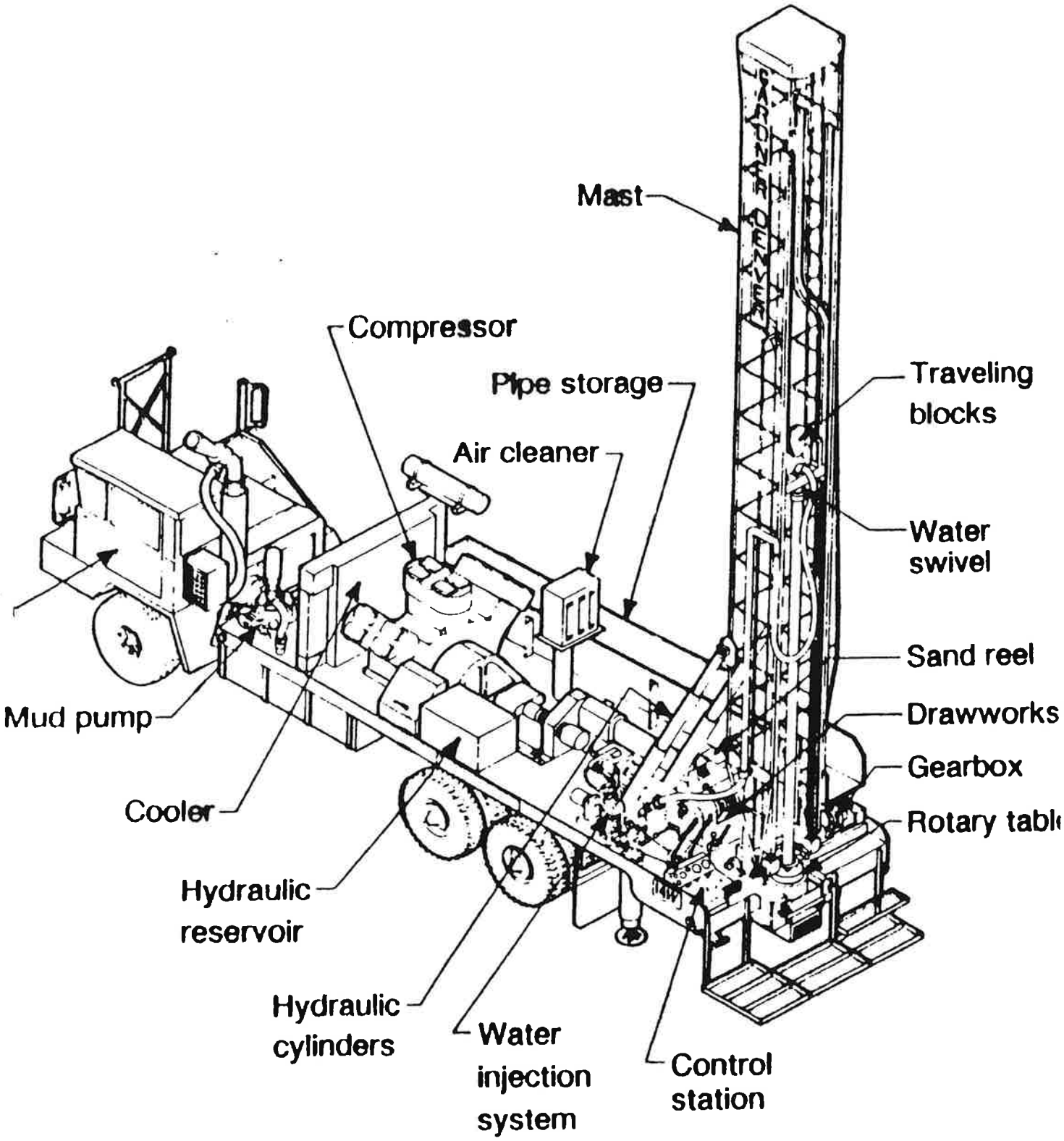
WELL CONSTRUCTION OPERATIONS

1. Drilling
2. Installing the casing
3. Placing a well screen and filter pack
4. Grouting to provide sanitary protection
5. Developing the well to insure sand-free operation at maximum yield

TYPE OF FORMATION	PERCUSSION DRILL	ROTARY DRILL (with fluids)	ROTARY DRILL (bottom-hole air tool)
Dune Sand	Difficult	Rapid	Not recommended
Loose sand and gravel	Difficult	Rapid	Not recommended
Quicksand	Difficult-except in thin streaks. Requires a string of drive pipe	Rapid	Not recommended
Loose boulders in alluvial fans or glacial drift	Difficult-slow but generally can be handled by driving pipe	Difficult-frequently impossible	Not recommended
Clay and silt	Slow	Rapid	Not recommended
Firm shale	Rapid	Rapid	Not recommended
Sticky shale	Slow	Rapid	Not recommended
Brittle shale	Rapid	Rapid	Not recommended
Sandstone-poorly cemented	Slow	Slow	Not recommended
Sandstone-well cemented	Slow	Slow	Not recommended
Chert nodules	Rapid	Slow	Not recommended
Limestone	Rapid	Rapid	Very rapid
Limestone with chert nodules	Rapid	Slow	Very rapid
Limestone with small cracks or fractures	Rapid	Slow	Very rapid
Limestone, cavemous	Rapid	Slow to impossible	Difficult
Dolomite	Rapid	Rapid	Very rapid
Basalts, thin layers in sedimentary	Rapid	Slow	Very rapid
Basalts-thick layers	Slow	Slow	Rapid
Metamorphic rocks	Slow	Slow	Rapid
Granite	Slow	Slow	Rapid

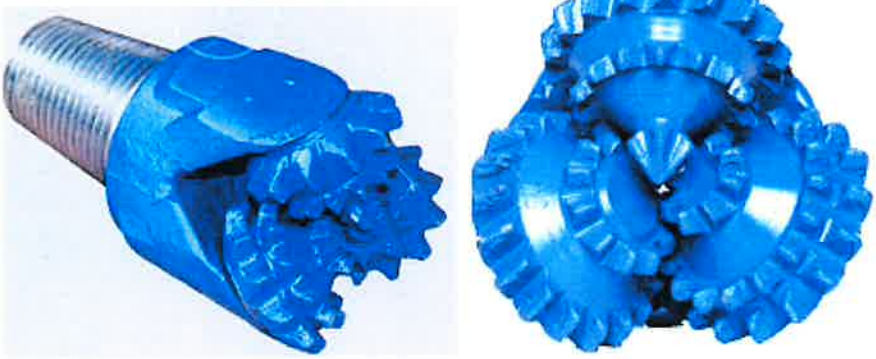

Mast
Compressor
Pipe storage
Air cleaner
Traveling blocks
Water swivel
Sand reel
Drawworks
Gearbox
Rotary table
Mud pump
Cooler
Hydraulic reservoir
Hydraulic cylinders
Water injection system
Control station

BITS

DRAG BIT

REVERSE DRAG BIT

BUTTON BIT



MILL TOOTH

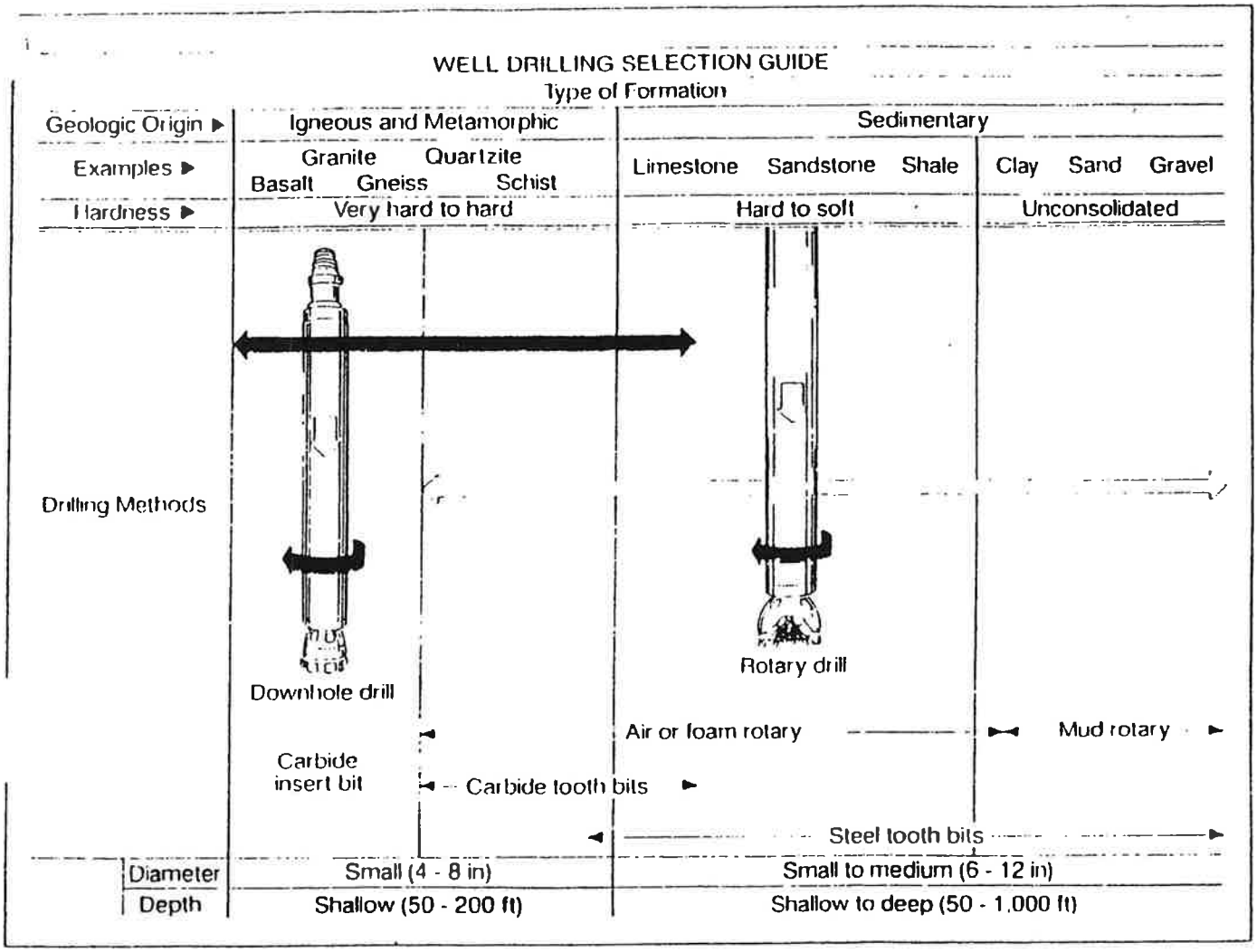
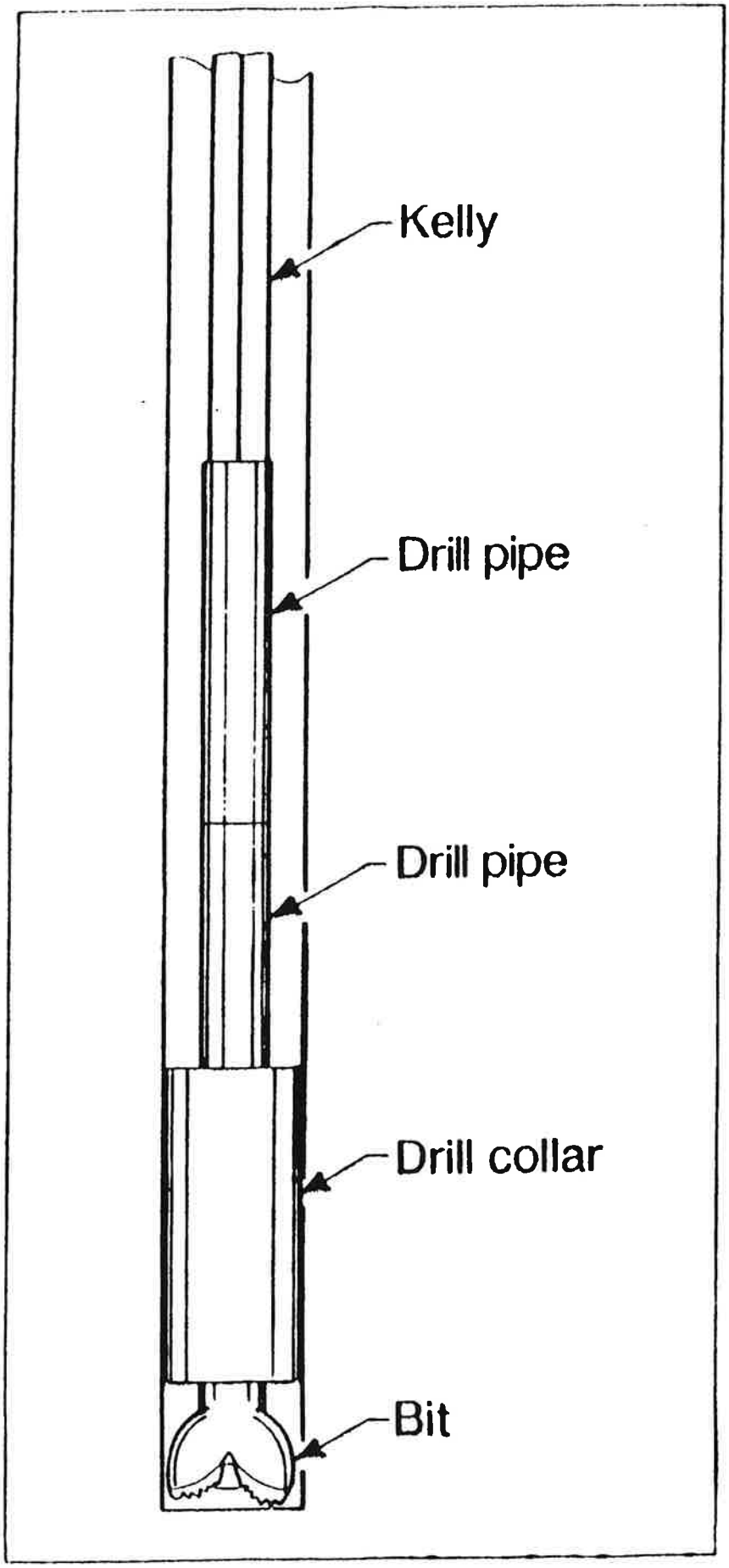
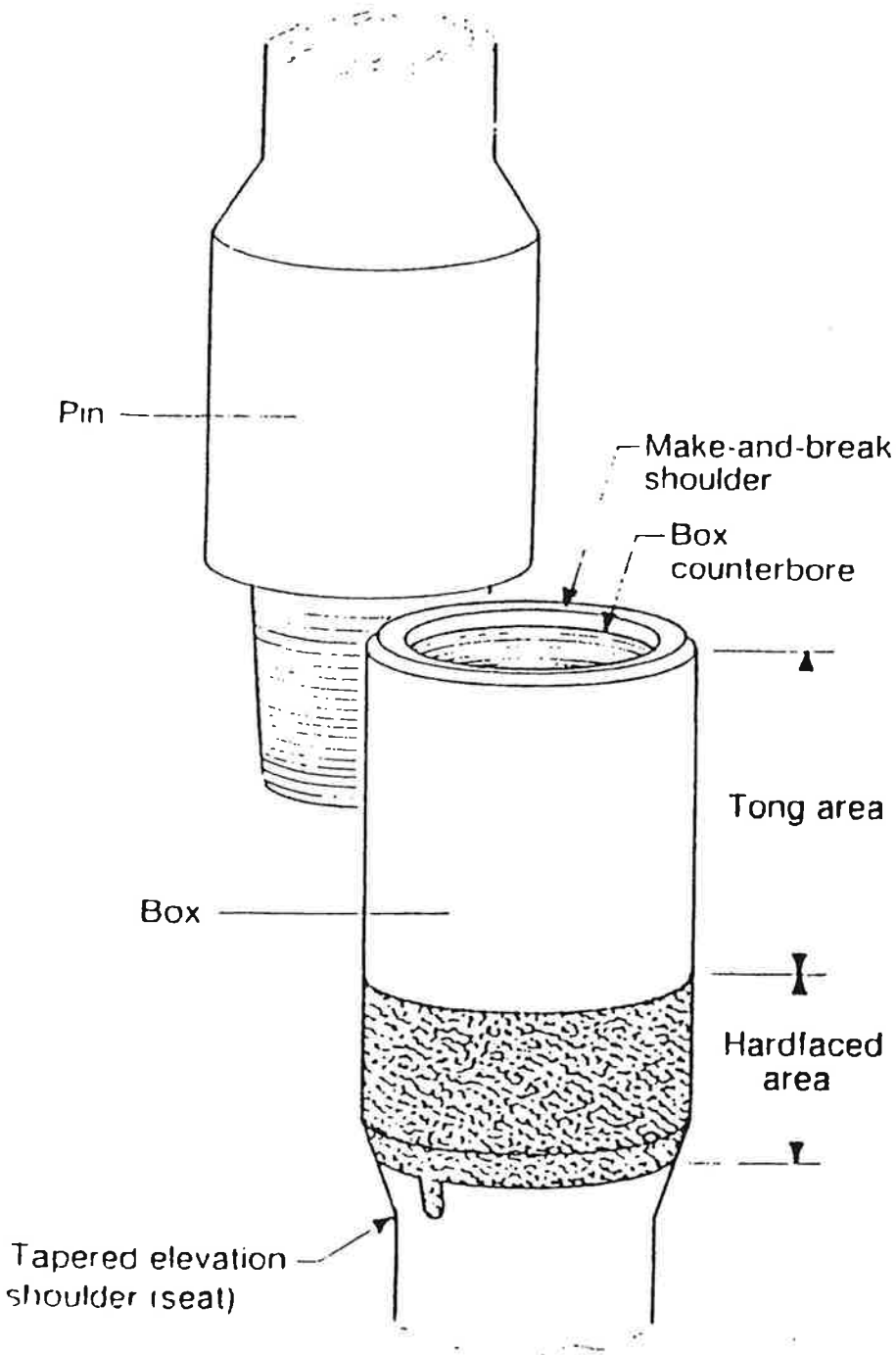


Figure 10.34. Guide for the use of bit types in air-drilling systems. *(Ingersoll-Rand)*


Kelly
Drill pipe
Drill pipe
Drill collar
Bit


Pin
Make-and-break shoulder
Box counterbore
Tong area
Box
Hardfaced area
Tapered elevation shoulder (seat)

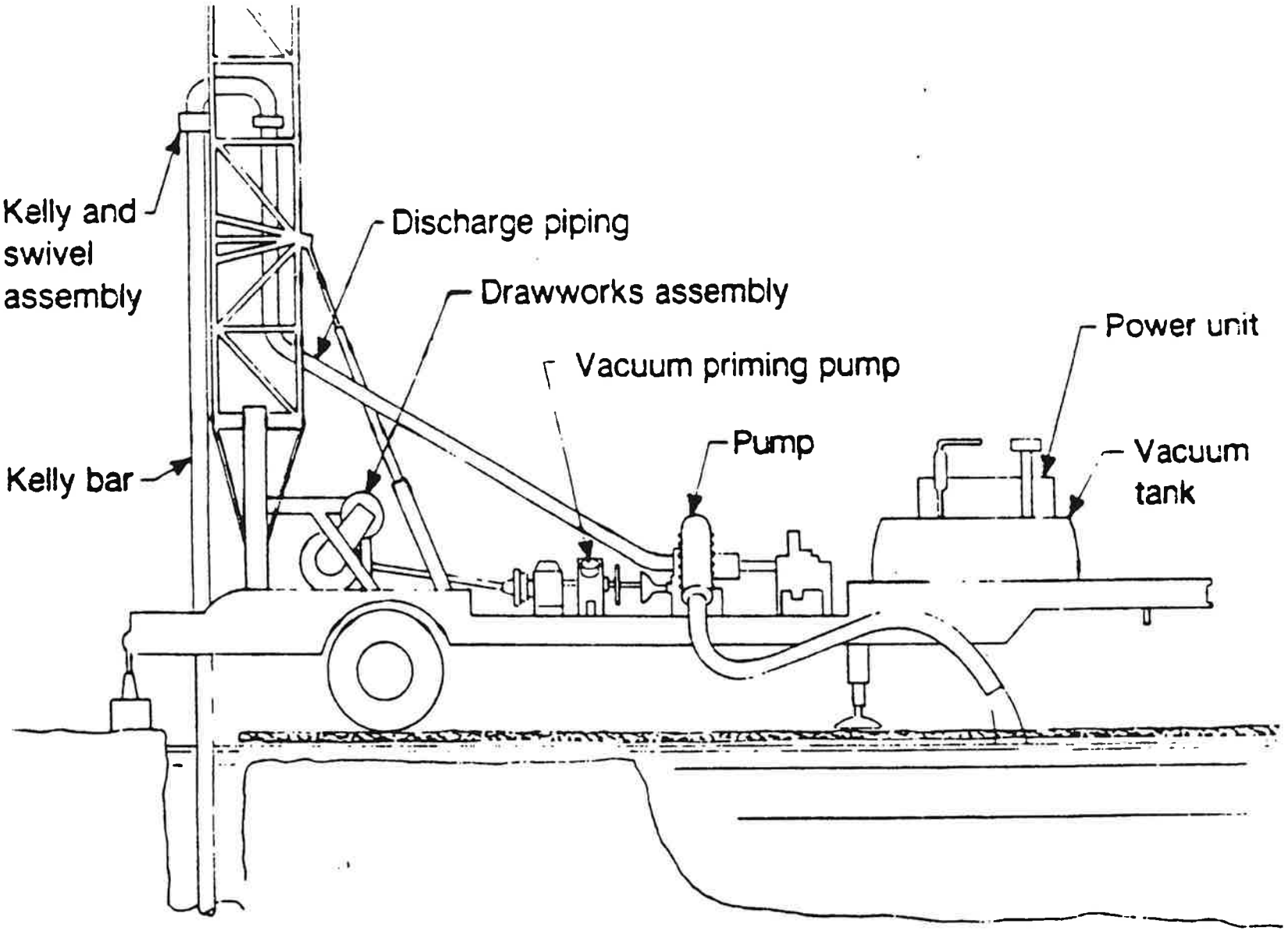
MUD ROTARY DRILLING

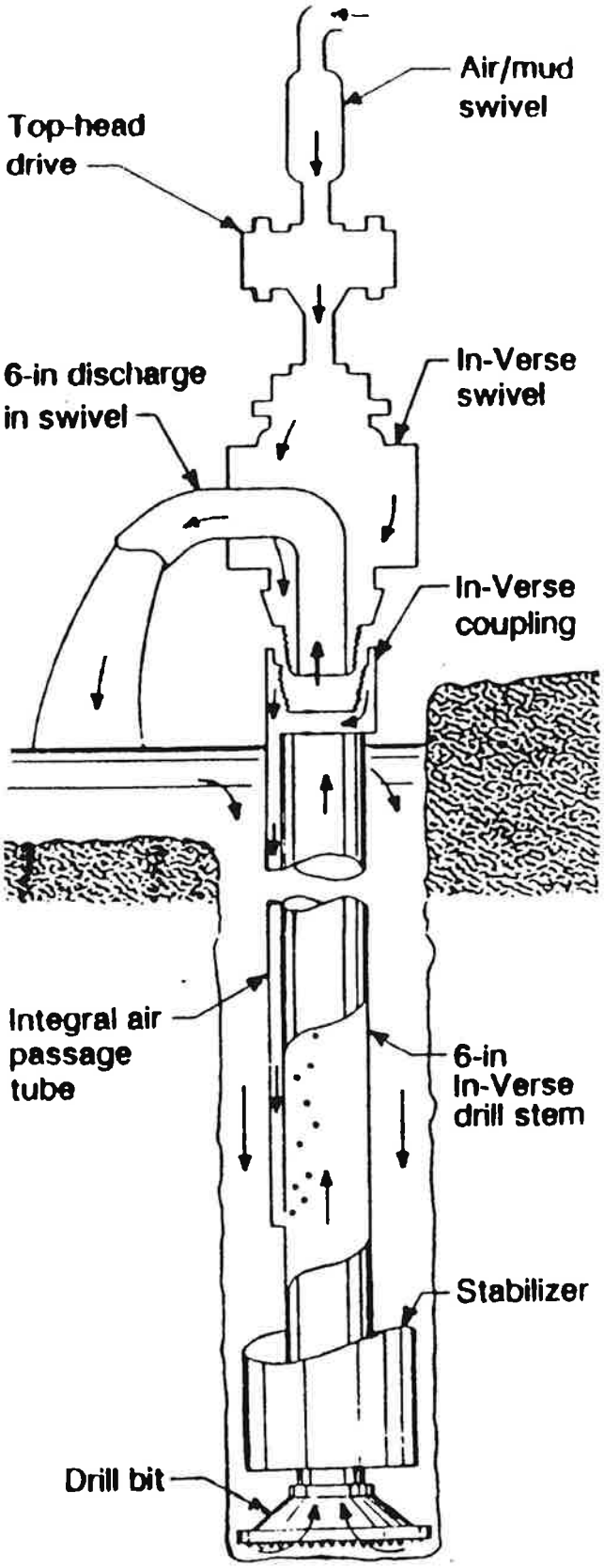
Advantages;

1. Penetration rates are relatively high in all types of material.
2. Minimal casing is required during the drilling operation.
3. Rig mobilization and demobilization are rapid.
4. Well screens can be set easily as part of the casing installation.

Disadvantages:

1. Drilling rigs are costly.
2. Drilling rigs require high levels of maintenance.
3. Mobility of the rigs may be limited depending on the slope and condition (wetness) of the land surface.
4. Most rigs must be handled by a crew of at least 2 persons.
5. Collection of accurate samples require special procedures.
6. Use of drilling fluids may cause plugging of certain formations.
7. Rigs cannot be operated economically in extremely cold temperature.
8. Drilling fluid management requires additional knowledge and experience.


Kelly and swivel assembly
Discharge piping
Drawworks assembly
Power unit
Vacuum priming pump
Pump
Vacuum tank
Kelly bar


Air/mud swivel
Top-head drive
6-in discharge in swivel
In-Verse swivel
In-Verse coupling
Integral air passage tube
6-in In-Verse drill stem
Stabilizer
Drill bit

REVERSE ROTARY DRILLING

Advantages;

1. The porosity and permeability of the formation near the borehole is relatively undisturbed compared to other methods.

2. Large-diameter holes can be drilled quickly and economically.

3. No casing is required during the drilling operation.

4. Well screens can be set easily as part of the casing installation.

5. Most geologic formations can be drilled, with the exception of igneous and metamorphic rocks.

6. Little opportunity exists for washouts in the borehole because of the low velocity of the drilling fluid.

Disadvantages:

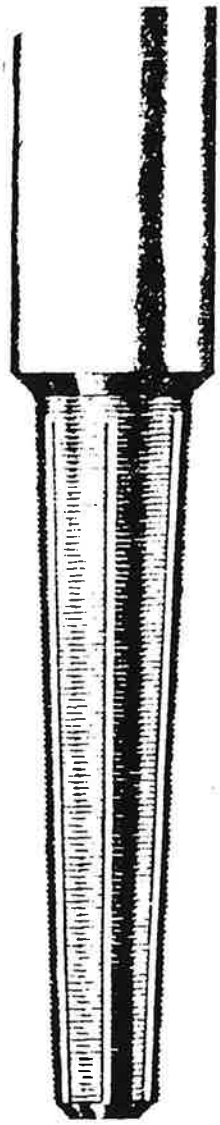
1. Large water supply is generally needed.

2. Reverse-rotary rigs and components are usually larger and thus more expensive.

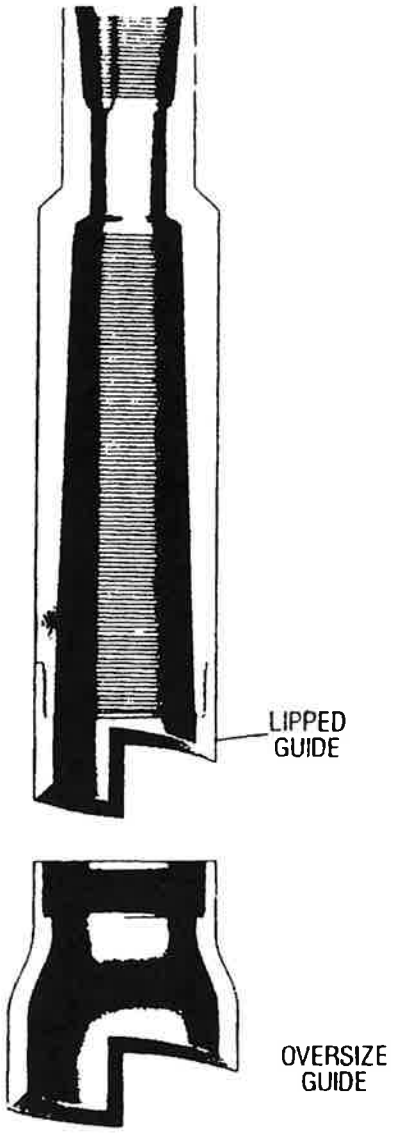
3. Large mud pits are required.

4. Some drill sites are inaccessible because of rig size.

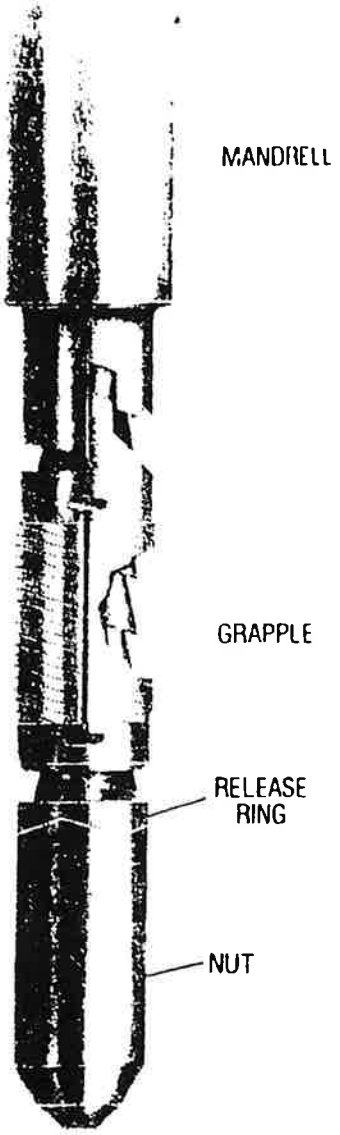
5. For efficient operation, more personnel are generally required than for other drilling methods.



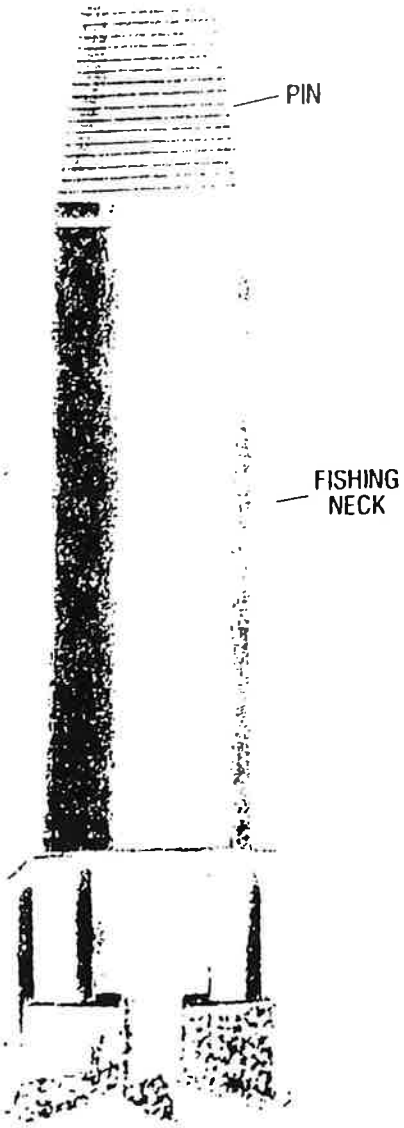
(a) Taper tap



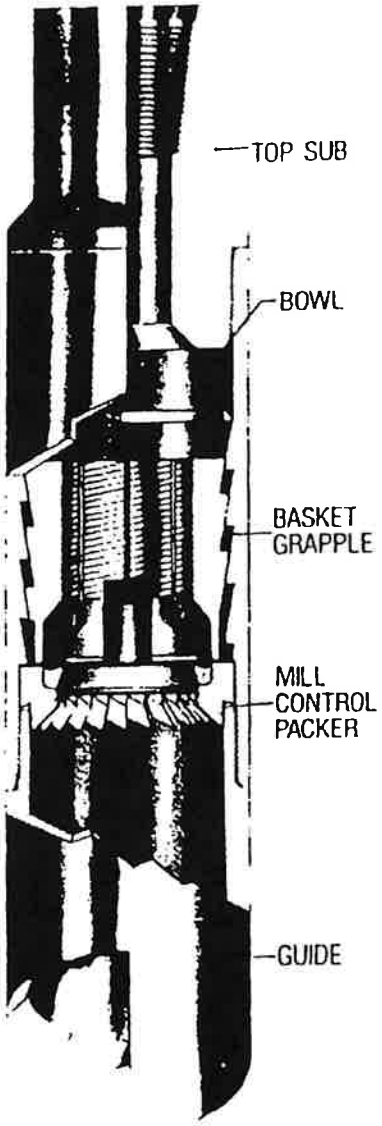
(b) Die collar



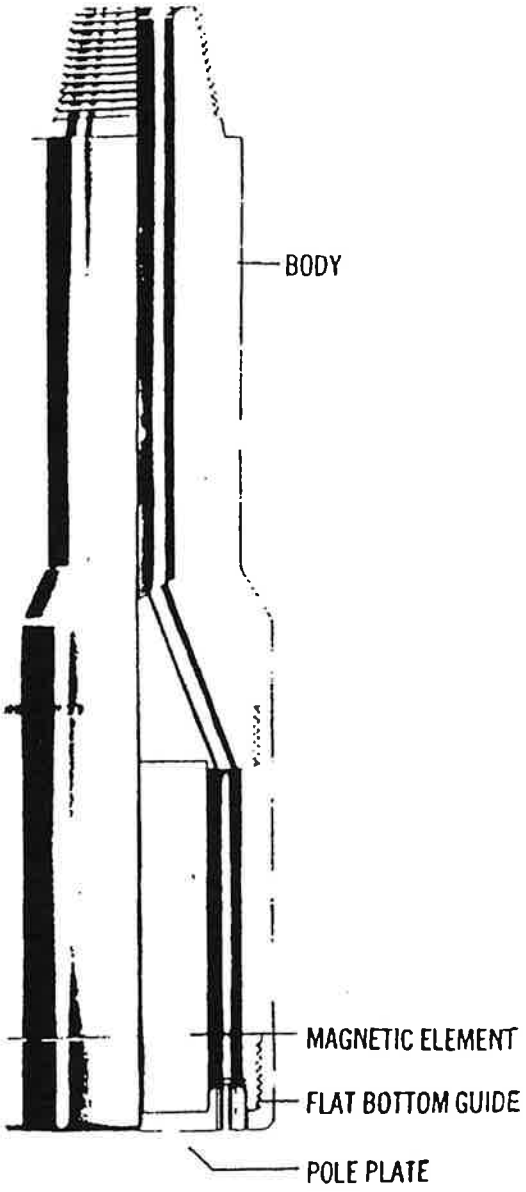
(c) **Releasing spear with bull nose nut (shoulder mandrel in engaged position)**



(d) Junk mill with fishing neck



(e) Releasing and circulating overshot with basket grapple



(f) Magnet

WELL SCREENS AND FUNCTIONS

1. **Criteria:**
    a. Large percentage of open area.

    b. Nonclogging slots.

    c. Resistance to corrosion.

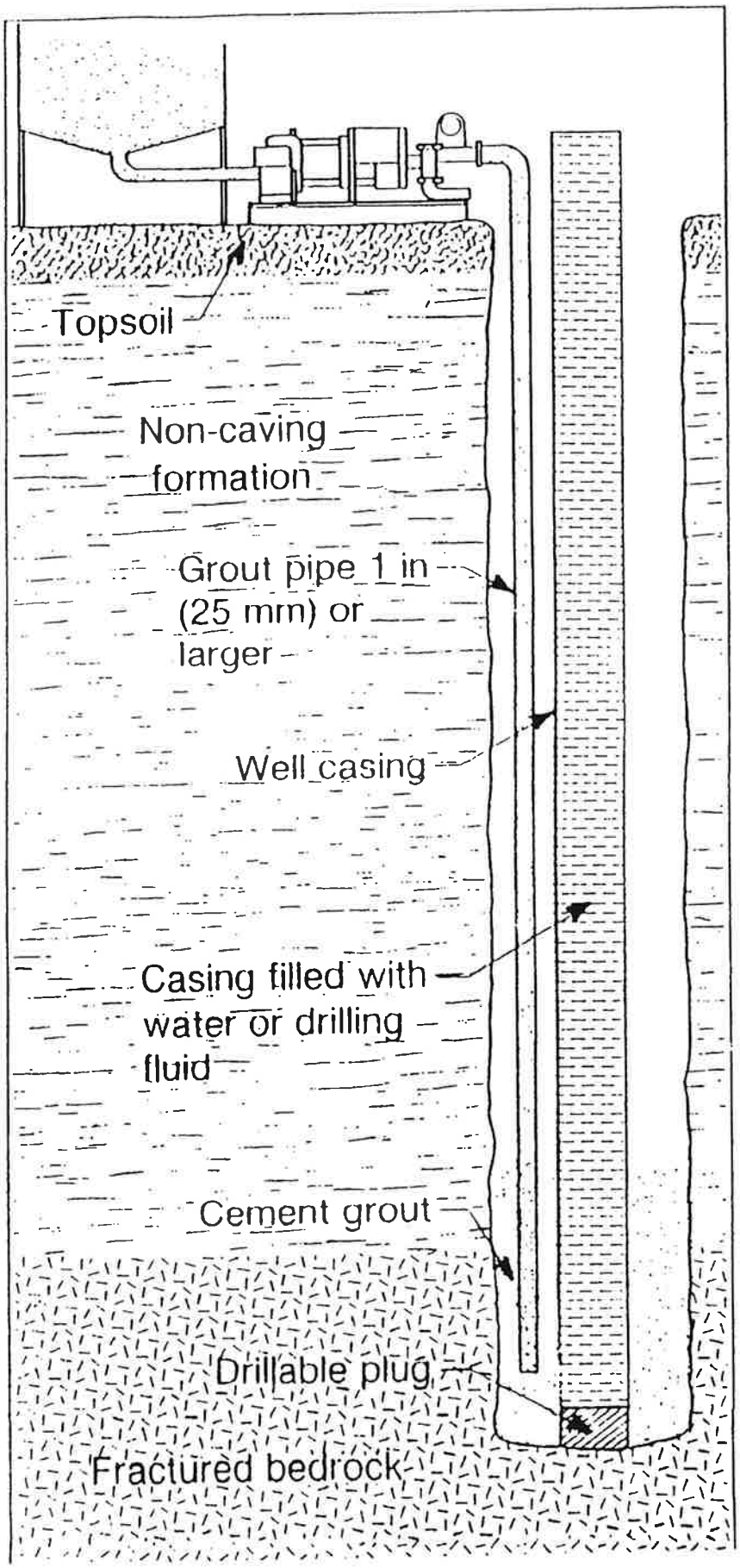
    d. Sufficient column and collapse.

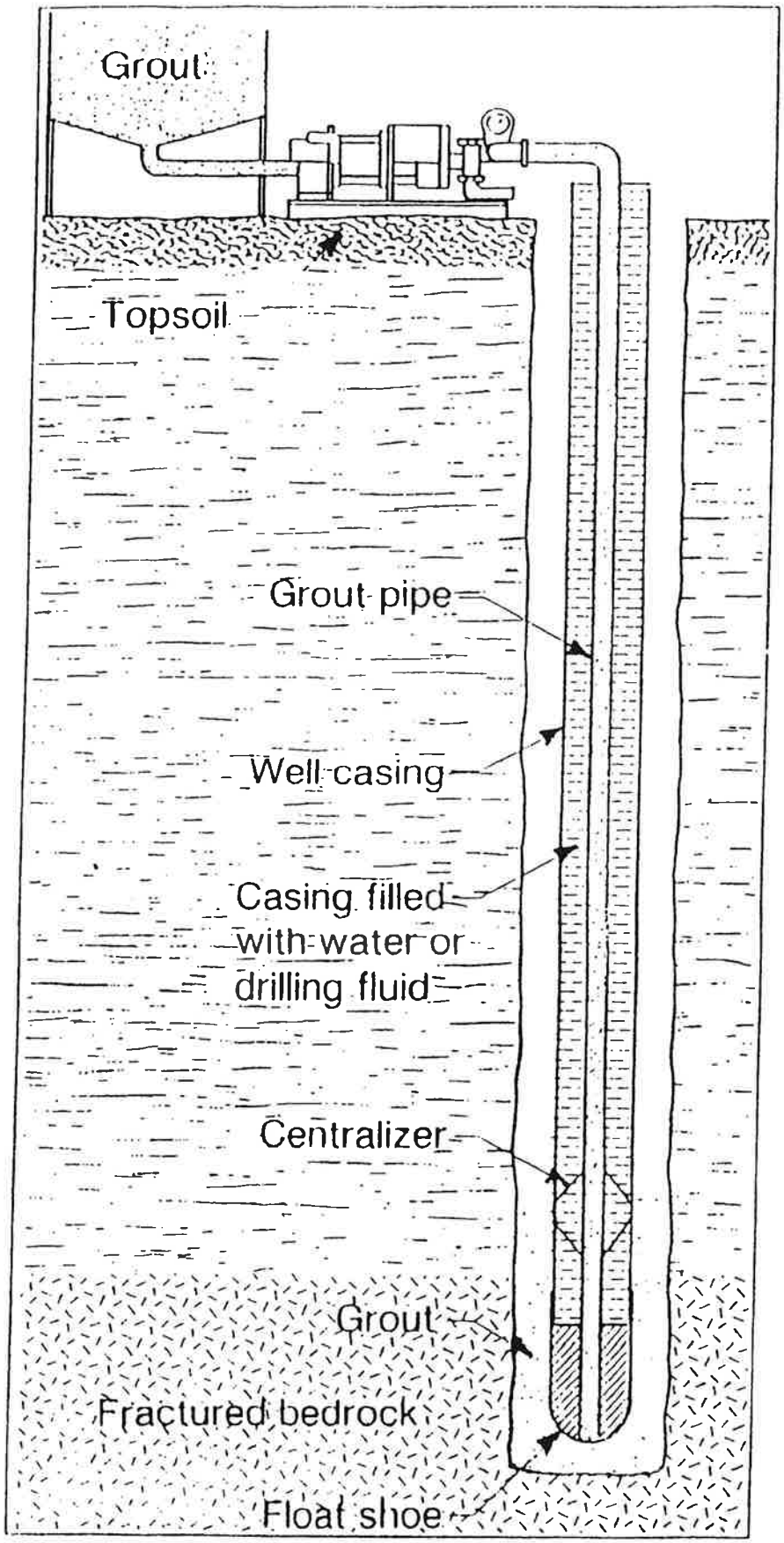
2. **Functions:**
    a. Easily developed.

    b. Minimal incrusting tendency.

    c. Low head loss through the screen.

    d. Control sand pumping in all types of aquifers.


Topsoil
Non-caving formation
Grout pipe 1 in (25 mm) or larger
Well casing
Casing filled with water or drilling fluid
Cement grout
Drillable plug
Fractured bedrock


Grout
Topsoil
Grout pipe
Well casing
Casing filled with water or drilling fluid
Centralizer
Grout
Fractured bedrock
Float shoe

WELL DEVELOPMENT METHODS

1. Overpumping
2. Backwashing
3. Mechanical surging
4. Air lifting

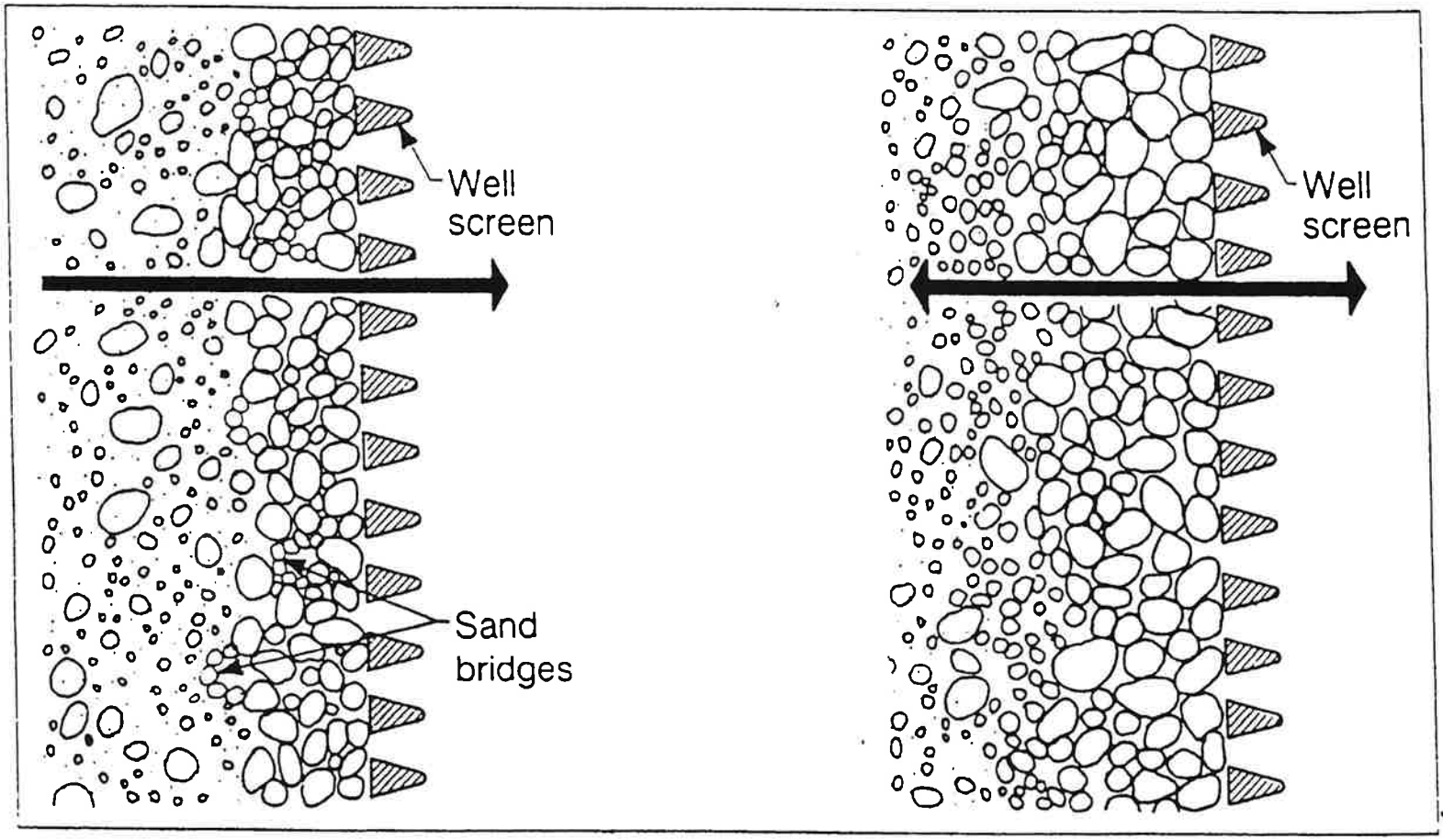


Figure 15.5. Effective development action requires movement of water in both directions through screen openings. Reversing flow helps break down bridging of particles. Movement in only one direction, as when pumping from the well, does not produce the proper development effect.

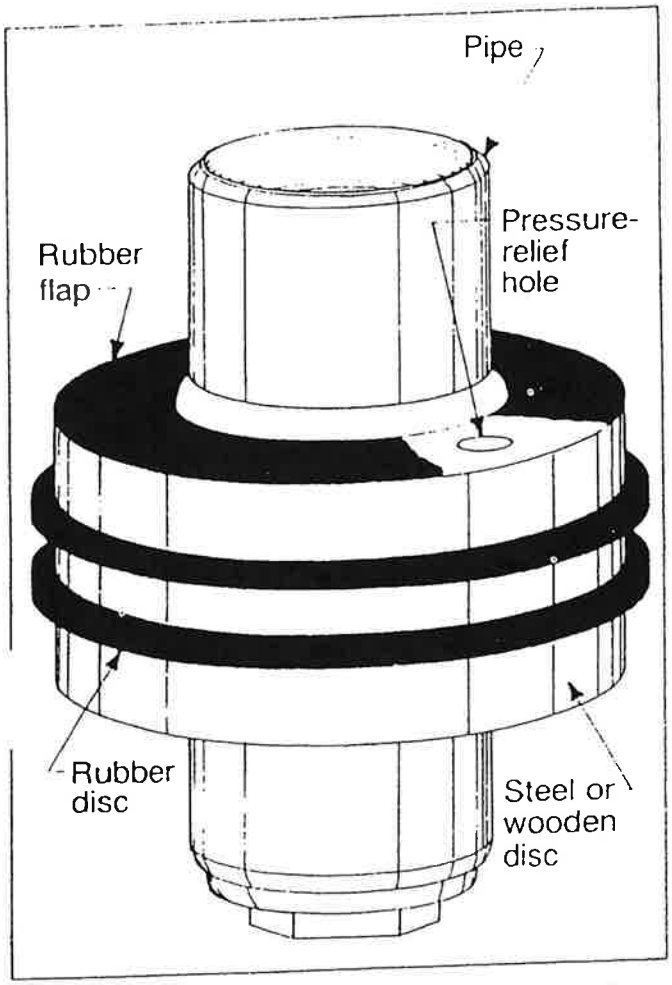


Figure 15.6. Typical surge block consisting of two leather or rubber discs sandwiched between three steel or wooden discs. The blocks are constructed so that the outside diameter of the rubber lips is equal to the inside diameter of the screen. The solid part of the block is 1 in (25.4 mm) smaller in diameter than the screen.

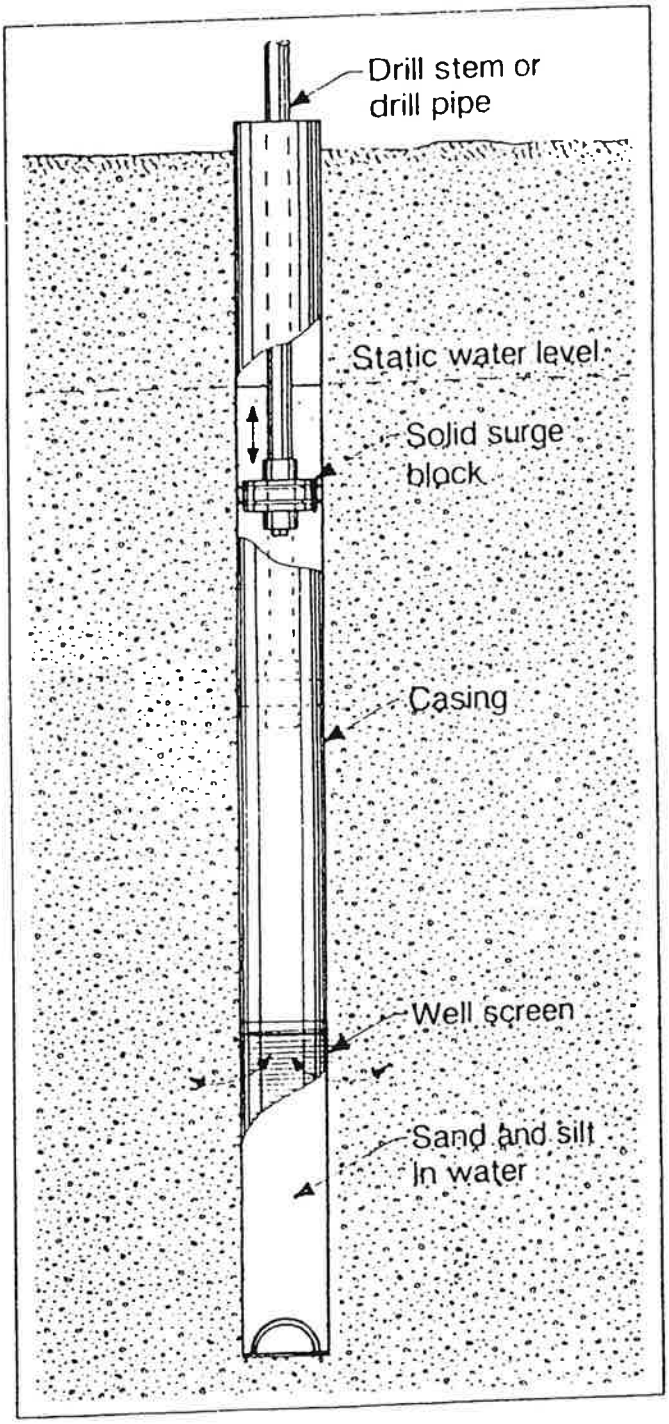


Figure 15.7. For certain types of formations, a surge block is an effective tool for well development. On the downstroke, water is forced outward into the formation; water, silt, and fine sand are then pulled into the well screen during the upstroke.

FUNCTIONS OF A DRILLING FLUID

1. Remove cuttings
2. Stabilize the borehole
3. Cool and lubricate the drill bit
4. Control fluid loss
5. Drop cuttings into a settling pit
6. Assist in the colllection of information about the well bore
7. Suspend cuttings in the borehole when the drilling fluid is not being circulated.

WEIGHT-(DENSITY)

Measures: Hydrostatic pressure in the bore hole, and solids content of unweighted muds.

Affects: Drilling rate, hole stability, transportation and settling rate of cutting.
Useless solids accumulation slows drilling rate, wastes fule, causes equipment wear, loss of circulation, differential sticking and damages the productive formation.

Desireable Limits: Below 9.0 lb/gal (water is 8.34 lb/gal).

Control: Bariod to increase weight; water dilution to decrease weight.
Good mud pit design.
Shale shakers, desander cones.

EFFECT OF SOLIDS CONTENT ON MUD WEIGHT
(Assumed Solids Specific Gravity=2.65)

Percent Solids	Mud Weight lbs/gallon
0	8.33
1	8.47
2	8.60
3	8.74
4	8.88
5	9.02
6	9.15
7	9.29
8	9.43
9	9.57
10	9.70
11	9.84
12	9.98
13	10.12
14	10.25
15	10.39
16	10.53
17	10.67
18	10.80
19	10.94
20	11.08

VISCOSITY-(THICKNESS)

Measures Carrying capacity and gel development.

Affects Hole cleaning, drilling rate, hole stability, cutting settling rate, circulating pressure.

Desirable Limits Thin as practical and still retain information stability and cuttings, lifting capacity. Usual range 32 to 38 sec/qt higher when necessary (water is 26 sec/qt)

Control QUIK-GEL®, QUIK-TROL® or CELLEX® to thicken. Water or BARAFOS® to thin.

Table 11.3. Approximate Marsh Funnel Viscosities Required For Drilling in Typic Types of Unconnsolidated Materials

Material Drilled	Appropriate Marsh Funnel Viscosity (seconds)
Fine Sand	35-45
Medium Sand	45-55
Coarse Sand	55-65
Gravel	65-75
Course Gravel	75-85

pH

Measures	Alkalinity or acidity of mixing water and drilling fluids.
Affects	Mud mixing, viscosity, gel and filtration of mud, hole stability, corrosivity of mud.
Desirable Limits	8.5 to 9.5 (Neutral solutions pH = 7.0)
Control	Raise with soda ash (1 to 2 lb/100 gal), lower with sodium bicarbonate (for cement contamination).

WATER BASED

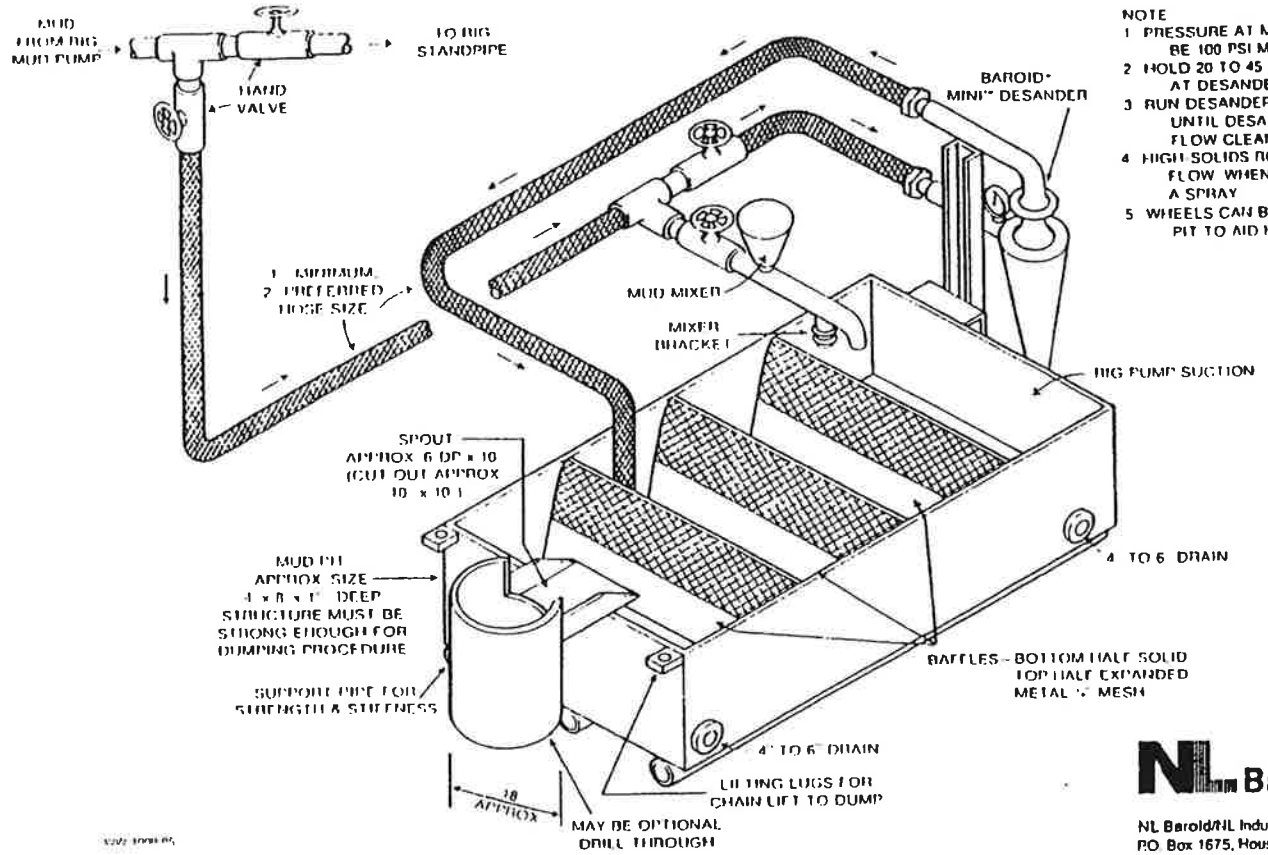
1. Clean, fresh water

2. Water with clay additives

3. Water with polymeric additives

4. Water with clay and polymeric additives

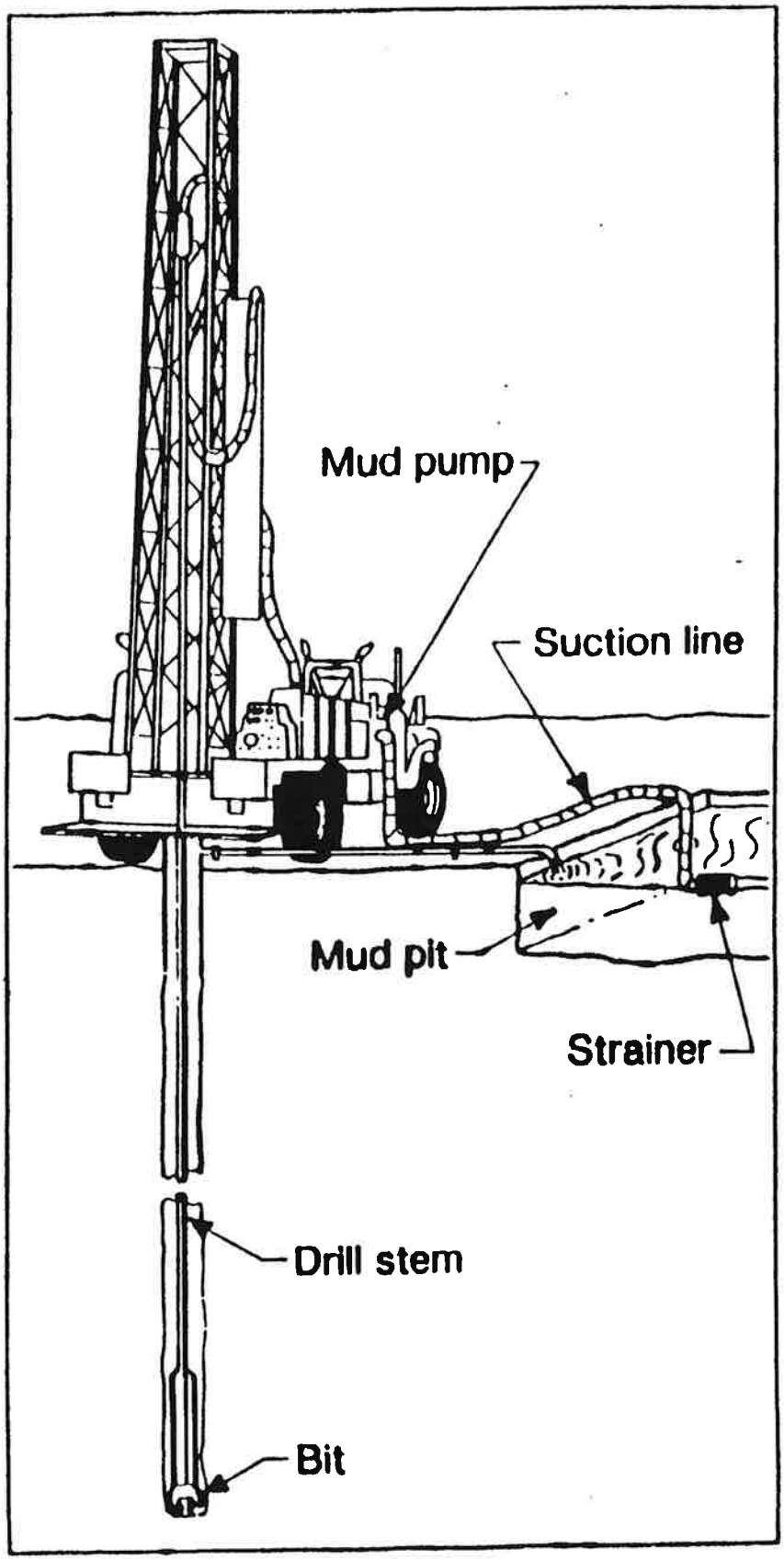
MUD TANK WITH BAROID® MINI™ DESANDER



NOTE
1. PRESSURE AT MUD MIXER SHOULD BE 100 PSI MINIMUM
2. HOLD 20 TO 45 PSI PRESSURE AT DESANDER
3. RUN DESANDER BETWEEN RODS UNTIL DESANDER UNDER FLOW CLEANS
4. HIGH SOLIDS ROPE AT UNDER FLOW WHEN CLEAN IT BECOMES A SPRAY
5. WHEELS CAN BE ADDED AT REAR OF PIT TO AID HANDLING

NL Baroid

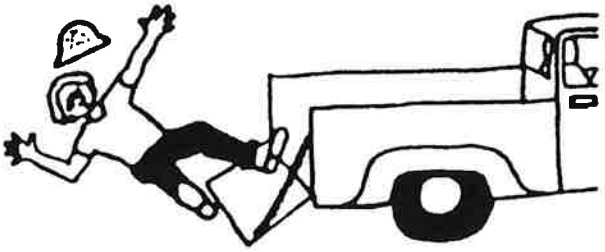
NL Baroid/NL Industries, Inc.
P.O. Box 1675, Houston, Texas 77251

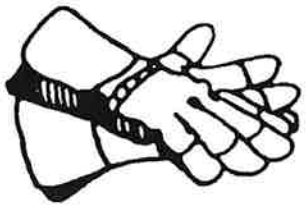

Mud pump
Suction line
Mud pit
Strainer
Drill stem
Bit

Safety Doesn't Cost, It Pays . .

in reduction of insurance premiums

- in eliminating lost labor hours
- in protecting the health and welfare of employees





TERMS AND DEFINITIONS OF EQUIPMENT USED IN ENVIRONMENTAL DRILLING

Hollow Stem Auger-An auger with an opening in the middle to either take samples through, or casing can be set through the hollow stem as it is pulled back out of the hole.

Flight Auger-A solid continuous auger used for sampling right from the auger, or to pull and screw an opening for further geotechnical sampling.

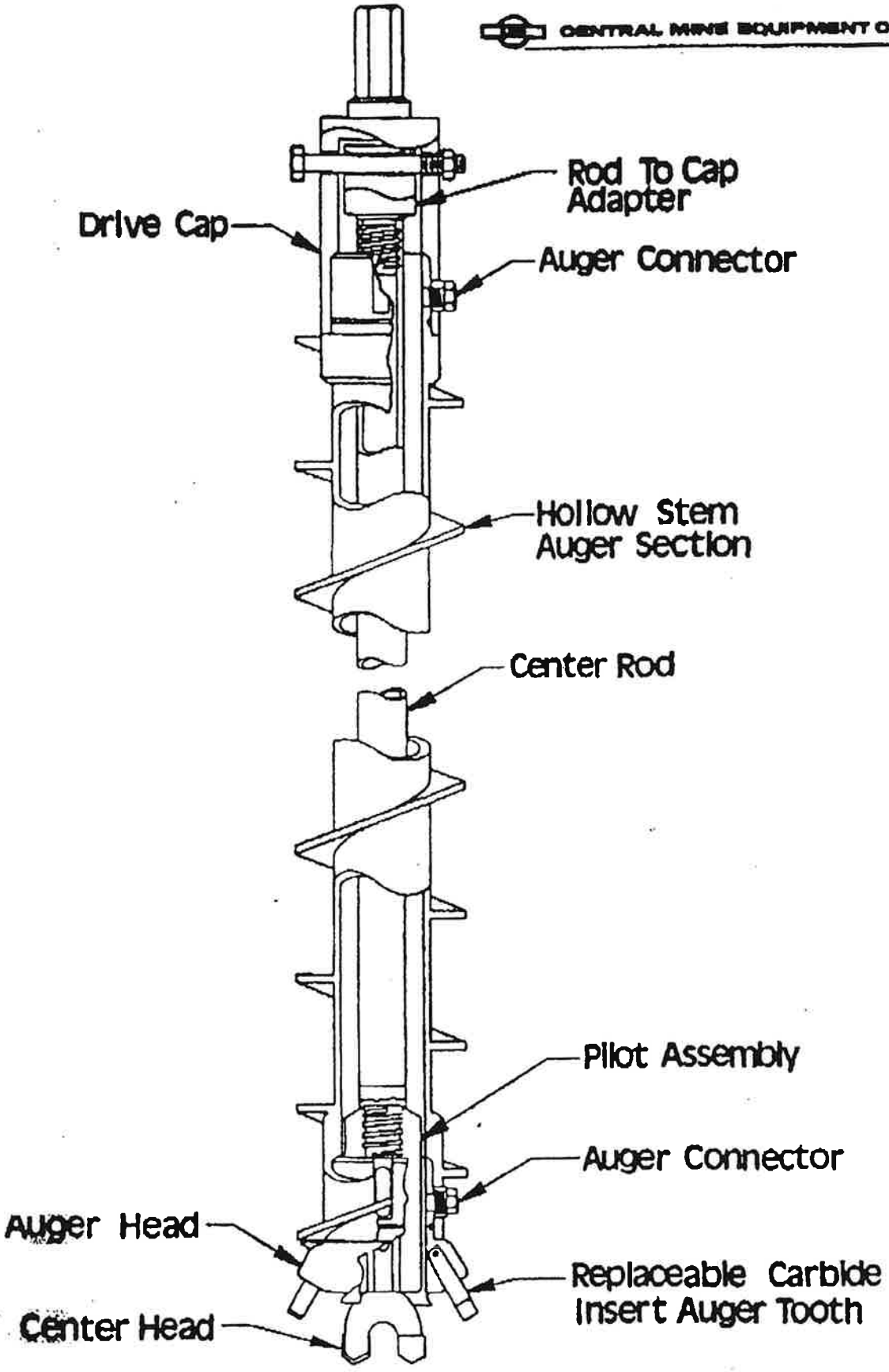
Split Spoon Sampler-A sampling device about 2 ft. long to drive into a formation then pull back, the barrel then splits in two pieces to expose the sample.

Continuous Sampler-A tube that takes a continuous sample as long as the augers, usually 5'. It is then pulled back and broken apart to expose a 5' long sample of the formation.

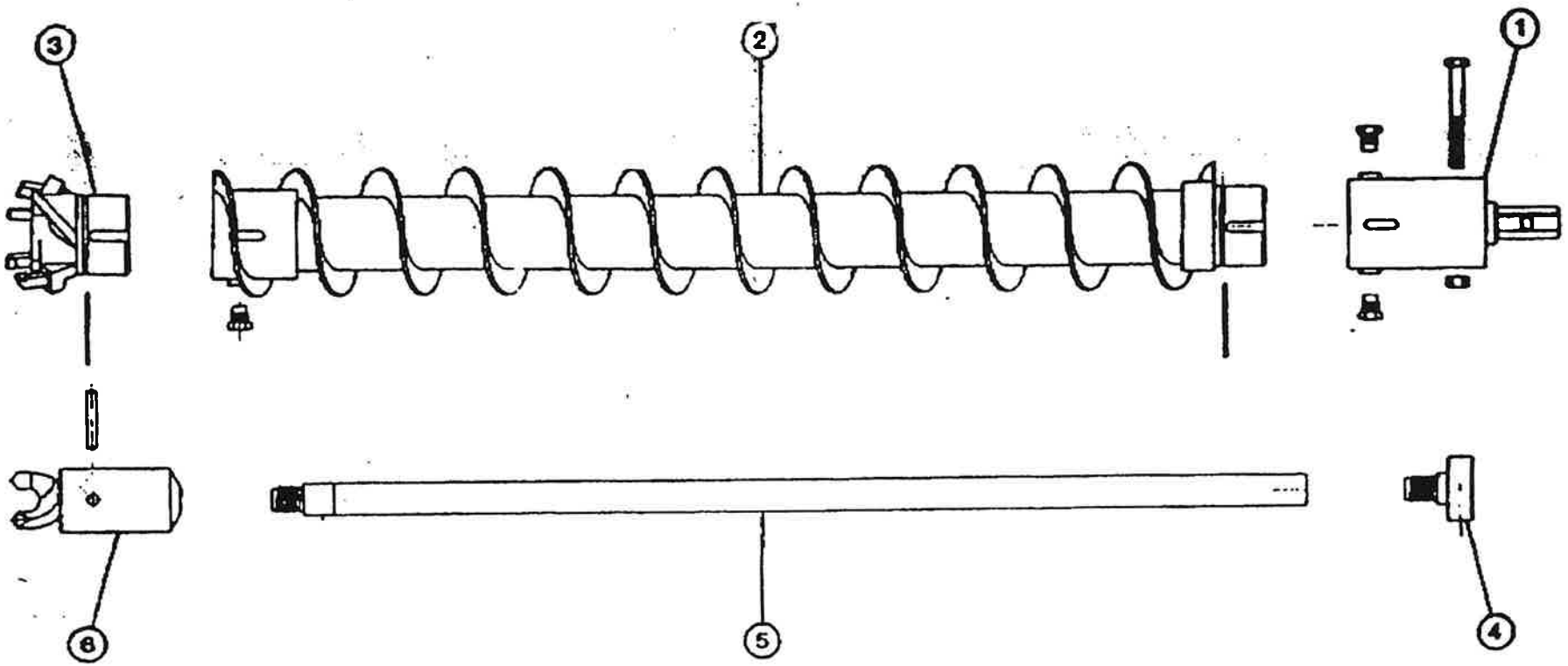
Blow Counts-Indicates the density of the formation during split spoon sampling. Two methods used to take blow counts are the automatic hammer and the cathead with rope. The distance to drop the hammer is 30" and the weight of the hammer is 140 lbs.

Shelby Tube-A hollow tube, usually about 30" long, that is pushed into the ground to get the formation sample. An extruder is needed to push the sample from the tube. Mostly used in geotechnical work.

Extruder-A hydraulic ram with a plunger on it to push samples from shelby tubes.

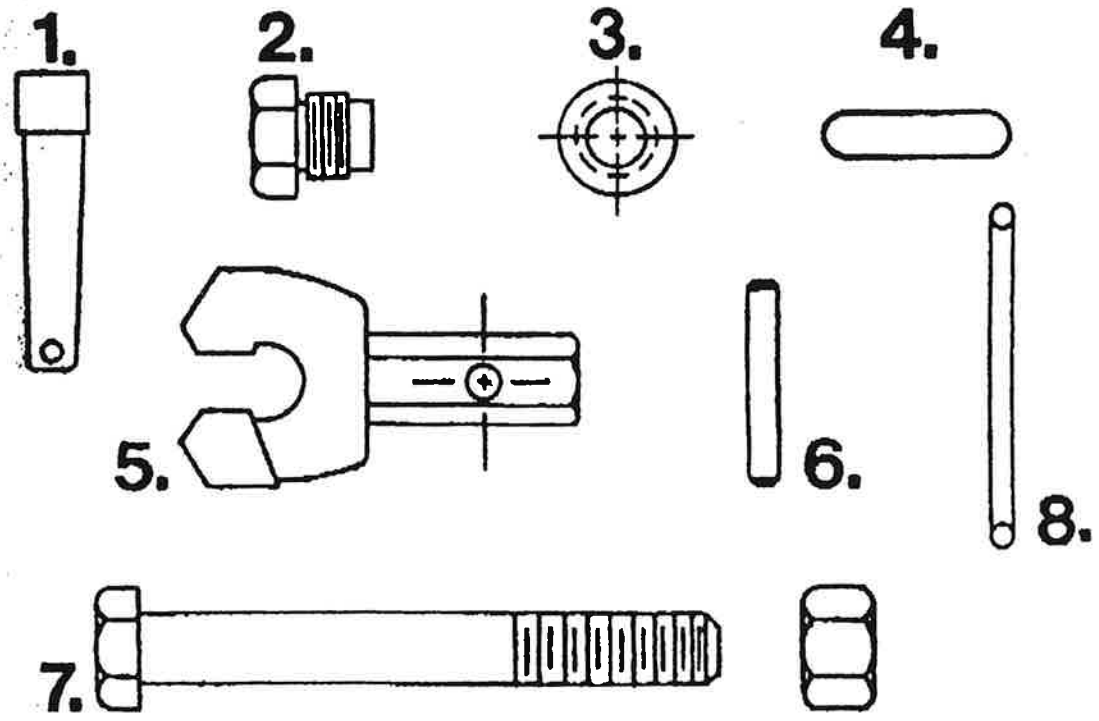


CME Key Type Hollow



ITEM	DESCRIPTION
1	DRIVE CAP
2	HOLLOW STEM AUGER
3	HOLLOW AUGER HEAD, 5T
4	ROD TO CAP ADAPTER
5	DRILL ROD
6	PILOT ASSEMBLY w/ CENTER HEAD

SPECIFY INSIDE DIAMETER OF AUGER) ROD SIZE WHEN ORDERING



ITEM	DESCRIPTION
1	AUGER TOOTH, 5T
2	AUGER CONNECTOR
3	THREADED INSERT
4	AUGER KEY
5	CENTER HEAD
6	CENTER HEAD PIN
7	DRIVE CAP BOLT WITH NUT
8	AUGER SEAL