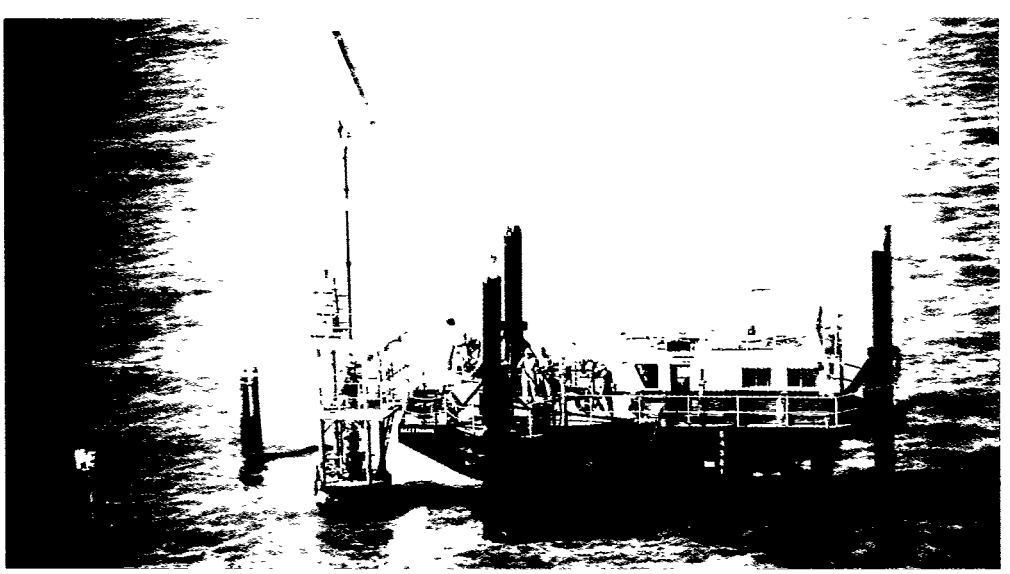
WIRELINE OPERATIONS AND PROCEDURES

THIRD EDITION

BOOK 5 OF THE VOCATIONAL TRAINING SERIES





EXPLORATION & PRODUCTION DEPARTMENT
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WIRELINE OPERATIONS AND PROCEDURES

Third Edition

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Exploration & Production Department

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FOREWORD

The third edition of this manual was written to update and outline the application of the various wireline tools, equipment, and operations in the oil and gas industry. The manual does not cover all aspects of the subjects presented. Instead, the basic applications and principles of wireline work are covered in a simple and uncluttered manner.

This manual should be used as an introduction and guide to wireline operations, not as a comprehensive treatise. An individual wishing to learn more should go to the specialized training texts or programs used by the various wireline companies.

Wireline equipment use and technology has been growing steadily, along with significant improvements in wireline capability. This was a natural evolution resulting from the variety of geographical frontiers and well conditions in which the industry operates today, i.e., offshore, arctic areas, deserts, inland waters, etc.

Chapter 1 contains a brief review of early wireline work and a description of surface equipment used in performing various wireline operations. Tool strings and service tools are described in Chapter 2. Subsurface equipment used in completion operations and production control is covered in Chapter 3. Wireline operations, including offshore procedures, are outlined in Chapter 4. Illustrations are used throughout this manual to make the words easier to understand.

Preparation and review of all material in the third edition of this manual — the fifth in the API Vocational Training Series of publications dealing with various oilfield operations — was accomplished by a Task Force appointed by the API Executive Committee on Training and Development.

Other publications in the API Vocational Training Series are:

Book 1: *Introduction to Oil and Gas Production*, American Petroleum Institute, Production Department.

Book 2: *Corrosion of Oil- and Gas-well Equipment,* American Petroleum Institute, Production Department. (Sponsored jointly by National Association of Corrosion Engineers and American Petroleum Institute.)

Book 3: *Subsurface Salt Water Injection and Disposal,* American Petroleum Institute, Production Department.

Book 6: *Gas Lift,* American Petroleum Institute, Production Department, 1994.

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CHAPTER 1
SURFACE EQUIPMENT

INTRODUCTION

Wirelines have been in use since the early days of the oil and gas industry. The development of surface equipment for solid wireline operations has kept pace with the development of new methods and tools used in well completion, remedial and work-over operations. Solid wireline is used for depth determination, deviated hole surveys, temperature and pressure surveys, paraffin cutting, and cementing operations. Solid wireline may also be used to set, retrieve, and manipulate chokes, circulating plugs, gage cutters, swaging tools, safety valves and gas-lift valves.

As the oil industry grew from the first shallow well in Titusville, Pennsylvania in 1859 to the first producing well on the Outer Continental Shelf in the Gulf of Mexico in 1947, wireline servicing also grew in complexity. Since then, wireline operations have kept pace with industry needs for work in deeper and more corrosive wells, deviated holes, and wells drilled in deeper water offshore.

The expansion of oilfield activities from conventional terrain to marsh, muskeg, desert and offshore locations has required mobility in wireline equipment for proper servicing.

In the early days of solid wireline operations few problems occurred with mobile equipment. Trucks with wireline winches, skid-mounted equipment, and fixed units mounted at strategic locations handled most solid wireline work. The truck is now the primary transport vehicle for wireline land operations.

Wireline equipment was later moved to inland water and marsh locations by mounting the equipment on speed boats, tugs, or small barges. Today a diesel powered shallow water spud boat, with a built-in hydraulic system that controls the wireline spool as well as the boat spuds, is usually used in bayous, streams, marshes or lakes.

As oilfield development moved offshore, equipment and methods of transportation changed. Self-propelled jackup vessels are ordinarily used on shallow water locations. The jackup vessel is built on the same principle as a spud barge, except that the spuds are replaced with long legs to jack the boat out of the water. This enables the crew to work in rough seas and water depths of up to a hundred feet or more.

In remote offshore areas a specially designed skid-mounted diesel-powered wireline unit with built-in hydraulic pumps and motors is used. The unit is transported to the offshore platform or rig on a supply boat and lifted onto the platform by a crane.

Drilling and completion of oil and gas wells in desert terrain is accomplished by mounting the equipment on large-wheeled vehicles (trucks or cars) capable of driving in soft sand. Wireline equipment is moved to desert locations the same way.

Weather conditions in arctic areas call for specially designed cold weather units; however, these are also easily transportable by truck to remote locations.

Since early days when the operator used a small hand crank and spool containing a short length of solid wire, many mechanisms have been developed for supplying the power source to turn the wireline spool. When the solid wireline proved a practical means of depth determination, and the need for greater depth runs developed, the power source also changed. Many new methods of rotating the reel came into use, such as: gasoline engines equipped with speed-reduction devices; diesel engines; electric motors; and hydraulic pumps and motors.

Due to fire hazard on offshore locations, a number of operators have restricted the use of sparking power sources and actuating devices. Diesel wireline units operating on the Outer Continental Shelf are required to be equipped with spark arrestor mufflers and shut down devices on the air intakes.

Transporting the wireline and associated equipment to a location is obviously a necessary part of the job. Surface equipment to be used at the wellsite is likewise an obvious necessity.

The surface equipment required to perform wireline operations depends largely on the well pressure and tubing size. Figure 1-1 shows the standard components used in a normal wireline operation on a well with less than 5000 psi surface pressure and 2½ inch ID tubing. The surface equipment list corresponds to the item numbers in Fig. 1-1.*

*A certain amount of flexibility must be considered when rigging up the surface equipment. The components are named and numbered only for identification by the reader as they are discussed in this chapter.

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WIRELINE

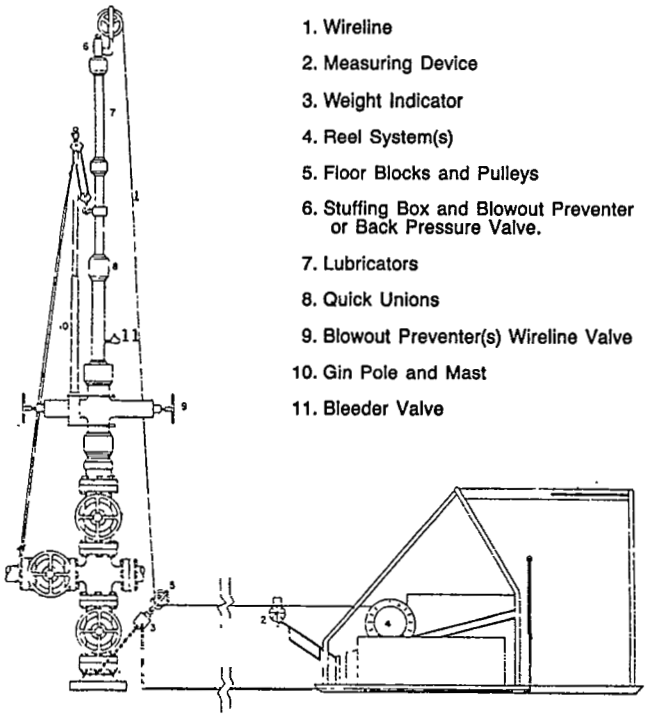


Fig. 1-1 — Wireline surface equipment (Example of an arrangement)

The earliest wireline used in measuring well depth was a flat steel tape with marked or stamped figures indicating footage, similar to a surveyor's tape. As well depths increased, tape of sufficient length became difficult to obtain. Correct depth readings were also a problem — stretching of the calibrated tape under load caused inaccurate measurement. When the flat tape was lowered into a well under pressure, the stuffing box and pack-off added to the problems. These disadvantages brought about the adoption of the solid wireline for depth measurements and pack-off control. The line was tagged at equal increments of length and the operator kept a record of the amount of line reeled in and out. Later, measuring devices with calibrated wheels came into use because they were more convenient and provided accurate measurements. The measuring device is discussed in detail later in this chapter.

Solid Wireline

Deeper wells and heavier loads imposed on the measuring lines necessitated development of high-strength steel wireline to minimize weight of the wire and size of the hoisting equipment. A small-diameter wire was developed with the following results:

1. Reduces the load due to its own weight.
2. May be lowered over a small-diameter sheave.

TABLE NO. 1
WELL-MEASURING WIRE SPECIFICATIONS
(Solid Wireline)

1		2	3	4	5	6	7
Nominal Diameter	in.	0.066	0.072	0.082	0.092	0.105	0.108
	mm	1.68	1.83	2.08	2.34	2.67	2.74
Tolerance on diameter	in.	±0.001	±0.001	±0.001	±0.001	±0.001	±0.001
	mm	±0.03	±0.03	±0.03	±0.03	±0.03	±0.03
Breaking strength							
Minimum	lb	811	961	1239	1547	1996	2109
	kN	3.61	4.27	5.51	6.88	8.74	9.38
Maximum	lb	984	1166	1504	1877	2421	2560
	kN	4.38	5.19	6.69	8.35	10.77	11.38
Elongation in 10 in. (254 mm), per cent							
Minimum		1½	1½	1½	1½	1½	1½
Torsions, minimum number of twists in 8 in. (203 mm)		32	29	26	23	20	19

*For well-measuring wire of other materials or coatings, refer to supplier for physical properties.

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3. May be wound on a small-diameter spool or reel without over-stressing by bending, keeping the size of the reel drum to a minimum.
4. Provides a small cross-sectional area for operation under pressure.

The most common diameter sizes of solid measuring line currently in use are: 0.066, 0.072, 0.082, 0.092 and 0.105 inch. Larger diameter line, 0.108 and 0.125 inch, are being used to some degree in wells with tubing strings larger than $2^1/_2$ inch ID. Measuring lines are available from the mills in one piece in standard lengths of 10,000, 12,000, 15,000, 18,000, 20,000 and 25,000 feet. The most popular material, because of its high ultimate tensile strength, good ductility and relatively low cost, is improved plow steel. Cold-drawn improved plow-steel measuring line has an ultimate tensile strength of approximately 230,000 to 240,000 psi. API Specification 9A, *Specification for Wire Rope** contains a section on well-measuring wire specifications. Table No. 1 contains requirements from API Spec 9A as well as information developed for this manual.

No wireline manual would be complete without mentioning Hydrogen Sulfide (H_2S) sometimes referred to as "sour gas", and Carbon Dioxide (CO_2). Many wells drilled in the past few years have been deeper completions in sour gas reservoirs. Severe corrosion, excessive temperatures and pressures — plus depth — have introduced many wireline problems that were unknown a few years ago. When corrosive components are encountered in a well, cold-drawn improved plow-steel lines may be affected by hydrogen embrittlement resulting in reduced service life. For service in hydrogen sulfide atmospheres, Type 316 stainless steel is recommended because of its resistance to hydrogen embrittlement. The ultimate strength of stainless steel measuring line is lower than that of improved plow-steel, its cost is appreciably greater, and it is less ductile. It is more susceptible to cold working which results in brittleness and reduction of service life. There are several methods which can be used in wireline operations to reduce or eliminate potential problems where corrosive environment is present. These methods are discussed in Chapter 4 — Wireline Operations.

Stranded Line

Stranded line is commonly used to replace solid line when line size is larger than 0.105-inch and added strength is required. This line is available in the following sizes: $^1/_8$ inch (0.125), $^9/_{64}$ inch (0.141), $^5/_{32}$ inch (0.156), $^3/_{16}$ inch (0.187), $^1/_4$ inch (0.250), and $^5/_{16}$ inch (0.312).

Wireline Handling

In order to realize good service and maximum life from wireline, it is necessary to take certain precautions in its handling and usage. Figure 1-2 shows the right and wrong practices when transferring or rewinding wireline.

1. Properly transferring the measuring line from the shipping spool to the reel is very important for extending the performance and service life of the line. Fig. 1-2(A) shows a recommended setup for rewinding so that the curvature of the line is not reversed. Fig. 1-2(B) shows an *improper setup.* Improper winding causes reverse bending of the line, making the line more difficult to handle, and causing it to kink and tangle. Fig. 1-2(B) shows a less desirable arrangement than Fig. 1-2(A) because it induces a partial reversal in the line, but does not affect the line as severely as the method shown in Fig. 1-2(C). Exercise caution in using this method, as there is a greater tendency for the line to cut into the wooden flanges of the spool, if it becomes misaligned. Line tension is increased by frictional drag of the spool on the ground. Best results are obtained when both spool and reel are mounted on horizontal shafts and spaced far enough apart to make level winding easier and reduce undercutting.
2. Avoid gripping the line with tools, such as pliers or hardened jaws. Nicking or gouging the surface of the wire can cause failure when the line is subjected to tensile and bending stresses.
3. Uncontrolled slack and resultant kinking must be avoided.
4. When retrieving the line from the well, clean the line of well fluids (See p. 8, Line Wipers), and give it a protective coat of oil as it is reeled onto the drum.
5. Do not pull a line beyond its elastic limit.
6. Before beginning a job or at frequent intervals during extended work periods, cut 15 to 20 feet of line off the spool and tie another knot.

There are times when a line may need changing because of

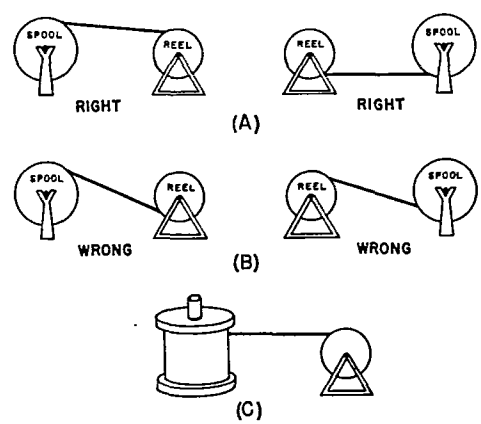


Fig. 1-2 — Recommended method for respooling or transferring measuring line.

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continuous use, damage, or lack of care. Some ways of detecting a bad line are:

1. When a line is laid out on the ground and does not form a coil or loop as on the drum. This indicates the line has exceeded its elastic limit and is considered a "dead" line.
2. When tying a knot, the wireline breaks easily. Remove a few feet of line and tie a new knot.
3. When kinks will not straighten out. This indicates the line has been subjected to extreme tensions or stress. Change the wireline.

MEASURING DEVICES

One of the most important pieces of wireline equipment is the measuring device, Fig. 1-3. It is a necessity on any job, whether it is simply measuring a shallow well with a lead weight on the end of the measuring line, a delicate logging survey, or the intricate setting or retrieving of a variety of special tools in the deepest known wells. In order to perform any type of wireline operation efficiently and safely, the operator must know the location of the tool with relation to the wellhead or other reference point. Knowing the location of a tool as it approaches the wellhead during retrieval enables the operator to control its speed and bring it to a stop before hitting the wellhead sheave or stuffing box. This will help to prevent a fishing job or damage to the tool.

A mechanical measuring device that has proven accurate, rugged and reliable with minimum maintenance is one which holds the measuring line in slip-free contact with an accurately ground, hardened measuring wheel driving a counter or odometer for registering the linear units (meters or feet) of line contacting the measuring wheel. The measuring device is generally mounted on moveable supports to allow it freedom to move.

When the measuring wheel is worn, the counter or odometer will give false readings and the wheel should be replaced. If not replaced, damage could occur by the "shaving" of the wire from the grooves cut into the measuring wheel. During extended jarring operations, it is recommended the wire be temporarily removed from the assembly. This will prevent the stress associated with the repeated bending/straightening of the wire around the measuring wheel. In addition, counter wheels are wire size specific and are not interchangable. For larger sizes of wire (.105, .108 and .125") the counter wheel and stuffing box sheave diameter must be increased to prevent over-stressing the line which would cause hardening. Care should also be taken to avoid over tightening the pressure wheels, which would result in the flattening of the wire and reduced life of the line. Under tightening of the pressure wheels or worn counter wheels will give false odometer readings.

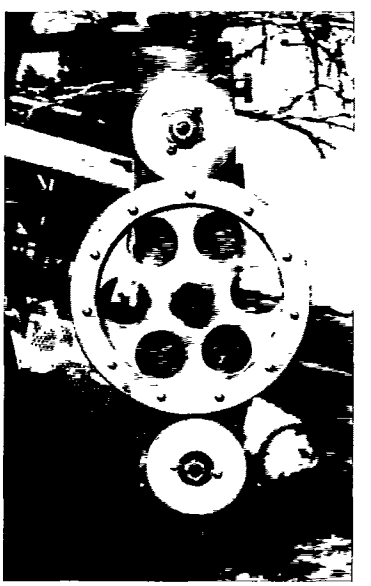


Fig. 1-3 — Measuring device

WEIGHT INDICATORS

In heavy-duty wireline operations when it is necessary to load the measuring line to its maximum safe load (usually in connection with mechanical or hydraulic jars), the use of some type of weight-indicating device is necessary. Various types in use are: Mechanical, Hydraulic and Electronic. A hydraulic weight indicator is shown in Fig. 1-4. These instruments are calibrated in pounds (or metric equivalents), and indicate the total load on the line at the weight indicator. These indicators are either incorporated into, or designed as attachments, to the measuring devices.

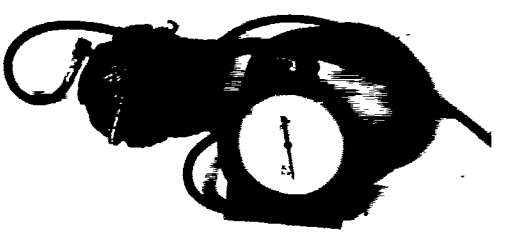


Fig. 1-4 — Hydraulic weight indicator

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REEL SYSTEMS

Wireline reels make it possible to conveniently and safely handle continuous measuring lines in performing wireline operations. Reels are necessary to transport the line from one wellsite to another without damage. Basically, the wireline reel is a spool of sufficient size to accommodate the required length of line to perform the job. The small measuring reels do not require a power source to lower a tool into the well. The weight of the line and tools is sufficient to unwind the line from the reel. However, all present day reels have provisions for some type of power source. On the larger reels where slow or constant speeds are desired, transmission or hydraulic brakes are used to lower the tool(s) into the well. Other necessary components on the reel assembly are: reel drum brake; clutch for disconnecting from the power source; power source start-and-stop controls; and speed controls where applicable. When a wide range of operating speeds is required, multi-speed mechanical transmissions are sometimes used.

Different types of measuring-reel mountings are:

1. Skid or base-mounted — portable (Fig. 1-5)
2. Truck-mounted — truck-engine-driven (Fig. 1-6)
3. Trailer-mounted (Fig. 1-7)
4. Boat-mounted — Engine-drive (see cover picture)
5. Automatic paraffin scraper mounted on wellhead.

On most current offshore wireline jobs, double drum units (two reels) are used. One is for routine wireline work, and has approximately 20,000 feet of 0.082-inch diameter solid line. On the other reel is approximately 20,000 feet of $^{3}/_{16}$ inch stranded line which is used for heavy pulling, such as swabbing or fishing operations. The reels and hydraulic controls are mounted on a separate skid from the power unit. Separation of the two is necessary to reduce the weight and ease the transfer from a supply boat to the offshore platform with a minimum size crane.

The newest type of single-reel hydraulic unit for a routine wireline operation is a compact system with the power section built on the same skid, because it is easily portable it is used extensively in offshore operations. However, because of its light weight it should always be properly secured to prevent movement and possible injury.

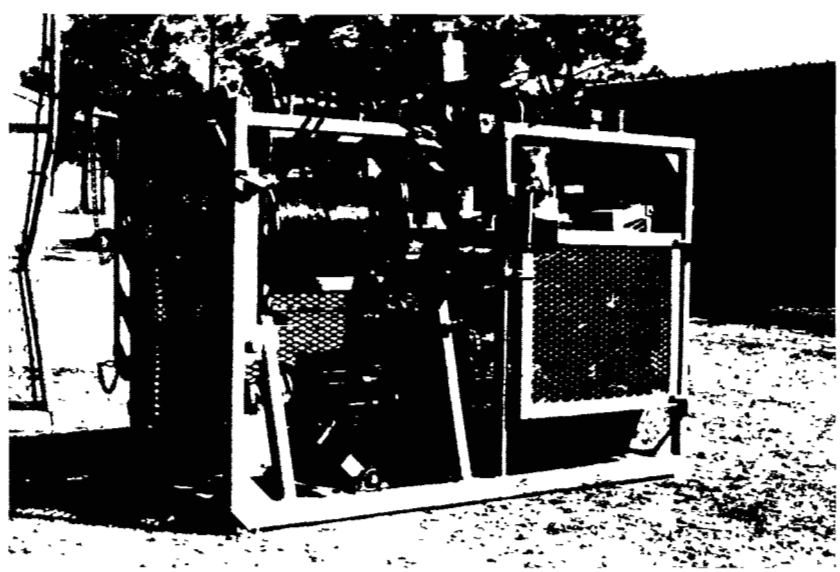


Fig. 1-5 — Skid or base-mounted (portable) measuring reel mounting

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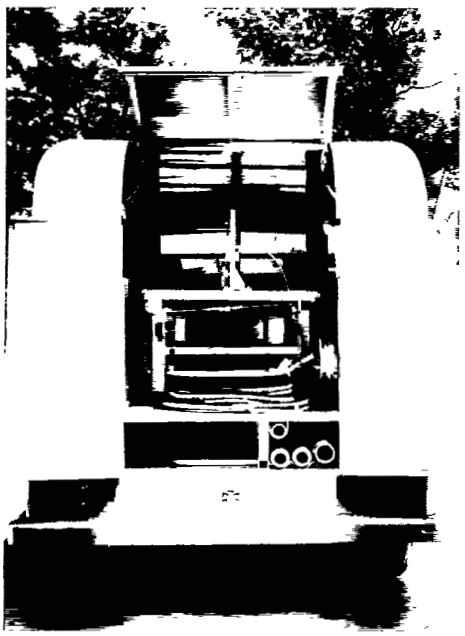


Fig. 1-6 — Truck-mounted — Truck engine driven measuring reel mounting

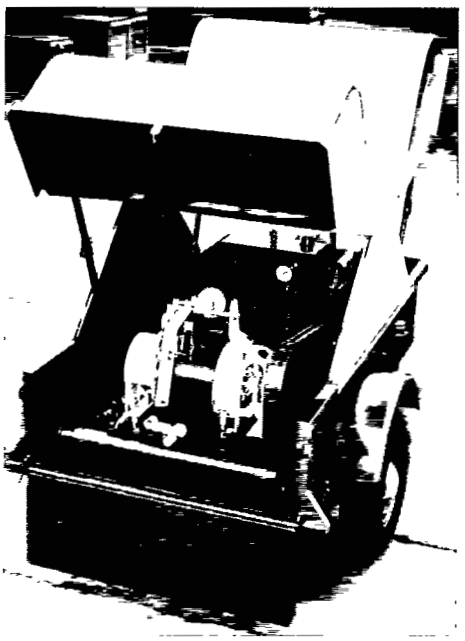


Fig. 1-7 — Trailer-mounted wireline reel

FLOOR BLOCKS OR PULLEYS

When the wireline is routed from the reel to the stuffing-box sheave, conditions may require changing the direction of the line several times. Floor blocks or pulleys with sheaves, properly sized to prevent over-stress in bending, are used for this purpose. Snatch-block type pulleys are generally installed on the line to keep from having to thread the end through the pulley supports, Fig. 1-8. Note that the pulley is attached to the load cell of the weight indicator. For accurate weight indicator operation the angle the wire makes around the pulley should be 90 degrees. Also position the pulley as close as possible to the lubricator to prevent side loading.

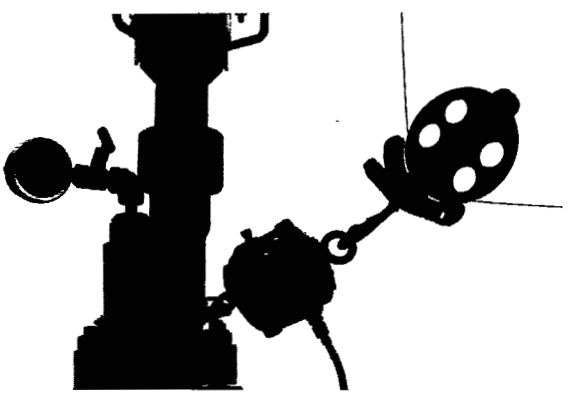


Fig. 1-8 — Snatch-block type pulley

STUFFING BOXES

Wireline stuffing boxes (Fig. 1-9) are used when it is necessary to perform work on a well under pressure. The stuffing box consists of a packing chamber with an external adjustable nut. The nut is either manually or hydraulically tightened to minimize leakage around the line resulting from well pressure. In most cases the stuffing box provides a swivel bracket and sheave which guides the measuring line down into the packing gland. The radius of the stuffing box sheave must also be changed to accommodate larger size wirelines.

Heavier stuffing boxes can be equipped with a bleedoff assembly and a place for setting a blowout preventer (not a wireline valve). The purpose of a blowout preventer is to shut-off the well flow through the stuffing box in the event the packing is cut, blown out, or the wire breaks.

When stranded line is used in wells under pressure, the multiple lays in the construction of the line make it difficult to seal off the well. For this reason, a stuffing box was designed with a grease seal. The grease is pumped into the stuffing box under pressure, forming a barrier against the flow of wellhead fluids or gases. This completely seals the flow and lubricates the line. This grease-seal stuffing box is used by all wireline companies (including electric line) whenever line is required.

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Fig. 1-9 — Stuffing Box

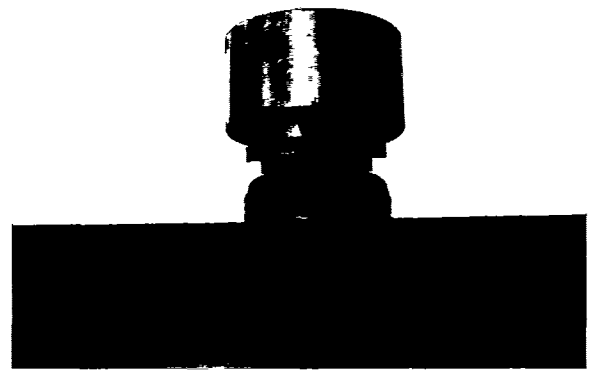


Fig. 1-10 — Quick union

LUBRICATORS

A lubricator may be described as a number of tubular sections of pipe assembled together with a stuffing box to pack off the wireline on top. The tubular sections are assembled on the ground (or platform) and held together with quick unions. The entire assembly is then raised to a vertical position above the wireline valve. The size and length of the assembly must accommodate the workover tools, any "fish" that might possibly be recovered, and have a working pressure rating equal to or higher than the string of pipe through which the tools are lowered. The lubricator is generally standard in length — just high enough to handle the longest string of tools between the wireline valve and the stuffing box and is easily transported to and from the location. For offshore wireline operations, the lubricator may be as long as twenty feet without the union connectors: however, most boats and platforms are equipped with either hydraulic gin poles or cranes so the length and weight present no problem.

Specially designed lubricators are used when problem situations arise, such as exposure to "sour gas" (Hydrogen Sulfide) or Carbon Dioxide. The lubricator is generally constructed of low alloy steel, heat treated and softened to comply with National Association of Corrosion Engineers (NACE) Standard MR-01-75, 1978 Revision, Section 11.9.5. Lubricators should be tested as referenced in 30 CFR 250 or API 14B. Test the lubricator to maximum anticipated well pressure, but do not exceed the manufacturer's recommended working pressure.

QUICK UNIONS

Quick unions are connectors which are screwed or welded on each end of all lubricator sections, and are designed with an O-ring type seal to hold the well pressure (Fig. 1-10). As a safety feature, one half of the union slips inside the other half union and is secured by a large nut which is screwed to the female half. It should not be disconnected while there is pressure on the lubricator.

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WIRELINE VALVES

The wireline valve is a ram-equipped device used on the wellhead to prevent or control blowouts, Fig. 1-11. In addition to providing positive protection against blowouts, the wireline valve is a means of isolating the well pressure from the lubricator without cutting or damaging the line. This is often necessary during wireline fishing operations. It is accomplished by manually or hydraulically pressing together a set of rams made of resilient packing to form a seal. Once the valve is closed, the lubricator can be bled off.After removing and changing wireline tools, the lubricator must be repressurized before opening the rams. This is done by opening a special equalizing valve on the side of the wireline valve. It allows the well pressure to be routed around the closed rams into the lubricator. Then the rams can be easily opened without damaging the tool string or lubricator. Regulation governing offshore wireline operations require the use of at lease one wireline valve. The valve should be pressure tested before beginning any job. Test the wireline valve to the maximum anticipated well pressure, but do not exceed the manufacturer's recommended working pressure.

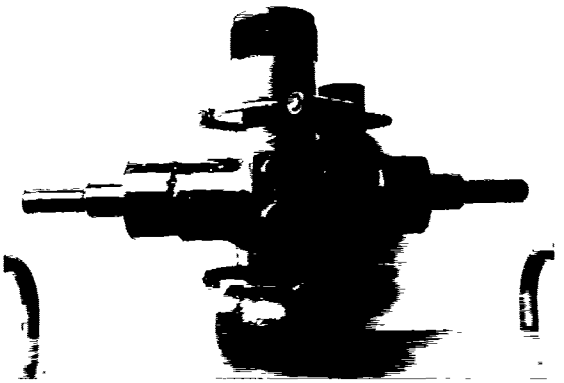


Fig. 1-11 — Wireline valve (Blowout preventer)

LINE WIPERS

When retrieving the wireline from a well, the fluid clinging to the line drips or is thrown off the floor blocks and pulleys, creating a possible safety, maintenance and housekeeping problem. Line wipers of various types generally do a very effective job of cleaning the line at or near the wellhead. One form of line wiper is a housing with an internal split neoprene rubber plug. This plug has a threaded bolt adjustment that compresses the rubber plug until it envelopes the line and strips it of fluid. This line wiper has a hinge pin to anchor it to the floor block or pulley frame for alignment on the line. Other types are built on the same principle as the stuffing box, containing packing and an adjustable gland for cleaning the line. Oil from the wiper should be collected in a suitable container.

GIN POLES OR MASTS

During wireline work-over operations when it is necessary to use tall high-pressure lubricators and heavy tool strings, removing and replacing the heavy loaded lubricator off and on the wellhead becomes a problem. A stiff leg, with a block and tackle, electric hoist, or mast-type structure (Fig. 1-12) mounted on a truck is sometimes used to handle the lubricator. When the work is performed on a rig, an air hoist or cat line can be used. Wireline boats have a special mast or crane to do the job. On offshore platforms, a platform crane, or an A-frame type structure over the well is used. However, it is recommended that a gin pole and a block and tackle be available as a backup, in the event other means of lifting is not available.

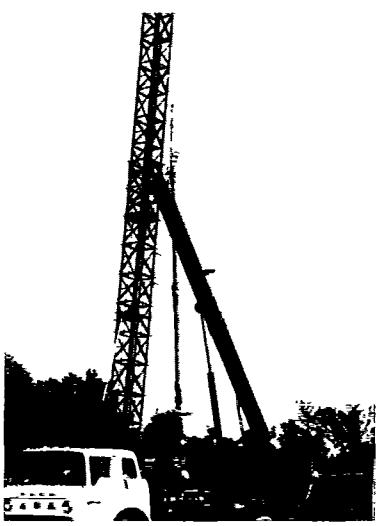


Fig. 1-12 — Truck mounted rig

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CHAPTER 2
TOOL STRING AND SERVICE TOOLS

INTRODUCTION

Various tools frequently used in wireline operations are described in this chapter. Descriptions of special fishing tools are included, along with their application to fishing jobs which sometimes occur during wireline operations.

WIRELINE TOOL STRING AND SERVICE TOOLS

Wireline Socket

The wireline (rope) socket (Fig. 2-1) fastens the wire to the tool string. The most common rope socket consists of a body, spring, spring support, and disc. The body is bored to accommodate the inner parts, accept the wireline through the upper end and the stem from below. Near the upper end is a fishing neck that accepts pulling tools in standard sizes. Above the fishing neck, the body is tapered to guide the pulling tool and facilitate its engagement. The flat on the upper end is a striking surface to prevent peening the metal and closing the wire hole, if the socket is subjected to jarring during fishing or other operations.

The spring acts as a shock absorber to prevent the knot from failing under severe impact, as during jarring operations. The spring support centers the disc and the load so that the force applied is a straight pull.

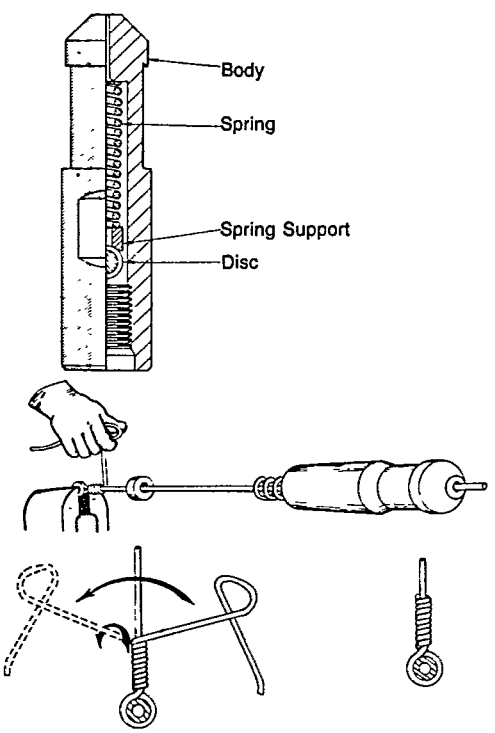


Fig. 2-1 — Wireline (rope) socket and knot-tying techniques

The wireline is fastened to the disc which is grooved around its entire circumference. This groove is deep enough to prevent damage to the line when the disc comes to bear against the spring support. To absorb the punishment to which it may be subjected, the knot fastening the wire to the disc must be tied with great care.

Stranded Line Socket

The stranded line socket serves the same purpose as the wireline socket. It provides the means by which a stranded line is fastened to the tools. It is secured by babbitt instead of being tied around a spool. Slip type rope sockets (Fig. 2-2) are designed to be used with small stranded lines, through $^{5}/_{16}$ inch diameter.

In some instances a rope socket with no knot may have to be used on conventional solid wireline. Conditions such as sour service require using a special metallurgy solid wireline which does not have much capability to withstand torsion effects. A no-knot or wedge-type rope socket similar to the stranded line socket should be used in these cases. However, remember to include a knuckle joint below the rope socket to provide the needed swivel action.

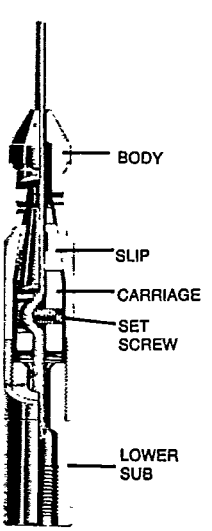


Fig. 2-2 — Stranded Line Socket

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Wireline Stem (Weight Bars)

The stem (Fig. 2-3) provides the weight to pull the wireline tool string into the well. The stem also adds the needed weight for jarring operations or shearing metal pins which release running and pulling tools. The stem's influence may be increased or decreased by changing its total weight, i.e., the total number of lengths of stem. To increase weight without increasing length, weighted stems are sometimes used. These are made by using a good grade of 4140 or similar steel tubes and filling them with lead. Box and pin ends are then screwed on the ends and welded in place to keep them from backing off. A stem is essentially a round rod with a pin connection and fishing neck at the upper end, and a box connection at the lower end. Stems can be provided in outside diameters of 3/4 in. 1 1/4 in., 1 1/2 in., and 1 3/4 in. They are usually made in 2-ft, 3-ft, or 5-ft lengths.

Stems also have special applications. They may be used as spacers when it becomes necessary to position tools at a higher level in the tubing. For instance, in perforating operations where a tubing stop has been set, the stem will space the perforation at a slightly higher level, if desired. A stem may also be placed immediately below jars to position them at a higher level in the tubing string when there is a possibility of their being fouled by wire during fishing operations. Other uses will be discussed later in the chapter.

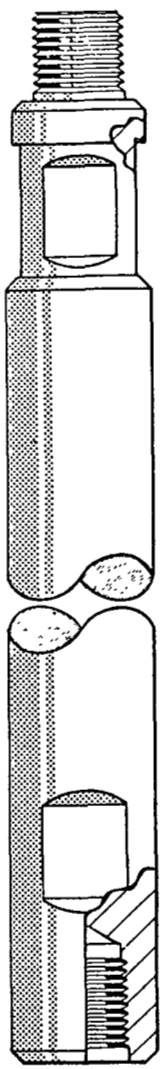


Fig. 2-3 — Wireline stem

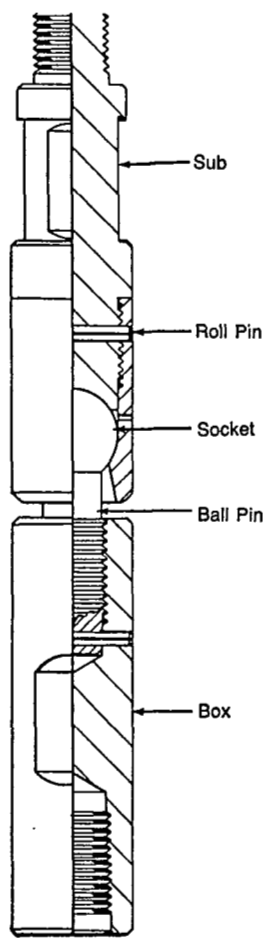


Fig. 2-4 — Knuckle joint

Knuckle Joint

The knuckle joint (Fig. 2-4) is similar to a stem, but has a ball swivel in its mid-section. Its purpose is to provide flexibility in the string of tools to facilitate taking hold of various tools, and to enable the tools to pass through crooked tubing where they might otherwise be fouled. The knuckle joint, when used in the string of wireline tools, should be immediately below the jars where flexibility is important. If crooked tubing is encountered, knuckle joints may be placed between the stem and jars; and, in extremely crooked tubing, between the individual stems.

The knuckle joint should be inspected frequently to make certain that the threads and ball and roll pins are in good condition. If the roll pins become loose, the tool should be sent in for rebuilding to prevent its coming apart in the well.

Wireline Jars

The purpose of the wireline jar is to provide a means of striking the wireline tools while they are in the well. The striking force can be either up or down. Stroke jars, tubular jars, and hydraulic jars are the most common, and they are available in various sizes and strokes.

Stroke jars (Fig. 2-5) are of the cable-tool type and use the weight of stems, connected immediately above, to deliver effective jarring impacts by manipulation of the wireline at the surface. Their effectiveness is largely dependent upon the weight of the stem and length of the stroke. However, the size and depth of the tools, density and viscosity of the fluid in the tubing, well pressure, and even wireline size are factors which must be considered. Stroke jars are composed of two pieces linked together much like long chain links. They are free to be extended or collapsed. In use, a string of tools consists of a wireline socket, one or more stems, wireline jars, and some form of operational tool (running or pulling tool, etc.) This tool string is lowered into the well bore on a solid steel measuring line. By manipulating the wireline at the surface, the jars may be extended or collapsed. If they are extended gradually or gently and permitted to collapse abruptly, a downward blow will be delivered. If extended abruptly, an upward impact will result.

The use of 1-1/2 in. outside diameter (OD) stroke jars in pipe larger than 2-1/2 in. inside diameter (ID) is not recommended, as this may allow the jars to bow or buckle and cause a "scissoring" of the two sections thereby preventing them from entering restricted openings. This is especially true when they are used in casing below a string of tubing.

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Tubular jars (Fig. 2-6) are ordinarily used in connection with jarring in casing or large tubing, during fishing or sandbailing operations. The jar is tubular in construction, and the tube section is perforated for fluid bypass when the plunger is moved up or down.

Hydraulic jars (Fig. 2-7) are designed for upward jarring only. The impact of the stroke is proportional to the strain on the wireline and the weight of the stem section used above the jars.

Since hydraulic jars do not permit downward jarring, mechanical jars are run in conjunction with and usually below them to provide for downward jarring action. Then, too, if the hydraulic jars fail to function properly because of loss of fluid or gas filtering into the chamber, the mechanical jars may be used to complete the operation. The hydraulic jar consists basically of an oil-filled body, machined internally over a portion of its length to restrict the movement of a tight fitting piston. As the piston moves upward through the body, it delivers the jarring stroke. A balanced piston in the lower body section maintains equalized pressure with the outside hydrostatic pressure. As strain is taken on the line, the piston movement is comparatively slow through the restricted body section because of the smaller annular clearance for the oil to bypass the piston. The jarring stroke occurs as the piston reaches the larger internal body area where the oil bypasses easily to provide rapid movement of the piston against the body insert. After the jar has been tripped, the weight of the stem collapses the piston for another stroke. Hydraulic jars should be checked by collapsing the mandrel, then pulling on the top sub while holding the lower sub. If the mandrel moves easily or has a springing action when released, the jar is not functioning properly and should be repaired.

Knuckle jars (Fig. 2-8) are items of accessory equipment on wireline units and are similar in construction to the knuckle joint. The difference is that the knuckle jar has a floating ball within a 4-in. socket and, in effect, is a tubular jar. Knuckle jars are commonly used as a means of jarring the stem loose



Fig. 2.5 — Stroke jar

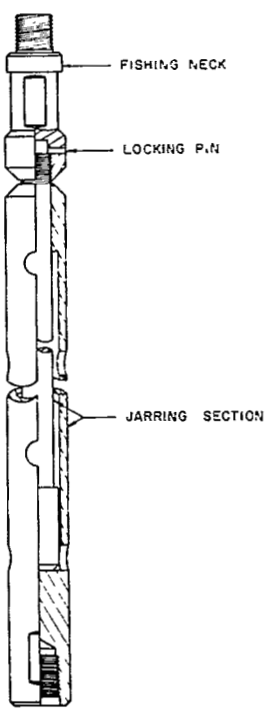


Fig. 2-6 — Tubular jar

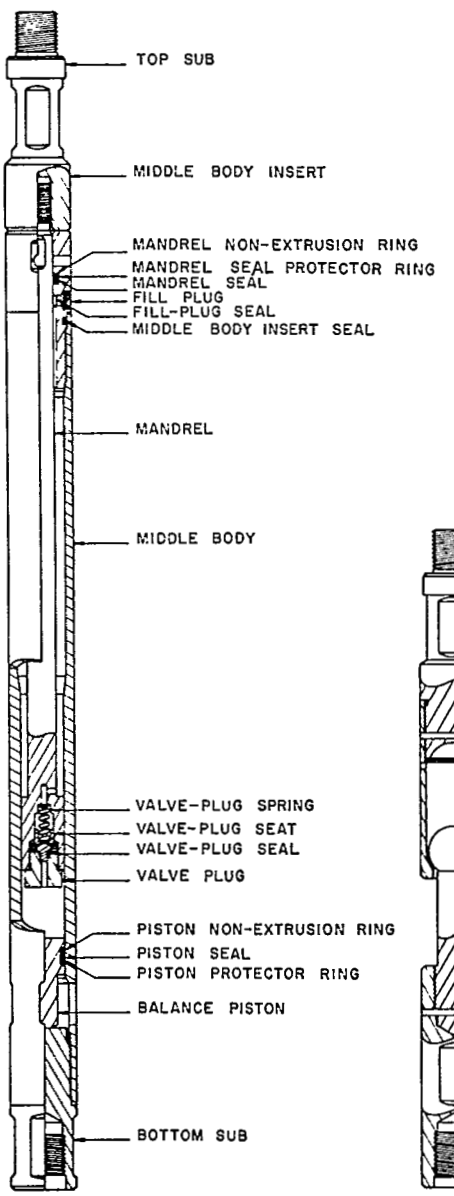


Fig. 2-7 — Hydraulic jar

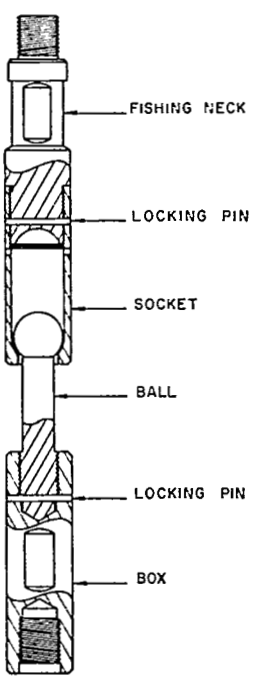


Fig. 2-8 — Knuckle jar

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from wedged places in the tubing when mechanical jars are fouled. With proper handling, the knuckle jar can be used to advantage as a jarring mechanism, but is not recommended for such use except in an emergency.

The explosive jar strikes downward with an explosive force that drives a hammer. (The knuckle joint and upper barrel of the perforator are used for the explosive force.) It can be reloaded and used again. The main purpose of this jar is to strike a hard downward blow when it is necessary to knock loose a stuck choke or similar control. It can also be used to put a hole through a bull plug or to take a deep impression with an impression block. It is almost impossible to get a mechanical jar to hit hard enough to loosen a stuck choke in an extremely deep or crooked hole. The explosive jar can therefore be of great value.

The tension jar accomplishes the same purpose as the hydraulic jar, except that this jar is spring loaded and the action is mechanical rather than hydraulic.

TUBING CONDITIONING TOOLS

Tubing Gage

A tubing gage (Fig. 2-9) should be run prior to running or pulling a subsurface control. This assures the operator that the tubing is unobstructed. This tool may also be used as a paraffin cutter.

Paraffin Scratcher

There are several types of tools used to cut or scratch paraffin. Fig. 2-10 shows one type of paraffin scratcher. It can also be used to scrape the tubing wall, clean landing nipples, and fish small pieces of wireline loose in the well. It is usually run before running the tubing gage.

Tubing Swage

A tubing swage (Fig. 2-11) is designed to swage out tight or mashed places in the tubing string. The outside diameter of the swage is the same as the drift diameter of the tubing.

Tubing Broach

A broach is a tool run to remove metal burrs and imperfections from the tubing wall prior to running or pulling service tools. It is equipped with graduated rings, diamonds, or segments that are case hardened and highly sharpened. One form of tubing broach is shown in Fig. 2-12.

Blind Box

A blind box (Fig. 2-13) is a service tool used when heavy downward jarring is required. The tool is flat on the bottom and hardened so as not to damage easily.

Impression Block

An impression block (Fig. 2-14) is a lead or babbit filled cylinder with a pin through the leaded section to prevent losing the lead. This tool is used during fishing operations to ascertain the shape or size of the top of the fish and may indicate the type of tool necessary for the next operation.

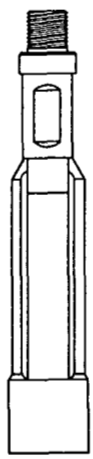


Fig. 2-9 — Paraffin cutter or tubing gage

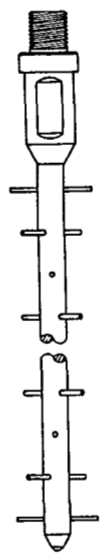


Fig. 2-10 — Paraffin scratcher

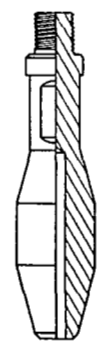


Fig. 2-11 — Tubing swage

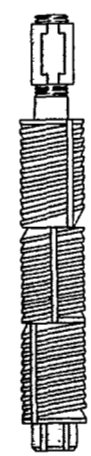


Fig. 2-12 — Tubing broach

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Fig. 2-13 — Blind box

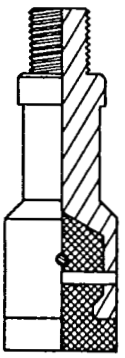


Fig. 2-14 — Impression block

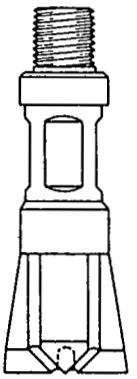


Fig. 2-15 — Star bit

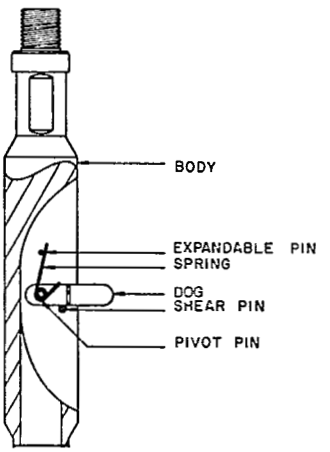


Fig. 2-16 — Tubing end locator

Star Bit

The star bit (Fig. 2-15) has blades on the bottom to cut or break up debris in the hole to drive the debris through an intended workover interval.

Locator Tools

These tools are designed to locate seating nipples, the bottom of the tubing, and the bottom of the well bore all in one wireline trip.

The tubing-end locator (Fig. 2-16) is used to accurately locate the end of the tubing string. Before the tool is run, it is imperative that tubing is cleared by running a tubing gage or bailer. This ensures that the locator will pass through the end of the tubing. A paraffin scratcher may also be used to locate the end of the tubing, eliminating the need for the tubing-end locator.

Sand Bailer

The sand bailer (pump type, Fig. 2-17) is designed to remove sand, mud, salt, paraffin, shale, or other debris from the tubing or casing. It may also be used as a bottom hole sampler.

Hydrostatic Bailer

The hydrostatic bailer (Fig. 2-18) is a cylinder or barrel about 5 ft. long, with a shear disc mechanism on bottom. The cylinder is sealed off from well pressure with O-rings, and is lowered into the well at atmospheric pressure. When the obstruction is reached, the shear disc is broken by downward jarring. This sheared disc allows the full well pressure and hydrostatic head to enter the cylinder with a sudden surge. The sand or debris is prevented from falling out by a check. This tool should be used only when attempting to remove debris from above a subsurface control or some object that will prevent it from burying itself. (See page 40)

Wireline Spear

The wireline spear, or grab (Fig. 2-19) consists of a housing with one, two, or three prongs with pointed barbs welded to the inner side. This tool is used to fish wireline that has broken in the well.

Wireline Retriever

This tool (Fig. 2-20) consists of a slotted guide and skirt, with a tapered spear point connected to a moveable inner mandrel. The full gage skirt forces the "straight standing" end of the broken wire past the spear point and slotted guide. When the inner mandrel is moved up, the wire is locked on the slip. This tool is especially useful and necessary when fishing for embrittled wire because retrieving does not require bending or crimping the line.

Magnetic Fishing Tool

The magnetic tool is used to fish from the well bore any small metallic object that would be attracted to a magnet.

Non-Releasing Pulling Tools

The non-releasing pulling tool is designed to fish cylindrical necks or tools that have no standard fishing neck. It should only be used in a final effort to retrieve subsurface devices when other releasing tools have failed. There are several types available. One is an overshot, shown in Fig. 2-21. It should be run with a rope socket and in conjunction with a releasing pulling tool to give the operator the advantage of being able to shear off at the pulling tool if needed.

Releasing Pulling Tools

Pulling tools are used to retrieve subsurface tools that have a standard fishing neck. They consist of a skirt and multiple dogs screwed onto a spring loaded core. The core has a brass or steel shear pin, which can be sheared by either jarring up or

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down, depending on the type of tool. Jarring releases the pulling tool from the subsurface tool when it cannot be retrieved. These tools can be repinned many times to add or subtract stem, or change the tool hookup before running back in the well.

Kickover Tool

The kickover tool is used to selectively locate mandrels that house retrievable side-pocket equipment. They can be of either orienting or non-orienting design.

Cutter Bar

A cutter bar is a stem with a blind box attached to the bottom. It is used to cut off line at the wireline socket.

Go-Devil

A go-devil is a slotted stem with a fishing neck. It is used when the tool string is entangled in or below the wireline. This fishing tool is illustrated in Fig. 2-22 and its operation described in Chapter 4.

Wireline Cutter

The wireline cutter (Fig. 2-23) utilizes a small cylindrical knife section within a slotted body to cut any solid line either within or below the tubing by simply attaching the slotted assembly around the line and dropping it into the tubing. The line is cut as the tapered knife and snipper move together upon impact against the wireline socket or a solid object.



Fig. 2-17 — Pump-type bailer



Fig. 2-18 — Hydrostatic bailer



Fig. 2-19 — Wireline spear

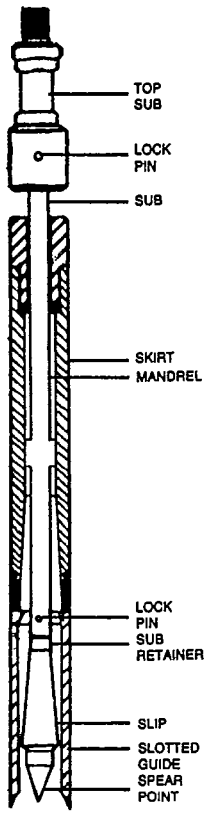


Fig. 2-20 — Wireline retriever

Sidewall Cutter

This tool is equipped with knives that overlap a tapered mandrel to cut the line against the tubing wall. It is used when the tools are stuck, the line has not parted, but the tools have been blown up the hole. It can be run with the tool string and set at any point in the tubing. Fig. 2-24 is a diagram of a sidewall cutter.

Shifting or Positioning Tool

The shifting or positioning tool is used to open or close a sliding side door or sliding sleeve. It may also be used as a nipple locator. Several types are available.

Tubing and Casing Caliper

Calipers are instruments for detecting and recording the internal condition of the tubing or casing. They may be run on wireline under pressure. Typical caliper instruments are shown in Fig. 4-10.

Bottom Hole Pressure Gage (Bomb)

This instrument is used to record bottom hole pressure and temperature. It is usually run on a conventional wireline.

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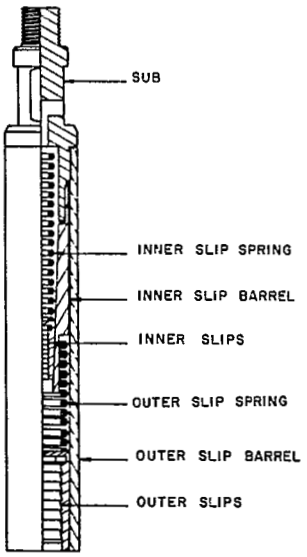


Fig. 2-21 — Overshot non-releasing pulling tool

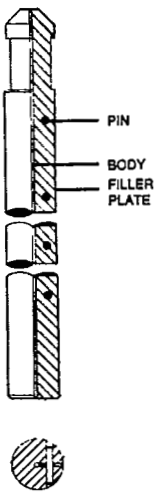


Fig. 2-22 — Go-Devil

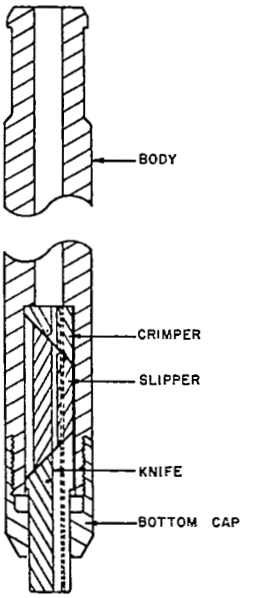


Fig. 2-23 — Wireline cutter

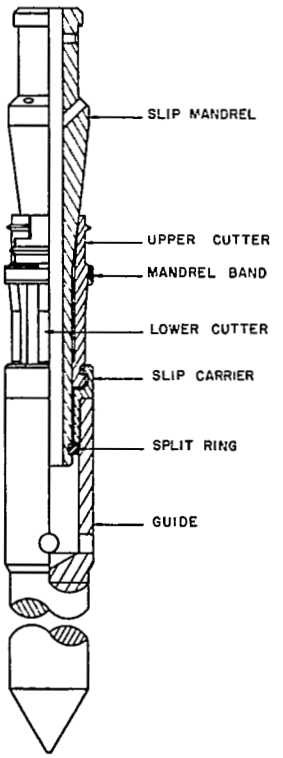


Fig. 2-24 — Sidewall cutter

Alligator Grab

The alligator grab is a tool used to pick up small objects that may have been accidentally lost or dropped in the well. It is designed with jaws similar in shape to those of an alligator, which are pinned open before running into the well. These jaws snap closed when contact is made with the fish, and are held closed by the tension of a coiled spring.

Tubing Perforator

This is a tool run on wireline to perforate a hole in the tubing to perform remedial work. Both mechanical and explosive type perforators are available. The tool is more fully described in Chapter 4.

Choke Extractor

The extractor was primarily designed to pull side-door chokes when pressure in the casing-tubing annulus is greater at the landing nipple than the pressure inside the tubing.

The choke extractor (Fig. 2-25) is pressure-operated and is used in conjunction with pulling tools. It consists of a sub to attach a pulling tool, a fishing neck, an equalizing sub, two choke cups which are mechanically expanded, and a spring-loaded ball which prevents flow through the extractor.

In wireline operations, when the foregoing conditions exist and normal pulling operations are used, a pressure over-balance in the casing causes the tools and side door to be blown up the hole and the wire to ball up when the lower packing passes over the side-door ports.

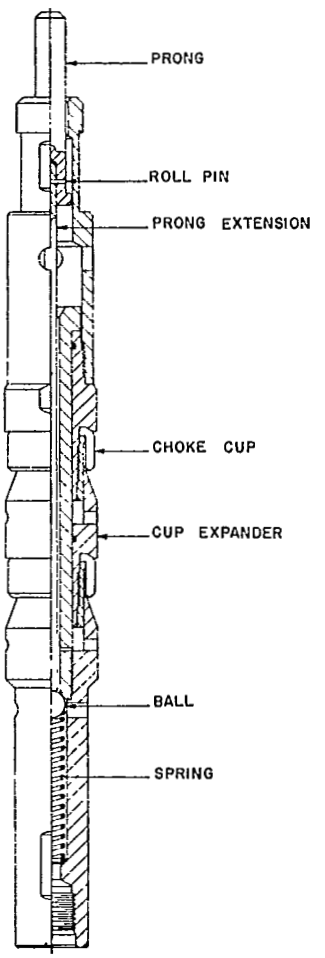


Fig. 2-25 — Choke extractor

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