VESSELS MADE FROM QUARTZ AND SOME OF THEIR USES.

BY PROF. JOHN TROWBRIDGE.

For many years silk fibers were used to suspend tiny collections of magnets in various forms of galvanometers. At one time this method of suspension had great practical importance, for galvanometers provided with such magnets, placed on minute mirrors, were universally employed in transmitting and receiving messages on submarine cables.

All testing work in laboratories also depended on this use of silk fibers, for the cobweb-like filament permitted the slightest movement of the magnet of the galvanometers. There was, however, always the difficulty of the torsion of the fiber, which resisted the free motion of the magnet while it was under the action of the electrical impulse, and also led to a permanent set or deviation of the magnet from the true position of rest after the electrical action had ceased.

Prof. Boys was the first to suggest the use of quartz fibers for delicate suspensions in the place of cobwebs or silk fibers. This suggestion has led to a remarkable improvement in electrical testing apparatus; and in all forms of physical instruments in which suspensions free from torsion are necessary. The method employed by Prof. Boys, and followed by others, is to fuse pieces of quartz in an oxyhydrogen blowpipe until a fairly large piece of amorphous silica is obtained. An arrow or dart is then made. One end of the dart is provided with a sharp iron point; this is the head of the arrow. A piece of elastic is attached to a board, the ends about three feet apart. A piece of the fused silica is tied to the blunt end of the arrow; another piece of this silica remains upon the operating table. The arrow is drawn back from the board a suitable distance. The two pieces of quartz are fused together in the blowpipe and the arrow is discharged, carrying with it an extremely fine thread of the fused silica.

These threads can be twisted many hundred times without showing torsion, and magnets suspended by them return absolutely to their position of rest. This amorphous silica has also another still more remarkable property, and the method of preparation has made it resemble a metal.

Some remarkable advances have been made lately in the employment of quartz for vessels capable of withstanding very high temperatures without cracking. It is well known that glass vessels must be annealed with the utmost care in order to resist sudden changes of temperature. A glass blower cannot put aside a piece of glass which he has heated without first tempering it in a smoky flame. Now vessels are made of quartz which can be heated to a white heat and while in this condition can be plunged into cold water without suffering the slightest injury.

The discovery of the new manipulation of quartz is due largely to Prof. Shenstone, of Bristol, England, and the method he employs is as follows:

Pebbles of Brazilian quartz are heated to a red heat or even higher in a muffle furnace. They are then thrown into a vessel containing distilled water. The cleanest and purest pieces are selected and welded by means of the oxyhydrogen blowpipe into long pieces like knitting needles. The quartz has now completely lost its crystalline character, and is not quartz, but amorphous silica. It has acquired the remarkable property of resisting extremely sudden changes of temperature, and vessels of any shape or size can be made from it. Time and money are the only considerations. Fig. 1 shows vessels of different sizes and shapes which I have obtained by this process. The photograph represents them half the original size. The needle-like pieces are also shown. The tubes are built up from these. In the test tube, for instance, which is represented in the photograph, a white-hot coal can be dropped without breaking it; it also can be heated to a white heat and then filled with cold water without cracking.

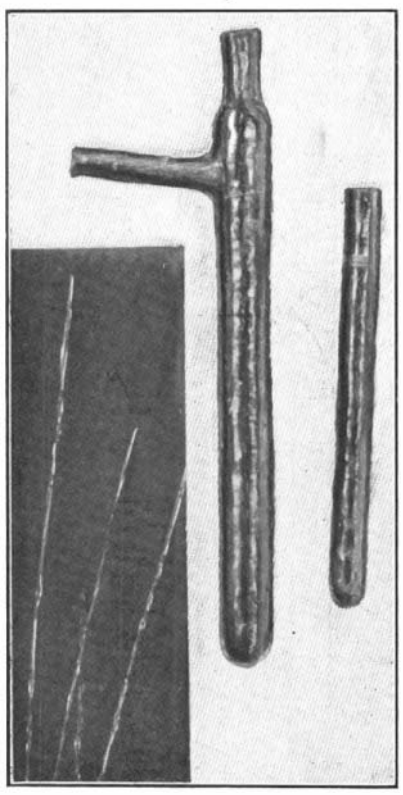


Fig. 1.—NEEDLE-LIKE PIECES OF AMORPHOUS SILICA, AND THE TUBES BUILT UP FROM THEM.

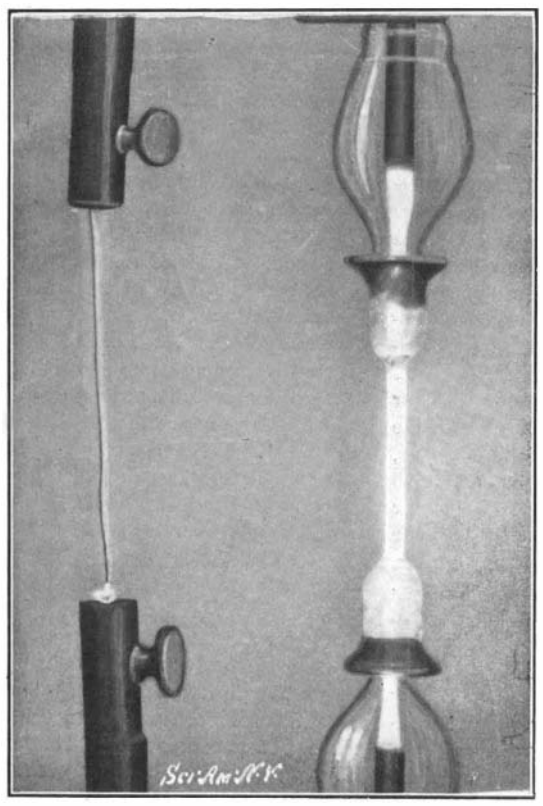


Fig. 2.—SPECTRUM TUBES MADE FROM AMORPHOUS SILICA.

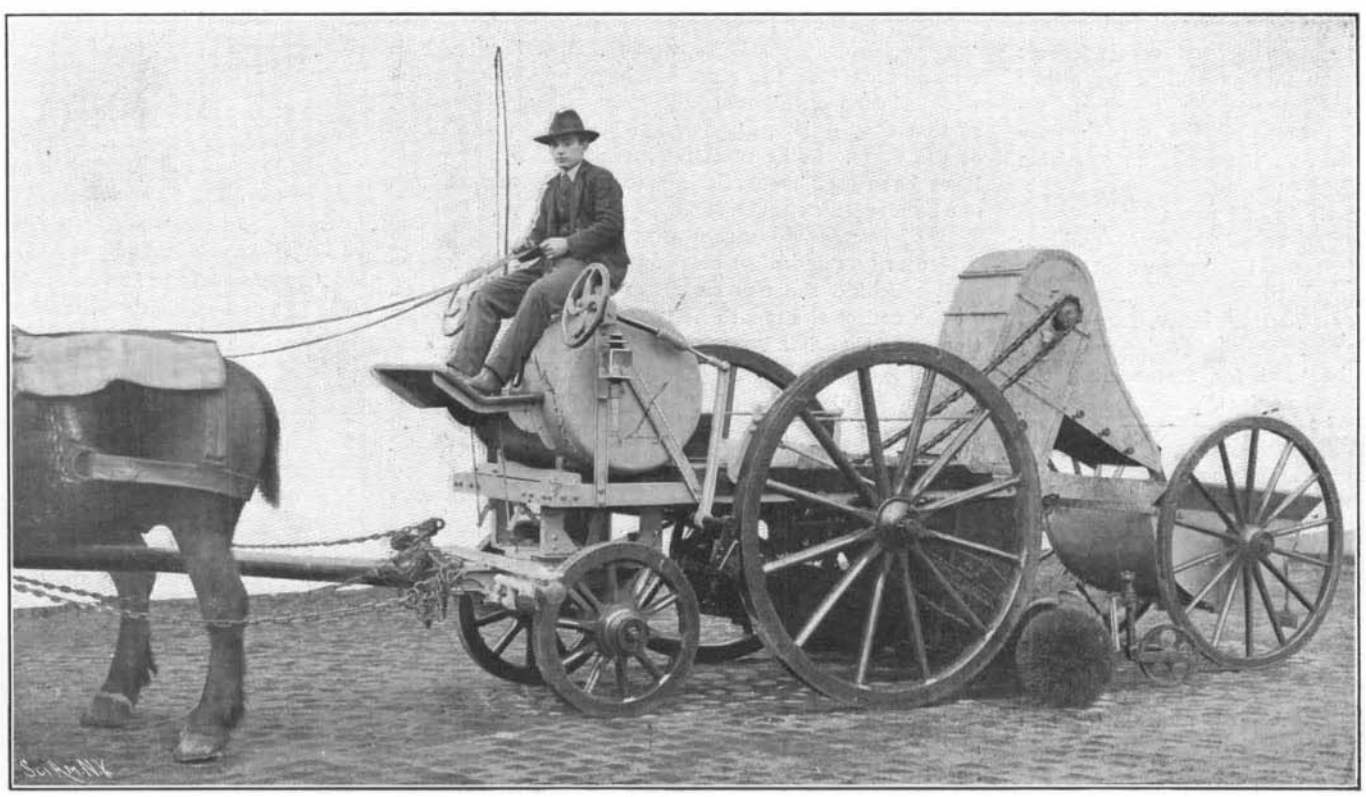
Fig. 2 shows spectrum tubes made for me from this amorphous silica. This tube was filled with hydrogen; a piece of iron wire No. 36 gage was placed in the same electric circuit. The quartz tube is illuminated by its own light, which is the most powerful artificial light which has ever been obtained. The duration of this light, in this case, was only one hundred-thousandth of a second. The iron wire is shown intact, although no trace of it could be found after the discharge. It took a comparatively long time to melt the wire, and this was accomplished when the light had entirely died out from the tube. These quartz tubes have proved of great importance in my work on hydrogen gas submitted to very high temperatures. Glass spectrum tubes speedily cracked or disintegrated under the powerful electrical discharges, but the quartz tubes withstood this high temperature without the slightest corrosion of the inner surfaces. By their use I have discovered new gaseous spectra which seem to me to be of great importance in regard to various speculations in regard to the changes going on in the sun and other heavenly bodies. When glass spectrum tubes are employed, various lines appear which some have attributed to the impurities coming from the glass. Most glass, for instance, contains the metal calcium; and two very strong calcium lines fall on the two most marked lines of the solar spectrum—the so-called great HH lines. When hydrogen is submitted to strong electrical discharges in glass tubes, two strong lines appear, which are also coincident with these great solar lines; and they have been therefore attributed to the calcium coming from the glass. The use of quartz tubes, however, shows that these lines are gaseous and that the gas is also contained in the earth's atmosphere. The lines may be due to hydrogen or to an unsuspected gas. I am now investigating this question.

The quartz tubes also allow the study of the invisible violet portion of the spectrum of hydrogen, for quartz permits the passage of rays which glass completely intercepts. A new region of gaseous lines is thus opened which has never before been brought to light. Under strong electrical discharges hydrogen shows dark lines as well as bright lines. These dark lines are due to a reversal on the photographic plate, and the phenomenon is of great importance in speculations on the nature of the changes which are occurring on the sun and in the variable stars.

A MECHANICAL STREET CLEANER.

The disadvantages of all those methods of road cleaning which involve the direct removal of dry dust and refuse are so obvious that it is scarcely necessary to point to them. Of the innumerable microbes which are set floating through the air by the brush drawn over dry ground, quite an alarming number must be carried into the respiratory organs of animals and man, not to mention the multitude which in one way or another reach vulnerable points of the system, after being whirled into the air with the dust.

Various ways of avoiding these evils have been proposed and put to the test. One machine designed to effect this and also to clean the road, was exhibited in the Public Health section of the recent Düsseldorf exhibition. The plan adopted is to sprinkle the road before the brush is sent over it, and to collect automatically the mud gathered by the brush. We reproduce a view of this machine, which will help to make clear its construction. The machine, which is called the "Salus" street cleaner, is mounted upon two pairs of large wheels and a pair of small wheels in the front truck. Above this latter is lodged a water tank of about 200 gallons capacity, and on this again is fixed the driver's seat. Within easy reach of the driver is a tap which controls the flow of water to the sprinkler, and a wheel, by turning which he can at will raise or lower the broom. This latter consists of two stiff portions at the sides, connected in the middle of a flexible piece, which is kept curved, with its convexity toward the back. A combination of gear wheels and sprocket chains transmits the rotation of the axle of the center pair of carriage wheels to the broom. Owing to the curved form of the broom the mud is driven in toward the middle, collecting there upon a platform, which grazes the ground just in front of the brush, until it is forced along by a scraper. The action of this scraper is such as to rake the mud periodically upon the platform toward a bucket chain, which is also driven from the middle carriage axle. This chain lifts the mud and



AN HYGIENIC STREET-SWEEPING MACHINE.

deposits it in a tank carried upon the rearmost pair of wheels.

When the machine is traveling at a rate of three miles per hour, the broom makes 91 revolutions per minute, and each bucket of the chain pump makes 4.8 journeys up and down per minute. The breadth of road sprinkled is about 8 feet. The sprinkler is found to be thoroughly efficient in preventing any dust rising even in the driest weather. The bristles of the brush are so chosen that the machine works without clogging on snowy ground. Any danger of obstruction of the chain pump is avoided by the comparatively small number of brackets. It has been estimated that two machines of this type, working one behind the other for 7 or 8 hours a day, perform the same work as 20 men working for the same length of time. Each machine requires one driver. A disadvantage is perhaps to be found in the weight of the machine, which is considerable, but which has of late been somewhat reduced by the simplification of certain parts.

ELECTRICITY IN MODERN MINING DRAINAGE INSTALLATIONS.

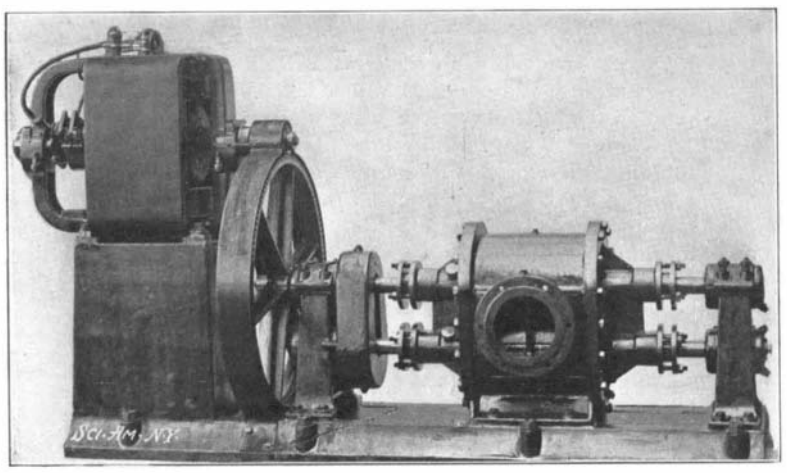
BY FRANK C. PERKINS.

The drainage of mines by electrically operated pumps has now reached a stage of reliability and economy in America as well as in Europe. It was necessary on account of the size of the shafts to construct the pumps and motors in parts which could be easily transported through these shaft openings and drifts. It was necessary for both the pump manufacturers and electrical manufacturers to make concessions in the speed limits of their products. The polyphase induction motors for mining pumps are reduced in speed for direct connection, and the design of the pumps now provides as high speeds as possible. The pumps designed by Prof. Riedler and the engineers of Ehrhardt & Sehmers, as well as those of the Breslau Engineering Works, of Europe, are operated at from 100 to 300 revolutions per minute and are highly efficient for mine working.

An electrically operated mining pump at Planitz has a Siemens & Halske alternating current motor placed at the center of the crank shaft with one plunger at each end, while in the case of the pump at the Ferdinand mine the motor stands on one side of a twin pump. The Planitz pump has a capacity of one cubic meter of water per minute at 145 revolutions per minute, the height of lift being 250 meters. A liquid starter is used with this alternating current motor. The capacity of the twin electric pump at the Ferdinand mine is 1.5 cubic meters per minute at 184 revolutions per minute, the head being 200 meters. At the latter mine there is also in use a much larger electric pump driven by the same type of motor direct connected at the side of a triple pump which has a capacity of 5.5 cubic meters of water per minute at a speed of 146 revolutions per minute, the height of lift being 300 meters.

Taking the efficiency of the dynamo machines, electric cables, and electric motors as tested at 93, 97, and 93 per cent respectively, the useful efficiency of the complete electrical plant is 83 per cent. The high speed pumps have an efficiency of 83 per cent and steam engine 85 per cent, so that the net useful efficiency of steam engine, generator, line, motor, and pump would be 50.5 per cent. The loss of condensation and leakage in a long steam pipe is very large and the steam must be kept up, while in case the electric pump is stopped for short periods no current is being used. The electric mine drainage plant is therefore of higher efficiency and has greater reliability with lower working expenses than hydraulic, steam, or compressed air systems.

The Helios alternating current motor mining pump in the underground installation at Germania I. mine of the Gelsenkirchener Bergwerks-Aktiengesellschaft,



A JAEGER ELECTRIC ROTARY PUMP.

consists of a 160 horse power Drehstron motor mounted between the plungers of a compound twin pump. This pump was constructed by the Maschinenbauanstalt Breslau on the Bergman system, and it has a capacity of 3 cubic meters of water per minute under a head of 160 meters. The polyphase motor built by the Helios Electricitats Aktiengesellschaft of Cologne-Ehrenfeld, operates at a speed of 180 revolutions per minute and is connected directly to a 2,200-volt three-phase circuit.

The Rateau-Gruben ventilator of the Germania II. mine is operated by a 400 horse power motor of the three-phase type. This great ventilator is directly coupled to the motor, which runs at a speed of 238 revolutions per minute and is driven from the same 2,000-volt alternating current circuit directly without reduction by transformers.

At the electric drainage installation carried out for the Hösch Steel Works at the Kaiserstuhl II. shaft at Dortmund a 750 horse power three-phase motor mining pump was installed by the Maschinenfabrik Oerlikon of Oerlikon, near Zurich, Switzerland. The motor frame of this machine is about 14 feet in diameter and 900 millimeters in width. The motor operates at only 75 revolutions per minute on a pressure of 19,000 volts. The present working of the electric pump requires it to raise five cubic meters of water per minute from a depth of 300 meters, but the outfit is designed to raise the same quantity of water at full load a height of 400 meters. The over-all efficiency of this pumping plant between the indicator and the water pumped to the shaft mouth when the steam engine was fully loaded amounted to from 65 to 67 per cent, which may be considered remarkably good.

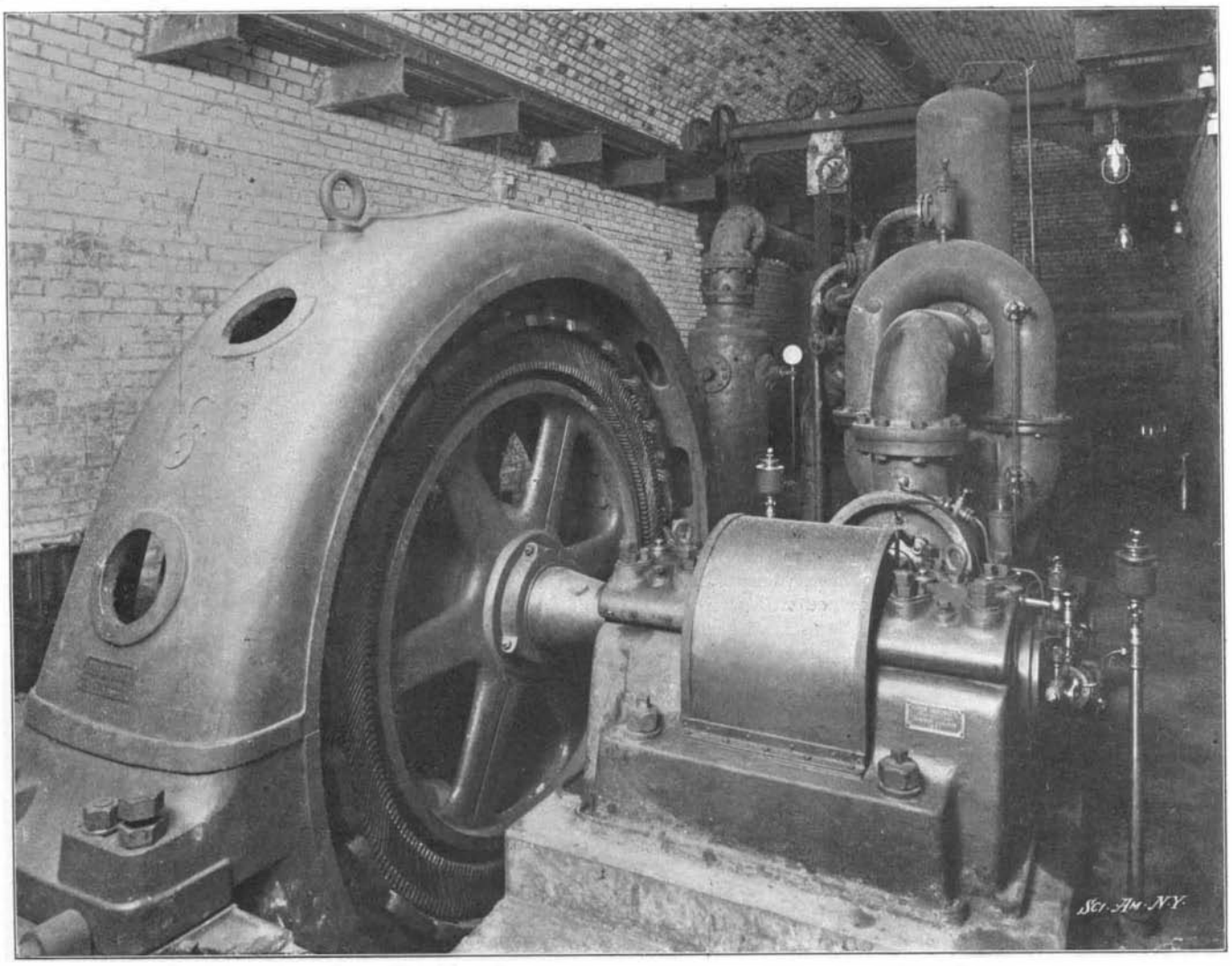
The high power mine pump working by electric power in Germany and throughout Europe has been carefully worked out and the alternating current slow-speed induction motors of the polyphase type have done remarkably well in this service.

The underground electric pumping plant of the Glückauf shaft of the Zwichauer Steinkohlenbau-Vereines was installed by the Schuckert Company of Nurnberg. There are two Bergman Zwillingpumpe, each directly connected to a 220-volt three-phase motor. These motors operate at a speed of 180 revolutions per minute and are supplied with current directly from the 2,000 volts polyphase power transmission line, although other machinery driven by electric motors in the mine has the current transformed down from 2,000 to 500 volts. In this plant, as well as nearly all of the large electrically operated mining plants in Germany, a large, well-equipped, and economical power plant is installed above ground for supplying the necessary power for use in the mines.

Many of the mines of England are operated by electric power. Large numbers of electric hoists, pumps, cutters, and auxiliary mining machinery have been supplied by Ernest Scott & Mountain, Limited, and their prominent engineers. In England as well as in America and on the Continent of Europe direct-current motor-driven pumps of both plunger and centrifugal types are in use with both open and closed or iron-clad motors according to the location and their liability to be subjected to moisture and rough usage.

The rotary pumps of C. H. Jaeger & Co., of Leipzig-Plagwitz, are extensively used abroad, and in the American mines the Worthington, Blake-Knowles, Deane, Goulds, and Allis-Chalmers types are commonly employed. The Risdon duplex and triplex electric pumps manufactured in San Francisco are largely used in the western part of the United States. They are double geared to reduce the speed and two motors are employed, as it is found impossible frequently to get very large machines down existing shafts. Where a special shaft for mine pumping is made, large motors are preferable, as they have much higher efficiency as well as lower speeds. Three Risdon electric triplex pumps driven by induction polyphase motors have been recently placed in an underground station with a capacity of 6,000 gallons per minute, the water being raised 1,000 feet. An extra large underground chamber is required for pumps of this character but with large motors there is greater economy of space.

At an ironstone mine in Yorkshire, England, which had been flooded, an electric pump of the centrifugal Scott & Mountain type was used. It was designed to deal with 1,000 gallons per minute against a head of 150 feet and ran at a speed of 700 revolutions per minute, a 100 horse power motor being used. The mine being flooded and the dip 3 inches to the yard, and it being necessary to have the pumps portable, this type of plant was suggested. In practice the electric pumps were lowered each 80 yards, which at 3 inches to the yard is equivalent to a suction of 20 feet vertical head. The inlet and outlet branches of the pump consisted of flexible rubber pipes, the total length over flanges being 27 feet, so that the raising main was laid as the pumps were gradually lowered. After each lowering of the pumps three 9-foot lengths of pipe took the place of the positions where the electric pumps operated, the suction pipes then forming



SIEMENS-HALSKE ALTERNATING-CURRENT MOTOR DRIVING A MINING-PUMP IN AN UNDERGROUND INSTALLATION.