

CHAPTER 3

PILE-DRIVING EQUIPMENT

Section I. STANDARD PILE-DRIVING EQUIPMENT

3-1. Basic driving and installing methods.

Piles are installed or driven into the ground by a rig which supports the leads, raises the pile, and operates the hammer. Rigs are usually manufactured, but in the field they may be expedient, that is, constructed with available materials. Modern commercial rigs use vibratory drivers while most older and expedient rigs use impact hammers. The intent is the same, that is to drive the pile into the ground (strata).

3-2. Rig mounting and attachments.

Pile-driving rigs are mounted in different ways, depending on their use. This includes railway, barge, skid, crawler, and truck-mounted drivers. Specialized machines are available for driving piles. Most pile driving in the theater of operations is performed using a steel-frame, skid-mounted pile driver or power cranes, crawlers, or truck-mounted units, with standard pile-driving attachment (figure 3-1). The attachments available through military supply channels include

adapters (figure 3-2) used to connect the leads to the top of the crane boom leads and a catwalk or lead braces used to connect the foot of the leads to the base of the boom. The leads and catwalk assembly support drop hammers weighing up to 3,000 pounds and diesel hammers weighing up to 13,000 pounds.

3-3. Steel-frame, skid-mounted pile drivers.

A steel-frame, skid-mounted pile driver with a gasoline-driven engine is a class IV item (figure 3-3). This pile driver may be used on the ground or on any permanent structure or sturdy transport. It can drive vertical or batter piles. The reach from the base of the boom to the front of the leads depends upon the weight of the hammer and power units. Reach may be increased by ballasting the back of the skid frame, or by securing it to the deck on which it rests to counterbalance the weight of the equipment. The skid-mounted pile driver consists of the following components.

a. Skid frame. The skid frame is two steel I-beams 40 feet long, cross-braced 8 feet apart at the front of the frame and 12 feet apart at

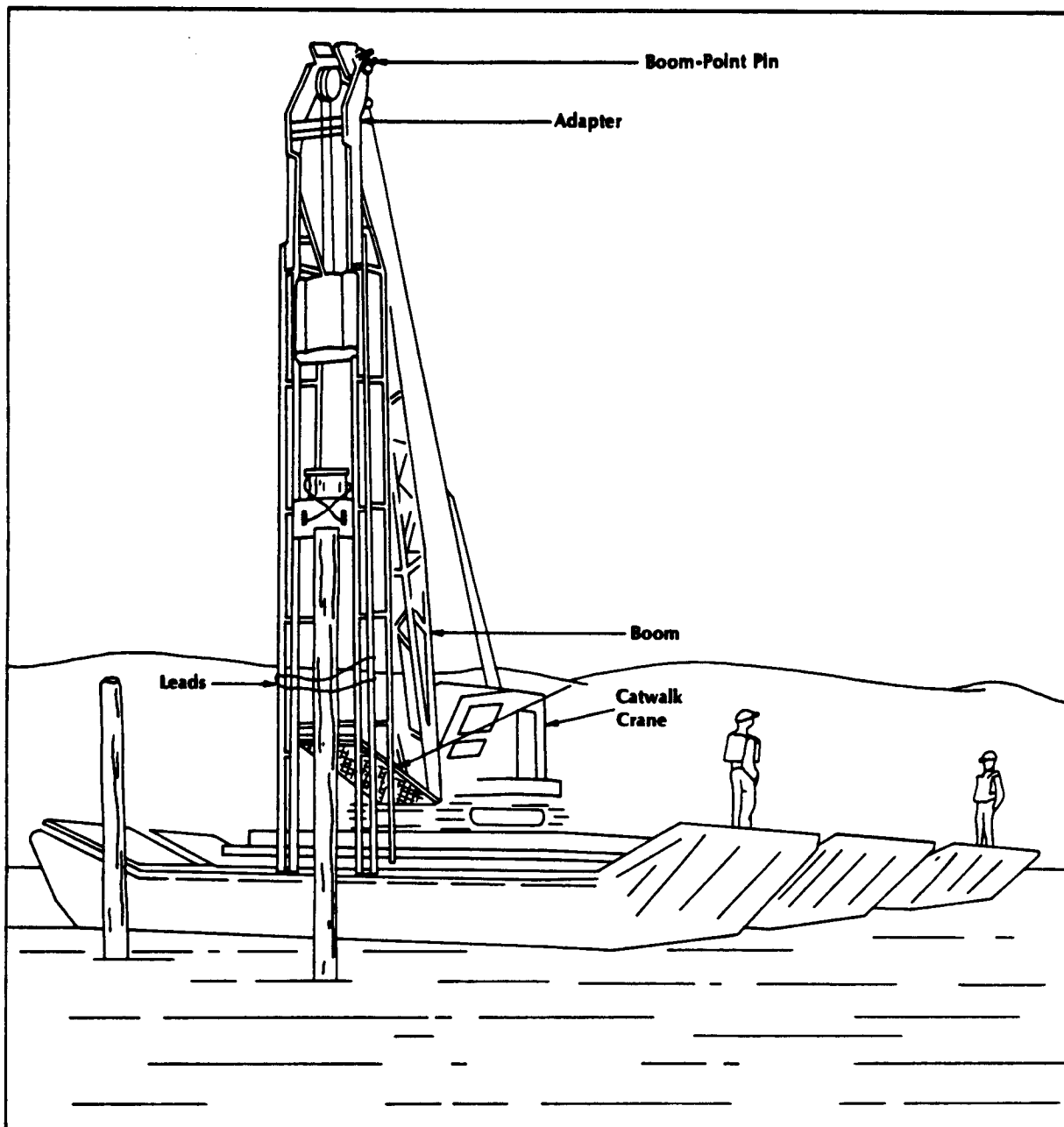


Figure 3-1 Crane with standard pile-driving attachments

the rear of the frame. A platform at the rear of the frame supports the winch.

b. Boom. A 45-foot boom is anchored to the skid frame 16 feet from the front end.

c. Leads. Leads standard to the unit are one 8-foot top section, one 17-foot reversible section, one 10-foot extension, one 15-foot intermediate section, and one 15-foot bottom section, totaling 65 feet. The length of the

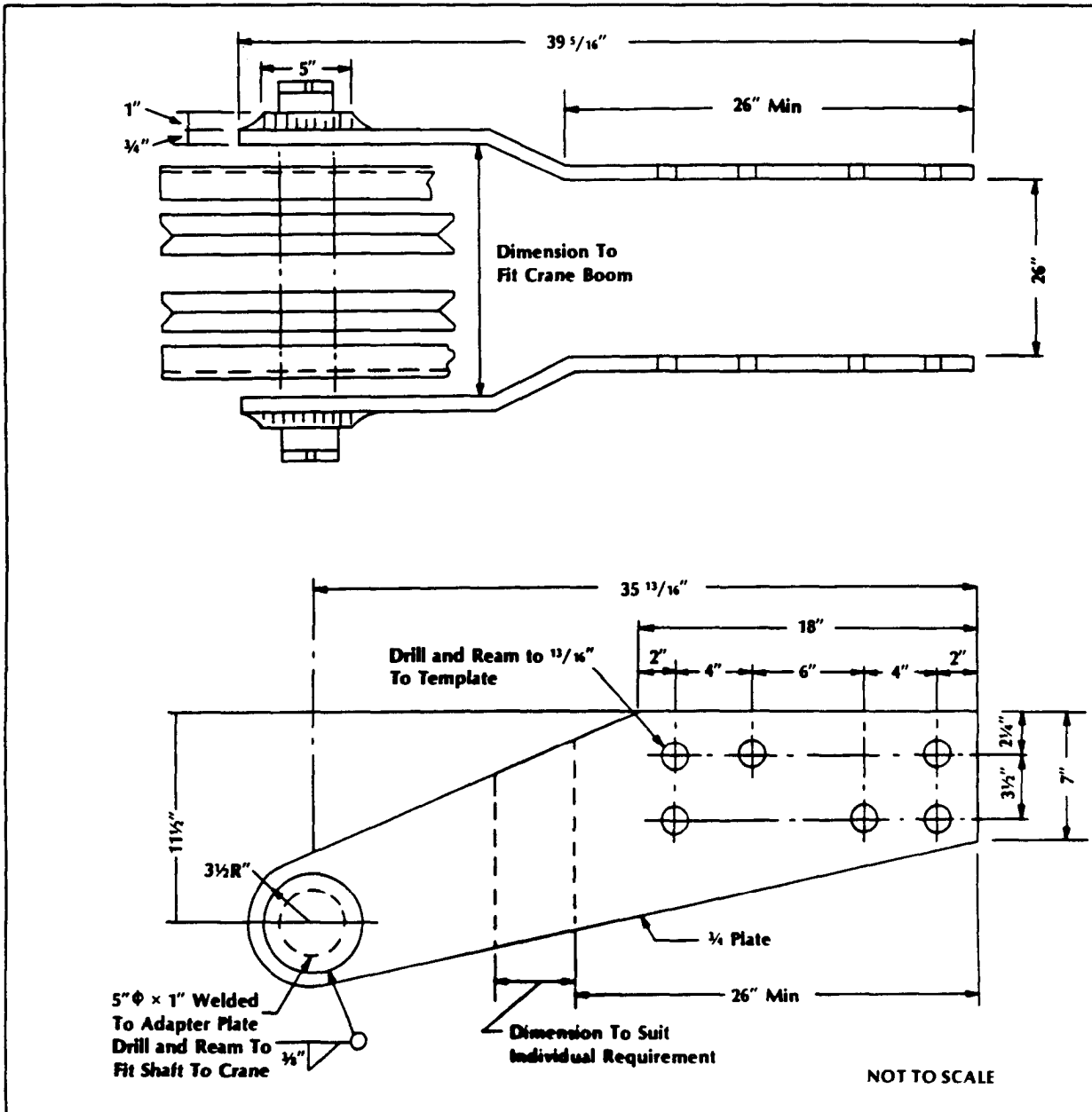


Figure 3-2 Pile driver lead adapter

lead may be reduced to 55 or 47 feet by leaving out sections. The length of the lead is determined by the length of the pile to be driven. The boom is attached to the midpoint of the top 20-foot section. A double-sheave bracket, attached at the top of the leads.

handles the hammer and pile lines. The leads to the skid-mounted pile driver can be tilted transversely, longitudinally, or in a combination of these as well as fore and aft of the vertical by adjusting the guides.

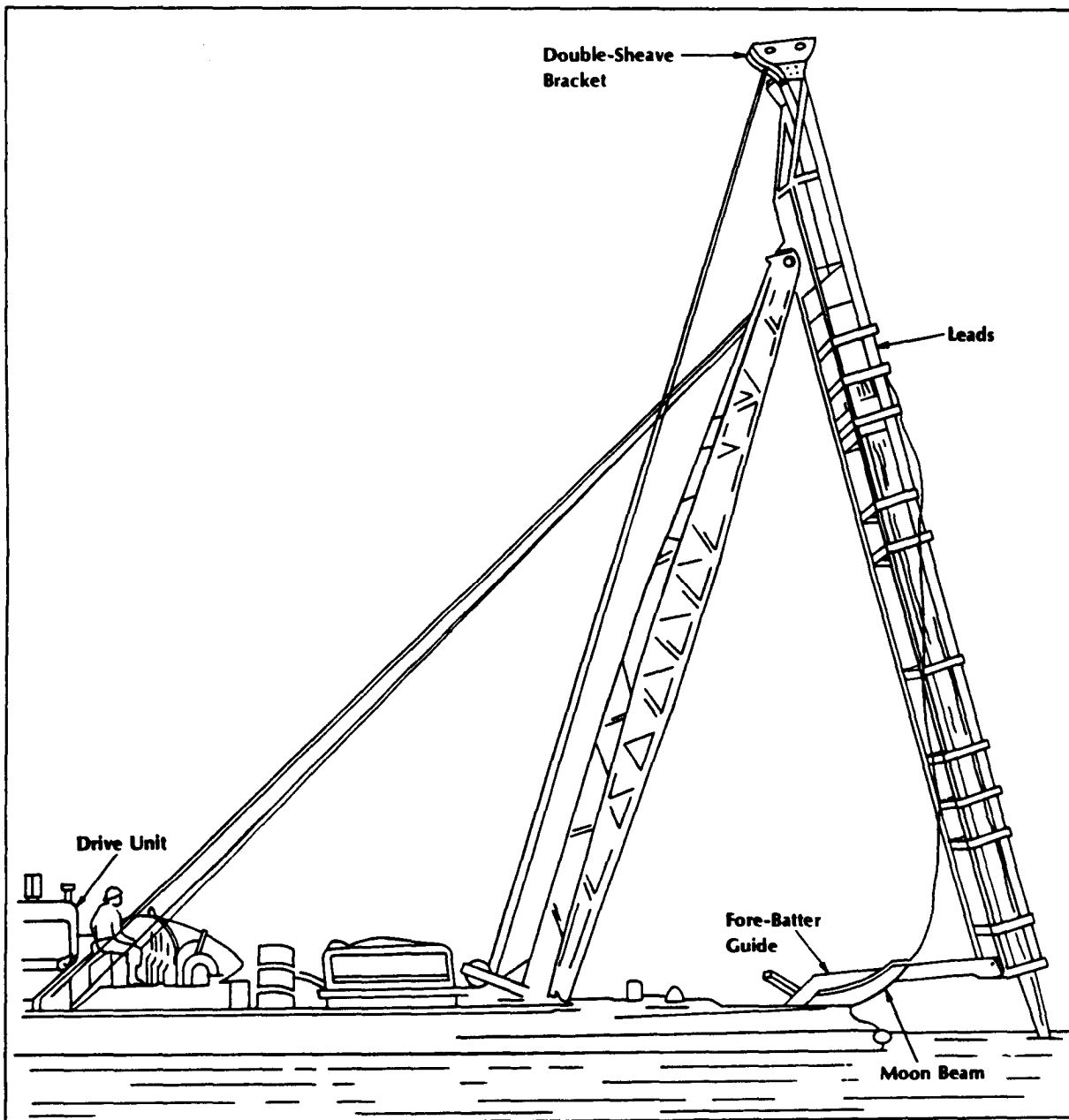


Figure 3-3 Steel-frame, skid-mounted pile driver

d. **Guides.** Two types of guides permit versatile aligning of the leads.

(1) **Fore-batter guide.** The fore-batter guide (figure 3-3), referred to as a spotter, is a beam extending from the forward end of

the frame to the leads. It fixes the position of the base of the leads and holds them vertically or at a fore-batter in the plane of the longitudinal axis of the equipment (figure 3-4, 2).

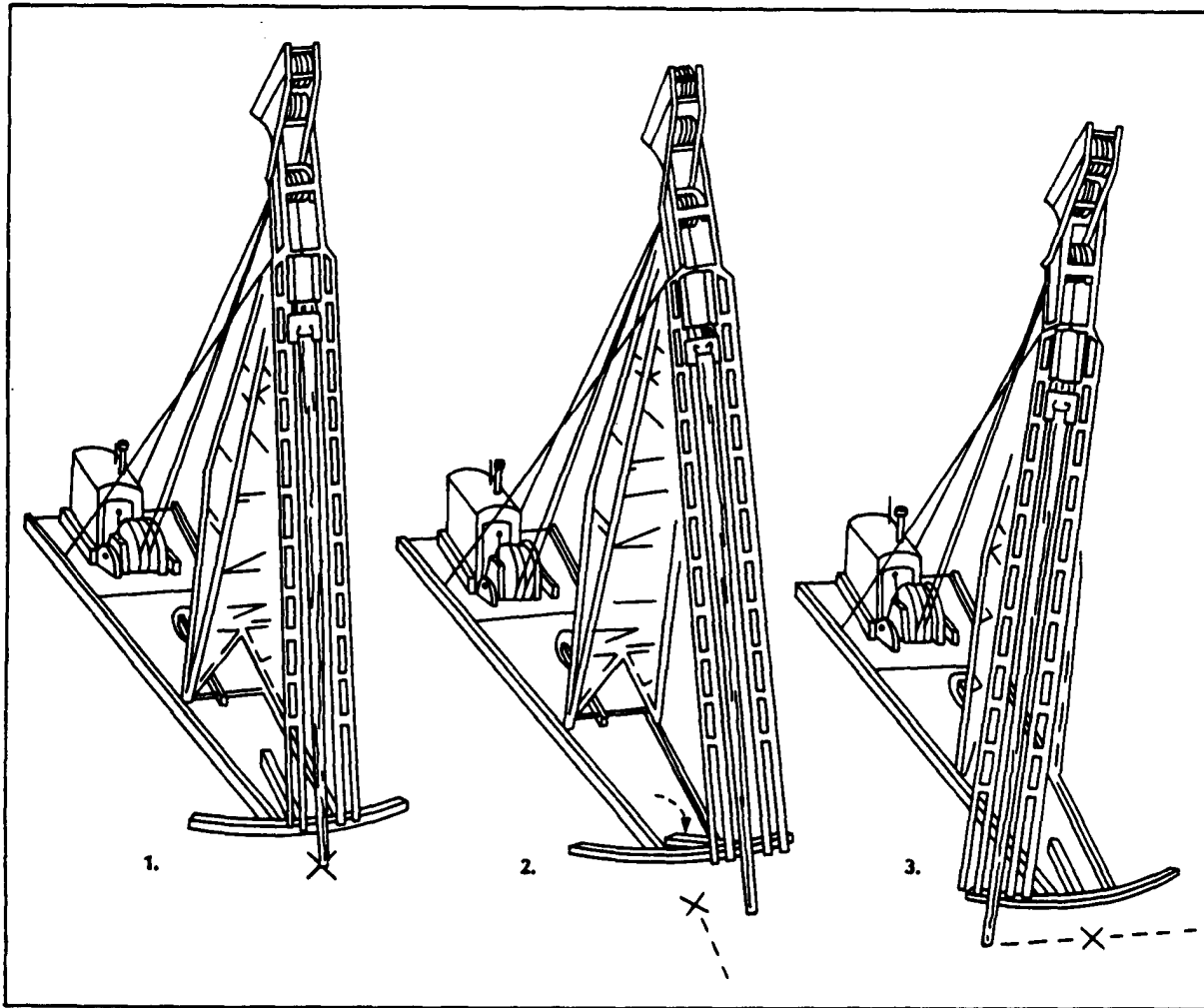


Figure 3-4 Aligning leads of the skid-mounted pile driver

(2) **Moon beam.** The moon beam (figure 3-3) is a curved beam placed transversely at the forward end of the skid frame to regulate side batter.

e. Drive unit. The drive unit (not provided as part of the pile-driver rig) is a 2-drum winch driven by a gasoline, diesel, or steam engine. The drive unit is mounted on the platform at the rear of the skid frame.

f. Hammer. A 5,000-pound, double-acting steam or pneumatic hammer; a 1,800-pound

or 3,000-pound drop hammer; or an 8,000-foot-pound or 18,000-foot-pound diesel hammer may be used.

3-4. Driving devices (hammer and vibratory driver).

There are three impact hammers used for pile-driving: the drop hammer, the pneumatic or steam hammer, and the diesel hammer. Drop hammers and diesel hammers are standard engineering equipment. Table 3-1 provides data on selected types of

TABLE 3-1. SELECTION OF DIESEL HAMMERS FOR VARIOUS SIZES OF PILING

Type	Size	Size of Hammer					
		A	B	C	D	E	
		Rate Energy (foot-pounds)	8,100	16,000	22,400	8,000	18,000
	Hammer Weight (pounds)	5,000	7,500	10,500	6,000	12,000	
Timber Piling	7 inch tip, 12 to 15 inch butt, 40 feet long Up to 15 inch butt, 9 inches tip and 10 by 10 inch square piling 40 feet long 7 inch tip, 13 to 17 inch butt, 60 feet long Up to 18 inch, 14 inch tip and square piling up to 14 by 14 inch size, 60 feet long	X				X	
Steel Pipe Pile	10 inch outside diameter, No. 7 gage, 25 feet long Up to 10 inch outside diameter, No. 7 gage, 25 feet long 12 inch outside diameter, No. 7 gage, 60 feet long	X				X	
Concrete and Steel H-Pile	8 inch and 10 inch, 40 feet long 10 inch and 12 inch, 60 feet long 12 inch and 14 inch, 60 feet long	X	X		X		
Steel H-Pile	8 inch, 10 inch, and 12 inch, 40 feet long 10 inch, 12 inch, and 14 inch, 60 feet long				X		X
Type Z-27 Sheet Piling	3/8 inch web thickness, 40.5 pound lineal feet, 20 feet long 3/8 inch web thickness, 40.5 pounds lineal feet, 60 feet long	X				X	
Steel Pipe and Round Concrete Pile	Up to 14 inch diameter, 60 feet long						X

commercially available hammers. Vibratory drivers/extractors are not classified as hammers and do not require pile caps for protection against impact stresses. They are clamped to the pile to vibrate as a unit.

a. Drop hammers. The drop hammer (figure 3-5) is a simple pile-driving hammer consisting of a block of metal raised in the leads by the drive unit, then permitted to drop, striking the pile cap. Drop hammers are cumbersome, and their driving action is slow compared to other hammers. Velocities at impact are high and damage the top of a pile. Two standard drop hammers are available in

military supply channels: size one weighs 1,800 pounds; size two weighs 3,000 pounds. The maximum height of fall should be limited to six feet. For most efficient driving, the weight of a hammer twice that of the pile will give the best results. As an expedient, a log hammer (figure 3-6) may be fabricated and used. Drop hammers should be used only in remote sites or for a small number of pilings.

b. Air or steam hammers. The air or steam hammers (figure 3-7) consist of stationary cylinders and moving rams which include a piston and a striking head. The piston is raised by compressed air or steam pressure. If

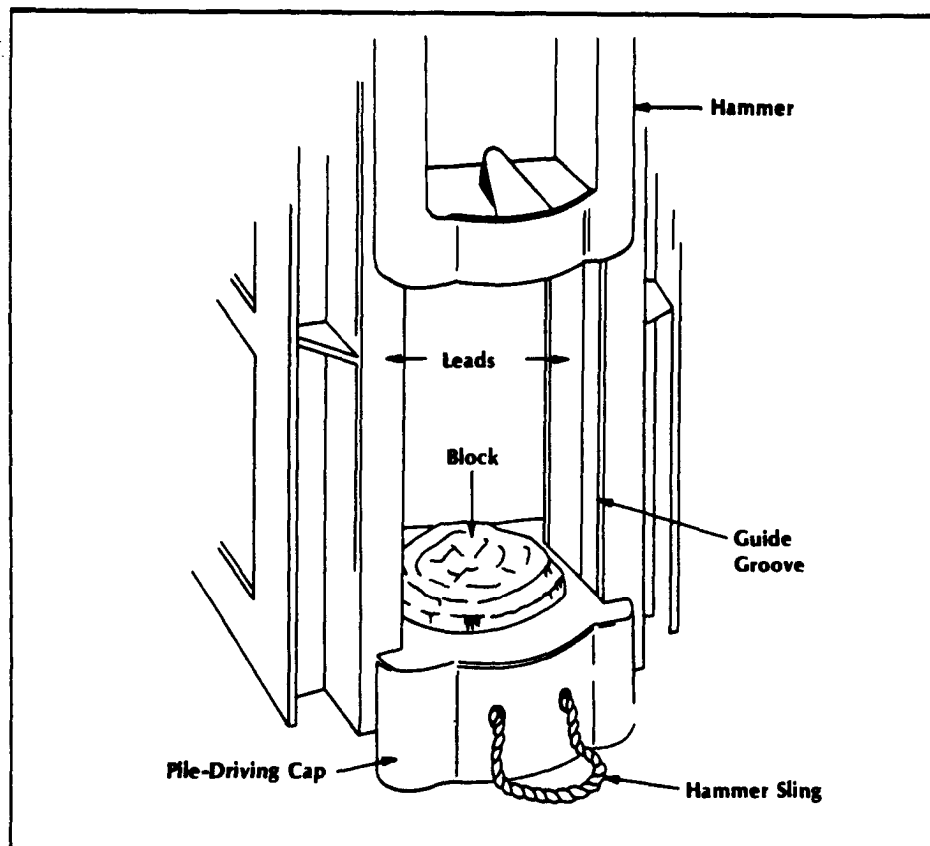


Figure 3-5 Drop hammer and pile cap placed in leads

the fall is gravity, the hammer is simple acting. In double-acting hammers, the air or steam pressure works on the upstroke and downstroke. Because they provide a high rate of blows (90 to 150 blows per minute), they keep the pile moving and prevent the building of friction thus enabling faster driving. The differential-acting hammer uses higher pressures and lower volumes of air or steam. After being raised, the ram is valved to be used for the downstroke.

c. Diesel hammers. Diesel hammers are self-contained and need no air or steam lines. Fuel tanks are a part of the rig. Diesel hammers are well suited for military

operations. Table 3-2 contains a list of diesel hammers available through military channels and the types and sizes of piles which can be driven by each hammer. Sizes A and D are suitable for use with 10-ton and 20-ton drivers. Heavier hammers are more suitable for use with 30-ton to 40-ton cranes. Diesel hammers may be either open-ended or closed-ended as shown in figure 3-8.

Diesel hammers function as follows.

- The ram is lifted by combustion of fuel and compressed gas in a chamber between the bottom of the ram and an anvil block in the base of the housing.

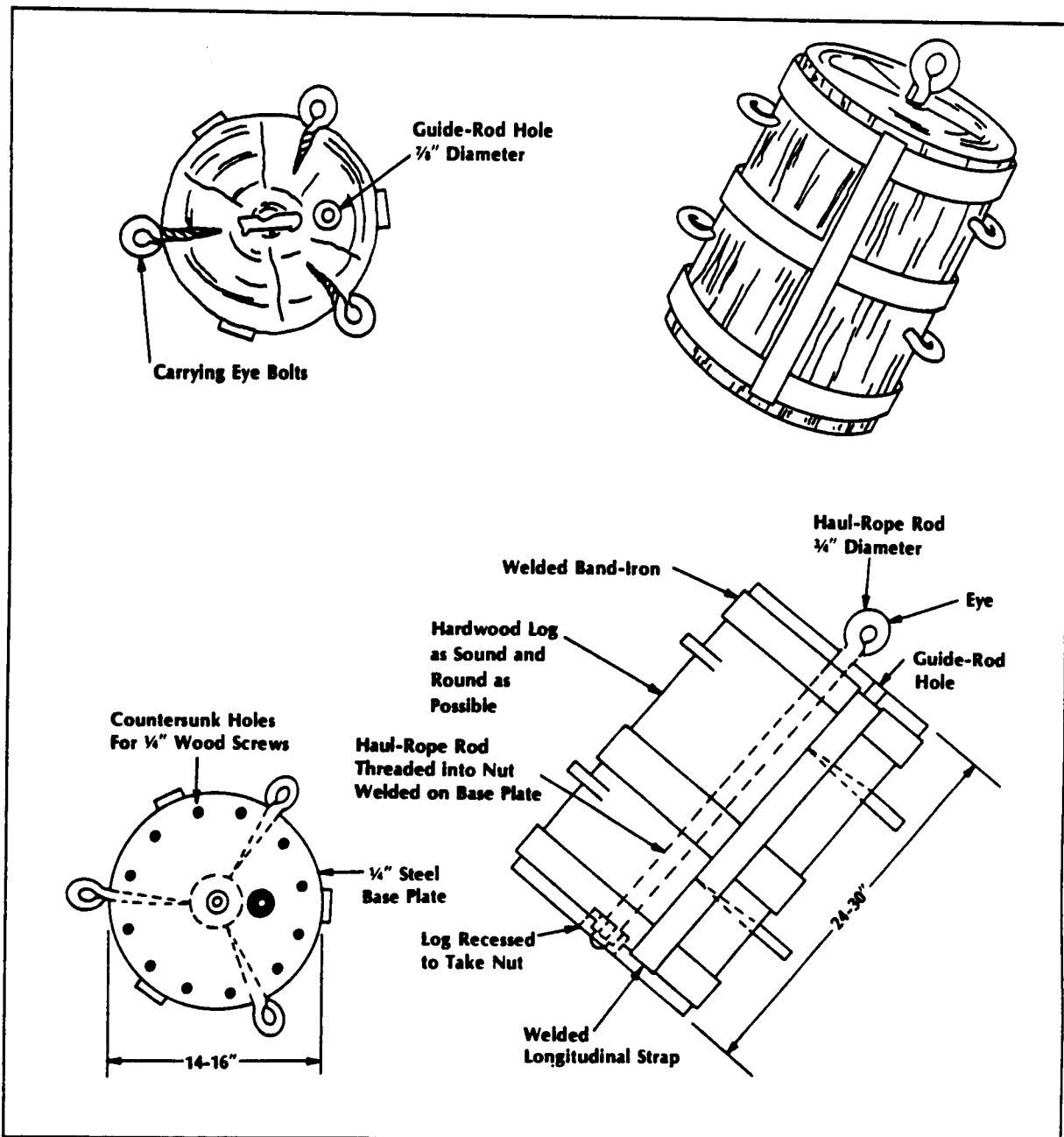


Figure 3-6 Details of expedient log hammer

- The crane-load line raises the ram for the initial stroke, and an automatic trip mechanism allows the ram to drop.
- During this fall, fuel is injected into the combustion chamber by a cam-actuated fuel pump.

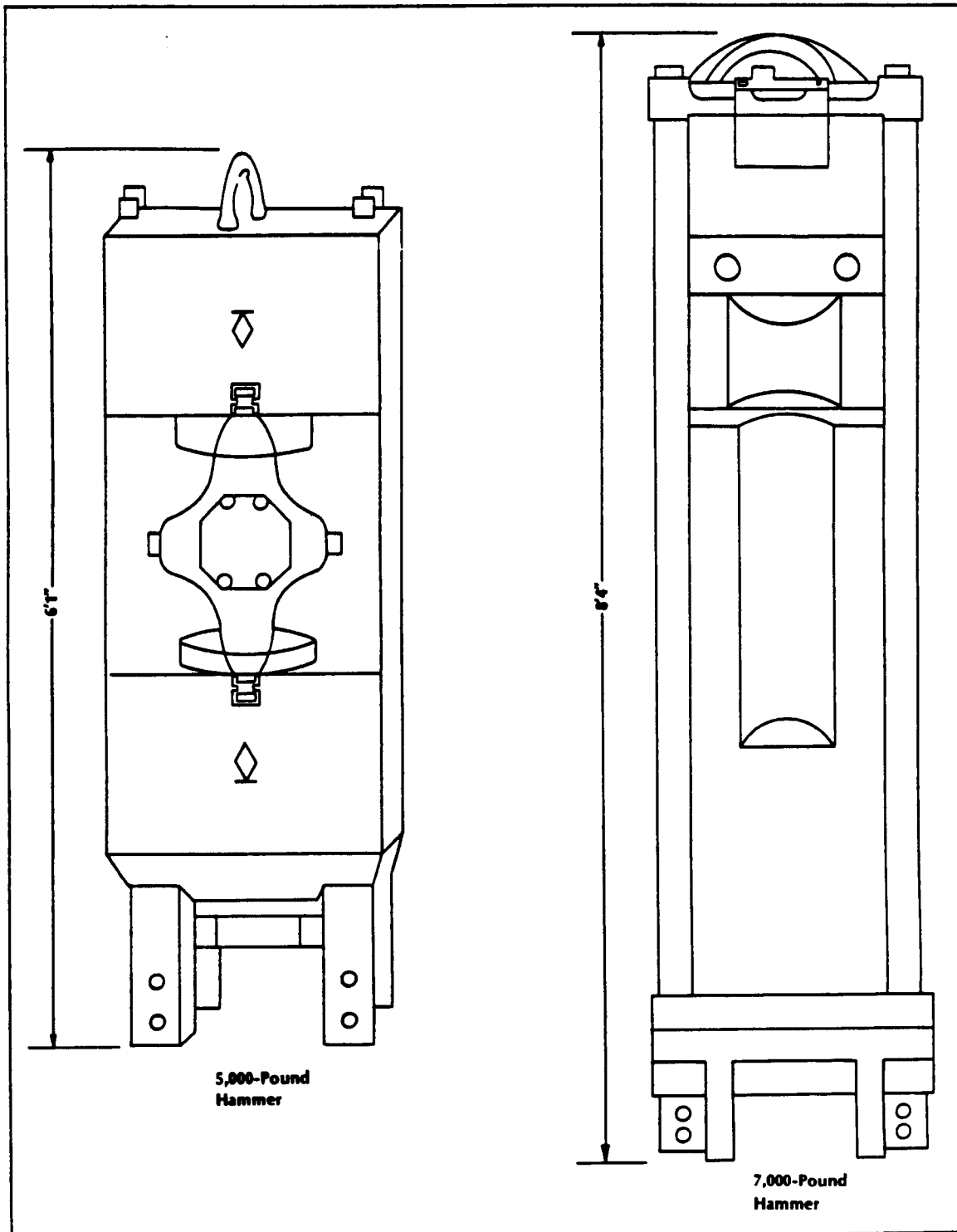


Figure 3-7 Pneumatic or steam pile-driving hammers

TABLE 3-2. PROPERTIES OF SELECTED IMPACT PILE HAMMERS

Rated Energy (foot pounds)	Make	Model	Type ¹	Blows per Minute ²	Stroke at Rated Energy (Inches)	Weight Striking Parts (pounds)
7,260	Vulcan	2	S	70	29	3,000
8,750	MCT ³	93B3	DB	145	17	1,600
13,100	MKT	10B3	DB	105	19	3,000
15,000	Vulcan	1	S	60	36	5,000
15,100	Vulcan	50C	DF	120	15½	5,000
16,000	MKT	DE-20	DE	48	96	2,000
18,200	Link-Belt	440	DE	86-90	36¾	4,000
19,150	MKT	11B5	DB	95	19	5,000
19,500	Raymond	65C	DF	100-110	16	6,500
19,500	Vulcan	06	S	60	36	6,500
22,400	MKT	DE-30	DE	48	96	2,800
22,500	Delmag	D-12	DE	42-60		2,750
24,375	Vulcan	0	S	50	39	7,500
24,400	Kobe	K13	DE	45-60	102	2,870
24,450	Vulcan	80C	DF	111	16	8,000
26,000	Vulcan	08	S	50	39	8,000
26,300	Link-Belt	520	DE	80-84	43¼	5,070
32,000	MKT	DE-40	DE	48	96	4,000
32,500	MKT	S10	S	55	39	10,000
32,500	Vulcan	010	S	50	39	10,000
32,500	Raymond	00	S	50	39	10,000
36,000	Vulcan	140C	DF	103	15½	14,000
39,700	Delmag	D-22	DE	42-60		4,830
40,600	Raymond	000	S	50	39	12,500
41,300	Kobe	K-22	DE	45-60	102	4,850
42,000	Vulcan	014	S	60	36	14,000
48,750	Vulcan	016	S	60	36	16,250

¹S= single-acting steam; DB=double-acting steam; Df=differential-acting steam; DE=diesel.

²After development of significant driving resistance.

³For many years known as McKiernan-Terry.

- Continuing its fall, the ram blocks the exhaust ports located in the cylinder and compresses the air/fuel mixture trapped below it to ignition temperature.
- When the ram hits the anvil, it delivers its energy through the anvil to the pile. At the same time, combustion occurs which drives the ram upward. The pressure of the burning gases acts on the anvil for a significant time, thus increasing the

magnitude and duration of the driving force.

- As the ram rises, the exhaust and intake ports are uncovered, combustion gases escape, and air enters. In the closed-ended type, the housing extends over the cylinder to form a bounce chamber in which air is compressed by the rising ram. Air trapped and compressed above the piston helps

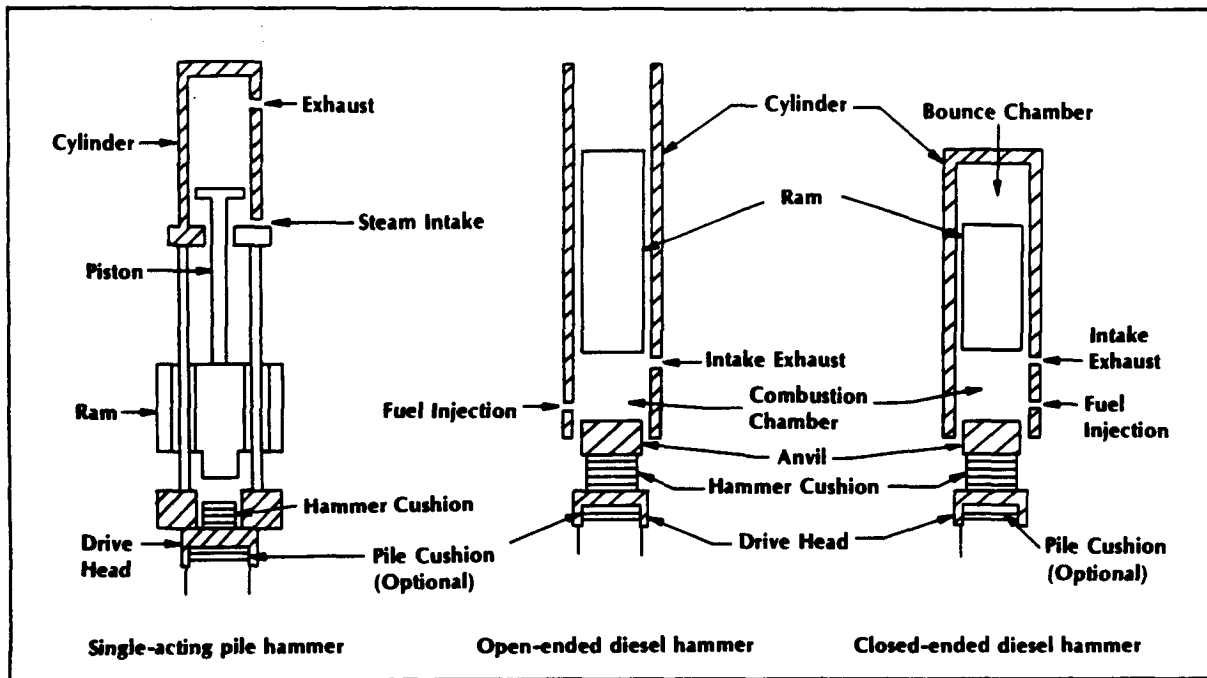


Figure 3-8 Types of pile hammers

stop the ram piston on its upward stroke and accelerates it on its downward stroke.

- The cycle is repeated.

d. Vibratory drivers/extractors.

Vibratory drivers are a recent development in pile-driving equipment. They are used in commercial pile construction, especially in driving sheet piling. They are not part of the military inventory. Vibratory drivers usually require either an auxiliary hydraulic or electric power supply. They consist of the vibrating unit which includes the rotating eccentric weights, the suspension system that isolates the vibratory forces from the lifting device, and the clamping system which connects the vibratory driver to the pile. Vibratory drivers have short strokes, less than two inches, and high impulse rates, up to 2,000 pulses per minute. Their driving ability derives from the vibrations and the weight of driver and pile.

3-5. Caps and cushions.

Caps and cushions protect the top of the pile and reduce the damage caused by the impact of the hammer. Although they serve the same purpose, they vary for different types of hammers.

a. Drop hammers. A standard driving cap for timber piles used with a drop hammer is a cast block. Its lower face is recessed to fit over the top of the pile, and its upper face is recessed to receive an expandable block of hardwood in end-grained position to act as a washer (figure 3-5). The cap is fitted with a wire rope sling so that the cap, as well as the hammer, may be raised to the top of the leads when positioning a pile in the leads.

b. Air and steam hammers. The ram of a Vulcan hammer strikes a cap block positioned in the base of the hammer. In other hammers, such as the MKT type, the rams strike directly

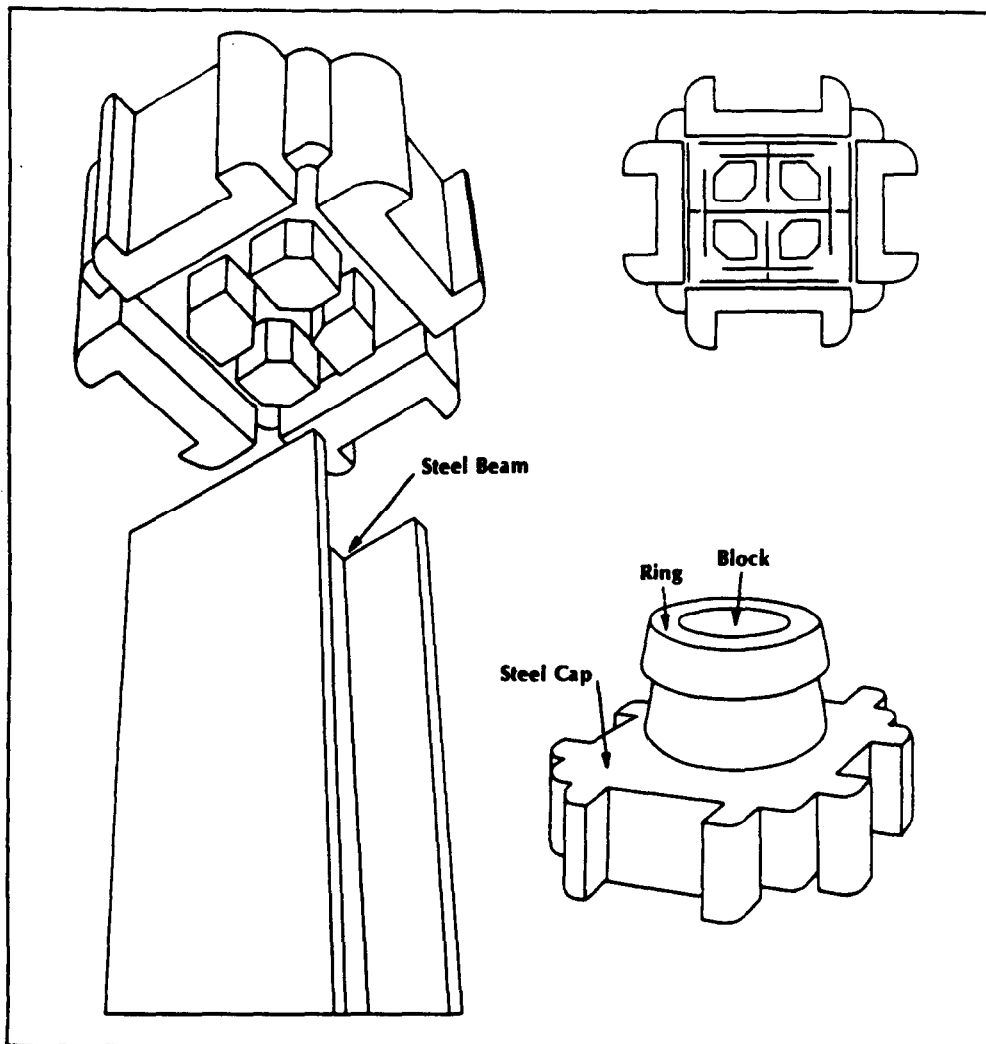


Figure 3-9 Special cap (helmet) for steel pile

on the base or anvil. The top of the pile is protected by a driving cap suspended from the base of the hammer and fitted to the dimensions of the pile. Driving caps for steel H-piles are shown in figure 3-9. The tops of concrete piles are usually protected from local overstress by a pile cushion inserted between the drive head and the pile. The cap block and cushion serve several purposes; however, their primary function is to limit impact stresses in both the pile and hammer.

Common types of cushion materials are sheets of Micarta with sheets of aluminum or large oak blocks in end-grained position.

c. Diesel hammers. Military diesel hammers are supplied with cushion blocks inserted between the anvil and the drive cap. The cushion blocks consist of laminated plastic and aluminum or cast nylon. Additional cushioning is required between concrete piles and the pile cushion.

3-6. Pile-driving leads.

Pile-driving leads (figure 3-10) are tracks for sliding the hammer and guides to position and steady the pile during the first part of the driving. Standard steel leads are supplied in 1-foot and 15-foot lengths. The 15-foot length is the top section. Leads must be approximately 20 feet longer than the pile to provide space for the hammer and accessories. There are three types of leads.

a. Swinging leads. Swinging leads are hung from the crane boom by a crane line. The bottoms of the leads are held in place while the boom is positioned so that the pile is plumb or at the desired batter. Swinging leads are the lightest, simplest, and least expensive. They permit driving piles in a hole or over the edge of an excavation. Swinging leads require a three-line crane (leads, hammer, and pile). Precise positioning of the leads is slow and difficult.

b. Fixed, underhung leads. A spotter easily and rapidly helps connect fixed, underhung leads to the boom point and to the front of the crane. The leads are positioned by adjusting the boom angle and spotter. A two-line crane is adequate to accurately locate the leads in various positions. The length of the leads is limited by the boom length. Military standard leads are underhung from the crane boom and fixed to the crane by a catwalk. They are comprised of a 15-foot top section and the required number of 10-foot lower sections to make up the required length (see figure 3-1).

c. Fixed, extended leads. Fixed, extended leads extend above the boom point. They are attached with a swivel connection which allows movement in all directions. A spotter connects the bottom of the leads to the front of the crane. A two-line crane is required. A headblock directs the crane lines over the top of the leads. Once the leads are set up, they can be positioned quickly and accurately; however, initial setup time is extensive. Side

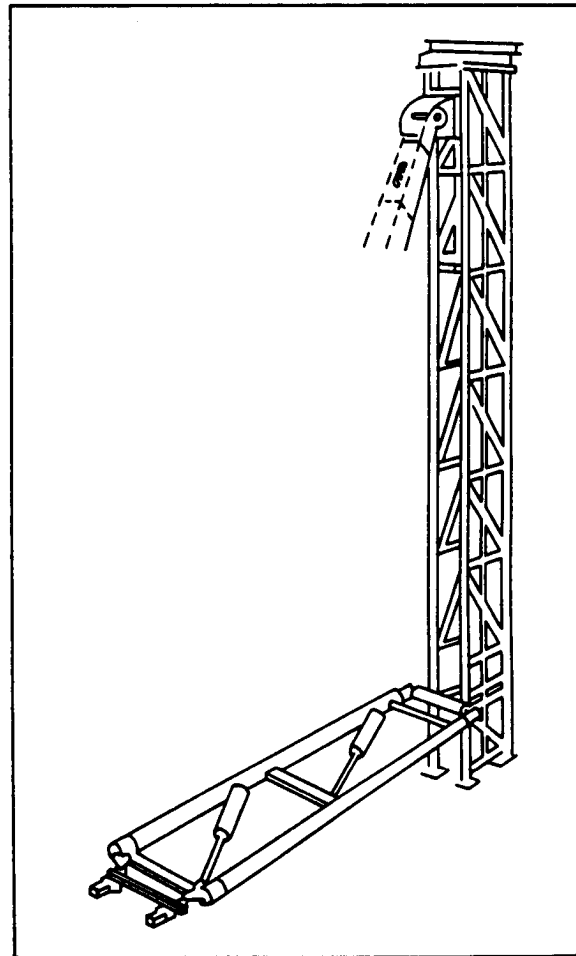


Figure 3-10 Pile-driving leads with bottom brace

to-side as well as fore-and-aft adjustment is possible. The military standard skid-mounted pile-driving rig has fixed, extended leads with capabilities of side-to-side and fore-and-aft batter.

3-7. Spotters and lead braces.

The spotter connects the bottom of fixed leads (underhung or extended) to the front of the crane. With military standard leads used with a crane, the catwalk connects between the bottom of the leads and the front of the crane's revolving upper machinery deck. It telescopes for fore-and-aft batter. The front of

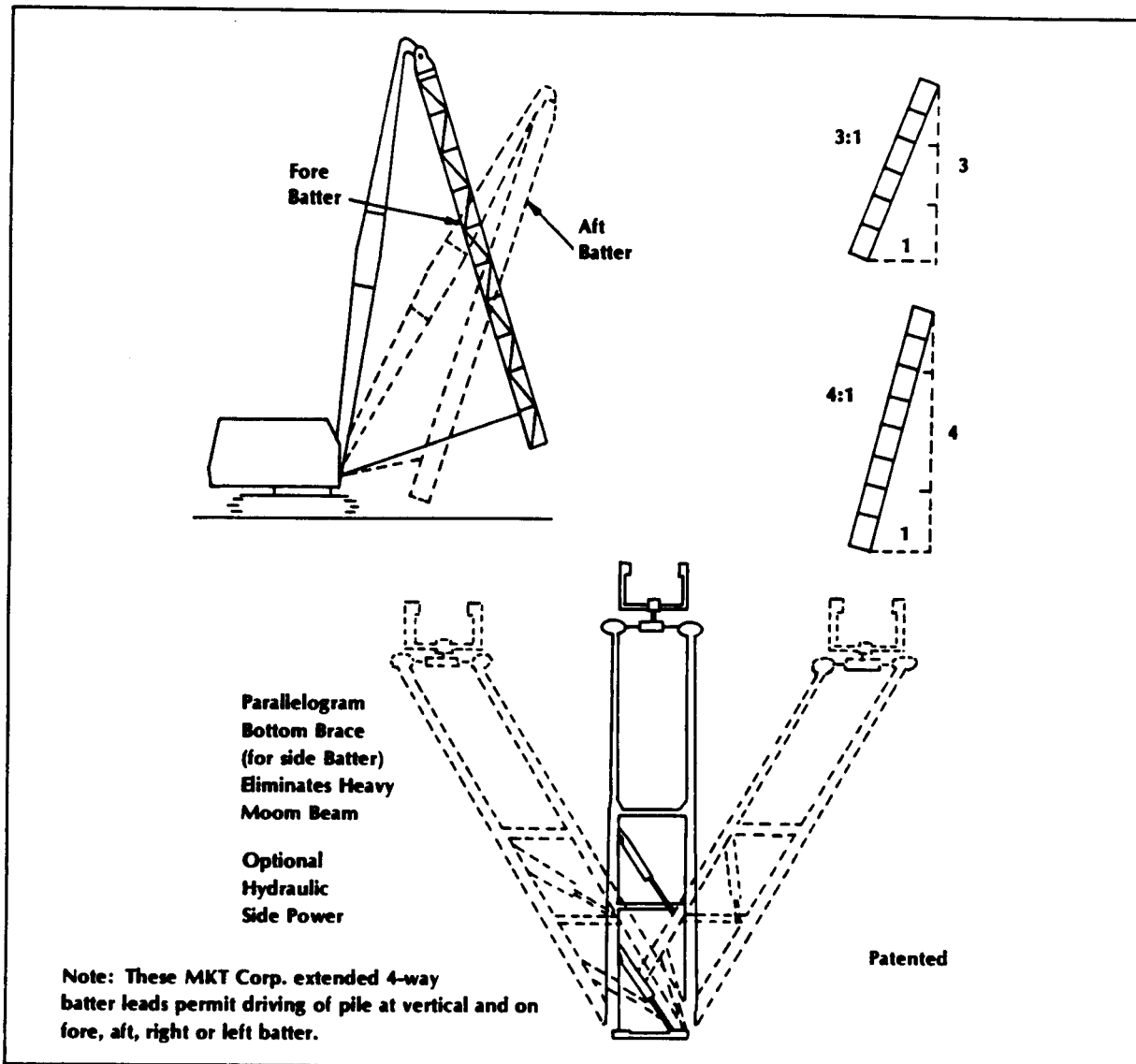


Figure 3-11 Bottom braces for adjusting batter

the spotter is moved for and aft for batter piles, and side to side to plumb piles either hydraulically or manually. Special bottom braces are available which permit this operation (figure 3-11).

3-8. Followers.

Followers are fabricated pile extensions placed between the top of a pile and the

hammer. They are used when driving piling below the water surface, especially with a drop hammer (which operates with reduced efficiency underwater) and with the diesel hammer (which cannot operate underwater). Followers are used under fixed or swinging leads and in tight spaces where there is no room for the leads and the hammer, as in a close pile grouping. When followers are used, the computation of the bearing value of the

pile using a dynamic formula is uncertain. Followers must be rugged and constructed to transmit the full impact of the hammer and to hold the hammer and the pile in positive alignment. Followers can be fabricated for timber, steel, and sheet piling.

a. Timber pile follower. The follower is made from around timber of hardwood 10-to 20-feet long. The bottom of the timber is inserted into, and bolted to, a follower cap which is recessed at the bottom the same as a pile cap. The top is trimmed to fit into the pile cap or hammer. If there is insufficient driving space for a follower cap, a flared wrought-steel band is bolted to the bottom of the timber follower.

b. Steel pile follower. For a steel pile follower, a section of the driven pile is reinforced by welding steel plates at the head to lessen damage from repeated use. Extension plates that fit snugly against the pile to be driven are welded to the base.

c. Sheet pile follower. Projecting plates are riveted on each side of the sheet pile being driven. These riveted plates are shaped to fit the form of the pile.

Section II. EXPEDIENT AND FLOATING PILE-DRIVING EQUIPMENT

3-9. Expedient pile drivers.

When standard pile drivers are not available, expedient pile drivers may be constructed.

a. Wood-frame, skid-mounted pile driver. A skid frame is made of two 12-inch x 17-inch timbers 44 feet long. The frame is cross braced with 8-inch x 8-inch and 12-inch x 12-inch timbers and stiffened on both sides with a king post and king-post cables. The leads are standard or expedient. Figure 3-12 shows expedient leads, 66 feet high made of

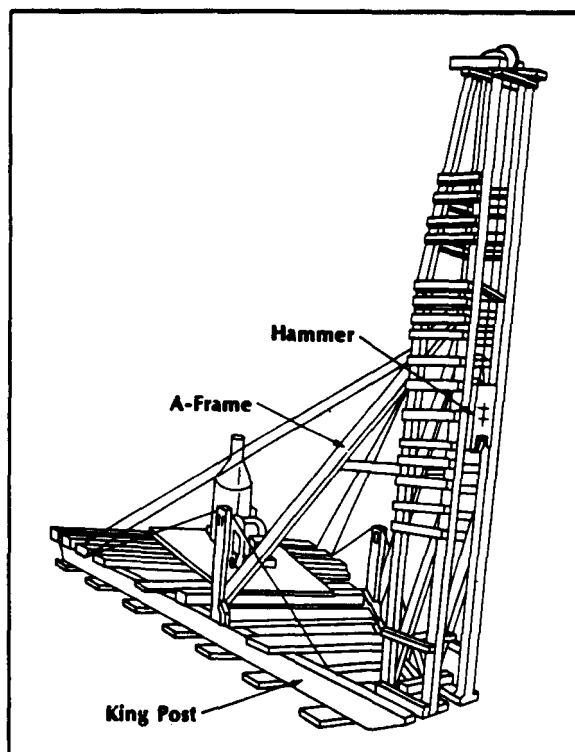


Figure 3-12 Expedient wood-frame, skid-mounted pile driver

timber with the bearing surfaces faced with steel plates to reduce wear and friction. The fixed leads are supported by guys run to the rear of the frame and by an A-frame from the midpoint of the leads to the midpoint of the frame. The rig can be skidded into place using a 2-drum winch. The rig is anchored, using natural anchors in the vicinity of the site. Any pile-driver hammers discussed in paragraph 3-4 can be used.

b. Timber pile driver. Figure 3-13 shows a rig with a 12-inch x 12-inch timber base and an A-frame using a section of standard leads. Cross braces are 3-inch x 12-inch members. The leads must be securely fastened to the tip of the A-frame and guyed at the base. Another design, using smaller dimensioned lumber, is shown in figure 3-14.

c. Tripod pile driver. Figure 3-15 shows a hand-operated rig constructed of local

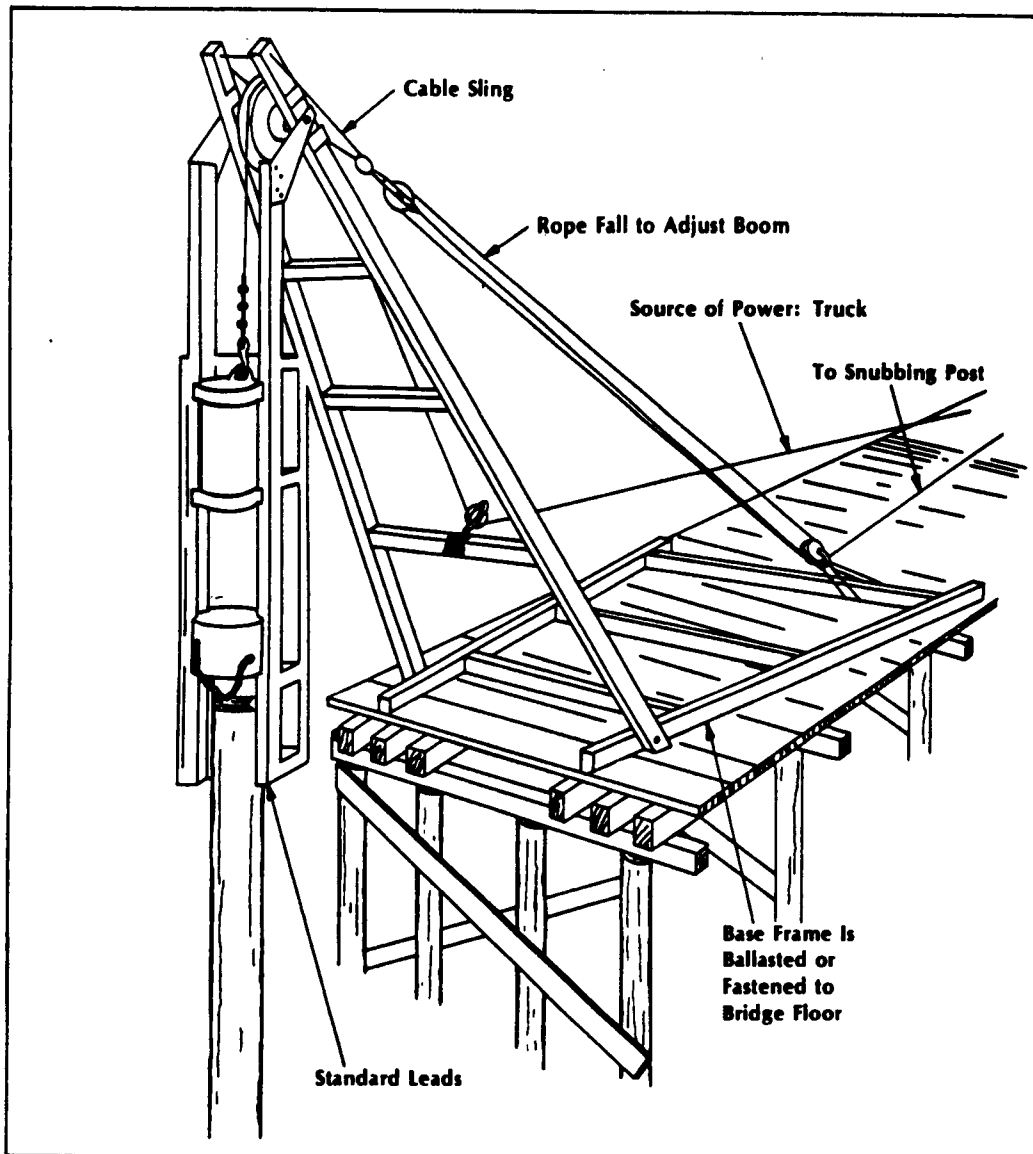


Figure 3-13. Expedient wood-frame, skid mounted pile driver using standard leads

materials. The hammer, guide rod, blocks, and line (rope) are the only equipment that must be transported. This rig is particularly well adapted for jungle operations where the transportation of heavy equipment is difficult. The rig will handle short lengths of piling up to 8 inches in diameter. Figure 3-16 shows the design features of the pile driver. The spars are 8 to 10 inches in diameter and

are lashed with $\frac{1}{2}$ -inch line. The base frame must be ballasted while driving piles. A log hammer (figure 3-6) can be used to drive the piles. The rig is built of hardwood and has a steel baseplate to protect the driving end. The guide-rod hole and the guide rod must be well greased to prevent binding when the hammer falls. The base of the guide rod is positioned by drilling a $\frac{3}{4}$ -inch hole 6 to 8 inches deep in

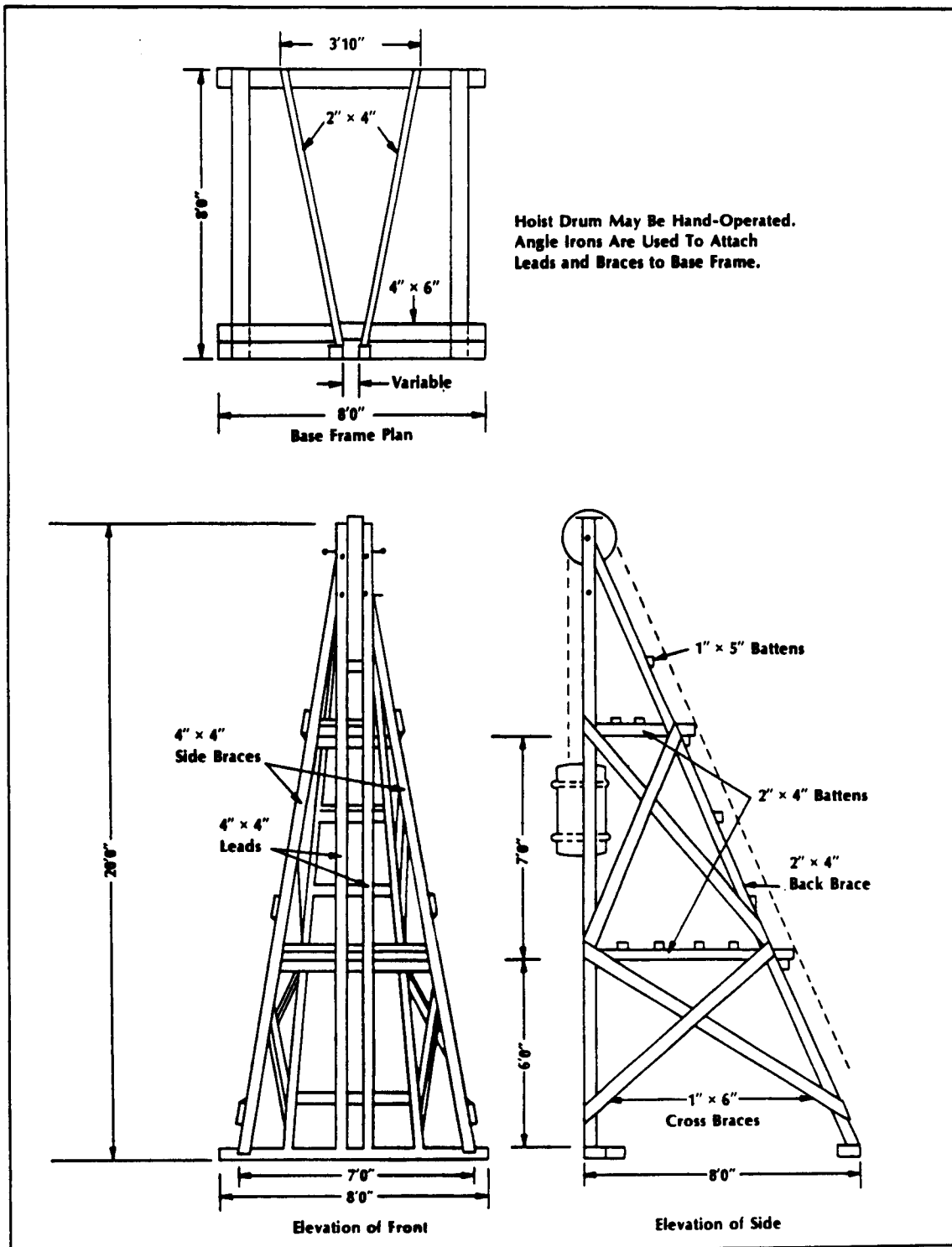


Figure 3-14 Expedient timber pile-driving rig using dimensioned lumber

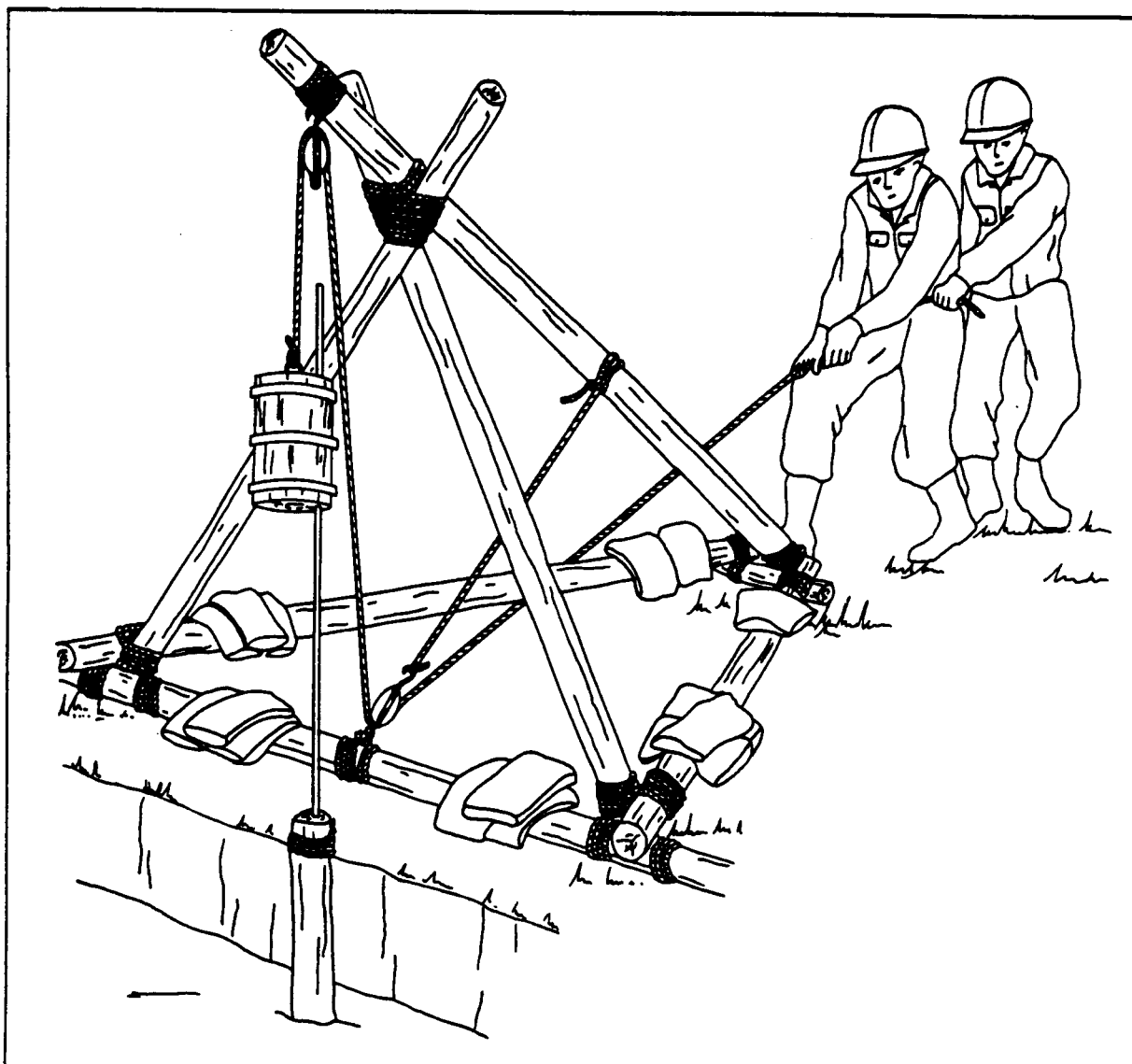


Figure 3-15 Expedient tripod pile driver

the head of the pile. Guying the pile helps position the guide rod.

d. Welded-angle construction pile driver. A piledriving rig can be built using four heavy steel angles as leads and a laminated steel plate cap of welded and bolted construction. The leads should be heavily braced and guyed (figure 3-17). The hammer can be operated by the rear wheels of any

four-wheel-drive truck *or* the front wheels of any front-wheel-drive truck.

3-10. Power for expedient pile drivers.

To raise the pile into position and operate the hammer in driving the pile, power is required. When available, the power unit for a standard skid-mounted pile driver should be used. In

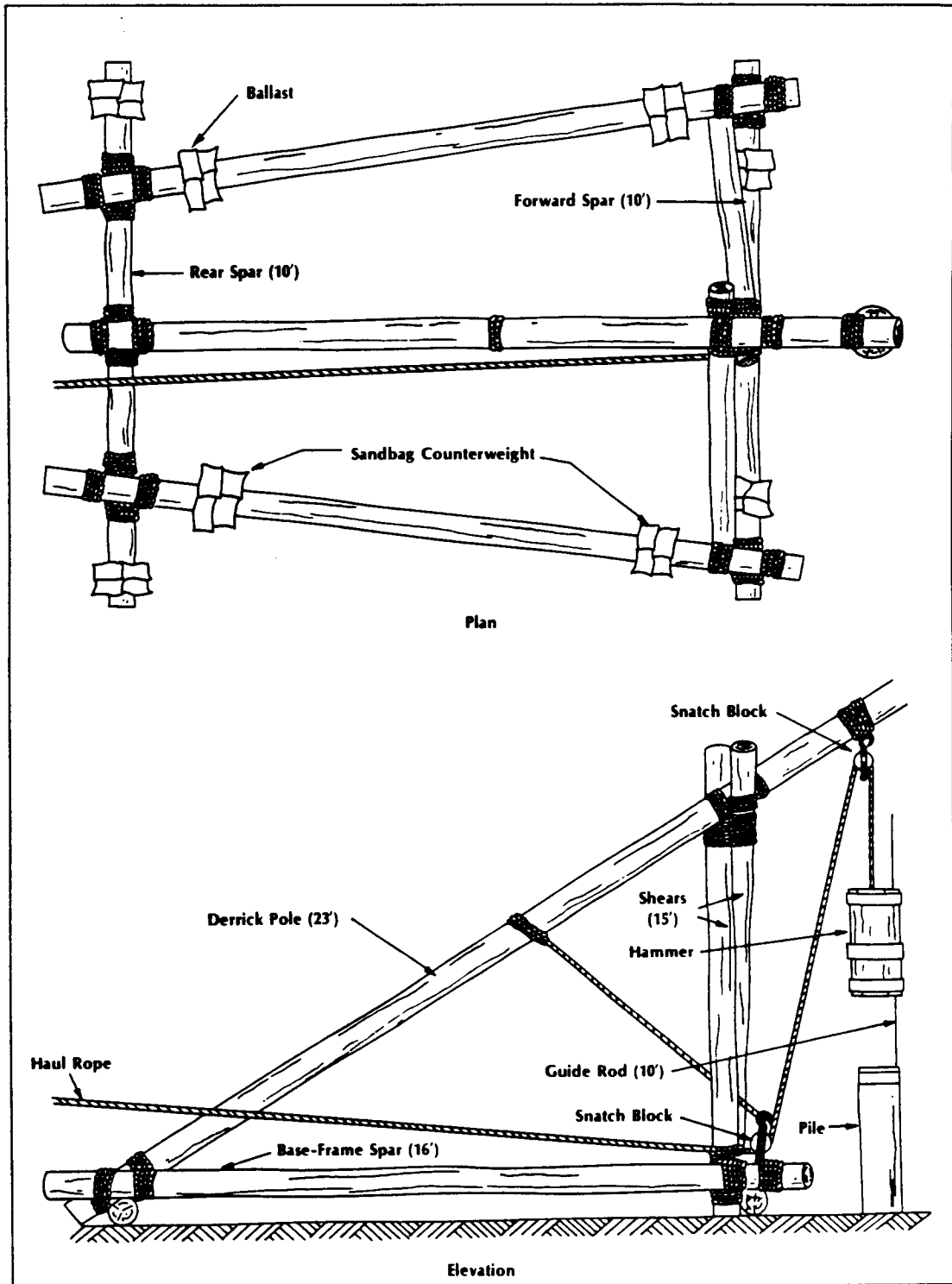


Figure 3-16 Design features of the tripod pile driver

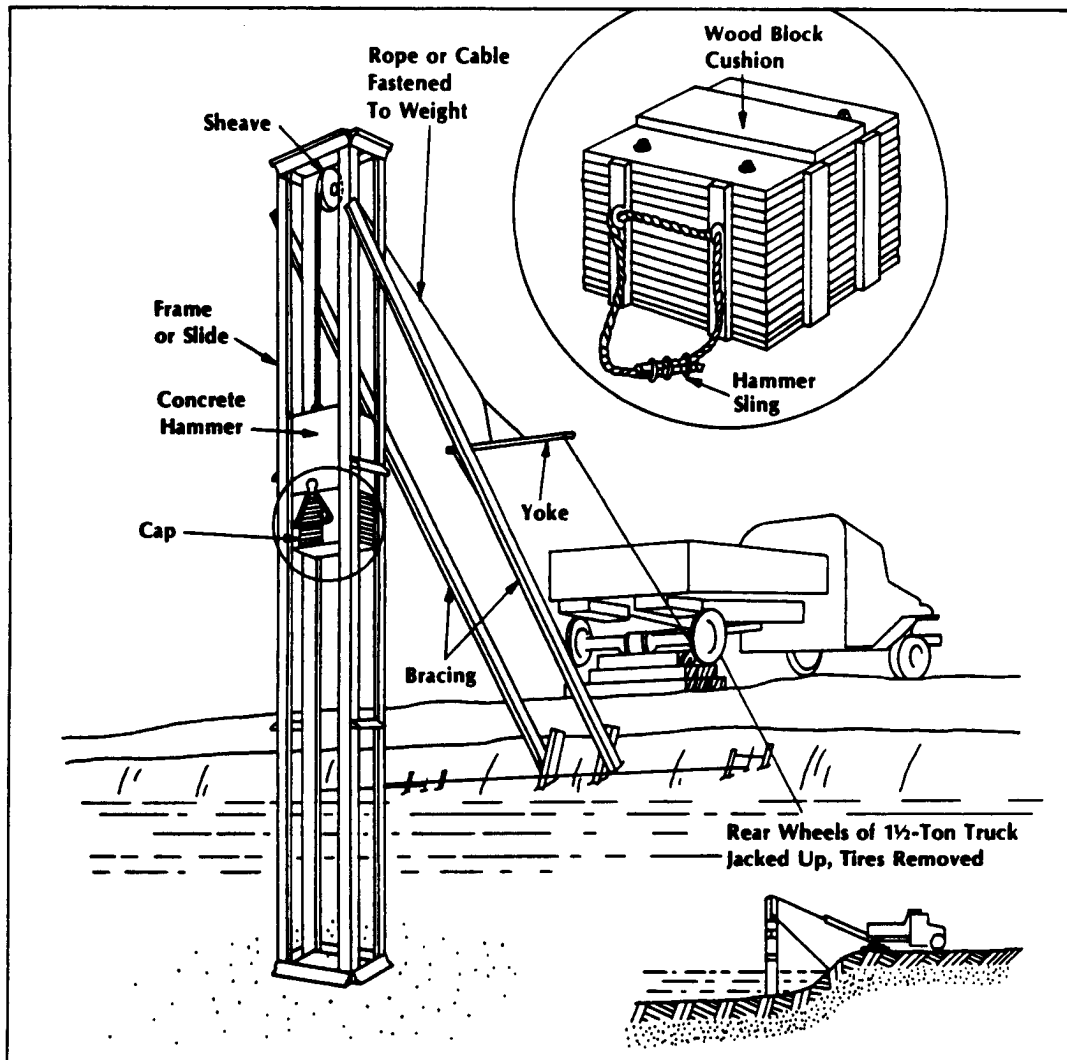


Figure 3-17 Expedient pile driver made of constructed welded steel angles

other cases a truck, truck motor, or manpower can be used.

a. Truck. The hammer line can be snubbed to a truck bumper and the truck backed away until the hammer is raised. The line is then freed allowing the hammer to fall (figure 3-13). The wheels of a truck can be jacked and used as hoist drums (figure 3-17). The truck winch should not be used except in emergencies since heavy use will cause excessive wear to the winch motor.

b. Truck motor. A truck motor can be mounted on the base frame of the rig. A drum is mounted on the drive shaft and controlled by the clutch. The hammer line is attached to the drum.

c. Manpower. Hammers weighing up to 1,200 pounds can be operated by 15-person crews if there is sufficient pulling distance at the site. Normally, a soldier hauling a line can pull 50 to 80 pounds. When steel hammers

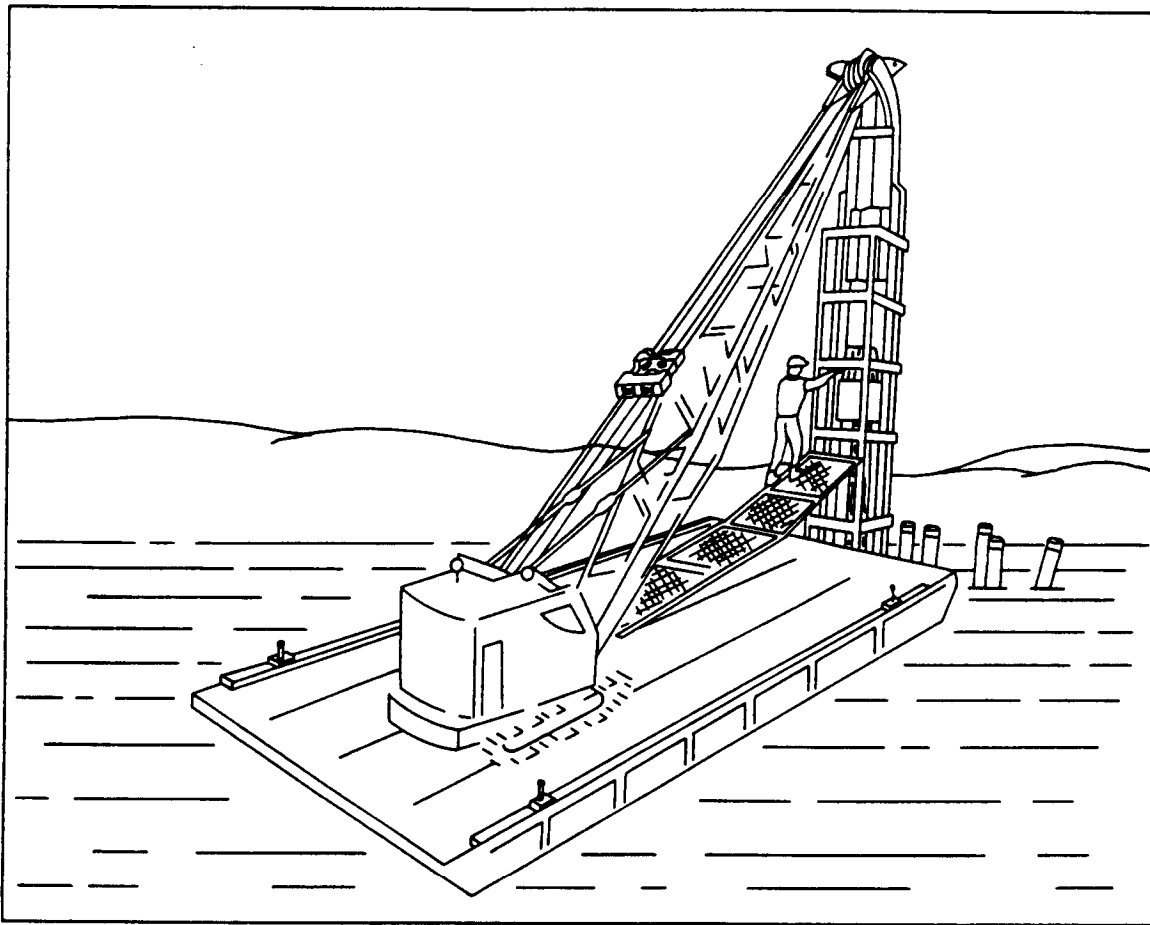


Figure 3-18 Crane-shovel with pile-driving attachment

are fabricated in laminated sections, they are easier to hand-carry over difficult terrain.

3-11. Floating pile drivers.

a. Floating cranes. Barge-mounted cranes can be adapted for pile-driving operating by using boom-point adapters and pile-driving attachments. If standard leads are not available, they should be improvised from dimensioned lumber faced with steel plate and adequately braced. For pile driving, a floating crane may be maneuvered with its own lead lines, and spuds put down before driving begins.

b. Barges or rafts. Crane-shovel units or skid-mounted pile drivers may be mounted on barges or rafts for work afloat. Driving may be off the end or side of the raft, depending on problems of current and maneuverability. Sandbags can counterbalance a raft to enable the pile driver to be positioned close to the end of the raft to extend its reach. A standard 4-foot x 7-foot barge assembly is adequate to support a pile driver adapted from a 12 ½-ton crane (figure 3-18). A pile driver adapted from a skid-mounted pile driver can be mounted on a 5-foot x 12-foot barge assembly (figure 3-19).

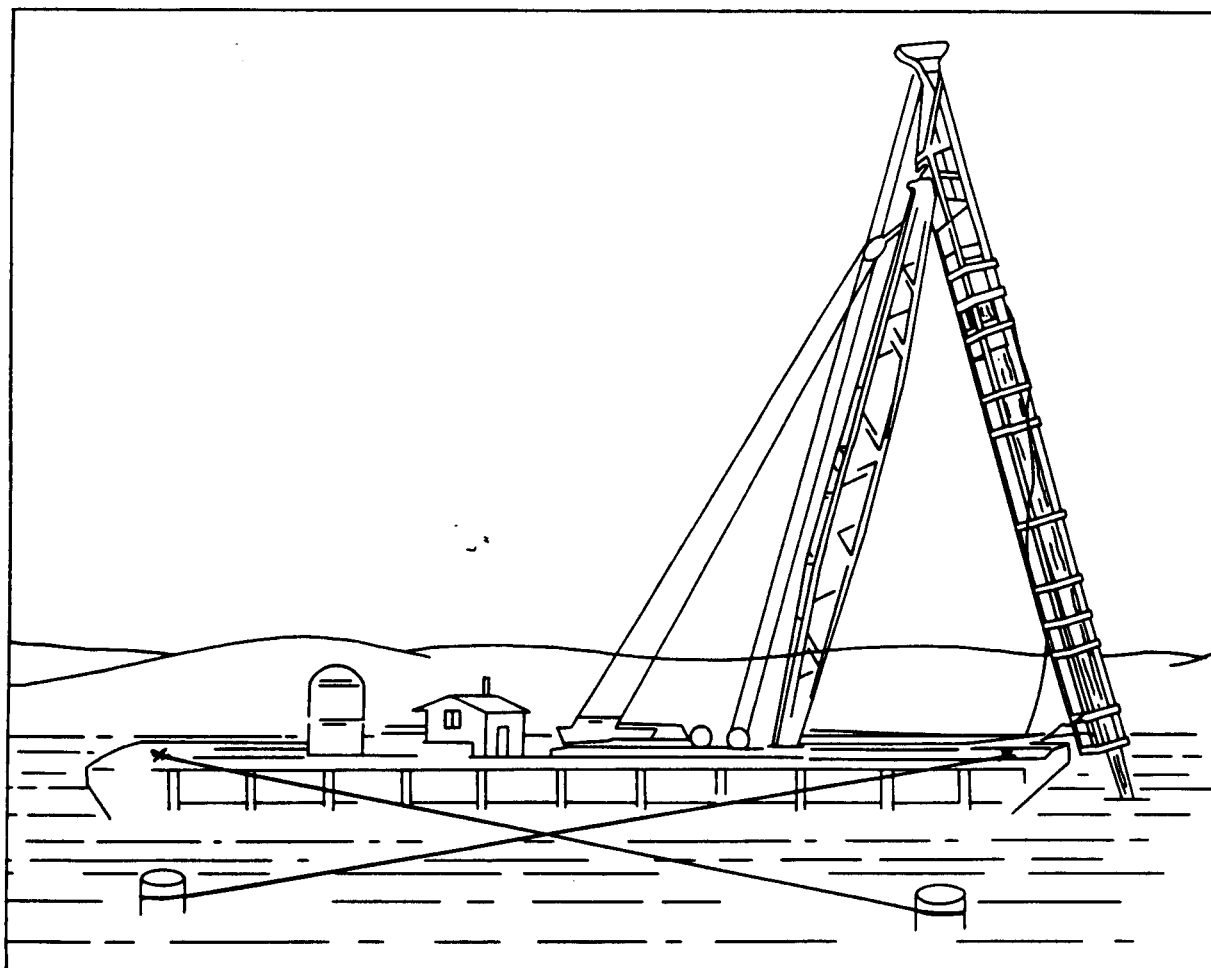


Figure 3-19. Skid-mounted pile driver on a 5-foot x 12-foot barge assembly

c. Pneumatic floats. Cranes or skid-mounted pile drivers may be mounted on rafts assembled from pneumatic floats which serve as platforms. Driving off the end or side of the float using counterbalances (such as sandbags) applies to this type of rig.

d. Anchoring of rafts. The raft must be held securely to position the pile accurately and to hold the leads and hammer in line with the pile during driving. For the first pile of an isolated off-shore structure, such as a dolphin, two transverse lines on capstans at bow and stern and one longitudinal line on a deck capstan will hold the craft if the floating

rig is not furnished with spuds. The first pile driven may be used as one of the anchors. It is possible to run the steadying lines from anchorages onshore. More control of the raft can be obtained if the lines are run like spring lines from a berthed ship, so that they cross each other diagonally.

Section III. OTHER PILE-DRIVING EQUIPMENT

3-12. Accessory equipment.

a. Support equipment. Equipment must be available for handling stockpiled piling and

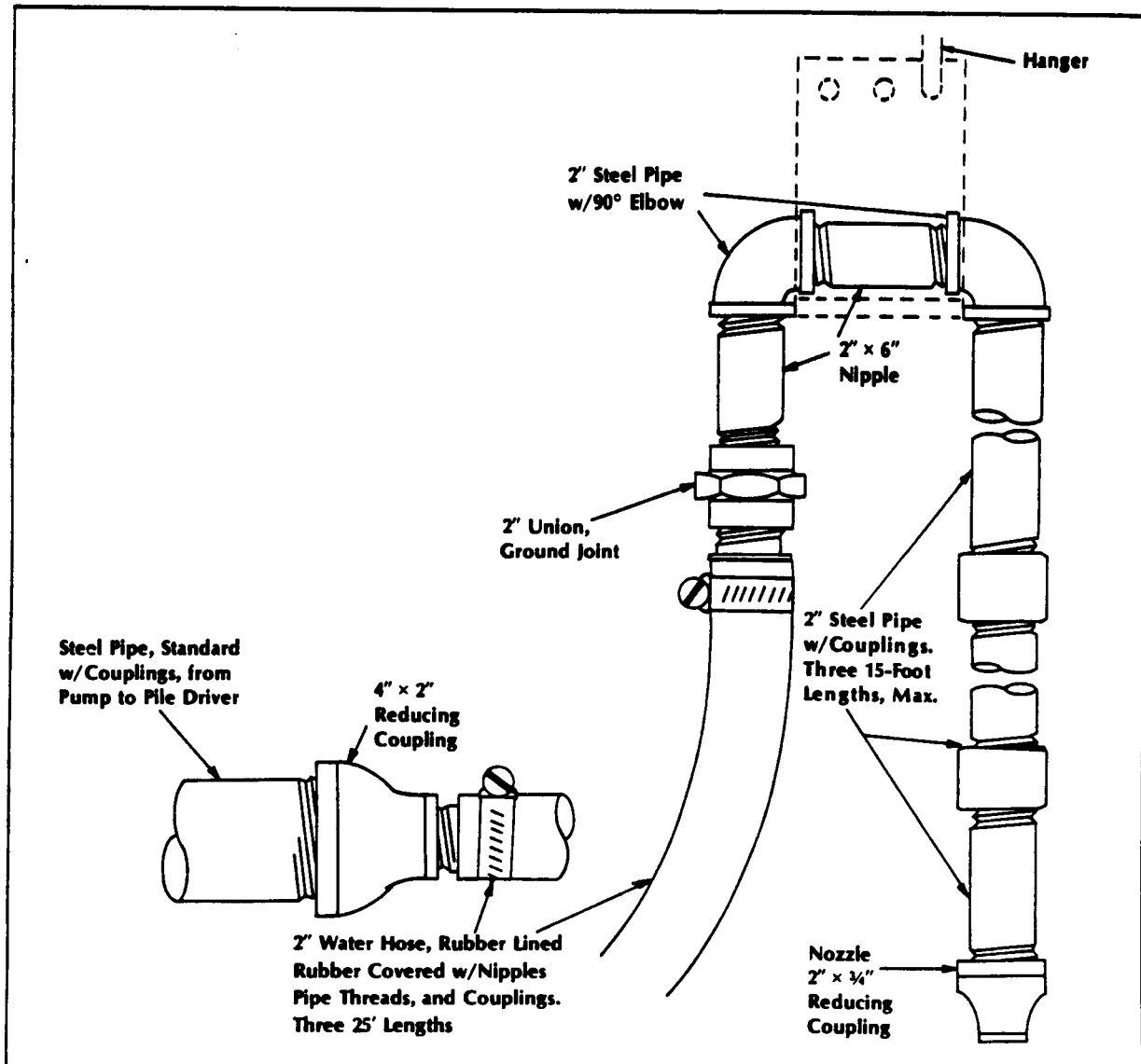


Figure 3-20 Jet pipe assembly

for straightening, cutting, splicing, capping, and bracing piles.

b. Jetting equipment. Jetting is a method of forcing water around and under a pile to loosen and displace the surrounding soils. Jetting operations are discussed in chapter 4, section II. The equipment consists of steel pipes, pipe fittings, water hoses, and

couplings. The pipes and fittings are made into a jetting assembly, and the water hoses and couplings are used to connect the jetting assembly to a water pump (figure 3-20).

(1) **Jetting pipes.** Jetting pipes are usually from 2½ to 3½ inches in diameter. The pipes are reduced to about half their

diameter to form nozzles at the point of discharge.

(2) **Jetting pump.** The jetting pump must be capable of delivering 500 gallons per minute (gpm) at a pressure of 150 to 200 pounds per square inch (psi). Gasoline or diesel-powered centrifugal pumps having from two to four stages and developing from 100 to 300 psi are normally used. For use in gravelly soils, water pressure should range from 100 to 150 psi. For sands, water pressure from 50 to 60 psi is generally adequate.

(3) **Jetting sizes.** Jet sizes are normally 2 ½ inches for 250 gpm, 3 inches for 250 to 500 gpm, and 3 ½ inches for 500 to 750 gpm.

(4) **Jetting with air.** Air may be used for jetting either alone or with water. Air compressors are required.

c. Sleeve. A sleeve is a 4-foot section of steel pipe bolted to the jaws of the hammer to hold the pile in place for driving when leads cannot be used. A three-point suspension keeps the hammer fixed at the desired angle when driving batter piles (figure 3-21, 1).

d. Pants. Pants consist of parallel plates bolted to the hammer body. These fit over the top of sheet piling that is being driven without the use of leads and serve to guide the hammer (figure 3-21, 2).

3-13. Equipment selection.

In military pile construction, little opportunity exists for selecting the equipment used in a given operation. Reduction in standard military equipment items available from the table of organization and equipment (TOE) and class IV equipment has simplified this problem. When selection is possible, consider the following factors.

a. Ground conditions. Stable soil conditions permit the use of truck-mounted cranes, while boggy areas require crawler-mounted units.

b. Piles. The number, size, and length of piles affect the choice of equipment. Diesel, air, or steam hammers are used to drive batter piles. Long piles require a large rig with long leads. It is better to drive a long pile as a continuous section than to drive short sections since alignment is controlled.

c. Hammers. Selection of the type and size of hammer will depend on availability, the type of pile, and the anticipated loadings.

- For air and steam hammers (single acting or double-acting) the ratio of ram weight to pile weight should fall between 1:1 and 1:2. For diesel hammers, the ratio should fall between 1:1 and 1:4.

- All types of air, steam, and diesel hammers can be used to drive timber piles provided they have energy ratings between 15,000 and 20,000 foot-pounds. Hammers with a rated energy up to 26,000 foot-pounds can be used for timber piles with butt diameters of 15 inches or more. Specific guidance for selecting the size of diesel hammers is provided in table 3-1.

- Except for diesel hammers, the size of the hammer selected should be one in which the desired energy is developed by heavy rams striking at low velocity. A high velocity impact wastes a large amount of the striking energy. It also deforms the pile head leaving less energy available for the useful purpose of driving a pile.

- The energy of a diesel hammer is developed by a combination of the falling of the ram, compression of the air in the combustion chamber, and the firing of the diesel fuel. This combination eliminates

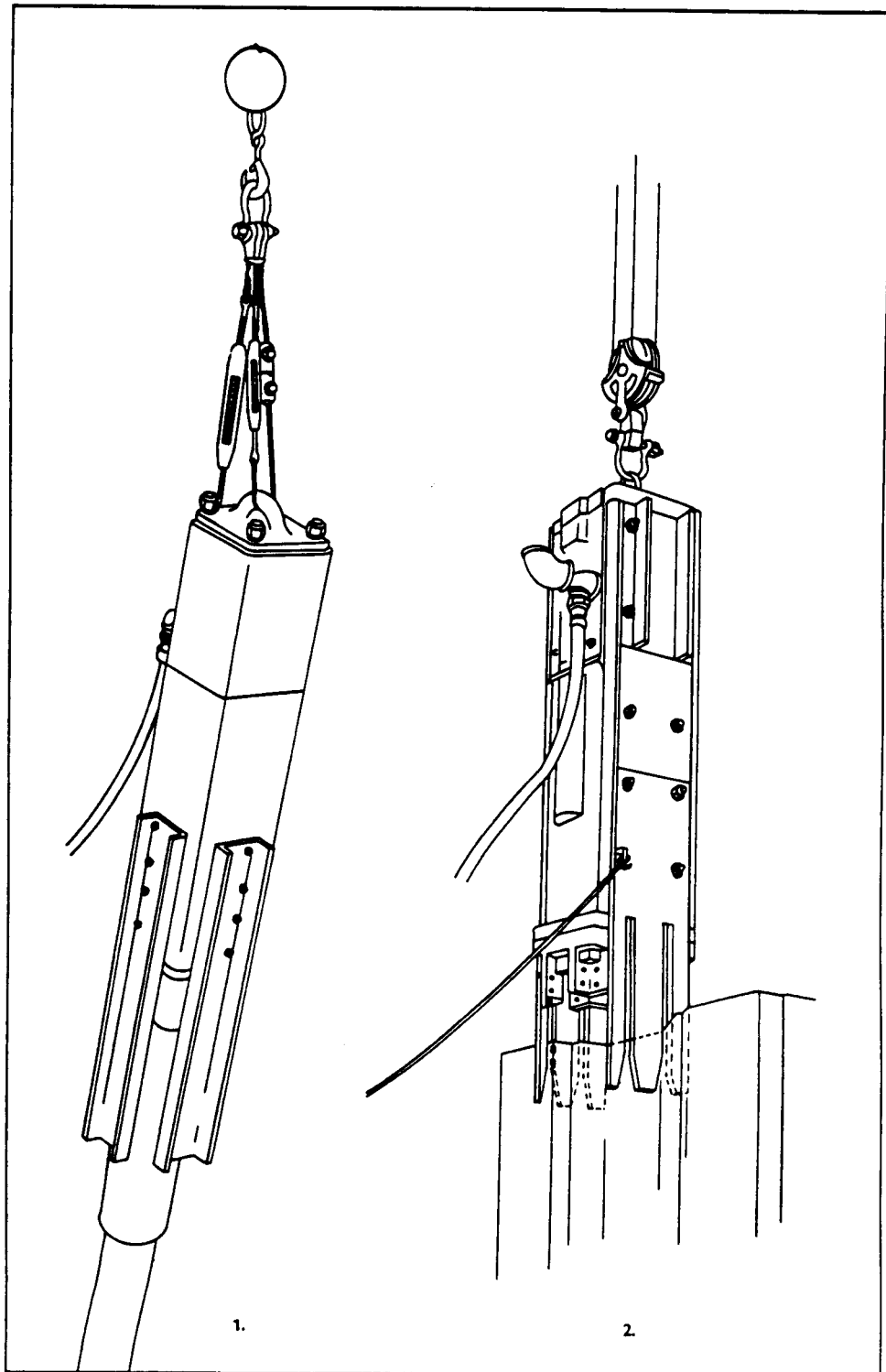


Figure 3-21 Improvised devices for aligning hammers without leads

the need for a heavy ram at a low velocity and depends only on sufficient energy to properly move the pile.

- With air or steam hammers, a double-acting or differential-acting hammer is preferred when piles must be driven to considerable depth where penetration per blow is small. The greater frequency of blows give faster penetration.
- The simple-acting hammer can be used where the soil above the bearing stratum can be penetrated rapidly under easy driving conditions.

- For driving precast concrete piles, a heavy ram with low impact velocity is recommended. When driving is easy, hammer blows should be minimized until resistance develops. This may avoid stress waves that might cause cracking.

3-14. Equipment assembly.

Skill and caution are required in the erection of pile-driving equipment. Assembly information is not within the scope of this manual. For comprehensive assembly instructions, consult the operator's manual for the pile-driving equipment to be used.