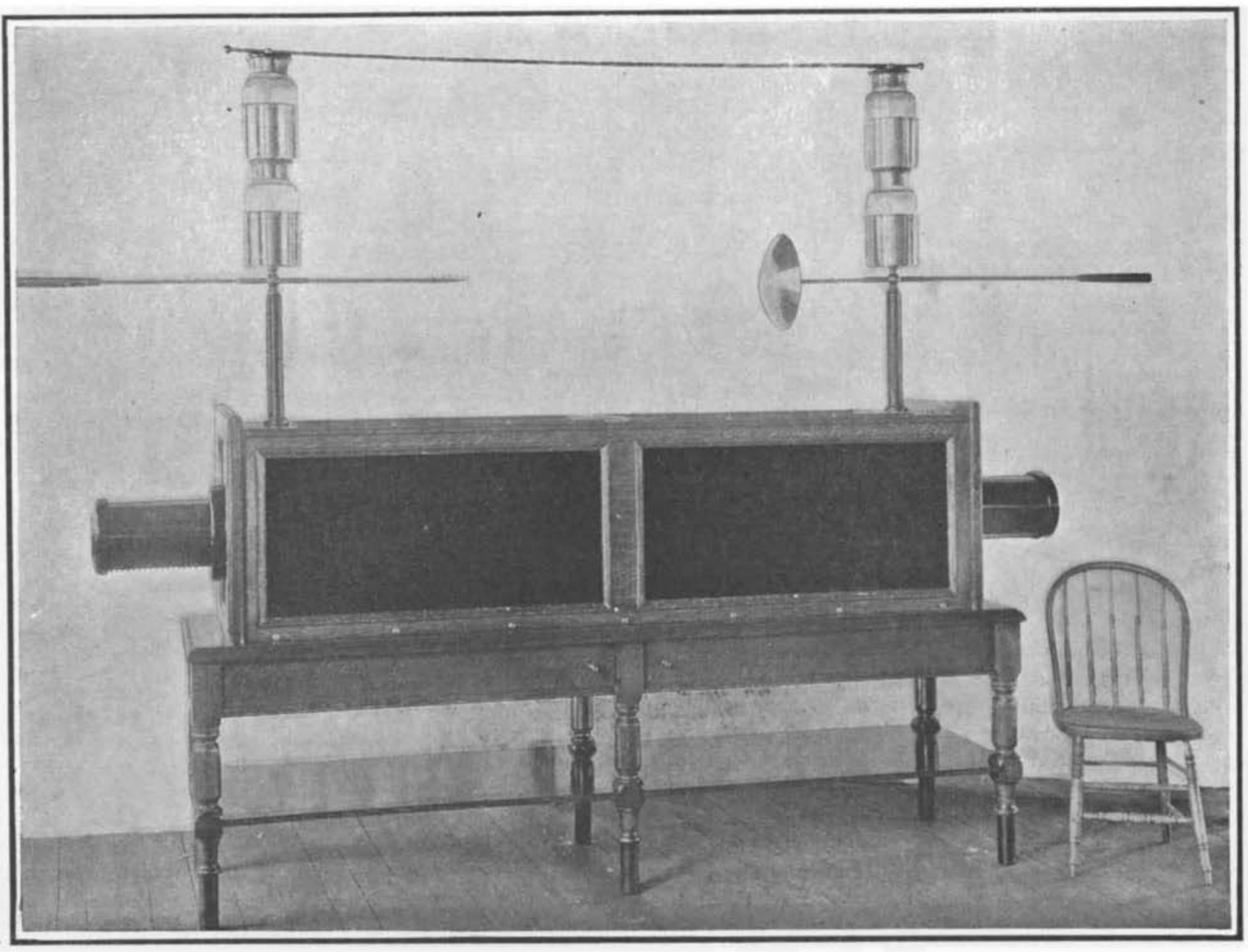
AN ENORMOUS INDUCTION COIL.

BY CHARLES B. HAYWARD.

Developments in automobile ignition on the one hand, and in wireless telegraphy on the other, have taken the induction coil from the laboratory, and in less than a decade have made of it a piece of electrical apparatus of far-reaching importance. With this difference, however: that on the automobile it has practically reached its zenith, and is likely to be supplanted sooner or later by a system of ignition employing a mechanical current generator, either embodying the coil within itself, or dispensing with it altogether, while in wireless telegraphy its possibilities are unbounded. The development spoken of has been along directly opposed lines, in that the aim of the experimenter has been to reduce the size and increase the efficiency of the coil for automobile use, while advances where wireless telegraph coils are concerned have been mainly in the direction of size and better insulation, current consumption naturally being a negligible factor for the latter service.



AN ENORMOUS INDUCTION COIL WHICH MAKES A SPARK 50 INCHES LONG.

The induction coil of the present day for automobile use has been brought to such a high state of refinement and efficiency, that it is scarcely half the size of its predecessors of as recent a date as 1904, and no longer bears the faintest resemblance to its prototype of the laboratory, though the classic lines given it by Ruhmkorff are still apparent to some extent in its powerful successors that are employed to flash messages across space. In fact, it was not until the induction coil and its makers went into experimental sessions extending over two or three years, that it really became an accessory of value to the automobile.

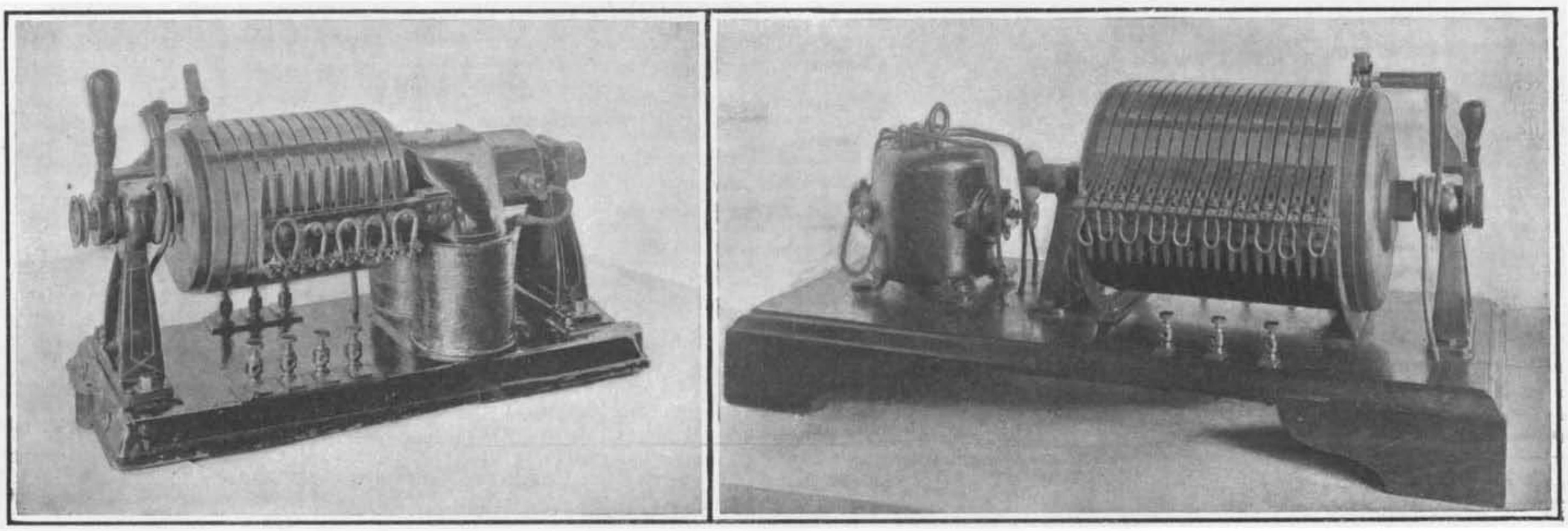
In the course of developing both types of coils, an American manufacturer undertook to build an experimental type that should be the largest of its kind extant, and the result of his efforts is pictured in the accompanying photograph. It is not only unique in point of size, but also differs totally in design and construction from the ordinary type of induction coil. To begin with, its primary core is 6 feet in length by 4 inches in diameter and weighs 210 pounds. The primary winding consists of two layers of No. 6 B. & S. gage, double cotton-covered magnet wire, there being 748 turns in all. The resistance of this winding is but 6.2 ohms, although the wire composing it tips the scales at an even hundredweight. The insulation between the primary and secondary—naturally one of the most vital factors in the entire construction of the coil—consists of a micanite tube 10 feet long. The walls of this tube are 1½ inches in thickness, its inside diameter being 5 inches, and the external diameter, 8 inches.

The secondary winding is made up of 284 separately-wound coils but 3/16 inch thick and not unlike a pancake. They are 9½ inches inside diameter by 13½ inches outside. Unlike smaller coils, no attempt has been made to use unusually fine wire, nor have any extraordinary precautions been taken to insulate superimposed layers from one another. Instead, No. 32 B. & S. double cotton-covered magnet wire has been employed, there being 961 turns in each of the pancake coils, the coils themselves being insulated from their neighbors on either side by means of micanite plates, 1/32 inch thick. These plates extend beyond the contour of the windings at every point in their circumference for an inch or more, utilizing the long air gap thus interposed to prevent short circuiting from one coil to another, instead of the customary practice of impregnating the entire coil with paraffin or similar insulating material. In the secondary winding, when assembled complete, there are no less than 272,924 turns, or 138.3 miles of wire in all. The weight of this wire is 213 pounds and its resistance is 118,428 ohms, the ratio of the resistances between the primary and secondary thus being as 1 : 19,101.1. This is naturally its cold resistance, based on a temperature of 68 deg. F., and would be increased by fully 10 per cent before the temperature had risen to a point exceeding the safe working limit.

The insulation throughout the coil consists of mica, the secondary coils all being exposed to the air. The cabinet work on the coil consists of wood that had been subjected to a long and thorough vacuum drying process, after which it was immersed in boiling paraffin, the remainder of its inclosure consisting of plate glass sunk in deep rabbets in the wooden frame, and protected by felt strips to exclude every possible suspicion of moisture from reaching the interior. The coil operates on 110-volt direct current, and when producing a spark 50 inches long, consumes 25 amperes.

It would manifestly be out of the question to construct a magnetic vibrator of the type ordinarily used on small induction coils to handle such a current, and the method of accomplishing this part of the coil's operation is quite as interesting as the details of the latter itself. A drum, 12 inches in diameter and carrying 20 copper rings, is driven by a small direct-current motor, as shown by the accompanying illustration. The drum consists of an insulating material, and each one of the rings is insulated from its neighbor, while the rings themselves are split at diametrically opposite points and mica sections inserted, thus making the whole construction similar to a 40-bar commutator, except that the bars are parallel in a vertical plane. The comparison may be carried further, in that there are two oppositely-disposed sets of brushes employed, the carriers holding 40 in all, or a pair for each ring. All of these brushes are connected in series, so that the current has to pass from one brush to its corresponding ring, through the latter to the brush diametrically opposite; from that brush to its neighbor, and back through the adjoining ring to the brush adjacent to the one at which it started, progressing in this manner through the whole series. For every revolution of the drum, two interruptions of the current are produced, but the brushes, rings, and the mica insulators of the latter are so arranged that this break is accomplished throughout the whole series at the same moment. At 1,000 R. P. M. of the driving motor, 2,000 impulses are thus produced in the coil, the duration of the interruption amounting to 1/39,424 part of a second. The length of the break as compared with the duration of the contact is as 1 : 2,240, from which it will be evident that the current is broken with practically the same rapidity with which the iron core demagnetizes. There is accordingly almost an entire lack of the inductive "back kick," common in coils depending upon a magnetic vibrator for their operation, and a condenser across the primary is of little or no service.

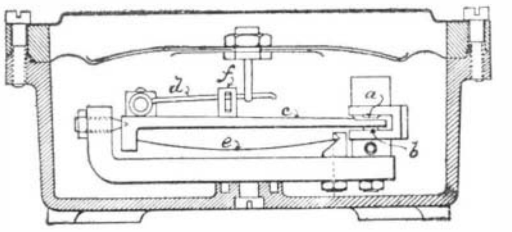
Larger coils than this have been built, notably those constructed by Prof. Elihu Thomson and by Nikola



The commutator forms part of the armature of the motor. The commutator is driven by the motor through step-down gearing.

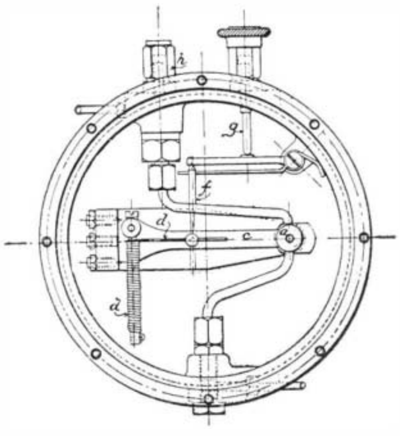
TWO FORMS OF INTERRUPTER FOR THE ENORMOUS INDUCTION COIL.

Tesla, but they were of the high-frequency type. Some other unusually large coils of a type similar to the Heinze coil just described are the Spottiswood coil, of English make, and designed to give a spark of 42 inches between terminals, and a coil of German design and manufacture, said to be at the University of Charlottenburg, Berlin, with a capacity of bridging a gap of 46 inches; so that the Heinze coil, which was made in this country, may be said to be the largest extant using a direct current and operating through a mechanically-driven circuit breaker.



The compressed-acetylene flashing chamber.

Considerable interest attaches to the calculation of the voltage produced in the secondary of such a monster coil as the 50-inch Heinze coil described. It has been ascertained that the voltage necessary to jump a gap increases rapidly up to one inch, and then decreases up to about 24 inches. From that point it appears to increase again, for the reason that the air is apparently such a good conductor, that it is necessary to provide an enormous amount of energy to make good the leakage through the air and still produce a spark. From all measurements and calculations that have been made, it is estimated that the voltage necessary to bridge the 50-inch gap is in the neighborhood of 1,000,000 volts. It goes without saying that no instruments have ever been designed to measure this more than approximately. This huge coil has largely been used for experimental work, and has given excellent results in service.



Plan view of the compressed-acetylene flashing chamber.

FLOATING LIGHTS OF INLAND WATERS.

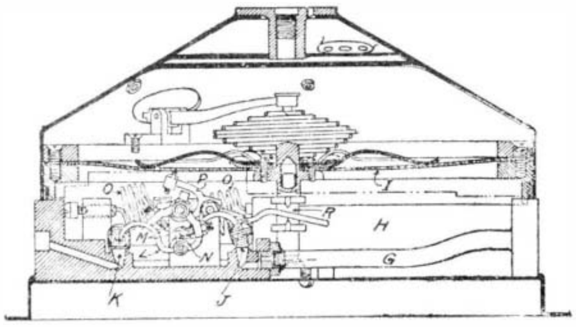
With the towering lighthouse that blinks its warning signal unperturbed while the tempest storms at its base, and the solitary stump-masted lightship that fights a hand-to-hand battle with the waves, we have been made familiar by many a thrilling tale; but seldom, if ever, do we find any mention of the humble light buoy which does its duty day and night without any attendance for months at a time. Yet these buoys are indispensable to navigation, and in themselves possess a great amount of interest.

Obviously, a buoy must be able to take care of itself. It would be enormously expensive to light and trim the lamps every evening, and it frequently happens that because of storm, fog, or ice, no one can approach them for weeks at a time. For this reason light buoys are usually arranged to burn continuously, night and day, the extra amount of fuel thus consumed being more than offset by the saving in expense of tending the lamp.

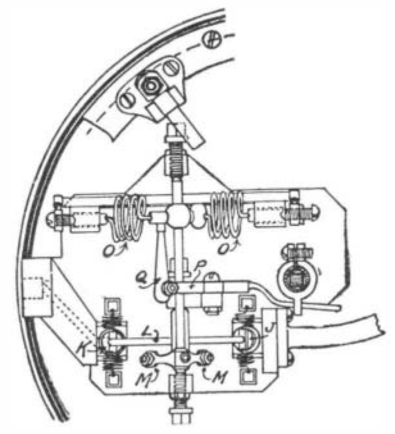
For many years the only light buoys used by this government burned compressed oil-gas, or Pintsch gas, stored in the shell of the buoy. Now, acetylene-gas buoys are being introduced with considerable success. Recently electricity was tried, but found wanting, owing to the difficulty of maintaining the electrical circuits.

As the lamp of a buoy lies close to the water, the light is liable to be mistaken for a ship's lantern, and for this reason it is customary to provide the lamp with a flashing mechanism producing an intermittent light, the character or period of which may be varied to differentiate one buoy from another. Furthermore, the intermittent light results in a great saving of gas, the exact amount of which will depend upon the relation of the dark periods to the flashes or light periods.

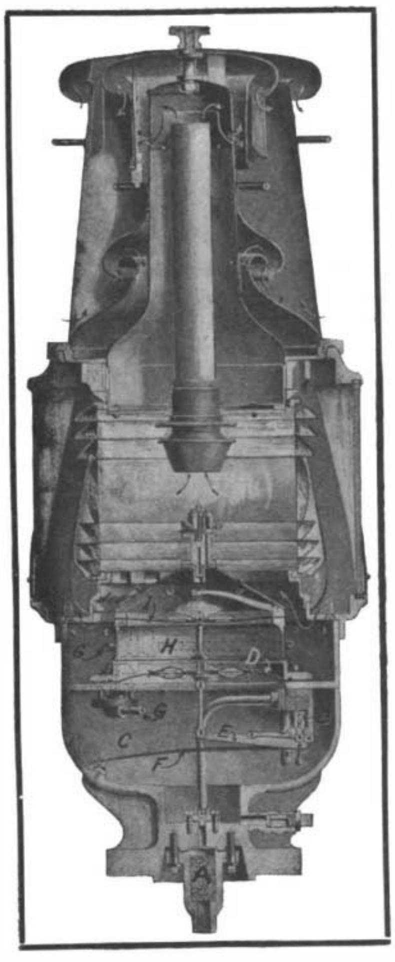
The flashing mechanisms used on these buoys are very ingeniously contrived, and have reached a high degree of development. They are actuated by the pressure of the gas they burn, and work with clocklike precision. One of our illustrations shows a vertical section taken through the flashing mechanism of a Pintsch light buoy. The gas enters the lamp through the strainer *A*, and passes by way of the valve *B* into the pressure-regulating chamber *C*. This chamber is provided with a flexible diaphragm *D*, connected by a link to a lever *E*. As the chamber fills, the diaphragm flexes upward, raising the lever *E*, and operating the valve *B* to throttle the flow of gas. A spring *F* resists this motion of the lever *E*, and thus governs the pressure of the gas admitted into the chamber. The gas flows from chamber *C*, through pipe *G*, to the flashing chamber *H*. The details of the mechanism in this chamber are best shown in the line drawings. The upper wall of the chamber *H* consists of a diaphragm *I*, which is normally pressed downward by a coil spring. When the chamber fills with gas the diaphragm rises, shutting off the inlet valve *J*, and opening the outlet valve *K*, through which the gas passes to the burners; and when the diaphragm falls, it closes the outlet valve and opens the inlet valve. A special mechanism is provided to effect a positive opening and closing of the valves, else they might assume a neutral or partly open position, and permit a continuous flow of gas to the burner. The valves are connected to the opposite ends of the lever *L*. A rock shaft carries at one end a pair of pallets *M*, adapted to engage a pin *N* formed on the lever *L*. A pair of compression springs *O* bear against the ends of a cross piece, mounted on the opposite end of the shaft. These springs serve to throw the shaft out of a central or neutral position, causing one or other of the pallets *M* to hold the valve lever *L* in inclined position. The rock shaft is operated by means of a yoke *P*, which bears either on the upper or lower side of plate *Q*, formed on the shaft. The yoke is carried by a lever, which at the opposite end projects between a pair of stops formed on a sleeve *R*, connected with the diaphragm *I*. While the flashing chamber *H* is filling with gas, the valve *K* remains tightly closed, and the lamp is dark with the exception of a tiny pilot flame fed from a small by-pass tube. When the diaphragm has been flexed upwardly sufficiently, the yoke *P* presses the plate *Q* downward, and the springs *O* then act to throw the left-hand pallet *M* sharply against the pin *N*, forcing the valve *J* shut and opening the valve *K*. The gas now flows to the burner



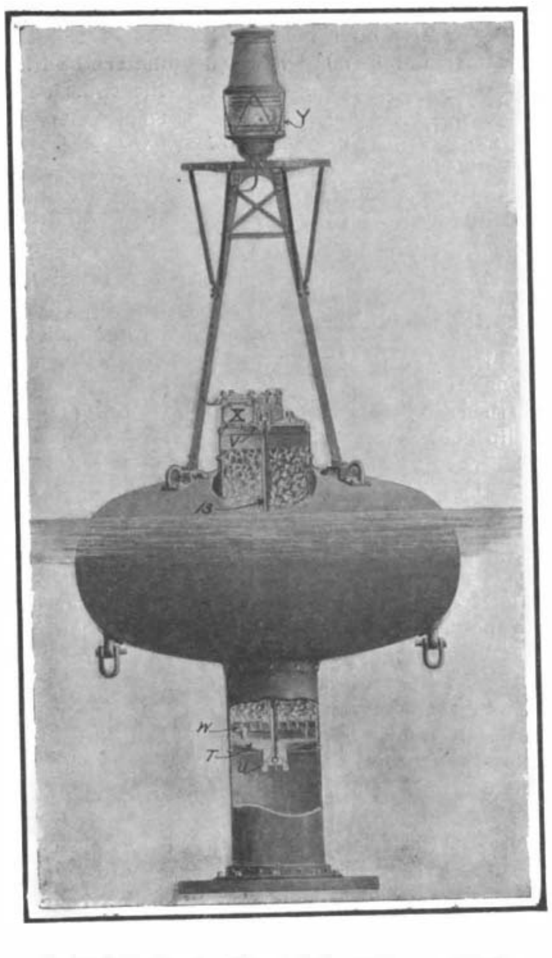
Section through the flashing chamber of the Pintsch lantern.



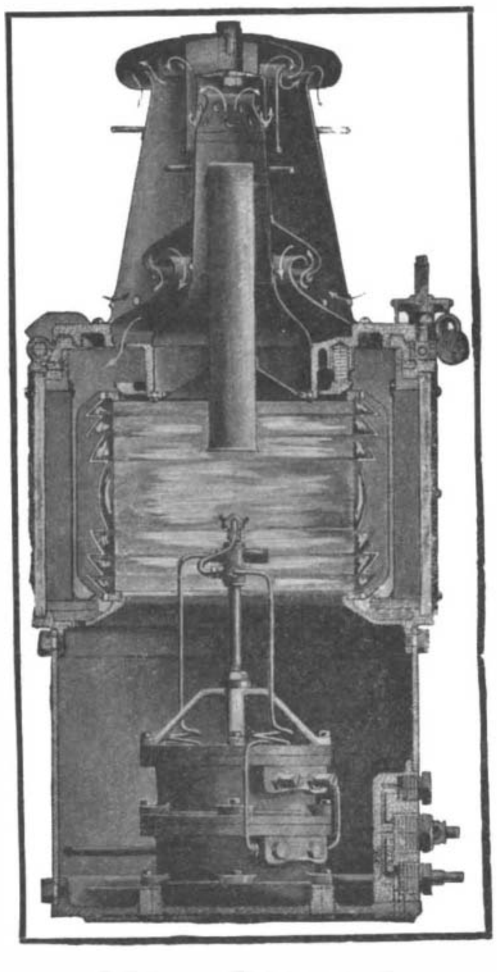
Plan view of part of Pintsch flashing chamber.



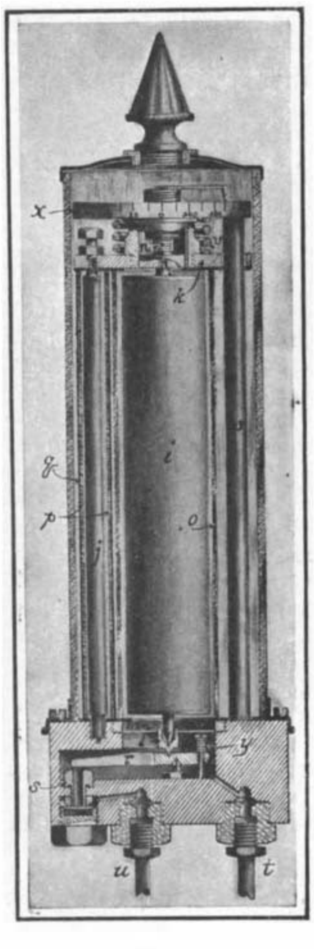
The flashing mechanism of the Pintsch gas lantern.



Acetylene is generated by entrance of sea water into the carbide tank.



A lantern using compressed acetylene.



Sun valve. Gas is turned off by day and on at night.

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