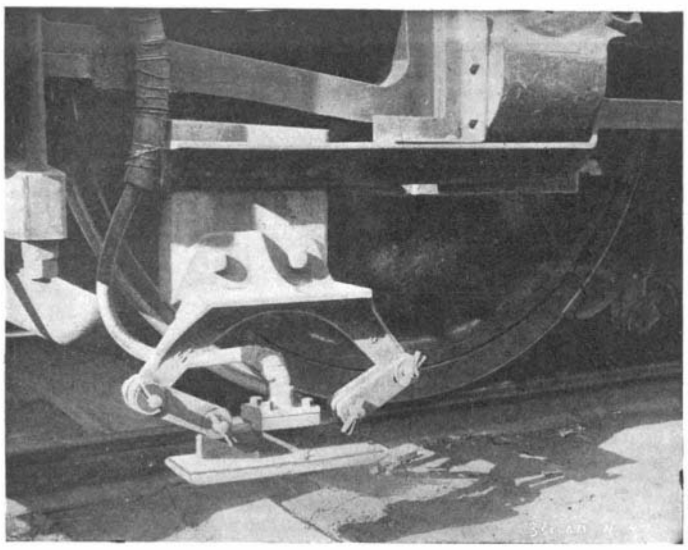
THIRD RAIL IN THE BALTIMORE BELT LINE TUNNEL.

A few years ago the Baltimore & Ohio Railroad Company spent about $7,000,000 in constructing a railroad through the city of Baltimore and its suburbs in order to save about half an hour in time and to secure an all-rail route from the metropolis to the capital of the country. Before the Belt Line was built passenger and freight trains were carried across the harbor on a huge car ferry named after the founder of the Baltimore & Ohio system, "John W. Garrett." The Belt Railroad cost nearly $1,000,000 a mile to build and equip, owing to the large amount of tunnel construction and other difficulties of the work, also to the fact that it was to be operated by both steam and electric service. It was the first railroad of any importance in the world to utilize large electric locomotives for hauling freight and passenger trains.



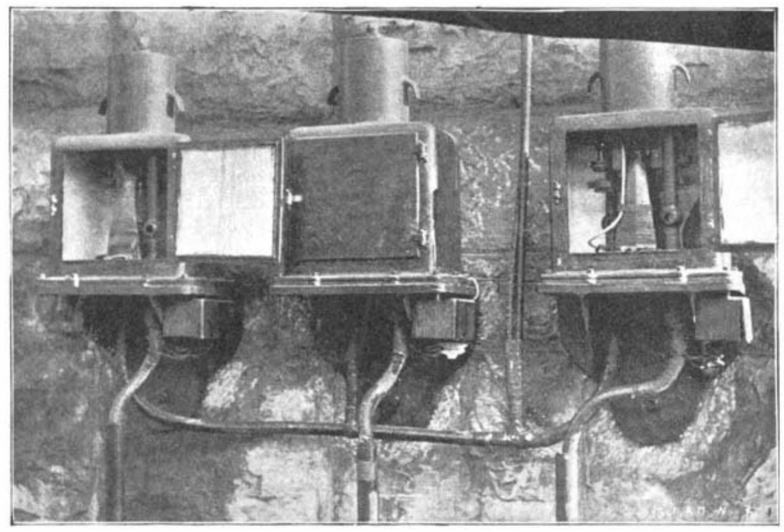
CURRENT-TAKING SHOE.

The use of electricity was decided upon for the reason that the Belt Line contains several heavy grades and has some of the sharpest curves of any railroad in the United States. To furnish the current, a power house was built from which the electricity was transmitted by cables to an overhead conduit system, consisting of a metal trough hanging from iron bars, which were in turn supported by metal archways located from 200 to 300 feet apart. A "shoe" made of cast iron slid through the trough, passing the current to the motors by means of an adjustable metal bar, which connected the shoe with the top of the electric locomotive. In the tunnels the conduit was supported from the roof without the necessity of the archways, but it was found that a large quantity of the current passed to outside conductors in spite of the insulated protection, and this leakage necessitated the generation of much more electric power than has been actually needed to work the motors. The overhead system has also required a considerable outlay yearly for repairs, and for some time past the Baltimore & Ohio management has been considering the adoption of some other mode of electric transmission, especially as it wishes to use electric traction on about 70 miles of what is known as the mountain division in Maryland and West Virginia, where ordinary freight trains require two and three of the largest steam locomotives to carry them over the grades. For the last six months the work of equipping the Belt Line with what is known as the third rail, also the sectional third-rail system, has been in progress. In the tunnels and in the vicinity of the railway stations the sectional system is used for a distance of 3½ miles, the third rail covering the balance of the Belt Line. Its installation is similar to the system on the New York, New Haven & Hartford Railroad between Boston and Nantasket Beach, but more current is required on the Belt Line. It is conveyed through an extra or feed rail laid about 18 inches outside of the regular track. This weighs between 70 and 80 pounds to the yard and is bonded by insulated copper cables fastened into the ends of each rail. The current from the power house is also carried to the end of the feed rail by cables which are buried in the ground. The electrical locomotive takes its power by means of a shoe which slides along the top of the rail. Each locomotive has four shoes, fastened, one outside the lower part of each driving wheel, and connected with the locomotive frame by spring attachment that adjusts itself to any deviation in the track, so that the shoe is automatically held upon the rail. The sliding shoe is utilized on both the third rail and sectional portions. Only the portion of the sectional third rail, however, is charged with electricity that is covered with the locomotive. It receives its name from being divided into sections controlled by electric switches, which are automatically operated by the movement of the locomotive.

The switches are practically of the solenoid type with two windings, one a fine winding, taking a current of about 550 volts from the generator on the electric locomotive, through the controller, the contact shoes and the third rail. This current raises a plunger, which closes the switch and feeds the power house current of 700 volts to the third rail. The moment the weaker generator current passes through the fine winding and closes the switch, current from the power house passes through the heavy winding of the magnet and keeps the switch closed until the contact shoes of the electric locomotive have passed to the next section. The circuits around the magnet being broken, the switch opens by gravity. The contacts last to operate are of carbon, and the spark, if any, is between these contacts, thus preserving the metallic contacts from injury. At the instant the contact shoe at the forward end of the locomotive comes in contact with the forward section of the third-rail conductor, the switch controlling the feeder for that section closes, and the switch for the rear section opens.

Each of the magnetic switches is provided with a single pole double throw knife switch in series with the fine winding of the magnet. This is used by the inspector to test the magnetic switch and ascertain whether it is in proper adjustment. Should it be necessary to make any adjustment while the section controlled by the switch is in use the current is fed to that section by means of a temporary bridge which he places in position.

In operating the motors, the motorman turns the controller to the first notch, opening the throttle to the air engine, which, taking compressed air from the storage reservoir of the air-brake system, drives an electric generator, which generates sufficient current to operate the magnetic switch and charge the third rail with current from the power house. At the instant the magnetic switch is closed the power house current passes through it to the third rail, thence through the contact shoe and the controller to the electric generator which operates the switch, and



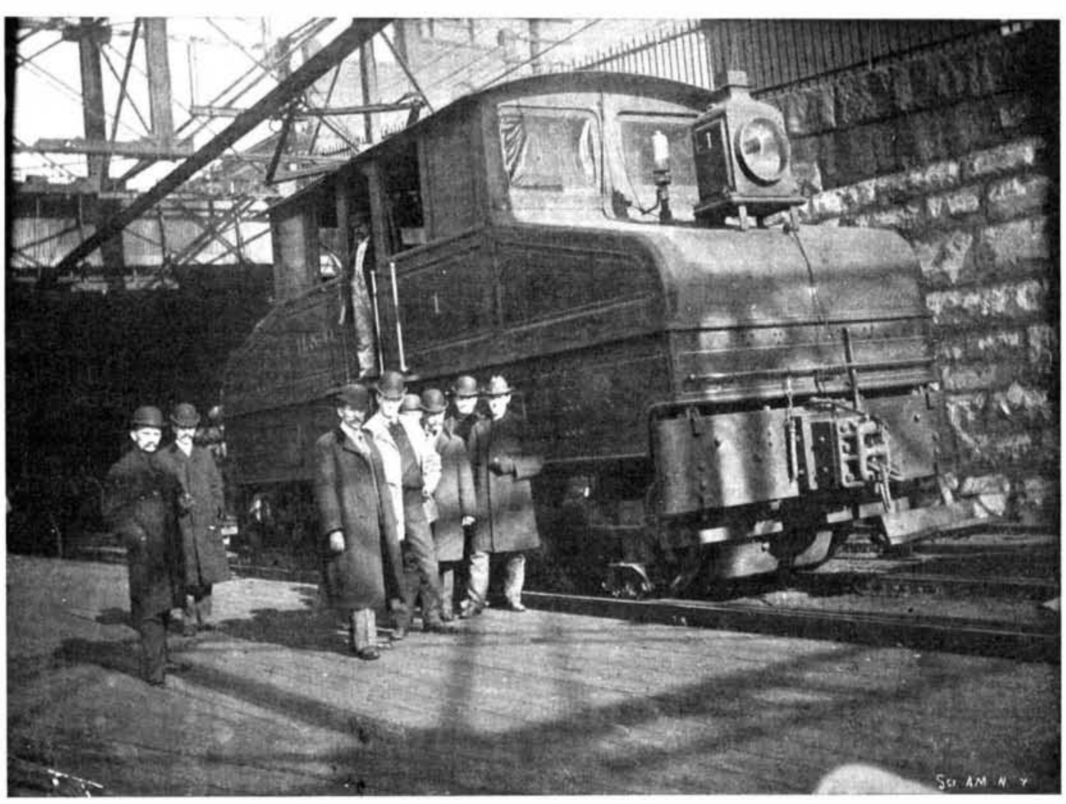
AUTOMATIC MAGNETIC SWITCHES.

also to the four 300 horse power motors of the electric locomotives. Immediately and automatically the generator becomes a motor, operated by current from the power house, and drives the air engine as an air compressor, recharging the compressed air reservoir from which the air engine originally obtained its power.

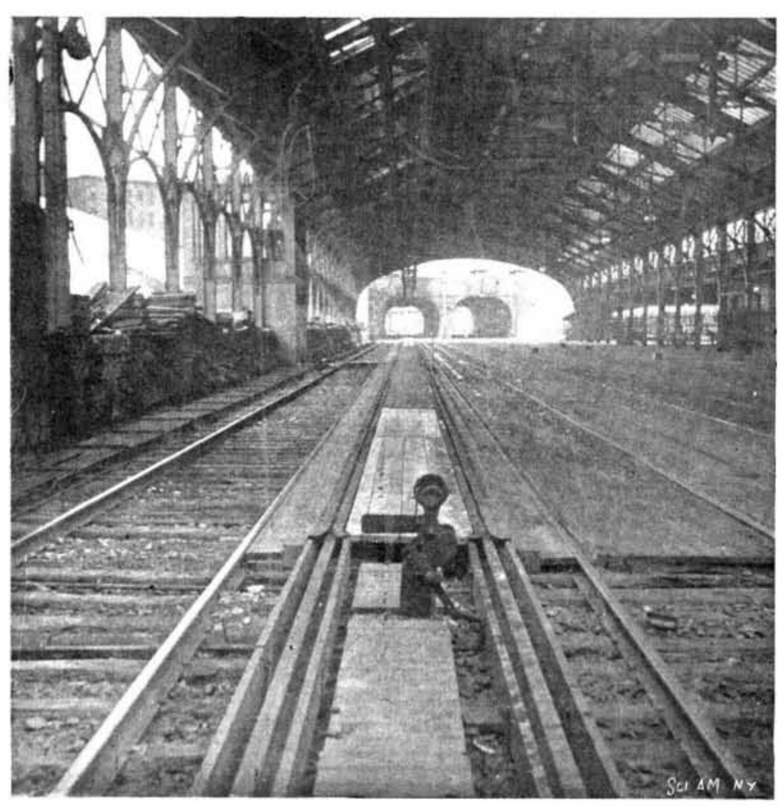
At no time is it possible during the operation of this system to have a charged conductor or third rail except when the motorman has turned the controller, and then only one section is charged, i. e., the section on which the electric locomotive is operating.

The locomotives in use on the Belt Line have hauled by the overhead system two loaded freight trains with their engines, representing about 2,500 tons of weight, unaided by the steam locomotives. This will give an idea of their transmission power. The same amount of current required for this pull has been transmitted by means of the sectional and third rails to the locomotives during the present tests without difficulty. The archways and conduits of the overhead system remain and the locomotives can take current as desired, either from the top or bottom. The accompanying photographs show the overhead connection, but the motive power is coming entirely from the shoe which can be seen connected to the third rail. The upper construction is to be removed in the near future.

The tests which have been made include the operation of the locomotives at slow, half and full speed with and without loads. They have been switched from one track to another, started and stopped on grade and placed in service to haul a train of twenty-



ELECTRIC LOCOMOTIVE TAKING CURRENT FROM THE THIRD RAIL.



THIRD RAIL SYSTEM IN MOUNT ROYAL STATION.

two 45-ton coal cars loaded during a heavy snow storm, the shoes taking current from the rail when covered with snow and ice to the depth of several inches. In adapting the motors for service with the systems, the mechanism was practically unchanged, a few alterations being made to the air compressors and the contact shoes connected as shown in the illustrations.

Both the sectional and third-rail installations were completed under the supervision of Mr. John McLeod Murphy, inventor of the sectional method and chief engineer of the Murphy Safety Third Rail Company.

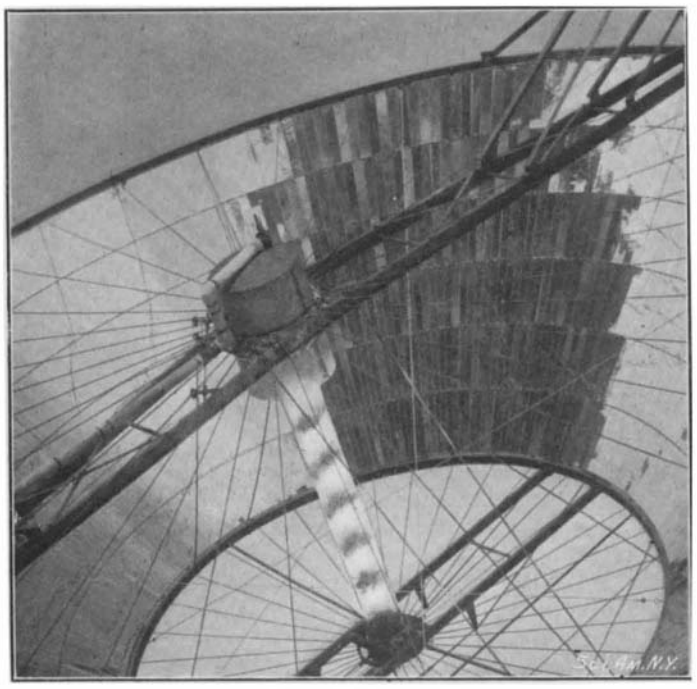
SOLAR MOTORS

BY CHARLES F. HOLDER.

For many years the attention of inventors has been directed to the question of utilizing the direct rays of the sun as a substitute for coal, wood, or other fuel; large burning glasses or reflectors being the general form of the various machines. Especially in France have these been seen. A so-called "burning mirror," made by a Frenchman named Villette, was four feet in diameter, and produced so intense a heat that, according to the report, it melted cast iron in sixteen seconds. The heat resulting from the sun's rays is remarkable. An Englishman, one Parker, years ago built a lens about three feet in diameter, which melted a cube of cast iron in three seconds, and granite was fused in one minute. This result was produced from a concentrating surface of seven square feet; which suggests that if the reflector could be made so that the field of concentration would be a square mile the iron would melt in less than a millionth of a second, suggesting the possibilities in this direction with enormous reflectors, or groups of small ones.

It was for a long time difficult to build a concave mirror of very large size, but this was finally overcome by having the surface of the concave mirror covered with small pieces of glass, or mirrors, each of which is so placed that the light or reflection from each side is thrown upon the same spot, the sum total, or the amount of heat centralized, being equivalent to the amount reflected by each glass, multiplied by the number of mirrors. In Europe the early solar glasses were generally of two kinds; that is, the heat was concentrated in two ways—by reflection from polished concave mirrors and by refraction through a convex lens. The earliest use, centuries ago, of such a contrivance was theoretically to dazzle or blind an enemy, metal disks being employed; but nearly all such devices failed to be of any practical value and fell into the category of "curiosities." The story of Archimedes will be remembered in this connection. Twenty years before Christ it is alleged he set fire to the enemy's ships by using an enormous sun glass. Sir William Herschel experimented with the sun's heat in Africa; and Captain Ericsson has made a number of studies in this direction and exhibited a solar motor in New York in 1884.

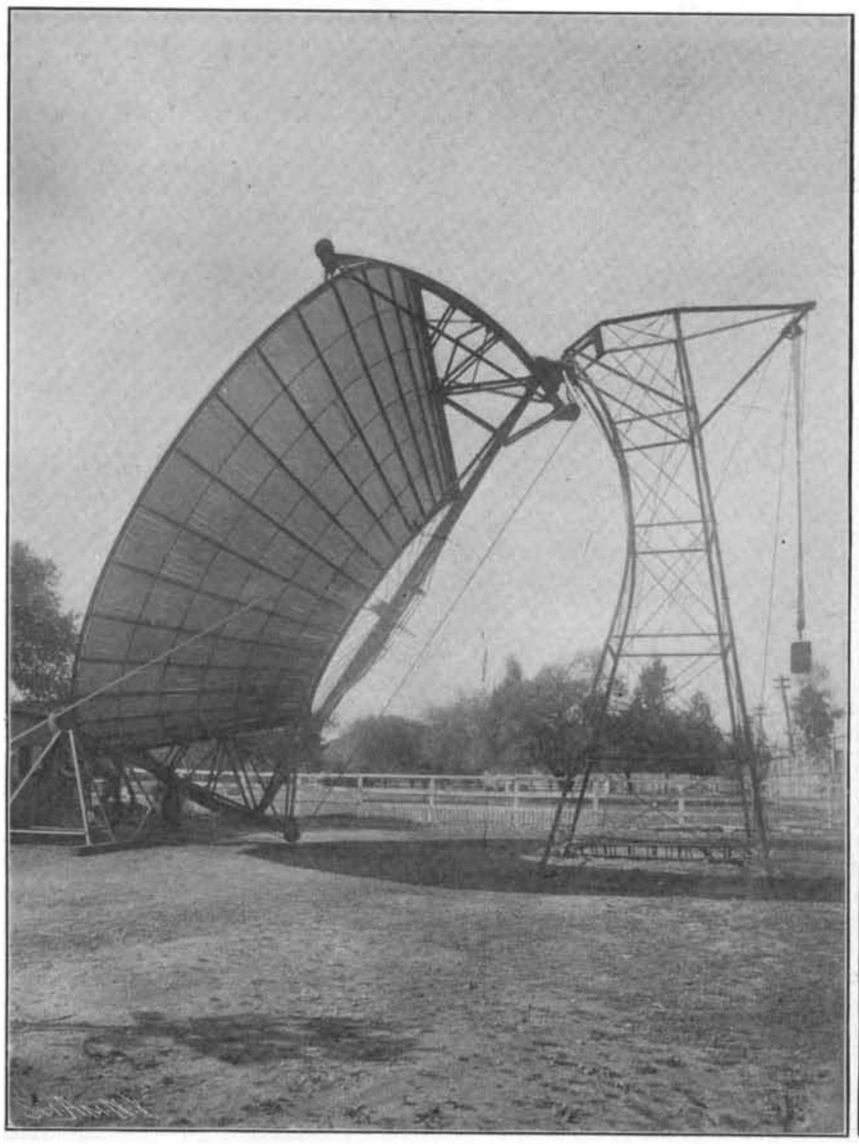
In Western America within the past twenty years it has been found that there are regions where it is especially desirable to obtain a motor which can be run practically without fuel. Such a region is the Californian desert, where vast mining interests have sprung up, and in arid sections where irrigation is necessary, and even in the richest portions of fertile California in connection with the question of irrigation. On the desert the sun shines almost continuously, and in Southern California the percentage of sunshine to cloud is remarkable. These conditions have called attention to the possibility of a practical sun motor, and it is interesting to note that in South Pasadena, California, such a machine has been set up and is successfully accomplishing the work for which it was made—an automatic engine running by the heat of the sun. This machine is exhibited at the Ostrich Farm, and has attracted the attention of a vast number of people, especially as Southern California is now thronged wtih tourists. In appearance the motor resembles a huge disk of glass, and at a distance might well be taken for a windmill of some kind; but the disk is a reflector thirty-three feet six inches in diameter on top, and fifteen feet on the bottom. The inner surface is made up of seventeen hundred and eighty-eight small mirrors, all arranged so that they concentrate the sun upon the central or focal point.



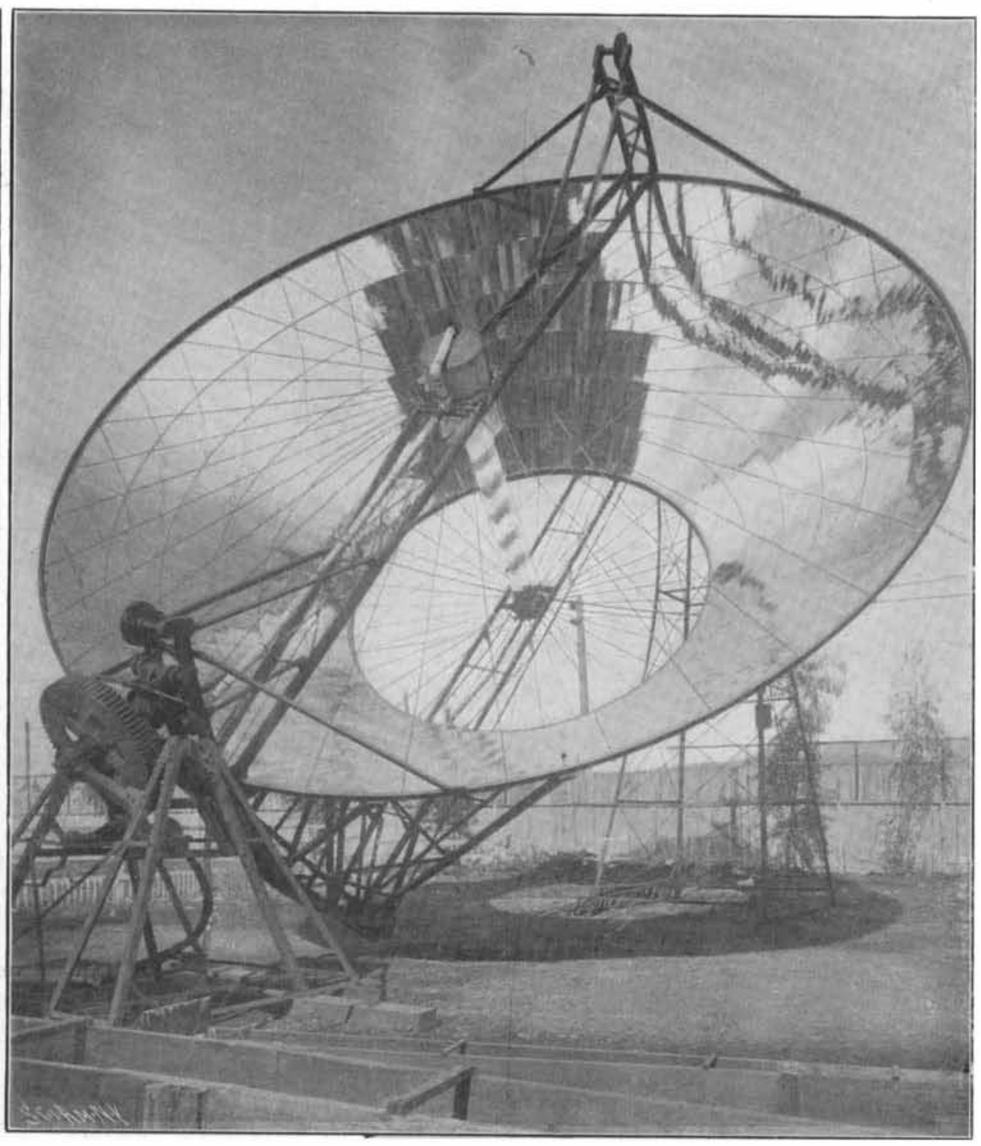
BOILER AND CONNECTIONS.

Here, as shown in the accompanying illustrations, is suspended the boiler, which is thirteen feet six inches in length, and holds one hundred gallons of water, leaving eight cubic feet for steam. At the time of the writer's visit to the farm the motor was the subject of no little comment, and the attendant stated, confidentially, that some of the questions asked were remarkable. One man assumed that it had something to do with the incubation of the ostrich eggs; and many asked what made it go, being unable to understand or appreciate the idea. The motor is attractive in appearance; built lightly, supported by seeming delicate shafts, though in reality strong enough to resist a wind pressure of one hundred miles an hour. The reflector must face the sun exactly, and as heavy as it is, weighing tons, it can be easily moved. It stands, after the fashion of the telescope, upon an equatorial mounting, the axis being north and south; the reflector follows the sun, regulated by a clock, the work being automatic, as, in fact, is everything about it. The true focus is shown by an indicator, and in about an hour after it is adjusted the boiler is seen to have attained a white heat and the steam gage registers one hundred and fifty pounds. The steam is carried from the suspended boiler to the engine in a flexible phosphor-bronze tube and returns again from the condenser to the boiler in the form of water, so that the boiler is kept automatically full. The engine is oiled automatically, and when the disk is once turned, facing the sun, it runs all day as independent of an engineer as does a windmill.

The amount of heat concentrated in the boiler by the seventeen hundred and odd mirrors cannot be realized, as nothing can be seen but a small cloud or escaping steam; but should a man climb upon the disk and cross it he would literally be burned to a crisp in a few seconds. Copper is melted in a short time here, and a pole of wood thrust into the magic circle flames up like a match. That the motor is a success is seen by the work it is doing—pumping water from a well, illustrating the possibilities of cheap irri-



SIDE VIEW, SHOWING THE FIXED SUPPORTS AND MOUNTING OF REFLECTOR.



FRONT VIEW, SHOWING THE SUN'S RAYS CONCENTRATED ON THE BOILER, AND GEARING FOR REVOLVING THE REFLECTOR.

A SOLAR MOTOR AT WORK AT LOS ANGELES, CAL.—15 HORSE POWER, STEAM AT 150 POUNDS PRESSURE.