SHIP WIRING AND FITTING

T.M. JOHNSON

INSTALLATION MANUALS

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CONDUCTORS, HOUSE WIRING, ETC.

LAMPS, SWITCHES, FITTINGS, TRANSFORMERS.

ARC LAMPS.

MOTORS AND SMALL POWER PLANT.

SHIP WIRING AND FITTING.

MINING INSTALLATIONS.

MILL AND FACTORY WIRING.

BELLS, TELEPHONES, ETC.

TESTING AND LOCALIZING FAULTS.

SHIP WIRING AND FITTING

By

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INTRODUCTION

This book is intended to treat in a simple and concise manner the systems of wiring most commonly used in the fitting of electrical apparatus on ships of the mercantile class, and does not pretend to cover any of the special appliances and wiring systems in use on warships. The Author has endeavoured to give others the benefit of his knowledge gained by practical experience in the fitting up of passenger and cargo steamers.

The installations of the largest Atlantic liners are very elaborate and expensive but after all much the same as those on the average vessel except that they are on a larger scale. As only a few large vessels are built compared with the number of vessels of medium size, the Author proposes devoting his attention to the latter class.

Improvements are continually being made in electrical gear for shipwork; the systems of wiring, however, remain almost unaltered. Shipwork is a special class, requiring skilled and experienced men, as the conditions met with are totally different to those obtaining in the case of similar work on land.

Firstly, the construction of the ship is materially different to that of buildings on shore—we have iron and steel in place of stone and bricks.

Secondly, there is the vibration caused either

by the motion of the ship through the water or by the propelling machinery.

Thirdly, the moisture and salt spray which penetrate to all parts of the ship.

All these adverse conditions have to be contended with and suitable precautions taken to safeguard the apparatus and maintain the efficiency of the installation.

The part played by electricity in the shipping world is more important now than ever, and while at one time electric lighting on board ship was looked on as a luxury it has long since become a necessity both for comfort and safety, whilst, for utility, it is undoubtedly superior to oil lamps or any other system of lighting.

No modern ship would be considered complete without it. Electric bells, too, have superseded the pneumatic and other systems which were in evidence at one time. Telephones are now quite common on board ship, and many other appliances, all of which add to the safety and comfort of modern travel.

The cargo steamer must not be forgotten, but here we have plain and serviceable rather than ornamental apparatus and fittings, and these ships are also fitted with portable arc lamps and clusters for use when loading and unloading cargo.

Electric light on vessels carrying oil and other dangerous cargo claims a great advantage in the matter of safety over oil lamps. The applications of electricity are by no means limited to passenger and cargo steamers. Many other types may be mentioned such as tug boats, dredgers, floating docks and cranes, private yachts, etc.

To sum up, then, electricity plays a very important part in the construction of vessels ranging from the "floating hotels" as the large Atlantic liners are called, down to the small tugboat or river steamer.

As this book is of a very concise character information on any points which may have been omitted will be gladly furnished by the Author to the best of his ability if he be communicated with through the Publishers.

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ELECTRIC LIGHTING, GENERAL.

GENERALLY speaking, electric lighting is installed on ships on either of two systems, viz., the "Double Wire" system, which is similar to that used on shore, and the single wire or "Ship return" system.

The principles involved in the former are met with in everyday wiring; the positive and negative or lead and return conductors are used throughout the installation from the dynamo to the farthest lamp; the whole system being insulated from the hull of the ship.

The ship return system, however, is the one which is peculiar to ships; the iron or steel hull of the vessel being a conductor is used to take the place of the return wire. Connexions are made with the skin of the ship wherever required.

Opinions vary as to which terminal of the dynamo should be connected to the ship. The usual practice is to connect the positive terminal to the ship's skin, thus preserving the cables in the event of any leakage and electrolytic action taking place between the hull and the copper of the cables. Both systems are carried out with distribution boards. This method obviates the necessity for joints in the cables, all connexions being made by looping in, either at the distribution boards or at the fittings. The accompanying diagrams show the two systems of wiring. In each case the cables are run from the dynamo to the main switchboard and from the latter to the heavier type of fuseboards, called

"Section boards." Fuseboards of even greater carrying capacity than the section boards are sometimes used for very heavy circuits, and are called "Junction boards" or Junction boxes.

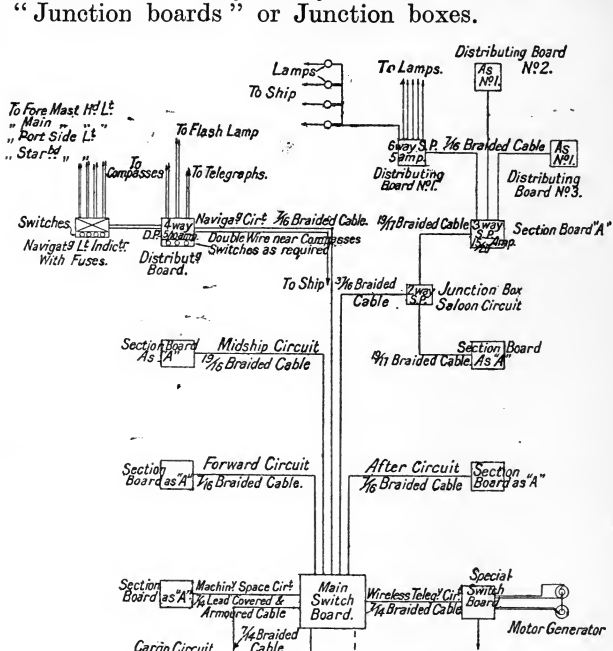


FIG. 1.—WIRING DIAGRAM: SHIP RETURN OR SINGLE WIRE SYSTEM.

If no reduction in the size of mains is made at a junction box, no fuses are fitted, but only connecting links between the main and branch cables.

From the section boards the cables are run to smaller boards called "Distribution Boards" and, finally, from them to the lights or other apparatus. The lights are looped together, about four on each

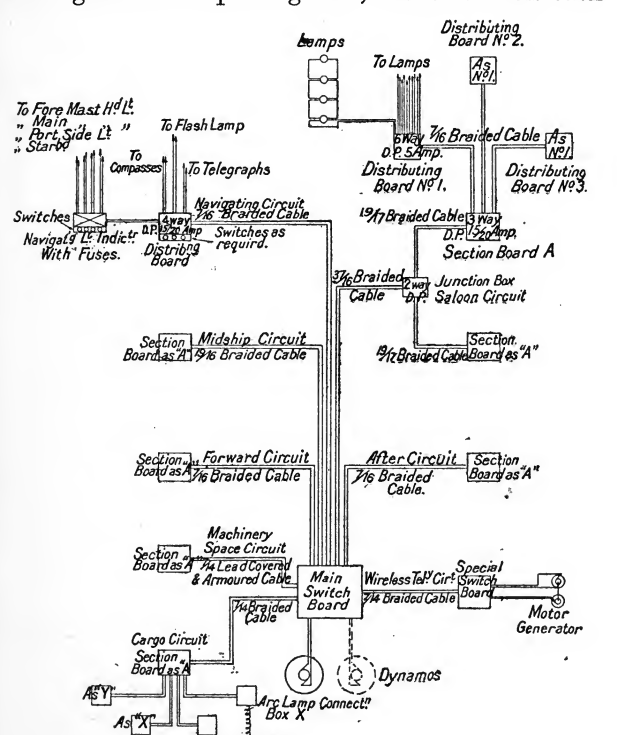


FIG. 2.—WIRING DIAGRAM: DOUBLE WIRE SYSTEM.

fuse. The number of fuses or "Ways" varies according to requirements and may be any number from three to eight. Larger boards than eightway are seldom required. A distribution board serves

any particular group of lights, such as those in a saloon, set of staterooms, crew's quarters, or officers' rooms. Where any compartment has more than one light it is an advantage to divide the lights and put them on two fuses, so that, in the event of one fuse giving out, the compartment will not be in total darkness. Controlling switches are often fitted on or beside a fuseboard to control all the lights fed off that particular board.

This gives the stewards the option of switching off the current completely from any section of the passenger accommodation. The same arrangement may be applied to any other part of the ship which may be under the control of any of the other officers.

The voltages used in shipwork are usually low, about 100 or 110. There are many ships with even lower voltages, 80, 60 or even 55 being common enough in old vessels. Not many installations, however, are now run at lower voltages than 100.

With reference to lamps; these have double-contact or centre contact caps according to the system of wiring on the ship. The lamps range in candle-power from 5 up to 32. That generally used is the 16 candle power, and this capacity is common to all fittings throughout the ship, with the exception of the compasses, telegraphs, and other instruments; also W.C.'s and similar locations, which are fitted with 8 candle-power lamps only. The navigation lanterns are fitted with 32 candle-power lamps (see navigation circuit). Tantalum lamps of 16 or 25 candle-power are used with success and an economy in wire is effected owing to their small current consumption.

Generating Sets

We will now proceed to consider the installation, step by step, commencing at the source of supply

of electrical energy, viz., the Engine and Dynamo, or, as they are usually termed, "Generating Sets."

The dynamos are driven by steam engines either of the turbine or vertical reciprocating type; the former are not very extensively employed as yet, but the number in use is steadily increasing, owing to the improvements which are being made in their design and running qualities. The reciprocating engine of the vertical type is the one found on most ship installations. The two types of vertical engine in common use for driving dynamos are—

(1) The enclosed high-speed engine, with forced or splash lubrication. The crank shafts and connecting rods are enclosed in a chamber. The average speed of this type of engine is from 400 to 600 revolutions per minute.

(2) The open type engine, which runs at a much lower speed, usually from 200 to 350 revolutions per minute.

The steam for the dynamo engines is supplied from the main boilers, but, as the main boiler steam pressure is usually higher than is required for the small engines, it is reduced to about 100 pounds per square inch by means of a special reducing valve, which is fitted either on the engine or at the boiler. A connexion is also made to the donkey boiler which supplies steam for the dynamo engines, winches, pumps, etc., when the vessel is in port and the main boilers are shut down.

The engines and dynamos are direct-coupled and mounted on one bedplate.

Belt driven ship lighting sets are almost if not entirely obsolete. The dynamos are nearly all of the multipolar compound-wound type, and are much the same in detail as those in use in shore power stations. The design of the engine also is much the same except in the case of the slow-speed open type. This is rarely used on shore. Many engineers, however, prefer a slow-speed open type to a high-

speed enclosed type of engine for marine work.

On vessels boasting the very best and latest equipments there is fitted an emergency generating set, usually in the upper part of the engine room, well above water level. The dynamo is driven by a petrol or oil engine and is of sufficient capacity to supply the wireless telegraph apparatus and a portion of the lights in the passenger accommodation also some of the outside deck lights. A special switchboard is fitted beside the dynamo so that the emergency plant could be run even if the engine and boiler rooms should be flooded.

Dynamo Mains

Passing to the main cables connecting the dynamo to the main switchboard, the Author considers that the best practice is to use ordinary vulcanized rubber cable with braided finish only, for these mains, as the run from the dynamo to the switchboard is usually very short, it being, as a rule, only a matter of a few feet from the dynamo terminals to the bulkhead on which the switchboard is fixed. The cable is clipped to the underside of a strong wood batten, supported in turn by a flat plate to which it is screwed. This plate being on top affords the necessary mechanical protection for the cable and the batten. The plate is turned down at right angles and one end fixed to the top of the dynamo body, the other being attached to the bulkhead. The cable is led from it to the machine terminals. The clips used should be of brass, and of the double-ended type.

With an arrangement of this kind armoured cable is unnecessary although specified by some shipowners. Separate cables must be run from each dynamo if there be more than one. Some ships have as many as four generating sets on board.

Main Switchboard

A ship switchboard is generally substantial rather than ornamental. It is usually of enamelled slate mounted in a strong teak frame. If small, it can be fixed to a bulkhead, but if large it should stand on the floor of a special platform with a space of about 2 feet at the back, between it and the bulkhead, to allow of easy access to the back connexions.

If mounted on the bulkhead, care must be taken that all connexions are accessible. The board can be erected in three different ways to ensure this.

One method is to mount the board on brackets of angle iron secured to the teak frame, leaving a space of about 12 inches at the back, and then closing in the top and two sides (the bottom is not important) with wood in the form of removable doors.

Another way is to leave only a small space, say 5 or 6 inches, at the back and make what practically amounts to another teakwood frame, which latter is secured to the bulkhead and the frame of the board strongly hinged to it. The board can then be swung out when it is desired to reach the back connexions, and sufficient slack must be left to allow of this being done.

The third alternative is to do away with the space altogether (except sufficient clearance between the back fittings and the ship's framework) and have all the connexions on the front of the board. The objection to this last arrangement is that the appearance of the board is spoiled, although it is possible with care to make a fairly neat job.

The circuit and dynamo cables are sweated into sockets on the board, and care should be taken that these are of ample size, with holes large enough to take the cables without cutting away any strands.

The board will be either single-pole or double-pole according to whether the system is single or double wire.

Fig. 3 shows the general arrangement of a marine single-pole switchboard for two 100 volt 25 kilowatt dynamos. There is one voltmeter on the board, which can be connected across any dynamo by means of a small switch fitted with a contact stud for each machine.

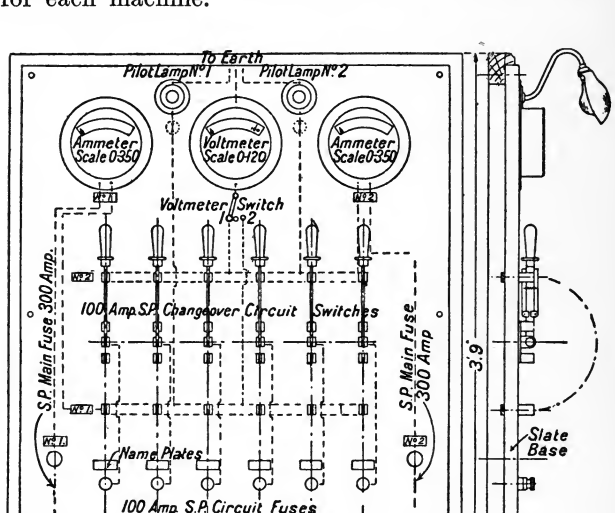


FIG. 3.—ARRANGEMENT OF SWITCHBOARD FOR SINGLE WIRE INSTALLATION.

An amperemeter is provided for each dynamo, as they are worked independently, and it is necessary to know the load on each machine. The volt and amperemeters should be of the moving-coil dead-beat marine type. The former should have a red line or other distinctive mark at the figure representing

the working voltage. The ammeter should read up to about 25 per cent. above the full load of the dynamo to which it belongs. The sizes of the meter dials vary from 6 inches in diameter for small boards to 9 or 10 inches for large boards.

The main circuit switches are of one, two, three or more ways, according to the number of dynamos,

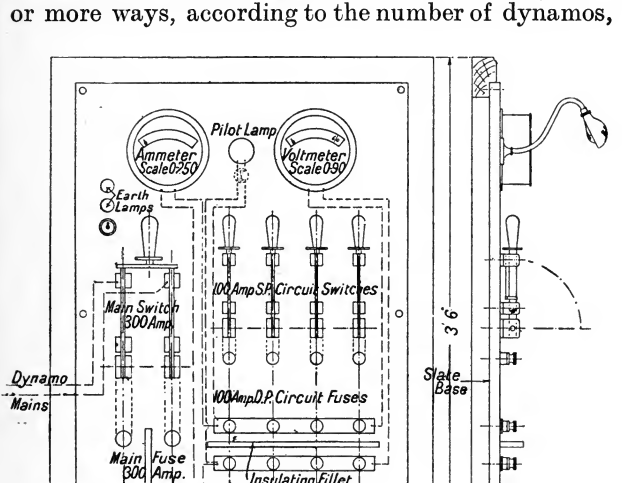


FIG. 4.—ARRANGEMENT OF SWITCHBOARD FOR DOUBLE WIRE INSTALLATION.

and any circuit in the ship can be switched on to any dynamo. With this arrangement, when only a light load is on, for instance a few lights in some particular section of the ship, the whole load may be switched on to any one dynamo which it may be desired to keep running. The running of dynamos in parallel is not usual practice on board ship.

Main fuses are supplied for each dynamo and also a pilot lamp, the latter being fitted on the board or immediately over the dynamo.

On a double-wire board (Fig. 4) test lamps are fitted (called "Earth Lamps") which indicate the condition of the insulation on either the positive or negative side. The connexions are as shown in Fig. 5.

*L*1 and *L*2 are lamps of the working voltage connected in series across the busbars. A connexion is made at a point between the lamps to the ship or *E*, through a switch *S*. When this switch is off

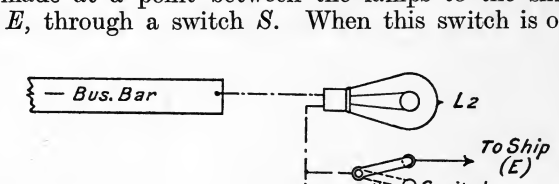


FIG. 5.—DIAGRAM OF CONNEXIONS OF LEAKAGE OR "EARTH" LAMPS.

the lamps will glow a dull red. All is clear if, when the switch is closed, the same effect is produced, but, if one lamp glows brighter than the other it indicates the existence of a leak on the opposite main; for instance L1 glowing brightly, indicates a leak on the negative side and vice versa.

Bracket lamps are fitted over the volt- and ammeters to illuminate the dials, and these can also be made to serve as pilot lamps.

Nameplates of brass or ivorine are fitted to each switch to indicate the circuit; also to the dynamos, if there be more than one. The size of fuse is also marked to facilitate renewal in the event of blowing. The illustrations (Fig. 6) show two such nameplates.

The various circuits of the ship supplied from the main switchboard will next be considered.

Circuits

The general practice is to divide the ship into the following sections or circuits; a switch and fuse being fitted on the main board for each one.

(1) *Machinery spaces circuit :*—which includes the

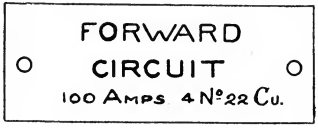


Fig. 6.—Examples of Switchboard Nameplates.

main engine room; refrigerating engine room; boiler rooms or stokeholds as they are usually called; the stokehold entrance from decks above which are called fidleys; the forced draught fan rooms; and the shaft tunnels.

(2) *Navigating circuit :*—which includes the ship's signal lamps, viz., Foremast head; mainmast head; sidelights; and sternlight; also the lights fitted to telegraphs, compasses and other instruments to illuminate the dials at night; and the Morse flashing lamp for signalling at night, described further on.

(3) *Cargo light circuit :*—which includes the portable arc lamps and clusters for working cargo (see Fittings) and the fixed lights in the holds, which

are only lit when the ship is being loaded or unloaded.

(4) *Starboard saloon circuit :*—which takes the principal saloons and staterooms on the starboard side of the ship.

(5) *Port saloon circuit :*—which takes the corresponding places on the opposite side.

(It may not be out of place to explain here that the "starboard" side of the ship is the right hand side when one is standing on the deck looking towards the bow, and the "port" is the left side.)

(6) *The Forward circuit :*—which usually includes the crew's quarters and the third-class passenger accommodation.

(7) *The Amidships circuit :*—which takes all the lower central portion of the ship including officers' and engineers' rooms, stores, galleys, butcher's and baker's shops, etc.

(8) *The After circuit :*—which includes the after accommodation, usually occupied by second-class passengers, ship stewards, and others.

(9) *Miscellaneous circuit :*—for electrically driven ventilating fans, galley and laundry machinery, electric hoist, and such-like machinery and appliances.

In the foregoing arrangement there are nine distinct circuits mentioned. It is not, however, necessary for all of the nine circuits to be controlled by separate switches on the main switchboard. This especially applies in the case of a large vessel. The circuits enumerated could be condensed into, say, four main circuits, for example :—

1, Forward ; 2, Amidships ; 3, After ; 4, Machinery Spaces. If this arrangement were adopted, separate auxiliary switchboards would then be fitted in the four sections of the ship, referred to. The sections would be split up into separate individual circuits, controlled from these auxiliary boards.

There is a special arrangement of the lighting circuits in the passenger accommodation specified

by some owners, which requires three distinct circuits as follows :—

1. *A Day circuit :*—which supplies all lights in positions where there is either insufficient or no natural light available at all.

2. *A Night circuit :*—supplying any lights which may be required up to and after midnight.

3. *A General circuit :*—which supplies all lights not included in either of the above groups, viz., lights required at and after dusk and which may be switched off entirely at or before midnight.

The circuits will now be dealt with in turn and a more or less detailed description given of each, which will be adaptable to most of the general cases met with in ship wiring. In most ships of average size all the circuits are run from the main switchboard in the engine room. It will be assumed, therefore, that all circuits are run in this way, and they will be treated accordingly. The reader will please note that when the word " cables " is used in this book, a pair of wires is indicated where the system is double-wire, and a single conductor where the system is ship return.

(1) MACHINERY SPACE CIRCUIT

The main cables are run from the main switchboard to the section board which may or may not be fitted with switches. The adoption of switches on the section board is optional. We will assume there are three " ways " or fuses on the section board. This would allow of three distribution boards being fed from it. The average capacity of each fuse is 15 to 20 amperes.

The distribution boards would be fitted in the following positions :—

No. 1 in the stokehold would supply lamps in the stokehold, also those in any passages between boilers, or from one stokehold to another, lights for illumi-

nating the water and steam gauges, lights in fan rooms, and in the entrances to stokeholds from above, called fidleys; also the portable lights, single handlamps, or three-light clusters for use in the coal bunkers. The last named are taken off plug and socket connexions fitted beside the bunker doors.

No. 2 Distribution Board would be fixed at the forward end of the main engine room, and would supply about half of the engine room lights, say, for instance, those situated at the forward end. These will include lights near the forward bulkhead over the pumps, also some near the main engines and on the starting platform. Those in the upper platforms and in entrances will be included, but the last named, if sufficiently numerous, will have a separate board to themselves.

No. 3 Distribution Board would be situated at the after end of engine room and would take the remainder of the lights beside the main engines and some in the side wings. The lights in the shaft tunnel would come off this board. There is usually one light over each main bearing and two in the recess at the end of the tunnel.

Beside the fixed lights already mentioned, a number of portable hand lamps are fitted through plug and socket connexions, say two at the forward end and two at the after end of the engine room, one lighting the cylinder tops and another the engineers' vice bench.

In arranging for switches it is only usual to fit them on each distribution board, one for each fuse. Thus each switch will control about four lights. A switch is also fitted beside each hand lamp plug and any individual lights in stores have their own separate switches.

It is impossible to give a definite figure for the number of lights required owing to the variation in the sizes and shapes of the machinery spaces on

different ships, but on the average a fairly good light can be obtained by arranging the lamps not less than 8 feet apart.

(2) THE NAVIGATING LIGHT CIRCUIT

This is a very important circuit and is nearly always used exclusively for the Board of Trade regulation lights, which are in operation when the vessel is steaming on her way, viz., The Foremast-head, Main-masthead, Port and Starboard side lights, Stern light; also lights to engine and docking telegraphs, steering and standard compasses, and Morse flashing lantern.

The main cables are run without a break right up from the main switchboard to the chart house, where the only fuseboard on this circuit is fitted. On small vessels having no chart house it is fitted in the wheel house. The run is often a long and rather difficult one, owing to the number of decks through which the mains must pass; also owing to the fact that the Chart House is almost invariably situated over one of the first-class saloons, music rooms, or other of the ornamentally decorated and panelled rooms, and it is difficult to find a suitable run for the cables which will be quite clear of the panelling. One method of getting over the difficulty, which is sometimes adopted, is to run the navigating light mains in tubing outside the deck houses. The chief advantage with this method is that the cables are always accessible in case of break-down, without having to dismantle the panels in any of the rooms. The arrangement of the fuse-board on this circuit allows for each light having its own fuse and also its own switch. Thus it is necessary to take a separate pair of wires to each of the steaming lights. The telegraphs and compasses however can be looped in pairs on one fuse.

As the whole of this wiring is unavoidably in the vicinity of the compasses, it must all be double and the positive and negative wires run together, so that there will be no electro-magnetic effect on the compass needles. This is a Board of Trade regulation and affects all wires within a radius of 15 feet around the compass. Any magnetic field produced by the positive wire will be neutralized by that surrounding the negative.

The lamps used in the masthead, stern, and side lanterns are specially constructed. They are of 32 candle-power, and have two filaments of 16 candle-power, each suitable for the working voltage and connected in parallel. If one filament gives out the other will remain burning. The illumination will then be only 16 candle-power until the lamp is renewed.

The run for the two masthead and stern lights is generally back alongside the mains as far as the upper or main deck, where the main run fore and aft in the ship will be. They then separate, each pair going to its respective mast, and passing up again through the deck and up the mast in a galvanized iron gas pipe of about $\frac{3}{4}$ inch bore. This enters the lantern from below and a nut is fitted inside and out. The pipe is secured to the mast by means of galvanized iron clips spaced about 3 feet apart. The pipe is taken right up through the bottom of the lantern, which is made a fixture on its shelf. The interior of the lantern and the run of pipe to it, is shown in Fig. 7. The two masts are wired in precisely the same manner.

The pair of wires for the stern light is run alongside the pair for the main masthead light, but continues right on to the after end of the ship to the lantern. This is sometimes fitted on the stern rail and sometimes on the after end of a deckhouse if there is no obstruction to the light. A lantern is not always fitted; in its place an ordinary bulk-

head fitting is often substituted. The two masthead, and the stern light, are all white lights.

Returning to the wiring for the two side lights;

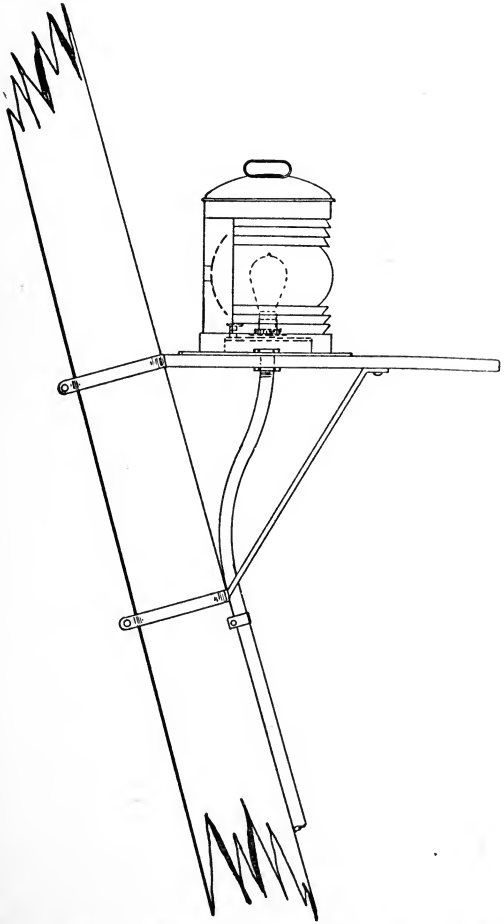


FIG. 7.—FIXING AND WIRING OF MASTHEAD LAMP.

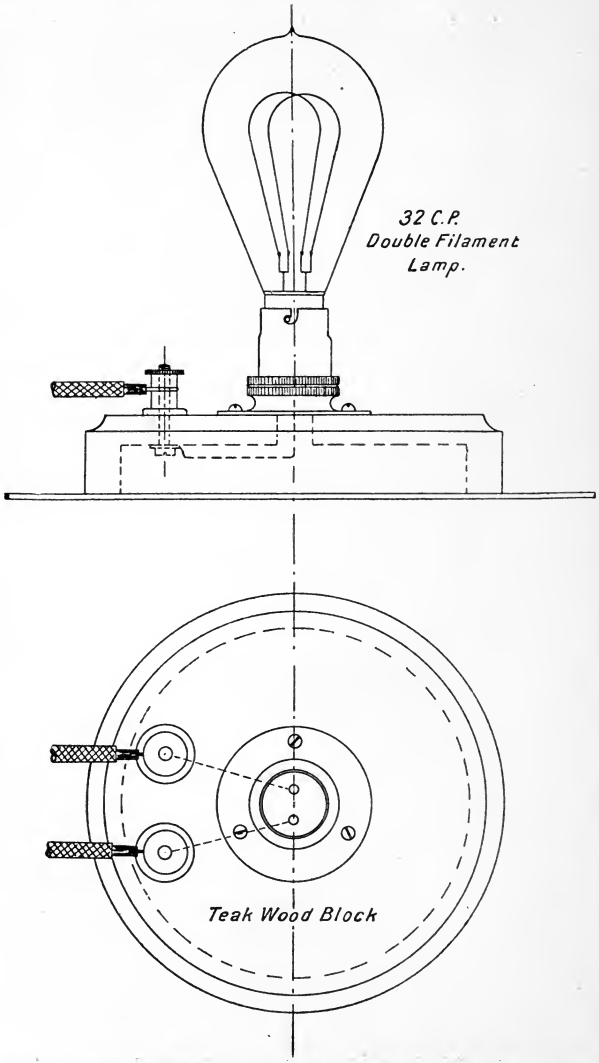


FIG. 8.—ARRANGEMENT OF LAMP, LAMPHOLDER, AND TERMINALS FOR NAVIGATION LANTERN.

these are always in lanterns fitted one on either side at the extreme ends of the bridge. The starboard lamp has a green, and the port lamp a red glass. The interior of these lanterns consists of a round hardwood block with a flanged lamp-holder mounted in the centre. There are also two terminals on the block connected to the lampholder (Fig. 8). The feed wires are brought into the lantern and connected to the terminals. Great care is necessary to see that the lamp is exactly in the centre of the lens. A run is found for these wires, under the bridge either in a teakwood casing or in galvanized iron piping. Any necessary branches are taken off this same run for lights to the compass and telegraph pedestals. These are fitted on the bridge above but are wired from underneath. Telegraphs are usually fitted with the lamp inside, behind the dials. For the compass pedestals or binnacles there are two methods of fitting the electric light, depending on the type of compass. One type has the light fitted inside in a similar manner to the telegraphs; in this case the wires are brought up inside. The other method is the one adopted for a compass having a pocket at each side, one of which is for the electric lamp. This type is portable, so that it can be removed in the event of failure, and an oil lamp substituted.

The lamp is connected by means of a short flexible lead, to a plug and socket fitted about half way down the pedestal (see Fig. 9). The arrangement of lighting for the instruments is always decided by the makers and connexion made according to their requirements. These telegraph and compass lights need not be on separate fuses. Two of each, for example, might be taken off one fuse. There are also two methods of wiring up the sidelights and sternlights. One method is to make the lantern a fixture, and pass the wires up through the underside from the casing or tubing beneath.

The other method is to have the lantern portable and connect it by means of a flexible lead, fitted with plug and socket. This is a similar arrangement to that described in connexion with the binnacles.

It is very important that the navigating lights of the ship should not fail at any time without some warning being given to the officer on watch. To accomplish this, there is fitted on most ships a piece of apparatus called a Navigating Light Indicator (Fig. 10), which gives warning by ringing a bell immediately any of the lights fail.

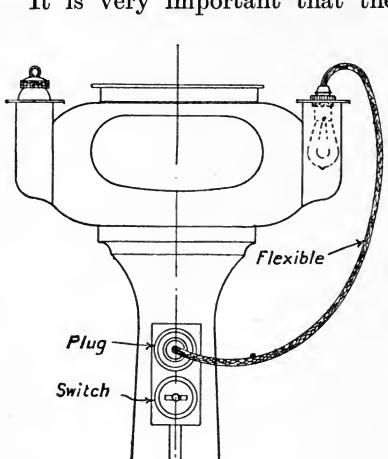


FIG. 9.—BINNACLE LAMP AND CONNEXION.

The following is a description of the working of a typical indicator of this kind. The first sketch (*A*) shows the outside appearance of the Indicator. The second (*B*) shows the connexions between the supply fuseboard, the indicator, and the alarm bell.

The indicator shown is arranged for three lights, viz., foremast head, port side light and starboard side light. A larger one can be obtained if required, to take the main-masthead light and the stern light also.

The working of the indicator is simple enough. Each movement consists of an electro-magnet with

armature and disc. The current of each lamp circuit passes round its respective electro-magnet, which, when the light is switched on, is energized, attracts the armature, and the disc is raised to the position which indicates light "ON." If the lamp burns out or the circuit is broken from any cause, the armature is released, falls on to a contact and thus completes the bell circuit, and the bell continues to ring until the fault is attended to. A special feature about the bell is that it is worked off the supply mains with a suitable resistance in circuit.

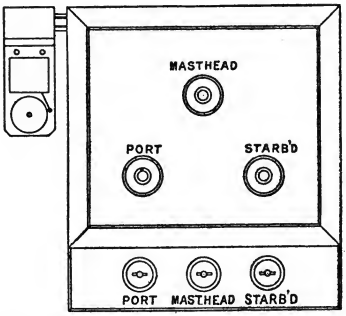


FIG. 10A.—NAVIGATION LIGHT INDICATOR—GENERAL VIEW.

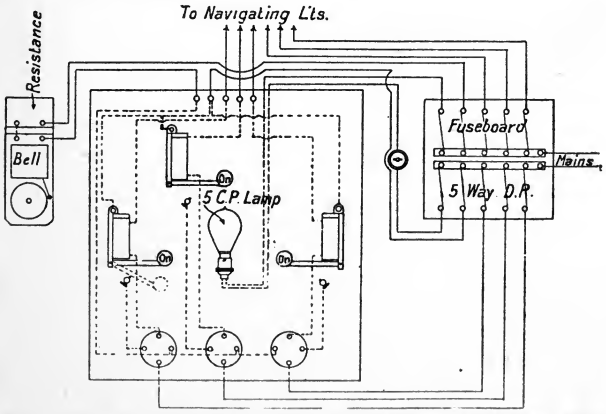


FIG. 10B.—NAVIGATION LIGHT INDICATOR—INTERNAL AND EXTERNAL CONNEXIONS.

The switches are of a special kind, and have four contacts; two for the lamp circuit, and two for the bell. The latter, therefore, is broken when the switch is turned off, and the bell thus stopped from ringing while the repairs are being carried out. The dial of the indicator is illuminated by means of a 5 candle-power lamp inside the case; this shows through the indicator hole immediately a disc drops. The fuseboard shown is of the double-pole type, as the wiring for the indicator is almost invariably near the compasses.

There are still two lights which have not yet been mentioned, viz., the two "Anchor" or "Riding" lights. They are sometimes electric, although more often they are only oil lamps. They are for use when the ship is riding at anchor. If electric, they take the form of portable lanterns with flexible lead, for connexion to a plug and socket, and, when in use are hung from the mast stays, one at the forward, and the other at the after end of the ship. The plugs are fitted in some convenient position on a deckhouse underneath the lamps.

It is not the usual practice, nor is it necessary, to take these lights off the navigating circuit. They can be taken off any of the other circuits.

(3) THE CARGO LIGHT CIRCUIT

This circuit, as its name implies, is the one which carries the lights in the holds (usually fixed), also the portable lights for deck use, viz., the clusters and arc lamps used for lighting the decks and hatches when the ship is in port and the work of loading and unloading cargo is in progress.

Fixed lights are rarely fitted in the holds and, in fact, electric cables of all kinds are kept out of the holds wherever possible. When cables must pass, unavoidably, through the holds, they are run

in galvanized iron gas-pipe, and the best possible mechanical protection given to them, so as to minimize the risks of fire through short circuit or by mechanical damage, which might result in an earth or a short circuit. Pipes should be run alongside the beams wherever possible, or in some sheltered place out of the way of the cargo.

The distribution fuseboards and switches for these lights are situated on the deck above (generally the main deck) where they are always accessible. A board would be fitted at each end of the ship where the cargo holds are situated. The centre lower portion of the ship is always taken up by the engines and boiler rooms. The number of ways on the fuseboards depends on the number of lights, allowing one way for each four lights, one way for each cluster connexion box, and one way for each arc lamp connexion box. The number of clusters is usually determined by the number of hatches, there being, as a rule, one for each hatch.

The arc lamps seldom exceed two in number. They are usually fixed, when in use, one at each end of the ship and fairly high up so as to throw a good general illumination over the decks and quay. The connexion boxes, of which there is one for each cluster and another for each arc lamp, are fitted near their respective hatches, in a convenient place on any of the adjacent deck houses.

The feed wires for the two distribution boards would follow the main fore and aft run, along the main deck, and meet at the engineroom entrance, which is a very suitable place for the section box feeding this circuit to be fitted. Two ways only will be required on the section box. The main cable from the connexion box would then continue down the engine room bulkhead to the main switchboard. There is very little further in the way of description, that can be given of this circuit, so a return will now be made to those fittings which

belong almost exclusively to the working of the ship's cargo.

There is nothing special about the section and distribution boards, and these are described later on in another part of the book.

The terminal connexion boxes for the arcs and clusters are similar in design, and of the cast-iron watertight pattern, with hinged door and wing-nut fastening. They contain a strong plug and socket coupling and a switch. One important difference must be made in the plugs belonging to the arc boxes, that is, they must differ in form so that they cannot be inserted into the cluster boxes in error. This rule must be strictly observed where line resistances are used in circuit with the arc lamps, but does not apply where the lamps have self-contained resistances.

There is another special requirement that applies to arc lamp plugs, viz., they should be so designed that they can be inserted in the sockets in one way only, thus ensuring that the lamps have their polarity correct each time they are plugged in circuit.

The connexion boxes have brass labels fitted on the outside of the lids engraved "ARC" or "CLUSTER."

With reference to the arc lamps themselves; both the open and enclosed type are in use. The principal difference in the construction of land and marine arc lamps, is that the marine lamp (Fig. 11) is fitted with a square or hexagonal lantern in place of the globe used on the land lamp. These lanterns are strongly constructed, and suitable for rough handling. They are tapered in shape, wide at the top and narrow at the bottom. The glass is clear, opalescent or of the Muranese variety and, in the best lamps, has wire netting embedded in it to strengthen it. Line resistances are almost invariably required in order to obtain the correct voltage across the lamp terminals. Enclosed lamps require about 70 volts, upwards, and are used singly on 100 and

110 volt installations. Open type lamps require from 45 to 50 volts, and are used singly on 55 and 60 volt installations, and two in series on 100 and 110 volt installations (see Fig. 12).

Cargo Clusters.—These consist of large shades or reflectors (Fig. 13) from 20 to 30 inches in diameter made of galvanized iron, blue and white enamelled iron, or brass. Inside is a ball or cone with a number of lamps radiating from it; six, eight, or ten being the usual number.

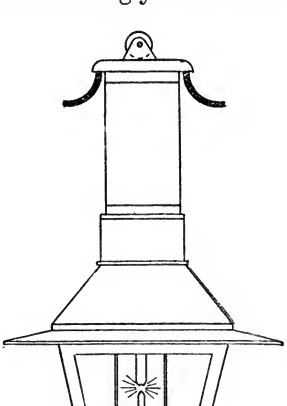


FIG. 11.—MARINE TYPE ARC LAMP.

In the ball are two terminals, fitted on a fibre base and making connexion between the main flexible lead and the lamp-holders. A wire guard is fitted over the front of the reflector to protect the lamps. Three eyes are fitted on the rim for attaching

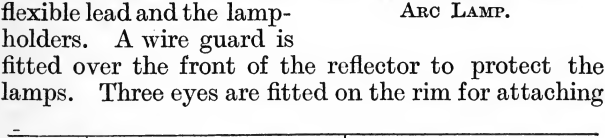


FIG. 12.—ARC LAMP CIRCUITS.

guy ropes to steady the fitting when in use in windy weather. The top portion of the fitting, outside the shade, consists of a brass eye or hook for suspension purposes, and a watertight gland to admit

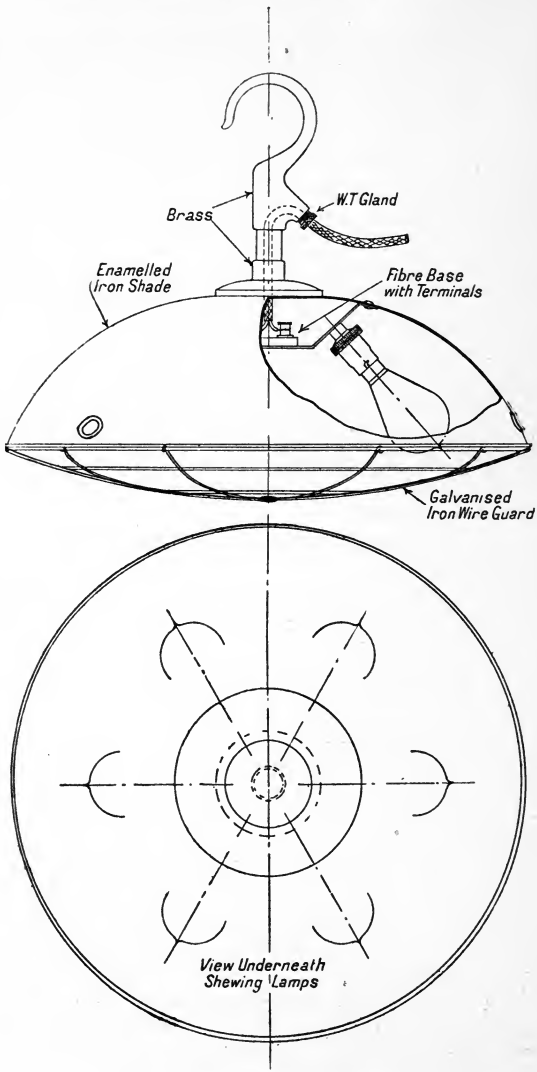


FIG. 13.—CARGO CLUSTER.

the flexible cable. This gland should be designed to turn downwards as an extra precaution to prevent water from entering, should the gland not be perfectly watertight. The twin flexible cable used as a lead to connect the clusters to the terminal box, is of a heavy type, extra strongly jute covered and braided to withstand the rough handling by the ship's crew. The extra strong covering makes the flexible look very heavy, but a large conductor is not necessary. The largest required for clusters would be for eight 16 candle-power lamps on a 60-volt circuit. The size in this case would be 283/38 or other equivalent section.

The flexible for arc lamps is heavier than that used for the clusters and must be suitable for 6 to 8 amperes, for the enclosed type, or 10 amperes for the ordinary open type or flame arc lamps.

For 8 amperes, flexible would be 168/38 or equivalent section.

For 10 amperes, flexible would be 283/38 or equivalent section.

(4) THE STARBOARD SALOON CIRCUIT

(5) THE PORT SALOON CIRCUIT

These two circuits are very much alike, one taking one side of the ship and the other the remaining side. The description of one circuit will apply to the other in almost every particular, so that a description of one only will be given in detail.

As with the other circuits, the mains would be run from the main board in the engineroom, up to the section box which would be in some convenient and suitable place, probably in an alleyway or a pantry. If in an alleyway it must be fitted in such a way as not to offer any obstruction to persons passing. The position chosen should be central to all the distribution boxes. It is not at all uncommon to fit the section box beside the first

one or two distribution boxes on the run, i.e. beside the boxes nearest to the engine room on the main run. Other leads would be taken from the section box to the various other distribution boxes on the circuit. The public rooms, viz., the dining saloon, social hall or music room, smoke room, etc., all belonging to the first class accommodation, would be on this circuit. The switches for the lights in these rooms are sometimes fitted in the rooms themselves, in some inconspicuous place; but they are more often fitted in the pantry. In any case they should always be accessible to the stewards.

Beside the rooms mentioned above there will be all the staterooms, lavatories, bathrooms, alleyways, pantry and entrance lights on the circuit. Separate and distinct distribution boxes are allocated to these lights. Each ordinary stateroom has one pendant light in the centre of the room or over the mirror; the switch being fixed in the most convenient position for the passengers to reach it from the berths.

The alleyway lights are usually pendants spaced about 20 feet apart, each with its own switch fitted underneath. It is usual to fit master switches at the section boxes, one for each distribution box, so that a section of lights, consisting of about 20 or 30, can be switched off without going round to the individual switches. Sometimes when this arrangement is adopted it is required to leave a few lights burning, say two or three only, in each public room or entrance, to serve as night lights, and to remain burning when all the other lights are switched off. The lamps intended for night lights would be on separate switches and fuses and not under the control of the master switches, neither would they be connected to the busbar of the section box. A sketch of the arrangement is shown (Fig. 14).

The cable runs will now be considered. In alleyways they will be under mouldings for the most part, and casing only used when stepping out to a

light or switch. The back of the moulding is hollowed and has two or three grooves ; one for main lighting cables, one for the small lighting cables, and another for the bell, telephone, and other similar wires. In cabins a small casing is run to the light and down to the switch. The arrangement in the pantries, lavatories and bathrooms will be similar.

In the special rooms, however, more attention is given to appearance. The rooms are decorated with ornamental panels, both on the ceilings and bulkheads, and therefore no ordinary-casing is used. Wires are run behind mouldings, panels, etc., which are screwed up so that access can always be had to the wires.

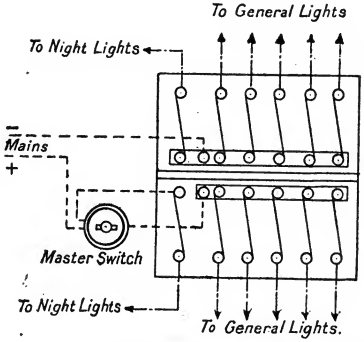


FIG. 14.—ARRANGEMENT OF FUSE-BOARD FOR NIGHT LIGHTS.

A main run is arranged beside a beam running fore and aft, which almost invariably forms a division between the panels. The lower side of the beam takes the form of a fancy capping, which is fixed with screws. The small wires step out from the main run to the centres of panels, where the fittings are usually placed.

Lights may be required in a dome or ornamental skylight, more for effect than for actual light. In some special cases where the skylight has stained glass, lights are fitted over, that is, outside the glass to illuminate it after dark instead of leaving the skylight black at night, as it would be if there were no lights at all. Of course, the lamps above the stained glass are not seen, and therefore

the kind of fitting used is immaterial, ordinary flanged lampholders being quite good enough.

In addition to the interior lighting there will be a number of decklights on this circuit. These are the lights fitted on the open decks, viz., the promenade and saloon decks. The fittings used for decklights are of the bulkhead or oyster type (see Fittings). They are fixed to the deck overhead if there is one, and if not, on the sides of the deckhouses. The spacing is usually about 20 feet apart on the open deck. The switches for these lights are fitted on the inside of and above the saloon doorways leading from the deck. In addition to fixed lights in the first-class accommodation (and also in the second-class on some large liners) plug and socket connexions are fitted so that a table fan, a table lamp, or curling-tong heaters can be connected up and used when required.

Radiators for heating purposes are often used in shipwork. These take a current of 5 to 10 amperes, which is very much more than that taken by a lamp or any of the above mentioned apparatus, and if numerous must have a circuit of their own, or, if taken off the lighting circuit they must have a special section box with fuses of from 10 to 15 amperes capacity.

Another type of fan beside the cabin fan is fitted in the passenger accommodation. This is the ceiling or flail fan and it is fitted in the principal saloons. They are fitted chiefly in ships which trade in hot climates. A description is given in the chapter dealing with fans. They are fitted to the deck, overhead, above the tables. The blades are turned downwards so that a gentle current of air is sent down towards the tables. The fans are of a peculiar design with long blades, and run at a slow speed, so that there is no noise whatever from them when running.

(6) THE FORWARD CIRCUIT

As its name implies, this circuit supplies the entire forward section of the ship. The compartments included are seamen's and firemen's accommodation, lamp room, paint store, carpenter's and boatswain's store, chain lockers, stairways and one or two deck lights. The main supply cables will be brought along the main run to a section box at the forward end of, say the main deck, fixed in a convenient and accessible position. This box would have two, three or more ways as required. The submains would run to the distribution boxes, the number of these being one or more for each deck. The lights are looped about four on a fuse as elsewhere. The switches are fitted in each compartment beside the lights, or just inside the doors. There is nothing very special in the way of fittings on this circuit. There are usually one or two docking telegraphs on the forecastle deck which will be fitted for electric light. Also the forward anchor or riding light will be fed from this circuit. For the latter a plug will be fitted under the forecastle deck with switch alongside. A flexible lead will connect the plug to the anchor lantern, of sufficient length to allow it to be hoisted up to the mast stay. The lantern has glass all round so that the light is visible in every direction.

The height to which it is hoisted is specified in the Board of Trade regulations.

(7) THE AMIDSHIP CIRCUIT

This circuit supplies the lights in the central portion of the ship, below or immediately abaft the part occupied by the saloon and passenger accommodation. The following compartments are included: Galleys, butcher's, baker's and similar shops, engineers' cabins and mess room, stewards' storerooms, deck and alleyway lights, etc.

The arrangement of wiring and boxes will be similar to that of the forward circuit so far as the lights are concerned, but ways will be required on the distribution boxes for a number of small-power motors ranging from ¼ to 1 horse-power, for driving such domestic machinery as potato-peelers, dish-washers, etc., and connexions will be required for egg-boilers and electric grills.

If there is a laundry on board equipped with machines driven by an electric motor, wiring must be arranged to supply it. The size of motor required will be about 5 horse-power. Electric flat-irons may also be used, so that a number of plug and socket connexions fitted on the bulkhead will be required for these.

(8) THE AFTER CIRCUIT

This supplies current to lights, etc., at the after portion of the ship, including, as a rule, the second-class passenger accommodation; also rooms set apart for the use of stewards, stewardesses and others; also lights in steering engine house, docking telegraphs and compasses.

In some ships the stern light is fed from the after circuit, and has a local switch, instead of being taken off the navigating circuit at the chart house fuse-box as already described in the section dealing with the navigating circuit. The stern light is not regarded by the Board of Trade as of such importance as the masthead and sidelights.

The after anchor light comes off the after circuit and has a similar plug connexion to that described in connexion with the forward light. The general arrangement of main and sub-cables and fuse-boards is similar to that of the forward and amidships circuit.

(9) GENERAL MOTOR CIRCUIT

This circuit is only required in medium-sized and large ships, and is intended to supply all motors which may be used for driving any of the following machinery: Large ventilating fans, galley and laundry machines, passenger and goods hoists; also pumps, turning gear for main engines, and other machines connected with the engine-room.

The number of boxes on the circuit depends on the number, disposition, and sizes of the motors in the ship.

One method of dividing them is as follows:—One circuit for engine-room motors, one for ventilating fans, one for hoist motors, and one for other sundry motors. The fuse boxes on this circuit will be heavier than those for the lighting circuits. Junction and section boxes will be used, but no small distribution boxes will be necessary.

Another circuit which may be mentioned is that for the forced draught fans for the main boilers, if they be motor driven; and any engine-room ventilating fans. These would have separate individual control switches, ammeter and starting gear fitted on or near the main switchboard. The foregoing circuits are shown on the wiring diagram, which appears in the section dealing with the various systems of wiring.

CABLES AND WIRING

This section will be chiefly devoted to a description of the various kinds of cable used in different parts of the installation. Also to showing which particular kind of cable is best suited to each section of the ship and the method of running the cables to suit the conditions met with in any particular case.

The cable is almost invariably of the pure and vulcanized rubber insulated class, with a minimum insulation resistance of 600 megohms per mile, as this is the minimum resistance allowed by Lloyds' insurance rules. As in the case of rubber cables in general use, it has a layer of tape over the rubber. Outside this again there may be any of the three following finishes, viz.:

(1) Braiding and compounding, either black or red; (2) Plain lead sheathing; (3) Lead sheathing; then another layer of tape; and finally a protection of armouring which consists of a layer of galvanized iron wires of suitable gauge.

Armoured cables, without a lead sheathing intervening between the rubber and armouring, should not be used, as they almost invariably give trouble, especially in places like engine and boiler rooms, where heat, moisture, and possibly oil, have to be contended with.

Single-conductor cable is most generally used, although some twin lead-covered and twin lead-covered and armoured cable is occasionally employed. Twin flexible cable is used for the portable leads for arc lamps and cargo clusters—this is described in the chapter on circuits (see Cargo Light Circuit).

The methods of fixing and running the three first named cables differ in some respects.

The braided and also the lead-covered cables are run in wooden casing, behind mouldings (Fig. 15) and panels, and sometimes in tubing. The running of wires in tubing will be dealt with in detail later on.

Lead-covered wires can also be fixed by means of clips to the ironwork of the ship, or as an alternative, clipped to wood battens. The clips used would be of the brass double-ended type, varying in size according to the number and diameter of the wires which are to go under one clip.

Sometimes wiring is erected in this way through-

out a ship, and, with care, a very neat job can be made. It is not absolutely necessary to have wood battens to run the wires on. They can be clipped direct to the iron beams and bulkheads, or to wooden bulkheads wherever possible. Armoured cables are almost invariably clipped. These cables also may be clipped direct to the ironwork or to wood battens. If the latter are used they should be of teak, as it is most suitable for withstanding the variations of temperature and degree of moisture to which they

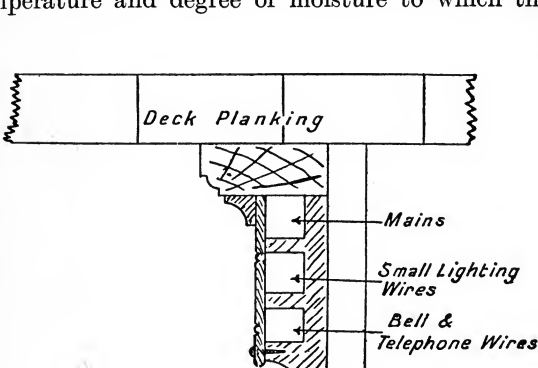


FIG. 15.—SECTION OF MOULDING, SHOWING GROOVES FOR WIRES.

are subjected, without splitting or warping. These unfavourable conditions have to be contended with in some parts of the machinery spaces. Brass clips for such cables are unnecessary; they can be fixed by means of galvanized iron clips. These vary in shape. Besides the ordinary saddle and single-ended type of clip there is another pattern as shown

in the illustration (Fig. 16) with one hole in the centre to take a $\frac{3}{8}$ inch screw. This clip accommodates a wire on either side. The chief advantage gained by its use is the economy effected in drilling and tapping fewer holes. When fixing cables to iron-work with any type of clip, the screws used are $\frac{3}{8}$ inch Whitworth, with snap heads. When fixing to woodwork No. 18 galvanized iron wood screws are employed. The spacing of the clips on an ordinary straight run is about one to every 12 inches. The spacing may have to be modified to suit special

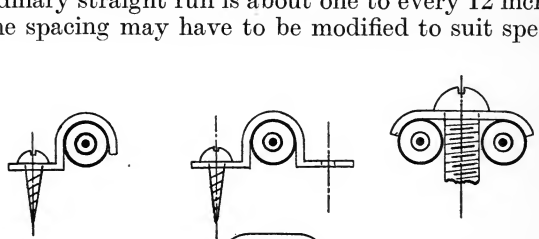


Fig. 16.—Four Types of Wiring Clip.

situations, such as between beams on an overhead deck run. The spacing should be divided up evenly, with not less than 12 inches between the clips. To effect this more clips may have to be used than under ordinary conditions. Some care is necessary when running armoured cable, as it is a very easy matter to disarrange the armouring and so damage the lead covering. If the latter should be damaged the rubber will quickly deteriorate and a fault develop. When running the cable around bends it should be bound with black adhesive tape 2 or 3 inches on each side of, and over, the place where the bend will occur. The radius of the bend should be as large as possible consistent with neatness.

Care should also be taken when connecting up fuseboards and fittings. The wire armouring should be cut well back and bound here also with tape, or, better still, a layer of fine wire. The lead should protrude beyond the armouring but it *should also be cut back about an inch and only the rubber insulation brought up to the terminals of the fuse or lamp-holders.*

The following will show as clearly as possible in which places in the ship the different kinds of cable above referred to are generally fitted.

Ordinary cable with braided finish, is used everywhere where there is wood casing. This is fitted in such places as: Passenger accommodation, staterooms, passages, pantries and lavatories, officers' and engineers' cabins and mess rooms, storerooms, crew's accommodation etc.; behind panels in public rooms and entrances, in fact, almost everywhere in the ship with the exception of the machinery spaces, galleys, and holds.

Plain lead-covered wire can be used in every situation where the braided cable is admissible. There are, however, places where lead-covered wire should always be used, more particularly in those situations which are exposed to the weather, such as the run under the bridge for the sidelights, instrument, and telegraph lights; also the runs to deck lights if wood casing be used. Braided cable can be employed in these places, if run in galvanized piping, and a watertight connexion made by means of a screwed joint between the piping and the fitting.

Clipped lead-covered wire can be used for practically every circuit where casing can be run, and if a "surface" job is required, i.e. an installation with all the wiring exposed to view, it can be carried out with clipped lead-covered wires. If braided or lead-covered wires are used for machinery spaces, holds, or such like places, where they will be exposed to mechanical injury, they must be run in piping,

either steel conduit or iron gas-barrel. When the latter is used care must be taken to see that it is quite free from burrs inside. The pipe must be of ample size to allow of the wires being easily withdrawn for inspection or renewal. To facilitate this, draw-in boxes are necessary (Fig. 17) and should be fitted at intervals of not more than 20 to 25 feet

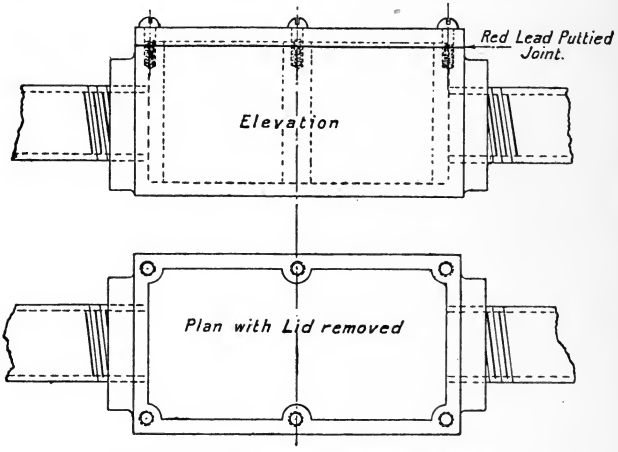


FIG. 17.—DRAW-IN BOX FOR CABLES.

apart. In addition to allowing inspection of the wires, the boxes greatly assist in the wiring of the job.

Coming now to the armoured cable, this is almost invariably used in the machinery spaces, galleys, and similar places where there is steam, moisture or heat present; and where the cable is liable to be damaged mechanically.

It is often necessary to run part of a circuit in braided cable and the remainder armoured. In cases of this kind the small junction boxes described elsewhere in this book can be used to connect the

two different kinds of cable. An arrangement of this kind, but on a larger scale, has sometimes to be resorted to for the main cables, running from the main switchboard in the engine-room to the sub-switch or section boards in the different parts of the ship. The two methods of running these main cables will now be described.

Method No. 1, which aims at keeping all the wiring in the engine-rooms uniform, i.e. armoured throughout. All the main cables are armoured, and secured by clips all the way from the main switchboard, right up to the main deck where the mains leave the engine-room casing. At this point heavy junction or joint boxes are fitted, to connect the armoured to the braided mains, which are run from this point to the sub-switchboards.

Method No. 2, which is rather less expensive, is to start from the main switchboard with braided cable, and continue it throughout the whole run. The cable is carried in a strong teakwood casing from the switchboard to the main deck where the fore and aft run of casing is located.

To return to the general wiring of the installation ; some other important points will be considered.

When cables are run through decks they must pass through special deck-pipes, made of galvanized iron gas barrel (see Fig. 18) standardized to an overall length of 14 inches. Of this overall length, about 6 inches is threaded at one end and the other left plain. The threaded end is fitted with two galvanized iron or brass nuts and two washers. Brass is not often used, as the galvanized iron is considered quite suitable. When the pipe is in position, as shown in sketch, it should project not less than 8 inches above the deck. Red lead putty should be used under the washers to make a water-tight junction between pipe and deck. A lining of fibre, or hardwood tubing, $\frac{1}{16}$ inch to $\frac{1}{8}$ inch thick in the wall, is inserted in the pipe. At the top or

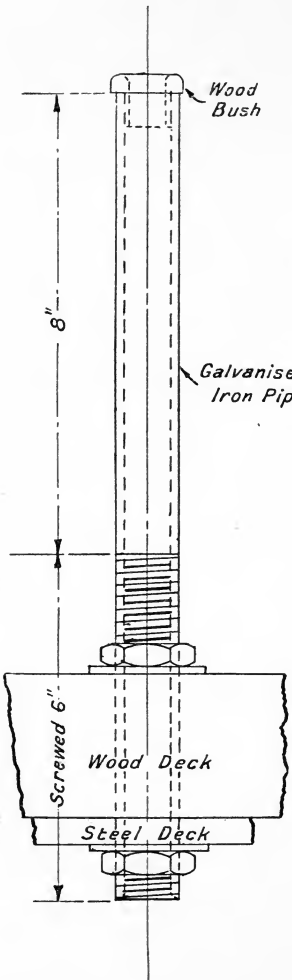


FIG. 18.—WATERTIGHT DECK PIPE.

plain end is fitted a hardwood insulating bush. When the cables are finally fixed in position, the top of the pipe is packed with cotton waste or spun-yarn for a space of about an inch from the top; it is then filled up with compound, run in hot.

Another essential accessory to ship wiring is the water-tight gland. These glands must be used in every case where it is necessary to pass cables through watertight bulkheads. These bulkheads are the walls, or partitions, which divide the ship into a number of watertight compartments; they may run fore and aft or athwartships. In order, therefore, that the watertight properties of a bulkhead may be preserved, all cables must be passed through glands, which can be packed around the cable in a similar manner to the packing of a piston rod on an engine. The illustration (Fig. 19) shows how a gland

is constructed. A piece of gas pipe of the required bore is threaded all the way along and cut off about 3 inches in length. The pipe passes through the bulkhead and is fixed by means of a nut and washer on each side. Some packing of red lead putty or other suitable substance is also inserted under the washers. The gland itself consists of a brass nut of special design with a recess which can be packed after the cables are drawn through.

The iron tube portion of the gland is lined with wood or fibre tubing similar to the deck pipes. The

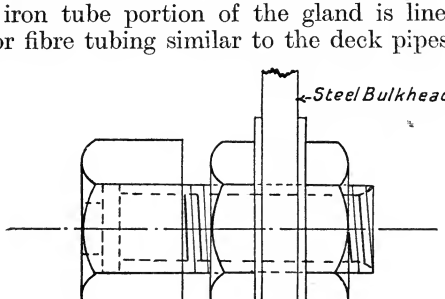


FIG. 19.—WATERTIGHT BULKHEAD GLAND.

deck-pipes and glands are always lined for braided and lead-covered cables but not always for armoured cables.

There is another requirement when running cables on a ship and that is, when they pass through holes in iron beams, ordinary non-watertight bulkheads, or in fact, ironwork of any description, the holes must be bushed with lead or have fibre or hardwood ferrules inserted in them, to prevent the cable from being damaged by coming into contact with and chafing against the iron. This precaution again does not apply so particularly to armoured cable although some engineers insist on having all holes

bushed throughout the ship. Generally speaking, however, armoured cables are passed through plain holes.

Nowadays, on wiring systems, joints are seldom if ever made, except in the case of breakage. The best method of connecting up a broken wire is by

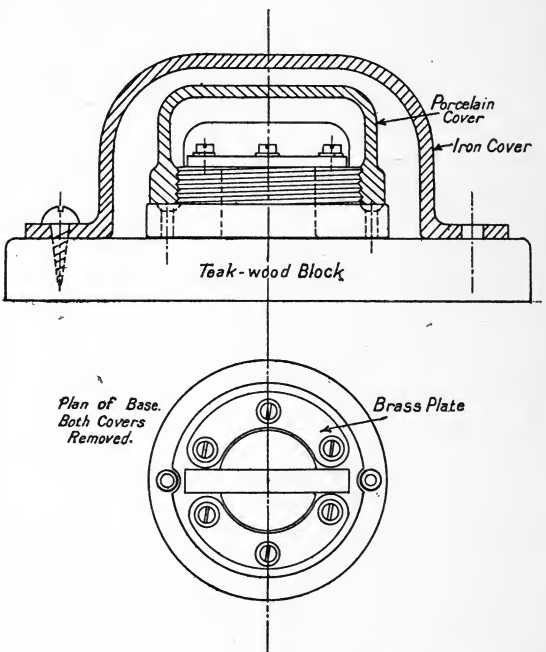


FIG. 20.—PORCELAIN JOINT BOX WITH CAST-IRON COVER.

means of a small (or large as the case may require) porcelain junction or joint box (see Fig. 20). Where necessary, in such places as the machinery spaces, the box can be covered and protected by means of a cast-iron dome shaped lid.

All wiring for lights is carried out on the loop-in system, and as many as four lights looped on one fuse of the distribution board. Looping can be effected in either of two ways according to how the lights are situated. When lights are in a straight

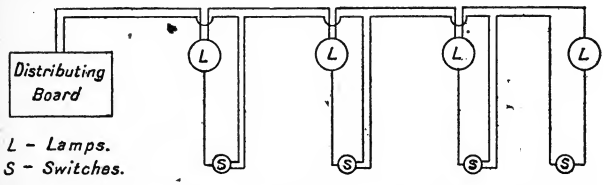


FIG. 21.—"LOOP" WIRING OF LAMPS IN A STRAIGHT RUN.

or fairly straight line they are simply looped up by wiring from one light to the next and so on (Fig. 21). When scattered they can be wired up to

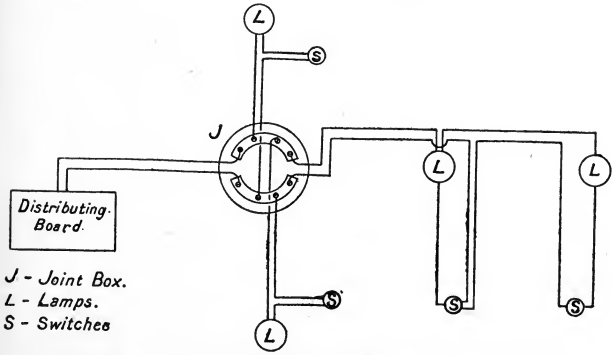


FIG. 22.—"LOOP" WIRING OF SCATTERED LAMPS.

a small junction or loop-in box. A pair of wires would be run from the fuseboard to the loop-in box and separate pairs taken from the box to each light (Fig. 22).

In the machinery spaces or any other space where armoured wire is used, and fittings with long tubular stems, these loop-in boxes should always be adopted, as it is not very good practice to run two pairs of armoured wires down the tubes of fittings, also a saving of wire is effected in cases where the fittings are spaced far apart.

One point must be observed, when connecting up fuseboards, fittings of all kinds, switches, etc., viz., care should be taken to *cut back the braiding and tape of the cable so that the bare rubber is exposed at least half an inch, and only the rubber comes into contact with the live terminals.* A large amount of leakage can thus be prevented, as the braiding and tape on the cable are not good insulators, especially if at all damp.

When deciding on the sizes of cable to be used on a job, it is necessary to take into account the voltage drop as well as the carrying capacity of the copper wire or strand. The drop should not exceed two volts at the lamp farthest away from the dynamo. This should be arranged when the wiring diagram is prepared.

The formula used is simply: Voltage drop = current in amperes × resistance of conductor in ohms. The drop is calculated for each different section, viz. (1) Main switchboard to section box; (2) Section box to distribution box; (3) Distribution box to light. The three results are added together, and, if the total does not exceed two volts the wires are all right. On the other hand, if the result should exceed two volts, larger mains must be substituted until the drop is reduced to the required minimum. For single lamps of 16 candle-power, $\frac{1}{18}$ wire is used. This is the smallest gauge of single conductor permissible.

A table (Fig. 23) is also given which will indicate at a glance the number of lamps certain sizes of wire will feed at standard voltages.

Fuseboards

There is not very much to be said about the fuseboards used on ship installations. The internal

Table of Cable Carrying Capacities.

		At 1000 Amps. per Sq Inch.			At I.E.E. Standards.		
		1/18 = 1·81 Amps.	1/17 = 2·46 Amps.	3/20 or 1/16 = 3 Amps.	1/18 = 4·2 Amps	1/17 = 5·4 Amps.	3/20 or 1/16 = 6 Amps.
16 c.p. Lamps.	At 60 Volts 1 Lamp = 1 Amp.	1	2	3	4	5	6
	At 100 Volts 1 Lamp = ·6 Amp.	3 – 2 or 1	4	5	7	9	10
	At 110 Volts 1 Lamp = ·55 Amp.	3 – 2 or 1	4	5 or 6	7	9	10

Flexible Leads for Arc Lamps and Cargo Clusters

	35/38 (= 1/20) 1 Amp.	108/38. (= 1/16) 3 to 6 Amps.	168/38 (= 1/14) 5 to 9·8 Amps.	283/38 (= 1/12) 8·5 to 15 Amps.
At 60 Volts.	Single 16 c.p. Lamp	3 Light Cluster	5 Light Cluster or 8 Amp. Arc Lamp.	8 Light Cluster or 10 Amp. Arc Lamp
At 100 Volts.	Do.	6 Light Cluster	8 Light Cluster or 8 Amp. Arc Lamp.	10 Amp. Arc Lamp
At 110 Volts.	Do.	Do.	Do.	Do.

Fig. 23.—Wiring Tables.

portions, that is, the slabs themselves, are very similar to those used in landwork, but the various

makes differ in detail. The boards and covers are made to suit each individual situation, as the particular surroundings and woodwork have to be matched. Under these circumstances the only parts of the boards which can be standardized are the slabs. These can be obtained, ready fitted with four, six, or eight ways as required, also a busbar and main terminal. Sometimes the fuseboards and even the switches themselves are fitted in recesses behind panelling; one of the panels being arranged to serve as a door. The fuses themselves should preferably be of the porcelain bridge type with visible fuse; the "Well" type fuse made by Messrs. Richardson & Co. being one which is commonly used on ship installations. For distribution boards the 5 ampere size is most suitable; the number of ways ranging from four to eight according to the number of lights fed from the board.

In the machinery spaces the fuseboards are usually enclosed in cast-iron boxes, although sometimes strong boxes of teakwood are used, as these afford a good mechanical protection to the fuse slabs. The iron boxes are not always watertight, but have plain doors and wing nut fastenings. They are best bought undrilled (without cable holes) as they can then be drilled or slotted to take the desired number of wires. The wires should always enter the box from below. If holes are drilled into the top of the box there is always the possible risk of water finding its way inside and causing trouble.

In addition to the passenger accommodation and machinery space fuseboards which have been mentioned, there will be a number of ordinary boards required for such places as the crew's quarters forward, or storerooms amidships. In all general places of this kind the boards are of teakwood, plain and strong, and either painted or varnished. On the inside of the lid of each distribution fuseboard is fixed a list bearing particulars of all the

lights supplied from that particular board, giving the number of the fuse they are taken off, and also stating the circuit to which it belongs, and the size of fuse wire for the bridges (see Fig. 24).

Saloon Port Circuit.

Section Box.

Fuses 1 N° 24 Cu.

1. Distributing Box N°1 in Passage, Saloon Deck.

2. Do. N°2 in 1st Class Pantry.

3. Do. N°3 in Do.

4. Do. N°4 in Smoke Room Bar.

Midship Circuit.

Distributing Box N°1.

Fuses 1 N°36 Cu.

1. Passages Port. *4. Galleys.*

2. Do. Starboard. *5. Wine Store & Prov.n Store.*

3. Butchers & Bakers Shops. *6. Emigrant Stores & Cabin Stre*

FIG. 24.—FUSEBOARD LABELS.

In the case of the section fuseboards the label would indicate the number and position of the distribution boards fed from that section box, as shown in the first table.

Switches of the 5 ampere size are fitted beside distribution fuseboards in places where the lights are in groups of three or four, such as the public rooms, engine and boiler rooms, passages, and deck lights, etc., where individual switches for each light are unnecessary. These switches are labelled to show at a glance to which lights they belong.

If desired, switches can be fitted inside the fuseboard cases, and locked up to prevent interference by unauthorized persons.

The master switches previously referred to are fitted beside the section boxes and control each separate distribution board. They are of about 20 amperes capacity and of the tumbler, knife, or chopper type. These switches should be distinctly labelled to indicate the lights controlled.

Fittings and Incandescent Lamps

The electric light fittings used for shipwork are of strong and substantial design. They are short, as compared with shore fittings, owing to the small head room available on board ship, and stiff and rigid to withstand the motion and vibration of the ship. In cabins and general passenger accommodation the average height from deck to deck is 8 feet. In the saloons and public rooms the height is very often more than this.

Generally speaking ship's fittings may be divided into three classes :—

(1) Special ornamental fittings for the saloons, music and recreation rooms, smoke rooms, etc.

(2) General staterooms, and alleyway fittings.

(3) Watertight fittings, which are used in machinery spaces, stores, galleys, on open decks, and other similar places. The finish on the fittings is decided by the owners, the most common being electroplate, copper, steel-bronze, green-bronze or ordinary lacquered brass.

Taking the three classes of fittings in order, the

first vary so much in style and design that any attempt at a detailed description is practically useless. It seldom if ever falls to the lot of a ship's wireman to select designs or choose the position of the special fittings. This is done by subcontracting firms who make a speciality of the decoration of ships' saloons. The designs of fittings must be in keeping with the decoration of the rooms. Nearly all special fittings are sent from the makers already wired, so that it is only neccessary to joint up the wires behind the baseplate.

Fittings of the second class are more ordinary and offer less variety in design, and a little more may therefore be said of them. One style of fitting may be chosen which can be used throughout the staterooms, passages, lavatories, bathrooms, W.C.'s, pantries, etc. It can be in the form of a pendant or a bracket, according to which is the more suitable for any particular situation.

The illustration, Fig. 25, shows five types of fittings which are largely used.

The first is a pendant with ordinary obscured spherical globe; the second is a bracket to match the pendant; the third is a husk fitting which requires no globe or shade but has a lamp only, of the totally obscured pattern. All three are fitted on wooden blocks slightly larger in diameter than the bases of the fittings. The fourth is a double bulkhead or divided-light fitting. It is used between two W.C.'s or similar places where the position of the light is immaterial. This fitting can also be used for a single light if required. In this case only one half would be used. The switches for W.C.'s are fitted beside the door on the outside.

The fifth is a portable table lamp with a silk shade; the standard has a loose joint and thumbscrew, so that it can be used as a bracket lamp on the bulkhead. A silk-braided flexible connects the lamp to a plug and socket on the bulkhead.

All lampholders used should not be less than $\frac{5}{8}$ inch in the neck, otherwise they will be too small for looping. Wherever possible a few inches of slack wire should be left behind the base of the fitting to facilitate removal and replacement, should this be necessary.

With reference to the position of the lights: In

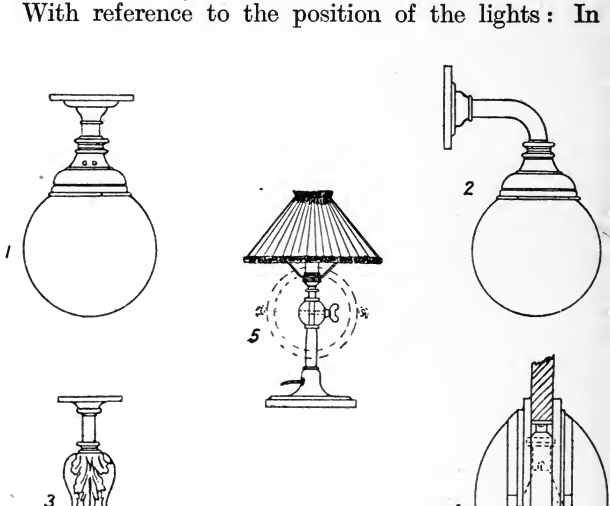


FIG. 25.—TYPES OF CABIN FITTINGS.

state-rooms the light is fixed near the washstand mirror. The switch is fitted in the most convenient position for the passengers using the berths.

In alleyways the lights are of the pendant type and spaced about 25 feet apart, with a switch fitted near each lamp. Separate fittings with coloured

lamps are fitted opposite the doors of lavatories to indicate whether ladies' or gents'.

A special "dimming" glow lamp is sometimes used in state rooms. This has two filaments, one to give 16 candle-power and a small one of 1 candle-power (see lamps). There are three contacts on the cap of the lamp, and the lampholder is a special type with three plungers to match the lamp cap. The diagram, Fig. 26, shows the connexions:—

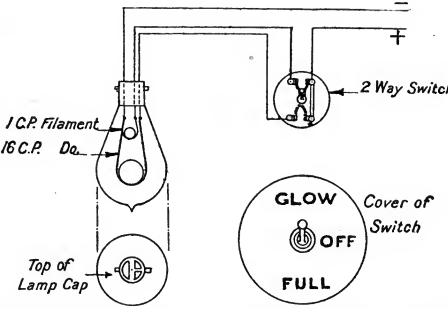


FIG. 26.—CONNEXIONS OF "FULL" OR "GLOW" LAMP AND SWITCH.

The third class of fitting, viz. the watertight pattern, is represented by four distinct types (see Fig. 27).

(1) This fitting is used in the machinery spaces, crew's quarters, stores, etc. The pendant fitting is made with a separate back plate and a short stem for ordinary use which is screwed into the fitting portion. The fitting can be made with a stem (usually $\frac{1}{2}$ inch gas barrel) of any required length to suit a particular situation. Similarly, the brackets can be made for any desired projection or drop. Short fixed brackets with knuckle joints are used where a small projection is desired (see (2) Fig. 27).

(3) The watertight portable hand lamp, which is used in the machinery spaces, storerooms, etc.

The illustration shows what is generally considered to be a very good pattern of hand lamp made of brass with cast brass guard. A hook is fitted beside each hand lamp plug to hang the lamp and flexible on when not in use.

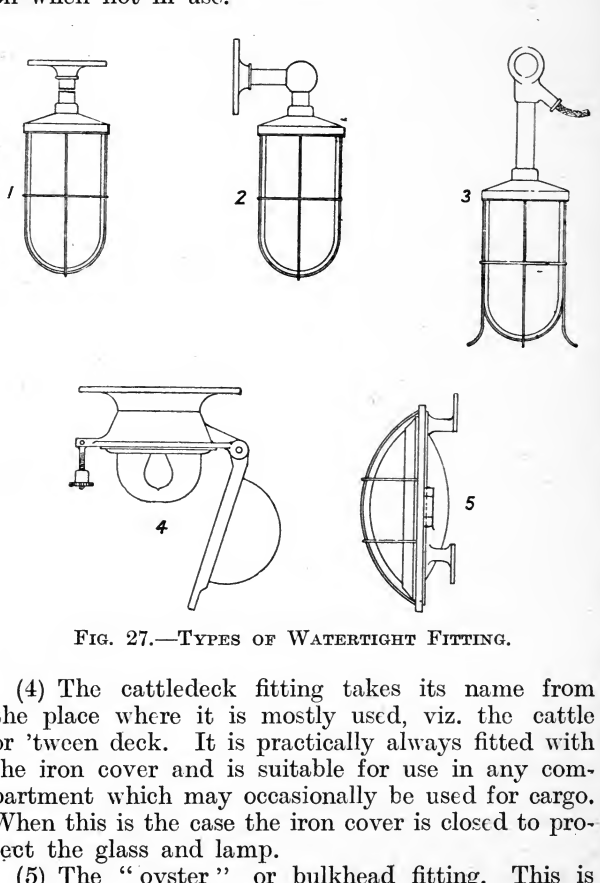


FIG. 27.—TYPES OF WATERTIGHT FITTING.

(4) The cattledeck fitting takes its name from the place where it is mostly used, viz. the cattle or 'tween deck. It is practically always fitted with the iron cover and is suitable for use in any compartment which may occasionally be used for cargo. When this is the case the iron cover is closed to protect the glass and lamp.

(5) The "oyster" or bulkhead fitting. This is mostly used on the open deck, but also occasionally

in the machinery spaces. When fitted on deck it can be in a position either overhead or on the side of one of the deck houses. It is made with or without a brass guard, also with or without an iron cover.

All the foregoing watertight fittings may be made either of iron or brass according to the shipowner's specification. If of the former metal they are painted, if the latter they may be painted or finished in polished brass, or steel-bronze.

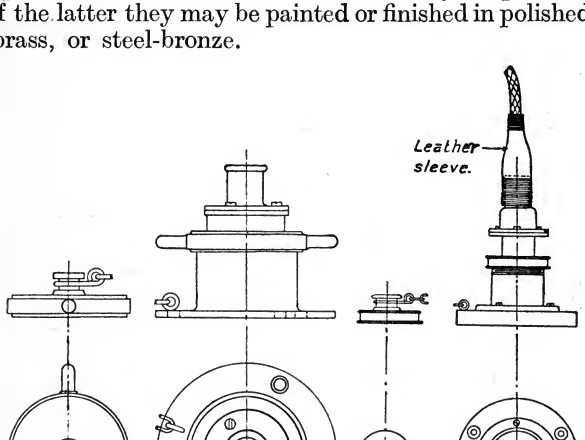


FIG. 28.—CARGO CLUSTER, AND HAND LAMP COUPLERS.

PLUGS AND SOCKETS

There are two sizes of the watertight pattern and one of the ordinary cabin pattern in general use. The former are often called couplers; the larger being used for cargo clusters or arc lamps and the smaller for portable hand lamps. The illustration (Fig. 28) shows the two patterns. Leather

sleeves are fitted on the nozzle of the plug where the flexible lead enters, as shown. They are tightly bound with cord both on the nozzle and on the flexible. This serves to prevent the latter being pulled out of the plug and also from being bent continually at one spot. The large size is for currents up to about 10 amperes, and the smaller for currents up to about 3 amperes.

For cabin plugs a small 3 ampere, two-pin, or concentric pattern is fitted for connecting up a cabin fan or table lamp. A combined switch and plug is often used, and of these there are several patterns on the market.

Switches

Generally speaking there are two kinds in use, viz., the watertight and the cabin. There are many designs of each class and they require no detailed description. Nearly all watertight switches have a stuffing gland through which the key spindle passes. The inlet for the wires is threaded to take iron tubing or conduit. Another arrangement which is sometimes adopted consists of a watertight cast-iron box with lid, and ordinary switches fitted inside. This box has a threaded inlet similar to the watertight switches. All switches fitted on decks or in any exposed places should be of the watertight pattern. The cabin switches are usually of the tumbler or thumb pattern with covers finished to match the fittings. The ordinary practice for staterooms being to mount the switch and push on one polished block in a convenient position near the berths.

In cabins having berths on either side, for the convenience of passengers two switches of the two-way pattern are fitted one on each side of the cabin, so that any passenger can turn the light off and on. The room is wired as shown in Fig. 29.

Where switches are fitted in groups, as, for instance,

beside a fuseboard, each switch should have a small ivorine or brass label underneath to indicate the lights controlled. The lampholders in ship work are of two kinds, viz., the ordinary double-contact, and the single, or centre contact. The latter is used for ship-return installations, one contact being made by the centre plunger and the other through the case of the lampholder to the cap of the lamp (see Lamps).

In all fittings incorporating centre-contact holders, which are screwed to woodwork, and not making

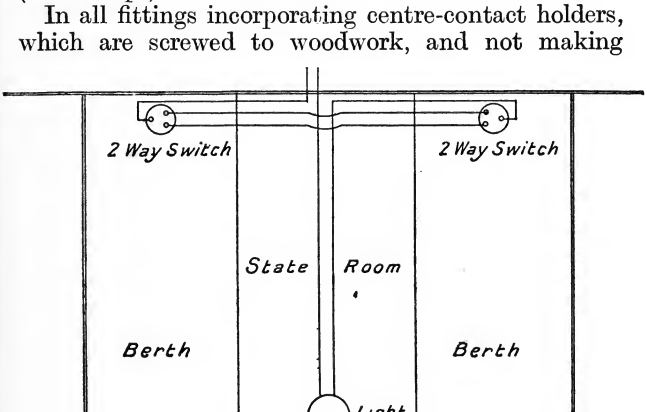


FIG. 29.—STATE ROOM LIGHT CONTROLLED BY TWO SWITCHES.

contact with the ironwork of the ship, a screw is provided called an "earth" screw. A wire is taken from this to another screw tapped into the nearest part of the ship's ironwork. Many fittings are screwed direct to a beam or iron deck; and when this is the case no earth wire is needed. It is necessary on a double-wire job to use double contact holders, although on the other hand on a ship-return

installation it is unnecessary to use single contact holders as the feed wire and the ship return wire can both be brought into a double contact holder. It is quite common practice to fit a single-wire installation with the latter type of holder throughout.

Lamps

Incandescent lamps for ship work are much the same as those in use on shore, with the exception of the centre contact lamp, and the double-filament lamp for the navigating lights (see Navigating Circuit). Lamps may be clear, semi-obscured, or totally obscured as the situation requires. One other feature of ship lamps may be mentioned and that is, the bulbs are of smaller size than standard shore bulbs. This is partly on account of fittings being smaller and also to allow of maximum headroom being obtained under fittings in cabins, alleyways and other places where the decks are low.

Lamps and lampholders on British vessels are practically all of the bayonet socket type, but on American and Continental vessels, the Edison screw-socket lamps and lampholders are still widely used.

Carbon lamps still hold their own for ship lighting, as most metal filaments as made up to the present are too fragile to stand the vibration and motion of a ship, at least for parallel burning. Of the different makes of metal filament lamps, the Tantalum has given the best results, and these lamps are in use on all voltages up to 110.

Fig. 30 shows the various types of lamps in use for marine work :—

(1) Double contact ; (2) Single, or centre contact ; (3) Screw socket ; (4) Double filament ; (5) "Full" and "Glow" lamp (see description under Fittings).

Electric Bells

Practically all passenger carrying ships have electric bells fitted in the saloons and staterooms. The

systems include pushes, indicators, bells and batteries, just the same as on shore, and the wiring and connexions also are precisely the same. The style and quality of the apparatus used and the details of the wiring differ somewhat, but the following description covers an average up-to-date installation.

The wire is insulated with vulcanized rubber and braided and is almost as good in quality as that used for lighting purposes. The amount of

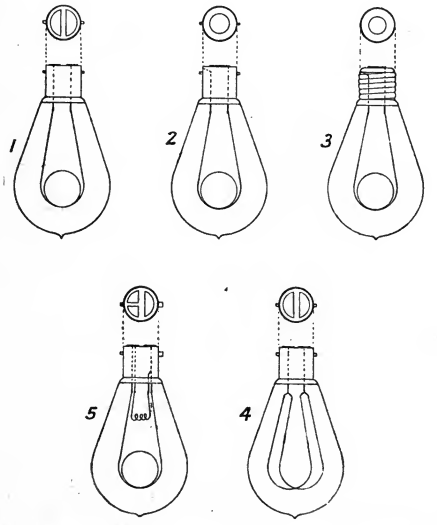


FIG. 30.—MARINE TYPES OF INCANDESCENT LAMP.

rubber used is less, so that the overall finished diameter of the wire is below that of the lighting wires.

It is necessary to distinguish the common battery wire, and this should therefore be coloured red, and preferably of No. 18 S.W.G. The return wires from pushes to indicator can be of No. 20 S.W.G.

Tappings are required off the battery wire for each push. There are three alternative methods.

(1) By making ordinary joints, soldered, then insulated with Chatterton's Compound, or rubber strip, and taped.

(2) By looping the battery wire to each push and connecting the two ends to one contact spring. There is no objection to this arrangement if the pushes are designed for looping, and have contact plates with connecting screws of ample size tapped into them.

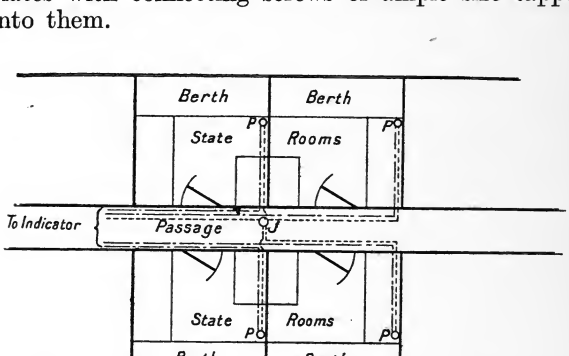


FIG. 31.—BELL WIRING SCHEME, USING JOINT BOX.

(3) The best method. This consists in fitting small porcelain connecting boxes at intervals, say one for every four pushes (see Fig. 31). This method besides effecting a saving in wire (as against the second method) also affords an easy means of locating faults as the wiring can readily be split up into small sections.

In ordinary work the bell wires are bunched together and run behind mouldings in a separate groove

from the lighting wires (see Fig. 15). A small casing is run, where required, from the moulding around a stateroom down to the push. The pushes most commonly used for staterooms are of polished ebony. In the saloons they match the surrounding woodwork. Bell wires passing through decks and bulkheads are run in deck pipes and glands respectively, in the same manner as described for lighting wires. The best practice is to keep the lighting and bell wires entirely separate. The battery is composed of four or six No. 2 size Leclanché wet cells or the equivalent size and number of dry cells. As to which type of battery to use, this is a matter of choice.

Indicators and bells are of teakwood unless fitted in some conspicuous position, where the surroundings must be matched. They are, however, nearly always fitted in the pantry. The bells are of the ordinary pattern with 3 inch or 3½ inch gongs. One point should be observed, viz., that the bells should be of low resistance in order to allow the indicator to work efficiently.

Coming now to the indicators. These are of the "drop" or "mechanical replacement" type; the pendulum pattern being, of course, out of court for shipwork. There will be one hole on the indicator dial for each stateroom. Separate holes for the captains, chief engineers and any other of the officers' rooms boasting pushes. Saloons will have one hole for the Port side and another for the Starboard side pushes. The indicators should be cockroach proof, especially for ships which trade in hot climates. This is effected very simply by arranging the terminals and inlet holes for the wires in a chamber, separate and distinct from that containing the movements. The wood partition dividing the two compartments fits tightly down on the thin, silk-covered wires which connect the terminals with the movements.

The replacement levers which project outside the indicator case, work in close fitting guides, with just sufficient play to allow the levers to move easily. Fig. 32 illustrates the arrangement.

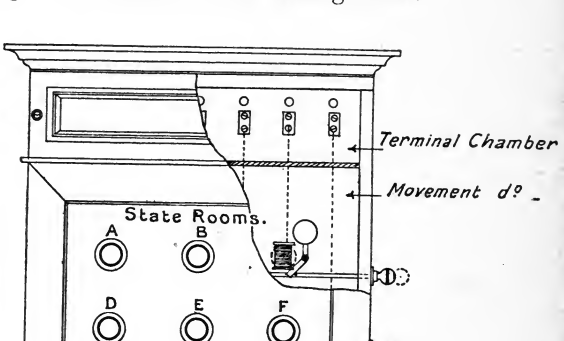


FIG. 32.—COCKROACH-PROOF SHIP'S BELL INDICATOR.

TELEPHONES

Telephone systems on board ship are not as a rule very complicated, so that under ordinary conditions no serious obstacles should present themselves to the wireman of average experience, when faced with the job of wiring, and connecting up, a system of telephones. At the same time, the fact remains that should a mistake be made in the connexions, or should any part of an instrument not be working satisfactorily, some little time and trouble may be necessary to locate the fault.

The systems commonly in use may be divided under three heads, viz., (1) Two station; (2) two or more stations to one central point; and (3) Intercommunication systems. In addition there are also loud-speaking telephones. These, when fitted

at all, are almost always employed in the working of the ship.

The connexions for ship telephones are exactly similar to those for shore instruments, but it may not be out of place to give one or two diagrams for reference.

Referring to instruments and apparatus generally, one important point to be observed is that everything should be rigid. There should be no loose receivers to rattle or, if the telephone itself is of the hand-combination type (i.e. with the receiver and transmitter portable as on the National Telephone Co.'s latest instrument) this should not swing about. Both the receiver and the hand-combination instrument, if hung on a hook of any kind should be provided with a spring clip attached to the bulkhead, into which it must be pressed, so that it is held firmly when not in use.

The cradle arrangement which holds the telephone is much better than the hook and clip. Some makers even go further, and, as an additional safeguard, fit a clip in the fork of the cradle so that the telephone is firmly held.

The batteries are similar to those used for the bells—either Leclanché or dry cells, and fitted in any convenient place such as a cupboard, or under a berth.

The wire employed is also similar to that used for bellwork and is run alongside, in the same groove, behind the mouldings.

Returning to a description of the systems; the two-station is fitted for communication say, for example, between the captain's and chief engineer's cabin, or captain to purser, or chief steward to second-class steward. Two wires will be required to join the stations, and a local battery of two or three cells at each end. The other external connexions of the telephones will be as shown in Fig. 33. The terminals of the instruments are always lettered

by the makers. *C* means carbon, *Z* zinc, *ZE* zinc earth (two wires go to this terminal), *MC* microphone carbon, *L* line.

It is possible to fit a pair of telephones using only one wire and the ship as "earth" or return (see Fig. 34). The single wire method is not recommended

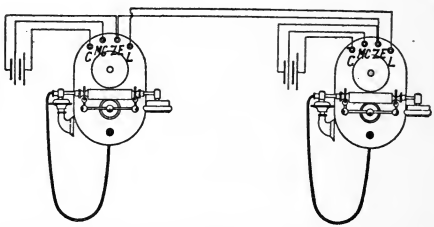


FIG. 33.—TWO-STATION TELEPHONE SYSTEM. DIAGRAM OF CONNEXIONS—METALLIC CIRCUIT.

as it has a tendency to develop faults more readily than the two-wire arrangement. The second system, where there are a number of stations which communicate with one central station, but cannot communicate with each other, is the one often used

FIG. 34.—TWO-STATION TELEPHONE SYSTEM. DIAGRAM OF CONNEXIONS—"SHIP" OR EARTH RETURN.

in passenger steamers and is probably the most common of all.

In many ships, telephones are substituted for bell pushes in staterooms and saloons as a means of communication with the steward in attendance

or, as is the case on some of the railway companies' passenger steamers, a system of telephones is fitted connecting the various sections of the passenger accommodation with the ticket office. The wiring may be carried out in two ways, first, with one battery only at the central station; second, with a local battery at each station.

With the first arrangement three wires are required from each telephone to the central point (see Fig. 35).

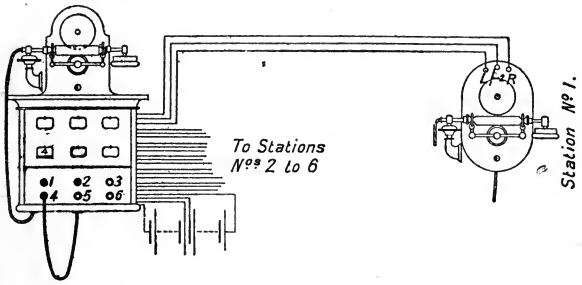


FIG. 35.

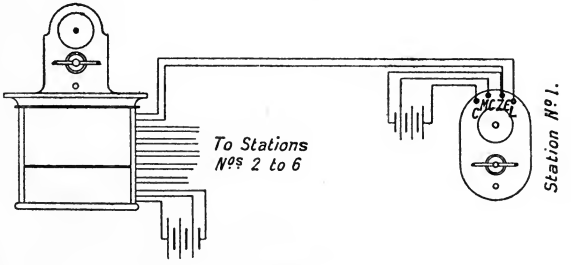


FIG. 36.

With the second arrangement only two wires are necessary (see Fig. 36).

The most elaborate systems of all are fitted on the large passenger liners. They are for inter-communication between the principal sections of the ship, officers' rooms, and staterooms. All the various

points are connected to a private exchange switchboard, and a special telephone operator is in attendance. When the vessel is in port, connexion is made with the shore exchange by means of a number of lines and special terminal boxes fitted on each side of the ship.

All the intricacies of a job of this sort are embodied in the switchboard and instruments. Only the usual wiring is required, consisting of two or three wires from each telephone to the exchange, and a pair from the switchboard to the connexion box for each shore line. All terminals intended for the connexion of external wires are clearly marked, so that the actual wiring and connecting up are not difficult.

Telephones of the loud-speaking type are largely used in shipwork. In fact they are almost exclusively made for use on board ship. They are especially suitable for machinery spaces and other similar places which are very noisy. The instruments work on the same principle as the smaller ones, but all the working parts are on a larger scale and more battery power is employed.

The telephones are very strongly made and have brass cases. They are watertight, so that they can be placed out in the open; the navigating bridge and the wheel-house being positions where they are often fitted. From these points they communicate with the engineroom, or steering-engine house at the after end of the ship. The wiring for these telephones is usually carried out with three or four-core lead covered cables supported by means of brass clips. Terminal boxes are always provided, to facilitate the inter-connecting of the instruments, batteries, etc. The various pieces of apparatus are provided with sweating glands, into which the lead sheathing of the wire is soldered (see Fig. 37). The gland is made watertight with red lead and screwed up tightly.

Diagrams of connexions are supplied by the makers with all sets of telephones, so that no great difficulty is experienced when connecting up. There is not very much more to be said about telephone wiring. The usual precautions which are necessary in all electrical work should be observed, such as making good clean connexions and leaving all screws and terminals tight and firmly gripping the wires.

For a complete treatise on telephones generally, the reader is referred to another volume in this series.

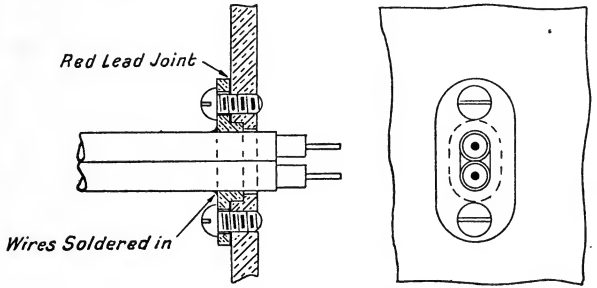


FIG. 37.—GLAND FOR WATERTIGHT BOXES, FITTINGS, ETC.

ELECTRIC FANS

The wiring of large ventilating fans was partly treated earlier in this book under the head of "Motor Circuits." As the horse-power of the motors driving ventilating fans may touch 30, some rather heavy cables are required to carry the current, which may be as much as 100 amperes and over on average ship voltages. For heavy circuits of this kind, the mains are usually taken direct from the switchboard in the engine-room.

There are two types of fan in general use, viz. the cased centrifugal, and the propeller. One of the best known of the former class is the "Sirocco,"

made by Messrs. Davidson & Co., of Belfast (Fig. 38).

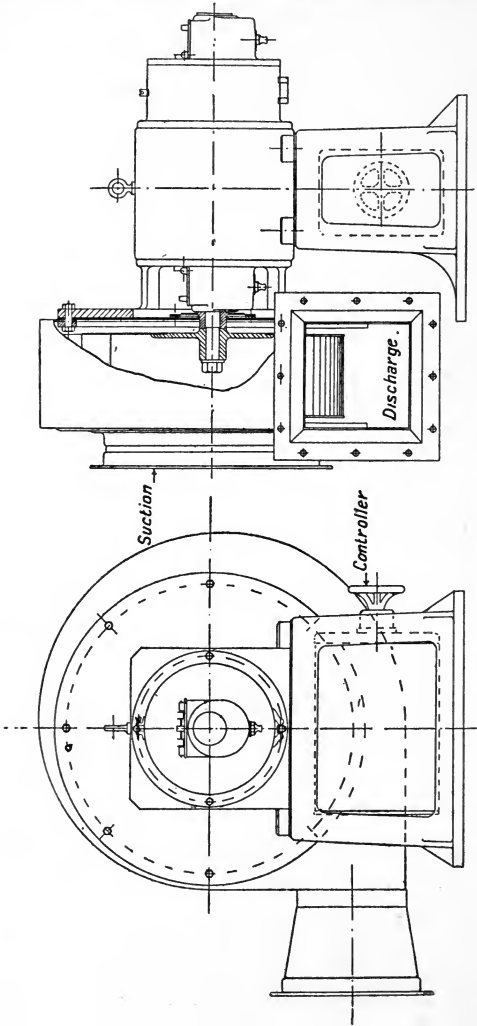


FIG. 38.—MOTOR DRIVEN "SIROCCO" FAN.

The motor and fan are mounted on one bedplate. The starter, which is also a series-parallel speed regulator, is contained in the hollow part of the cast bedplate on which the motor is mounted. All the connexions are self-contained, so that there is nothing to do but connect the external mains to the terminals provided for the purpose.

Diagram Fig. 39 shows the connexions for a two

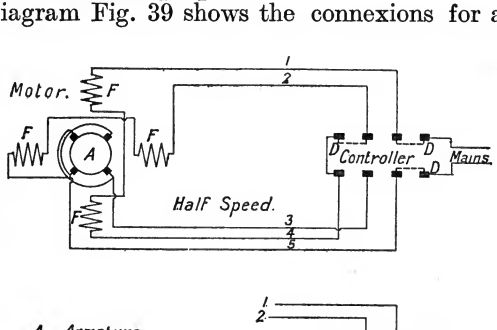


FIG. 39.—CONNEXIONS FOR TWO-SPEED FAN AND CONTROLLER.

speed fan, which suits a case where it is necessary to fit the regulator in a position remote from the fan.

The propeller fan (Fig. 40) is perhaps the better known of the two. They are made for lighter work than the cased fans. The makes of propeller fans are too numerous to mention, and the designs do not vary very much excepting perhaps in the shape of the blades.

Some propeller fans are reversible, so as to supply air to a compartment or exhaust the air from it, according to which is required. A reversing switch

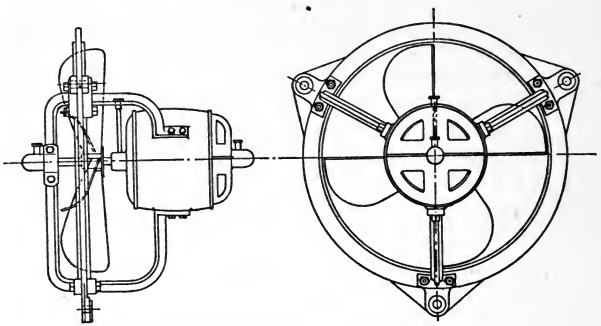


FIG. 40.—ELECTRIC PROPELLER FAN.

is necessary with this class of fan and the various connexions are shown in Fig. 41. Referring again

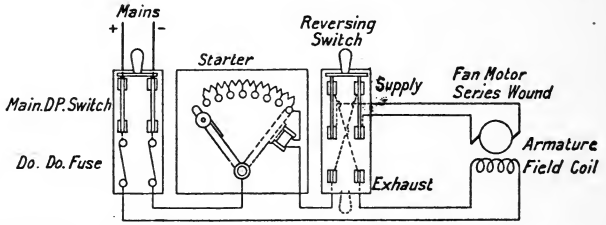


FIG. 41.—CONNEXIONS OF FAN MOTOR, STARTER AND REVERSING SWITCH.

to circuits for ventilating fans, if the fan motors are only of medium size and take a current of say 25 to 30 amperes, then three or four can be connected on one circuit, with a suitable fuseboard. The mains from this fuseboard will then be run back to the main switchboard.

In addition to the foregoing types of ventilating fans there are the ceiling or "flail" fans, and the cabin table or bracket fans. There are no special circuits for these, as owing to the small current

required (less than 1 ampere), they are connected to the lighting distribution boards.

The flail fans (Fig. 42) are of special design, having

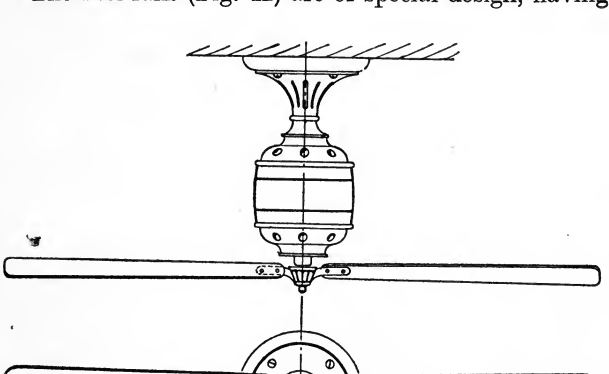


FIG. 42.—CEILING OR "FLAIL" FAN.

only two blades, measuring from 3 to 4 feet across from tip to tip. Regulators, two or three-speed, are used with flail fans but are not contained in the base as with the table fans, owing to the inaccessible position. They are usually fitted in groups in the pantry or other suitable place. The fans themselves are fixed to the ceiling, over the saloon tables with blades downwards, so that, when running, a gentle current of air is sent down towards the table. The fans are always slow speed and quite silent.

The cabin table fans (Fig. 43) are 9 inches, 12 inches or 15 inches diameter across the blades and connected by a coloured flexible cord to a plug on the bulkhead. They are of the swivelling type and can be used as brackets on the bulkhead. These fans have regulating switches enclosed in their bases.

The finish depends on the surroundings. They may have electro-plated metal work with white and gold bodies, or just plain brass and black bodies.

Special Apparatus

There is certain apparatus of a special nature which, though fitted on many, is not common to all ships.

The Flashing Lantern.—This is used for signalling at night by means of the Morse code. The position

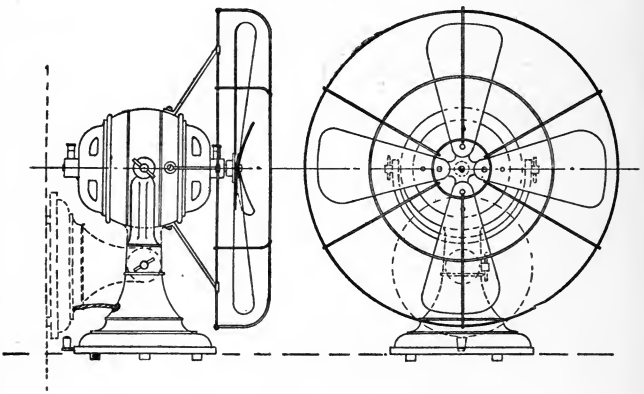


Fig. 43.—Cabin Table Fan.

of the lantern is usually a prominent one, on the highest part of the navigating bridge. It may be either fixed or portable. The signals (dots and dashes being represented by short and long flashes) are made by means of a Morse key, mounted on a board fitted on the bridge. A condenser is used in connexion with the apparatus to enable short flashes to be made. The lantern itself is fitted with glass, all round, and contains a number of (about 8) small tubular lamps, each of 6 to 8 candle-power. The

diagram (Fig. 44) shows the connexions for the flash lamp circuit.

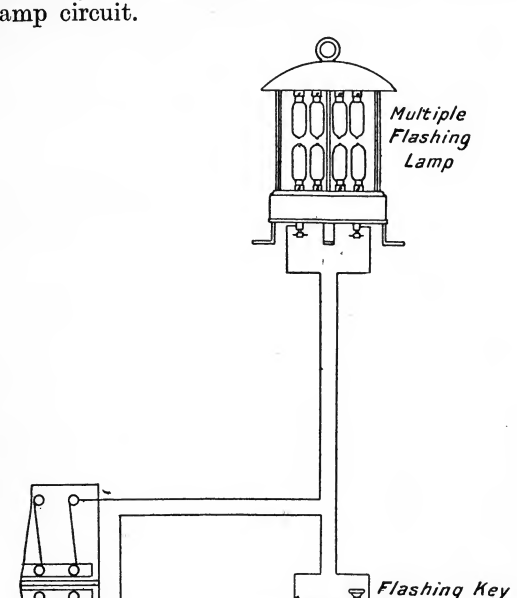


FIG. 44.—CONNEXIONS OF MORSE FLASHING LAMP.

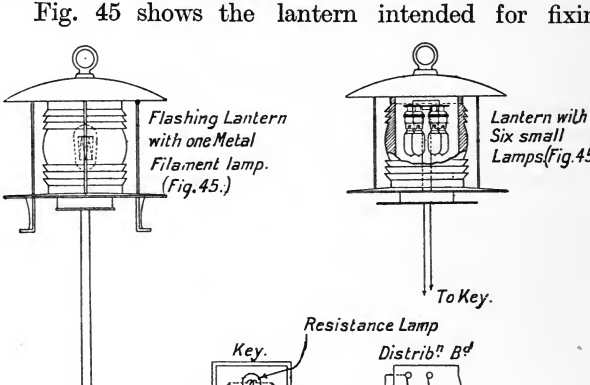
In the case of portable lanterns, a long flexible lead is used to connect it to a plug and socket in the wheel house, or on the bridge. When in use the lantern is hauled up clear of the bridge houses so as to be plainly visible from all sides.

The multiple lamp has the advantage that, if the filament of one lamp burns out, the signalling can still be carried on with the others.

There is another type of flashing lantern on

the market, viz., the Wightman's patent, manufactured by Messrs. McGeoch & Co., Limited, of Birmingham. There are two designs of this lantern as shown in the illustrations.

Fig. 45 shows the lantern intended for fixing



FIGS. 45 AND 45A.—WIGHTMAN'S PATENT FLASHING LANTERNS, WITH DIAGRAM OF CONNEXIONS.

on a semaphore pole or on a suitable bracket built out from any part of the navigating bridge or wheel house.

Fig. 45A shows the lantern intended for fixing to the masthead truck where considerable vibration has to be contended with. The following is a copy of the maker's specification for the latter design of lantern.

This flashing lamp has been designed to meet the requirements of the Board of Trade for signalling to ships at night by means of the Morse Code.

The lamp consists of a circular dioptric lens clamped between two brass plates by means of three brass rods. A dome top is attached to the upper plate

which projects three inches beyond the dioptric lens, and is fitted with a substantial screw eye held in position by a hexagon nut and lock nut underneath the dome. The bottom plate is arranged to fix to masthead truck, and is removable, so that new lamps can be fitted at any time.

Inside the dioptric lens a stem is fixed carrying six miniature lamp holders, to take 5 candle-power incandescent lamps.

Main terminals are fitted in the lantern for attaching a twin flexible cable, about 50 feet long, leading down to a watertight Morse key on the bridge deck, which is readily connected by inserting a two-pin plug into one side of the box. There is also another two-pin plug fitted on the other side with a short length of cable suitably arranged with a bayonet adapter for fixing into any lampholder for supplying the necessary current.

The Morse key may be arranged in a watertight brass box (or of polished wood if desired) with the key projecting through the front. This is substantially made and can be worked by the foot in place of the hand if required.

Another great advantage of this Morse key is that anyone can signal with it without having any knowledge of the signs required for the different letters ; this is arranged by two pieces of glass suitably sunk into the lid with the Morse alphabet engraved upon the under side of the glass, which is illuminated by a small carbon resistance lamp inside.

To connect up the flashing lamp ready for signalling purposes, all that is required is to unship an ordinary lamp bulb and insert the adapter, which is fitted on the one end of the cable leading to the Morse Key, the alphabet is then illuminated by the resistance lamp inside box. This lamp is in series with the flashing lamp, and allows a small amount of current to flow through the lamp, but only sufficient to obtain a slight glow, which is not

visible when the flashing lamp is hoisted up a short distance. On depressing the key the resistance lamp is instantly cut out of circuit and allows the full pressure to flow direct to the flashing lamp which works instantaneously either on or off. The resistance lamp, which illuminates the alphabet from inside the key box works exactly the reverse of the flashing lamp, therefore the signs can easily be distinguished when making the necessary pauses between the letters, and as the lamps are working in series, there is excellent check that the flashing lamp is working correctly, every signal being distinctly shown on the illuminated dial on key box.

This flashing lamp has been thoroughly tested at sea on various steamers during the last twelve months. Signals can easily be distinguished up to a distance of 10 to 15 miles.

The contacts on Morse key are made of platinum ; no condenser is necessary, as the current required for working the flashing lamp is so small.

There is no sudden strain put on the filaments of the lamps, as there is always a small amount of current flowing through them, sufficient to heat the filaments ; by this means the filaments will stand severe shocks without any injury.

This specification can be applied to the first mentioned design of lantern also, with the following exceptions :—The bottom plate in this case is fitted with hooks for guy ropes and three brass feet for standing the lantern upon a pole or bracket as previously mentioned, or both lantern and key can remain portable if desired.

Inside the Dioptric Lens a metallic filament lamp of 25 to 50 candle-power is attached to a batten holder, which is suitably fixed in a removable brass tray held in position by means of a bayonet fixing or a flanged backplate which is attached to the bottom plate. Two locking screws are also fitted to prevent it coming loose.

Lightning Conductors

Most vessels have lightning conductors fitted to their masts. The conductor consists of a flexible wire rope of hard drawn copper, about $\frac{3}{8}$ inch overall diameter. It is run from the truck on top of the mast down the side of the top-mast, which is usually of wood and to which the wire rope is attached by means of brass clips. On reaching the shrouds or rigging it passes from the mast and proceeds down the mast stay or the side of the rigging; as these consist of steel wire rope, insulators are required. These are of glass, bobbin-shape, and are bound to the rigging side, about 2 feet apart (Fig. 46). The wire passes through them. At the lower end, where the rigging meets the deck, the wire is left loose with sufficient slack to allow the end to trail in the water over the ship's side. A lead sinker is fastened to the end to keep the wire submerged.

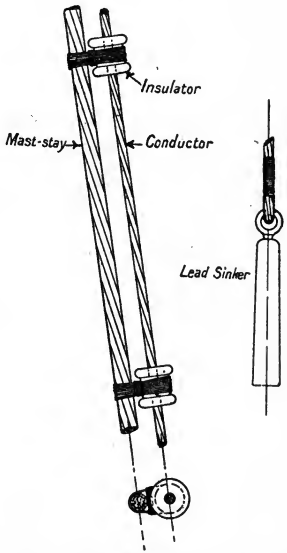


FIG. 46.—METHOD OF ATTACHING LIGHTNING CONDUCTOR TO MAST STAY.

The point of the conductor at the head of the mast is terminated in a small vane having a spike at the extreme top, Fig. 47.

Wireless Telegraphy

It is quite beyond the scope of this book to deal with the subject of wireless telegraphy in detail.

Only one portion of the work will be considered therefore, and that is, the portion which concerns the ordinary wireman.

The power required is about 3 kilowatts and the current is transformed from continuous to alternating by means of a motor-generator. All the connexions of the apparatus are made to a special

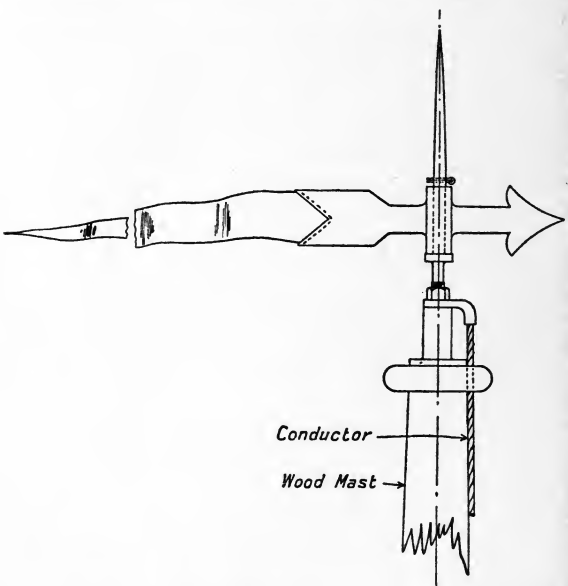


FIG. 47.—METHOD OF TERMINATING LIGHTNING CONDUCTOR AT MASTHEAD.

switchboard in the wireless telegraph cabin. The mains, say $\frac{7}{14}$ S.W.G., are brought from the main switchboard in the engine-room up to the wireless telegraph switchboard, without any break, and connected to the special switchboard.

All the other work in connexion with the apparatus

itself, such as the fitting-up of the aerial wires between the masts, also all connexions between the transmitting and receiving apparatus, motor generator and switchboard is carried out by the firms who make a speciality of wireless telegraphy installations.

Searchlights

Searchlights are not often fitted on merchant vessels and most of those which have them are on services which take them through the Suez Canal. The regulations of the Canal require all vessels passing through to be fitted with a searchlight on the bow. The projectors are from 12 to 30 inches in diameter, and are fitted on pedestals which contain the switch. The circuit is a separate one running from the main switchboard. The resistance frame is fitted in the engine-room entrance or other suitable place.

The subject of searchlights, their construction and working is not within the scope of this book, but other works are available which deal fully with the subject.

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