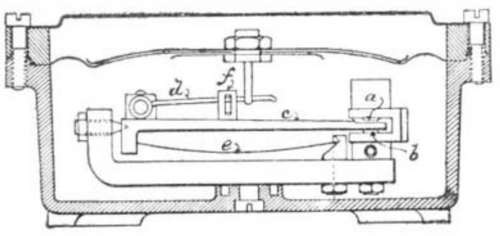
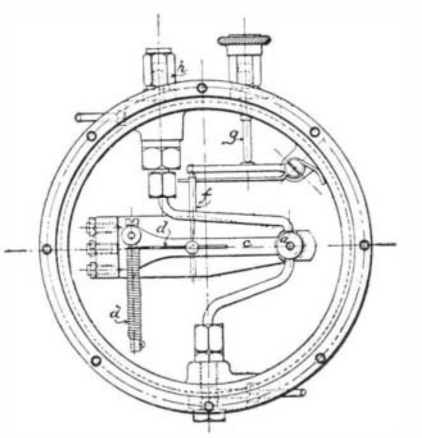
Tesla, but they were of the high-frequency type. Some other unusually large coils of a type similar to the Heinze coil just described are the Spottiswood coil, of English make, and designed to give a spark of 42 inches between terminals, and a coil of German design and manufacture, said to be at the 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



The compressed-acetylene flashing chamber.

using a direct current and operating through a mechanically-driven circuit breaker.

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.

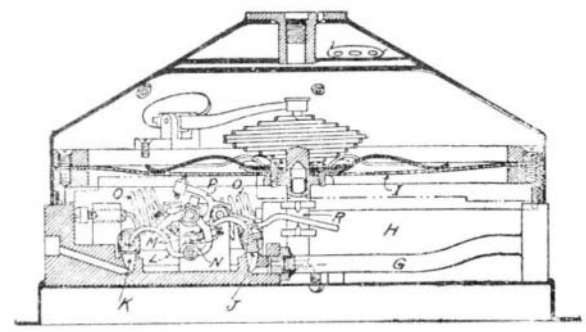
With the towering lighthouse that blinks its warning signal unperturbed while the tempest storms at its base, and the solitary stump-masted lightship that fights a hand-to-hand battle with the waves, we have been made familiar by many a thrilling tale; but seldom, if ever, do we find any mention of the 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.

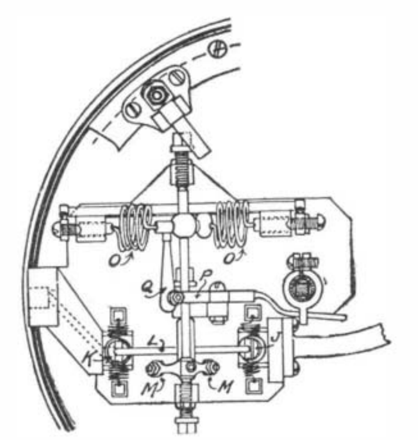
As the lamp of a buoy lies close to the water, the light is liable to be mistaken for a ship's lantern, and for this reason it is customary to provide the lamp with a flashing mechanism producing an intermittent light, the character or period of which may be varied to differentiate one buoy from another. 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



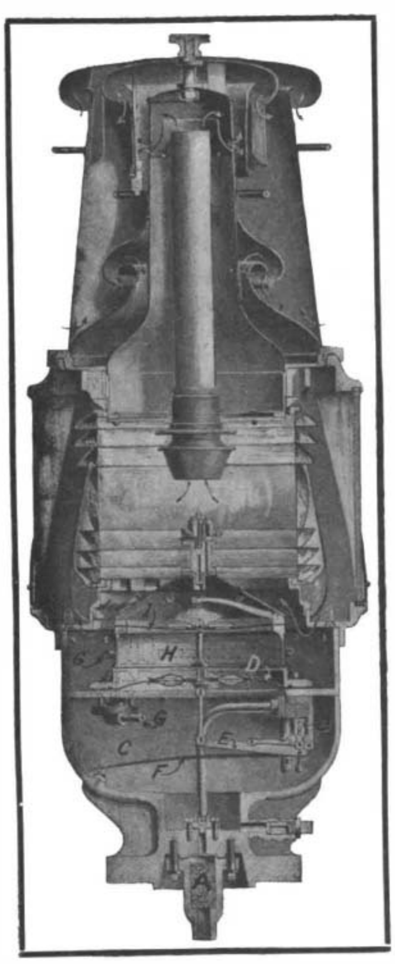
Section through the flashing chamber of the Pintsch lantern.

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

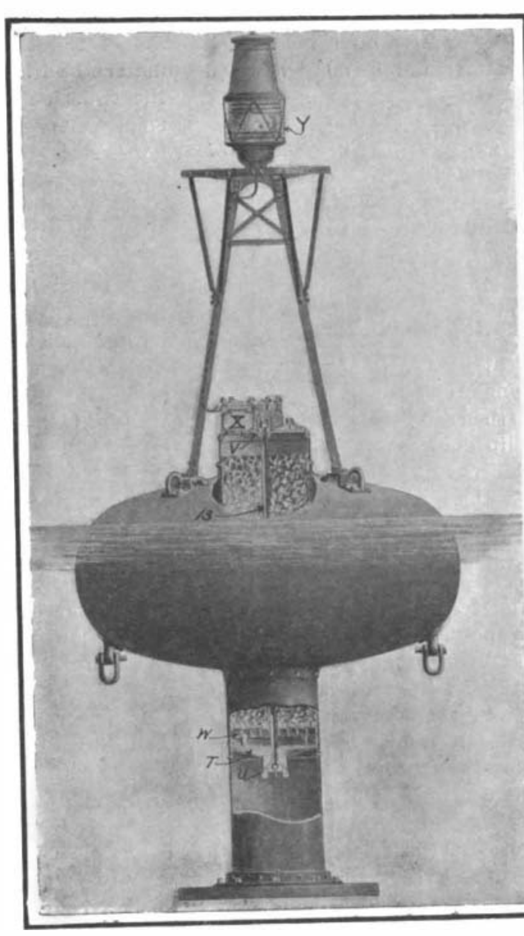


Plan view of part of Pintsch flashing chamber.

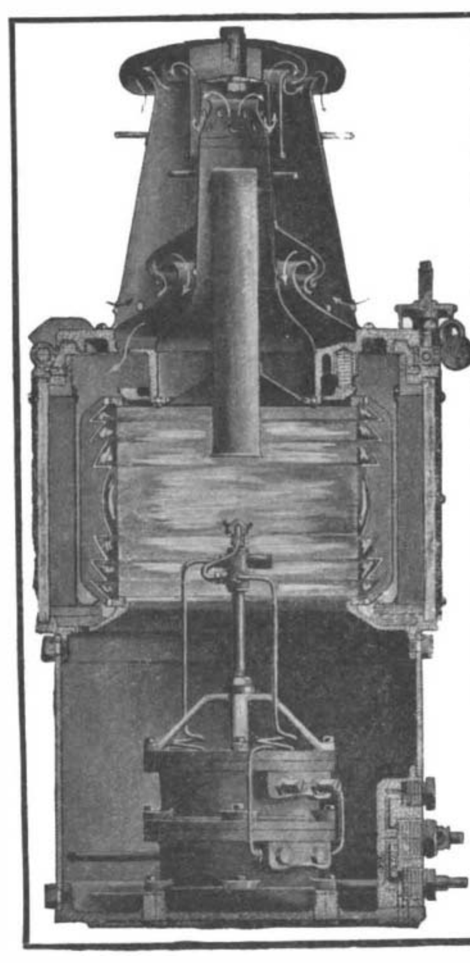
tightly closed, and the lamp is dark with the exception of a tiny pilot flame fed from a small by-pass tube. When the diaphragm has been flexed upwardly sufficiently, the yoke *P* presses the plate *Q* downward, and the springs *O* then act to throw the left-hand pallet *M* sharply against the pin *N*, forcing the valve *J* shut and opening the valve *K*. The gas now flows to the burner



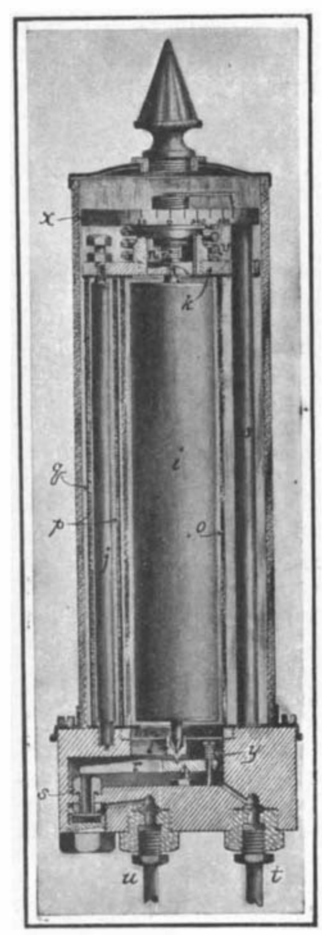
The flashing mechanism of the Pintsch gas lantern.



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.

FLOATING LIGHTS OF INLAND WATERS

under pressure of the spring, which bears against the diaphragm. A constant pressure at the burner is thus assured, even though the pressure in the gas reservoir may fall greatly during the several months of consumption. The flashing mechanism is usually adjusted to give equal periods of light and darkness of five seconds each. While the period of light cannot be regulated, a valve controlling the flow of gas into the flashing chamber may be adjusted to increase or decrease the interval of darkness. The lantern is fitted with a cylindrical lens of the type used in lighthouse lanterns, which projects the light in a horizontal zone.

Of the acetylene buoys, the oldest type is one in which the gas is generated by the admission of the sea water into a tank containing calcium carbide. One of our engravings illustrates the complete buoy, partly broken away to show the steel generator tube in which the carbide is stored. The tube is supported by a float chamber, on which the lantern tower is mounted. A counter weight in the form of a disk with a small central opening to admit the water is bolted fast to the bottom of the generator tube, in order to give the buoy the necessary stability. A diaphragm *T* is located in the lower part of the generator tube, and is fitted with a conical valve *U*, the stem of which passes up through the generator head *V*. A nut on the end of the stem permits of adjusting the valve. A cap screwed down on the generator head may be adjusted to press the stem downward, and keep the valve open to the desired degree. The generator tube is filled with large crystals, 8 by 4 inches, of calcium carbide. Water enters through the valve *U*, and passing through the grate *W*, comes in contact with the carbide. The gas which is immediately generated passes through a purifier *X* and thence to the lantern *Y*, which is fitted with a flashing chamber of the same type as the one described above. At first the gas is formed more rapidly than it can be consumed at the burner, but soon it reaches sufficient pressure to prevent water from entering through the valve, and this pressure is automatically maintained; for as soon as the pressure drops, the water enters and more gas is formed.

In a more recent type of acetylene buoy the gas is generated, not by admitting water into the carbide, but by dropping carbide into the water. At first sight, it might seem as though the result would be the same; but it is claimed for the latter method that the gas produced is more pure, because the heat generated when gas is formed is absorbed by the water. The cool generation prevents the breaking up of the acetylene into other hydrocarbons. The carbide used in this buoy is in granular form.

In another type of acetylene light buoy, the fuel is not generated in the buoy, but is stored under pressure in tanks. The tanks contain a porous material which absorbs acetone, a fluid similar to wood alcohol. The acetone has an affinity for acetylene, and absorbs twenty-five times its own volume of gas at a pressure of 150 pounds under a normal temperature. The porous material which absorbs the acetone prevents danger of an explosion, for under ordinary conditions compressed acetylene is very highly explosive. The advantages claimed for the use of compressed acetylene are that the gas being generated in the factory may be made absolutely pure, so that there is no danger of carbonizing at the burner. This permits the use of a much smaller pilot flame, the lamp we illustrate using 1/75 of a foot per hour for this purpose. The tanks in which the gas is stored are placed on each side of the central tube and contain a supply sufficient to last from nine months to a year, depending upon the duration of the flash.

The flashing mechanism used in this type of buoy differs materially from the one described above. As shown in the drawing, the upper wall of the flashing chamber consists of a flexible diaphragm. The inlet valve seat is indicated at *a*, and the outlet at *b*. A valve lever *c* is mounted to operate between these valve seats. The valve lever is magnetized, and clings strongly to the seat, with which it is in contact. It is moved into engagement with valve seat *a* by the diaphragm, acting through a spring *d*, while the spring *e* serves to return the lever against the valve seat *b*. The spring *d* is mounted on the lever *c*, and its tension is adjustable. The end which is fastened to the diaphragm projects through a slotted yoke on the lever. As the diaphragm rises during the filling of the chamber, the end of the spring is drawn upward without moving the lever until it strikes the upper wall of the slot, when with the increased leverage thus afforded, the diaphragm lifts the valve lever off the valve seat *b*. Thereupon the lever springs against and clings to the valve seat *a*. The gas now flows out of the chamber to the burner at a rate that is determined by the tension of the spring *d*. The dark period, or the interval during which the chamber is filling, may be varied at will by means of a wedge *f*, which is forced into the slotted yoke to limit the play of the spring therein, so that the diaphragm will more quickly lift the lever to close the inlet port and open the outlet to the burner. The wedge *f* is operated by a thumb screw *g*. The flow of gas can be regulated by means of a thumb screw *h*. So delicate is the adjustment, that one cubic foot of acetylene can be divided into 56,000 flashes.

In connection with this type of light buoy, a most ingenious device called a sun valve is sometimes used for turning off the gas by day, and turning it on again at night, thus saving from 30 to 40 per cent of the gas consumed. The device is a Swedish invention, and has been used with success in Sweden for a number of years. At present it is being subjected to an exhaustive test by the United States Lighthouse Establishment. The sun valve depends for its operation upon the difference of expansion between a copper cylinder coated with lampblack and three copper rods protected from radiant heat by silver-plated sleeves. As shown in the engraving, the carbon-coated cylinder is placed in the center at *i*. Equally spaced about it are three copper rods *j*, mounted in the base of the instrument and supporting a head *k*. The cylinder *a* rests at the bottom in step *l*, carried by a diaphragm *m*, while at its upper end it engages a slide *n* in the head *k*. The cylinder *i* is protected by a heat-insulating tube of glass *o*, and the rods *j* are protected by similar glass insulating tubes *p*. Over the tubes *p* silver-plated sleeves *q* are placed, which serve to reflect radiant heat. In the base of the instrument is a gas chamber, in which is fulcrumed a valve lever operating over the valve seat *s*. This lever is magnetized, so that it will adhere to the valve seat. The gas flows from the gas tanks through the sun valve by way of the inlet *t*, valve *s*, and outlet *u*, and to the flashing chamber. At night the valve lever *r* is raised, so that the flow of gas is not interrupted; but in the day time, when the radiant heat of daylight strikes the sun valve, it is absorbed by the carbon coating of cylinder *i*, causing the latter to expand, but it does not expand the rods *j*, owing to its reflection from the highly-polished silver-plated sleeves *q*. The head *k* is held down by means of a spring *v* abutting against a disk supported by the rods *w*, and hence the cylinder *i* presses the step *l* downward, forcing the valve *r* into engagement with the valve seat *s*, and thereby shutting off the flow of gas. As darkness comes on, the cylinder *i* loses its heat and contracts, permitting the lever *r* to rise under action of a spring *x*. The sun valve may be regulated by an adjusting nut *y*, which may be moved to raise or lower the slide *n*, and thus vary the pressure of the cylinder *i* on the valve lever *r*. It must be understood that the valve cannot be operated by heat conducted from the surrounding atmosphere, for the sleeves *q* offer no resistance to heat of this form, and the rods *j* will expand and lift the head *k* while the cylinder *i* is expanding. Thus, should there be a sudden change of temperature during the night, it will not affect the sun valve, but as soon as daylight comes, the radiant heat that accompanies light passes through the glass insulating tubes, and causes the unequal expansion which operates the valve. The advantage of this valve over a clock mechanism is that it does not have to be regulated for days of different length, but operates automatically at any time of the year, turning on the gas as soon as it commences to grow dark, whether because of a fog or lowering clouds. Although as we have stated above, the sun valve has been used on light buoys, the instrument is really too delicate to be exposed to the buffeting it would receive on buoys placed in stormy waters, and is more adapted for use on a fixed light.

AERIAL DEFENSE ARTILLERY.

It is a curious fact that the promise of a practical fighting ship of the air has called forth means of defense which are strikingly similar to those which are used against the fighting ship of the high seas. To oppose a hostile fleet, we build opposing fleets, and send them out to meet the enemy as far distant as possible from our own shores, and destroy him. Should he elude our ships, or defeat them and appear off our coasts, he is met by the long-range gun.

Things are so shaping themselves in the development of the military airship and aeroplane, that it is already evident that similar means of defense will be employed. Unquestionably, the most effective way to defeat an aerial navy, and to detect and destroy its outlying circle of scouting aeroplanes, will be to build and equip similar fleets, and surround them with a far-extended fringe of aerial scouts. If military aeronautics ever are carried to the point at which airships are built in sufficient numbers to be assembled in fleets, it is probable that these fleets will be made up of dirigible airships, built in sizes corresponding to our cruisers and battleships. It is also probable that to the aeroplane will be relegated the duties which now fall upon the fast scout, the destroyer, and the torpedo boat.

At the present time, however, the science of aerial attack and defense is very much in the air in more senses than one. Nobody knows in just what way the new engine of war will be used in attack, and it is just as problematical as to what will constitute the best form of defense. The SCIENTIFIC AMERICAN has always believed that the only practicable way to resist aerial attack is from the air itself; that is to say, by opposing dirigible to dirigible and aeroplane to aeroplane. But failing this, as a forlorn hope, recourse must be had to artillery. We have several times pointed out that the difficulties of accurate shooting are enormously increased when the object aimed at can move in three dimensions. Moving objects upon the land or the sea may be located, thanks to modern range-finding, with great accuracy. As far as the gunner is concerned, the distance of the object may be met by a corresponding elevation, and direction by corresponding traverse; the range finder will give the changes of position, and the gun may be kept upon the object with remarkable accuracy. Furthermore, errors of range and traverse may be corrected by observing the fall of the shot, as indicated on land by the cloud of dust or the burst of explosion, and on the sea by the splash of the water.

But in the air, where the moving object is ever changing its position laterally, longitudinally, and vertically, the difficulties of the range finder and the gun pointer are increased to the point of bewilderment. Moreover, with ordinary artillery he has no means of determining by dust clouds or water splash whether his shots are long or short, to right or left, above or below, the object.

However, the military men of Europe have so far recognized the potentialities of the new warfare, that they have already designed artillery for the express purpose of attacking the dirigible and the aeroplane; and the great firm of Krupps have worked out two designs of weapons for aerial defense. Necessarily, all firing must be of the high-angle kind; and the guns must be capable of rapid training over a wide arc of fire. These conditions are met in the two guns herewith illustrated, one of which is mobile for operations in the field, and the other designed for a fixed position either on fortifications or on board ship, or possibly on a moving platform, such as would be afforded by an automobile or an auto truck. The field gun is a 2½-inch piece, which fires a 9-pound shell with a velocity of 2,000 feet per second. The gun is mounted to slide on a chassis, in which is contained the spring recoil mechanism. The chassis is pivoted near the breech of the gun, and elevation is secured by means of a large vertical hand-operated screw. The methods adopted for traversing the gun, which may be moved through a circle of 360 degrees, are particularly ingenious. A large pin passes through the tail of the gun carriage into a fixed shoe, which is driven into the ground. The two wheels of the carriage are attached pivotally near the front of the carriage, and, by means of a hand wheel and suitable gear, they may be swung around in front of the gun until their axles are radial to the fixed tail pin above referred to. By this arrangement the whole gun carriage may be traversed through a circle of 360 degrees. Furthermore, the gun itself may be traversed upon its carriage by means of a system of swivel bearings, which permit of a rapid change of training independently of the gun carriage.

The most novel and meritorious feature of this gun, however, is the means which have been adopted to enable the gunner to follow the flight of the projectile. The shells have been so designed that they are ignited at the moment of discharge, and the slow-combustion material with which they are filled burns slowly, with the emission of much heat and smoke. The trail of smoke marks the exact line of flight of the projectile, and assists the gunner in "finding" the mark. In one of the accompanying illustrations, the path of the shell is recognizable by the dark gray line, passing diagonally across the picture just above the balloon. This type of shell is designed for use against gas-inflated balloons and dirigibles; and it is believed that when the shell passes through the gas bag, the gas will be ignited and the balloon destroyed.

For the attack of aeroplanes, some other form of projectile must be used; and we believe that shrapnel will be found the most effective. The burst of explosion will assist the gunner in correcting his aim; and the wide dispersion of fragments and bullets will afford the only likely means of "winging" the small and elusive aeroplane in its swift flight through the air. The aeroplane of the near future, if present indications are reliable, will fly at a speed of 60 miles an hour or more, and swing to the right or left and swoop up and down with the swiftness of a stormy petrel. It will be an exceedingly difficult object to hit.

It is probable that the institution of the North American Conservation Congress for the protection of National Resources, the first session of which was held on February 18th, will lead to the extension of the idea by the institution of a great international conference for the conservation of all natural resources. President Roosevelt formulated a call for such a congress, and it is proposed that the conference meet at The Hague in September of this year. This action was prompted by many intimations conveyed through diplomatic channels that such a conference would be welcomed by a considerable number of the powers.