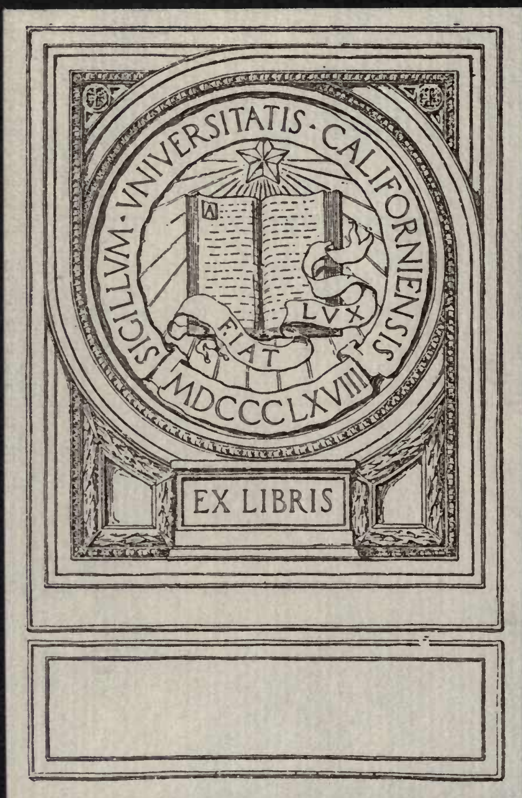
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US Lighthouse Board

REPORT ON USE OF ACETYLENE GAS BY THE CANADIAN GOVERNMENT AS AN ILLUMINANT FOR AIDS TO NAVIGATION

BY

ALBERT ROSS

Captain, U. S. N., Member of the Light-House Board

WASHINGTON

GOVERNMENT PRINTING OFFICE

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LETTER OF TRANSMITTAL.

DEPARTMENT OF COMMERCE AND LABOR,
LIGHT-HOUSE BOARD,
Washington, October 3, 1906.

SIRS: I have the honor to report that in obedience to the Board's orders of September 21, 1906, I proceeded to Ottawa, Canada, and conferred with the Canadian light-house officials on light-house matters, and especially in regard to acetylene lighting. My report is appended hereto.

The trip was made successful and its value very much enhanced by the interest shown by the prime minister, Sir Wilfrid Laurier; the consul-general of the United States at Ottawa, Mr. John G. Foster; the deputy minister of marine and fisheries, Col. F. Gourdeau, and Mr. James F. Fraser, commissioner of lights Therefore especial acknowledgment is made of their courtesy.

Respectfully,

A. ROSS,
Captain, U. S. Navy.

The LIGHT-HOUSE BOARD,
Washington, D. C.

ACETYLENE GAS AS AN ILLUMINANT FOR AIDS TO NAVIGATION.

STATUS OF LIGHTING IN CANADA.

The greater number of light-houses in Canada still use oil, most of which is purchased in the United States, of the standard required by the United States Light-House Board for the use of stations having dioptric lights. Oil for other lights is purchased from a Canadian company.

Buoys of the Pintsch gas type are operated under a pressure of 8 atmospheres. Buoys of the Willson automatic low-pressure acetylene gas type have been adopted, and will eventually take the place of all other lighted buoys in the Canadian light-house service. Some shore stations use acetylene gas under pressure of from 10 to 14 atmospheres and others use the Willson automatic low-pressure acetylene-gas beacon. The most important stations, however, are fitted with petroleum vapor lamps.

ACETYLENE-PRESSURE LIGHTS.

Acetylene gas was first used in the Canadian light-house service in 1901, when acetylene generators were installed in several small river lights. Experiments were made with several gas-generating machines, but none proved entirely satisfactory. Great difficulty was experienced from carbonization of lava tips, as well as in the construction of the tips themselves. The most satisfactory tip discovered is that at present in use. It is made in the United States.

In 1903 all the gas buoys were fitted with "Economic" burners, that burned acetylene with single one-fourth foot burners. The standard Pintsch gas lanterns of 200 mm. lenses were used.

A pressure plant was installed on the light-house tender *Scout*, and its use was continued until the spring of 1905, when an explosion occurred while the tender was engaged in filling three gas buoys at the government dry dock at Kingston, Ontario. Two had been filled to 12 atmospheres and a third was being filled. A pressure of at least 6 atmospheres had been obtained, when, without warning, the first buoy, which had been filled for about an hour and a half, exploded. The shock ruptured and exploded the second buoy alongside and blew the third buoy on its side, breaking the hose and lighting the gas. As a result 4 men, including the captain, were killed and the steamer's upper works were burned. The buoys which failed were two of 39 shallow-draft gas buoys which had been handed over in 1902 by the department of railways and canals when the marine department took over the buoyage of the upper St. Lawrence between Lachine and Prescott. They were defective in construction. The vessel was rebuilt, and the generating plant was installed at the Prescott Buoy Station.

Since the explosion the method pursued has been to reduce the pressure in the gas receptacles to about one-half or two-thirds, with the consequent expense of more frequent refilling or recharging.

Another difficulty found in the acetylene buoys was that the copper hood of the gas lantern was affected by the gases of combustion, which caused a slimy deposit to fall on the lantern and burner. This was obviated by substituting sheet nickel for sheet copper in the central tube and by heavily nickel plating the surfaces exposed to the gases of combustion. At the same time an effort was made to purify the gas, and this has been accomplished in such manner that little difficulty is now experienced from carbonization of tips.

Up to this time endeavor had been made to keep the consumption of gas at about the same as the Pintsch gas on the score of economy. The Canadian government officials now feel that the best light that can be obtained should be burned in order to give to navigators the most efficient aid that can be supplied. This standard was shown in everything offered for inspection. In 1904 the burner was increased to 2 half-foot main flames and in addition occulting burners were fitted with 2 one-eighth foot pilot flames. Since the adoption of the Willson buoy it has been the policy of the Canadian government to remove all pressure buoys at a distance from the compressing plants and to use them as permanent beacons on shore.

In the shore stations between Montreal and Kingston two cylinders 42 inches in diameter and 20 feet long were installed in the lower story of each light-house, and acetylene was substituted for the oil. This change was readily made, as the tender can approach within 300 or 400 feet of each light and supply acetylene gas through hose. These welded-steel gas holders contain 265 cubic feet per atmosphere and were filled to a pressure of from 10 to 12 atmospheres, since reduced to 10. A reducing valve is used, and keepers are found unnecessary.

In many cases where the tower was old and built of wood it was torn down, and a steel gas holder was up-ended on a concrete base, the gas lantern being placed on a square steel box 20 inches on a side containing the reducing valve, which was bolted to the manhole cover. This made a permanent structure which required only painting. The question of protection from cold weather was not considered, as shown in the picture of the Dock Island, British Columbia, beacon.

By this system of installation numerous keepers were dispensed with, allowing the establishment of other lights. In some cases a series of from 4 to 7 lights in close proximity was placed in charge of one caretaker. After a trial of two years the system has been found economical and practical. It requires, however, that the stations be in proximity to the gas-generating plant, and that a vessel be furnished to attend them.

In the ship channel of the St. Lawrence River 45 compression gas buoys are in service, requiring as a tender a gas and derrick scow 90

Dock Island, British Columbia, light, on the run between Victoria and Vancouver, installed March 7, 1906. It contains a 200 mm. lantern, is charged with 1,000 pounds of carbide, and runs four months without recharging. As will be seen, no particular care is taken with regard to temperature conditions.

feet long, 26 feet wide, and of 6 feet draft, with a steam derrick and drum hoist engine of 10 tons capacity. The generating plant located in the after end of the scow includes a "Scout-type generator" with a capacity of 4,000 feet of gas per hour, and has the necessary scrubber, low pressure (fore) drier, to dry the gas over calcium carbide, twin three-stage gas compressors of the Ingersoll-Sergeant type, an after cooler and after drier (high pressure), and a purifying plant.

The compression system of acetylene is in use in other districts both for buoys and for shore stations, and it was intended to establish it in Halifax Harbor, but this will not now be done on account of the adoption of the Willson low-pressure buoy.

PETROLEUM VAPOR LAMPS.

In about eight-tenths of the lights under the Canadian government oil is still used, and in about one-tenth of the most important petroleum vapor lamps are now being installed. The intention was to install this lamp in all of the first-order lights with a mantle sufficient for the requirements of that order. Difficulty, however, has been experienced in the use of mantles of sufficient size to fulfill the requirements of a first-order light. An 85 mm. mantle has been tried, but it is not so reliable as desired. The smaller mantles up to and including 55 mm. have been found entirely satisfactory, and, in the light-houses so far equipped there has been a "consequent increase of light of 500 per cent over the ordinary burner in proportion to the oil consumed."

Experiments are also being made in the use of a mantle with acetylene gas for lights of the first, second, and third orders. This, however, is only in the experimental stage, and the greater amount of work is being done on the production of a larger mantle for use with the petroleum vapor lamp.

It is the intention, as funds become available, to continue the installation of these lamps in all of the important stations, and to extend the Willson low-pressure automatic acetylene system to minor stations and floating aids to navigation, thus obtaining much more satisfactory results than have been obtained by the use of ordinary oil, Pintsch gas, or acetylene gas under pressure.

WILLSON AUTOMATIC GAS BUOY.

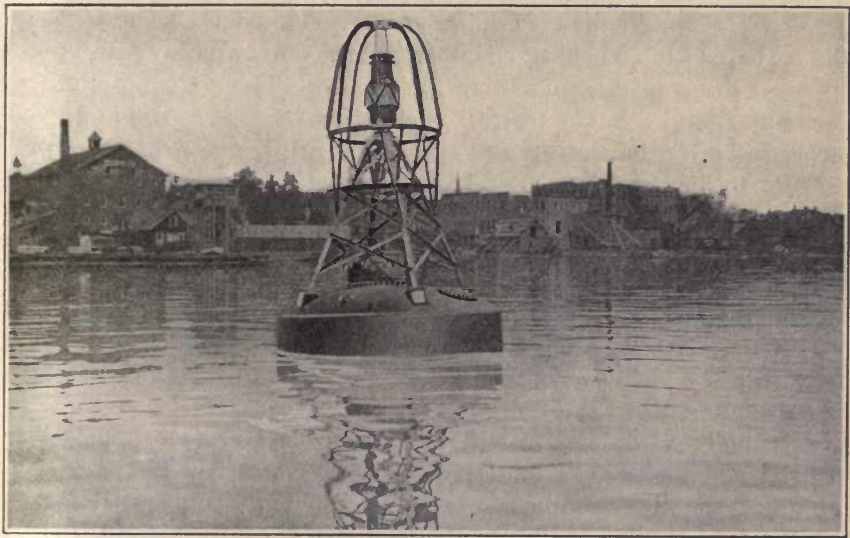
The first automatic gas buoy was made by Mr. Thomas L. Willson. It was given to the Canadian government for test in August, 1904, and shortly thereafter was followed by three others, each of a special type, including the combination gas and whistling buoy. The department of marine at once recognized the utility of the invention and gave Mr. Willson orders for additional buoys of various types to the number of 48 for the year 1904-5. This was later supplemented by an order for 12 shallow-draft buoys and an automatic beacon.

The International Marine Signal Company, of Ottawa, was incorporated August 24, 1906, to manufacture the Willson automatic buoy and carry on a general marine-signal business. The plant at present is composed of two buildings. The larger is a one-story shop, 575 feet long by 60 feet wide, and is now being extended, so that by November, 1907, it will be 1;200 feet long. A railroad track extends through the center of the building and connects with the Canadian Pacific Railroad. This shop, as well as the other, was filled with buoys in all stages of construction, the entire plant being used exclusively for manufacture for the Canadian government. The present daily capacity of both shops is one buoy. After November 1 it will be two buoys, and by November, 1907, it is estimated the output will be an average of four buoys daily.

TYPES OF BUOYS.

A description of the types of gas buoys and gas and whistling buoys which have been placed in service follows:

Nos. 5 and 6 shallow-draft river and harbor gas buoy.—This is a small buoy in which a Pintsch gas lantern is used with two one-fourth foot main flames and two one-eighth foot pilot flames. The flotation chamber, 6 feet in diameter, is cylindrical and is formed of a body plate and two shallow dished heads. The generating tube is 24 inches in diameter. The light is exhibited 7½ feet above the water.



No. 7 buoy off light-house depot, Prescott, Ontario.

No. 7 standard gas buoy.—This size of buoy has been adopted as the standard for general requirements. It has a cylindrical flotation chamber composed of a body plate and two shallow dished heads. The diameter of the flotation chamber is 7 feet. A standard Pintsch gas lantern is used with two one-fourth foot and two one-eighth foot pilot flames, and the light is exhibited 7½ feet above the water. The generating tube is 30 inches in diameter and the carbide charge is 2,500 pounds.

No. 9 combined gas and whistling buoy.—This is the lighted whistling buoy, the Courtenay principle being used to produce the sound. It has a cylindrical flotation chamber 9 feet in diameter, is composed of a body plate and two shallow dished heads, and draws about 19⅓ feet of water. The generating tube is centrally located, and twin whistling tubes, 20 inches in diameter, are provided. It has a 10-inch whistle, and was designed to have the same whistling power as the Courtenay buoys now in the Canadian service. The light, exhibited from a standard gas lantern, is shown 16 feet above the surface of the water. The generating tube is 30 inches in diameter, and the carbide charge is 3,000 pounds.

The types of buoys mentioned below are modifications of those already described, the changes consisting only in shape and size. Illustrations of these buoys and the method of their construction will be found in the pamphlet entitled "Automatic Gas Buoys."[a]

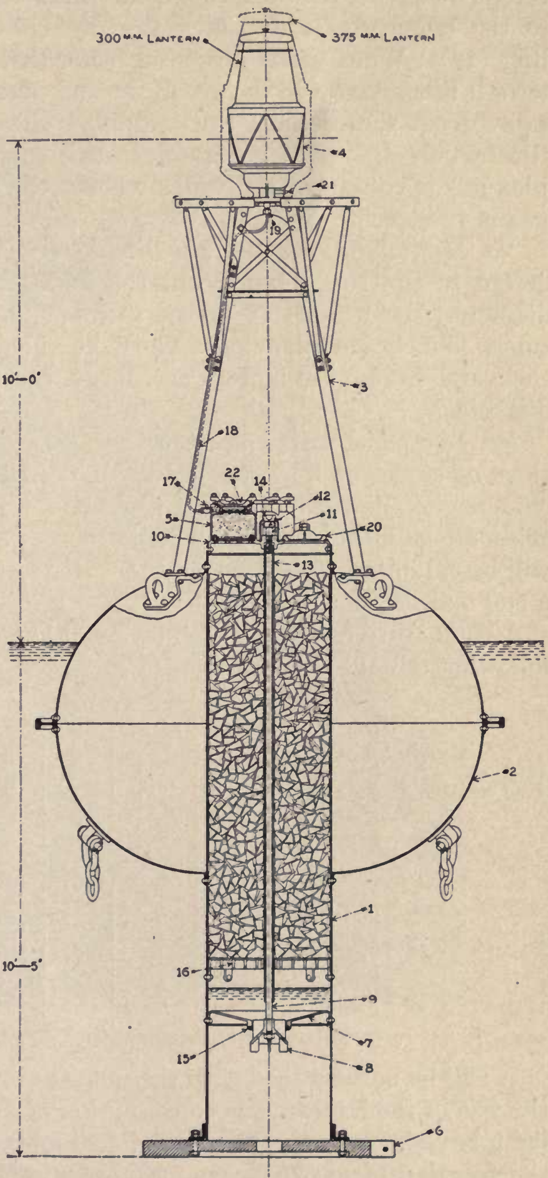
No. 6½ shallow-draft gas buoy.—In future this will be used for the same service as the No. 5 buoy. The flotation chamber consists of two symmetrical hemispheroidal heads with a collision rail of 65-pound railroad steel riveted at the junction of the two pieces.

No. 8½ automatic gas buoy (standard).—This buoy is shown in the figure herewith. The float chamber is formed of two heavy steel plates pressed to hemispheroidal shape, as shown. The abutting edges are machined, and a heavy tee rail is closely riveted over the joint so as to form both a butt strap and a collision rail. The float chamber is 8½ feet in diameter, and it is 9 feet 4 inches in diameter over the collision rail. The generator tube is a heavy welded steel tube, holding a charge of 2,500 pounds of carbide. The lantern table is fitted to take either the 200 mm., 300 mm., or the 375 mm. lantern. The weight of this buoy is 5 tons without its charge and 6¼ tons when charged. The operating parts of all automatic gas buoys are similar, although the various types differ in size, shape, draft, and height of focal plane.

The buoy consists essentially of a gas generator (1) supported by a float chamber (2), a lantern support (3) attached to the deck of the float chamber, a lantern (4), and a purifier chamber (5) located in the top of the generator; there is also a counterweight (6) attached to the bottom of the generator tube, to give the buoy sufficient stability. The generator (1) has a diaphragm (7) near the bottom; the center of the diaphragm is fitted with a conical-seated valve (8), which is shown open; this valve is mounted on the valve stem (9), which passes up through the center of the generator and through the generator head (10); the upper end of the valve stem has a thread cut upon it, and is fitted with a hexagon nut (11) just above the generator head; the part of the stem passing through the generator head has a keyway cut in it, and a spline is fitted into the generator head engaging the keyway, so that when nut (11) is turned to open or close the valve, the stem can not turn, but can only move up or down. To the extreme top end of the valve stem is attached a

[a] On file in the Office of the Light-House Board, Department of Commerce and Labor, Washington.

stop collar (12) to prevent the nut (11) being turned so far as to drop the valve and valve stem. A cap (14) screws down onto the generator head against a rubber packing, so as to prevent leakage of gas when the buoy is in operation; it also serves to prevent the valve stem (9) rising, and so holds the valve (8) securely open. The valve stem (9) is surrounded by a guard pipe (13), where it passes through the carbide charge; this pipe is screwed firmly into a hub on the under side of the generator head. The conical valve seat in the center of the diaphragm (7) is provided with a rubber packing (15) which is held in a groove in the valve seat so as to project enough to make a good joint with the valve (8) when it is closed, even if it is quite foul. A steel grate (16) is attached to the inside of the generator a short distance above the diaphragm; the charge of calcium carbide rests on this grate.



Interior view of a Willson low-pressure automatic gas buoy.

The operation of the gas apparatus is as follows: The generator (1) is filled with carbide as shown, and the buoy is placed in the water with the valve (8) open and the valve cap (14) in place. Water enters the bottom of the generator tube through the hole shown in the center of the counterweight (6) and then passes through the valve (8) up toward the grate (16) and finally reaches the carbide resting on the grate; this at once produces gas, which passes through the purifier (5), thence through the small valve (17) and pipe (18) to the lantern (4), to which the pipe is connected by the coupling (19). When gas is produced faster than it is burned in the lantern, it accumulates in the generator and presses the water downward away from the carbide, thus stopping the generation of gas (the illustration shows the generator in this condition). When the surplus gas is consumed the water reaches the carbide again and more gas is produced.

No. 11 combined gas and whistling buoy.—This is similar in general design to the No. 9 buoy, but the flotation chamber is 11 feet in diameter, the whistle 18 inches in diameter, and the two whistling tubes 36 inches in diameter. The light will be exhibited 30 feet above the water from a gas lantern carrying a lens either 375 or 500 mm. in diameter.

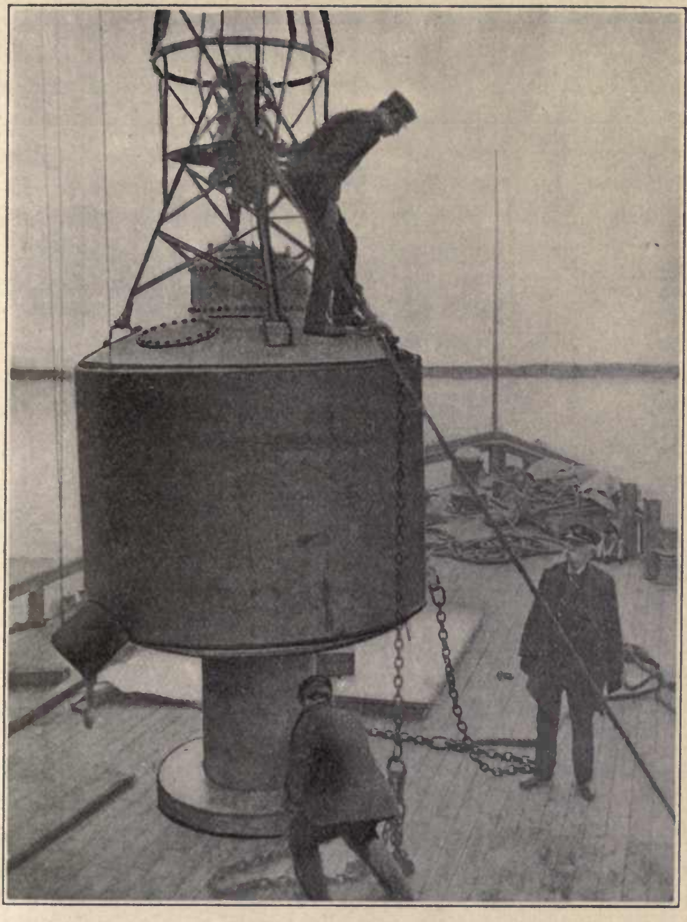
No. 14 combined gas and whistling buoy.—This is designed for positions of sufficient importance to call for a light-ship. The flotation chamber is elliptical, with axes of 11 and 14½ feet. The whistling tubes are 48 inches, and the whistle 18 inches in diameter. The light will be exhibited 30 feet above the water from a gas lantern carrying a 500 mm. lens.

A comparative idea of the buoys will be gained from studying the following table:

Type number of buoy.	Draft fully charged.	Shape of flotation chamber.	Diameter of flotation chamber.	Diameter of generator tube.	Carbide charge.	Diameter of twin whistling tubes.	Diameter of whistle.	Diameter of lens of lantern.	Height of focal plane above water.
	Ft. In.		*Ft. In.*	*Inches.*	*Lbs.*	*Inches.*	*Inches.*	*mm.*	*Ft. In.*
5	6 0	Cylindrical	5 9	24	1,000	0	0	200	7 4
6	6 0	do	6 0	24	1,000	0	0	200	7 4
7	9 4	do	7 3	30	2,500	0	0	200	7 6
8½	10 5	Spheroidal	8 6	30	2,500	0	0	300	9 0
9	19 4	Cylindrical	8 10	30	3,000	20	10	300 or 200	15 9
11	26 8	do	11 0	30	3,000	36	18	375	30 0
11×14½	26 8	Elliptical	11×14½	30	3,000	48	18	500	30 0

It will be noticed that with the increase in the size of the gas buoy, the size of the lantern, the consumption of gas, and the power of the light have increased. The lens of 500 mm. diameter corresponds to the fourth order; 375 mm., fifth order; 300 mm., sixth order, 200 mm., to less than the seventh order, while the lens of 100 mm. can not well be classified. The 375 mm. lanterns will be used on all whistling buoys, and eventually 300 mm. lanterns on all standard buoys, while the No. 11 gas and whistling buoys may carry 500 mm. lanterns if the importance of the locality warrants it.

The great increase in the light power of the larger automatic buoys, due to the use of acetylene and the size of gas lanterns employed, makes them in reality floating light-houses of an order superior to many of the light-houses in Canada.



No. 7 buoy on deck of Canadian light-house tender *Scout.*

BURNERS.

The principal difficulty experienced in the use of acetylene for light-house work has been with the burners, but each season has produced changes and improvements. It was not considered necessary to purify the acetylene used until the middle of 1905, when purifiers were added to the automatic buoys with excellent results.

"Economic" burners are used in buoys and shore stations using compression and low-pressure acetylene gas. They are of the type shown in the samples[a] and vary from the single one-fourth-foot flame, one-eighth pilot burner, to the six-burner type, one-half-foot flame with four and six one-eighth pilot burners. At present use is made of the following sizes, tips for which are made in the United States:

Size of buoy.	Main flames (one-fourth of a foot).	Pilot flames (one-eighth of a foot).	Lens.	Order.
			mm.	
No. 5	2	2	100–200	7
No. 6	2	2	200	7
No. 6½	2	2	200	7
No. 7	2–4	2–4	200–300	6–7
No. 8½	2–4	2–4	200–375	....
No. 9	4	2–4	300–375	5–6
No. 11	[a] 6½	4–6	375–500	4–5
Light-ship	6½	6	500	4
Fixed for shore stations	2–6	....	500 and up.	....

[a] One-half foot.

CHARGING THE BUOY.

In the low-pressure acetylene buoy the carbide charge (from ½ to 1½ tons) is carried in a central generating tube of welded steel, supported by a flotation chamber. The carbide rests on a cast-steel grating, below which is a diaphragm of steel with an 8-inch opening closed by a valve operated by a valve stem which passes through a tube in the carbide chamber, then through the cast-steel head of the same, and is operated from the deck of the buoy. The bottom of the generating tube is open to the water, and the top is closed by a steel casting containing the purifier and the door for filling the buoy. The buoy, with valve closed, is filled with carbide before placing on station. The valve is opened when the buoy is moored, admitting water to the charge. The air is then blown out of the generating tube through a small plug and out of the gas lantern in the usual way, after which the lamp is lighted. At Quebec the officials, on learning of our arrival, delayed the filling of two low-pressure automatic Willson buoys with carbide until we were present. The method of charging, etc., at this station was as follows:

The valves in the bottom diaphragm had been closed and the manhole plates removed. Carbide in tin cans was emptied into coal scuttles, passed up a ladder, and poured into a canvas chute, which was long enough to extend to the grating in the charging chamber. The chute was used to prevent the lumps of carbide from striking

[a] On file in the Office of the Light-House Board, Department of Commerce and Labor, Washington, D. C.

the iron walls or grating, and thus to avoid sparks and the ignition of gas evolved from any moisture in the chamber. These were No. 9 buoys and had a capacity of 3,000 pounds of carbide. When the chamber was filled, the manhole plates were put on, connections were made, and the buoys were ready to put on station. The moorings used for anchoring them were 1-inch to 1½-inch chains of a length not less than two to two and one-half times the depth of the water, with cement sinkers, mushrooms, or stockless anchors, depending on the character of the bottom and attendant circumstances. After the buoy is in the water the bottom valve is opened, allowing the water to attack the carbide and the small blow-offs, provided in the head of the buoy and the lantern, are opened to permit the gas to drive out the air in the buoy. The connections between the buoy and the lantern are then tested with soapsuds and the lantern lighted. The No. 11 and light-ship buoys require for handling a vessel having a 25-ton derrick and large deck space. It has been the custom to fill the buoys at the wharf and tow them to the station. They can be filled on station by closing the bottom valve, pumping or blowing out by ejector the water and lime deposit, then filling from a tender or other vessel. The better method, however, is to lift the buoy clear of the water, wash out the carbide chamber above and below the grating, close the lower valve, and then charge with carbide, opening the lower valve when the buoy is in the water and ready for service.

SIGNALS.

The Courtenay principle is used in the whistle signal. Instead of a single central tube for compressing the air to sound the whistle, twin tubes are used, the axes of these tubes and the axes of the generating tube being in the same plane. Standard buoys may or may not be fitted with a bell. Gas and signal buoys are fitted with a whistle and may be fitted with a bell as service conditions require. Number 11 is fitted with gas, 18-inch whistle, bell, and submarine bell. Light-ship buoys are fitted with a fourth order light, 18-inch whistle, bell, and submarine signal apparatus. Some idea of the increased power of the whistle blast of the automatic buoy compared with the Courtenay is given by a comparison of the horizontal area of the compressing tubes. The area in the largest size Courtenay is 4¼ square feet; that of the automatic gas and whistling buoy is 14 square feet.

The tubes for the striking balls in the bell mechanism of the buoys now in use are on the outside of the framework. This has been changed in the newer type, where these cylinders are inside of the frame. The tubes used in the construction of these buoys vary from 1 foot, 8 inches, to 4 feet, and are made in New York. The heads and bottoms are made in Coatesville, Pa.

In the future the buoys will be elliptical in cross section, made of but two pieces, formed by the head and the bottom, with a bulb iron

Comparative size for 10 and 18 inch whistle for buoys.

T-rail at the junction to strengthen, and also to act as a collision fender. In order to manufacture these buoys in this way the company supplying them is installing a press at a cost of $100,000. Further details of these buoys will be shown in blue prints and letters patent No. 791119, May 30, 1905.[a]

The lights shown from gas buoys are occulting, unless for special reasons a fixed white light is required. At the office of the inventor tests were made of the various lanterns, varying from the Pintsch size 200 millimeter, to the largest fourth order light size, or 500 millimeter. The larger sizes were also tested with red shades or chimneys. Considerable time was taken up in the inspection of plans, blue prints, etc., copies of which are submitted.[a]

ADVANTAGES OF LOW-PRESSURE BUOY.

A discussion of the advantages of low-pressure buoys over the compression system may not be amiss, for my tour of inspection leads me to believe that the compression system will eventually be replaced by the automatic.

The desire of the Canadian government is to make use of the compression system until it can be replaced by a low-pressure buoy of the latest automatic type. The points of advantage of compressed acetylene over compressed oil gas are as follows:

1. For an equal volume of gas burned, acetylene gives more than five times the light.

2. Acetylene gas can be generated on the deck of a light-house tender in a portable apparatus, whereas oil gas must be transported in storeholders from a gas works on shore.

3. All over 10 atmospheres pressure, more acetylene than oil gas can be compressed into a holder, as the latter begins to deposit liquid hydrocarbons at or before this pressure, thereby reducing the illuminating power of the gas.

The great advantage of low-pressure acetylene buoys over the compression system is summarized in the following:

1. In the compression type the gas is raised to a maximum pressure of 225 pounds per square inch; in the automatic type the maximum pressure does not exceed a few pounds per square inch.

2. Compression buoys require for their maintenance a gas generating plant. In the case of acetylene this can be placed on the deck of a light-house tender or scow; with oil gas it must be located on shore and the gas transported in holders to the buoy. The automatic buoy is charged with carbide and requires no gas generating plant except that within itself.

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[a] On file in the Office of the Light-House Board, Department of Commerce and Labor, Washington, D. C.

3. The elimination of compression and the fact that automatic buoys may be recharged from a boat, if necessary, permits the installation of gas buoys in isolated positions where their use was not practicable before.

4. An automatic gas buoy, fully charged, can carry from 9,000 to 10,000 feet of gas in the form of carbide. The standard compression buoy (170 cubic feet per atmosphere) at 15 atmospheres will hold about one-fourth as much gas. An automatic buoy can be charged on the opening of navigation and requires no attention, so far as gas supply is concerned, until navigation closes. One charge is sufficient for one year where the gas consumption is equal to that of the old type buoys.

5. This principle more readily permits the lighting of other classes of buoys, such as whistling and bell buoys.

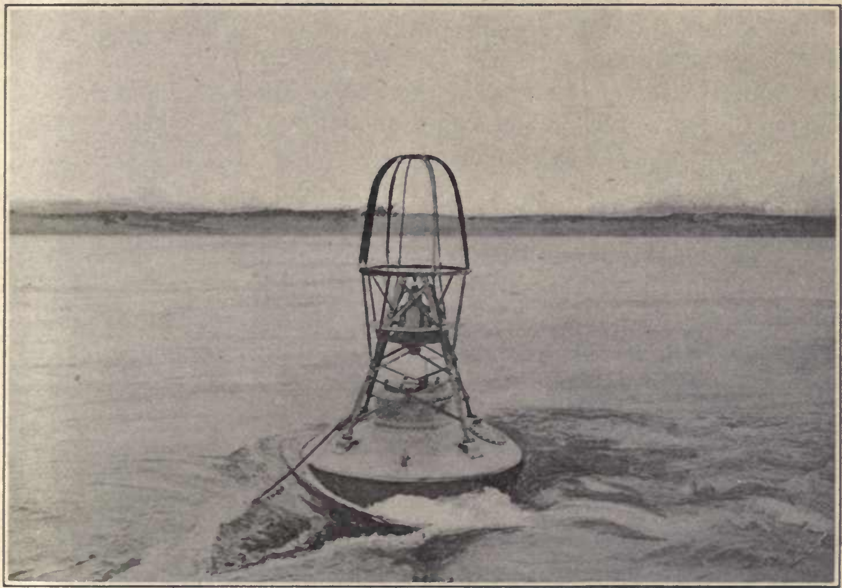
TEST OF SERVICE.

On my tour of inspection I examined the Willson low-pressure buoys which had been in position on the St. Lawrence since April. All were found in most excellent condition. The tips were as clean as when the buoys were put in position. Only one change had been made in any of them during the summer, and this a small alteration in the occulting mechanism. In the examination I landed on a buoy and the vessel backed off. The stability in a swift channel may be judged from the photographs and by the fact that when the vessel backed off and away from the buoy I was left with three other men on the lantern platform. These buoys ride well in strong currents and with the different changes that can be made to adapt them to all circumstances, the whistle, bell, large lens, occulting lights, and submarine signal apparatus seem to fill perfectly all the requirements of the most efficient aid to navigation that has been offered to mariners. The advantages offered are greater than those of any other system. The duration of service depends only on the strength of light desired and the carrying capacity of the carbide chamber. The season requiring lights being about eight months, selection of sizes is governed accordingly. The most notable instance of long service is that of an acetylene buoy that burned for fifty-three weeks. The carbide charge was not then exhausted. The buoy was taken up for painting.

A case of carbonization and smoking was shown in a low-pressure Willson buoy exhibited at the Exposition Lake in Ottawa. On examination this was found to have been caused by a derangement of the small occulting lever. This was quickly remedied and the report made regarding it was: "Of the many hundreds of these lanterns which have been made, this is the only time we have known of such a difficulty."

AUTOMATIC BUOYS ON COAST OF NOVA SCOTIA.

A map of Nova Scotia is submitted[a] showing the location of automatic gas and whistling buoys, and the remarkable adaptability of this admirable system for guarding that coast. It is the intention of the Canadian government so to girdle the coast of Nova Scotia with these buoys that it will be impossible for a vessel to reach it without coming within the radius of visibility of one of these lights. A report of the submarine bell attachment for the Willson buoy at



Upper St. Lawrence, Dixon Island, No. 7 gas buoy in 8-mile current.

the outer automatic station off Halifax Harbor is interesting in this connection. The commissioner of lights in a letter says:

I note that you proceed to Boston on submarine signal duty and in this connection I may mention that we recently took in the submarine bell attachment for the Willson buoy, outer automatic station, off Halifax Harbor, and owing to the light construction of the apparatus it was practically wrecked. We have written the Submarine Signal Company, pointing out the necessity of making their apparatus much stronger and heavier. Experimenting in Boston Harbor they do not appear to appreciate the severe conditions obtained on the Nova Scotia coast. I do not doubt that a strong and serviceable bell attachment can be designed.

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[a] On file in the Office of the Light-House Board, Department of Commerce and Labor, Washington, D. C.

GOVERNMENT PURCHASES—PRICES.

The appropriations made by the Canadian government in the past three years for automatic low-pressure gas buoys, were—1904–5, $192,000; 1905–6, $360,000; 1906–7, $350,000; total, $902,000.

It is estimated that it will probably require 300 buoys to light the St. Lawrence River from Montreal to the sea in such a manner as to light the channel perfectly and completely on both sides, using the gas buoys carrying the large lanterns, namely, 300 mm. with white light, and 375 mm. with red screen. The cost will be approximately $1,000,000. For the St. Lawrence River, the Great Lakes, and British Columbia, an appropriation of from $1,500,000 to $2,000,000 would probably be required.

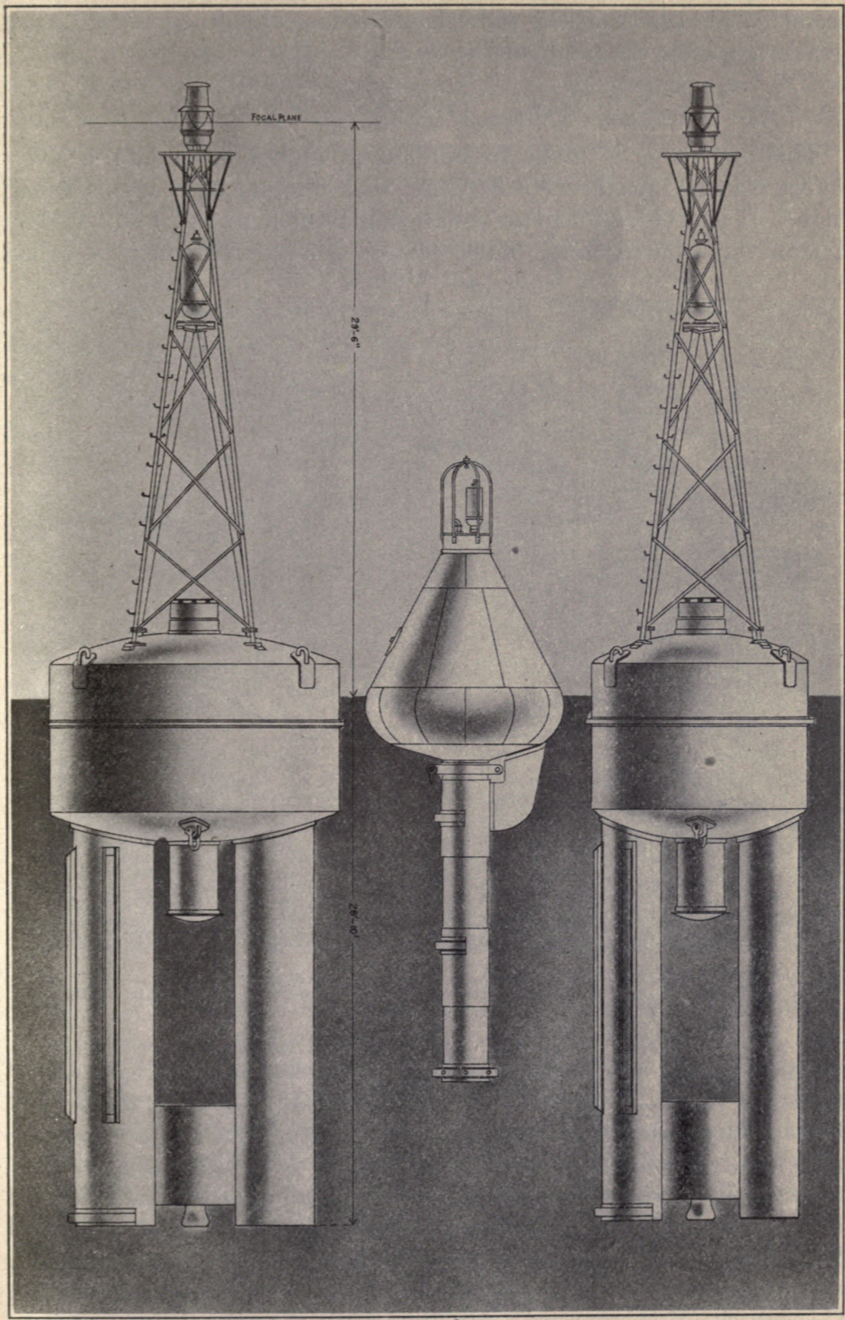
In reply to the question as to the cost of the buoys it was stated that the price would be the same for all countries. The Canadian government has paid the following prices: For type number 8½, and lighting buoys of the same capacity, $3,000 without lanterns; for type number 9½, which is the standard combination gas and whistling buoy, $5,000 without lantern; for type number 11, which is the small lightship buoy, $8,500; the large lightship buoy, not yet completed, subject to a price to be settled in the future, about $15,000.

In regard to these prices my informant stated that they are less than one-half the average price paid by the Canadian government for the compression type of buoy. This statement of relative cost is based upon the actual gas contents or capacity of the buoy. By the use of acetylene instead of the oil gas furnished by the Pintsch company a lighting value seven times as great is obtained. Taking into consideration the increased quantity of gas which the automatic buoys, of approximately the same weight as the compression buoys, contain, a light is produced of from twenty to thirty times the candle-power that it is possible to obtain by the use of the old system of compression oil gas buoys, and at a much lower comparative cost.

Mr. Willson wished to place himself on record as desirous of lighting the new Ambrose Channel with buoys of his construction at no cost to the United States Government, the buoys to be removed if they prove unsatisfactory.

PRESCOTT STATION—PORTABLE GAS GENERATOR.

The Prescott Buoy Station was established in 1903 as the central depot for the manufacture, storage, and distribution of stores and light-house apparatus. The good water front is being improved with docks, slips, and hauling-out ways. A basin is in contemplation. The depot has carpenter and machine shops, gas testing and store-houses, office buildings, and an acetylene gas manufacturing plant. The station is well provided with efficient standpipes and pumps for

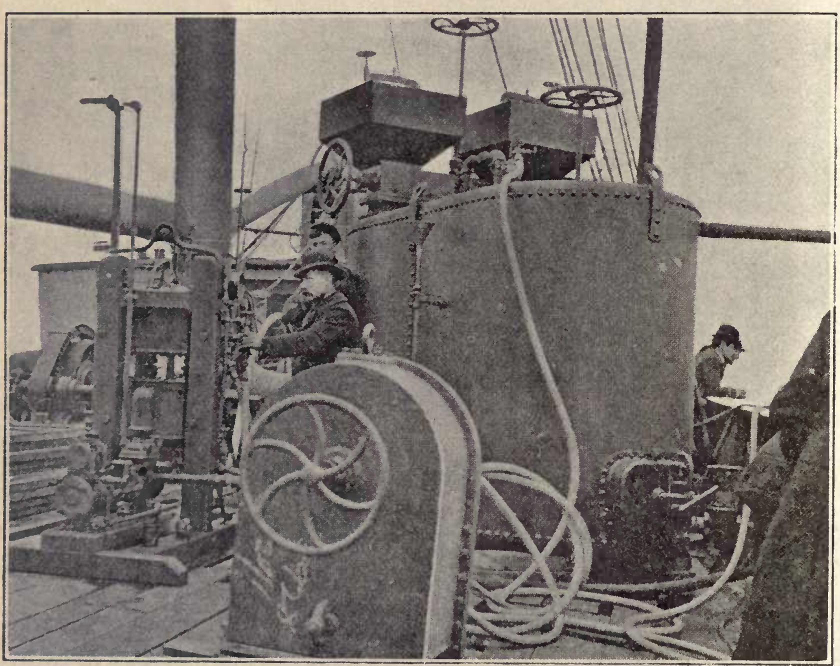


Comparative size of No. 14 light-ship gas and whistling buoy, Courtenay whistling buoy, and No. 11 light-ship gas and whistling buoy.

fire purposes. The acetylene manufacturing plant is installed in a wooden structure near the water front and is called the "Scout" type generator, after the name of the tender *Scout*.

"SCOUT" TYPE GENERATOR.

This generator is made of one-fourth inch boiler plate, is 9 by 4 feet 6 inches inside measurement, with circular end, and is 6 feet high. It is divided into two equal compartments, "A" and "B," by a transverse partition of boiler plate. One compartment is called



Portable acetylene gas plant operating on steamer's deck, as used on the barge and in the station at Prescott.

the generating side and the other the expansion side. About 18 inches from the bottom of the transverse partition is a row of eight 3-inch holes. An agitator is provided for each compartment, operated by a vertical shaft and wheel from the deck of the generator.

On the generating side are two hoppers, each capable of containing 600 pounds of carbide. These are fitted with gas-tight covers, and the carbide is fed into the generator by means of a feed screw. A valve is provided which enables a hopper to be cut out if desired. This permits of one hopper being filled while the other is in operation.

A scrubber, "C," is formed on the expansion side by means of a large tube let into the deck of the generator. The top of this tube is covered by a gas-tight cover, and the gas is led from the generating side to the bottom of the scrubber, where it passes through a large number of minute holes and is washed in the water with which the scrubber is filled. It has not been found necessary to use any chemical solution in scrubbing the gas, as water has been found sufficient.

To operate, the generator is filled about half full of water, the carbide hopper is filled, and when connection has been made with a buoy or gas holder through the compressor and various other parts of the apparatus the hopper feed screw is worked, which passes carbide into the generating side. The carbide falls on a screen inclined at an angle of 45° within the generator, and the acetylene is disengaged. The gas passes through the scrubber and thence to the compressor and the holder.

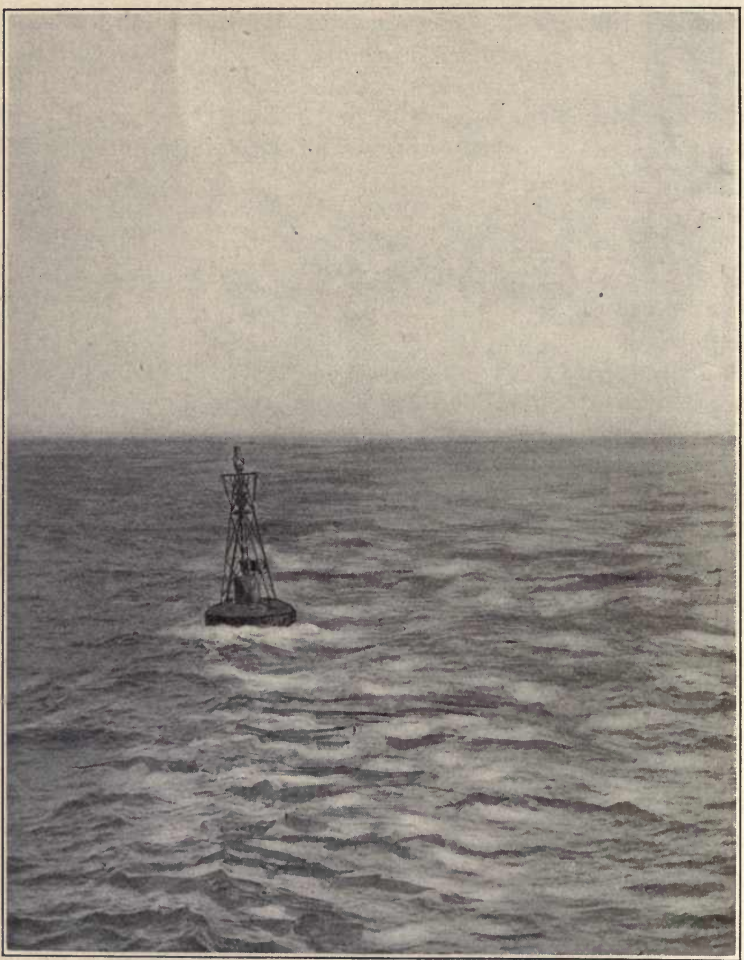
If more gas is made than the compressor can hold, the pressure on the generating side increases, the water is driven through the holes in the transverse partition and rises on the expansion side. If a large volume of gas should be disengaged, and if at the same time the feed pump is working and the blow-off cocks do not receive attention, the water may rise in the expansion side and blow off through the 3-inch overflow provided for this purpose. As the compressor takes gas from the generator the water returns to the generating side.

The feed water in the yard machine enters the generating side near the bottom. In the latest type of generator the feed water enters about half way up the generator. By means of a small gauge attached to the top of the generating side it is possible for the attendant to keep the water level practically constant, at the same time blowing off the lime sludge from each side after it has been stirred by the agitators. Sludge cocks have also been added on each side of the generator, intended to replace the blow-off tube on the right of the right-hand side of the generator.

Low-pressure gas drier.—The low-pressure drier consists of an inclosing cast-iron shell, inside of which revolves a steel squirrel cage full of carbide. The cylinder of the squirrel cage is perforated with holes. Through the axis of the cage a 4-inch gas pipe passes, which is also perforated with one-half inch holes. Between the inclosing cast-iron case and the gas outlet are sheets of hair felt which strain and filter the gas, which is then compressed to eight atmospheres in the three-stage compressor.

Three-stage gas compressor.—This is of the Ingersoll-Sergeant straight line class F C 3 type, with intercooler between low and intermediate pressure cylinders and intercooler between intermediate and high pressure cylinders. The intermediate and high pressure cylinders, with their intercoolers, are inclosed in a water box. The dimensions of the cylinders are: Steam cylinder, 10-inch diameter by 10-inch stroke; low-pressure gas cylinder, 9-inch diameter by 10-inch stroke, double acting; intermediate gas cylinder, 6½-inch diameter by 10-inch stroke, single acting; high-pressure gas cylinder, 3⅞-inch diameter by 10-inch stroke, single acting; 65 revolutions per minute.

The bedplate is an extra heavy casting of box girder pattern, connecting the steam and gas cylinders. The front part of the bedplate carries main bearings, which are of the one-fourth box type, adjust-



Buoy No. 9, whistler, at strongest tidal current off Lurcher Shoal, Bay of Fundy.

able for wear. The gas inlet valves on the low-pressure cylinder are of the poppet type, with brass springs, so that should a stem break they can not be drawn into the cylinder. The gas inlet and discharge valves on intermediate and high pressure cylinders are of improved mushroom type working in bronze guides. A fly-ball governor is placed in the main steam pipe.

Cooler, drier, purifier.—The after cooler consists simply of a coil of pipes around which water is made to circulate in a suitable casing.

The general design of the high-pressure drier is similar to that of the low-pressure drier, but it is tested to a working pressure of 300 pounds while the low-pressure drier is tested to 20 pounds.

The purifier is a box containing Kieselguhr saturated with chromic acid through which the gas is passed, and thus successfully purified. The same compound is used in the small purifying chamber on top of the buoy and alongside of the manhole used for charging the buoy with carbide.

The following blueprints, to accompany this description, will be found in the files of the Light-House Board: (1) Acetylene-gas generator *Scout* type, one print; (2) low-pressure gas drier, two prints; (3) high-pressure gas drier, four prints.

WINDMILL LIGHT.

The Windmill light-house carries in the ordinary lantern two channel lights with annular lenses and reflectors. In the lower portion is an acetylene compression plant of two gas cylinders 42 inches by 20 feet. The gas is manufactured at the Prescott station and conveyed by the *Scout* to this and the other stations using this system. Hose connections are made with the tanks in the bottom of the tower, which are then filled from 8 to 10 atmospheres. The burners were badly carbonized, a bridge having formed in each case between the tips.[a] The cause given for this excessive carbonization was that the purifying plant was evidently in bad order, and directions were given to overhaul it.

ST. LAWRENCE RIVER LIGHTS BETWEEN MONTREAL AND QUEBEC.

On the St. Lawrence River, between Platon and Montreal, there are 45 gas buoys, principally of the Pintsch type, but using compressed acetylene gas. For the purpose of looking after the ship channel buoy service, the agent, Mr. Bonder, has under his direction the C. G. S. *Shamrock* and the gas and derrick scow *Acetylene*. The buoy service of the Dominion is done by contract or by departmental officers. The trip for the purpose of delivering the yearly supplies is made by contract, because the Dominion government has not a suitable available steamer for that purpose. Dredging operations to improve the river channel are progressing favorably, and as they are completed powerful range lights and gas buoys are established, thus making the

[a] Burner and accumulation of carbon on file in the Office of the Light-House Board, Department of Commerce and Labor, Washington, D. C.

channel safe for night running. It is proposed to establish automatic low-pressure acetylene gas buoys for this purpose at a cost of $1,000,000. The present acetylene compression gas buoys will then be removed and used on shore stations. The work completed was very satisfactory. The range lights at Sorel were found in excellent condition.

I also had the opportunity of seeing the lights near Quebec, using the petroleum vapor lights; those at Craven Island, Belle Chase, St. Juan, St. Laurent, and Petronella, fourth-order lights, using 25 mm. mantles, Canadian burner, and occulting screen.

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