Wire Rope--Past, Present and Future

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HISTORY OF MANUFACTURE

HISTORICAL record and research tell us that a form of wire-making dates back to around 5000 B.C. This early wire was not like the wire we have today, as it was made by hammering out thin sheets of copper or gold and shearing off narrow strips. About 4100 years later, it was found that the usefulness of these strips could be increased by pulling them through a half-round, or at least a partially rounded, notch or groove in some hard material to remove the sharp edges.

The assembling of several wires into one strand to make a rope dates back to around 800 B.C. A bronze rope of this period was unearthed at Nineveh in Asia and is now in the British Museum. This rope (or strand) consists of parallel wires bound together at intervals so that they could be used as one unit.

The development of a helical (twisted) rope, formed of helical strands, dates back to about 500 B.C., according to the evidence given by a rope believed to have been made at this time, which was uncovered in the ruins of Pompeii. This rope consists of three strands twisted together; each strand, in turn, consisting of several bronze wires twisted together.

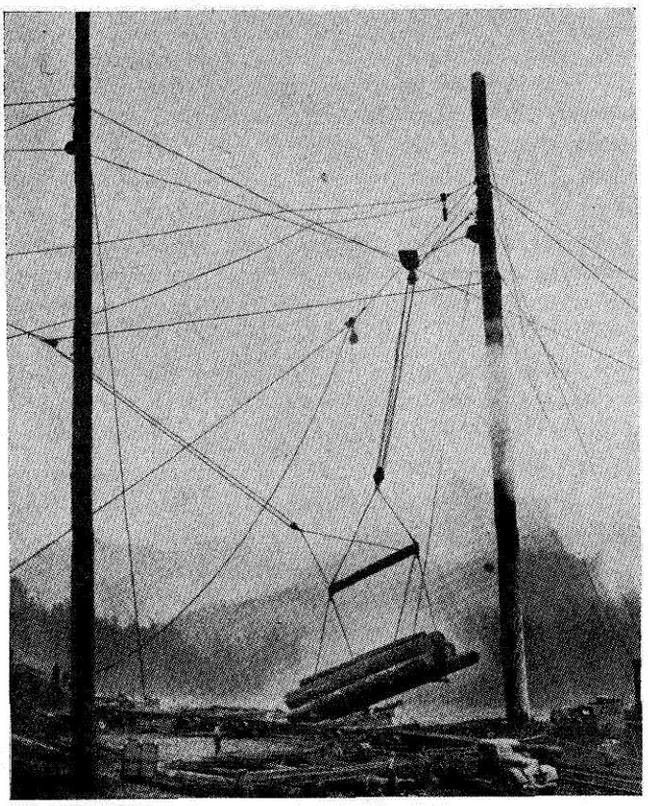

Figure 1. A typical logging wire rope setup

A 15 foot piece of this rope is now in the Naples Museum.

Many years then elapsed before the records indicate any further developments. Sometime between the sixth and tenth centuries A.D. a method of drawing soft square rods through round holes in iron drawplates to form wire was developed. This drawing, however, was done by hand and was a very slow and tedious process. A mechanical method of drawing wire was not developed until 1351. Still later (A.D. 1600), a method of drawing hard steel wire was developed in Germany, although it was still done from square rods, sheared from hammered or rolled sheets. In 1728 a Frenchman, by the name of Fleuer, is said to have made round rods by the use of grooved rolls, and thereby materially aided the drawing of wire.

Around 1830 the use of wire rope was given a big boost by the invention in England of the "Steam Plough," consisting of two ploughing engines which traveled down opposite sides of a field, pulling a plow back and forth by means of a wire rope. The use of these "ploughs" was greatly incrased as better grade and cheaper steel for wire ropes was made available by the development of the Bessemer process in 1855, and the development of the open hearth process in 1862. These "Steam Ploughs," by the way, give us the origin of the term "Plough" Steel (or Plow Steel, as we know it today.)

All of these early ropes were made by hand on rope walks, where a number of wires were laid out, then twisted into strands by men walking along with a device for rotating one end of the group of wires. The process was then repeated on a group of the strands to form a rope. The rope-making process was gradually mechanized and speeded up to the present rates of as high as 5,000 feet of finished rope per hour, in continuous lengths of 40,000 feet to 50,000 feet and greater.

IMPORTANCE IN WORLD WAR II.

Wire rope was used in so many ways by our armed forces that its numerous applications will not be listed here. Instead, the experiences of a hypothetical draftee in his contact with wire rope during his tour of duty will be described.

As our man (we'll call him Joe) arrives at his training camp, fresh from the induction station, he is greeted by the sight of a huge camp under construction. He finds the ground being leveled off by bulldozers, scrapers, and carryalls, operated with wire rope; the buildings are being erected by cranes using wire rope, and supplies and equipment are being unloaded with wire rope slings. As Joe progresses in his training, he comes in contact with wire rope on the parachute training tower, on the desert equipment salvage truck, and on the big "Jiminy," or surf

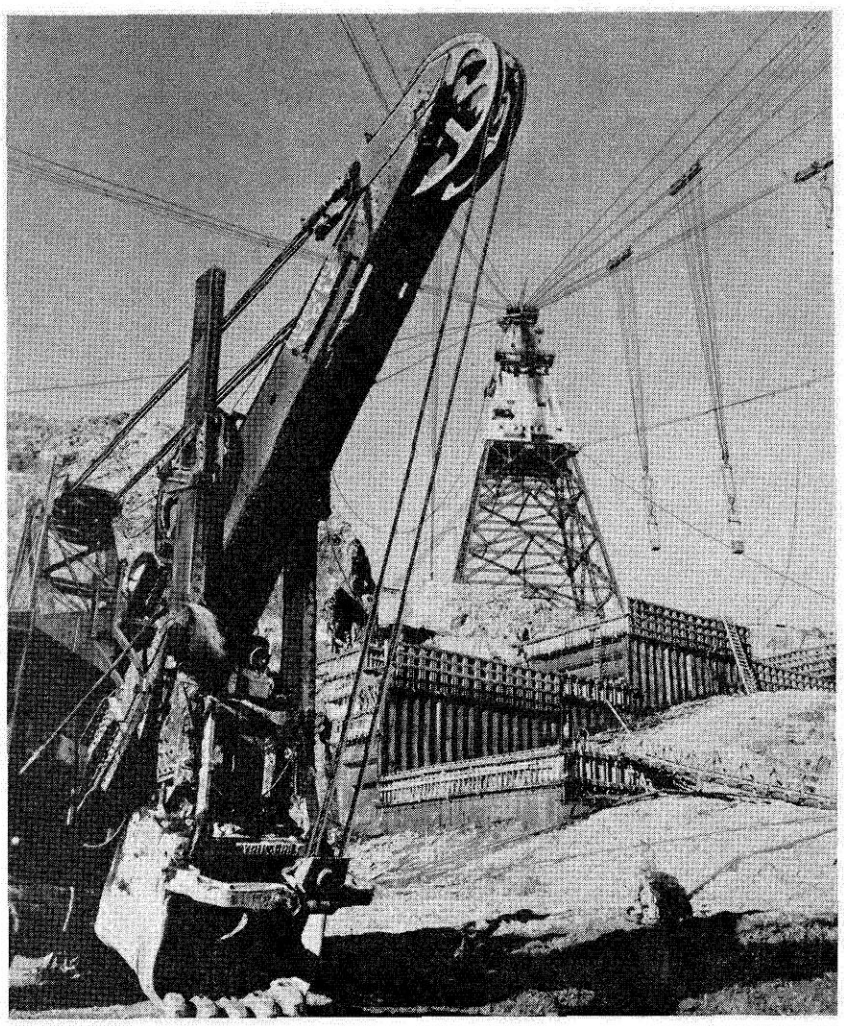

Figure 2. Shasta Dam Head Tower. Note the wire ropes on the shovel in the foreground.

rescue device for landing craft. After he finishes his training he is shipped to a seacoast town to await shipment to the battle zone. As he wanders around the town, he sees enormous aircraft plants camouflaged by artificial hills, built of chicken wire, feathers, and paint, supported by wire rope networks. He sees the Navy and Maritime ships being loaded by wire rope slings, winches, and hoists.

At last, Joe embarks on his voyage on a big transport, which carries him out through the wire rope anti-submarine nets to the open sea, where his convoy is assembled. On the trip the ships are guarded by fast destroyers, D.E.'s, and cruisers. The cruisers launch observation planes by the use of wire rope devices in the catapults, and then pick the planes up again from the sea by wire rope slings and hoists.

After a few days, the convoy reaches the staging area, where Joe sees literally thousands of ships of all sizes gathered for the invasion. Joe is surprised to learn that each ship carries many tons of wire rope in use as mast stays, antenna supports, boat slings, cargo slings, boom hoists, hoist ropes, mooring pennants, towing hawsers, and cargo lashing lines. Finally, the ships have all arrived and the entire fleet gets under way to approach the battle area.

As the fleet nears its objective, the men can hear the battleships and heavy cruisers battering away at the shore installations. Stories are circulated about the minesweepers which have gone in ahead of the "heavies" and towed long special serrated sweep cables through the waters to cut the enemy mines loose from their anchors, so that the riflemen on deck could explode the mines with a few well-placed shots. These plucky little craft had no protection at all from the heavy enemy fire from shore batteries; in fact, they could not even boast a gun large enough to answer the fire.

After the softening up is completed, the transports move toward the shore, and the men are loaded into landing craft, which are lowered into the water by wire rope slings and cranes. The landing craft all head for the beach at the highest speed possible, and, as the shore is approached, an anchor, attached to a winch on the stern of the boat, is thrown overboard to act as a brake to help keep the stern of the landing craft directly into the seas as she goes up on the beach. This anchor and rope, incidentally, are used later to remove the same craft from the beach by merely coupling the winch to the main motor and pulling the landing craft off. After the craft finally reaches the beach, the ramps in her forward end are lowered by the use of wire rope operated mechanisms, and the men and equipment surge forward onto he beach. In this first wave are many combat tanks, which are equipped not only with a wire rope sling, which can be used to lift the tank at any time, but often with a wire rope winch, which can be used to pull the tank out of a hole, or pull another damaged tank out of the line of fire.

After the beachhead has been established, trucks and bulldozers come ashore to carry equipment and clear away the debris in order to make a permanent landing point for materials. These trucks and bulldozers are also equipped with wire rope winches and operating mechanisms. This rope, incidentally, takes a terrific punishment by bending over small sheaves and running with little or no lubrication, and often in sand.

As Joe and his buddies advance, they cross deep gorges on suspension bridges, built by the Combat

Engineers out of wire rope and timber. Farther inland, they come to a large river, which they span by a pontoon bridge, tied together and anchored with lengths of wire rope. After the entire island has been cleared of any active enemy troops, Joe and his buddies return to the shore to watch the tremendous job of salvaging ships which have been wrecked and capsized in the initial landing operation. Some of the smaller craft are actually lifted with wire rope slings and loaded aboard larger ships by the use of heavy cranes.

We may digress for a moment to mention that, after Pearl Harbor, quantities of wire rope were used to salvage the wrecked and capsized U. S. Fleet. The righting of one of our heavy battleships was carried out in miniature to determine the loads involved, and special wire ropes were fabricated, to be attached to the hull and turn it right side up, so that it could be floated and returned to the Navy yard for repairs.

The island on which Joe finds himself is rapidly turned into a supply base for further operations, and as Joe wanders around the camp, he sees wire rope operated carryalls and scrapers clearing off landing strips, and construction crews erecting communication and radar towers, guyed with wire rope and strand. He marvels at the high speed with which ammunition skids are handled, with their built-in wire rope slings for lifting or pulling. Later, Joe is ordered to another part of he island to prepare for the next advance. On the way to his new base, the truck in which Joe is riding becomes mired down in a deep mud hole. The men watch with interest as the driver has the truck ahead turn sideways to the road so that he can hook on his wire rope winch line and let the powerful truck pull itself out of the hole. Before Joe can embark on the next invasion fleet, his orders come through to fly back to the States for special assignment. During his trip, one of the fliers aboard tells Joe that the control system of their big transport contains something over 4,000 feet of wire rope.

By this time, the reader is probably as thoroughly convinced as Joe of the importance of wire rope as a war material; so we will take leave of our wire rope conscious G.I. Joe, and go on to the post-war future of wire rope.

INDUSTRIAL USES

Since the fields of application of wire rope in this post-war period are so broad, the present description will break them down into the major classifications under which the consumers of wire rope can be placed, and give a quick summary of how this rope is used in each industry.

One of the principal consumers of wire rope is the petroleum industry. Wire ropes are used to set up and guy the rig, drill the hole, set the casing, and keep the well cleaned out and producing. There have been two major changes in drilling techniques. First, from cable tool drilling to rotary drilling, and second, from permanent derricks and machinery, which are a familiar sight to most of us, to two new types of equipment. These two new types are, first, the new portable masts and machinery mounted on a special truck, which can be speedily moved from one location to another to drill new shallow wells, or service the old ones, and, second, the so-called "big rigs," which are large derricks and heavy semi-portable machinery units, capable of drilling to great depths. The portable high-speed rigs have now reached depths of 9,000 feet

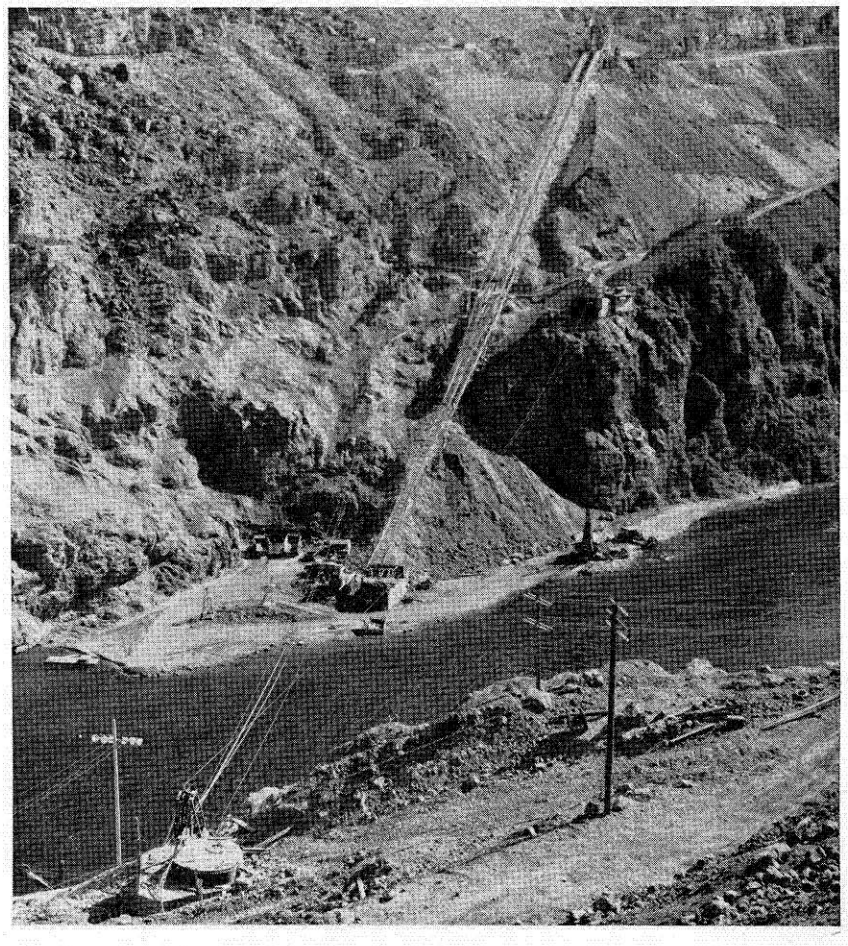

Figure 3. General layout of Guy F. Atkinson Cableway and Incline Hoist. (Note main cable around anchor in the foreground is three inches in diameter.) Courtesy U.S. Bureau of Reclamation, Boulder City, Nev.

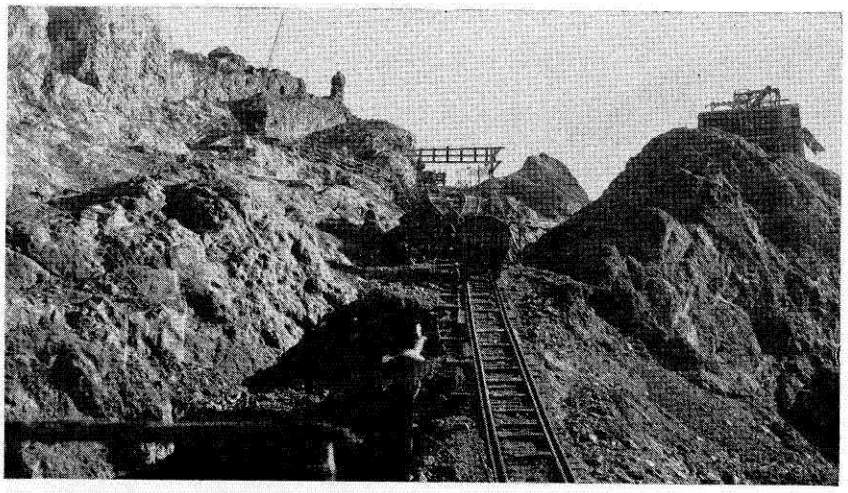

Figure 4. Closeup of Incline Hoist, Cableway Hoist House, and Head Tower. Courtesy Guy. F. Atkinson Company.

in West Texas, and, with planned improvements, they should go deeper. The "big rigs" are now being developed to reach depths of 20,000 feet and more. These changes have necessitated the development of stronger, more flexible wire ropes, adaptable to heavier loads and the high speeds encountered on the new equipment. Thus it may be seen that the problem of designing ropes for maximum service on this industry's equipment is a continuous and important one.

Another vast market for wire rope is in the lumber industry. There are many logging systems, but, essentially, the operation consists of the following steps: the timber is lifter by Choker ropes, wrapped around the log and attached to another wire rope, which is pulled by a tractor or lifted by a hoisting line running over a carriage, supported by a high line of some type, to pull the logs to the nearest transportation. In steep, mountainous areas, wire rope "inclines" are trackways, where flat cars loaded with timber are eased down the slope by cables, are used to get lumber out to the railroads or rivers. Trees are sometimes guided in their falls by wire rope, to protect young trees from damage. Wire rope skidders are often used for yarding the logs or loading them onto flat cars or trucks. When the logs reach the sawmill, they are further handled by wire rope cranes and pulled through the saws by "carriage" ropes, which pull the big sawing carriages back and forth.

Mining and quarrying industries, such as deep shaft mines for coal, copper, and zinc, are entirely dependent on wire rope to move material and men in and out of the hole by the use of large hoists. Incline hoists and aerial tramways, many miles in length, are frequently used to move materials out of inaccessible mines and quarries.

The transportation industry (or industries, one should say, as there are so many related fields under this heading) is a large user of wire rope in the form of slings and hoist lines to lift anything from a spare tire on a motor truck to a full-sized locomotive engine. Railroad maintenance shops would be almost crippled without wire rope for their overhead cranes, crawler cranes, pillar hoists, and equipment slings. Ships would certainly be hampered without wire rope rigging, cargo falls, nets, and slings.

Another industry which depends on wire rope to do many varied jobs is that of construction. For example, the construction of dams, like Boulder or Shasta, requires great quantities of rope for excavating machinery, such as shovels, draglines, cats, carryalls, and scrapers, or for cableways, inclines, and truck cranes to handle the construction materials to their final installation points.

A typical dam construction cableway head tower is shown in Fig. 2. A recent construction job which shows the use of wire rope is the Guy F. Atkinson job at Boulder Dam. There rock is taken out of the river with a dragline, or taken off the bank with a shovel, operated by wire rope, and dumped into a truck which takes it to a cableway. At the cableway, the rock is dumped into a car, which is lifted by hoist lines running over sheaves in a carriage supported by a main cable, and pulled by an endless wire rope running over a power driven "gypsy." It is carried across the river to an incline hoist, where it is dumped into a car which is pulled up the incline by wire ropes. At this point, the rock is dumped into railroad cars for final disposal. Figures 3 and 4 give the general idea of the cableway and incline hoist.

Many government agencies use wire rope and wire rope equipment in the building and maintenance of our highway systems, breakwaters, reservoirs, and sewage disposal plants. Our public utilities companies use wire rope slings and hoists for handling materials and equipment. Most of us realize that large quantities of wire rope are used in the building of a suspension bridge like the Golden Gate Bridge, but few people realize that wire rope is constantly in use for the maintenance of such a bridge. Manufacturing industries of all types call on wire rope to handle materials of heavy or bulky nature.

A few unclassified but important applications of wire rope are as follows: Elevators in tall buildings require special elevator ropes. We all appreciate the importance of these ropes when we contemplate climbing the stairs to the top of some building of 15 stories or more. The manufacture of recreational equipment, such as ski lifts, Ferris wheels, and yacht rigging, is a fertile field for the application of special constructions of wire rope and strand. Agricultural harvesting is developing as market for wire rope. For example, converted clamshell hoists are being used for sugar cane harvesting grabs.

Each new application of wire rope has its own engineering conditions and limitations, which determne the size and construction of rope to be used. Thus, the wire rope manufacturers maintain staffs of engineers to assist the users of wire rope in determining the proper rope for the given job; also to develop special constructions for abnormal operating conditions encountered on new equipment being built for this highly competitive post-war period.