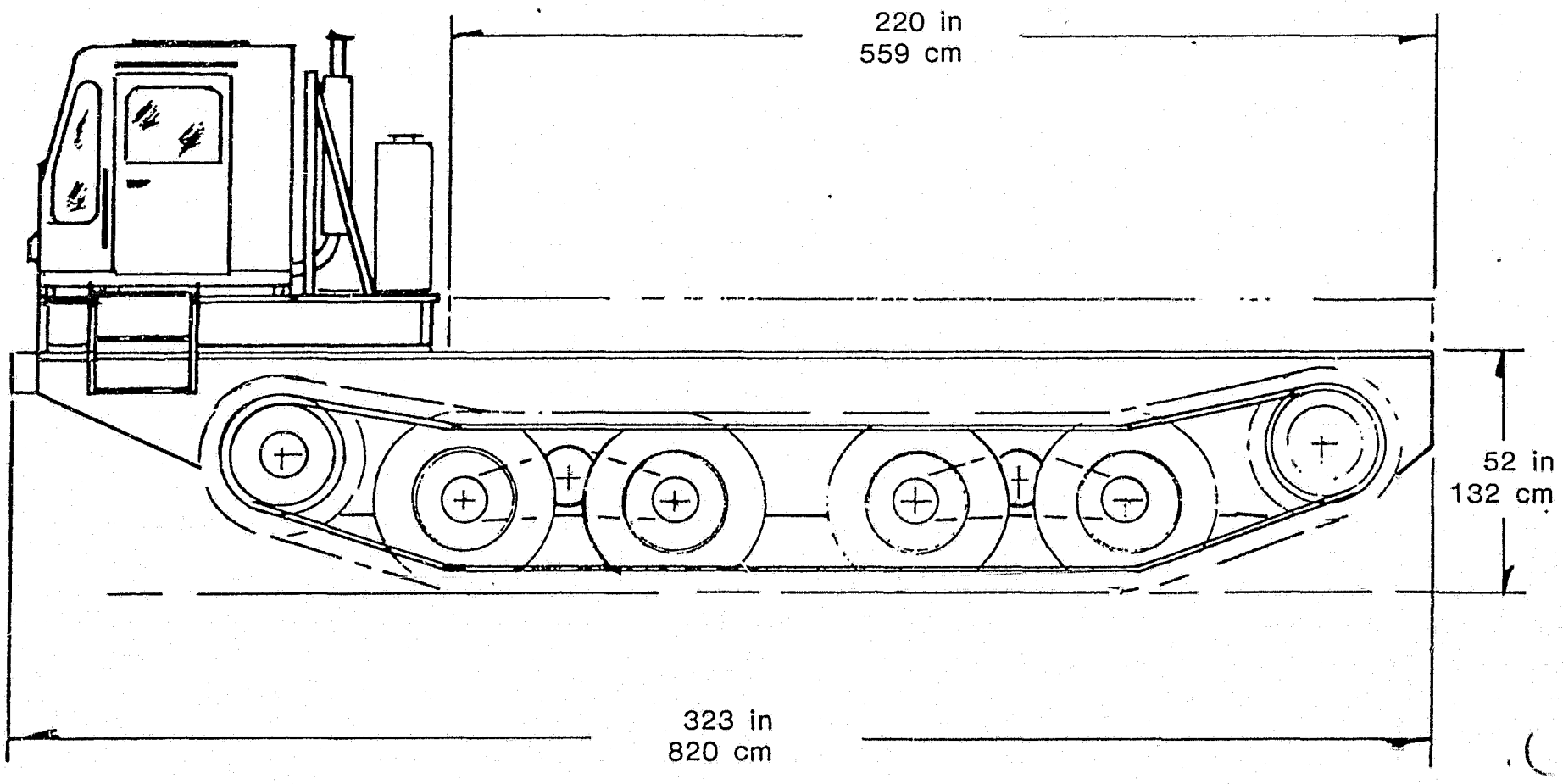
TF-360



OPTIONAL ONE-MAN CAB

AND SIDE DECK





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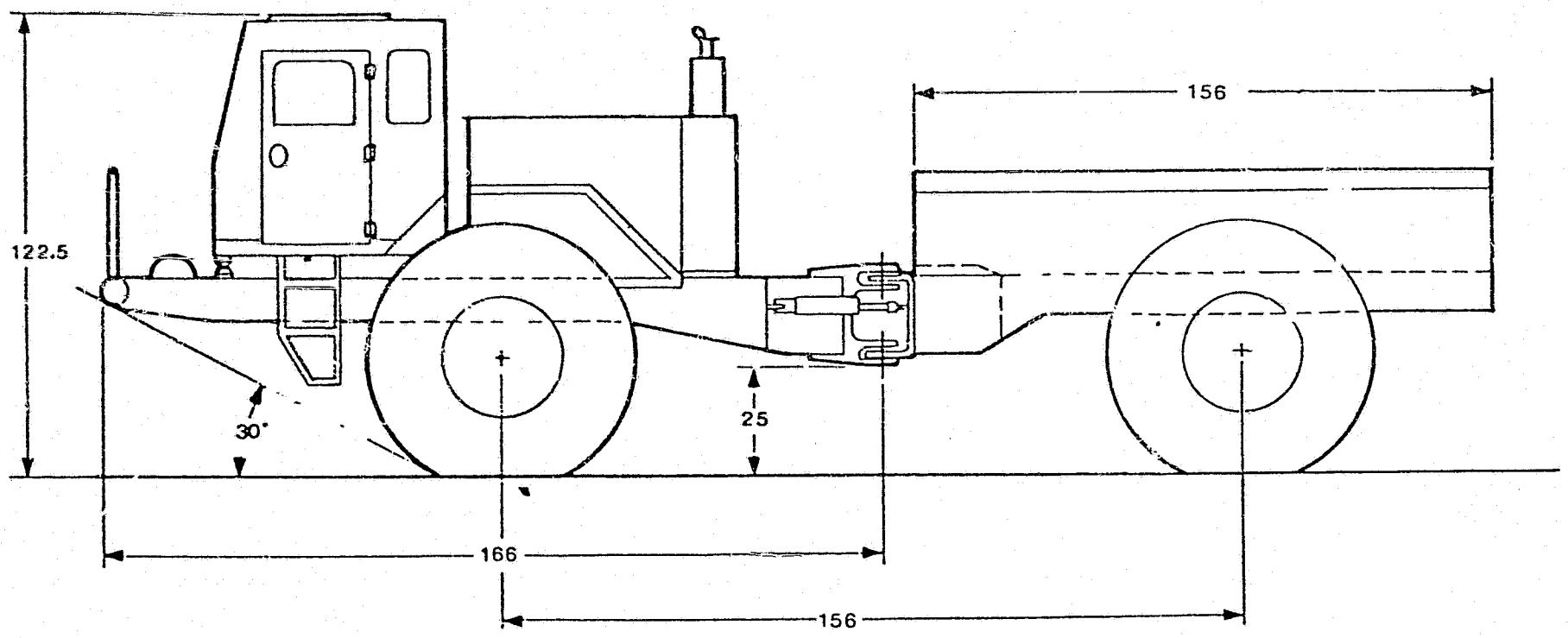

TF 100 TT

GENERAL DATA

Weight - basic c/w deck and 5-man cab	17,000 lb. 7,711 kg.	Overall height	118 in. 300 cm.
Max. rated payload	10,000 lb. 4,536 kg.	Deck Height	73 in. 185 cm.
Gross weight	27,000 lb. 12,247 kg.	Ground clearance at axle	22.5 in. 57 cm.
		at pivot	26.5 in. 67 cm.
Ground bearing pressure, no load, 5 psi tire pressure, 6" penetration	2.45 psi 0.17 kg/cm^2	Fuel tank capacity	80 gal.I. 363 litres
5000 lb. payload/basic unit	3.14 psi 0.22 kg/cm^2	Maximum speed	30 mph 47.3 kph
10,000 lb. payload/basic unit	3.90 psi 0.271 kg/cm^2	Gradeability forward	60%
		side	40%
Turning radius (outside of tires)	35 ft. 10.7 m	Max. approach angle	35 deg.
		Max. departure angle	35 deg.
Overall width	131 in. 333 cm.	Max. angle of roll at pivot	±22 deg.
Overall length	266 in. 676 cm.	Articulation	±40 deg.

P.T.O.....

MECHANICAL STANDARDS

Engine - GM 4-53 Diesel

Transmission - Clark 28,000 Series
4 speed powershift

Axles - front and rear, Clark planetary type

Brakes - Drum brakes air

Front bumper

Steering - Articulated frame, full hydraulic power

Service brake - mechanical drive line

Tires - Terra Tire 66 x 43.00 - 25 6 Ply
Optional 66 x 43.00 - 25 10 Ply

Electrical - 12 volt, 86 amp., 200 amp/hr. H.D. battery

Cab - 5 man, escape hatch, lined and insulated heaters & defrosters, headlights, roll down windows

Instruments - tachometer, ammeter, oil gauge, fuel gauge, hourmeter, etc.

Subject to change without notice

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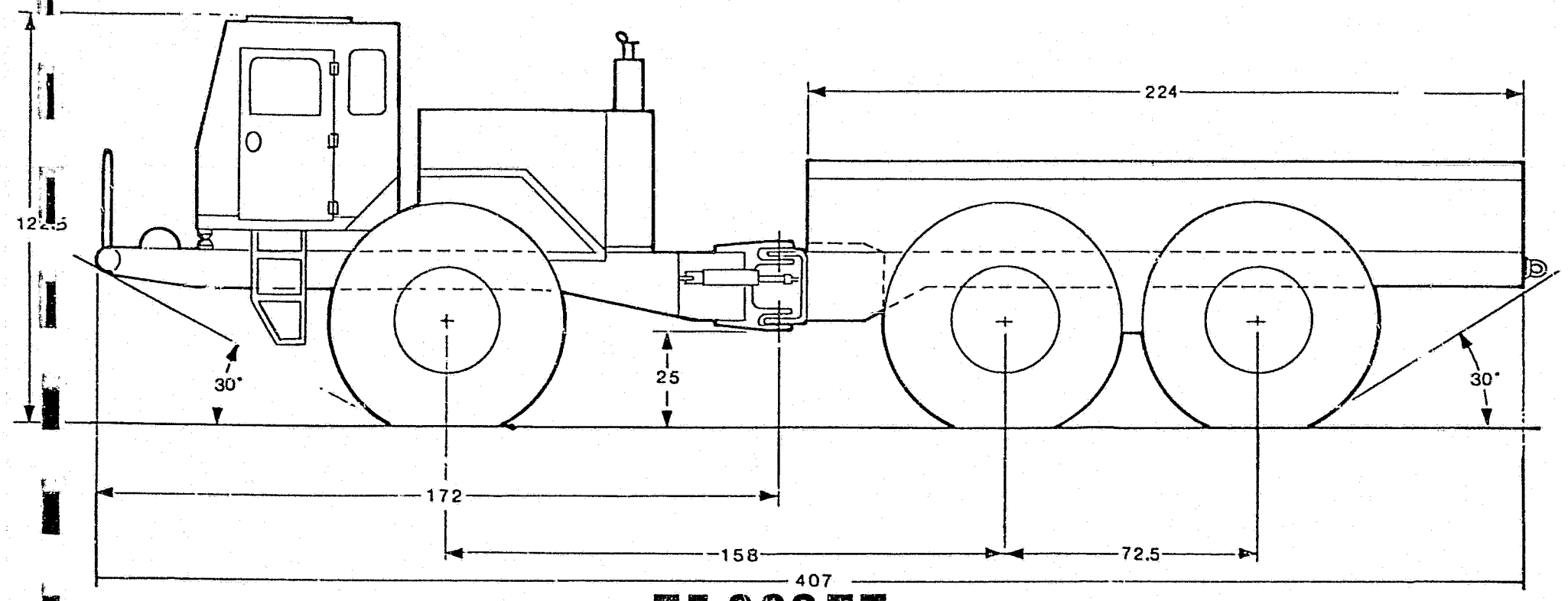


TF 300 TT

GENERAL DATA

Weight - basic c/w cab & deck (approx.):	27,500 Lbs. 12,470 Kgs.
Payload rated:	30.000 Lbs. 13,620 Kgs.
Gross weight (approx.):	57,500 Lbs. 26,080 Kgs.
Overall length:	407 In. 1134 Cm.
Overall Width:	132 In. 335 Cm.
Overall Height:	122.5 In. 311 Cm.
Tires 66 x 43.00 - 25 terra tires:	10 Ply
Ground Pressure at GVW & 6" Sinkage:	7.00 psi 0.49 Kg/cm^2
Speed at 2800 R.P.M.:	27 mph 43 km/h
Fuel Tank Capacity:	100 Imp.Gals. 450 Litres
Gradeability - forward: side:	60% 40%
Maximum approach angle:	30%
Turning Radius Outside	37 Ft. 1128 Cm.

TF 300TT

MECHANICAL STANDARDS

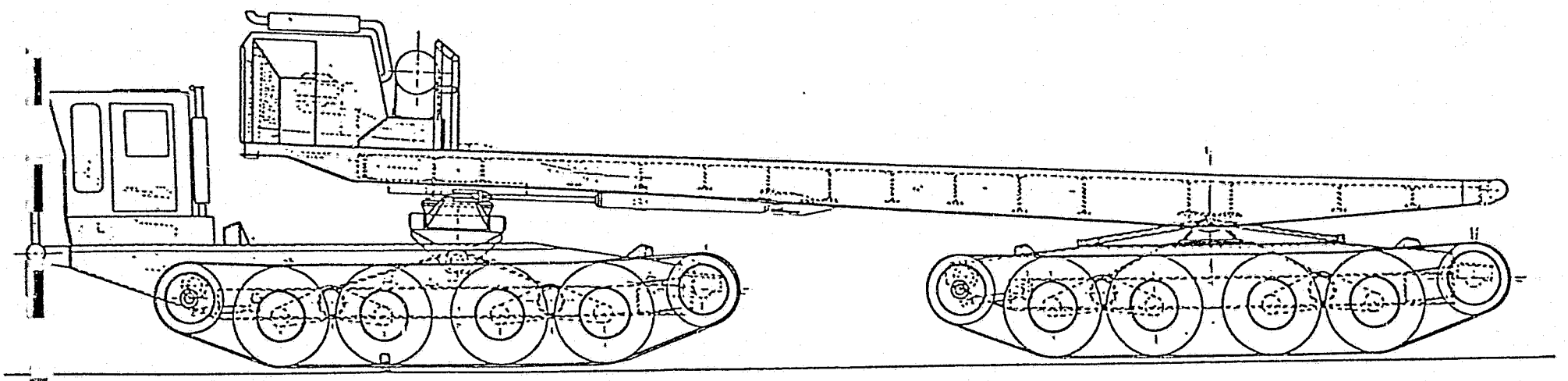
Frame:	Fully welded steel
Engine:	Detroit Diesel
Transmission:	Powershift, Clark 28000 Series
Axles:	H.D. Planetary Type, Clark
Suspension:	Rigid Front Axle, Roll Joint $\pm 22^{o}$ Roll Walking Beam rear
Steering:	Articulated frame, full hydraulic power
Brakes:	Drum axle mounted, air operated, Spring parking brake
Electrical:	12 V., 80 Amp., Alt. & 200 Amp. H.D. Battery
Instruments:	Gauges, oil & oil pressure, water temp., trans. temp., hourmeter, ammeter
Warning Lights:	For low air pressure, hot transmission, spring brake on
Cab:	5 Man, lined & insulated, head, dome, panel & engine compartment lights Two speed wipers
Air System Controls:	12 CFM direct engine driven compressor, Bendix dryer, desiccant type

Maintenance and Parts Manuals

TF-900

Terra Flex — A DIVISION OF BOMBARDIER INC

P.O. Box 787, Station "T", Calgary, Alberta T2H 2H3
Phone (403) 279-7271 Telex 038-25756



STANDARD SPECIFICATIONS

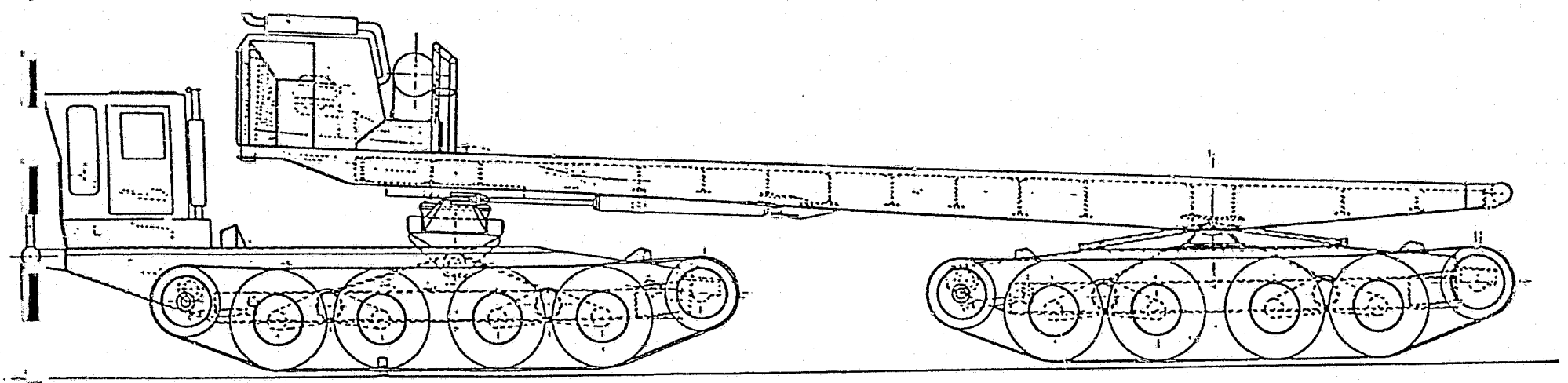
Weight, Basic	104,000 Lbs. - 47,187 Kgs.
Payload	100,000 Lbs. - 45,372 Kgs.
Gross Weight	204,000 Lbs. - 92,559 Kgs.
Ground Pressure (Loaded)	
54" Tracks	5.1 PSI - .358 Kgs./Sq.Cm.
60" Tracks	4.59 PSI - .322 Kgs./Sq.Cm.
Ground Pressure (Unloaded)	
54" Tracks	2.61 PSI - .183 Kgs./Sq.Cm.
60" Tracks	2.35 PSI - .165 Kgs./Sq.Cm.
Overall Width, Tracked	
54" Tracks	151 In. (12 Ft. 7 In.)
60" Tracks	157 In. (13 Ft. 1 In.)
Overall Length	57 Ft.
Overall Height	14 Ft. 4 In.
Deck Height at Live Roll	76 In.
Live Roll Dia.	10 In.
Turning Radius	55 Ft.
Engines	GM. 6V71, 238 B.H.P. at 2100 R.P.M.
	Torque - 600 Lbs. Ft. at 1600 R.P.M.
Starting	24 Volts
Transmission	Allison MT 654 CR, 5-Speed Automatic
	Torque Converter Stall Ratio: 2.7
Axles & Planetaries	Clark 37000 Series
Electrical System	12 Volt
Starting System	24 Volt
Winch, Deck	Braden MS 50 / 100;000 Lb. Line Pull, Bare Drum
Cab	Steel, Lined & Insulated
Fuel Capacity	400 Imp. Gallons (1816 Litres)
Maximum Speed	9 M.P.H.
Gradeability	Forward & Rearwards - 60% / Side - 40%
Wheels, Rims	8.50 x 20 x 10 Stud (Studs 1-1/8" Dia.)
Tires	12.00 x 20 x 16 Ply Rockgrip
Hubs	Oil Bath Type with Caterpillar Metal Face Seals
Sprockets	Replaceable Urethane Inserts
Color	Customer Choice, Single Color

SUBJECT TO CHANGE WITHOUT NOTICE

TF-900

Terra Flex
A DIVISION OF BOMBARDIER INC

P.O. Box 787, Station "T", Calgary, Alberta T2H 2H3
Phone (403) 279-7271 Telex 038-25756



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Maximum Speed	9 M.P.H.
Gradeability	Forward & Rearwards - 60% / Side - 40%
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Tires	12.00 x 20 x 16 Ply Rockgrip
Hubs	Oil Bath Type with Caterpillar Metal Face Seals
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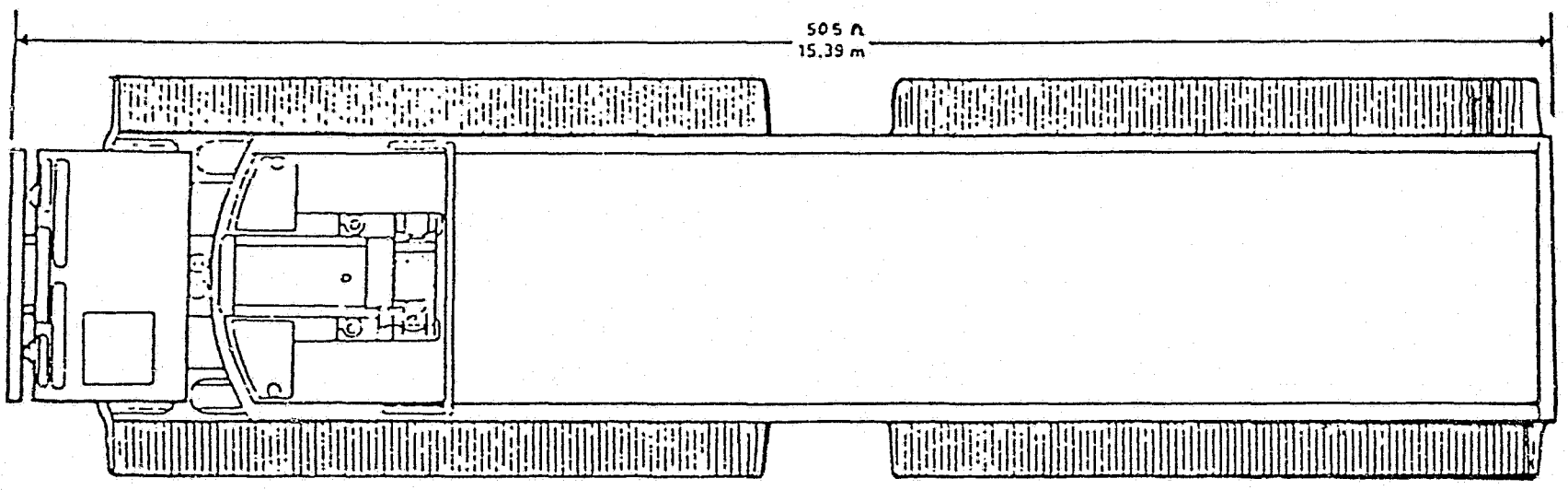
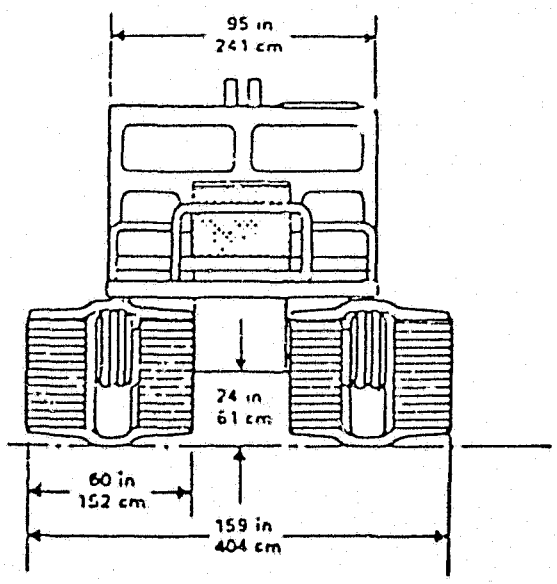
Color	Customer Choice, Single Color

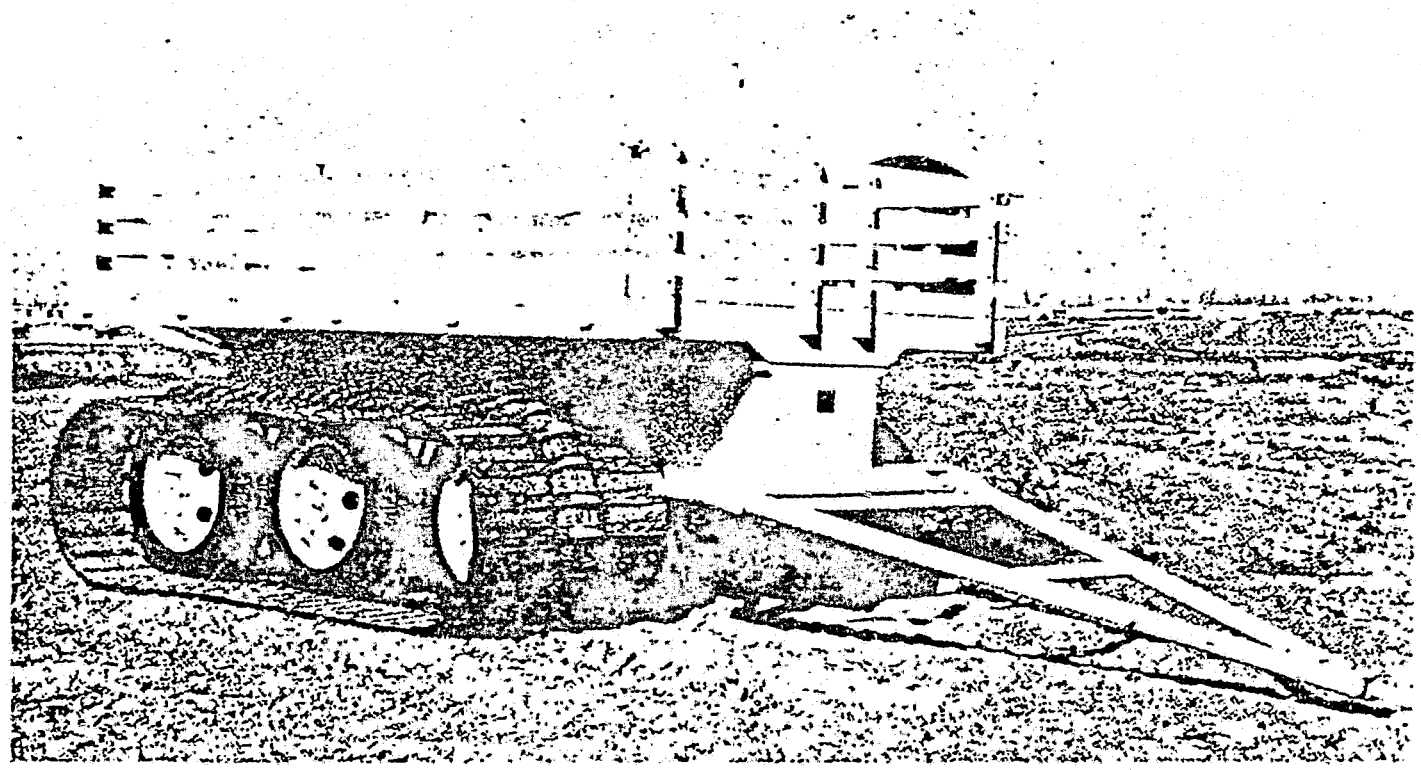
SUBJECT TO CHANGE WITHOUT NOTICE


505 in
15.39 m

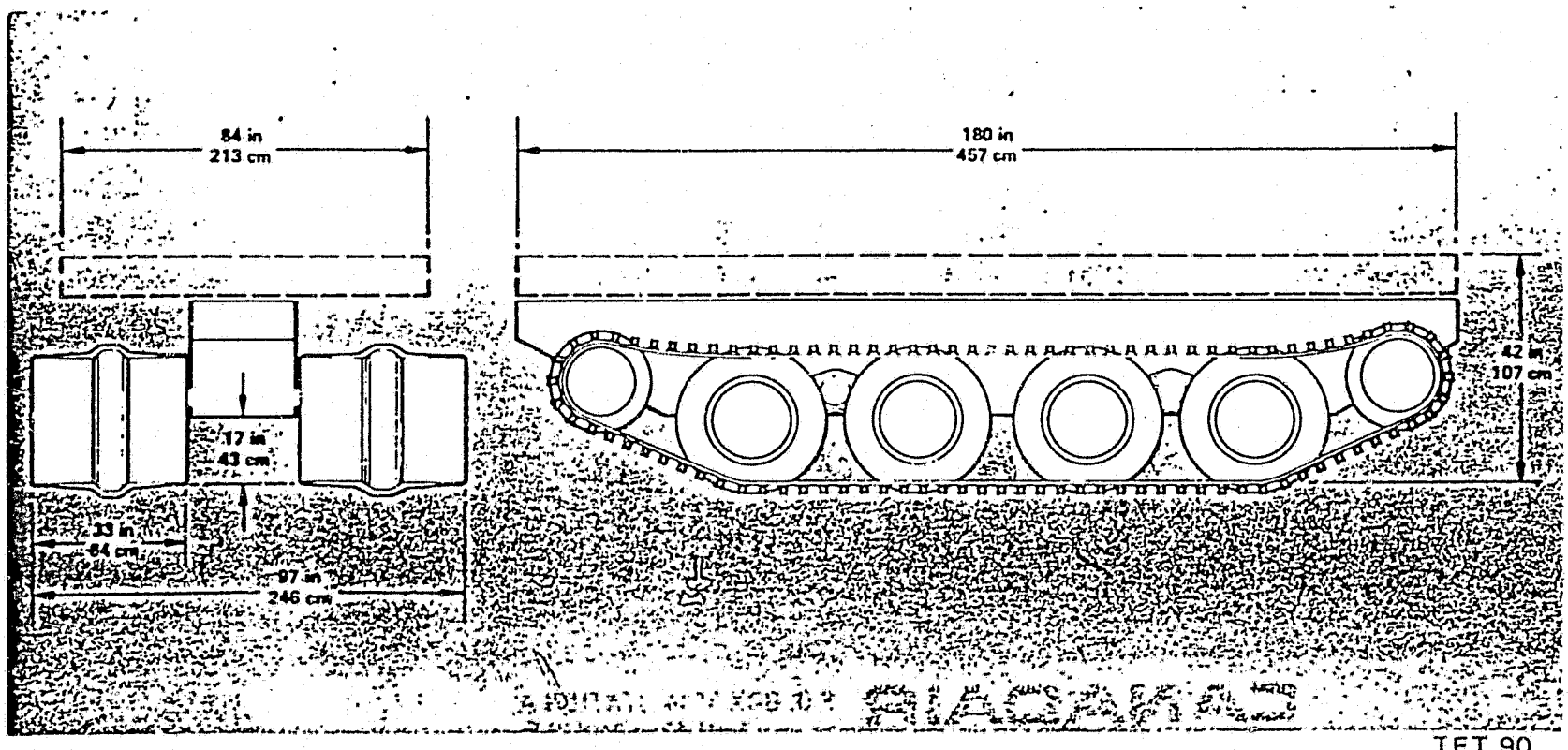

95 in
241 cm
24 in
61 cm
60 in
152 cm
159 in
404 cm

Standard Specifications

TERRA-FLEX TRAILERS



TFT *120 160 and 180 (Typical)*



TFT 90

REPRESENTATIONS AND DATA HEREIN FOR ALL FEATURES OF PERFORMANCE MAY VARY IN PRACTICE DUE TO MANY FACTORS INCLUDING THE SELECTION OF POWER TRAIN AND TRACK OPTIONS, ENVIRONMENTAL CONDITIONS, STANDARD OF MAINTENANCE AND OTHER CIRCUMSTANCES AFFECTING THE OPERATION OF ANY PARTICULAR VEHICLE. PLEASE CONSULT WITH OUR SALES ENGINEERING DEPARTMENT FOR ADVICE CONCERNING THE BEST COMBINATION OF OPTIONS TO SUIT YOUR PARTICULAR REQUIREMENTS

GENERAL SPECIFICATIONS — TRAILERS

	TFT 90 4-axle	TFT 120 3-axle	TFT 160 4-axle	TFT 180 5-axle	TFT 300 4-axle
Payload	12000 lb 5444 kg	14000 lb 6350 kg	18000 lb 8170 kg	22000 lb 9980 kg	35000 lb 15880 kg
Gross Weight	19000 lb 8620 kg	22000 lb 9980 kg	28000 lb 12700 kg	34000 lb 15420 kg	50000 lb 22686 kg
Deck Length **	180 in 457 cm	144 in 366 cm	184 in 467 cm	224 in 569 cm	240 in 610 cm
Deck Width **	84 in 213 cm	96 in 244 cm	96 in 244 cm	96 in 244 cm	96 in 244 cm
Deck Height **	42 in 107 cm	54 in 137 cm	54 in 137 cm	54 in 137 cm	— — — —
Track Width	33 in 84 cm	40 in 102 cm	40 in 102 cm	40 in 102 cm	— — — —
Bearing Pressure — Loaded	2.38 psi 0.167 kg/sq cm	2.75 psi 0.194 kg/sq cm	2.48 psi 0.174 kg/sq cm	2.38 psi 0.167 kg/sq cm	4.23 psi 0.297 kg/sq cm
Bearing Pressure — Unloaded	1.43 psi 0.099 kg/sq cm	1.1 psi 0.077 kg/sq cm	0.97 psi 0.678 kg/sq cm	0.96 psi 0.068 kg/sq cm	1.41 psi 0.098 kg/sq cm
Ground Clearance	17 in 43 cm	17 in 43 cm	17 in 43 cm	17 in 43 cm	17 in 43 cm
Length — Less Tongue	180 in 457 cm	151 in 384 cm	193 in 490 cm	231 in 587 cm	— — — —
Width — With Tracks	97 in 246 cm	110 in 279 cm	110 in 279 cm	110 in 279 cm	— — — —
Track Tightener	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic
Tracks	Rubber Belts with Drop Center Grouser Bars				
Number of Load Wheels	8	6	8	10	8
Suspension	Walking Beam	Axle Crank	Axle Crank	Axle Crank	Walking Beam
Tires	6:00x16 8-ply	7:50x20 12-ply	7:50x20 12-ply	7:50x20 12-ply	8:25x20 12-ply
Elevated Front Idler	Standard	**	**	**	Standard

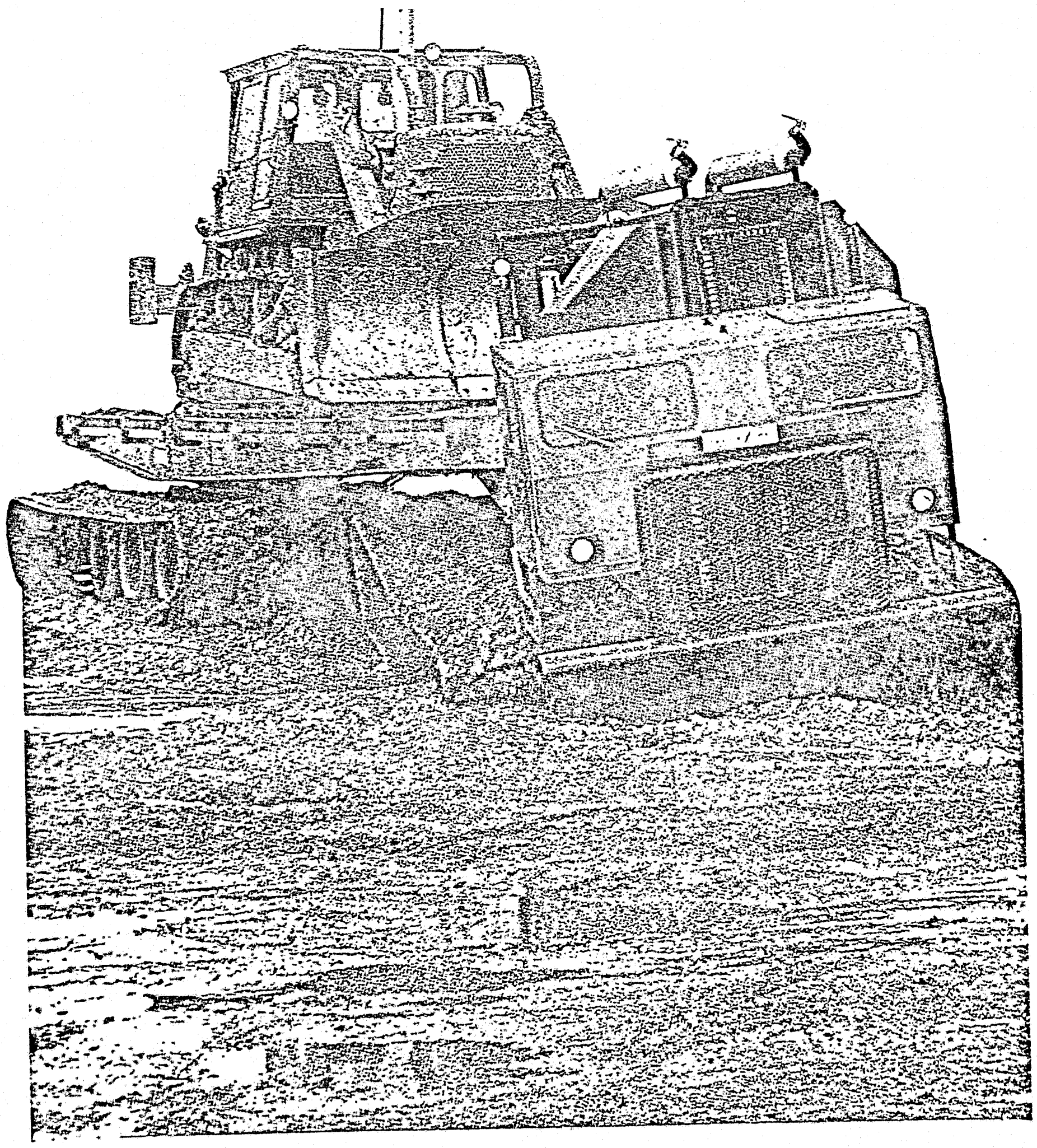
subject to change without notice.

** OPTIONS: Decks, Stake Sides, Swinging Tongues, Front Idlers where not included. Urethane Filled Tires, Etc.

Terra Flex
A DIVISION OF BOMBARDIER INC
8525 - 52nd Street S.E.
P.O. Box 787, Station "T"
Calgary, Alberta. Canada T2H 2H3

OFFICE: (403) 279-7271
RES: (403) 281-4342
TELEX: 038-25756

F. L. (Frank) SMITH
General Manager



drill systems
A DIVISION OF CHALLENGER INTERNATIONAL SERVICES LTD.
111 - 58 AVENUE S.W., P.O. BOX 5140, STATION "A"
CALGARY, ALBERTA T2H 1X3
PHONE (403) 253-7451 TELEX 03-825750

October 19, 1982

Mr. Lance Duncan
Acres American 1000
Liberty Bank Building
Buffalo, New York
USA 14202

Re: SUSITNA HYDRO ELECTRIC PROJECT
HAMMER DRILLING PROGRAM

Dear Mr. Duncan:

Further to our recent telephone conversation and our discussion regarding drilling equipment and operation on the above mentioned project, we are pleased to confirm the following points:

1. All equipment used on a project of this type, considering terrain difficulties and winter conditions, should be in first class condition, preferably new. All equipment should be fully tested before transported to site. All operators should have extensive experience on this type of equipment, and in particular, given your specifications, deep hole experience, if possible.

2. As you know, there are two styles of hammer drill pipe currently being used by various drilling contractors. The old style has restricted air passages in the annulus, which limits depth capacity. For this reason we would recommend that only new style, floating inner tube, greater air passage capacity be used on this project.

3. Given climatic conditions that will prevail, we would further recommend that the rig be "closed in" with tarpaulins or some other cover. This relatively inexpensive operation would add greatly to the efficiency and safety of the drilling programs.

4. We enclose herewith a brochure (AP1000) describing our hammer rig, as well as brochures describing our rotary reverse circulation drilling rig, and our newly released helicopter lift multi-purpose rig.

We trust that this provides the information you require. Should you have any questions or need further details, please do not hesitate to contact the writer.

Yours truly,

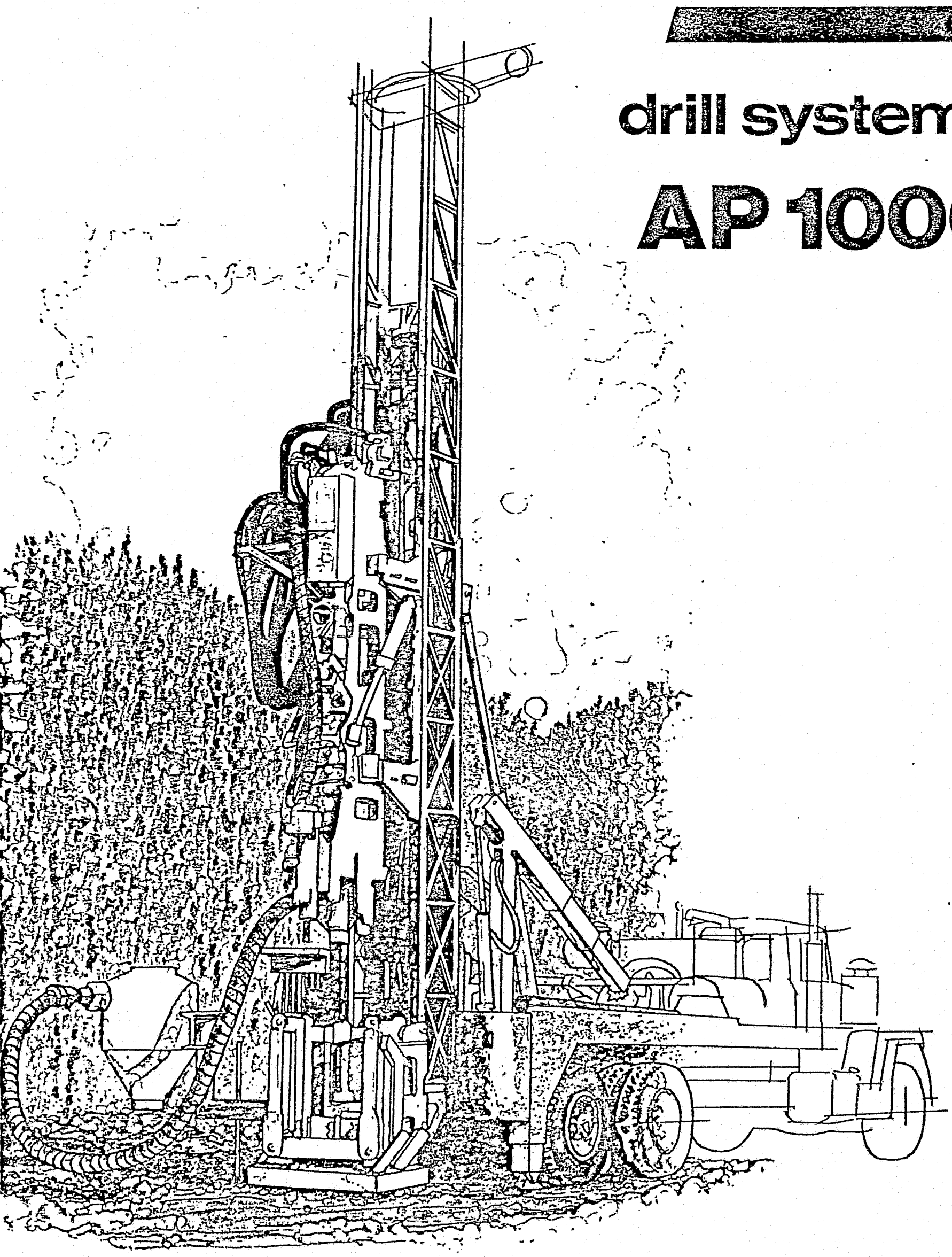
Floyd Becker
Director Research and Development

/lm
enc.

DRILL SYSTEMS

drill systems

AP 1000



Introduction

ill Systems began the manufacture and sale of the Percussive Hammer and the Center Sample Rotary Drill as well as drill pipe and accessories has been continually developing equipment particularly suited to today's expanding world markets for mineral exploration, construction, tie backs, requiring low cost, clean sampling methods.

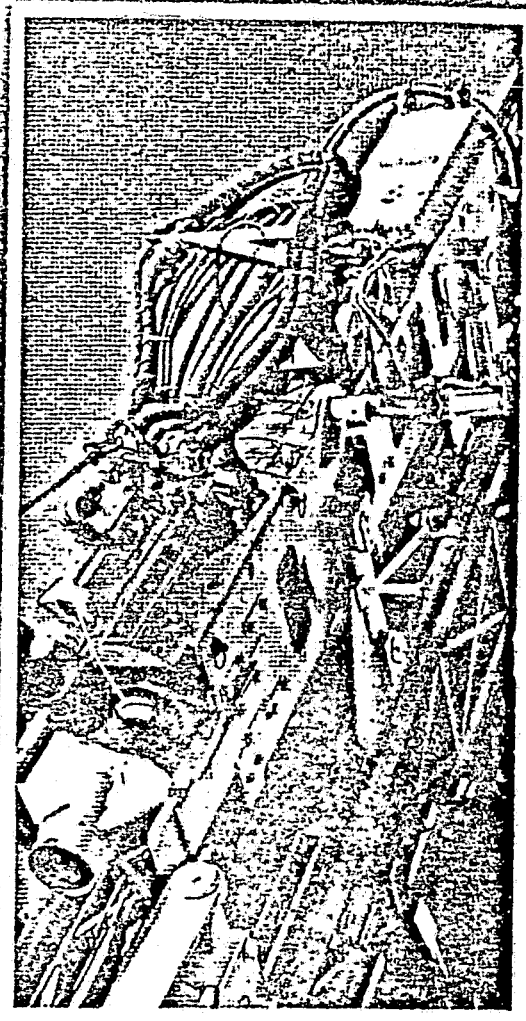
Comparison to conventional drilling methods, either the Percussive Hammer or the CSR drilling techniques are extremely efficient in a variety of overburden soil conditions such as gravel deposits, tills, unconsolidated sediments, or placer deposits. The CSR drilling methods also deal with penetrating solid rock. Both the Percussive Hammer and the CSR drilling methods produce uncontaminated samples that are necessary for proper soil testing and mineral exploration.

The competitive nature of today's mining and construction tie backs business has prompted Drill Systems to constantly improve drilling methods through extensive research and development.

With the introduction of the AP-1000 Drill System has incorporated all the drilling methods into one complete unit. The result has been an all purpose drill that allows the operator to convert between drilling methods with a minimum of labour. Whatever the formation encountered the AP-1000 is equipped with a Percussive Hammer, CSR Rotary Drill, Diamond Rotary drill and a Hammer to perform the job rapidly and efficiently.

Manufactured and Distributed By:

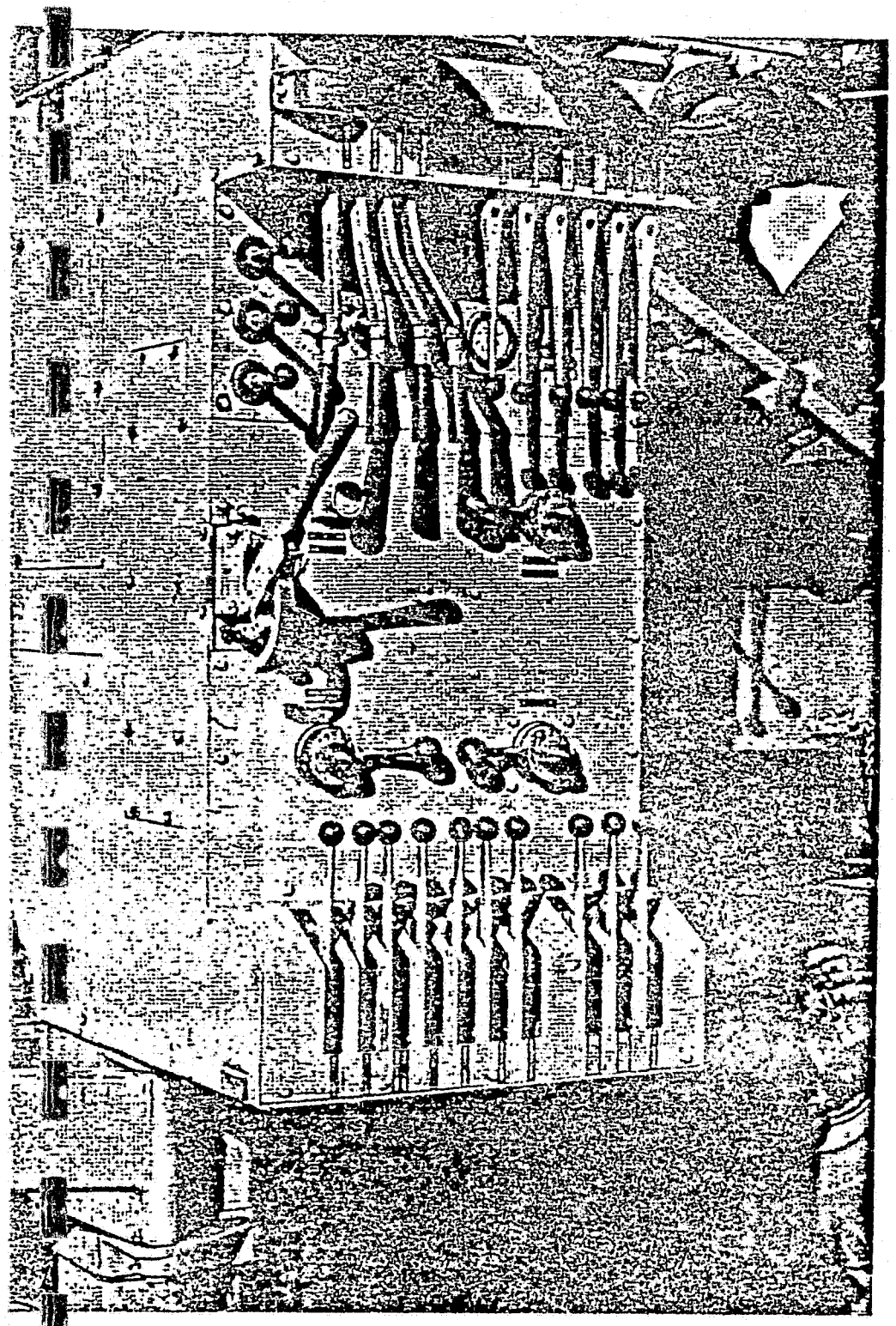
Drill Systems
Division of Challenger International Services Ltd.
Member of the Turbo Resources Group of Companies
111 - 58th Avenue S.W.
Calgary, Alberta T2H 0A3
Phone: (403) 253-7451 Telex: 03-825750



1 Diesel Pile Drive Hammer

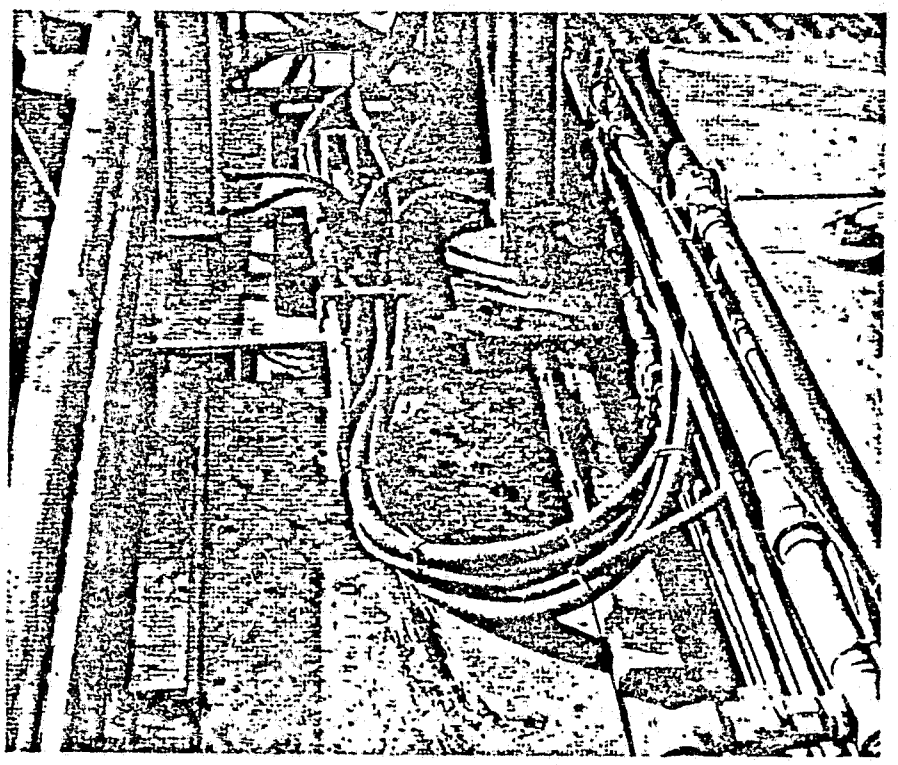
With a force of 8,000 lbs per blow, the diesel pile drive hammer operates at speeds variable to a maximum of 95 blows per minute penetrating the overburden rapidly and efficiently providing immediate accurate analysis of the formation encountered. Using 5" O.D. 3" I.D. or 7" x 5" I.D. drill pipe the hammer is capable of drilling to a depth of 350 ft. dependent upon soil conditions. For maximum efficiency when adding or pulling drill pipe the hammer retracts out of the way.

perator's Console



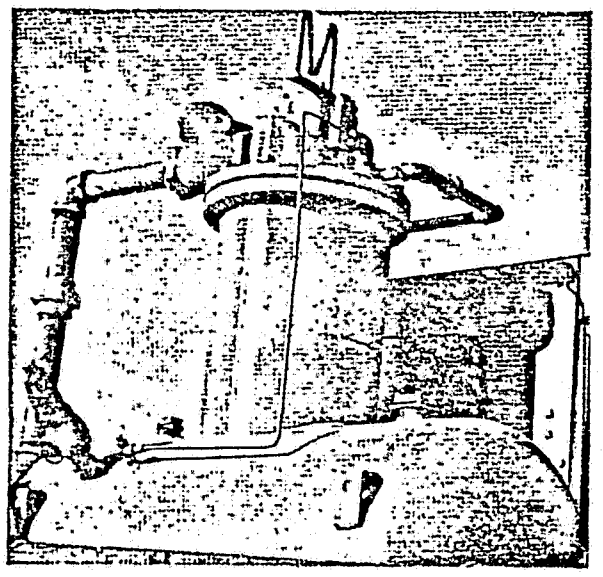
operator in position at the console can control the total drilling ati n, from starting the motor to levelling the drill unit, and commen- dr ng. Gauges for hydraulic oil pressure, water and air pressure cle rly visible for inspection. The controls are arranged in a logical ence so that each drilling procedure can be carried out smoothly.

Deck Features



Angle and Vertical Drilling.

The drill is designed to drill holes from vertical to 45° off vertical. The lateral travel of the mast on the deck and the mast slide, allows the hole to be positioned within working distance of the operator. When pulling drill pipe, the breakout or puller reacts against the ground and relief valves and the mast slide cylinders eliminates loading the mast.



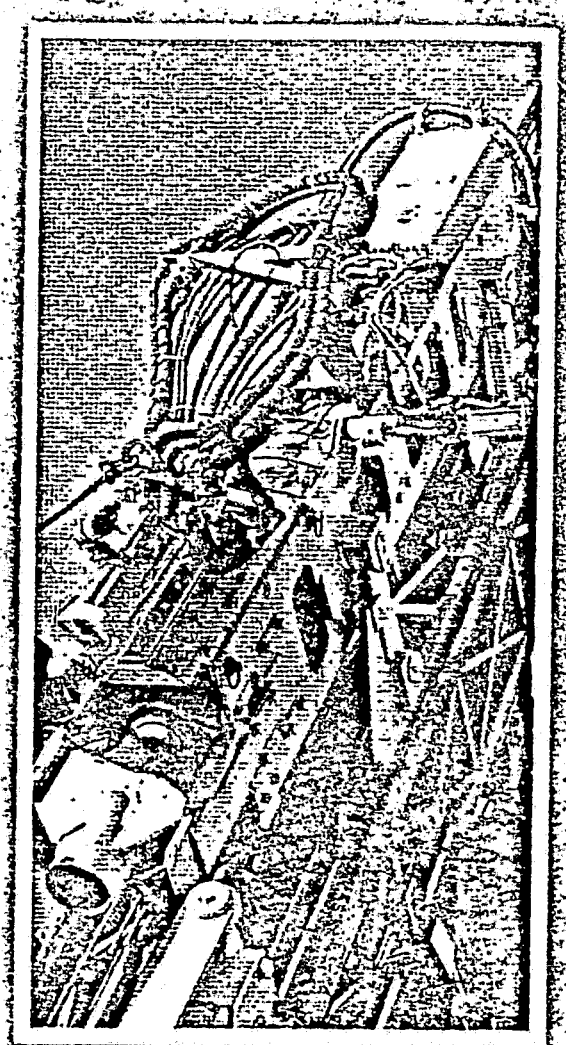
Drill Compressor.

A Sullair Rotary Screw Compressor provides a regular flow of air on demand. Air is supplied at the rate of 750 CFM @ 125 PSI, (optional 250 PSI) cooled and lubricated by an independent oil supply. Power for the compressor is provided by the carrier engine, via the transfer case.

Additional Deck Fea

The deck and control system is readily a system has bee removable sections.

All hydraulic lines, fi tubes have been stan ple replacement. The the deck allow for fu inspection of all pa equipped with a lig night operations.



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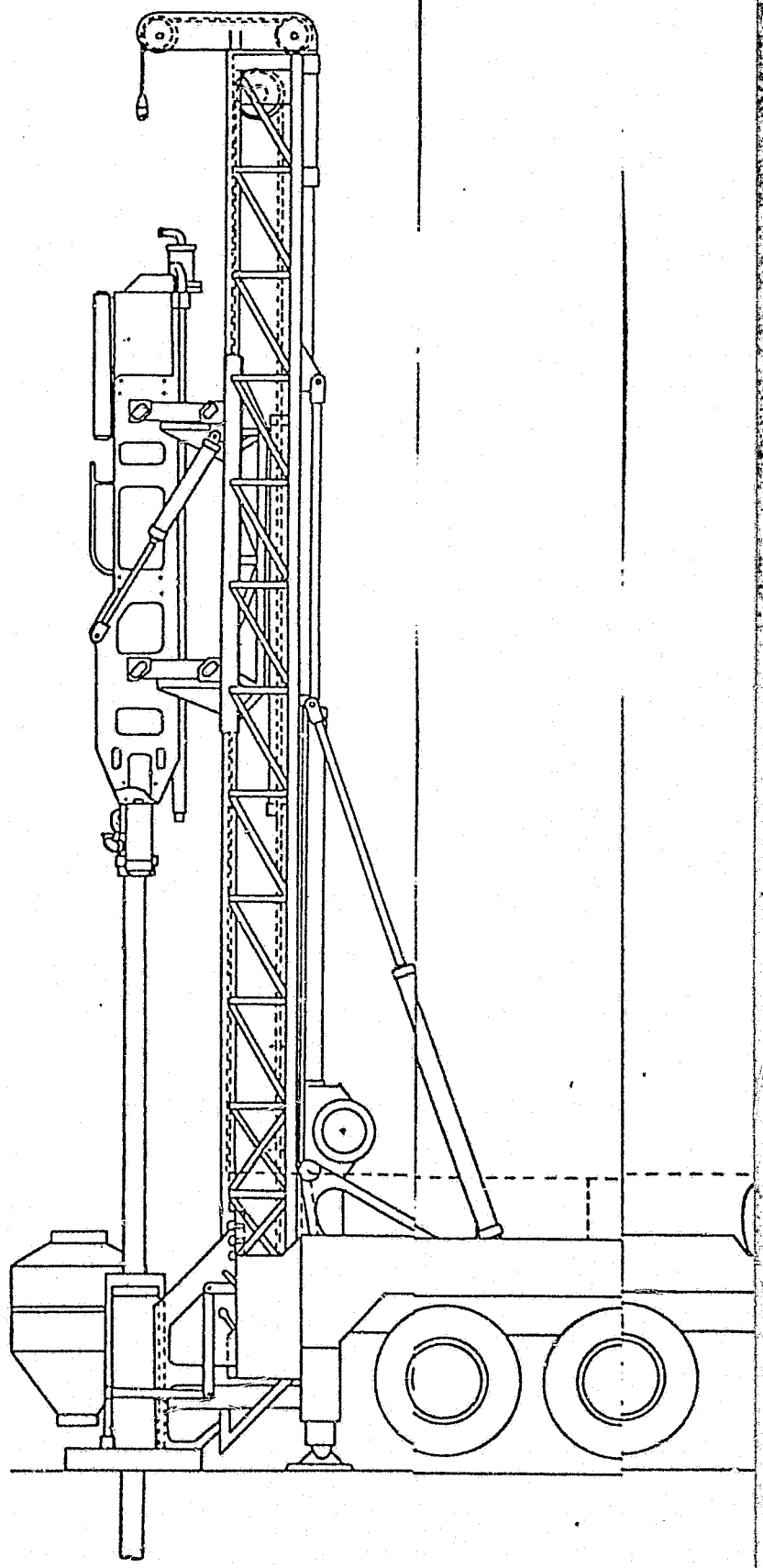

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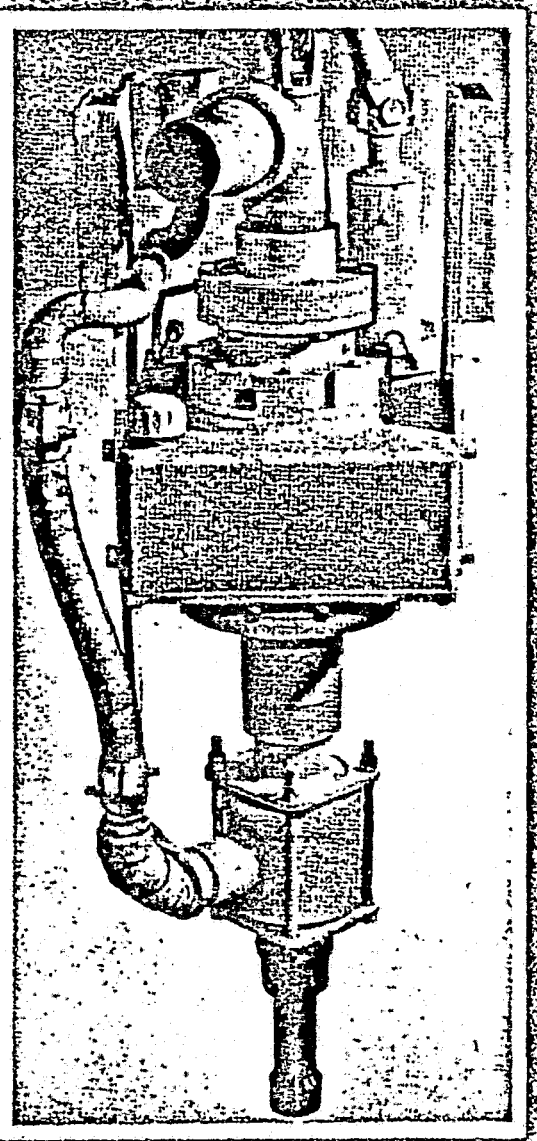
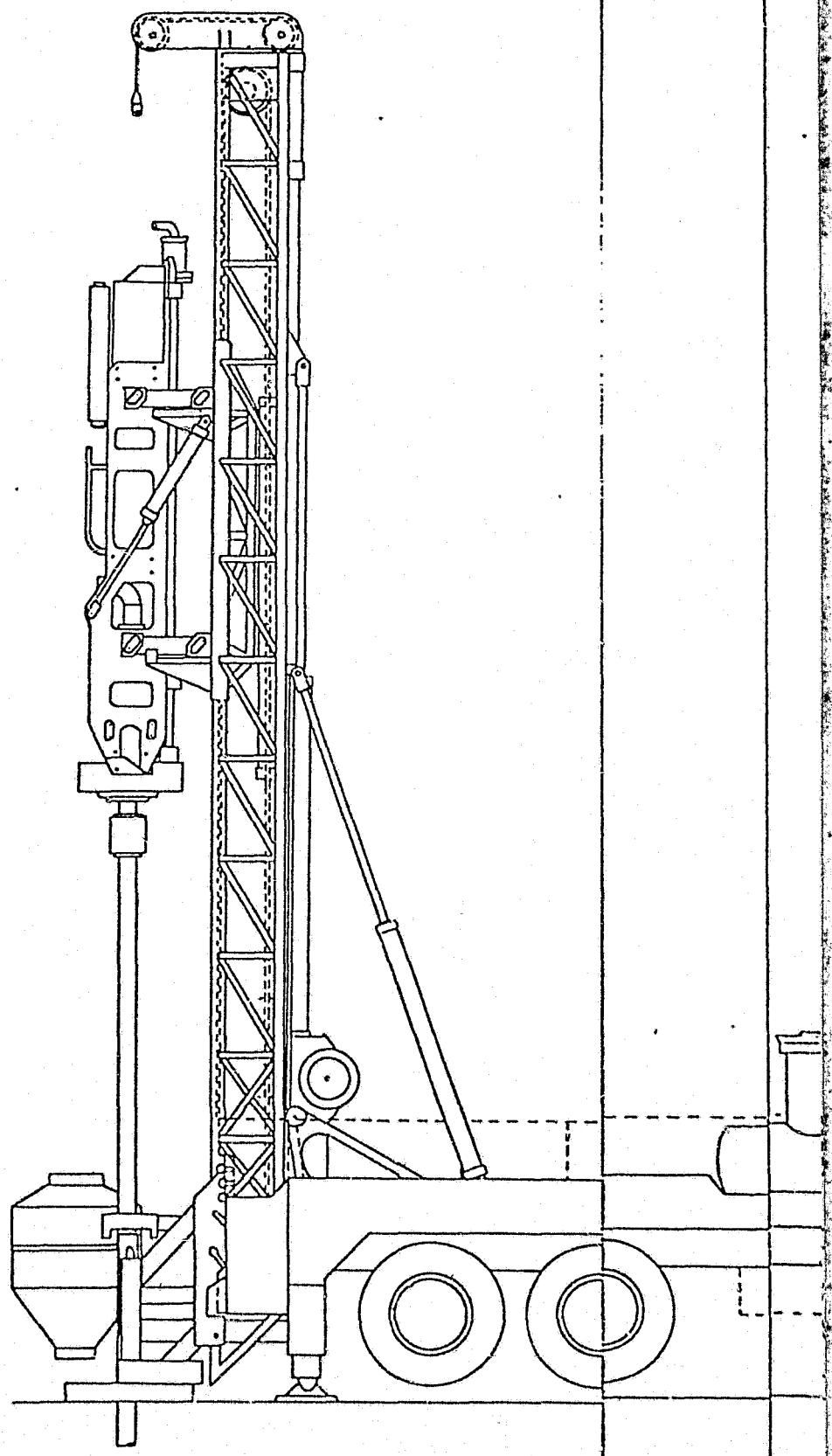
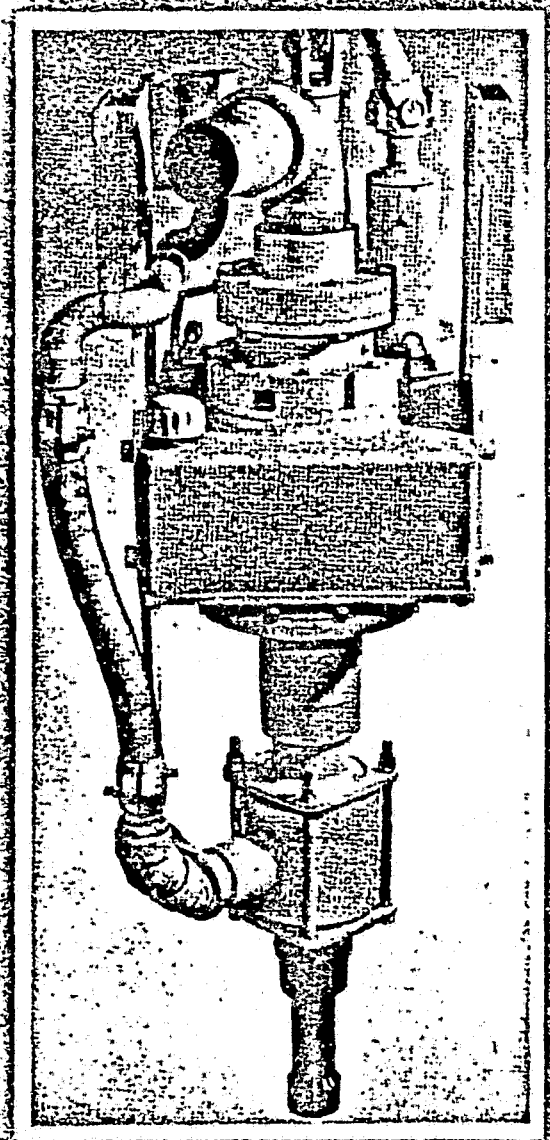


2 CSR Rotary Drive

The CSR rotary drill is an ideal method for soil sampling and mineral exploration. The drill-in water injection system promotes easier drilling and dust suppression when required. The drill produces 4300 ft lbs of torque, variable to a maximum speed of 90 RPM. In ideal conditions, the rotary drill can reach a depth of 1000 ft using 4½" CSR drill pipe.

Optional





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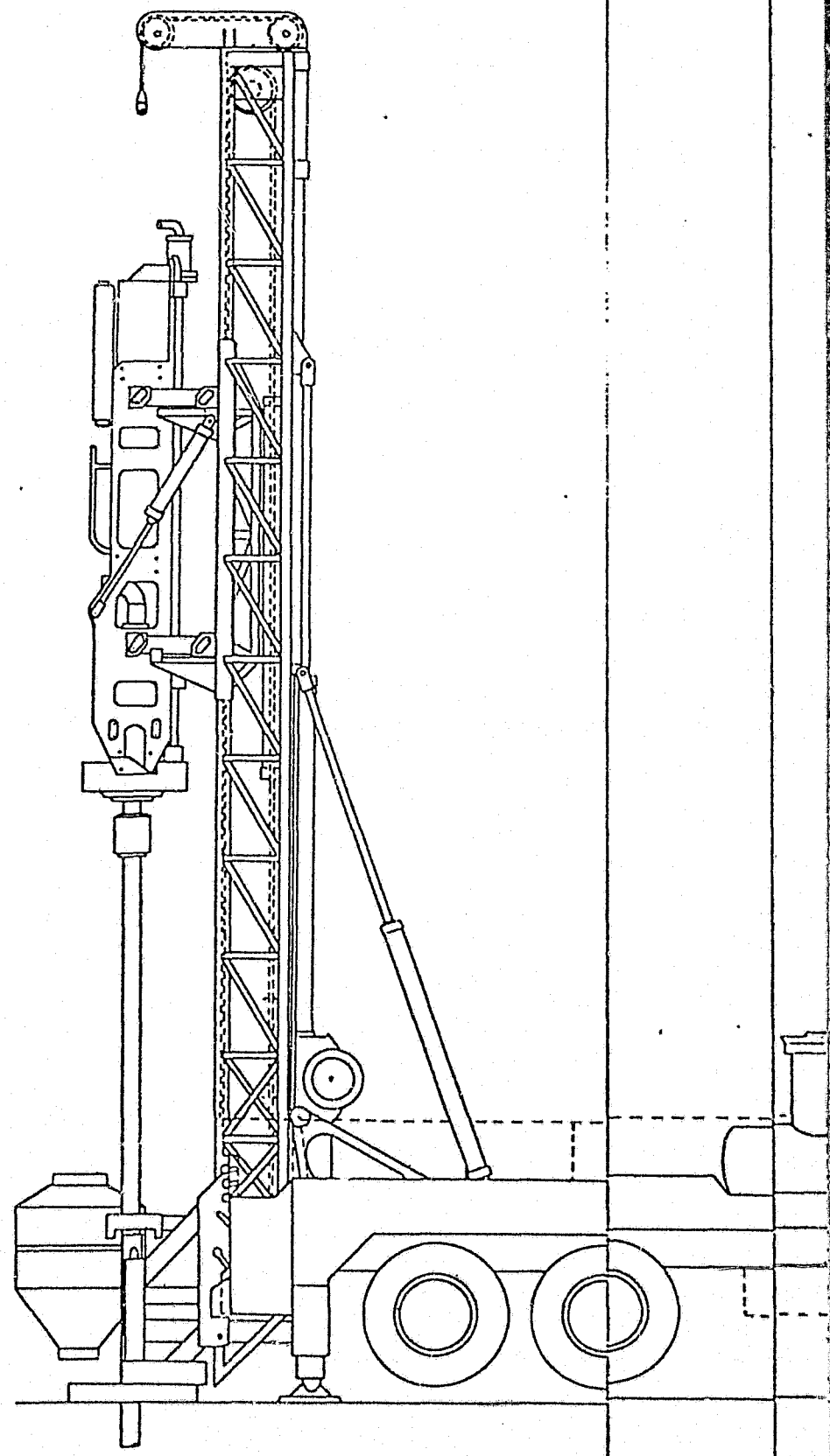
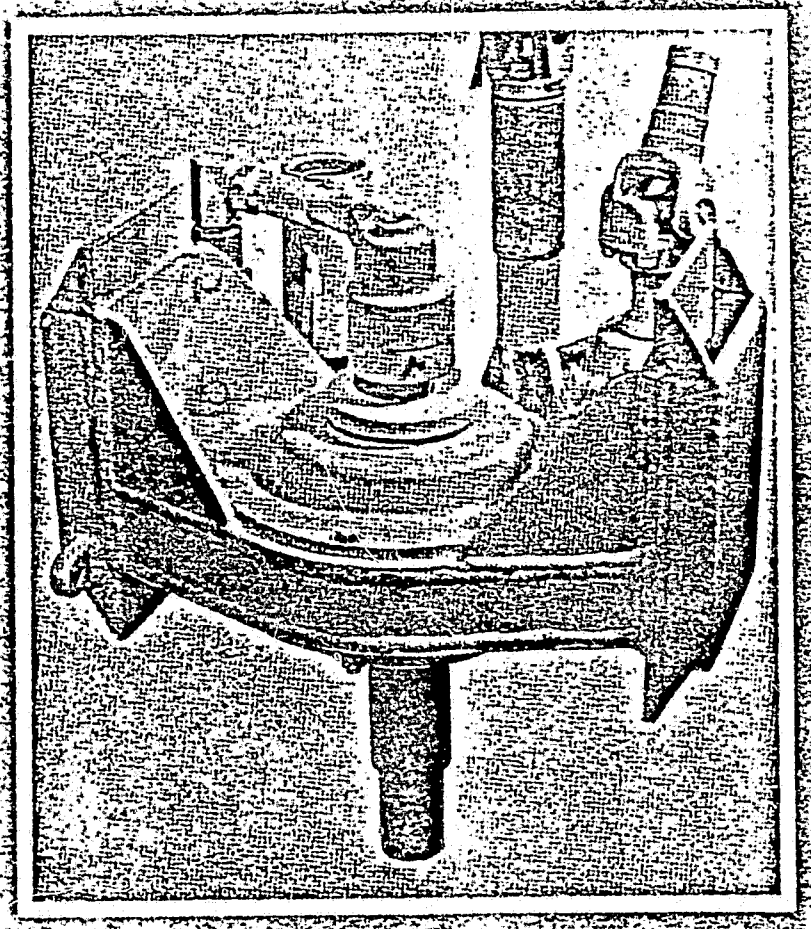
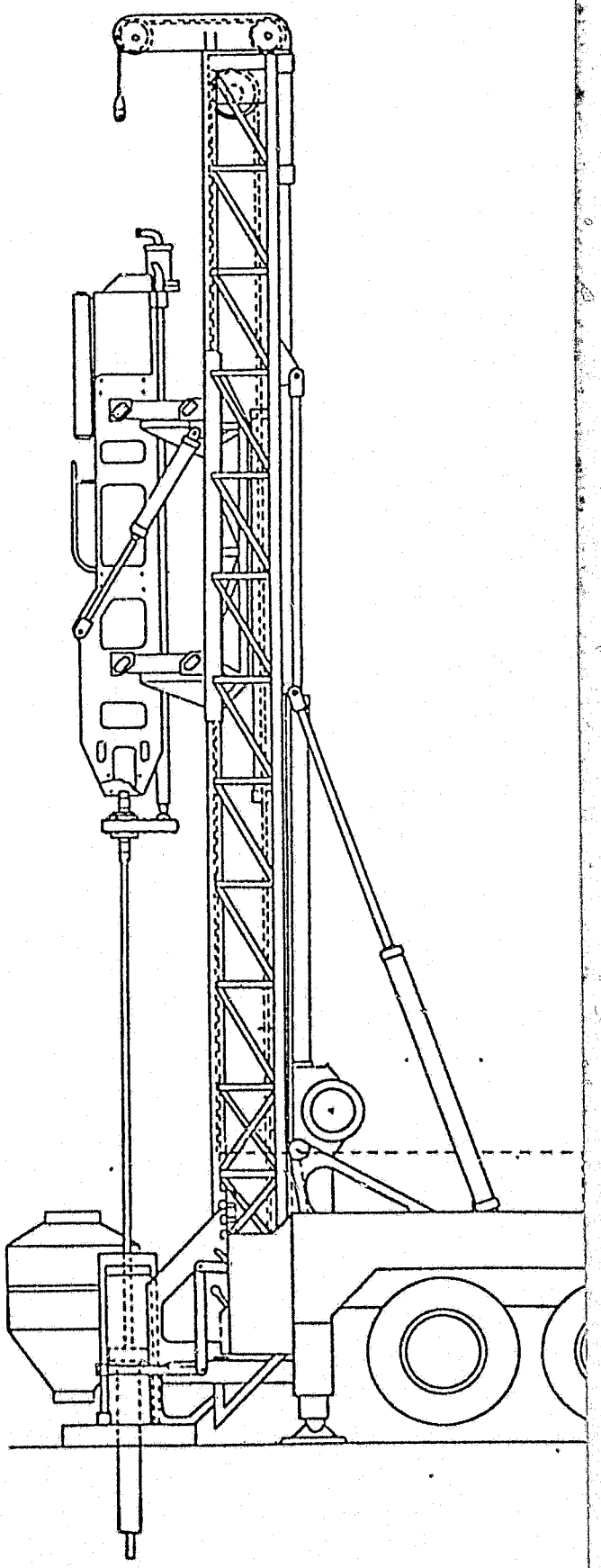


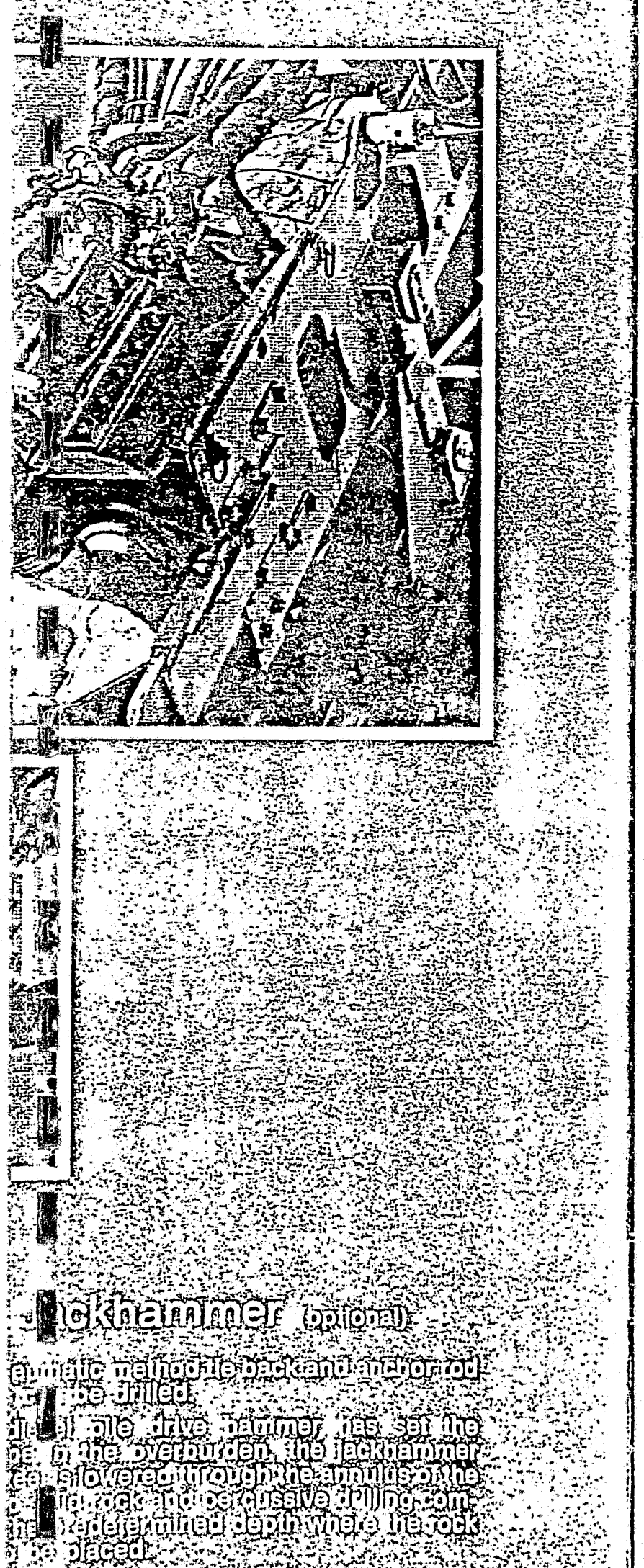


3 Diamond Drill Rotary

The diamond drill rotary is a compact, high speed unit designed for drilling into solid rock once the overburden has been penetrated. Conversion from hammer drilling takes only minutes. The drill produces 720 ft. lbs. of torque, operating at a speed that is variable to a maximum of 600 RPM. Using diamond drill rod the drill can reach a depth of 1500 ft.

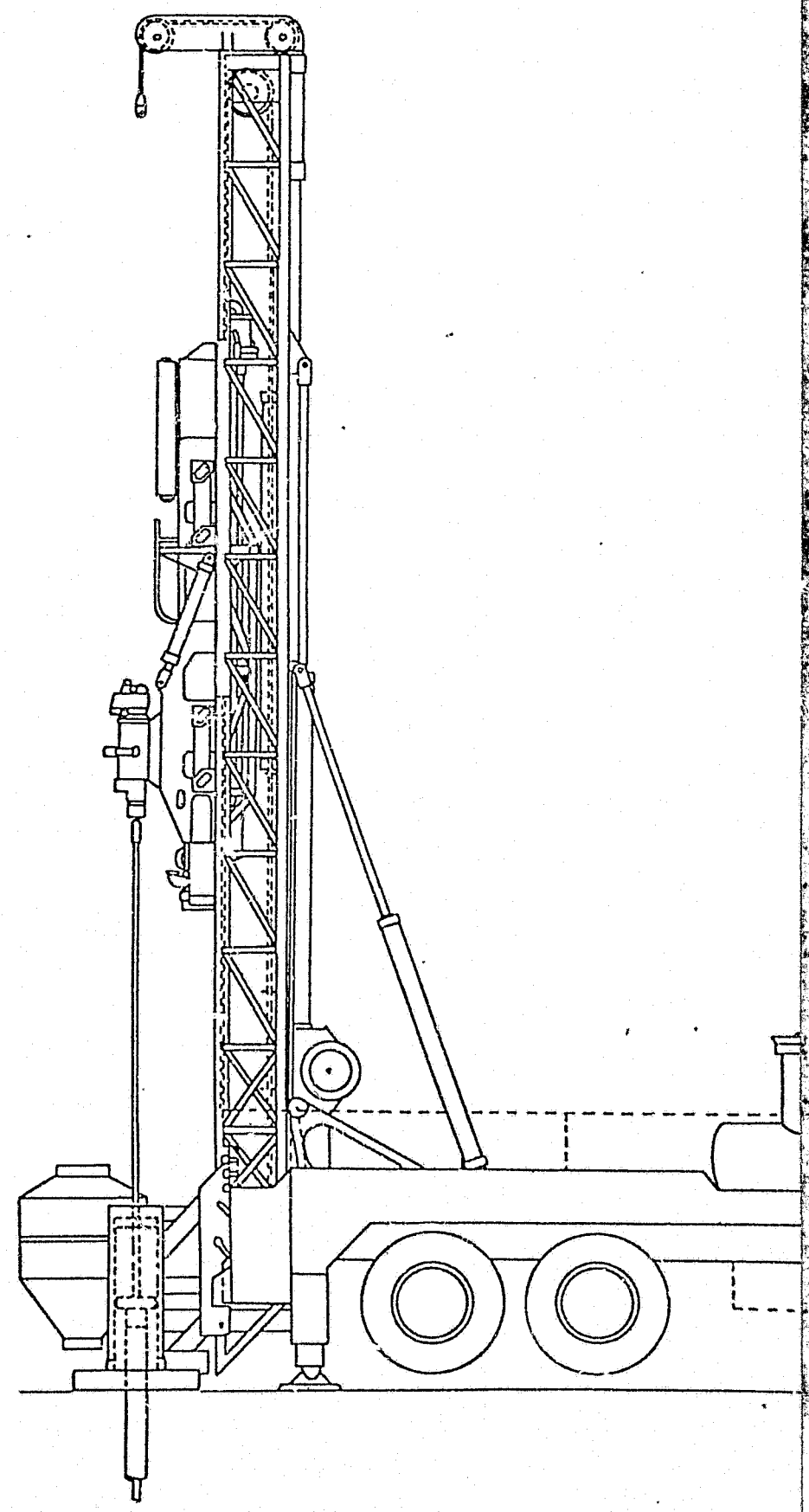
(optional)

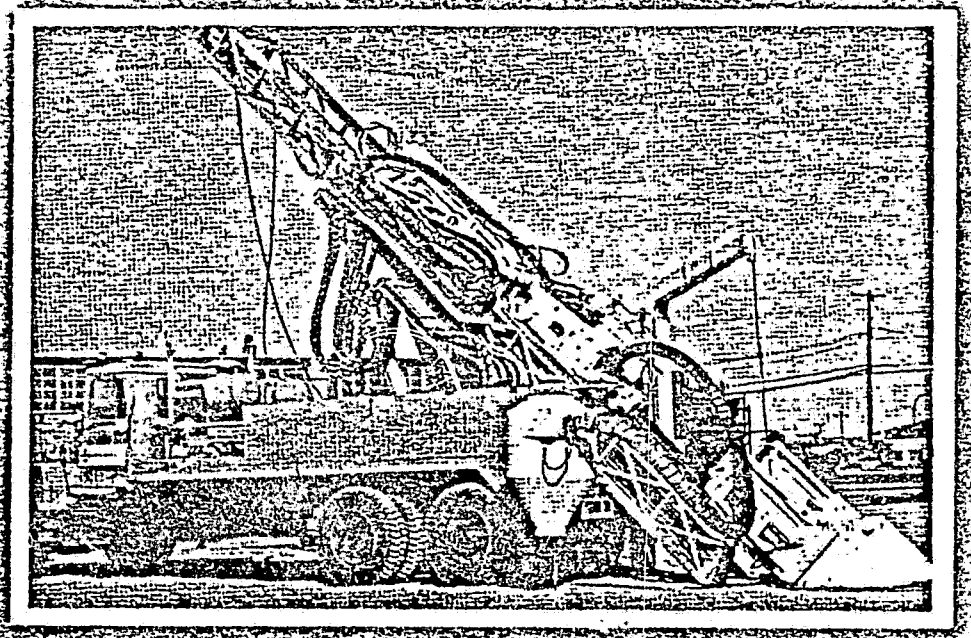


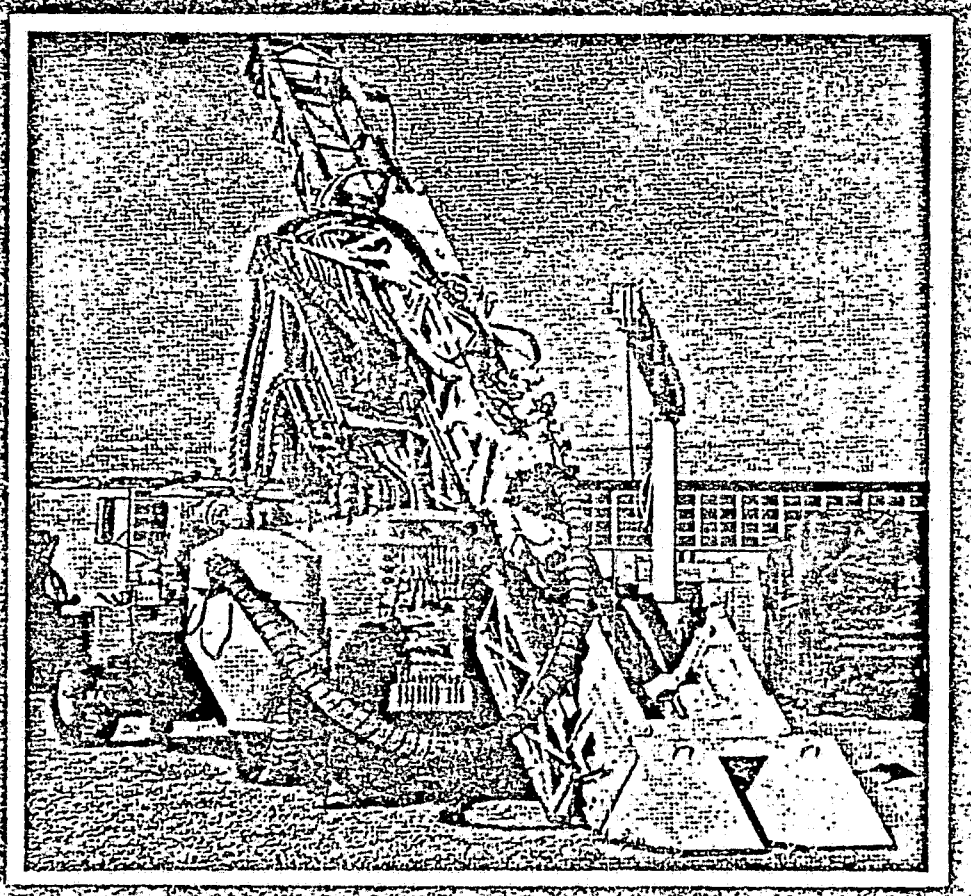


ckhammer (optional)

matic mainpipe backand anchor rod
be drilled.
pile drive hammer has set the
the overburden, the jackhammer
lowered through the annulus of the
rock and percussive drilling com-
ed determined depth where the rock
placed.





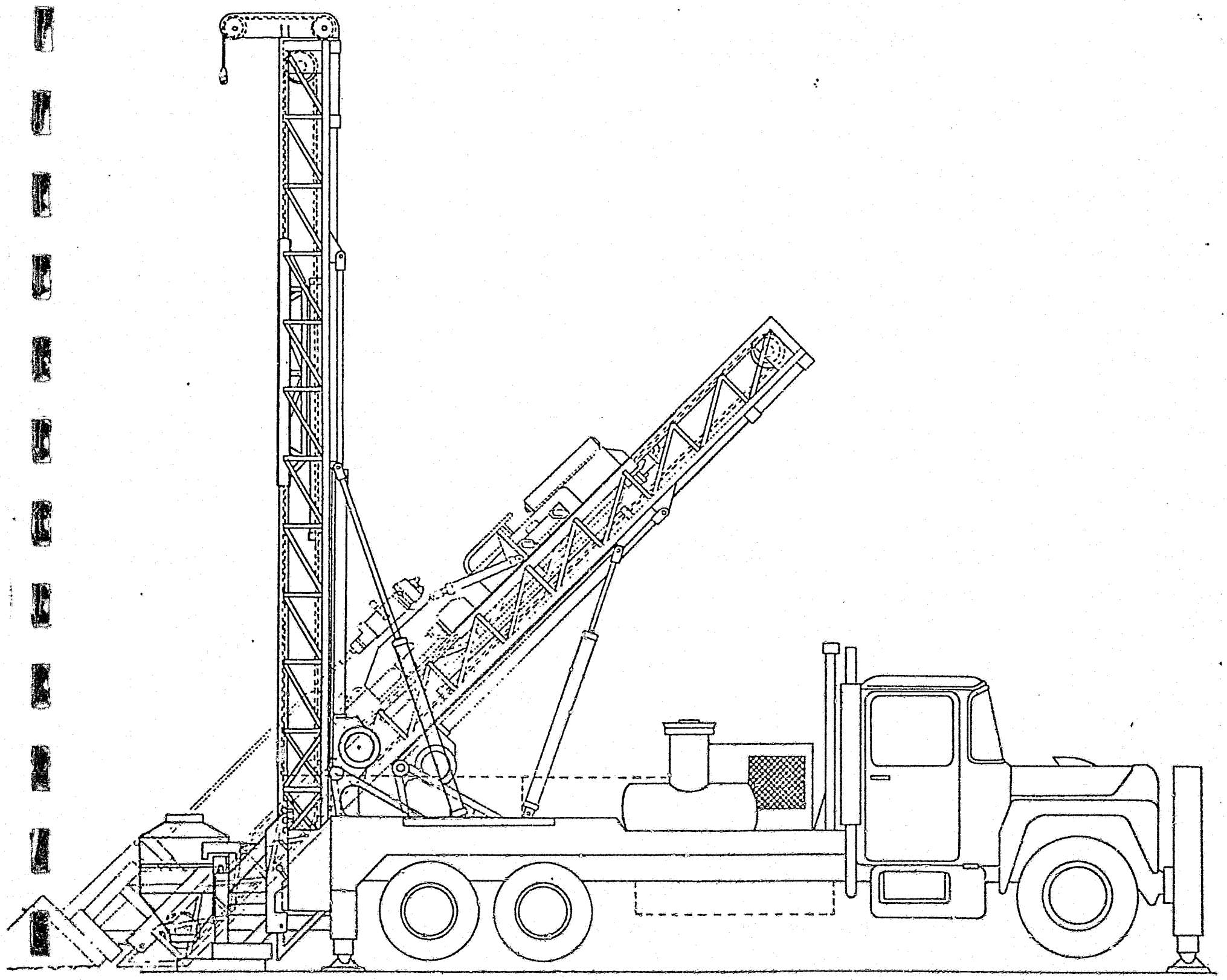


5 Angle Drilling

The drill is designed for vertical and angle hole drilling to a maximum of -5° off vertical. The mast base rests on the ground allowing the forces exerted on the mast to be carried by the surface terrain rather than the mast supports.

The lateral travel and vertical travel of the mast allows the drill hole to be positioned close to the operator providing the operator with an efficient and safe working base.

5



SPECIFICATIONS

DRILLING DEPTH CAPACITY

A. Rotary Drilling
1. CSR rotary drive — 1000 ft., with 4½" CSR drill pipe.
2. Diamond drill rotary — 1500 ft., with diamond drill rod.

B. Percussive Drilling
1. Pile drive hammer drilling — 300 ft., with 5½" hammer pipe.
2. Jackhammer (optional) — 400 ft., with drill steel.

CSR Rotary Drive
— produces 4300 ft. lbs. of torque.
— maximum speed, 90 RPM infinitely variable.

Diamond Drill Rotary
— produces 720 ft. lbs. of torque.
— maximum speed, 600 RPM infinitely variable.

Diesel Pile Drive Hammer
— Link Belt 180.
— equivalent wh energy maximum ft. lbs. 8100.
— hp rating 23.3.
— speed, blows per minute, 95 infinitely variable.
— fuel oil capacity, 5.5 gals.
— lub oil capacity, 1.9 gals.

Jackhammer (optional)
— from major manufacturers of jackhammers.

Total weight
— 34,000 lbs., less carrier.

Mast
— constructed of A-500 tube steel.
— width between legs on front of mast, 27".
— depth, 20".
— drill pipe centerline, 21⅞" ahead of the mast.
— will accept 10 ft. pipe lengths.

Levelling jacks
— front, one 4" bore x 36" stroke.
— rear, two 4" bore x 24" stroke.

Breakout assembly
— breakout torque, 8000 lb. ft.
— spinning torque, 750 lb. ft.

Spinning wrench assembly
— 600 ft. lbs. of force.

Puller assembly
— 100 ton force. — 30" stroke.

Pullup and pulldown
— accomplished through two 4" hydraulic cylinders.
— travel, 14 ft.
— pullup force, 20,000 lbs.
— pulldown, 24,000 lbs.
— feed rate variable to a max. of 22 ft. per min.

Hydraulic System
— tandem gear pump supplies hydraulic power for all the major components of the drill.
— 1. supplies 60 GPM @ 2000 PSI.
— 2. supplies 45 GPM @ 2000 PSI.
— fluid reservoir, 150 U.S. gals.

Compressor
— Sullair Rotary Screw type.
— provides air as drilling fluid at the rate of 750 CFM @ 125 PSI. optional 250 PSI.
— speed infinitely variable.

Water injection
— hydraulically operated pump.
— injects water at 600 PSI.
— flow rate 20 GPM.
— speed infinitely variable.

Winch
— produces 22,000 lbs. of line pull.
— line speed is variable to a maximum of 75 ft. per minute.

Pipe size, hammer
— 5½" o.d. x 3¼" i.d. — 9" o.d. x 6" i.d.
— 6⅝" o.d. x 4¼" i.d.

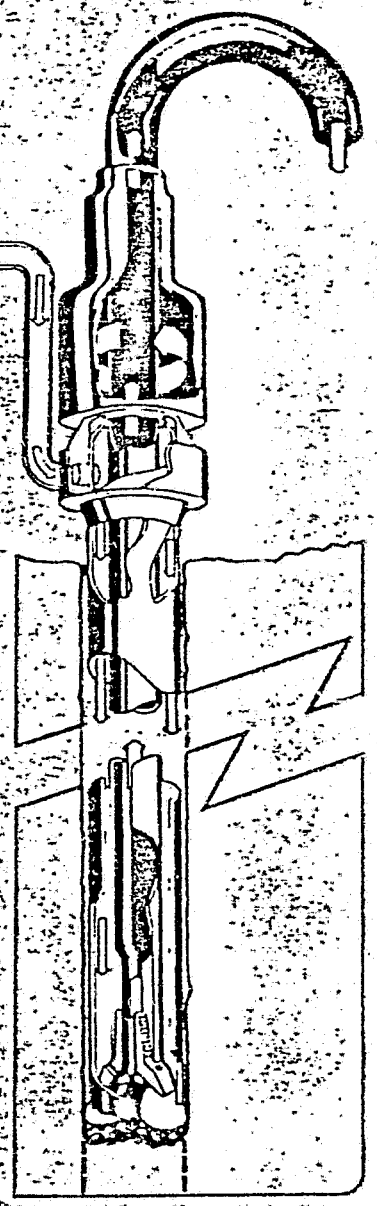
Pipe size, CSR
— 3½" o.d. x 1¾" i.d. — 5½" o.d. x 3¼" i.d.
— 4½" o.d. x 2-7/16" i.d.

RECOMMENDED CARRIER

— tandem axle conventional.
— 16,000 lb. front axle. — 44,000 lb. rear tandem suspension.
— front tires, 16.5 x 22.5, 18 ply rating.
— rear tires 10.0 x 20.0, 12 ply rating.
— engine brake hp 285 and 1800 RPM, governor full load speed 2100 RPM.
— transmission as desired.
— fuel tanks, 90 to 95 gal. capacity.
— electrical, 12 volts, 75 amps.
— cooling system, automatic shutter on radiator for operating in hot or cold temperatures, radiator should be adequate for expanded stationary operation.
• suitable all-terrain vehicles meeting the above hp requirements may be used.

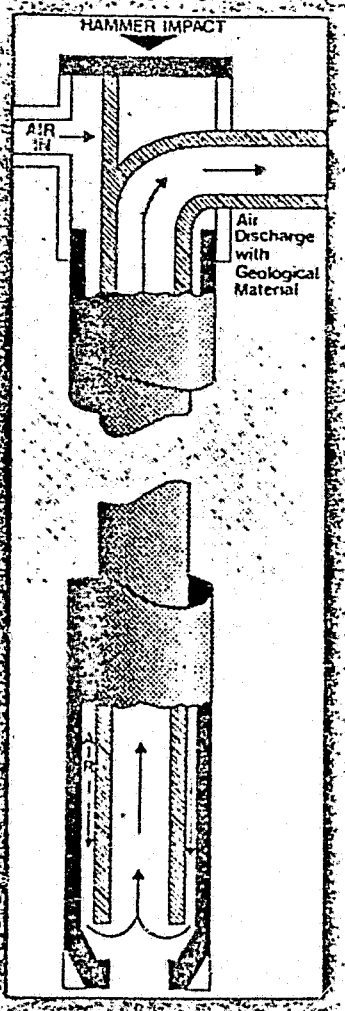
— all specifications are subject to change without notification —

Basic depth ratings, arrived at by using the specific drill pipe diameters stated herein, are dependent upon suitable drilling conditions, and may vary as a result of excessive amounts of water or other in-hole conditions. However, diameters within the normal range of this drill, can be exceeded under favorable conditions using specialized procedures



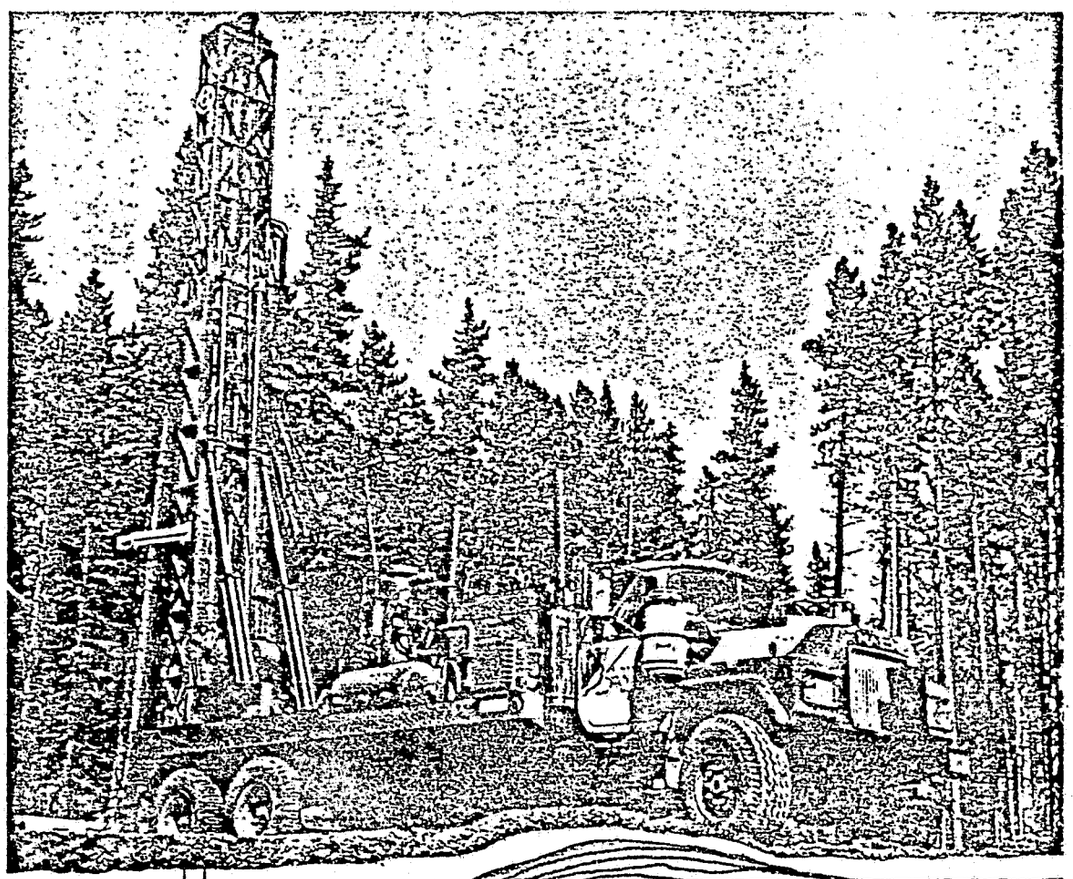
CSR Drilling Method

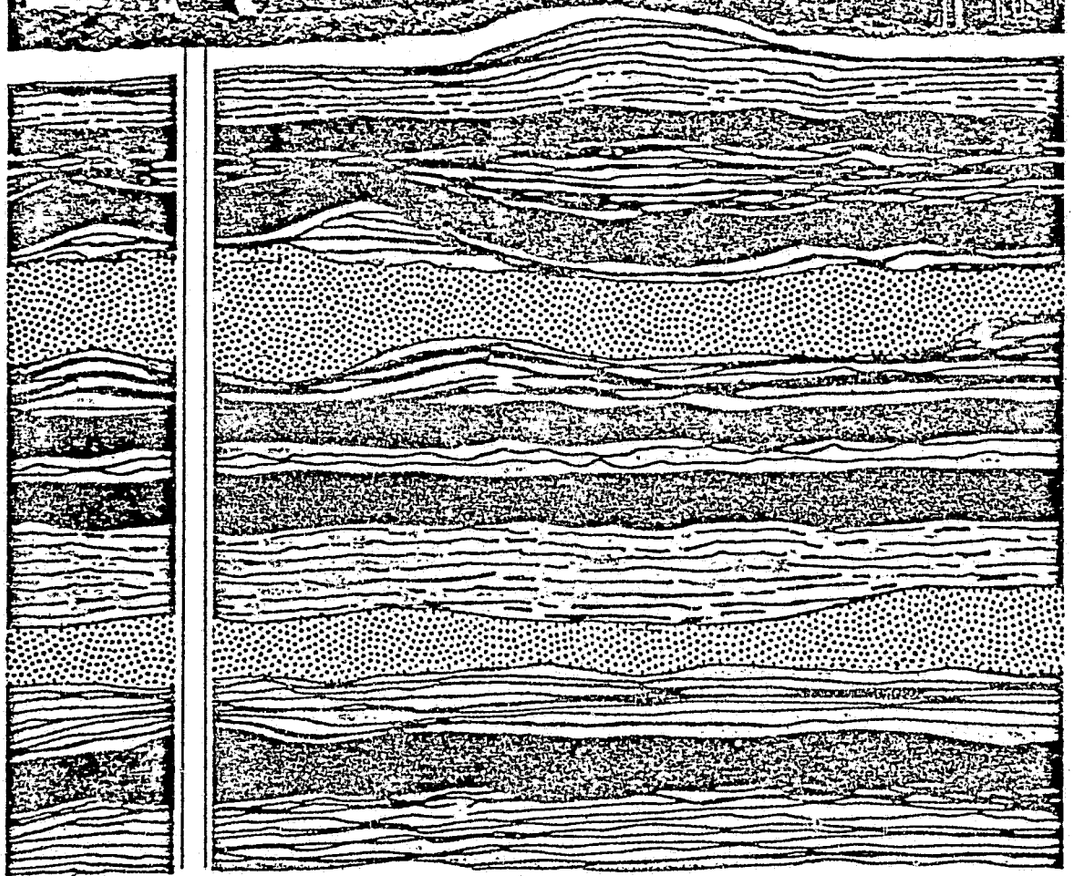
CSR drill pipe consists of two pipes, one within the other. The outer pipe is designed to the torque and shock loads that are transmitted in conventional rotary drilling. The actual drilling and sampling bit is fastened to the bit sub. The drilling fluid (air, water, air mist) is injected down the outer pipe across the bit face. The drilling fluid is returned up the inner pipe to the surface with the sample cuttings. The samples are returned continuously and uncontaminated.



Percussive Hammer Method

The percussive method uses dual wall pipe driven by a diesel pile hammer to penetrate the overburden rapidly and efficiently, providing immediate accurate analysis of the formation encountered. Through reverse circulation, air or water is forced down the annulus of the pipe, returning all cuttings to the surface through the center of the pipe, providing a continuous and uncontaminated sample.





DRILL SYSTEMS

CSR - 1000AV

DRILL SYSTEMS

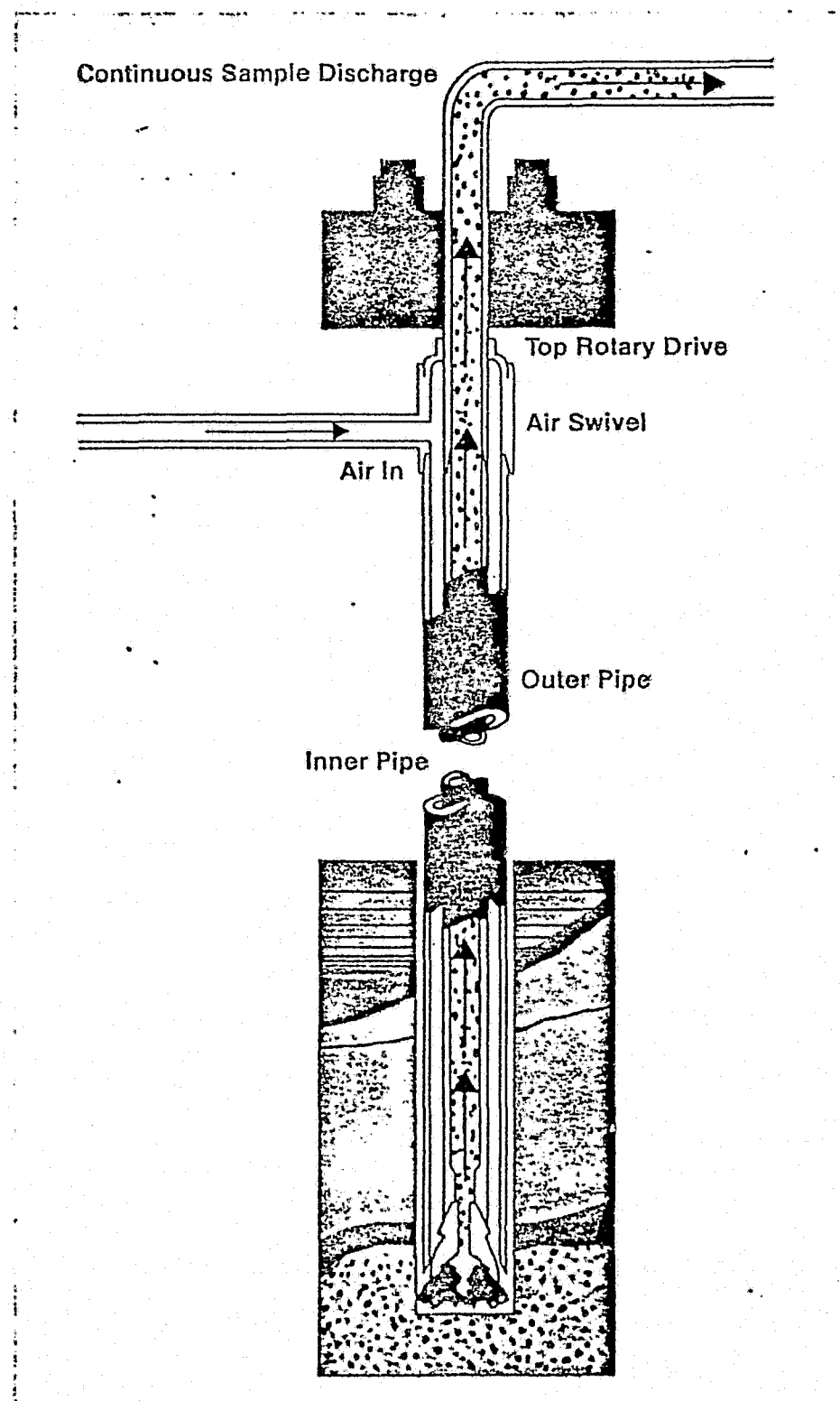
INTRODUCTION

Drill Systems is a leader in the development and manufacture of the "Becker" hammer drill and the performance proven CSR1000 rotary drill. Drill Systems has also developed and manufactures reverse circulation drill pipe and related drilling accessories which are particularly suited to today's requirements for low cost and highly accurate sampling systems.

In comparison to conventional drilling methods the reverse circulation techniques are extremely effective in a variety of overburden soil conditions such as gravel deposits, till, unconsolidated sediments or placer deposits. Reverse circulation drilling provides the representative samples necessary for accurate soil testing and mineral exploration.

REVERSE CIRCULATION (Dual Tube) by Drill Systems

The reverse circulation systems provides continuous representative sampling and ensures fast and economical drilling. The drilling fluid (air, water, drilling mud, air mist) is injected down the pipe annulus, and across the bit face. The drilling fluid is then returned at high velocity up the inner tube with all cuttings.



APPLICATIONS

- Mineral exploration
- Geotechnical sampling
- Construction drilling
- Placer mining
- Water well drilling
- system is compatible with down the hole hammers

ADVANTAGES:

- continuous representative samples are provided
- high production
- increased bit life
- maximum return of sample in lost circulation zones
- minimal loss of drilling fluid in lost circulation zones
- samples are returned through the centre tube eliminating all contact from the actual hole

CONVERSION PACKAGES

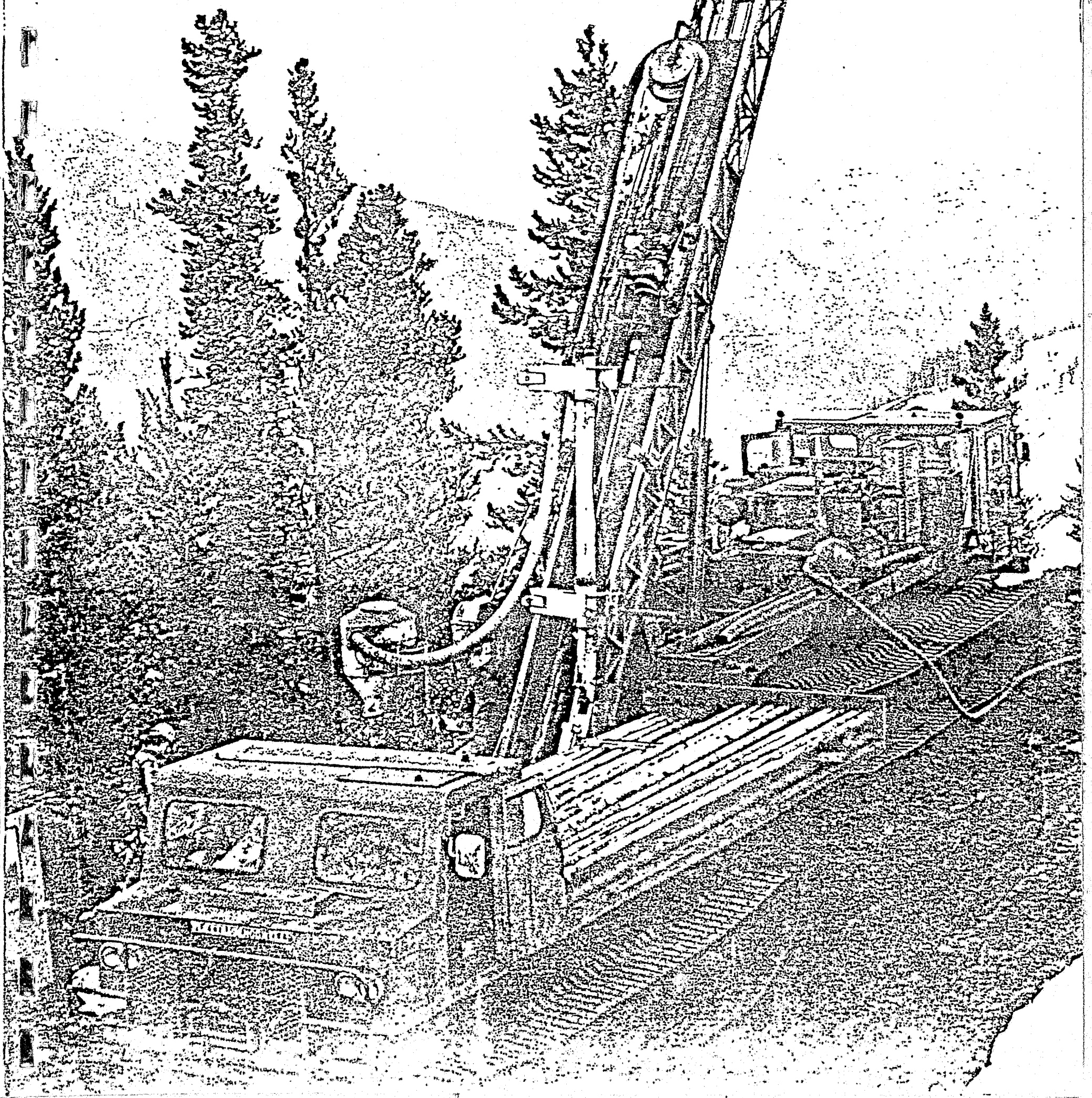
Drill Systems can convert most top head rotary drill rigs to reverse circulation drilling. Conversion kits and drill pipe are available from stock.

ANGLE & VERTICAL DRILLING

The drill is designed to drill holes from vertical to 45° off vertical. The lateral travel of the mast on the deck allows the hole to be positioned within working distance of the operator. The mast base rests on the ground allowing the force exerted on the mast to be carried by the surface terrain rather than the mast rest.

HYDRAULIC PIPE CHANGER

Provides extremely quick and efficient addition or removal of drill pipe.



DRILL SYSTEMS

1 ANGLE & VERTICAL DRILLING

The drill is designed to drill holes from vertical to 45° of vertical. The lateral travel of the mast on the deck allows the hole to be positioned within working distance of the operator. The mast base rests on the ground allowing the force exerted on the mast to be carried by the surface terrain rather than the mast rest.

2 OPERATOR'S CONSOLE

The operator in position at the console can control the total drilling operation, from starting the motor to leveling the drilling unit and commencing drilling. Gauges for the total operation are clearly visible. All controls are arranged in a logical sequence to ensure smooth operation.

3 DRILL COMPRESSOR

A rotary screw compressor provides air at a rate of 750 CFM at 350 PSI. The compressor is cooled and lubricated by an independent oil supply. Power for the compressor is provided by the carrier engine via the transfer case.

4 ROTARY TOP DRIVE

Produces 51,600 in. lbs. of torque (optional 66,900 or 81,000 in. lbs.). Speed is variable to a rate of 100 rpm. .

5 HOSE REEL ASSEMBLY

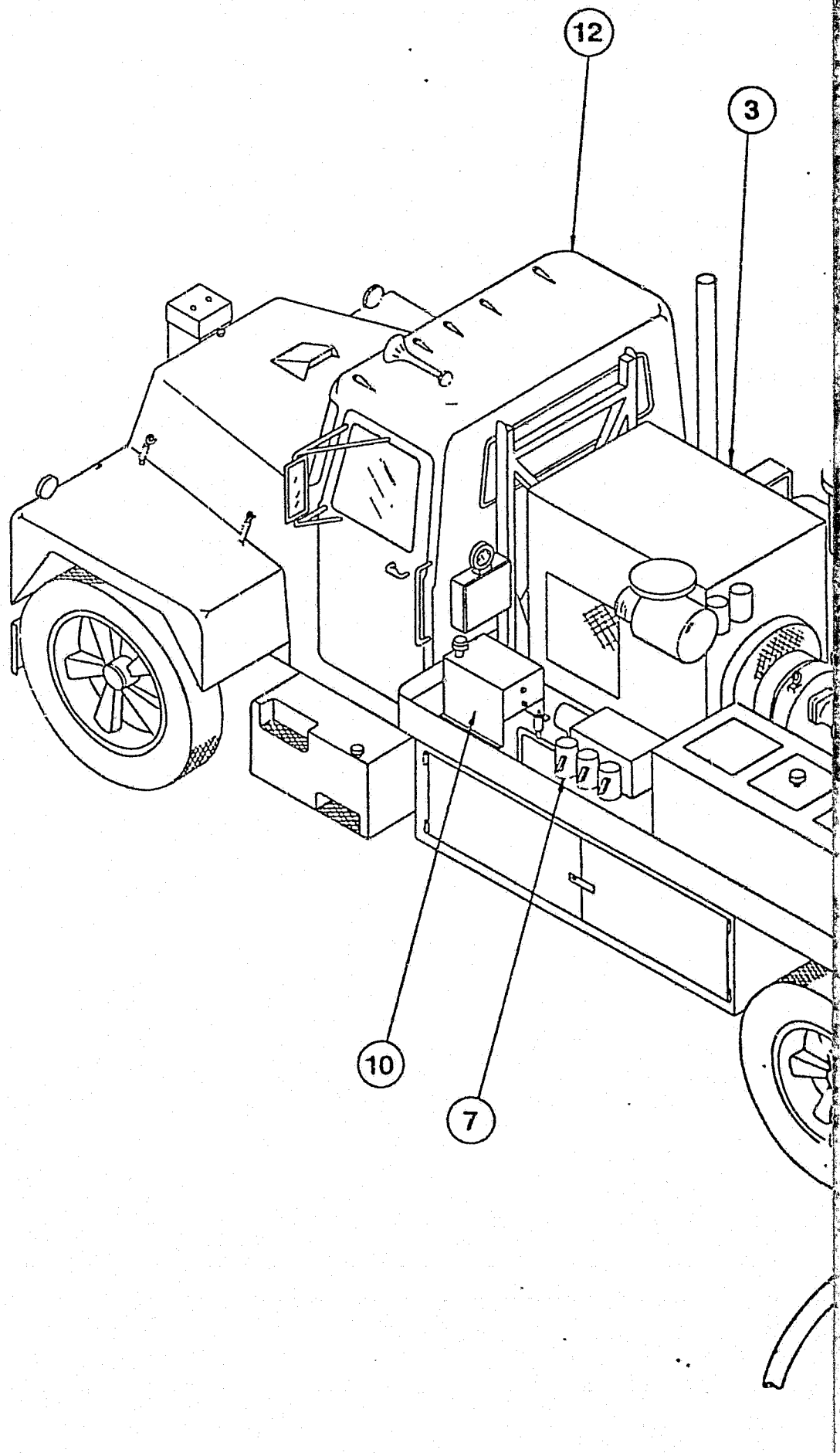
Allows the discharge hose to travel freely up and down the mast ensuring trouble free operation.

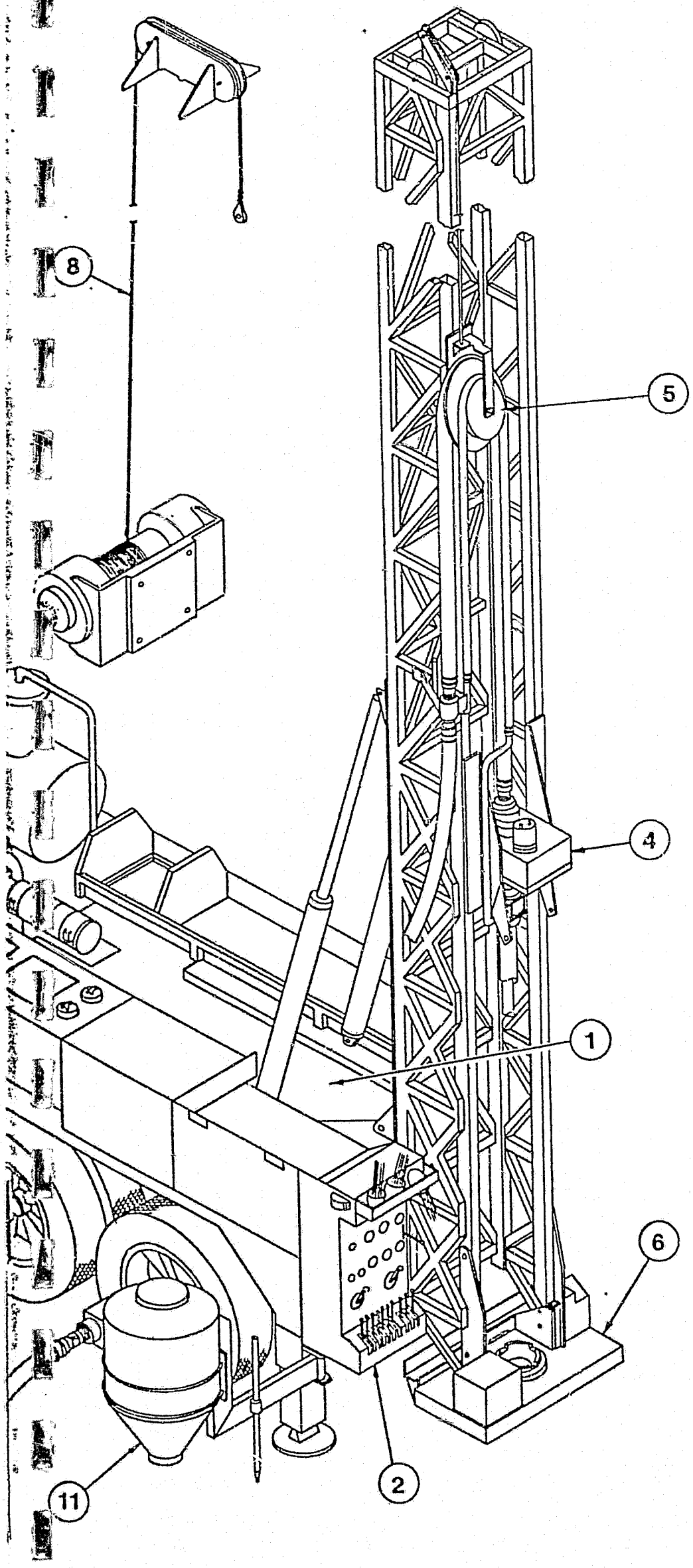
6 ROTARY BREAKOUT

Twin hydraulic motors ensure quick and efficient separation of drill pipe.

7 WATER INJECTION

— hydraulically operated pump
— injects water at 600 PSI (4100 Kpa)
— flow rate variable to 20 GPM (76 L min)
— speed variable to maximum rated delivery





8 WINCH

— produces 22,000 lbs (98,000 N) of line pull
— line speed is variable to a maximum of 75 feet per minute (23 M/MIN)

9 HYDRAULIC PIPE CHANGER

Provides extremely quick and efficient addition or removal of drill pipe.

10 AIR LINE LUBRICATOR

Provides lubrication to hammer drill tools at a fully adjustable flow rate. Reservoir has a 7 gallon capacity.

11 CYCLONE

Efficiently separates the sample from the drilling air (fluid).

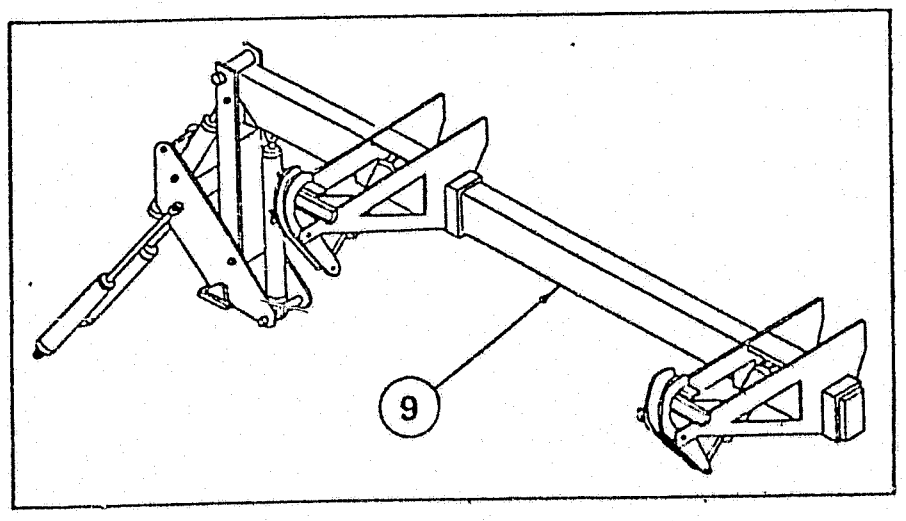
12 CUSTOM CARRIER

Drill unit is designed for mounting on a carrier (truck or tracks) of customer's choice.

ADDITIONAL FEATURES

The deck and control console hydraulic system is readily accessible as the system has been designed in removable sections.

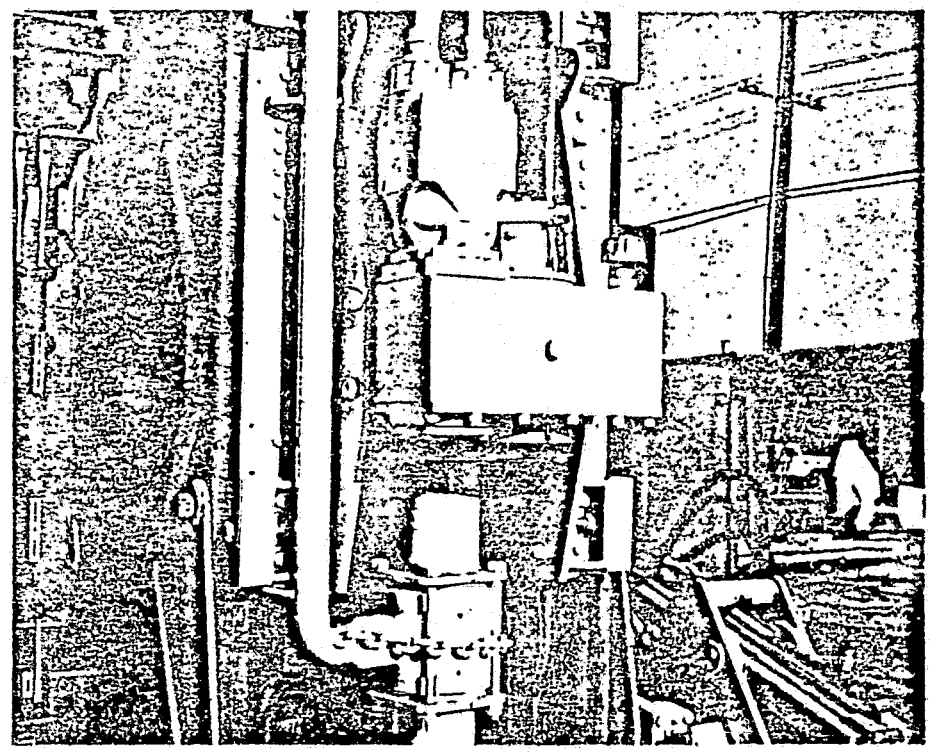
All hydraulic lines, fittings, hoses and tubes have been standardized for simple replacement. The cover plates on the deck allow for full access to all parts.



DRILL SYSTEMS

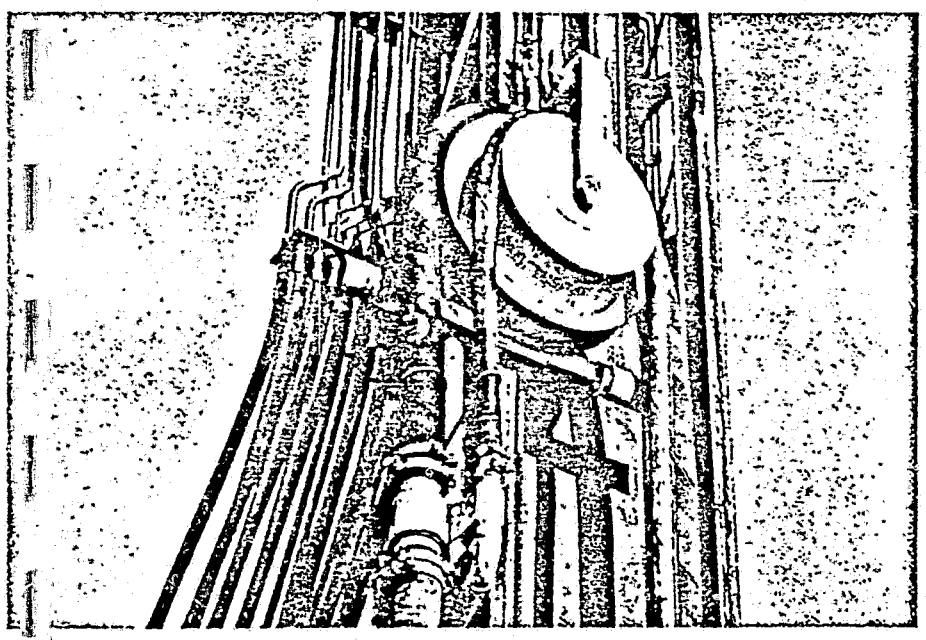
DRILLING ACCESSORIES

Drill Systems manufactures a full range of drilling accessories including conventional and reverse circulation drill pipe.



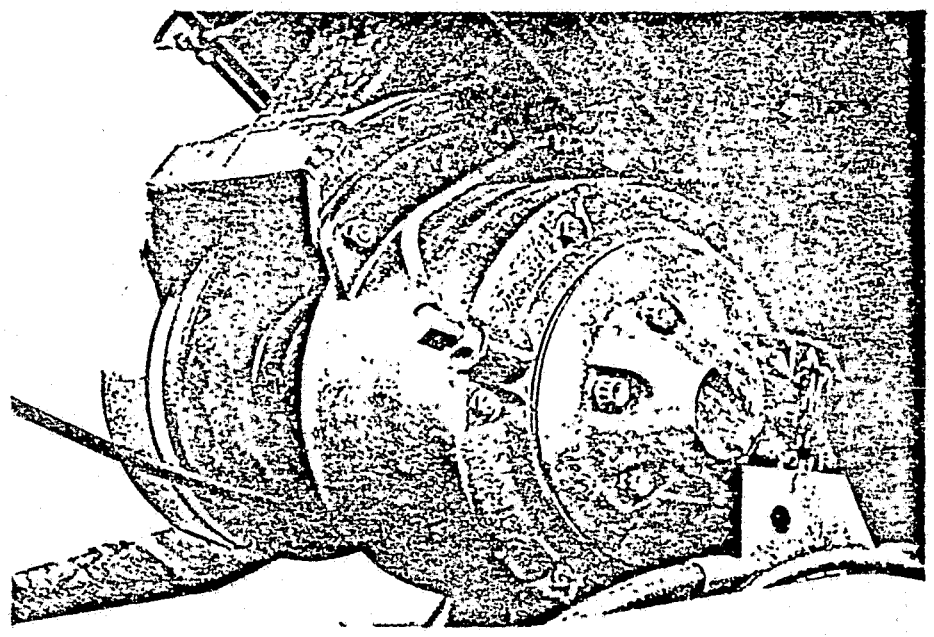
Rotary Top Drive

Produces 51,600 in. lbs. of torque (optional) 66,900 or 89,000 in. lbs.



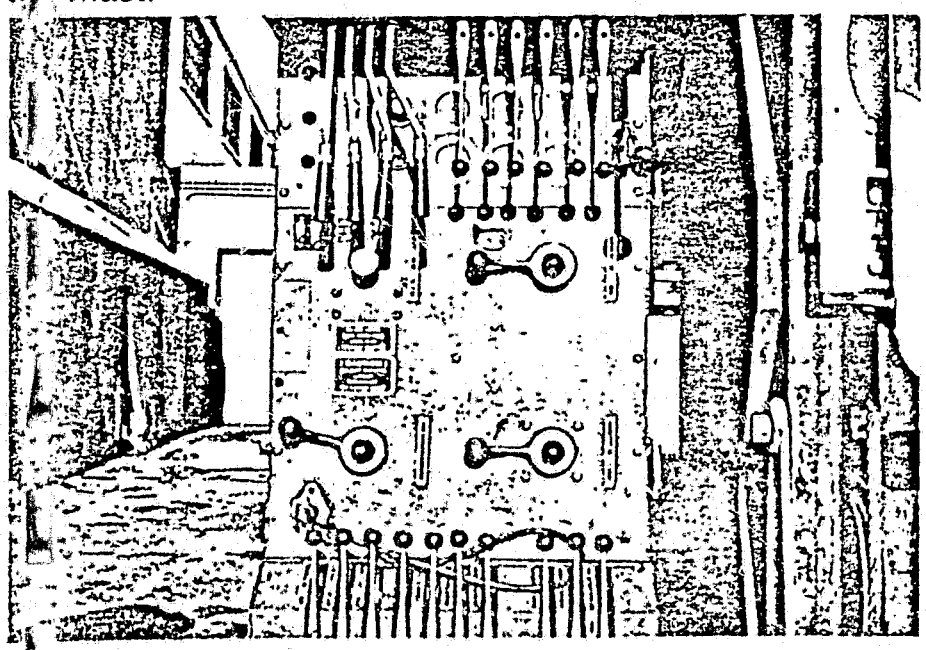
Hose Reel Assembly

Allows discharge hose to travel freely up and down the mast.



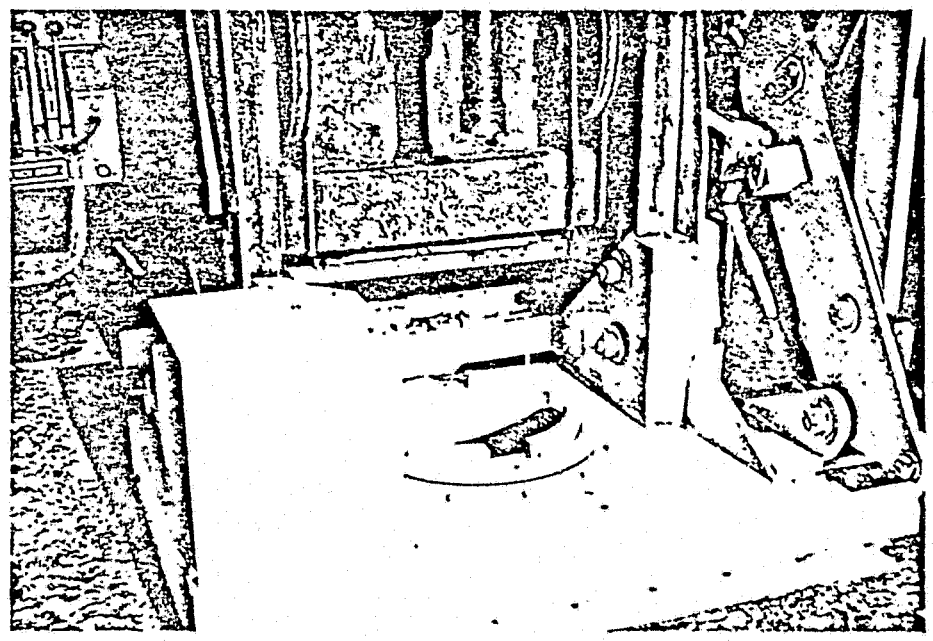
Winch

Produces 22,000 ft. lbs. (98,000N) of torque. Line speed variable to a rate of 75 ft. per minute.



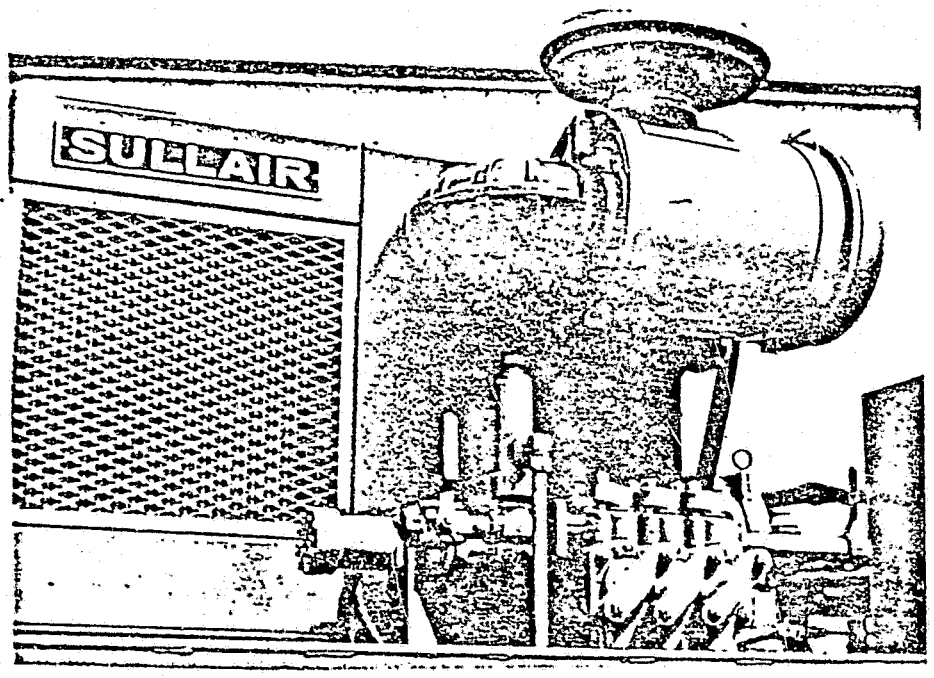
Operators Console

All controls and gauges are designed for total operator control.



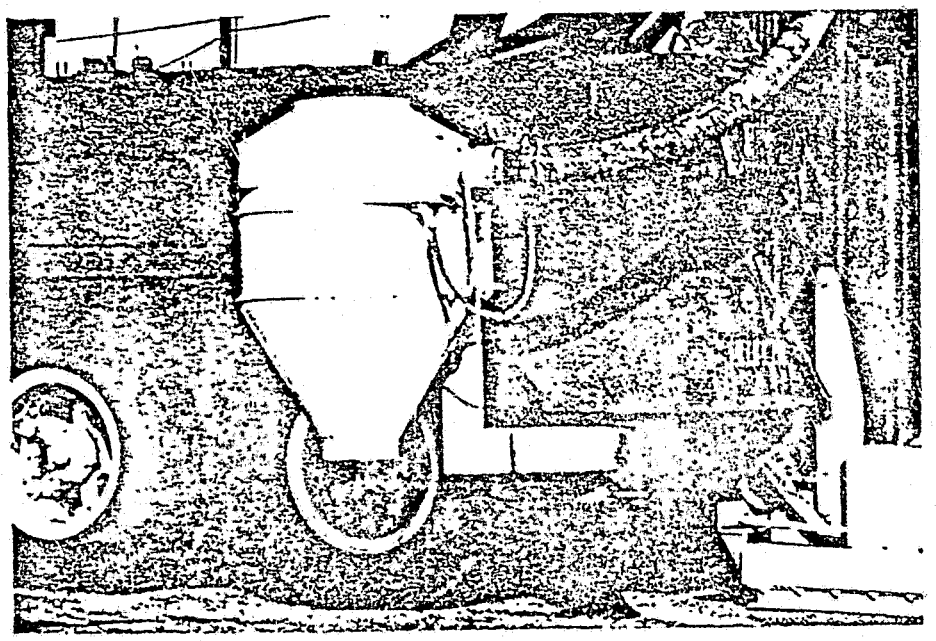
Rotary Breakout Assembly

Powered by two hydraulic motors that break and spin tool joints apart.



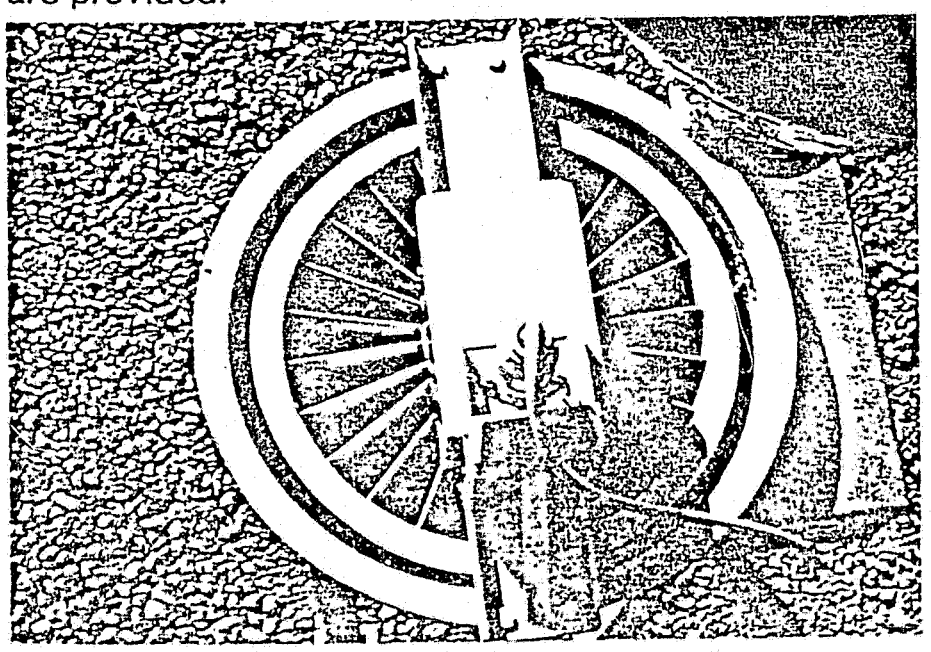
Air Compressor & Water Injection

Screw type compressor provides air at a rate of 750 CFM at 350 PSI. Water injection unit injects water at 600 PSI at 20 GPM.



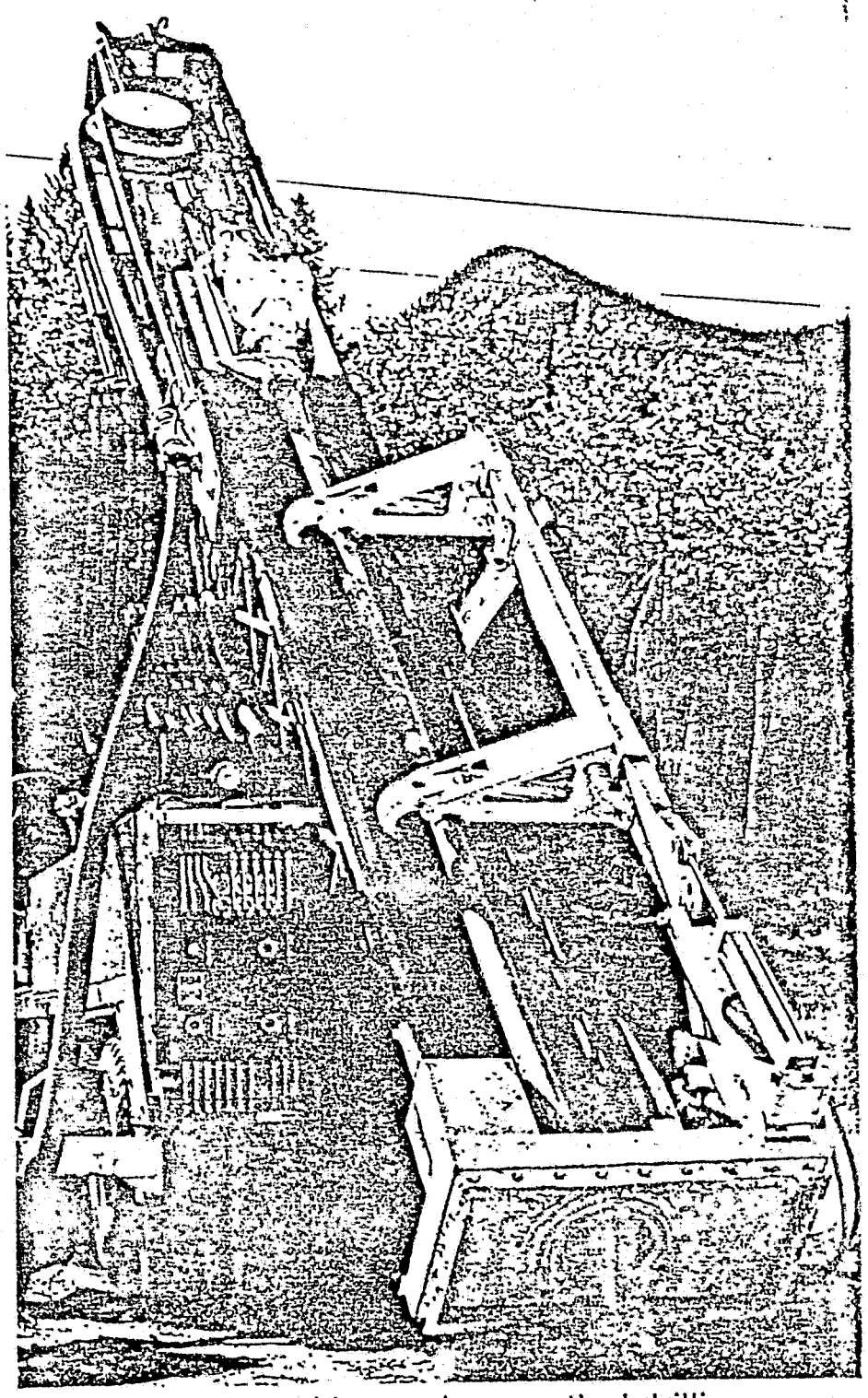
Sample Cyclone

Representative and virtually uncontaminated samples are provided.

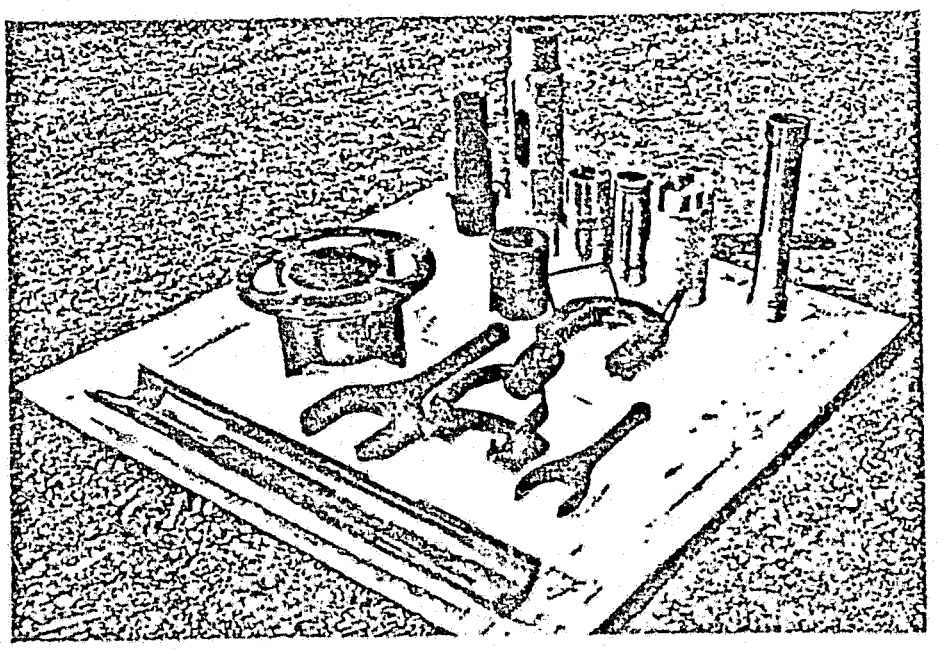


Hydraulic Sample Splitter
(Optional Air)

Provides a wet split variable to 1 in 16.



CSR - 1000AV provides angle or vertical drilling capacities in any terrain. Mobility is assured with unit mounted on either truck or all-terrain tracked vehicles.



Drill Tools

Drill Systems manufactures a wide range of accessories allowing the use of tricone bits or down hole hammer with reverse circulation drill pipe.

DRILL SYSTEMS

SPECIFICATIONS

HYDRAULIC SYSTEM
- Three gear pumps supply all hydraulic power at 2000 P.S.I. 60 GPM, 30 GPM, 15 GPM

PULLUP & PULLDOWN
- Accomplished through two 5" (12.7 cm) hydraulic cylinders
- travel 26 ft. (7.9 m)
- pullup force 38,000 lbs. (169,000 N) winch adds 22,000 lbs. (98,000 N) total pullup force — 60,000 lbs. (264,000 N)
- pulldown force 26,000 lbs. (116,000 N)
- feed rate infinitely variable to 100 ft. per minute (30.48 m/min)

ROTARY TOP DRIVE
- Produces 51,600 in. lbs. of torque (5830 NM)
- Optional 66,900 in. lbs. of torque (7558 NM) or 89,000 in. lbs. (10,000 NM)
- Speed is variable to 100 RPM

BREAKOUT ASSEMBLY
- Powered by twin hydraulic motors
- Provides for pipe & casing to 12 in. (30.5 cm)
- breakout torque 8100 ft. lbs. (11,000 NM)
- spinning torque 8,100 ft. lbs. (11,000 NM)

MAST
- Constructed of A-500 tube steel
- Width between legs 27" (68.6 cm)
- Depth 20 in. (3.8 cm)
- will accept 20 ft. drillpipe (6.10 m)

DIMENSIONS
- Length mast down — 36'-7" (11.5 M)
- Length mast up (34'-1½") (10.4 M)
- Height mast up (36'-7") (11.05 M)
- Height mast down (dependent on carrier)
- Width — 8 ft.

COMPRESSOR
- Rotary screw type — oil flooded
- Provides air at a rate of 750 CFM at 350 P.S.I. (21.2 m 3/min at 2412 kPa)
- Optional compressors of varying capacity are available

WATER INJECTION
- hydraulically operated pump
- injects water at 600 P.S.I. (4100 kPa)
- speed infinitely variable to 20 GPM (76 L/Min)

WINCH
- produces 22,000 lbs. (98,000N) of line pull
- line speed variable to a maximum of 75 ft. per minute (23 m/min)

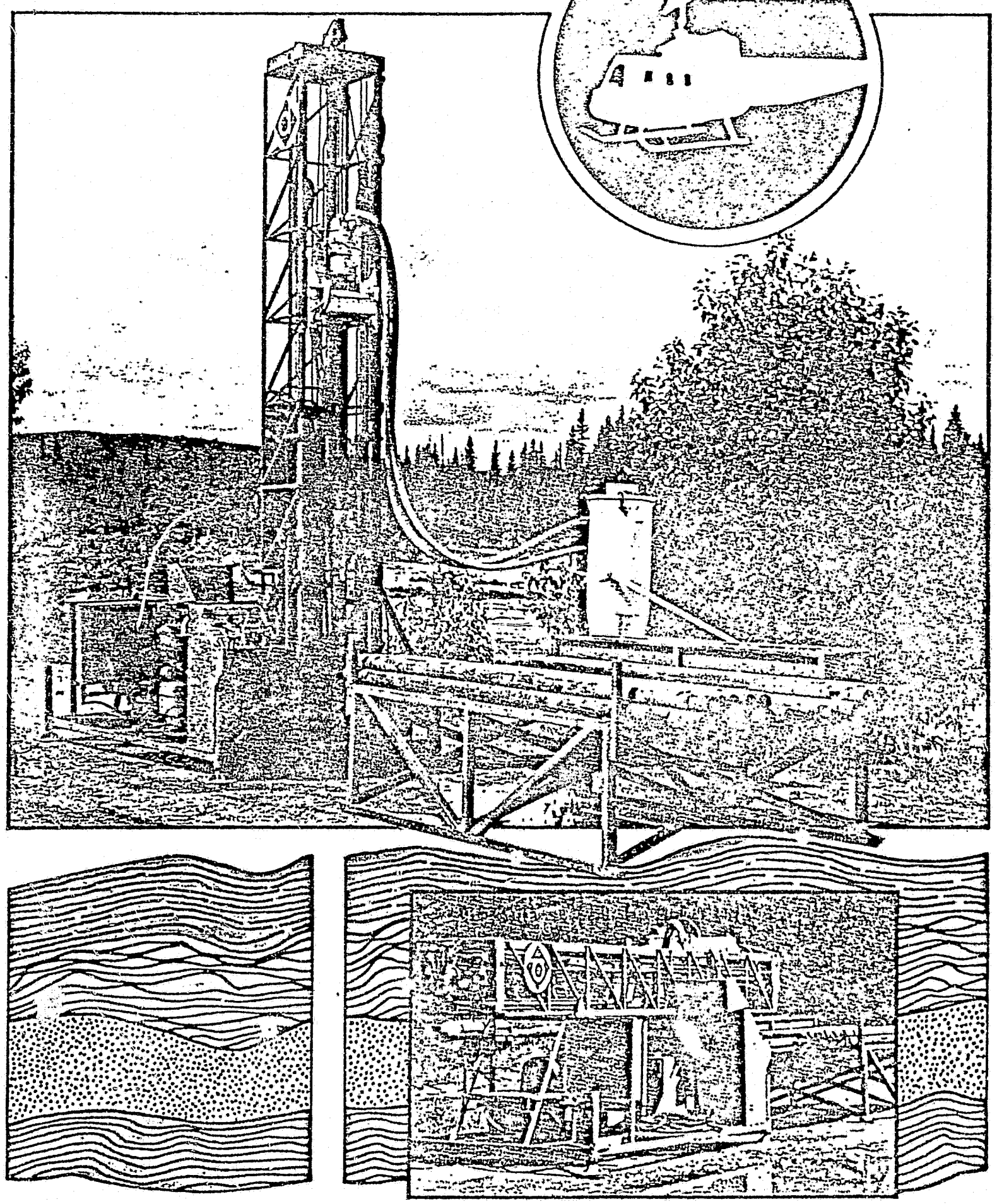
LEVELLING JACKS
- One front — 4" bore x 24" stroke (10.2 cm x 61.0 cm)
- Two rear — 4" bore x 24" stroke (10.2 cm x 61.0 cm)
- Pad size 12 in. diam. (30.56 M)
- Check valves ensure stability is maintained

AIR LINE LUBRICATOR
- Pump provides oil at one quart per hour (.95 L)
- Reservoir capacity 7 gallons (26.5 L)

RECOMMENDED CARRIER
- Tandem axle conventional
- 16,000 lb. (7300 kg) front axle
- 44,000 lbs. (20,000 kg) rear axles
- engine brake H.P. 400 at 1800 RPM governed full load speed 2100 RPM
- transmission as desired (auxiliary not recommended)
- fuel tank U.S. 95 gallons (360 L)
- cooling systems — automatic shutter on radiator
- Suitable all-terrain vehicles meeting the above requirements may be used

DRILL SYSTEMS

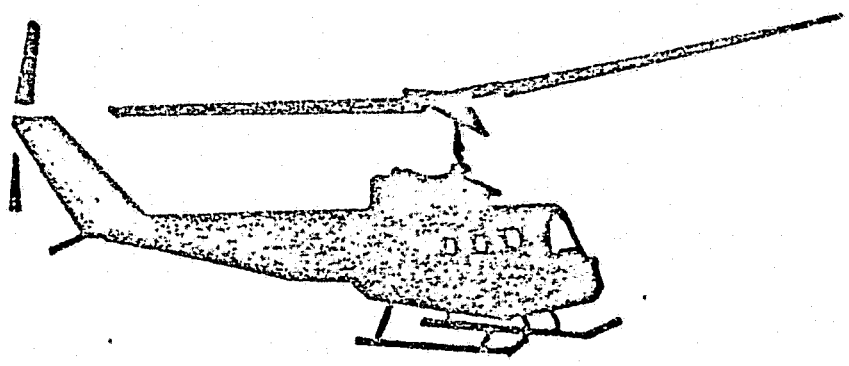
DESIGNED AND MANUFACTURED BY
DRILL SYSTEMS, A MEMBER OF THE TURBO RESOURCES GROUP OF COMPANIES
111-58 Avenue S.W., Calgary, Alberta, T2H 0A3, Canada
Telephone (403) 253-7451
Telex 03-825750



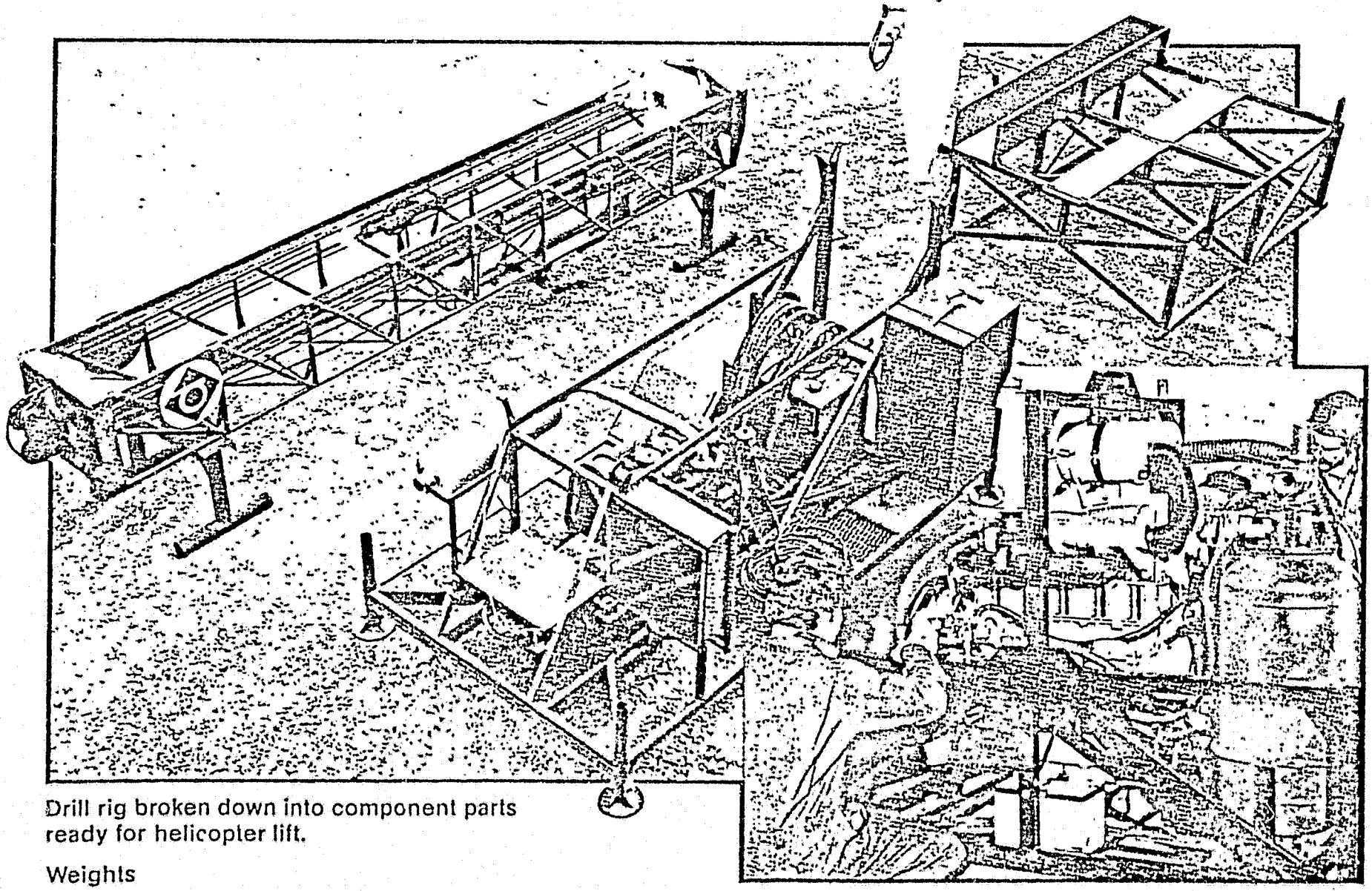
DRILL SYSTEMS

MPD HELICOPTER LIFT DRILL

INTRODUCTION



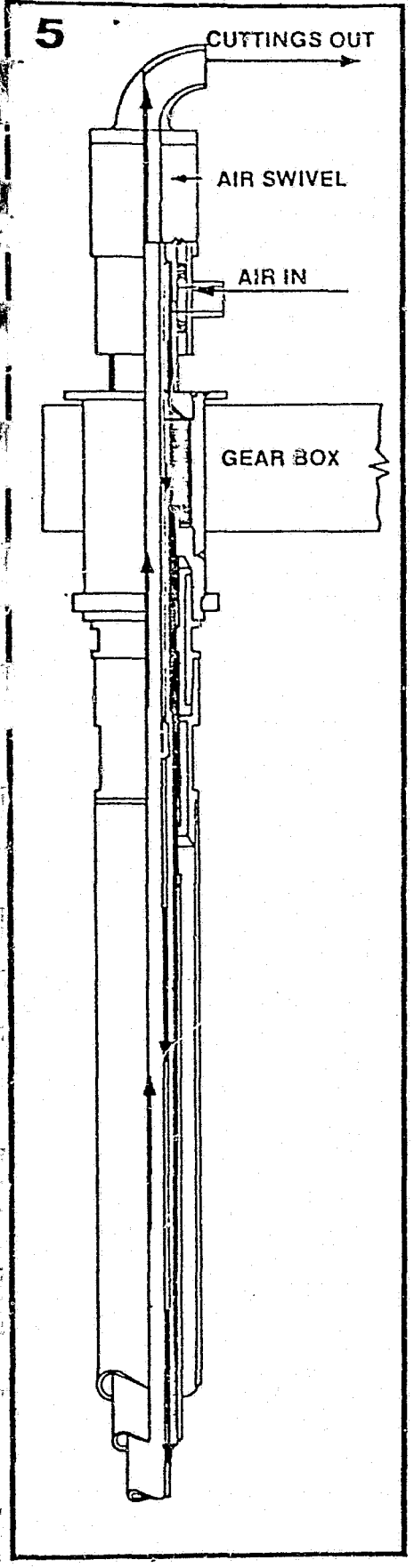
THE DRILL SYSTEMS MODEL MPD light weight rotary drill has been specifically designed as a multi-purpose highly mobile drilling rig. The unit has the capability of being transported in 4 helicopter lifts or can be mounted on a 4 wheel drive truck. The drill has been equipped with DRILL SYSTEMS' patented reverse circulation drilling system, which has proven extremely successful on our "BECKER" hammer drills and our CSR1000AV rotary drill. Our system is recognized as "state of the art" technology for mineral and coal sampling, geotechnical drilling, and tie-back installation throughout the world. The MPD drill incorporates features such as angle or vertical hole capability, full hydraulic operation, a completely automatic breakout system, and highly efficient pipe handling system. THE MODEL MPD DRILLS can be easily and quickly adapted to operate optional systems including diamond drilling, (optional drop-in gear box) auger drill, (optional drop-in auger stem adaptor) or wireline coring and conventional drilling. A totally new and innovative drill system utilizing TRIPLE TUBE DRILL STEM has been developed for this range of drills. The triple tube system, further explained in this brochure, incorporates its own casing which can be recovered or left in the ground as required.

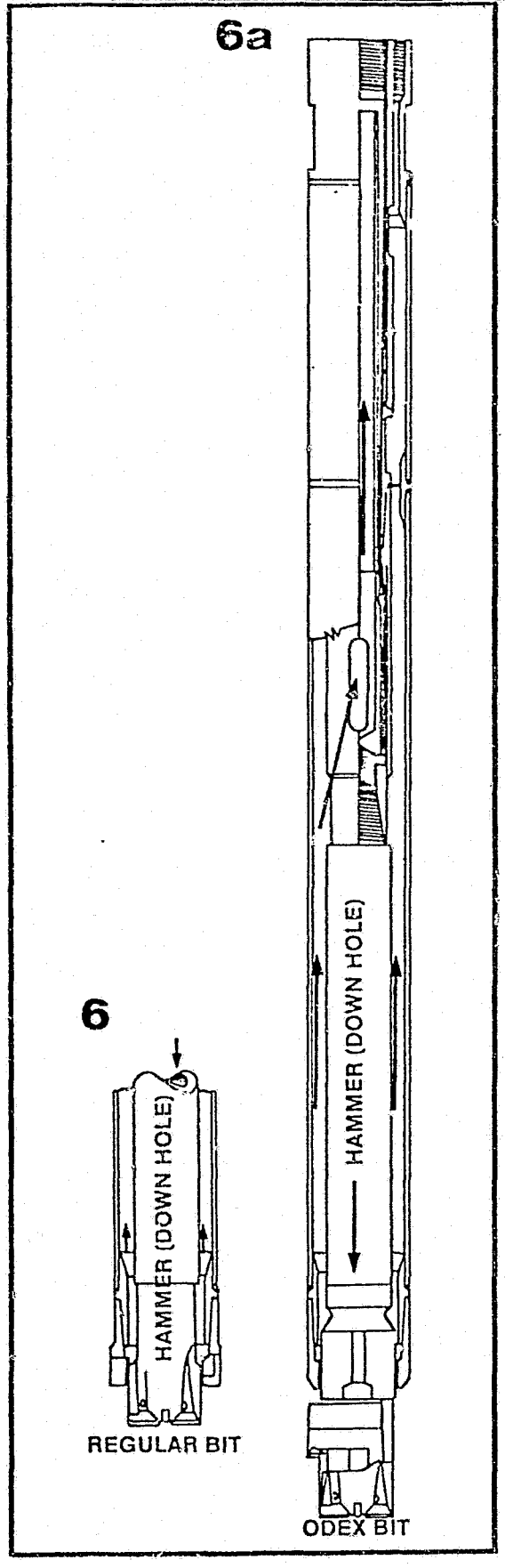


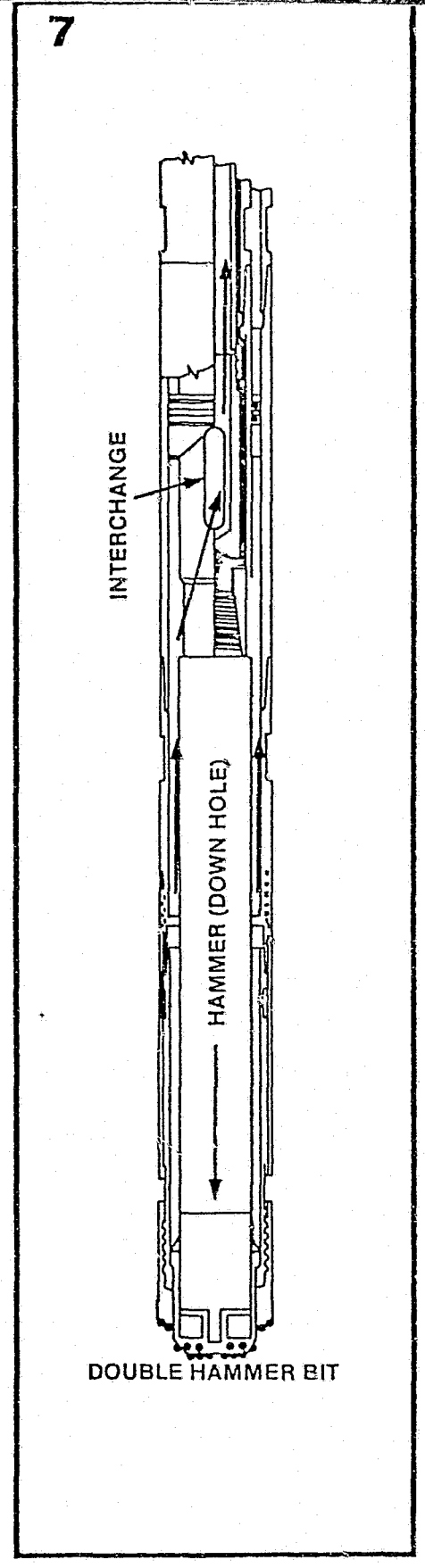
Drill rig broken down into component parts ready for helicopter lift.

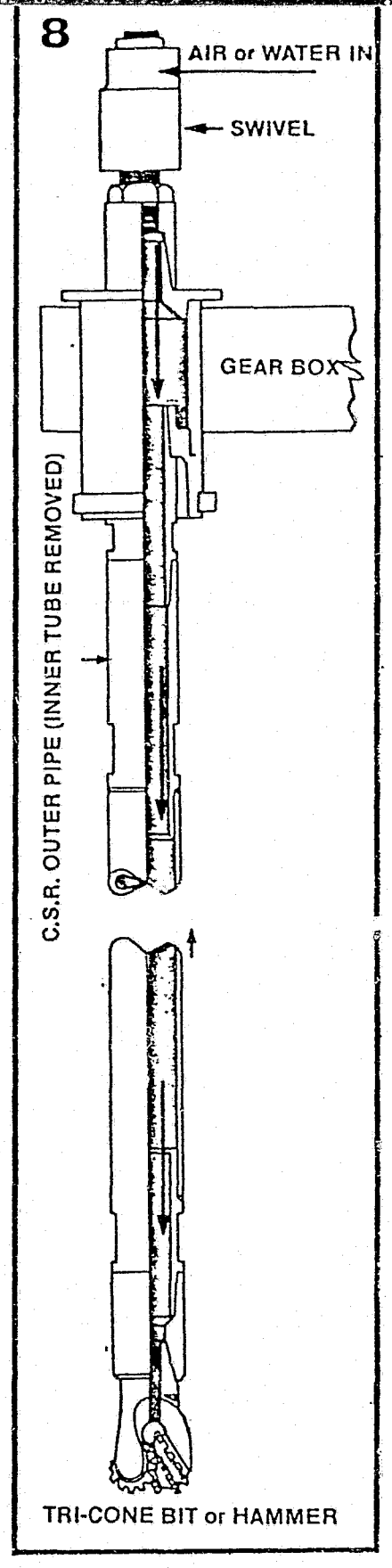
Weights

a) Mast & Rotary 2,000 lbs.; b) Compressor Skid 2,540 lbs.; c) Pipe Rack 500 lbs.; d) Engine, Frame & Hydraulics Skid 3,100 lbs.









5. Triple Tube

- basic method of setting casing through overburden, (Top End View)

6.

- setting casing using down the hole hammer with tungsten shoe on casing

6a.

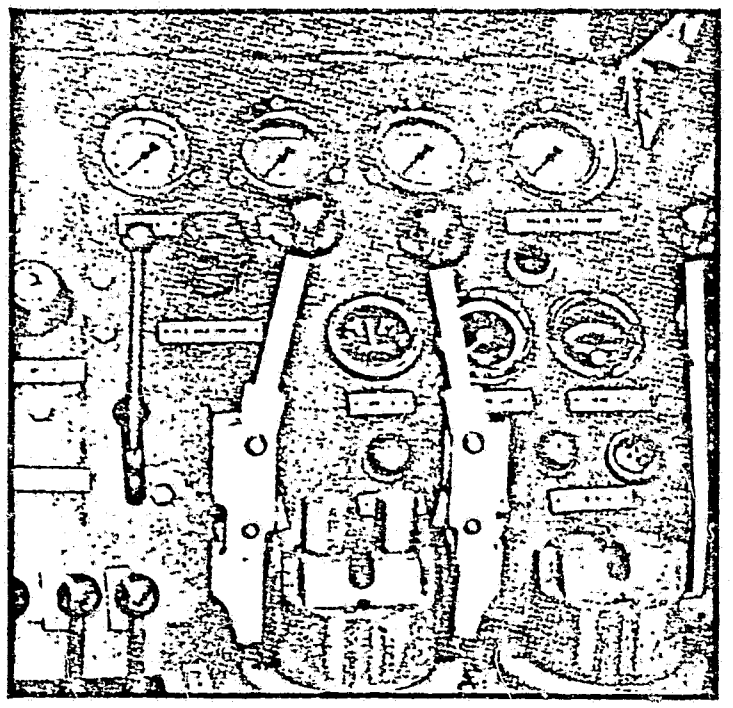
- down the hole hammer using eccentric bit system

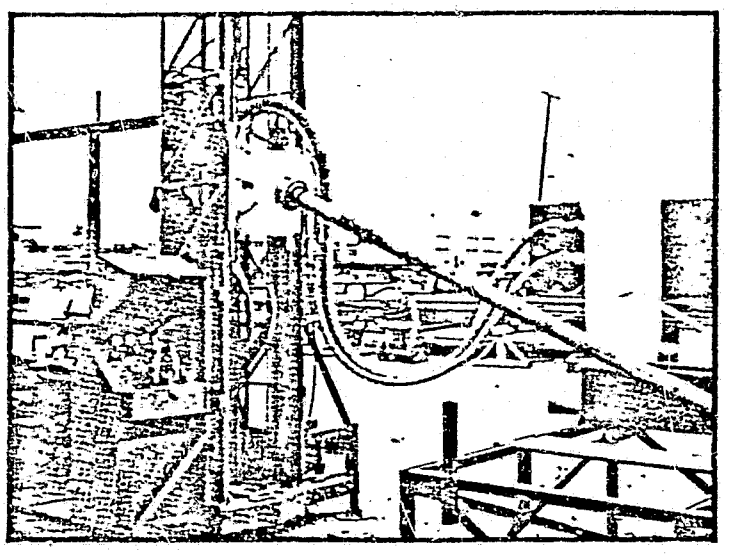
7.

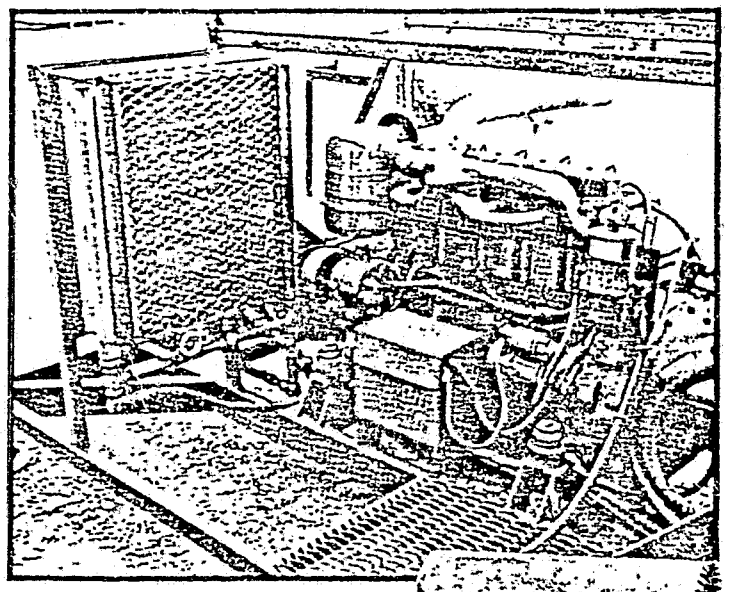
- down the hole hammer using DRILL SYSTEMS splined casing shoe and a special collared hammer bit

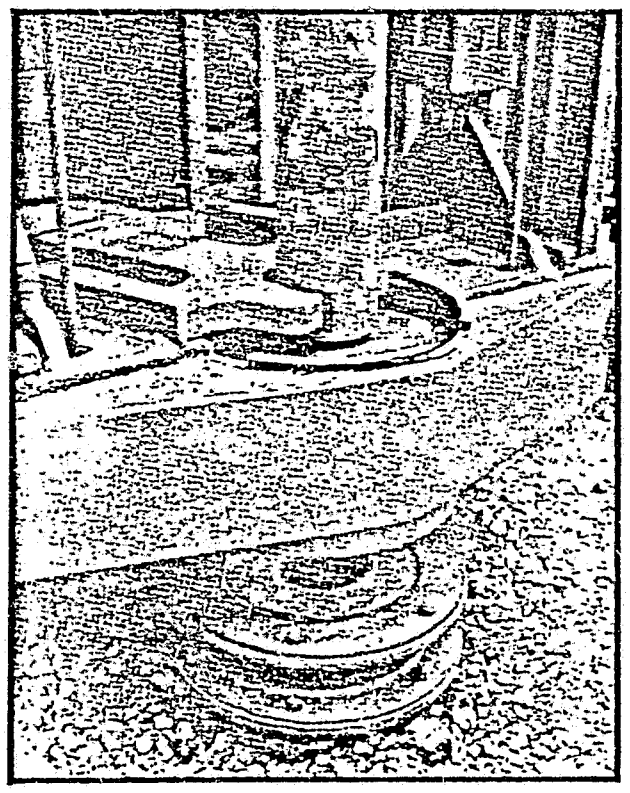
8. Conventional Drilling

- DRILL SYSTEMS dual tube pipe with inner tube removed can be used for conventional drilling including water wells, seismic, etc.
- Casing sizes to 9"

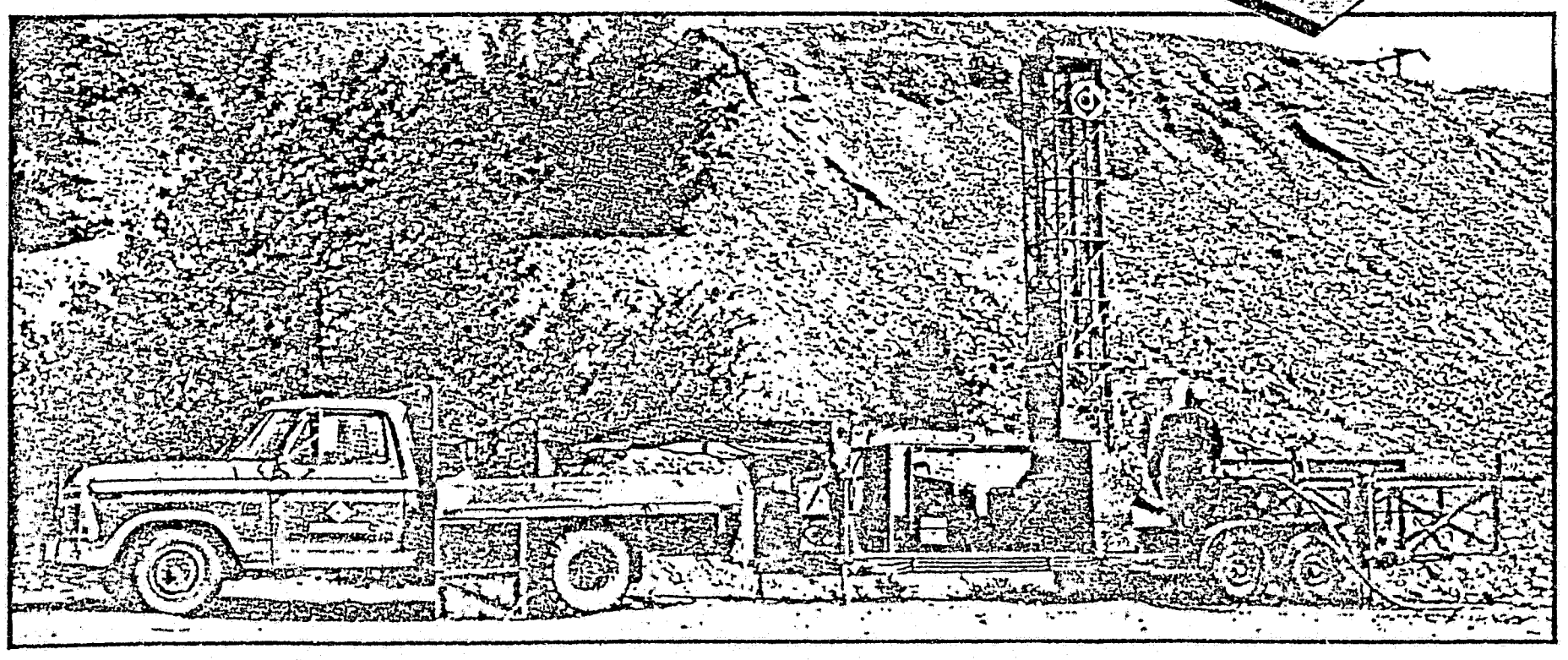








1. CONSOLE - Controls are fully variable and can be locked in any position.
2. ROTARY TOP HEAD DRIVE - Pivoted for ease of pipe handling.
3. BREAK-OUT SYSTEM - Hydraulically operated wrench (spring loaded) is controlled from the operator console for quick and safe operation.
4. ENGINE - A Deutz air cooled diesel engine is standard equipment. Other engine options are available.
5. ACCESSORIES - A wide range of standard and optional accessories are available to meet all drilling requirements.
6. TRAILER MOUNT - Drill can be mounted on any suitable carrier such as the 5th wheel trailer depicted, a four wheel drive truck, or all terrain tracked vehicle.



DRILL SYSTEMS

SPECIFICATIONS

Model M.P.D. 1000 AV Helicopter Lift Drill Rig

Hydraulic System
- Two axial piston variable flow pumps provide pressures to 4000 P.S.I. (275 bar)
- One rotary vane pump provides pressures to 2000 P.S.I. (138 bar)
- Reservoir capacity - 36 Imperial Gallons (163 litres)

Pull Up & Pull Down
Hydraulic pull back - 30,000 lbs (13,000 kg)
- 10,000 lbs (4365 kg) on sand line & 20,000 lbs (9075 kg) pull back on rotary - infinitely variable

Hydraulic pull down - 10,000 lbs (4536 kg)

Rotary Top Drive
- Produces 3,300 ft.lb. (4475 Nm) of torque
- Rotary speed 0-200 R.P.M. - infinitely variable

Power Source
- Deutz 4 cylinder 4L-912 67 H.P. at 2150 R.P.M.

Compressor
- Rotary screw oil flooded
- Provides air at rate of 350 C.F.M. at 220 P.S.I. (9.9 m^3/min - 15.17 bar)
- Optional compressors of varying capacity are available

Water Injection
- Hydraulically powered piston type pump
- Injects water at pressures up to 400 P.S.I. (27.58 bar)
- Infinitely variable to 10 G.P.M.
- Optional pumps available on request

Dimensions
- Mast - 18' (5.48 m) long - 28" (.71 m) wide
- Skid - 10'6" (3.2 m) x 6' (1.83 m)
- Mast Rest - 66" (1.67 m) High

Weight
- Engine frame & hydraulic skid 3100 lbs (1406 kg)
- Mast & rotary - 2000 lbs (907 kg)
- Compressor skid - 2540 lbs (1152 kg)
- Pipe rack (less pipe) - 500 lbs (227 kg)
- 3½" (88.9 mm) x 10' (3.048 m) lengths of pipe 12.52 lbs per ft - 18.63 kg per meter

DESIGNED AND MANUFACTURED BY DRILL SYSTEMS

DRILL SYSTEMS

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PENETRATING ALLUVIALS

BY

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December, 1979

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ABSTRACT

PENETRATING ALLUVIALS

A proven concept of reverse circulation drilling has been incorporated into a percussion hammer method of drilling to successfully penetrate alluvial conditions.

The method and history of development progressing to today's equipment will be explained as well as the applications, versatility, and accuracy of the end results and what it means to the engineer.

Specific applications and well-known major projects will be discussed.

ABOUT THE AUTHOR

Name: Hank Sydor

Born: Ontario, Canada

Education: Haileybury School of Mines
Sir George Williams University

Experience:
- -Structural and geotechnical field work throughout Canada and Canadian Arctic and Alaska
- -Original introduction of "Raise Drills" on a world-wide basis
- -Manufacture of drilling machines and accessories
- -Specialist in reverse circulation drilling and related equipment
- -Contractor for reverse circulation drilling

Previous Papers Presented:
- -Soviet Union
- -U.S.A.
- -Australia
- -Canada
- -Zambia
- -Sweeden
- -Ireland

SECTION I

HISTORY OF THE "BECKER HAMMER DRILL"

In the late 1950's a large seismic drilling contract was obtained by Becker Drills Ltd. in northern, Alberta, Canada. The conditions were found to be almost totally gravel and cobbles and conventional drilling practices were not able to keep the hole open for loading the explosive charges. It was at this time that the situation forced the development of the "Becker Hammer Drill." The concept was the use of a double wall drive pipe under impact by a conventional pile driver, with air as an assist for cleaning the hole.

It was several years and a good quantity of bent and broken drill pipe later, before the system and method could operate reliably and feasibly.

Becker then began to receive inquiries from throughout the world. Over the first six or seven years, twenty two (22) rigs were sold.

Many applications of this method have been employed as well as a few variations which will be discussed later and explained in more detail.

The Becker Drill is still manufactured in Calgary, Alberta, with Becker Drills Inc. as the prime user of the system. Most of the many rigs sold over the years are owned by operators. Becker Drills Inc. is still the major contractor using this system in North America and the free world.

SECTION II

THE BECKER HAMMER METHOD

The most noteworthy characteristic of the Becker Hammer Drill is the method by which sand, gravel and boulder formations can be penetrated rapidly and efficiently, giving immediate, accurate analysis of the formation encountered.

A double wall drive pipe is driven by a diesel operated pile hammer, while air or water, under pressure, is forced down the annulus of the drive pipe. The material cut by the drill bit is rapidly transported to the surface through the inside pipe by the drilling fluid. The discharged materials can be accumulated in suitable containers as they emerge from a cyclone and samples bagged at specific intervals for analysis of the drilled formation. As the center of the drive pipe is always clear and the bit remains on the bottom of the hole, Pentrometer, Shelby, or Split-Spoon tests can be taken at any desired interval. Upon reaching bedrock, a hydraulic driven rotary attachment can be swung into position, and the drive pipe then acts as the overburden casing and conventional drilling methods may proceed for the coring of bedrock. Chip sampling with air and tricone bits or down-the-hole hammer bits can be achieved very economically as the difficulty of penetrating the overburden has been overcome.

Designed for drilling in gravel, sand, and boulder formations, this rugged unit achieves penetration rates up to 100 feet per hour and provides a continuous sample. For sampling, close to 100% recovery can be achieved (See Figure 1).

CHARACTERISTICS

The significant features of the Becker method are:

a. The highly efficient method of driving the casing with a diesel pile hammer.

b. The double walled casing with a large hollow center. Due to this large center opening, material up to three inch size can enter the bit, where it is airlifted instantly and effortlessly. The conventional process of grinding the cuttings down to dust size is eliminated.

c. Drilling the hole and casing it, is one-and-the-same operation. There is no duplication of efforts by first drilling the hole, then casing it, then cleaning out the casing.

HOW IT WORKS

The Becker drill is a self-contained unit with all required components mounted on a tandem axle truck. The diesel hammer, delivering 95 blows per minute, at 8,000 foot-pounds per blow is mounted on a standard mast (Figure 2).

A 750 cfm compressor at 125 p.s.i. and a 130 gpm pump are driven from a transfer case. The hydraulics operate all functions such as: leveling truck, raising mast, lowering and raising of hammer, handling of casing, etc.

On completion of the hole, the casing is withdrawn by a puller system comprising two 50 ton hydraulic cylinders operating tapered slips that grip the casing.

The drill is capable of carrying one hundred and twenty feet of casing plus bits. Extra pipe and supplies must be carried by an auxiliary supply vehicle.

The Becker double-wall casing is a complex product fabricated from two heavy duty pipes, plus one female and male tool joint. The two pipes are assembled concentrically with the inner pipe being easily replaceable if damaged. An "O" ring seal on one end of the inner pipe seals one inner pipe to the other without leaks.

With this construction, only the outer pipe takes the impact during the hammering cycle. Inner pipe floats inside against a neophyrene cushion.

Standard sizes of casing are:

- $5\frac{1}{2}$" O.D. X $3\frac{1}{4}$" I.D.
- 6 5/8" O.D. X $4\frac{1}{4}$" I.D.
- 9" O.D. X 6" I.D.

conveyor	HSA	Sampler
3" auger		3"
3½"		3½, 4"
5"	5¾, 6" w/ reduced head or 6¾ spec built	5", 5½"

The bit is of tempered cast-steel, and long research has gone into the development of a special steel tough enough to withstand the continuous impact and yet not brittle enough to chip or fracture.

The bits come in various designs to suit different formations encountered. Depending on conditions, bit life varies from 300

to 1,500 feet.

The in-going air from the deck-mounted compressor and the air return are distributed to their proper places by the drive spout, which hangs underneath the diesel hammer and which also transfers the impact from the hammer to the casing. The drill with tandem truck weighs approximately 20 tons (Figure 3).

OPERATION

This particular drill over the past twenty some years, has been mounted on a complete variety of configurations such as:

- skids
- steel tracks (Figure 4)
- soft track (Figure 5)
- terra tire
- tandem truck
- barge (Figure 6)
- ocean going vessel (Figure 7)

For the purpose of our discussions in this paper, we will concentrate most of our thinking to the standard truck-mounted drill.

The truck-mounted rig is highly mobile and travels the highway at 50 mph. On sites accessible to a truck, the rig can drive in, level up, raise the mast and be drilling in less than ten minutes. Many drill sites are of course, not directly accessible and in such cases it beocmes necessary to prepare roads with a dozer; and in some cases, the dozer is required for towing assistance.

To drill, the bit is threaded to the outer wall of the double wall casing, the spout lowered over the casing, and the mast plumbed. The ram inside the diesel hammer is lifted hydraulically, then dropped. The ram compresses the air-diesel fuel mixture, and explosion occurs, driving the casing into the ground, and lifting the ram for the next stroke. As long as fuel is injected, the cycle automatically repeats itself at the rate of 95 blows per minute. Diesel consumption is three gallons in a ten hour shift.

The compressor is now activated. The air is forced down the annulus and ports just above the bit direct the air to the inside where it returns up the center of the inner pipe with all of the

material as it enters the inside of the pipe. Lifting of the cuttings to atmospheric pressure is unrestricted as downward air pressure is negligible. Cutting lift is a result of airspeed of approximately 5,000 feet per minute rather than air pressure.

This process of continuous air lift as part of the drilling process provides a continuous accurate sample of the penetrated formation. Since the drilling fluid is air, rather than water, the sample is basically unchanged and strata changed can be easily pinpointed. To reduce dust loss, the discharged sample is collected in a cyclone.

Angle holes can be drilled up to an angle of 45 degrees off vertical. Due to the handling of the heavy casing and reduced efficiency of the diesel pile hammer, progress is definitely slower.

Drilling below the water table or into artesian conditions or into heavily water-bearing sands, it becomes necessary to use water for the drilling fluid instead of air. The drill is equipped with a water injection pump for this purpose.

In ten minutes, a hydraulic rotary drive can be affixed under the diesel hammer. Large boulders can be triconed or bedrock can be cored using the "N" series core barrel. Extensive diamond drilling with such a large rig is not recommended.

PERFORMANCE

The Becker Hammer Drill can penetrate any type of overburden, but will penetrate bedrock for only a few feet. Highly fractured and oxidized zones may possibly be penetrated to a greater depth. The rate of penetration varies considerably with the type of overburden. The fastest drilling takes place in loose water-bearing gravel and cobble formations. Penetration in these formations will average 50 feet per hour and depths beyond 300 feet can be attained.

As the density of formations increase, the drilling slows down in a direct relation to density. In extremely well cemented glacial tills and hardpans, penetration is likely to be limited to 10 feet per hour with maximum attainable depths of 150 feet.

In rare occasions, large boulders can become a problem and require blasting. In most cases, the bit and hammer action will

break the boulders and bring them up in the shape of a minus one-inch crushed rock.

COST

A very distinct advantage of the Becker Hammer Drill for overburden sampling is that it is fast and more economical than other mehtods. This means that within allotted time and finances, a greater number of holes can be drilled and sampled accurately. Due to the drilling speed, an indirect saving occurs; the cost of inspection is significantly reduced. As a fact, in many instances, the cost of drilling with the Becker Hammer Drill has been less than what the cost of inspection alone would have been with other methods.

SECTION III

MAIN USES

1. GEOLOGICAL SAMPLING OF OVERBURDEN
   - -gravel and placer deposits
   - -setting casing for diamond drilling
   - -nickel laterite explonation
   - -tailings or dump exploration
   - -offshore exploration
   - -tin exploration
   - -freeze holes
2. GEOTECHNICAL ENGINEERING
   - -in-situ piles seated into bedrock
   - -gravel and borrow pit deposits
   - -dam exploration
   - -dewatering holes
   - -grouted anchors
   - -instrumentation holes
   - -Becker Density Test
   - -soil sampling
3. CONSTRUCTION DRILLING
   - -tie back anchors
   - -pulled-in-piles
   - -seismic
   - -waterwells
   - -site investigations

SECTION III. Item 1.
GEOLOGICAL SAMPLING OF OVERBURDEN

There have been untold numbers of aritcles and books published relating to various phases of alluvial mining (both offshore and onshore). With very few exceptions, none has related to or provided any record of the results of mining, versus that expected from exploration. The records of existing experience in unconsolidated formations, both on shore and offshore, have developed records that can at least be used and are necessary in

evaluating new properties.

On shore, the precious metals, gold and platinum group, have been found in the greatest variety and types of formations. They range from tough clays, tightly compacted and cemented gravels and boulders, to looser formations.

The standard drill used onshore in past and present times has been the churn drill. Although slow in progress, the churn drill is not adaptable to offshore work because it is not practical or adaptable to offshore environments.

Volume measurements are extremely important for combined with metal values, the percentage of volume obtained to that actually existing in the formations will assist in calculating the effective evaluation. (Figures 7a, 7b, 7c, & 7d).

Both onshore and offshore, the Becker hammer Drill has proven most reliable and adaptable for alluvial sampling and able to return the truest value of sample by volume.

Case Histories

a. Magnetite Sampling

Sovereign Industries-near Coolidge, Arizona

Over 15,000 feet of hammer drilling with hole depths of 250 feet.

Rate of penetration was 29 ft/hr average.

Formations consisted of sand, gravel, and some caliche.

b. Sulphur Sampling

Chapman, Wood and Griswald Ltd.-near Beaver, Utah

Approximately 7,000 feet of hammer drilling, with average hole depth of 77 feet. Rate of penetration averaged at 17.7 feet per hour for the entire project.

c. Daitomaceous Earth Sampling

Kaiser Engineers-near Mammoth, Arizona

Over 1,100 feet of drilling. Holes were in various depths, but averaged 20 feet per hour penetration.

d. Cinnabar Sampling

Kollsman Mineral Chemical Inc.- near Tonopah, Nevada

Over 5,000 feet of drilling with holes averaging 63 feet in depth. Rate of penetration averaged at 19.6 feet per hour.

e. Gold Placer Sampling-Offshore

Asarco-offshore on ice near Nome, Alaska

Drilling consisted of drilling through 3 feet to 10 feet of ice, 20 feet of water and up to 60 feet of ocean sediment to bedrock. Recovery of samples was very good on all locations and values were recovered. Over 45,000 feet of drilling was completed.

A detailed experimental test was run prior to this project to convince the client that the Becker method of sample recovery was effective. On this test, six fine placer gold colors were dropped down a hole 40 feet deep. The hole was drilled an additional two feet, flushed with 3 to 4 gallons of water, and the sample recovered was panned. The gold had been brought up. On the next test, a small nugget weighing 0.989 gms., was dropped down the hole and the process was repeated. The nugget was brought up with such velocity that it was flattened by the force.

f. Tin Sampling: Offshore

Union Ore Corporation - Puket, Thailand

A five year operation with water depths of 8 feet to 110 feet. The ocean floor of alluvials is 50 feet to 120 feet deep. The deepest hole had 110 feet of water and 115 feet of sediment. Monthly footage was approximately 3,500 feet on single 12 hour shifts. The barge was designed to work in swells of up to 5 feet. 10'/hr

g. Development of Undersea Mining Methods

U.S. Bureau of Mines for operation off the coasts of Alaska, California and Oregon, mounted on an ocean going ship "S.S. Virginia City"

The project was instituted to develop new undersea mining systems as well as research to develop economic ways of evaluating sea-bed minerals.

Water depths ranged from 100 feet to 150 feet. Ocean floor penetration ranged from 45 feet to 90 feet. Samples recovered were sealed and later evaluated at the Marine Technology Center in Tiburon, California.

SECTION III. Item 2

GEOTECHNICAL ENGINEERING

The recognition of the Becker Hammer Drill was slower in the science of Geotechnical Engineering. However, it has become apparent to most soils engineers that the many unique features make it a superb tool for engineering studies of soil properties.

The Becker Hammer Drill is extremely versatile, but by no means is it the universal tool which is ideal in each and every situation. It will drill any soil formation, regardless of the variable conditions. This offers one distinct advantage to the engineer, and that is where formations to be encountered are unknown, the Becker Drill will be able to penetrate and complete the hole.

Just as the continuous sample is suitable for the geologist, the geotechnical engineer will readily appreciate the unaltered but severely disturbed sample that is truly representative and indicative of any changes in strata. The sample can easily provide grain size determination in granular soils and moisture content in cohesive soils.

The continuous sample ensures that no critical formations, for example: soft seams, organic layers, slickensides, etc. are missed. With other drills that sample by tube sampling, half of the sample could be missed and critical areas overlooked. The rapid progress of the drill does have its shortcomings. Because of the continuous and rapid progress of the sampling procedure, it usually justifies the presence of a soils engineer at the drill at all times. Such direct control is advantageous but experience has shown that the engineer does not like to spend a full continuous shift at the drill.

STANDARD PENETRATION TEST

The Becker Hammer Drill is fully equipped for Standard Penetration Testing (SPT) using a 2" O.D. splitspoon, advanced by means of an automatic 140 lb. hammer with a free 30 inch hammer drop.

SHELBY SAMPLING

Three incn diameter shelby tubes for laboratory strength testing can be taken when desired. Using the 6,000 lb. diesel pile hammer as a weight, the samples are advanced by pushing.

HYDRAULIC PISTON SAMPLING

In cases where extremely soft soils are present, a hydraulic piston sampler can be used. The sampler is advanced ahead of the casing in closed position; at the desired depth, the sample is taken by applying hydraulic pressure through the extension rods. This method eliminates any drilling disturbance and assures the highest possible quality of sample.

SAMPLING GLACIAL TILL

Where samples for lab testing are required of denser soils, such as glacial till, $2\frac{1}{2}$" diameter heavy wall tubes are driven.

DENISON SAMPLER

Samples of hard clays and cemented soils can be recovered using a Denison Sampler.

CONTINUOUS BLOW COUNT

As the hole is advanced, blow count on the advancement of the Becker open casing (BOC) provides continuous information regarding the densness of the soil. The approximate relation between BOC and SPT is:

$$SPT = \frac{1}{2} \times BOC$$

The BOC value is a valid value in most soils, however, in water bearing sands, it is totally meaningless due to quicking and heaving of the sand. While engineers highly experienced with the BOC might eliminate the SPT altogether, most engineers will use it as a complement to the SPT. The BOC has the advantage of being continuous, thus covering the space between the SPT.

DENSITY DETERMINATION

Determination of the density of any sand-gravel formation, or of a water bearing sand, is an extrememly difficult undertaking. The standard SPT yields questionable results. To

overcome this problem, Becker has developed a new method, the Becker Density Test (BDT) (Figure 8). The bottom of the Becker casing is closed off, the air is shut off and the casing is driven as a giant penetrometer. The BDT has been found highly sensitive, more accurate and with a wider range than the SPT. The numerical relation between SPT and BDT is 1.

Normally, a conventional Becker sample hole is drilled adjacent to the BDT. The combination of the two holes thus provides continuous blow count plus continuous sample (Figures 9 to 15 inclusive).

TESTING FOR PILES

For any project where piles might be a consideration, the BDT is a vastly superior exploration tool; it is in fact, a pile driving test on a 5 inch closed end pile.

INSTRUMENT INSTALLATIONS

Because of the open cased hole, the Becker Drill is well suited for any type of installations such as piezometer instruments or slope indicators.

WATER INFORMATION

In any engineering program where accurate information regarding soil/water characteristics are important, the Becker Hammer is the most suitable drill; the features of the rig combined with pertinent procedures, will provide more accurate information than any other drill.

(a) The hole is cased at all times.

(b) No drilling mud is used.

(c) No water is intoduced into the soil.

(d) Air is used for drilling, therefore, the presence or absence of water can be detected.

(e) Rising, falling or constant head permeability test can be run at any time.

(f) The double wall pipe system provides a built-in airlift system so that mini pumping tests can be run if so desired.

(g) Due to the cased hole, no mud features, and rapid and controlled pulling of the casing, the Becker Hammer is perfect for piezometer installations.

AQUIFER EXPLORATION

Previously, the search for adequate aquifers for water supply was very slow and costly. Now with the Becker Drill, aquifers can be located in a fraction of the time and cost.

CASE HISTORIES

1. Alyeska Pipeline Service Company

Project was a final (1974) belowground Mode Confirmation.

In otherwords, the drilling program was to make a final determination of precise transition points between elevated and buried sections of the oil pipeline.

Some other uncertainties also had to be resolved such as, depth of burial and the exact location of shallow ice lenses that may require construction mode changes.

Twelve transition points were tested and two were relocated. There was a rush on the project due to early thaws and early road restrictions. All equipment therefore had to be brought to Alaska via Hercules aircraft.

Customs inspections and assembly was done in one day and ready for a 100 mile trip over ice roads, river ice, snow drifts and ungraded terrain.

The crew consisted of three men and began on April 28, 1974 and 46 holes were completed by May 9, 1974. All drilling was done below budget and in less time than estimated.

1974 Drilling Program

	Actual Cost	Engineer's Estimate
Scope of work	46 perft?	70
(No. of holes)	12	42
Drilling Costs		
Mob-Demob	45,000	30,000
Operations	46,000	183,800
Expendables	900	9,400
	92,100	223,200

	Actual Cost	Engineer's Estimate
Support Equipment		
Helicopters	------	80,500
Rolligon	28,000	------
D-8	5,400	31,000
Pick-up	------	------
Subtotal	33,400	112,500
Geotechnical Service	5,040	63,000
Room and Board	12,800	42,200
Fuel	3,000	5,100
Subtotal	19,840	110,300
TOTAL	146,000	446,000

The actual cost is not minimal. Without the urgency associated with the start of this program, further savings could have been effected. Normally, it would not be necessary to fly equipment and crews from Calgary. The major factors involved in this cost reduction can be applied to any drilling operation. To fully evaluate the magnitude of imporvement, the 1974 program is compared to the 1973 soils boring program.

TIME	1974 VERIFICATION	1973 SOIL BORING
Drilling	66%	66%
Moving	23%	7%
Stnadby	2%	26%
Down (mechanical)	9%	1%

Movement of the rigs was done with helicopters in 1973 and distance between holes was short . In 1974 the rig was moved over rough terrain and greater distances. In both contracts moving time was paid at the same rate as drilling, but standby was paid differently. In 1973 working time and standby were paid at the same rate. In 1974 the standby rate was approximately 60% of the working rate.

RATIO	'74 PROGRAM	'73 PROGRAM
Drilling hours/hole	2.5	29.6
Feet/drilling	9.5	1.65
Dollars/hole	3,174	12,000
Dollars/foot	131	253

Realtive economic efficiency of the two programs can only be approximated. Because of the smaller number of holes and distribution of fixed costs over a shorter time period, the figures for the '74 program appear to be disproportionatly higher than they would if the scope of both programs were equal.

2. TARABELLA DAM - WEST PAKISTAN

At this 1966 site of the world's largest earthfill dam, the river valley presented a unique drilling problem in that sediments in the valley consisted of dense cobbles and silt up to 600 feet deep. It was necessary to find out the extent of open water channels that required grouting.

A larger hammer drill, the Model 440 was developed.

The Becker equipment drilled three rows across the Valley from 200' to 250' each at a spacing of 50 feet apart. Total footage was 68,000 feet.

Then, 20" drain wells were drilled. A 6" diameter stainless steel screen and riser pipe was set in the hole. At completion, the flow from these wells was directed back into the river by means of a concrete spillway.

The original de-watering well program consisted of 120 wells up to 250 feet in depth for a total footage of 27,000 feet.

After the dam was filled, additional relief wells were required. An additional 70 wells were installed.

CONSTRUCTION DRILLING

Guy Anchors

Over the past dozen years, the use of guy anchors, drilled into overburden and rock to support transmission line towers, has increased rapidly. The Becker Drill has been found the most versatile and suitable for this application. On most transmission lines, anchors are installed at an angle of 38 degrees to 45 degrees from vertical (Figures 16 to 19 inclusive).

a) As most transmission lines cover great distances, it is impractical to perform prior soil sampling at every tower and every hole. Yet, at the time of installation, it is imperative for the engineers to know the soil type in each hole so that the anchor length can be adjusted should unexpected, unconsolidated soils be encountered. The Becker drilling method, with it's continuous sample return, provides this vital information.

b) As neither water nor drilling mud are used in the Becker drilling, there is no softening and loss of soil strength, nor any lubrication and reduction of friction.

c) No caving or loosening of the formation occurs, as the hole is cased.

d) Where bedrock is encountered at a shallower depth than the required overburden anchor length, the double wall casing is seated into the rock, sealing off the overburden. A percussion type rockdrill incorporated into the Becker unit is then used to drill the required length into the bedrock.

e) When the total depth is reached, the anchor rod with a tremie hose attached, is lowered to the bottom of the hole. The grout is pumped into place through the tremie hose, thus filling the hole from the bottom upwards, When the hole is filled with grout to the surface, the tremie hose is withdrawn and the drive pipe pulled out. The top portion of the hole is then filled with grout pumped in from the top.

Installation of transmission line anchors in rough formations is one of the most specialized and difficult undertakings in today's construction industry.

UPLIFT ANCHORS

Construction of tanks, tunnels, abutments, etc., also require anchors. The application is the same as with Guy Anchors except that they are vertical.

TIE-BACKS

Tie-back anchoring has now established itself as a superior method of shoring. Where tie-backs are to be installed through gravel or till formations, the Becker Hammer is usually the best method, as it offers a cased hole and assurance that the difficult formation can be penetrated.

CAST-IN-PLACE PILES

Because of its ability to penetrate gravel and boulder formations, the Becker Hammer lends itself to the procedure of installing cast in place piles through such formations and socketing the piles into bedrock.

GROUTING

When grout curtains through sand-gravel formations are required, the Becker Hammer is the natural choice. Not only is it more economical than other methods, but it is often the only method that can complete the drilling program within the tight schedule usually associated with such projects. Since the double wall pipe has an open center, a grout packer is set at the drive shoe; the grouting then proceeds until the desired grout pressure is attained, at which time the double wall drill pipe is pulled up the desired distance and the grouting process repeated. At the Tarbela damsite in West Pakistan, the Becker Hammer has drilled over 100,000 feet of grout holes through one of the toughest gravel formations ever encountered.

LARGE DIAMETER CASING (TRIPLE TUBE)

Installation of large diameter casing for relief wells and dewatering wells, through sand-gravel boulder formations, is a slow and costly procedure.

Becker has developed a special technique as well as a recently designed larger drill, Model H-520 capable of imparting 30,000 ft. lb. at 85 strokes/minute (Figure 20).

The drive pipe is usually 12" or 18" inside diameter and

16" or 20" outer diameter. A third casing is fitted over the drive pipe with an oversize bit machined to allow the outer casing a tight fit. High pressure air is forced down the annulus between the dual wall drive pipe. The air and cuttings return up the center of the inner pipe. The outer casing sleeve is being simultaneously driven down together with the dual wall drive pipe.

When the desired depth is reached, the dual wall drive pipe is withdrawn, leaving the outer casing in the hole. This casing is capable of withstanding normal end bearing and lateral bearing loads to be utilized as a pile. The casing can also be used to keep the hole open while a support member of different design or material can be inserted and slurried in the hole. Specially designed hydraulic casing pullers are then employed to remove the outer casing for reuse on other holes (Figure 21).

This triple-tube method is faster than the conventional methods of drilling large diameter holes and has the ability of always being able to guarantee an open hole in alluvial soils either in frozen, semi-frozen, or thawed conditions.

The outer casing also acts as an insulator from the effects of the cold temperatures of the perma frost.

CASE HISTORIES

Guy Anchors

a) Client: Manitoba Hydro
Location: Grand Rap ds to Cross Lake
Distance: 136 miles
Total Anchors: 3,900
Total Footage: 104,600' @ 13.50/ft
Average Depth: 26.8'
Test load (KIPS): 65
Average Cost/Anchor: $362.00

b) Client: Ontario Hydro
Location: Sudbury to Parry Sound
Distance: 40 Miles
Total Acnhors: 690

Case Histories, Cont.

Ontario Hydro

Total Footage: 21,200'
Average Depth: 30.8'
Test load (KIPS): 65
Average Cost/Anchor: $219.00

$ 7.11/ft

c) Client: Manitoba Hydro

Location: Suwanee River to Ruttan Lake
Distance: 40 miles
Total Anchors: 578
Total Footage: 11,610'
Average Depth: 20.1'
Test Load: (KIPS): 65
Average Cost/Anchor: $270.00

$ 13.43/ft

Note:

The following is quoted from a paper prepared in 1973 and the writer acknowledges and thanks the two authors of this paper for the use of the information.

"An Investigation of the Load Carrying Capacity of Drilled Cast-In-Place Concrete Piles Bearing on Coarse Granular Soils and Cemented Alluvial Fan Deposits"

Authors: G. H. Beckwith and D. V. Bedenkop

Sergent, Hauskins & Beckwith Consulting Soil & Foundation Engineers

3940 W. Calrendon

Phoenix, Arizona 85019

This paper was prepared for the Arizona Highway Department, Research Division.

The following is a direct quote from the paper:

The Becker Hammer Drill is recommended as the primary method of subsurface exploration. The same diameter drive pipe and the same type of drill bits used in the previous investigations mentioned in this report should be used. Care should be exercised that the full hammer energy of 8,000 ft/lbs. is delivered and

that sufficient compressed air is provided to rapidly clean cuttings. Blow count should be kept in 6 inch increments to fully define the degree of stratification and the presence of boulders. A 2-man field engineering crew should be used with one man directing operations and keeping blow count with a tally page and the other continuously observing cuttings recovery and taking samples. Reference samples of cuttings should be taken at 5 foot intervals or each soil change, whichever is less. Where sand layers are encountered, standard penetration tests should be performed. Shelby tube or open-end drive samples should be taken of any clay or clayey sand layers encountered.

CONCULSION

Prior to any advancement of mineral discoveries--DRILLING IS REQUIRED.

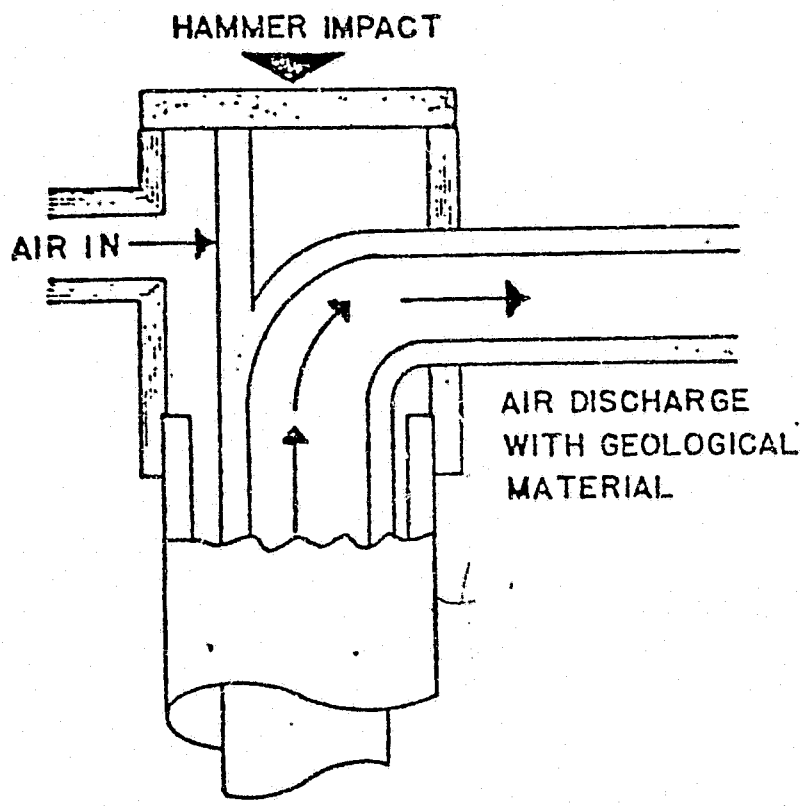
Prior to outlining mineral deposits or anomalies--DRILLING IS REQUIRED.

Prior to the development of new settlements and towns in new areas--DRILLING IS REQUIRED.

Prior to the construction of major structures, be they large buildings or dams--DRILLING IS REQUIRED.

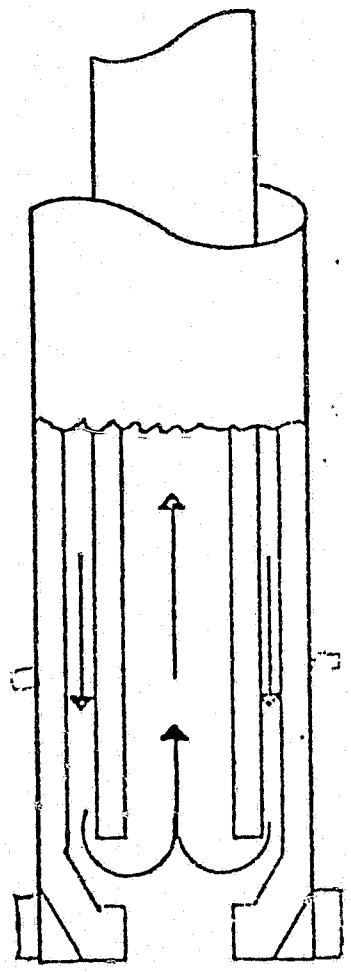
Therefore, our planning and development for the future whether in present densely populated areas or in remote arctic regions, the geological or geotechnical engineers will have to be the first to visit or approve any site. It can truly be said that these men and women hold the key to man's expansion and development.

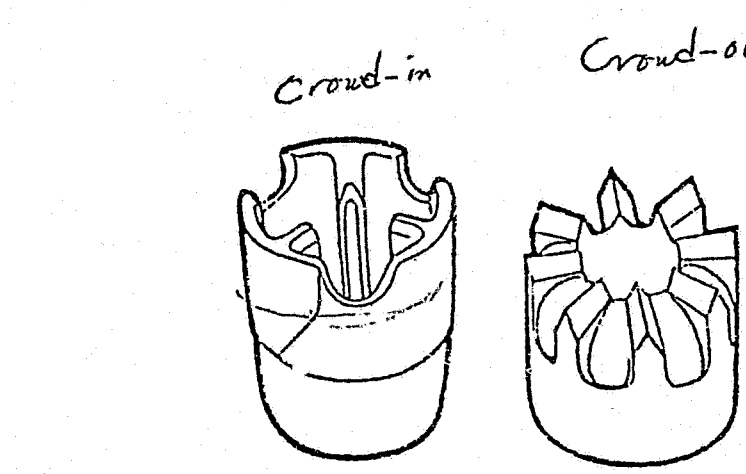
Becker Hammer Drill



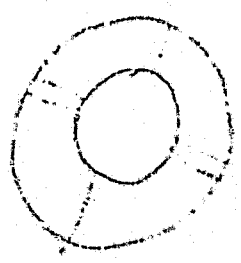
The Becker Method

The Becker Method uses a dual wall pipe driven by a diesel pile hammer. Through reverse circulation, air or water is forced down the annulus of the pipe returning through the center of the pipe carrying all cuttings and tailings to the surface — providing a continuous and uncontaminated sample.





The design of Becker drive bits virtually eliminates sample contamination. A variety of standard and custom-designed Becker drive bits are available.



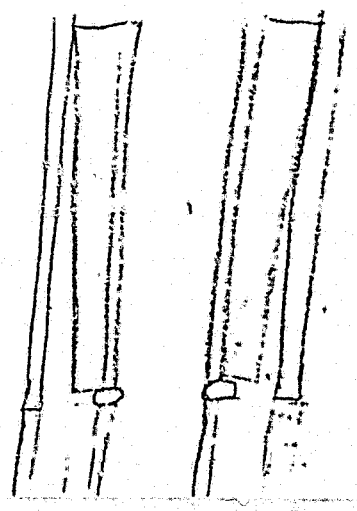


FIGURE NO. 1

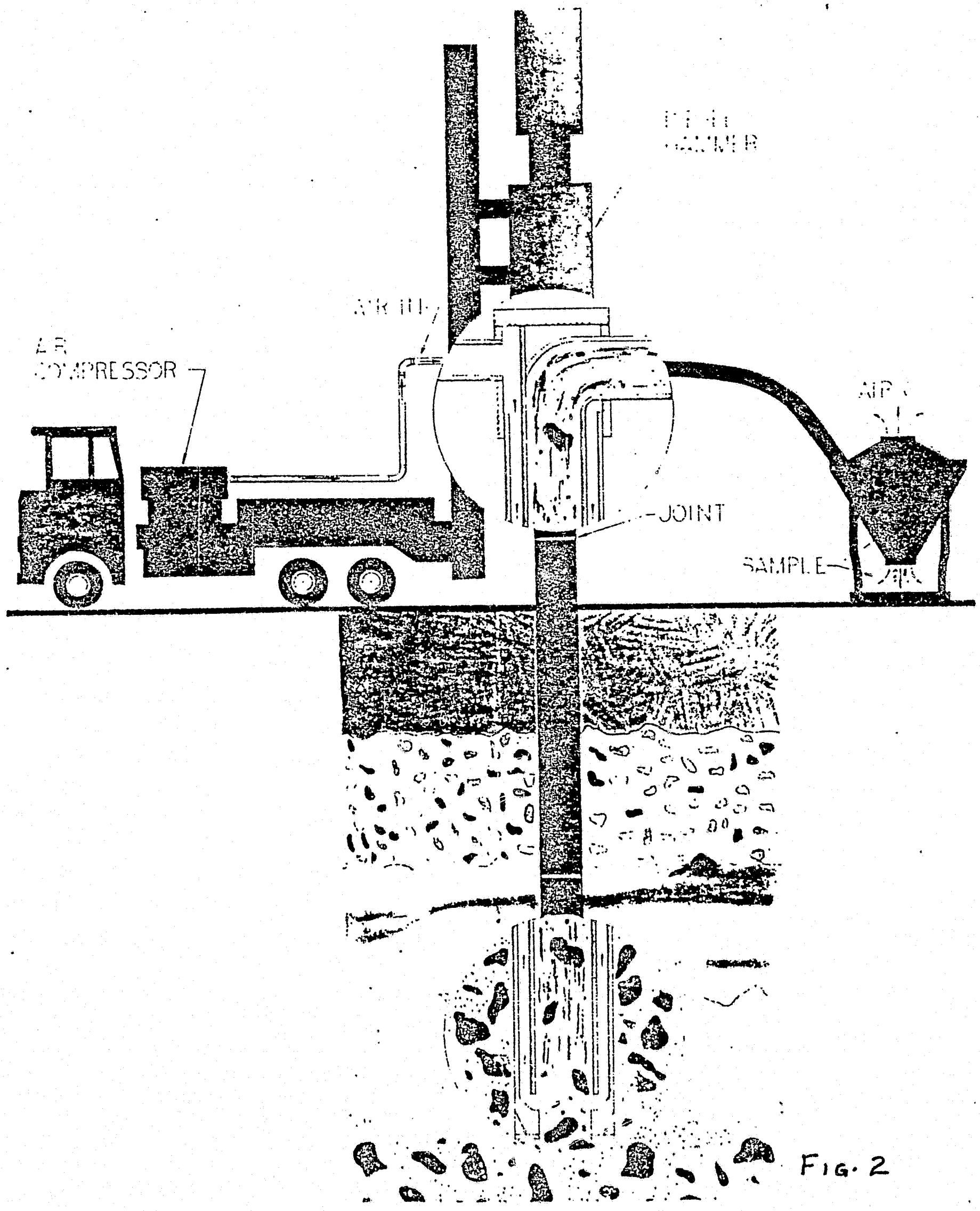


FIG. 2

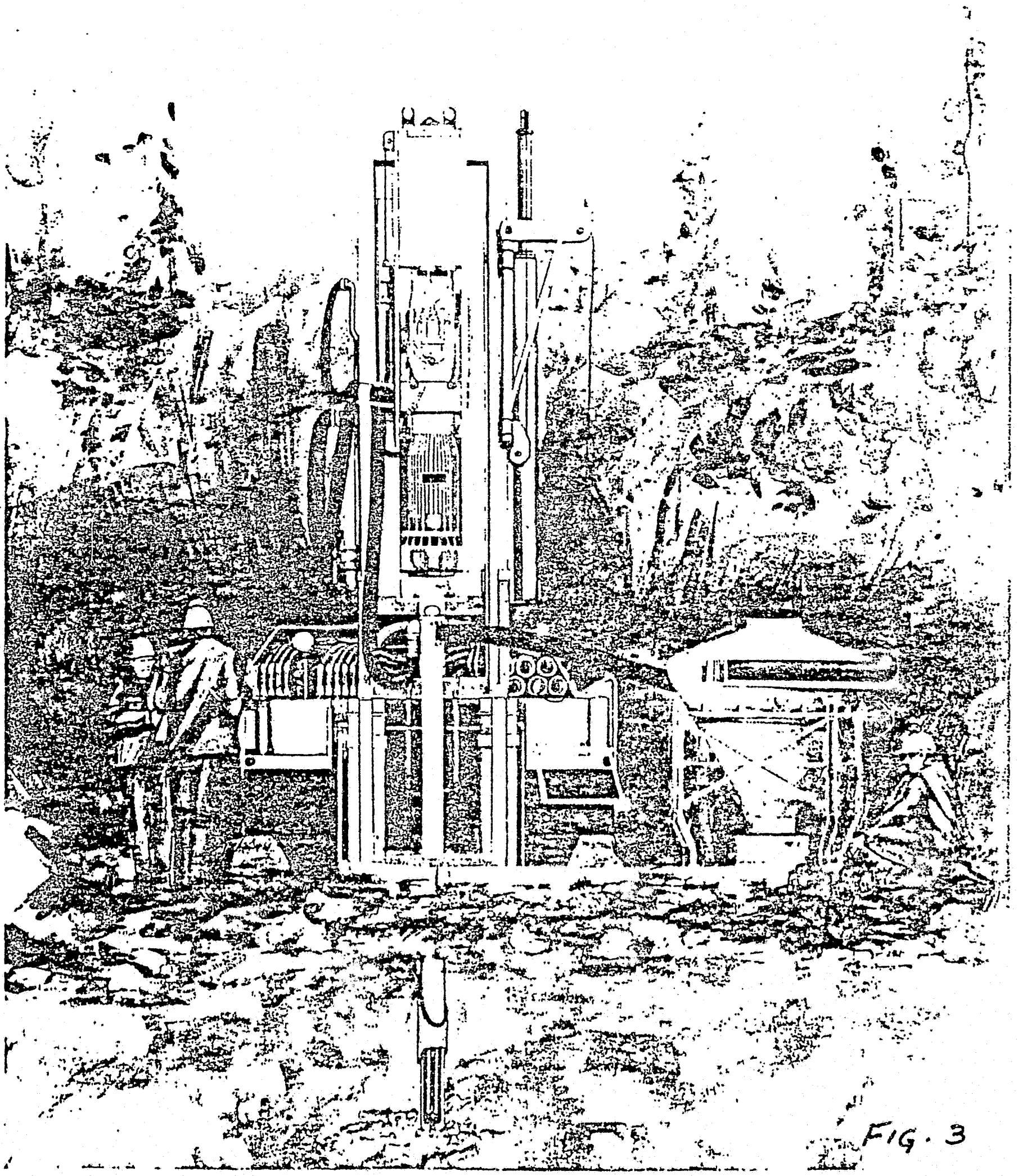
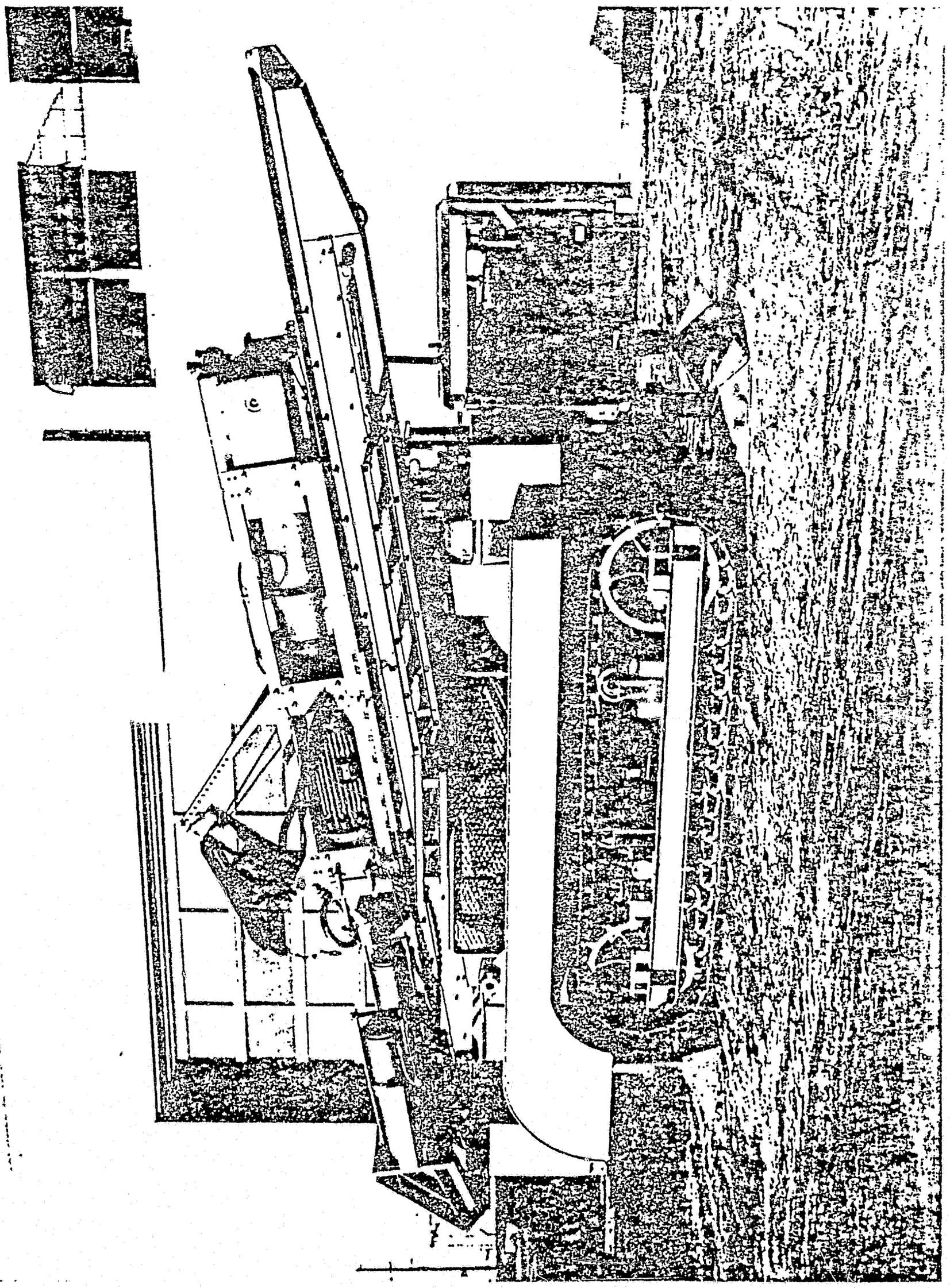


FIG. 3

FIG. 4



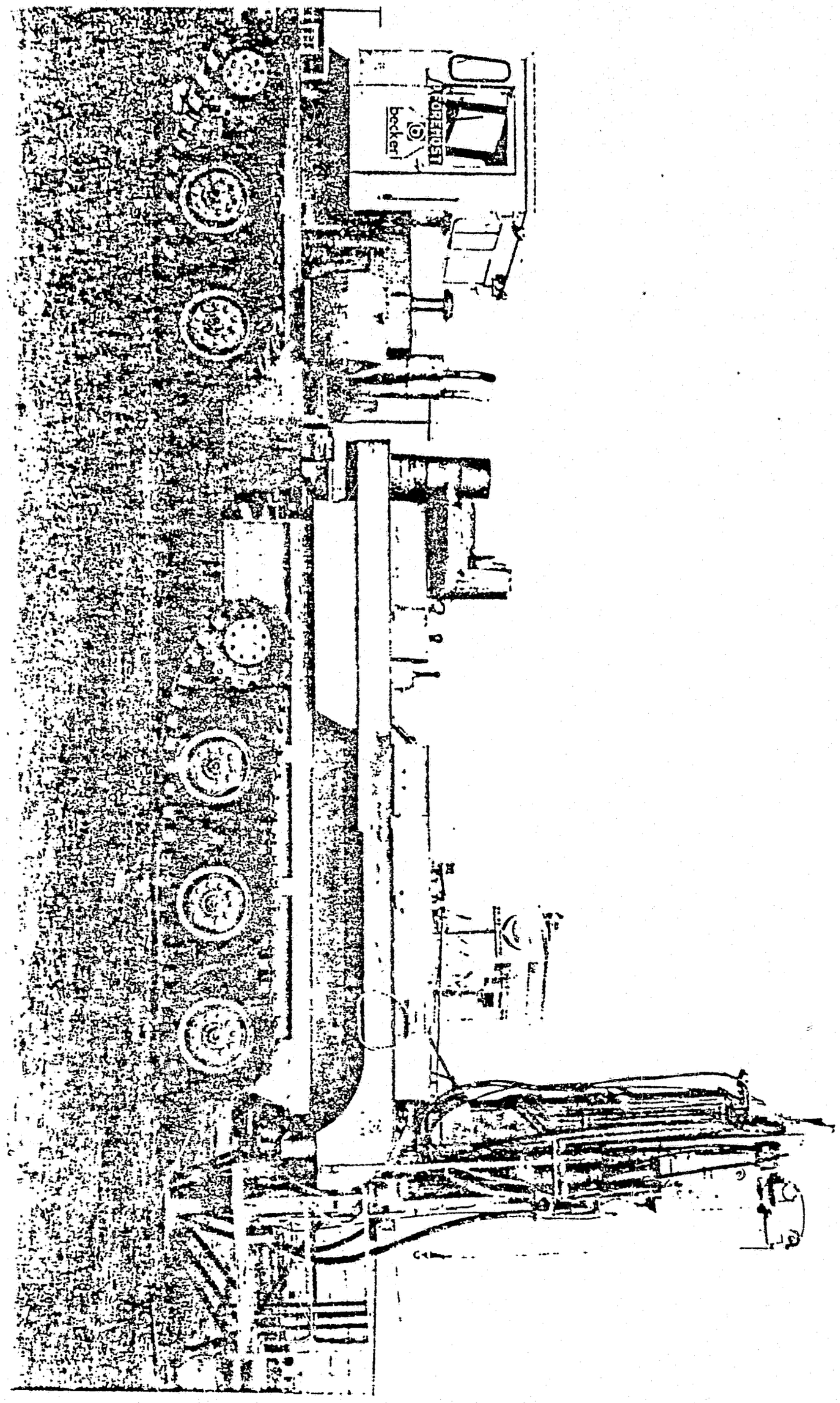


FIG. 5

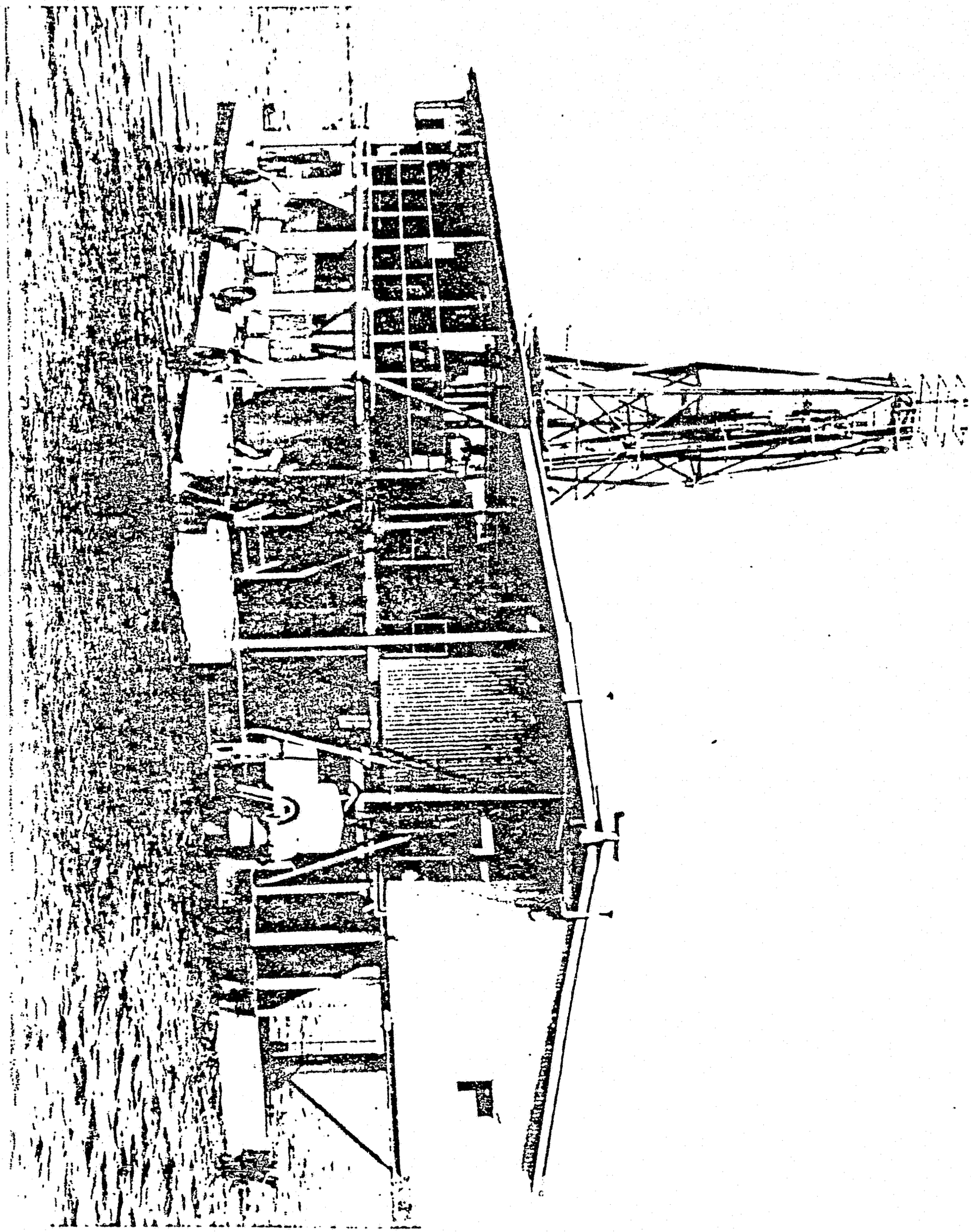


Fig. 6

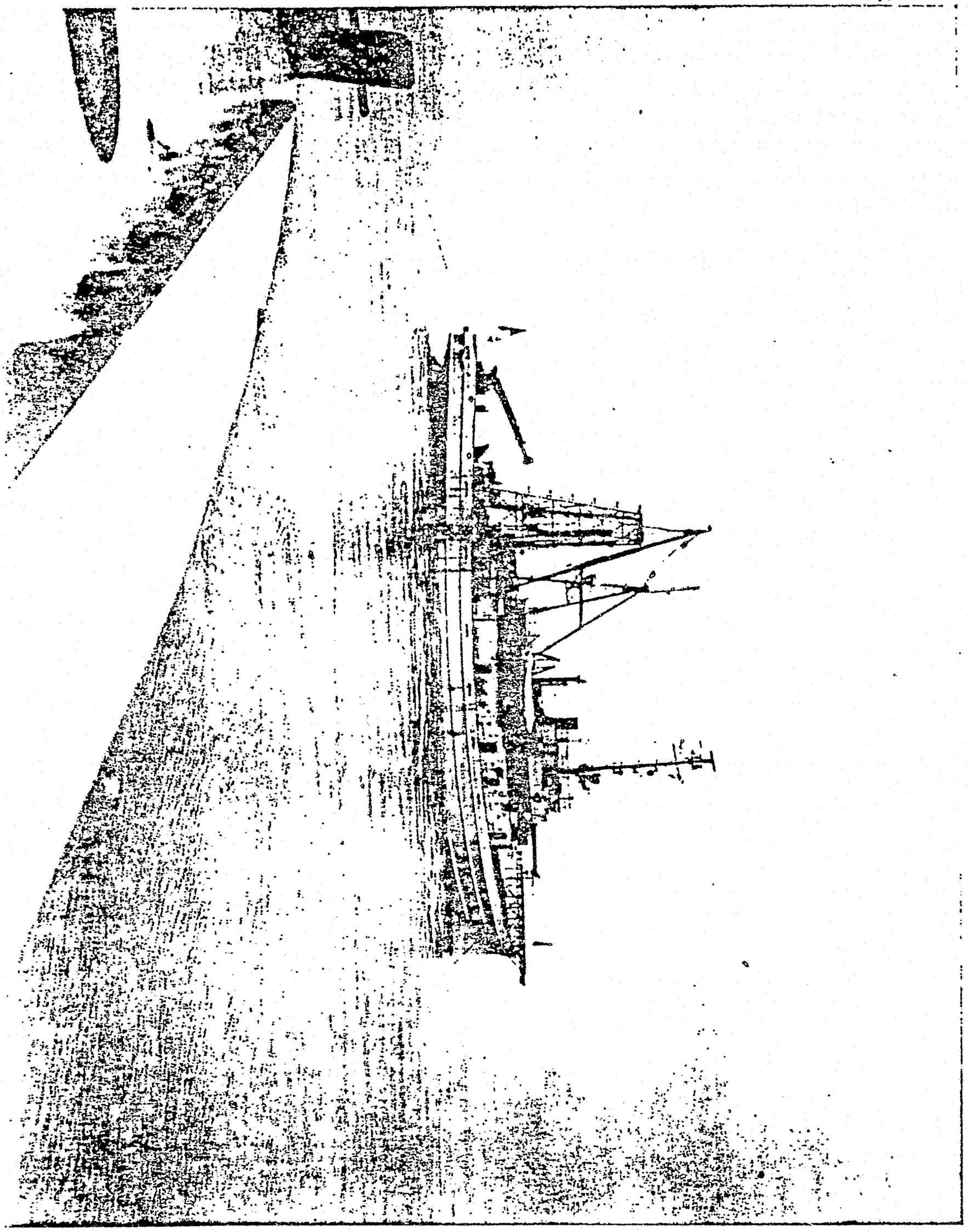


FIG. 7

COMPARISON OF BECKER HOLE AND CHURNDRILL HOLE

TEST RUN BY U.S. BUREAU OF MINES

AT YUBA GOLD FIELD CALIFORNIA

HOLE NO. 5 DRILLED NEAR HOLE NO. 1773

FIG 4A

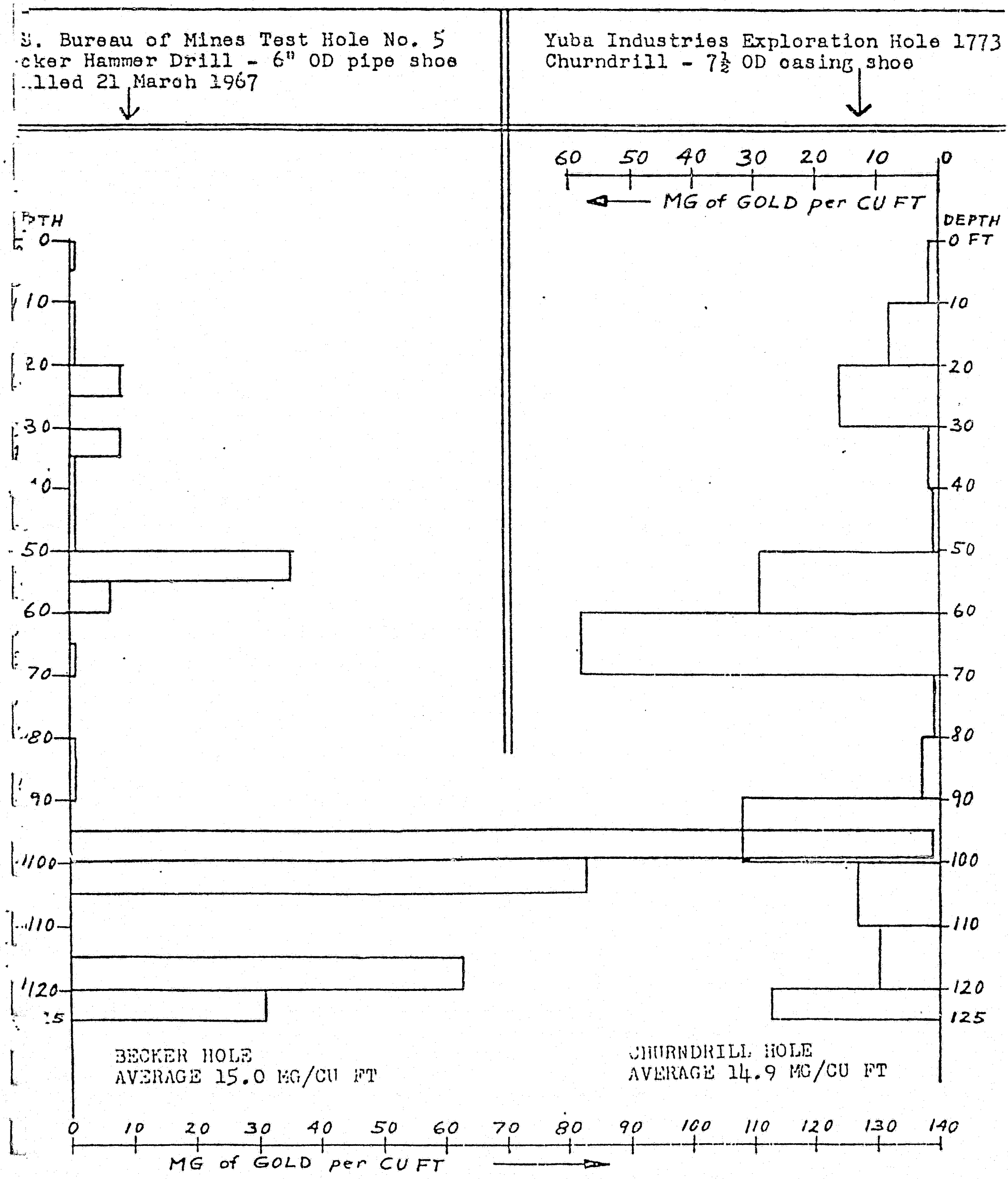


FIG. 7B

BECKER DRILL HOLE NO. 5

Depth Ft	Weight MG For 5 ft of hole	Sample Volume Measured. Cu Ft for 5 Ft	Factor for converting sample volume to one Cu Ft per Ft of hole	Converted Weight in MG per Cu Ft
0 - 5	tr	.1		tr
5 - 10		.6		
10 - 15	tr	.7		tr
15 - 20	tr	.7		tr
20 - 25	½	.3	5/.3 = 16.7	8.3
25 - 30	tr	.5		
30 - 35	1	.6	5/.6 = 8.3	8.3
35 - 40	tr	.6		tr
40 - 45	tr	.3		tr
45 - 50	tr	2.6		tr
50 - 55	5	.7	7.1	35.5
55 - 60	1	.8	6.3	6.3
60 - 65		.5		
65 - 70	tr	1.9		tr
70 - 75		2.3		
75 - 80		1.7		
80 - 85	tr	1.0		tr
85 - 90	tr	.7		tr
90 - 95		1.2		
95 - 100	25	.9	5.6	140.0
100 - 105	10	.6	8.3	83.0
105 - 110		.4		
110 - 115	tr	.9		
115 - 120	10	.8	6.3	63.0
120 125	7	1.1	4.5	31.0
				375.4

5 ft × 375.4 = 1877

$\frac{1877}{12.5\text{ ft}}$ = 15.0 MG/CU FT

Average for Becker Hole

CHURNDRILL HOLE #1773

Converted Weight in MG per Cu Ft	Factor for converting Sample volume to one Cu Ft per Ft of hole	Sample Volume Cu Ft for 5 Ft	Weight MG for 5 Ft of hole	Depth Ft
1.6	3.2	1.54	.5	0 - 5
1.6	"	"	.5	5 - 10
8.0	"	"	2.5	10 - 15
8.0	"	"	2.5	15 - 20
16.0	"	"	5.0	20 - 25
16.0			5.0	25 - 30
1.6			.5	30 - 35
1.6			.5	35 - 40
tr			tr	40 - 45
tr			tr	45 - 50
28.8			9	50 - 55
28.8			9	55 - 60
59.2			18.5	60 - 65
59.2			18.5	65 - 70
tr			tr	70 - 75
tr			tr	75 - 80
3.2			1	80 - 85
3.2			1	85 - 90
32.0			10	90 - 95
32.0			10	95 - 100
12.8			4	100 - 105
12.8	"	"	4	105 - 110
9.6	"	"	3	110 - 115
9.6	"	"	3	115 - 120
27.2	3.2	1.54	8.5	120 - 125
372.8				

5 ft × 372.6 = 1863

$\frac{1863}{12.5\text{ ft}}$ = 14.9 MG/CU FT

Average for Churndrill Hole

COMPARISON OF BECKER HOLE AND CHURNDRILL HOLE

TEST RUN BY U.S. BUREAU OF MINES

AT YUBA GOLD FIELD CALIFORNIA

HOLE NO. 4 DRILLED NEAR HOLE NO. 1763

FIG 7C

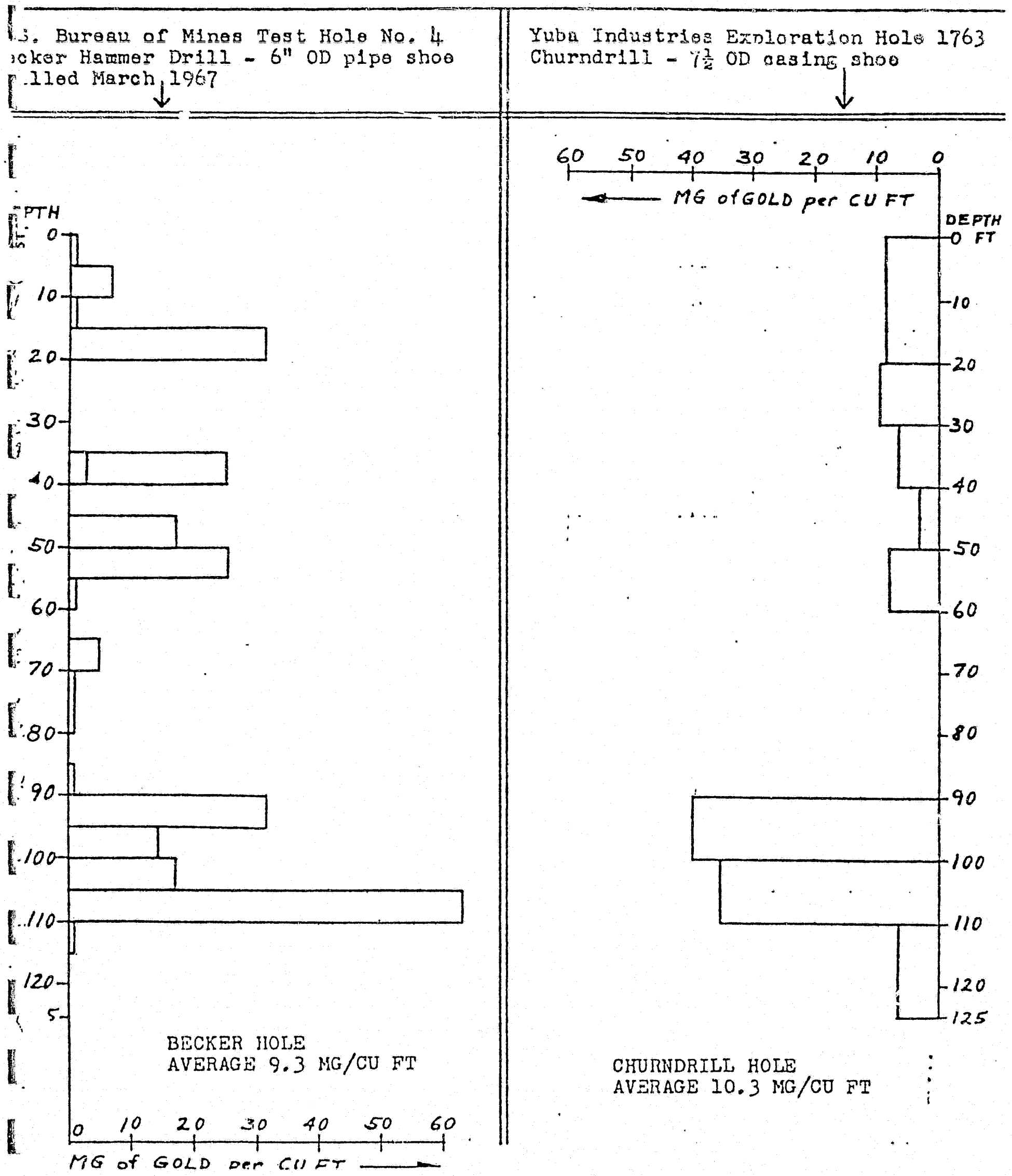


FIG 7D

BECKER DRILL #4					CHURNDRILL #1763				
Depth Ft	Weight MG For 5 ft of hole	Sample Volume Measured. Cu Ft for 5 Ft	Factor for converting sample volume to one Cu Ft per Ft of hole	Converted Weight in MG per Cu Ft	Converted Weight in MG per Cu Ft	Factor for converting sample volume to one Cu Ft per Ft of hole	Sample Volume Cu Ft for 5 Ft	Weight MG for 5 Ft of hole	Depth Ft
0 - 5	tr	.4		tr	8.6	3.2	1.54	2.7	0 - 5
5 - 10	1	.8	5/.8 = 6.3	6.3	8.6	"	"	2.7	5 - 10
10 - 15	tr	.7		tr	8.6	"	"	2.7	10 - 15
15 - 20	7	1.1	5/1.1 = 4.5	31.4	8.6	"	"	2.7	15 - 20
20 - 25		.4			9.6	"	"	3	20 - 25
25 - 30		.7			9.6				25 - 30
30 - 35		.7			6.4			2	30 - 35
35 - 40	2	.4	12.5	25.0	6.4				35 - 40
40 - 45		.5			3.2			1	40 - 45
45 - 50	2	.6	8.3	16.6	3.2			1	45 - 50
50 - 55	3	.6	8.3	24.9	8.0			2.5	50 - 55
55 - 60	tr	.6		tr	8.0			2.5	55 - 60
60 - 65		.9							60 - 65
65 - 70	1	1.1	4.5	4.5					65 - 70
70 - 75	tr	1.0		tr					70 - 75
75 - 80	tr	.5		tr					75 - 80
80 - 85		.3							80 - 85
85 - 90	tr	1.4		tr					85 - 90
90 - 95	7	1.1	4.5	31.4	40.0			12.5	90 - 95
95 - 100	2	.7	7.1	14.2	40.0			12.5	95 - 100
100 - 105	3	.9	5.6	16.8	35.2			11	100 - 105
105 - 110	10	.8	6.3	63.0	35.2	"	"	11	105 - 110
110 - 115	tr	.6		tr	6.4	"	"	2	110 - 115
115 - 120		.7			6.4	"	"	2	115 - 120
120 - 125		.9			6.4	3.2	1.54	2	120 - 125
				234.1	258.4				

$5\text{ ft} \times 234.1 = 1170.5$

$\frac{1170.5}{125\text{ ft}} = 9.3$ MG/CU FT
Average for Becker hole

$5\text{ ft} \times 258.4 = 1292$

$\frac{1292}{125\text{ ft}} = 10.3$ MG/CU FT
Average for Churndrill hole

BDT

WHAT IS IT?

The BECKER DENSITY TEST is a new soils and foundation exploration tool in the form of a giant dynamic penetrometer.

WHAT DOES IT DO?

It measures the Denseness of the soil.

HOW DOES IT WORK?

The regular 5½" Becker Drill Pipe is blocked off at the bit, the drilling air is shut off, and the pipe is driven by the diesel pile driving hammer as if it was a steel pile, counting the blows for each foot of advancement.

HOW ACCURATE IS IT?

The BDT is very sensitive yet has a wide measuring range. It is a highly accurate tool with none of the 'wild' values frequently produced by the Standard Penetration Test (SPT).

WHY IS IT MORE ACCURATE THAN THE SPT?

There are four main reasons why the BDT provides a more accurate Density index:

1. The driving is mechanical — influence of human factors (skill/errors) is reduced.
2. No hole is drilled — there is no drilling disturbance.
3. Insignificant local variations, for example small rocks, produce dramatically misleading SPT values. The BDT is a test on a much larger scale, not influenced by minor local anomalies.
4. The SPT is intermittent (usually 5 ft. spacing) whereas the BDT is continuous, providing five tests in five feet.

In summary, each individual BDT value is more accurate, and there are five times as many values, continuous through the formation.

HOW DOES IT COMPARE IN COST WITH THE SPT?

Normally the BDT is less than half the cost of a corresponding drill hole with SPT at five foot intervals.

BUT WHAT ABOUT SAMPLES OF THE SOIL AND INFORMATION ON GROUND WATER?

By drilling a conventional Becker Drill Hole beside the BDT, continuous, representative samples are obtained and ground water information provided. Usually a BDT and a Becker Sample Hole can be run for less cost than one SPT hole.

WHERE IS THE BDT BEST SUITED?

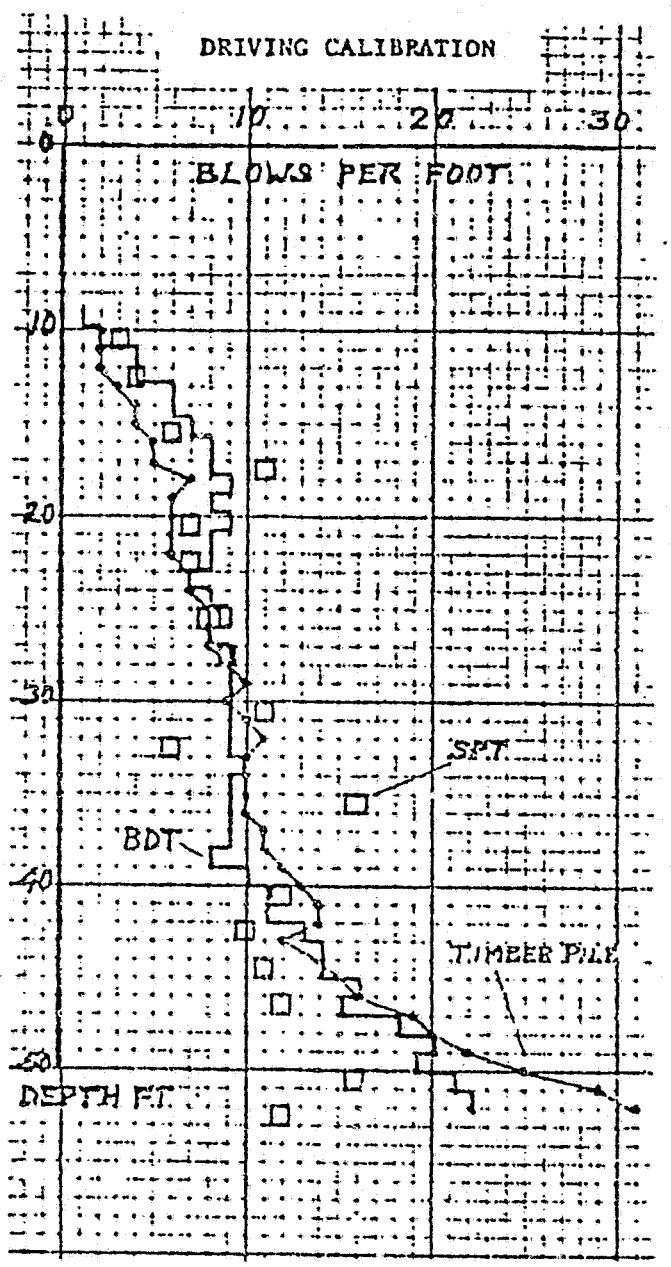
For granular formations where information on the Denseness of the soil is required.

BEARING VALUES AND OTHER CORRELATIONS ARE AVAILABLE FOR THE SPT. HOW CAN THE CORRESPONDING BDT VALUE BE APPLIED?

Driving calibrations indicate that — by coincidence — the average numerical relation between SPT and BDT is 1:1, it is therefore very simple to use the conventional SPT correlations.

WHAT ABOUT TESTING FOR PILING?

For any project where piles might be considered, the BDT is a vastly superior exploration tool. It is in fact a pile driving test on a 5" closed end pipe pile.



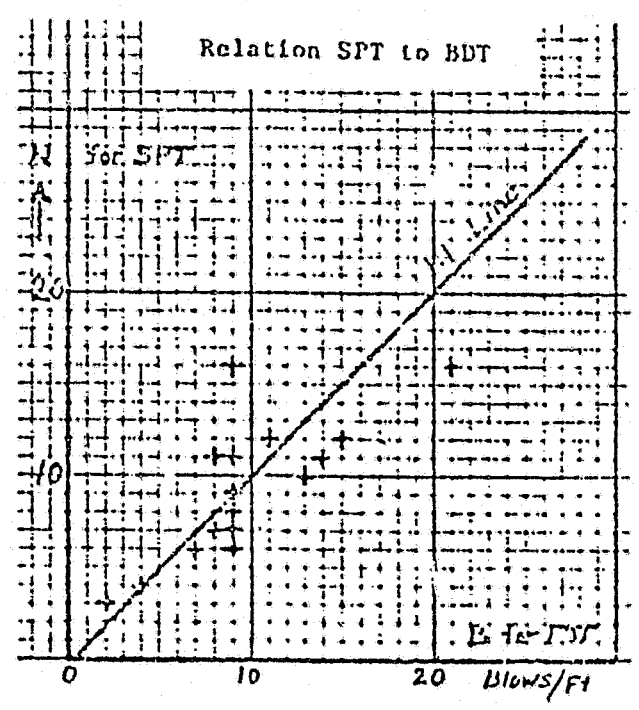
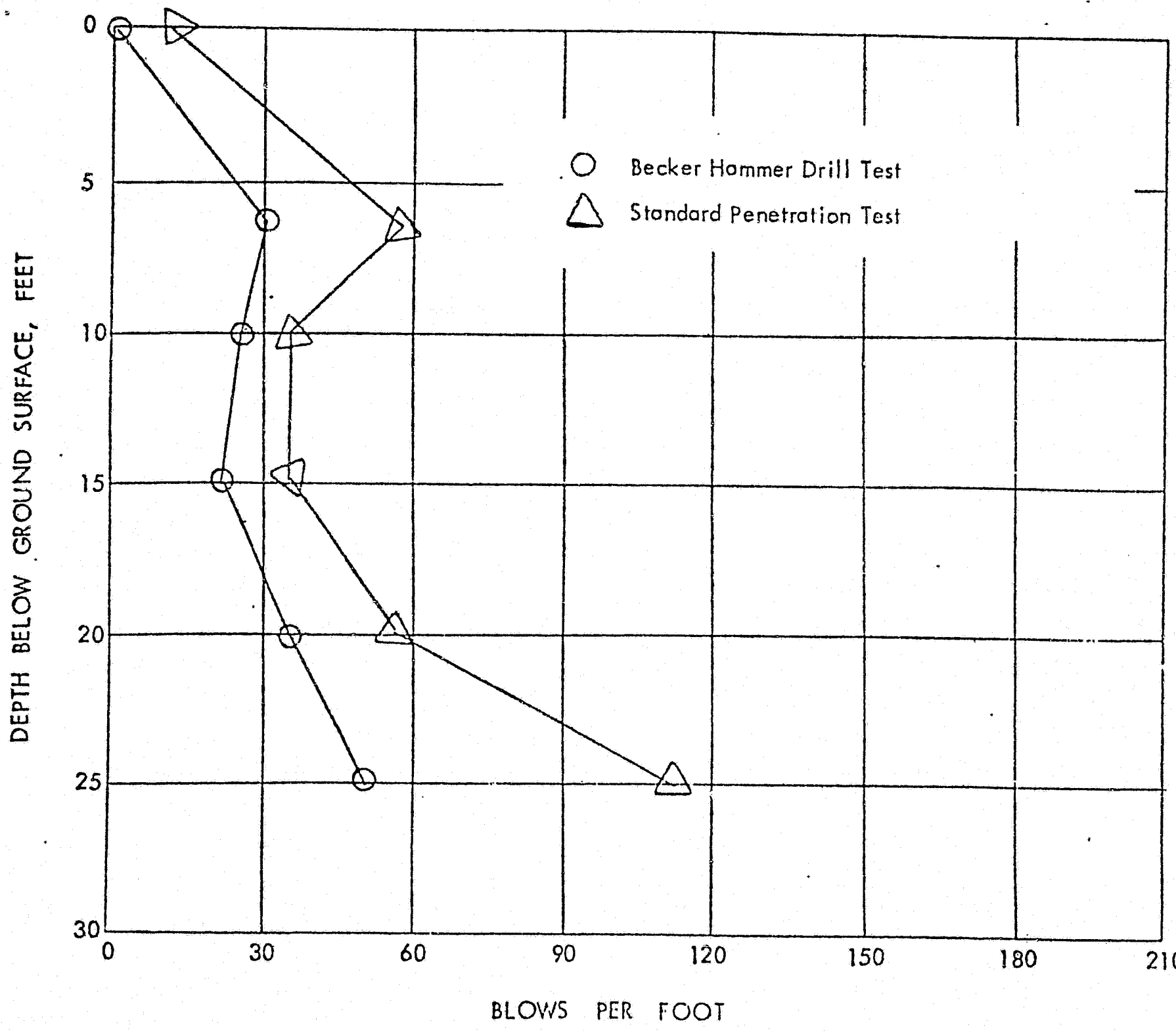


FIGURE NO. 8

FIGURE NO. 9
DEPTH - BLOW COUNT RELATIONSHIP



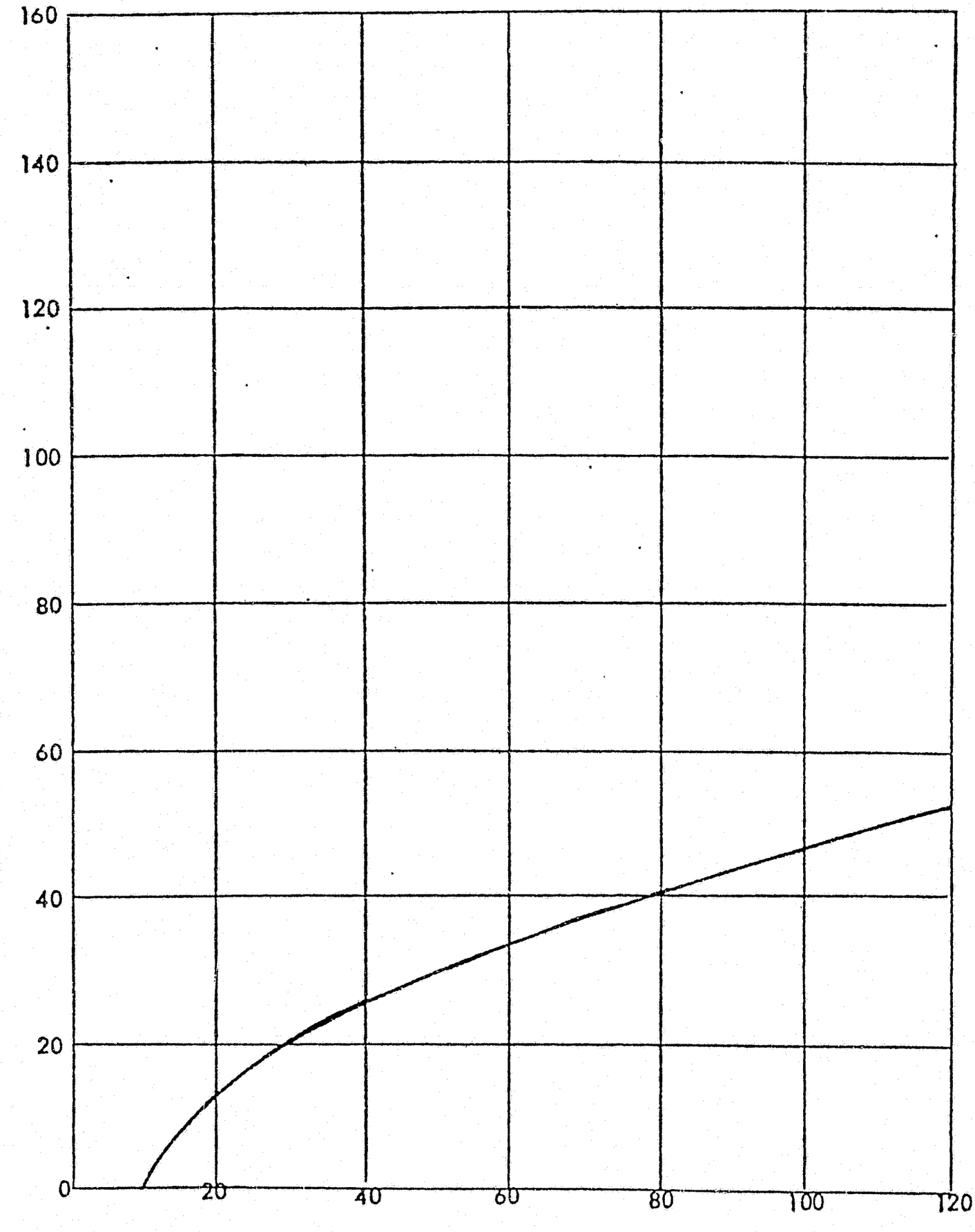
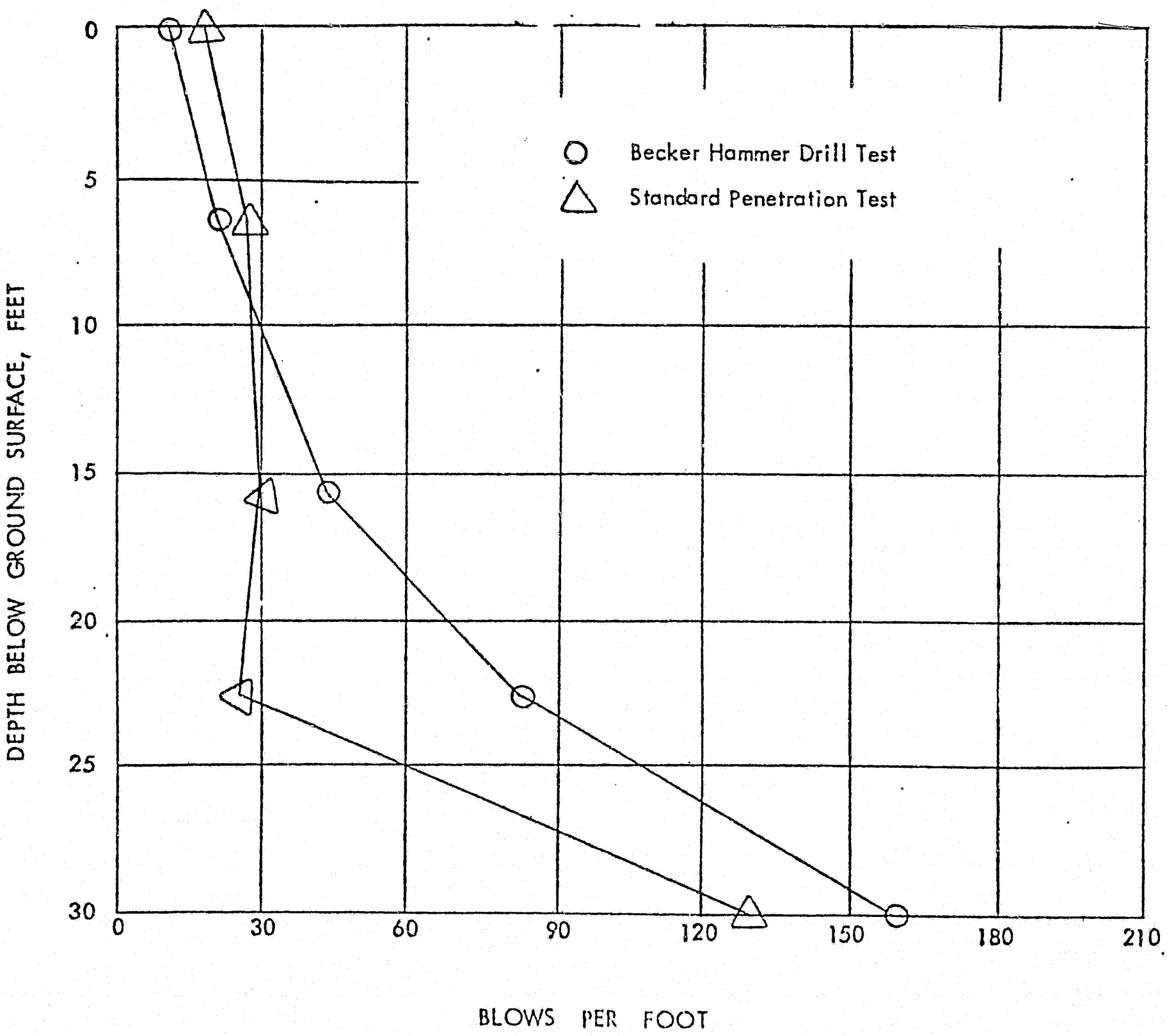


FIGURE NO. 10
SPT - BHD CORRELATION

FIGURE NO. 11
DEPTH - BLOW COUNT RELATIONSHIP



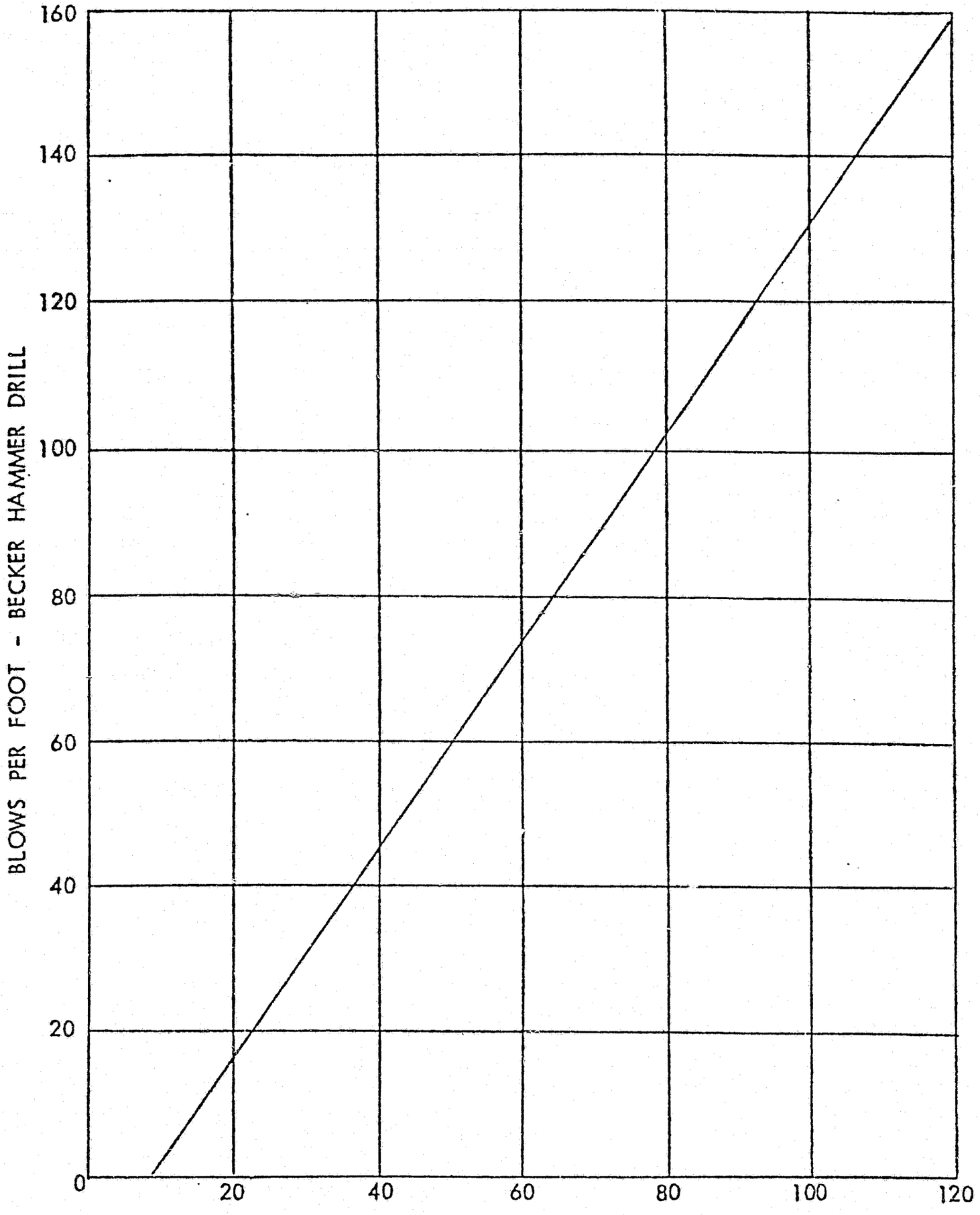


FIGURE NO. 12
SPT - BHD CORRELATION

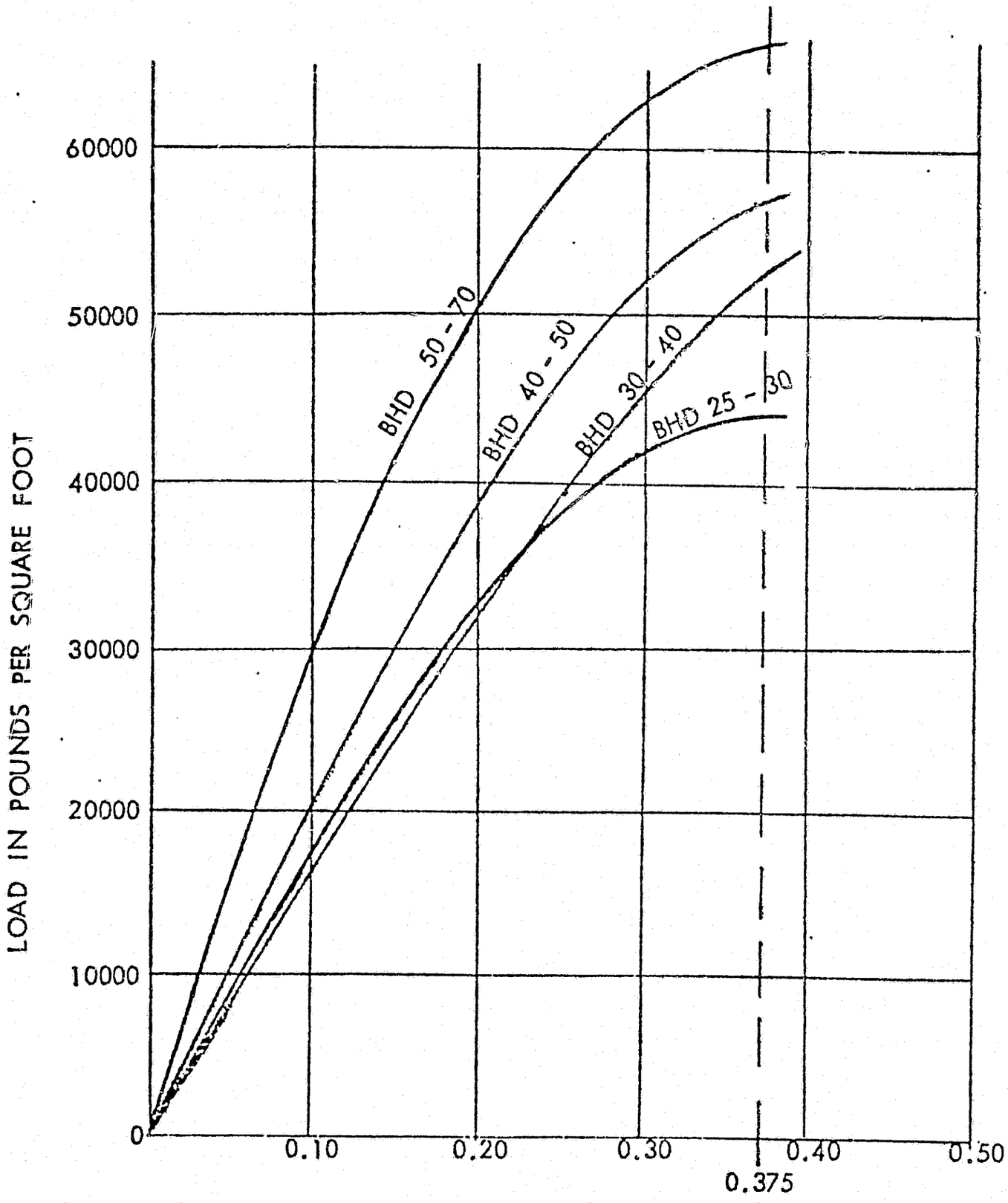


FIGURE NO. 13
LOAD-SETTLEMENT CURVES
WITH BECKER HAMMER DRILL BLOW COUNTS

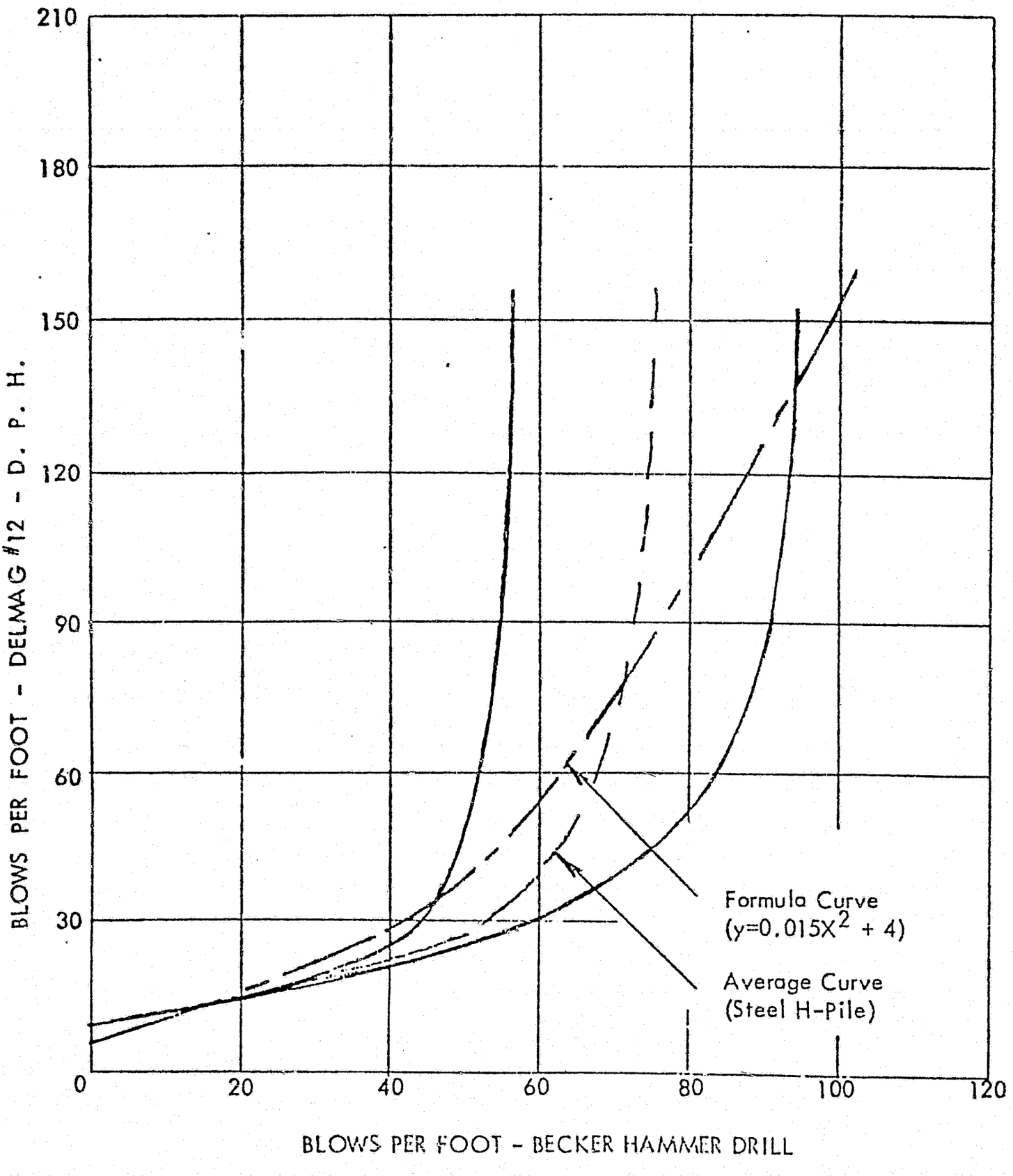


FIGURE NO. 14
BLOW COUNT CORRELATION
BECKER HAMMER DRILL - DELMAG #12 STEEL PILES

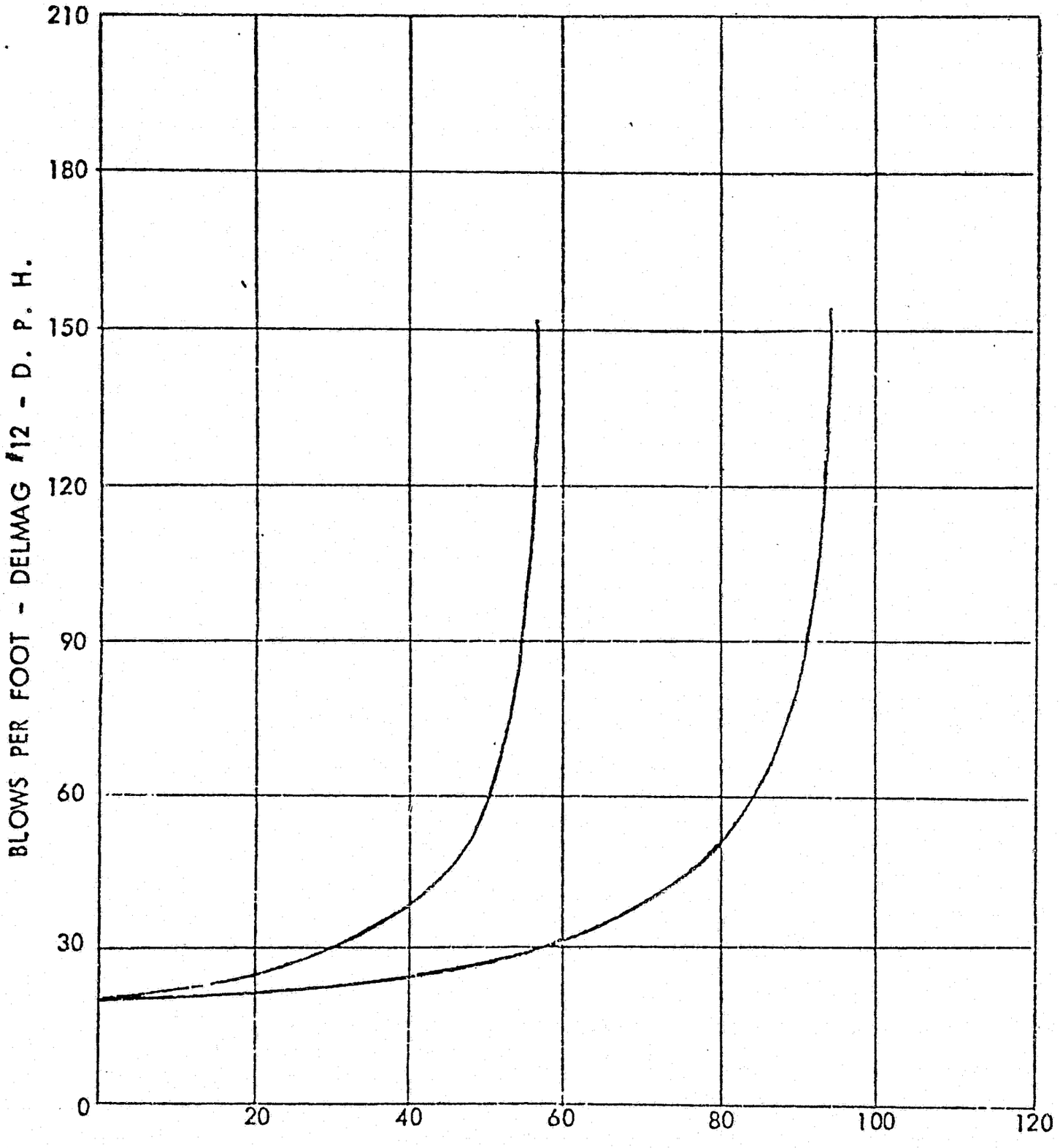
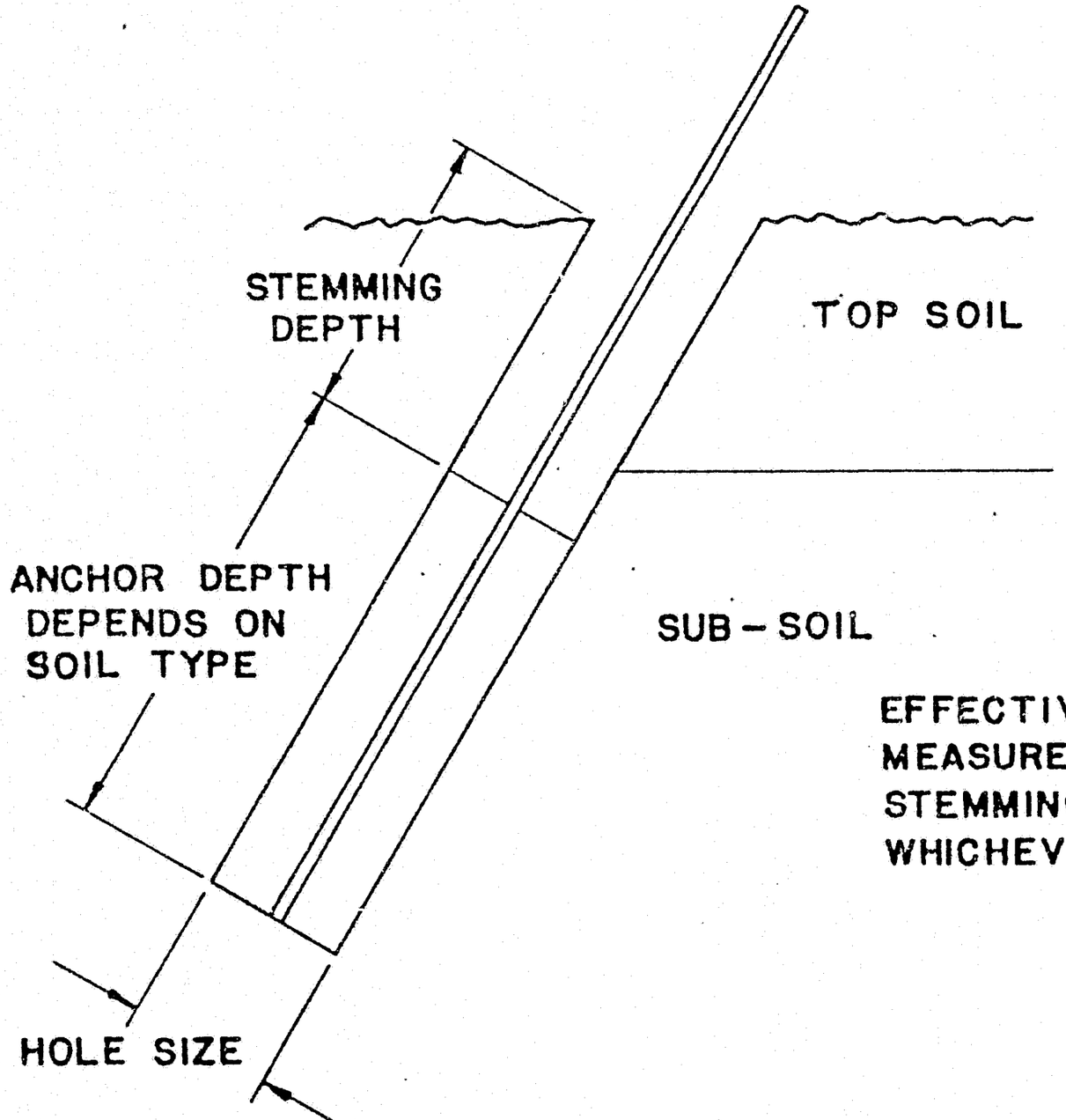


FIGURE NO. 15
BLOW COUNT CORRELATION
BECKER HAMMER DRILL-DELMAG #12 D.P.H.- WOOD PILES

TYPE I TYPICAL OVERBURDEN ANCHOR



EFFECTIVE ANCHOR DEPTH MEASURED FROM BOTTOM OF STEMMING OR MUSKEG DEPTH, WHICHEVER IS GREATER

FIG. 16

TYPE II COMBINATION ROCK & OVERBURDEN ANCHOR

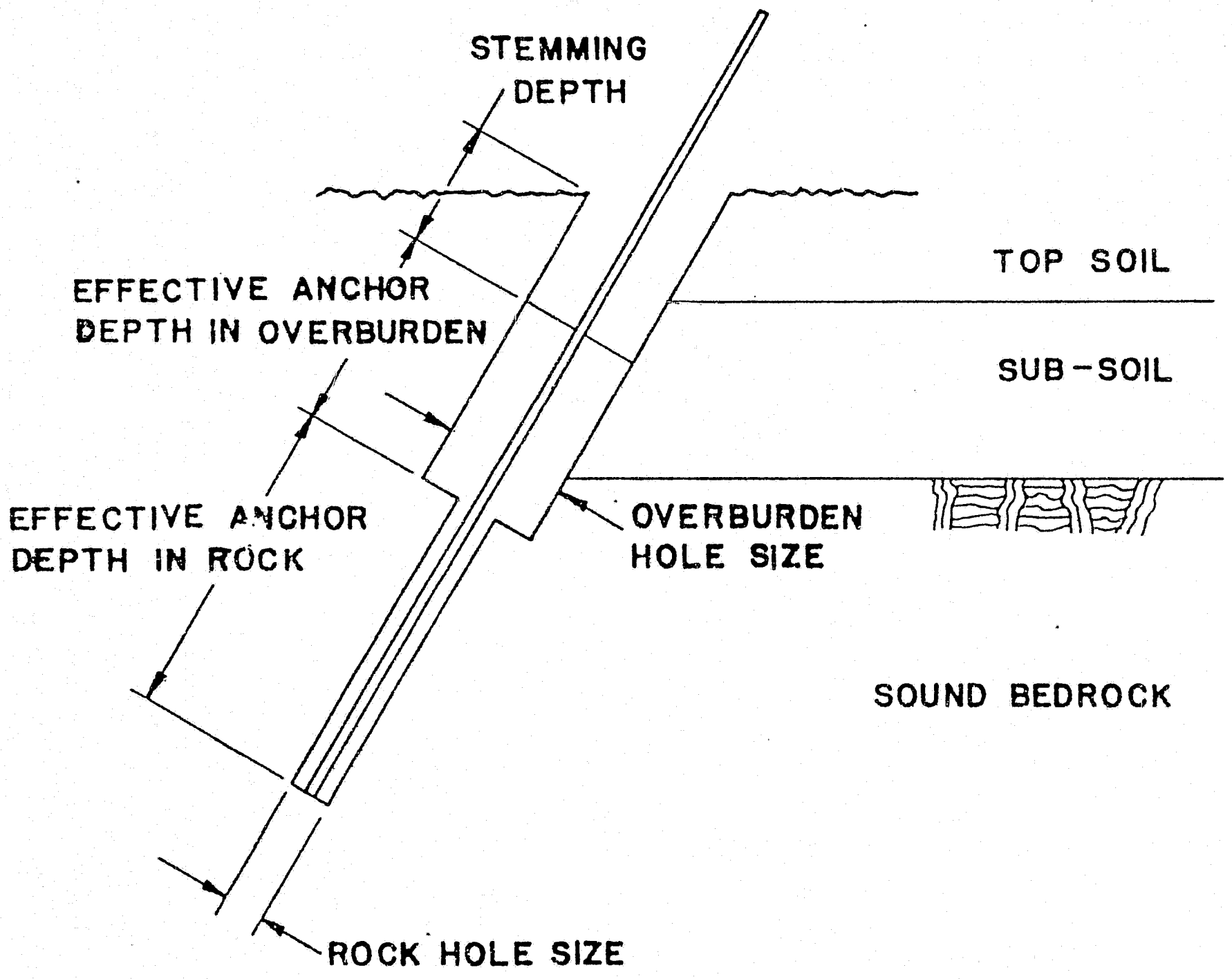
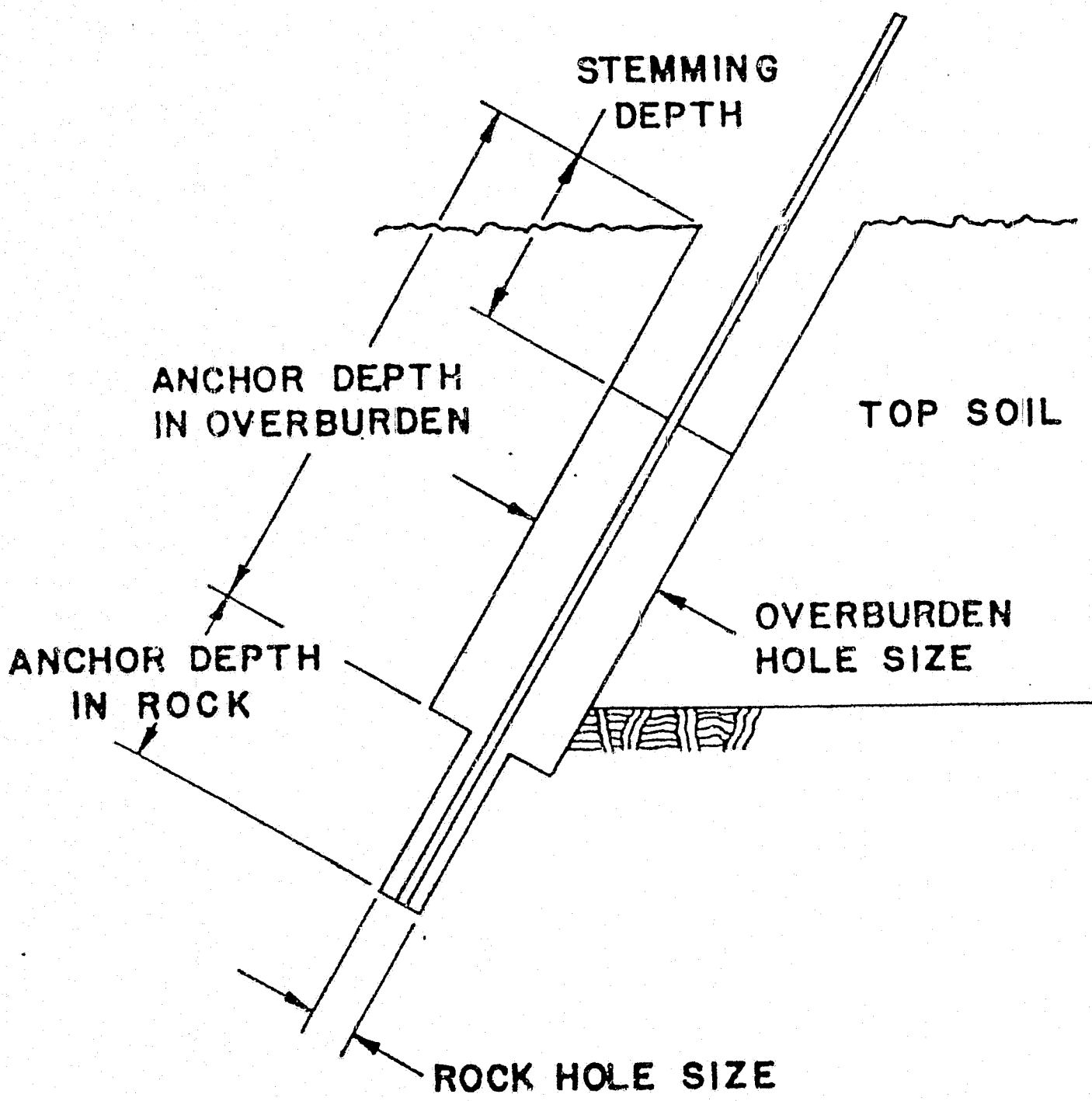


FIG. 17

TYPE III ROCK ANCHOR WITH DEEP OVERBURDEN



STEMMING MAY BE MINIMUM DEPTH
OR ENTIRE OVERBURDEN DEPTH

EFFECTIVE ANCHOR DEPTH
IN ROCK PORTION ONLY

FIG. 18

TYPE IV ROCK ANCHOR

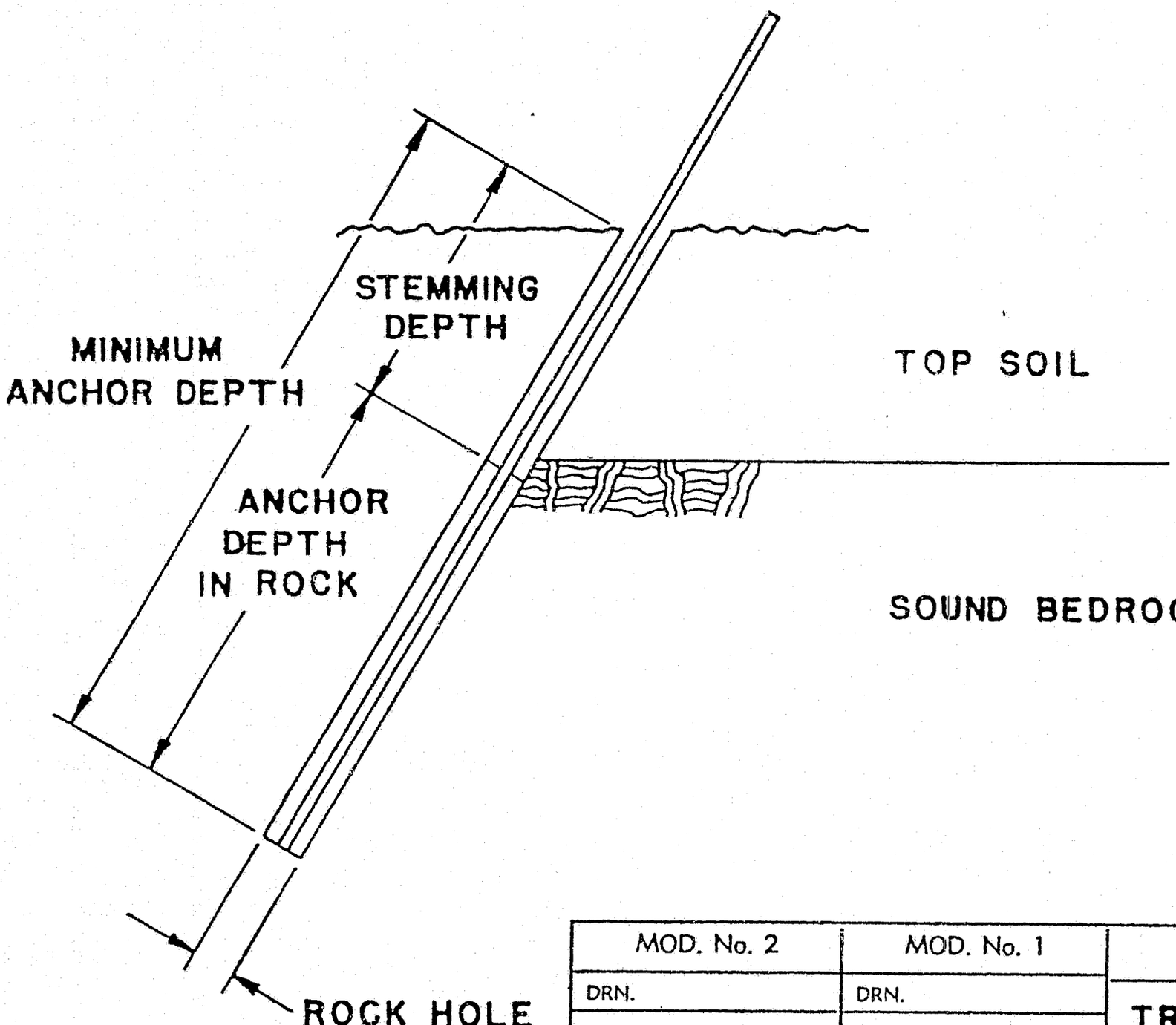
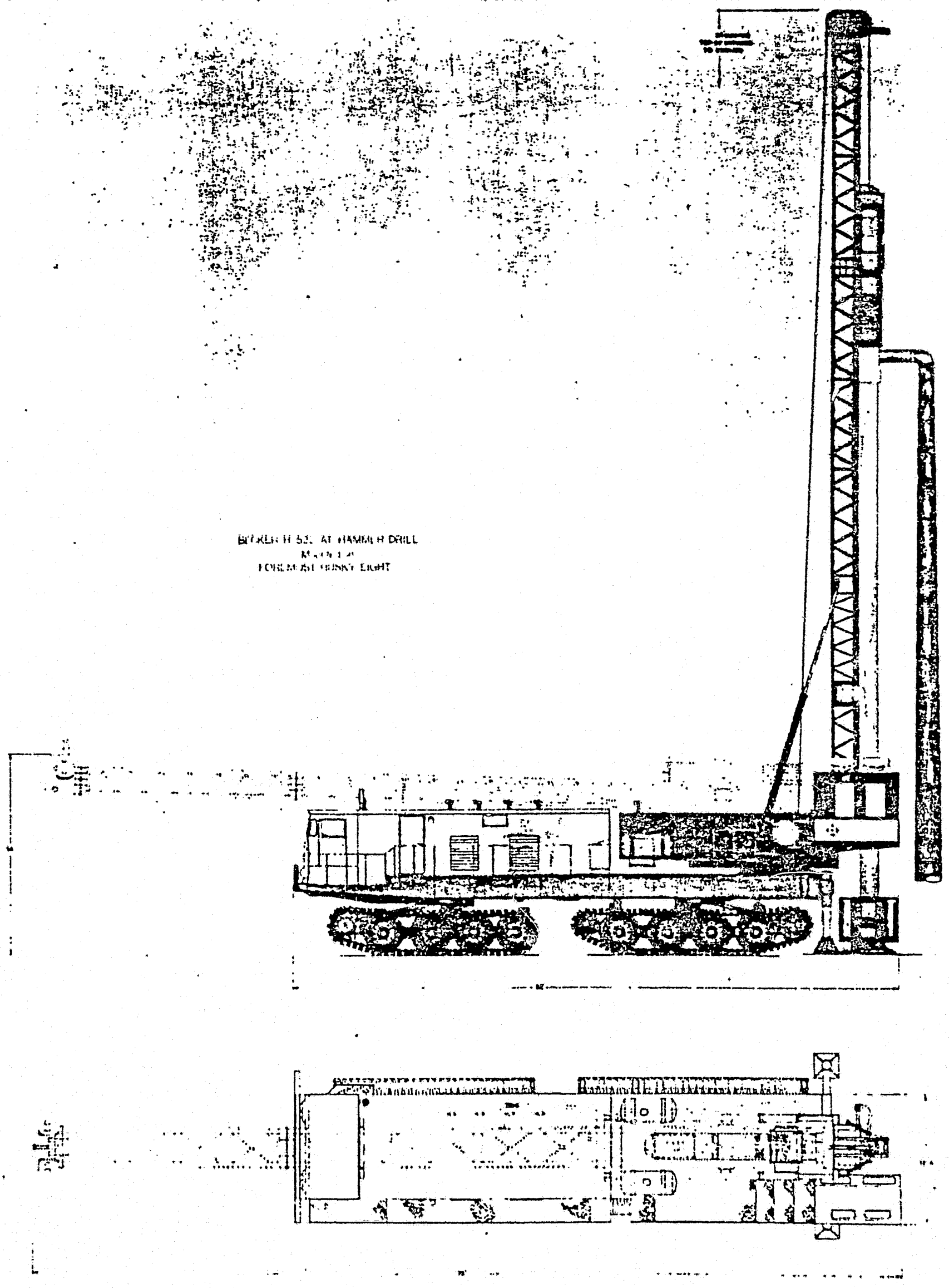
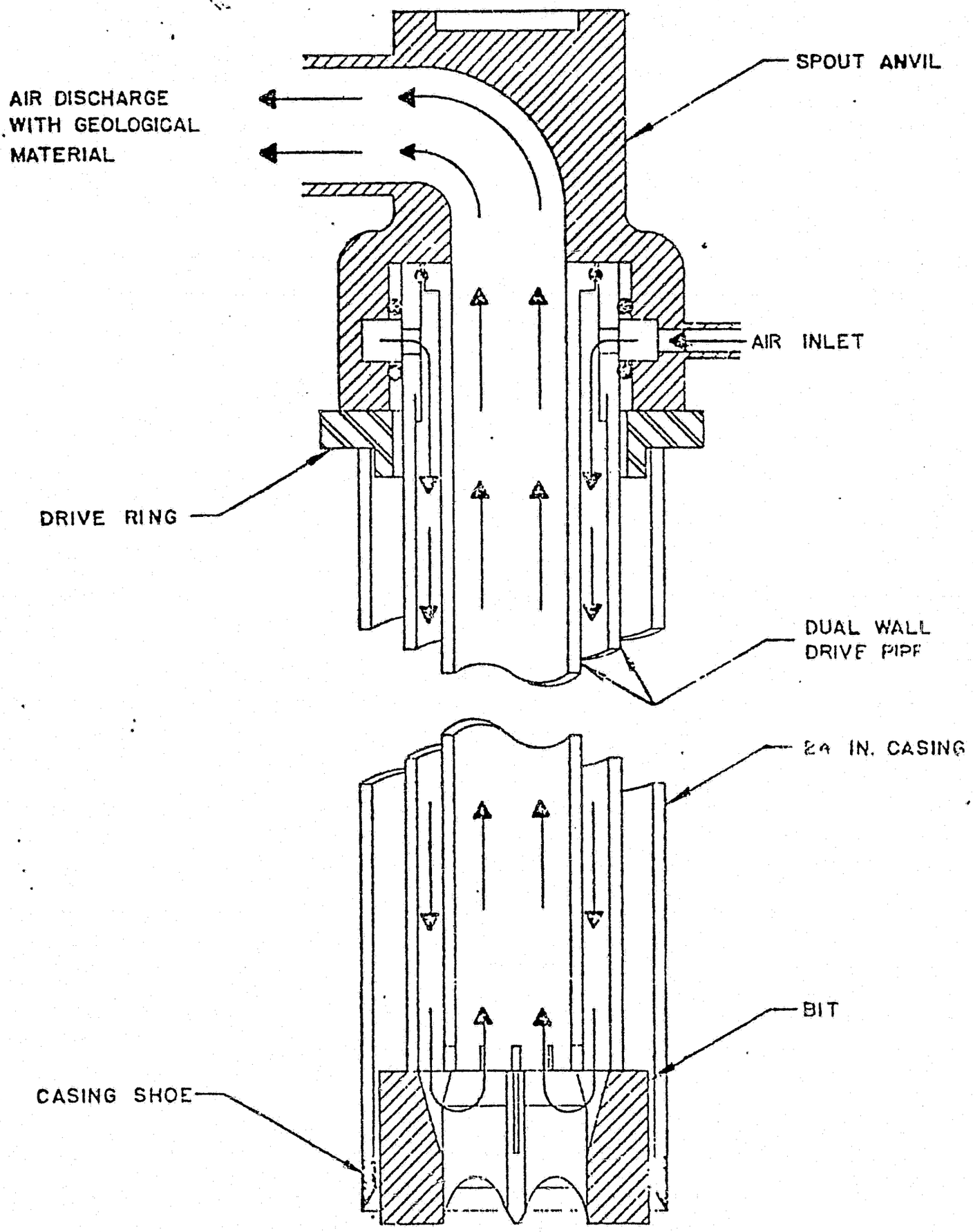


FIG. 19

MOD. No. 2	MOD. No. 1	BECKER DRILLS LTD.			
DRN.	DRN.	TRANSMISSION ANCHOR TYPES			
		ASSEMBLY DWG. No.:		UNIT No.:	
		SCALE: N.T.S.		1351	C
		DATE: MAR. 1 '71	DWN. BY: E.K.		

FIG. 20



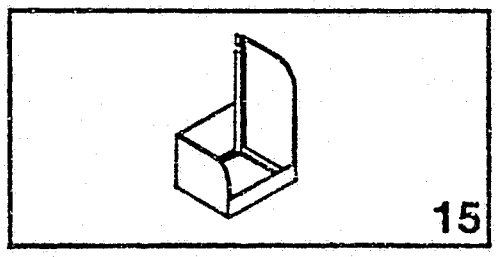


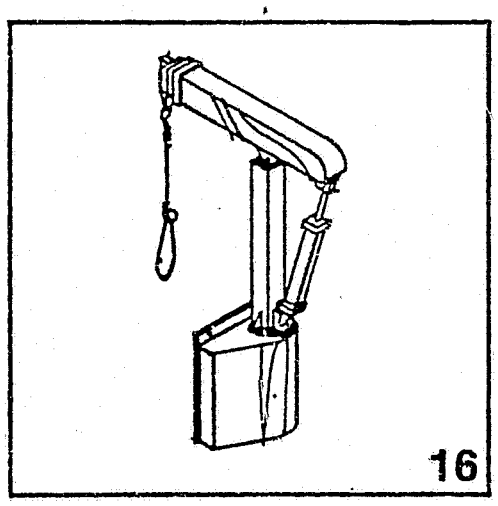
Triple Tube Drive Pipe

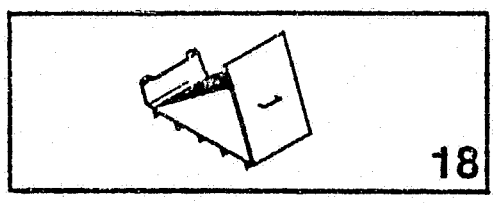
FIGURE NO. 21

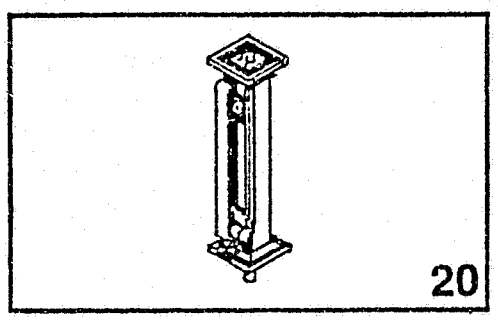
drill systems inc.

616 - 58 Avenue S.E.,
Calgary, Alberta T2P 0P8
Telephone: (403) 253-7451
Telex: 03-825750

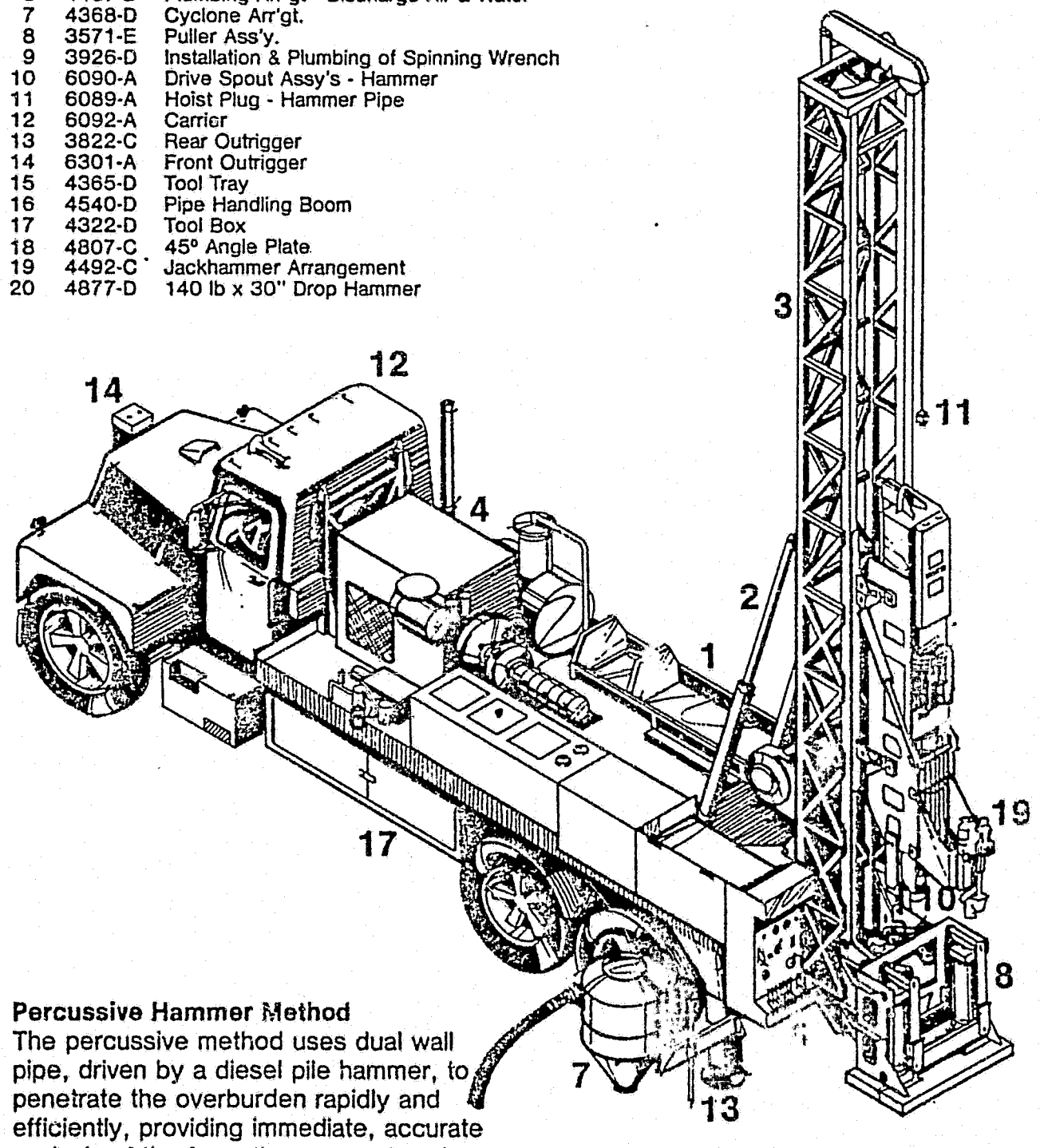








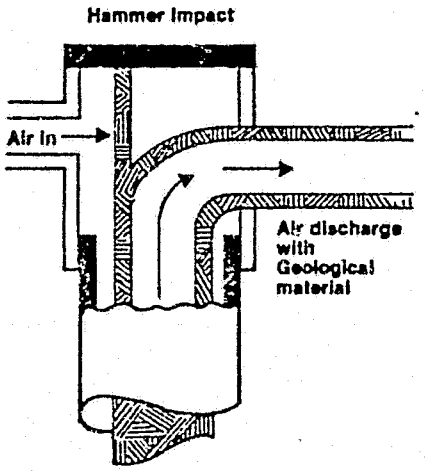
ITEM	PART NO.	DESCRIPTION
1	5962-C	Deck Ass'y.
2	4139-D	Deck & Mast Slide Arr'gt.
3	3903-C	Mast Ass'y.
4	6060-B	Compressor Pkg.
5	5900-D	Control Station Ass'y.
6	4437-D	Plumbing Arr'gt - Discharge Air & Water
7	4368-D	Cyclone Arr'gt.
8	3571-E	Puller Ass'y.
9	3926-D	Installation & Plumbing of Spinning Wrench
10	6090-A	Drive Spout Assy's - Hammer
11	6089-A	Hoist Plug - Hammer Pipe
12	6092-A	Carrier
13	3822-C	Rear Outrigger
14	6301-A	Front Outrigger
15	4365-D	Tool Tray
16	4540-D	Pipe Handling Boom
17	4322-D	Tool Box
18	4807-C	45° Angle Plate
19	4492-C	Jackhammer Arrangement
20	4877-D	140 lb x 30" Drop Hammer

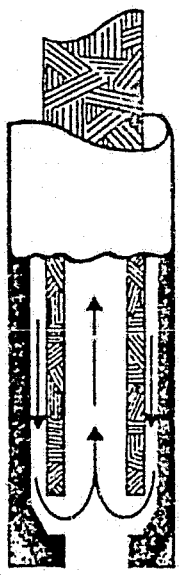


Percussive Hammer Method
The percussive method uses dual wall pipe, driven by a diesel pile hammer, to penetrate the overburden rapidly and efficiently, providing immediate, accurate analysis of the formation encountered. Through reverse circulation, air or water is forced down the annulus of the pipe, returning all cuttings to the surface through the center of the pipe — providing a continuous and uncontaminated sample.

specifications

Dual-Wall Drilling is a more economical and faster method to get results.





ADVANTAGES

- Continuous uncontaminated geological samples
- high production
- Increased bit life as regrinding is minimized
- maximum return of sample in lost circulation zone
- minimal loss of drilling fluid in lost circulation zone

APPLICATION

Mineral exploration drilling
Geotechnical sample
Construction drilling
Down-the-hole hammer drilling
Water well drilling

Diesel Pile Drive Hammer

With a force of 8100 ft lbs per blow, the diesel pile drive hammer operates at speeds variable to a maximum of 95 blows per minute, penetrating the overburden rapidly and efficiently, providing immediate, accurate analysis of the formation encountered. Using 5½" o.d. x 3¼" i.d. drill pipe, the hammer is capable of drilling to a depth of 350 ft, dependent upon soil conditions. For maximum efficiency when adding or pulling drill pipe the hammer retracts out of the way.

Angle and Vertical Drilling

The drill is designed to drill holes from vertical to 45° off vertical. The lateral travel of the mast on the deck allows the hole to be positioned within working distance of the operator. When pulling hammer pipe the attached puller assembly reacts against unstable ground conditions causing a load on the mast. The pressure relief valve on the mast slide cylinders eliminates this load on the mast.

Operator's Console

The operator in position at the console can control the total drilling operation, from starting the motor to levelling the drill unit and commencing drilling. Gauges for hydraulic oil pressure, water and air pressure are clearly visible for inspection. The controls are arranged in a logical sequence so that each drilling procedure can be carried out smoothly.

Specifications

Drilling Depth Capacity
- 350 ft (10 m) with 5½" (14.0 cm) hammer pipe

Diesel Pile Hammer
- Link Belt 180
- equivalent wh energy, maximum ft lbs 8100 (11,000 Nm)
- hp rating 23.3 (17.4 Kw)
- speed blows per minute, 95
- infinitely variable
- fuel oil capacity, 5.5 gals (20.8 l)
- lub oil capacity, 1.9 gals (7.2 l)

Total weight
- 34,000 lbs (15,400 kg) less carrier

Mast
- constructed of A-500 tube steel
- width between legs on front of mast, 27" (68.6 cm)
- depth, 20" (50.8 cm)
- drill pipe centerline, 21⅞" (55.6 cm) ahead of mast
- will accept 10 ft (3.05 m) pipe lengths

Levelling jacks
- front, one 4" bore x 24" stroke (10.2 cm x 61.0 cm)
- rear, two 4" bore x 24" stroke (10.2 cm x 61.0 cm)

Spinning wrench assembly
- 600 ft lbs (810 Nm) of force

Puller assembly
- 100 ton (90.7 t)
- 30" (76.2 cm) stroke

Pullup and Pulldown
- accomplished through two 4" (10.2 cm) hydraulic cylinders
- travel 14 ft (4.3 m)
- pullup force, 20,000 lbs (89,000 N)
- pulldown force 24,000 lbs (107,000 N)
- feed rate variable to a maximum of 22 ft per minute (6.7 m/min)

Hydraulic System — tandem gear pump
- 1. supplies 60 GPM @ 2000 PSI (227 l/min @ 13,800 kPa)
- 2. supplies 30 and 15 GPM @ 2000 PSI (113 and 56 l/min @ 13,800 kPa)
- fluid reservoir, 150 U.S. gals (568 l)

Drilling fluid (Air)
- provided by Sullair Rotary Screw Compressor
- 750 CFM @ 125 PSI (21.2 m³/mm @ 862 kPa)
- Speed infinitely variable up to maximum rated delivery)

Water injection
- Hydraulically operated pump
- injects water at 600 PSI (4100 kPa)
- flow rate up to 20 gals per minute (76 l/min)
- speed infinitely variable up to maximum rated delivery

Winch
- produces 22,000 lbs (98,000 N) of line pull
- line speed is variable to a maximum of 75 ft per minute (23 m/min)

Pipe Size
- 5-1/2" o.d. x 3-1/4" i.d. (14.0 cm x 8.3 cm)
- 6-5/8" o.d. x 4-1/4" i.d. (16.8 cm x 10.8 cm)
- 9" o.d. x 6" i.d. (22.9 cm x 15.2 cm)

Recommended Carrier

- tandem axle conventional
- 16,000 lb (7,300 kg) front axle
- 44,000 lb (20,000 kg) rear tandem suspension
- front tires, 16.5 x 22.5, 18 ply rating
- rear tires, 10.0 x 20.0, 12 ply rating
- engine brake hp 285 (213 Kw) @ 1800 RPM, governed full load speed 2100 RPM
- transmission as desired (Aux. Transmission not recommended)
- fuel tank capacity, 90 to 95 gals (340 to 360 l)
- electrical 12 volts 75 amps
- cooling system, automatic shutter on radiator for opening in hot or cold temperatures, radiator should be adequate for extended stationary operation
- suitable all-terrain vehicles meeting the above hp requirements may be used.

Basic depth ratings, arrived at by using the specific drill pipe diameters stated herein, are dependent upon suitable drilling conditions, and may vary as a result of excessive amounts of water or other in-hole conditions. However, diameters within the normal range of this drill can be exceeded under favorable conditions using specialized procedures.