Thesis

The Electrical-
-Equipment of an Ocean-going Vessel.

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A Thesis.

"The Electrical Equipment of an Ocean-going Vessel."

The rapid advancement of electrical science has led it to invade the field of marine engineering. On ship-board, all ship's lights, searchlights and signal lights are entirely electric. Of power appliances outside of uses on men of war, ship's ventilation is completely electric; electric deck winches and boat cranes are very successful as such.

Interior communication appliances are almost entirely electric, but are in some cases paralleled with mechanical devices, as for example voice tubes and paralleling telephones.

A specially designed boat which we shall call throughout the "Steamer Thesis" shown in the accompanying scale drawing (A), is of the sea-going type adapted to work on the bars of the rivers of the Northwest. Since our work is the electrical apparatus on board the ship, the above mentioned drawing will be self explanatory and will be referred to as "Drawing A."

First will be taken up the theory and the general practice touching pieces of apparatus used in Marine Work, there being special requirements in this class of work.

Dynamos: For use aboard ships there can be no doubt that slow speed dynamos give the least trouble. The importance of providing a ship with electrical machinery that calls for little attention can easily be seen, when one considers that the electric lighting has usually to be looked after by the engineers in turn as they come on watch.

The mechanical engineers, although perfectly competent in their profession, are not to be expected to pose as experts in the handling of dynamos or faulty circuits. Hence, apart from mere mechanical attention, the ship dynamo should not need any kind of supervision.

This condition is perhaps better filled by compound series and shunt wound dynamos, running at slow speed, than any other kind of a machine. It must give a self regulating current and pressure suited to lamps.

The compound dynamo, if well designed, can be made to regulate itself so closely that if half the lamps be suddenly turned off or on, scarcely a flicker will be observed in the remaining lapms. A ship's dynamo should be self regulating down to at most 10% of the lamps.

If 100 volt lamps be used, the dynamo is generally selected to give a pressure of 110 volts at least, with a minimum of half an ampere of current for each lamp. Thus if 62 hundred volt lamps are to be run, the dynamo must give at normal speed 31 amperes at 110 volts.

These figures are approximate only, depending upon the "watts per candle" of the lamps to be used; upon the size of the leading wires and the insulation employed. The volts in no case should be less than 50, on account ofthe necessity for the use of arc lapms aboard ship.

Driving: Direct driving or attaching the dynamo direct to the engine shaft, is the most generally applicable plan. Special engines have been designed for this purpose by the General Electric Co. and others.

A special separate engine, nicely self regulating, is an absolute necessity. The main engines of a steamship in rough weather run at all speeds and cannot be utilized for driving a dynamo if the machine is used for lighting lamps direct.

Ship Wiring: The wire employed must first have a conductivity at least as high as 95% . It must be insulated in a very thorough way with pure Indian rubber , combined with cotton insulation or other substances and completely vulcanized viz. vulcanizing Indian rubber one coating rubber covered tape, vulcanized together and covered with preservative compound .

Size of wire to be selected from a wire table to satisfy the given conditions of electro motive force (E.M.F.) and current (I) flowing .

In the ships wiring , when thes wires can scarcely be kept free from damp ,the insulation must be especially effective. The general opinion is in favor of simple cleat wiring without casings when it can be employed below decks. The cleats are double groove cleats.

Precautions against fire are taken by the use of double pole fuses at the dynamo,and the insertion of two at every branch circuit and frequently fuse is inserted for single lamps. A fuse is of course put to every cluster of lamps.

The wiring of ships is usually carried out on the parallel system. The Saloon and cabin wiring is generally done under casings or mouldings. Insulated wire does not last in use indefinitely. It may have to be removed every few years. For this and other reasons the position of the wires should be such that they may be accessible at all times for purposes of repair or renewal.

Ship's Fittings: These are a class of themselves. They form apparatus of a very solid make. The bulkhead,engine room and passage way lamps are placed behind glass screens,and protected by iron gratings. Side lights are used fed from the nearest mains. Each cabin lamp has its own switch. The saloon lights are controlled by attendants by means of a main switch.

The main switch board is generally placed in the dynamo room and is fitted to control:

(I) The "saloon's circuit".

(2) The "cabin's circuit."

(3) Officers and Men's circuit.

Thus there are frequently a number of seperate circuits run so that any one section of lamps may be controlled separately.

Compass Lamps: These are now in extensive use,and are a practical success. The effect of induction upon the compass needle is eliminated by carefully twisting the two leading wires together and by placing the lamps axially over the compass,obviating the inductive effect of the current in the filament.

The following is a short description of the ship "Thesis'" electrical outfit calculated to supplement the information shown on the drawings.

Dynamo Room: On account of the small space at hand in the hold of our ship it is impossible for us to have a separate compartment for the generating set;therefore it had to be set in the engine room at the point marked on drawing "A" on the floor of the engine room near the port side of the vessel and nearly amidships,close enough to the main engine to be well cared for by the one engineer in charge of the handling of all of the ship's machinery.

On account of its adaptibility to the existing conditions of floor space,steam pressure from the boiler and with reference to data obtained from the load curve,(Fig. I,Drawing C) the General Electric Generator Set (Drawing B) was chosen. It is known as a direct coupled generating set vertical single cylinder enclosed type engine,multipolar generator with iron-clad armature compound wound. The following tabulation will give specifications in the most condensed and intelligible form.

Type	Poles	KW	Speed	Volts Full Load	Amps Full Load	Floor Space	Height	Wt. Lbs	Dia Steam Pipe	Dia Exhaust Pipe	Dia Cylinder	Stroke
MP	4	10	450	110	91	63"X33"	52"	3160	1 1/2"	2"	6 1/2"	5"

Ratings of sets with single cylinder engines are based on 80 pounds steam non-condensing.

All of the moving parts are enclosed by the engine column,allowing perfect lubrication and reducing wear and attention to a minimum. With this system of lubrication,quiet running under all conditions of load is practically assured.

The cylinder is separated from the column;giving access to the stuffing boxes when the engine is in operation,and water is not allowed to mix with the oil.

Among the many advantages q uoted for this type of machine,in advertising bulletins,is in that very important part that takes care of the speed regulation of the engine. It has only one moving part,a fly ~~wheel~~, weight, fitted on the fly-wheel,this fly-weight contains the eccentric pin and a spring opposes the centrifugal force of the weight. If the load be decreased, the fly-weight by increased centrifugal force, moves out and draws the eccentric pin toward the center of the shaft. The consequent reduction in the throw of the valve causes the steam admission to change to suit the load, and maintains the speed of the engine practically constant.

This governor requires the least amount of attention, as it has practically no parts that can give trouble or wear out.

As has been stated, the tabulation of dimensions, type etc. form the best description, when accompanied by "drawing B" that can be given of the generating set proper.

The switch board, which is 2½ feet by 4 feet, slate base, is equipped as shown in "drawing D" with one "Weston" Ammeter to register 100 amperes, one "Weston" Voltmeter of 125 volts capacity, and 8 switches with a suitable rheostat to control the output of the apparatus. This rheostat is one designed by the General Electric Co, and is sent with the completed plant.

Arrangements of circuits: The lamps are arranged on six circuits controlled by separate switches, on switch board in engine room close to the dynamo. In addition to these there are two other independent circuits one for the motor, situated on the bow and used for hoisting purposes; the other is the searchlight installed to aid navigation, loading etc. at night. Of course there is one other large switch situated on the board for closing the main circuit, direct from the dynamo. On the switch board, as mentioned above, the ammeter is connected in series with the line, it being suitably protected by resistance and the voltmeter connected across the main buss bars, also protected, to show the volts impressed on the circuit.

The distribution of lights is shown by the following list of the number of lamps used in the principal rooms and parts of the ship. See "drawing A" for complete distribution system.

Place.	Number of Lamps.
Mast just forward of pilot house.	3.
Pilot House.	3.
Front of main cabin.	2.
Forward cabin.	4.
Engine room.	I2.
Crew's Mess and Galley.	I4.
Guage lights Boiler room.	3.
Over beds in various places.	8.
Rear cabin or saloon.	IO.
On after end of main cabin.	2.
Toilet.	I.
Shaft way.	2.
Man hole by boiler.	I.
Motor.	IIO volts,40 amps.
Searchlight.	45-48 " ,20 ".

In the list shown above the lapms are IO4 volts $\frac{1}{2}$ amp.I6 candle power fitted with sorrw sockets. In connection with that a point of marine electrical work comes into play;it is that of the vibration of the ship causing expense in the lamp renewals. To obviate this as much as possible when screwing the lamps in place on ship board,they should be so placed that their filaments vibrate in a line through their thickest,and consequently their stromgest parts. Numerous places are provided for extension plugs to be put in to facilitate repairs.

The load curve shown in "drawing C" was calculated from data based on the afore mentioned list of power distribution. For wiring diagrams see "drawing A".

Thus we have taken up the main parts of the electrical equipment of our ship,so in conclusion we will give a brief description of the auxiliary apparatus of which there are two pieces;the searchlight and the motor,the latter being used in connection with the"boom tackle" shown on the bow of the boat in "drawing A" and again more in detail in drawing D".

We chose for our searchlight a I3"projector of the General Electric Co. make for which they claim points of advantage as follows:simplicity of construction,efficiency of operation and durability of service. The projector is fitted with Mangin ground glass silver plated mirrors. This type of mirror has two spherical surfaces of different radii and the reflection and refraction of the glass cause the rays of light to be projected in a parallel beam when the arc is in focus.

The projector is fitted with a horizontal automatic ratchet feed focusing lamps. The lamps are designed to throw the greatest possible amount of light on the reflector,and screen shutters are provided to prevent the direct rays from leaving the projevtor,so that all the rays of light are reflected and sent out parallel.

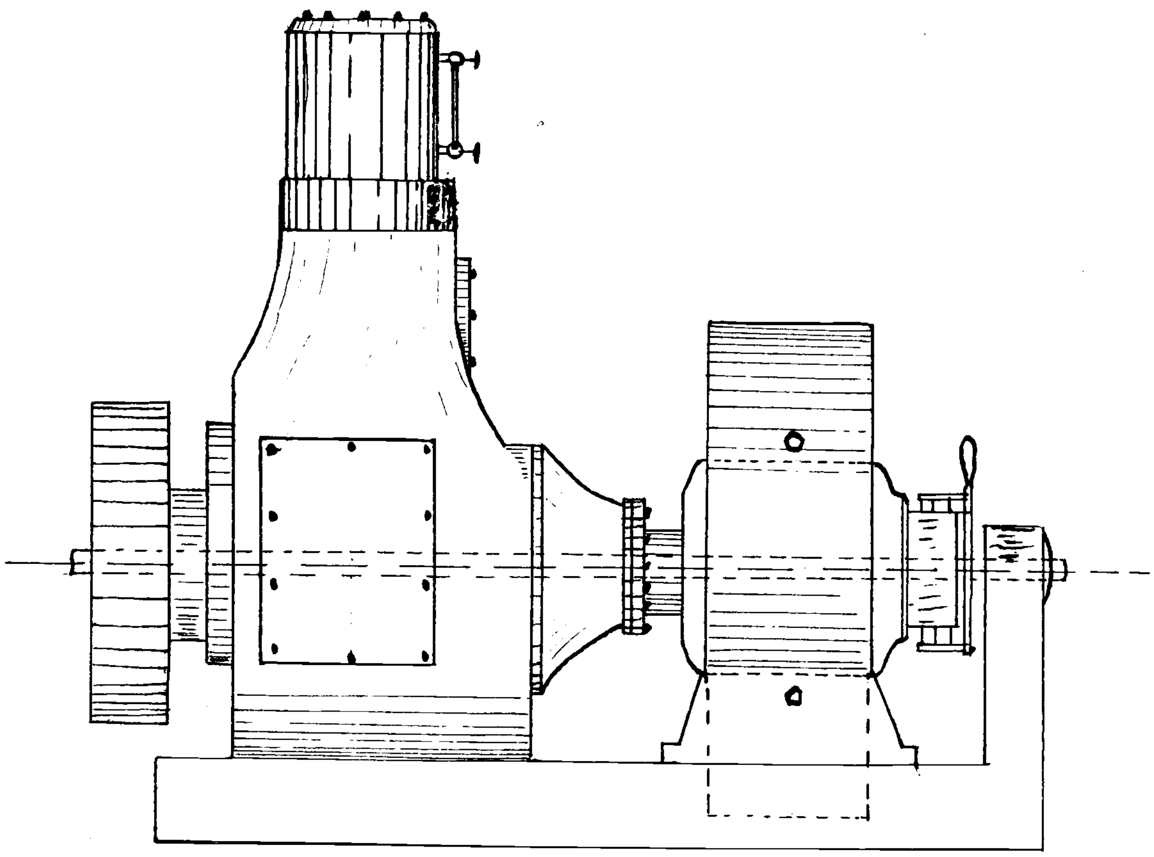
Both positive and negative carbons are fed automatically at the sametime,and are so porportioned that the arc remains in the focus of the mirror until they are entirely consumed. The carbon holders or carriages for vertical and horizontal adjustment of the carbons,andby means of a magnet fastened on the inside of the projector and surrounding the arc on all sides but the top,the arc is made to burn steadily near the center of the carbons and in the focus ofthe mirror.

The projector is designed to operate on our direct current incandescent circuit. A regulating resistance is placed in series with the lamps to reduce the voltage to the proper potential,which varies from 45-48 volts. We chose a rheostat suitable for the II0 volt circuit for use in connection with our projector. "Drawing C" figure 2 shows the lamp in detail with dimensions etc.

The remaining piece of auxillary apparatus to be described is the motor to be used for hoisting and general power purposes on the bow of the ship. It is similar to type G.E. 58 taking II0 volts and 40 amps. This type is very similar to a street car motor,it being for outside use, is perfectly water tight, allowing no water to enter the outer casing and is strongly built and of such form as to enable us to fasten it securely in its place on the bow.

The controllers are beneath the deck where they are thoroughly protected from moisture and are connected with controller handles by bevel gears. The mechanical features such as connection with the "hoisting drum" "cat head" etc. are clearly shown in drawings A and D.

The End.



G.E. Generator Set.

Type	Poles	KW	Speed	Volts full load	Amps. full load	Floor Space	Height.	Wt. Lbs.	Dia. steam pipe	Dia. exhaust pipe	Dia. Cilinder	Stroke
MP	4	10	450	110	91	63"x33"	5'2"	3,160	1½"	2"	6½"	5"

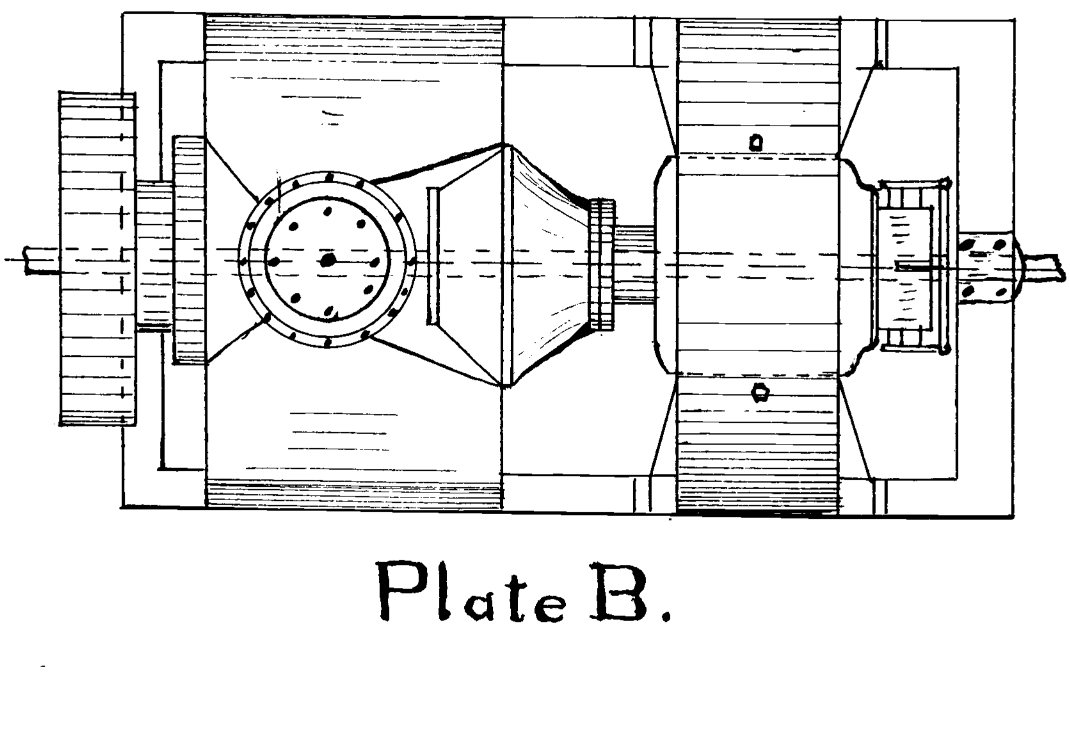
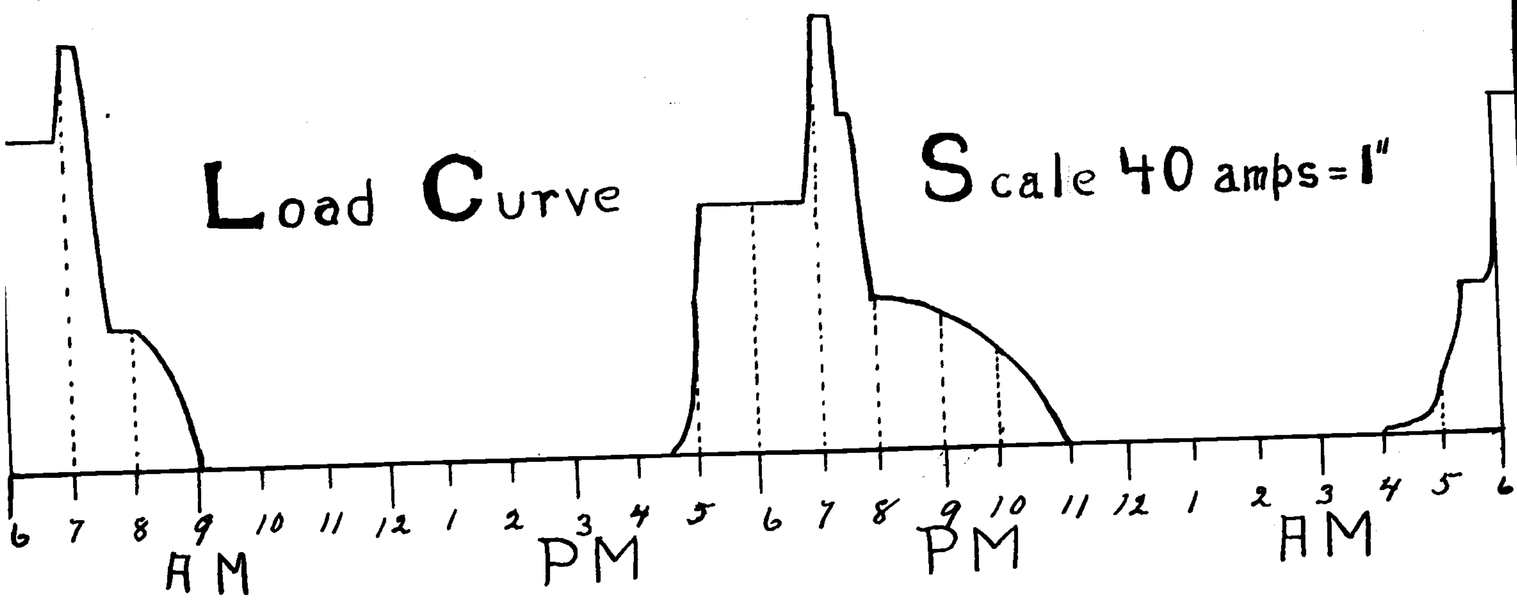
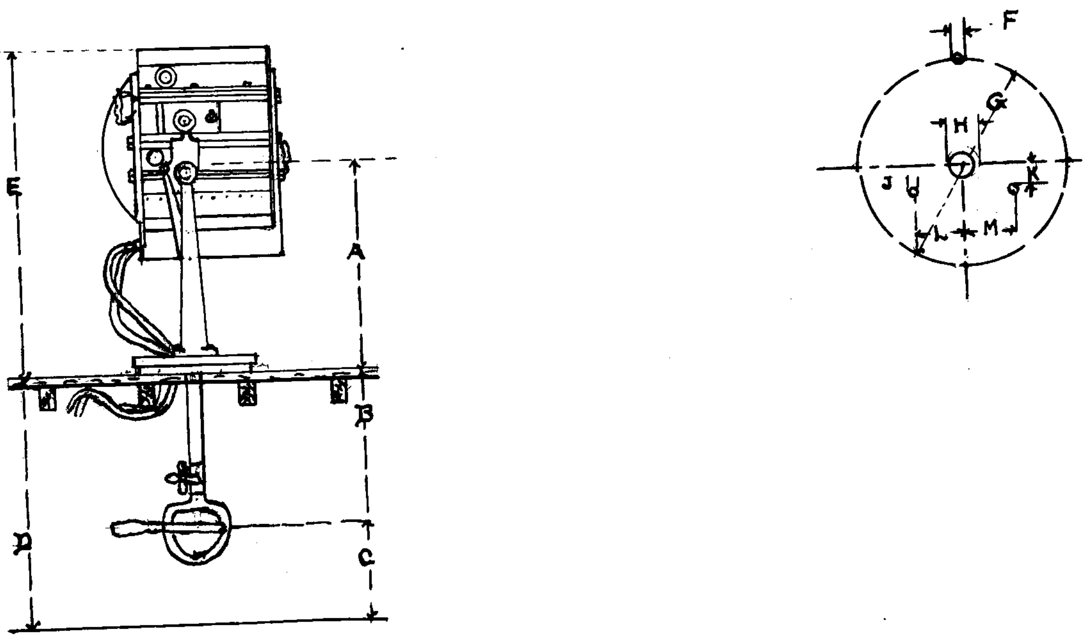


Plate B.



Fig

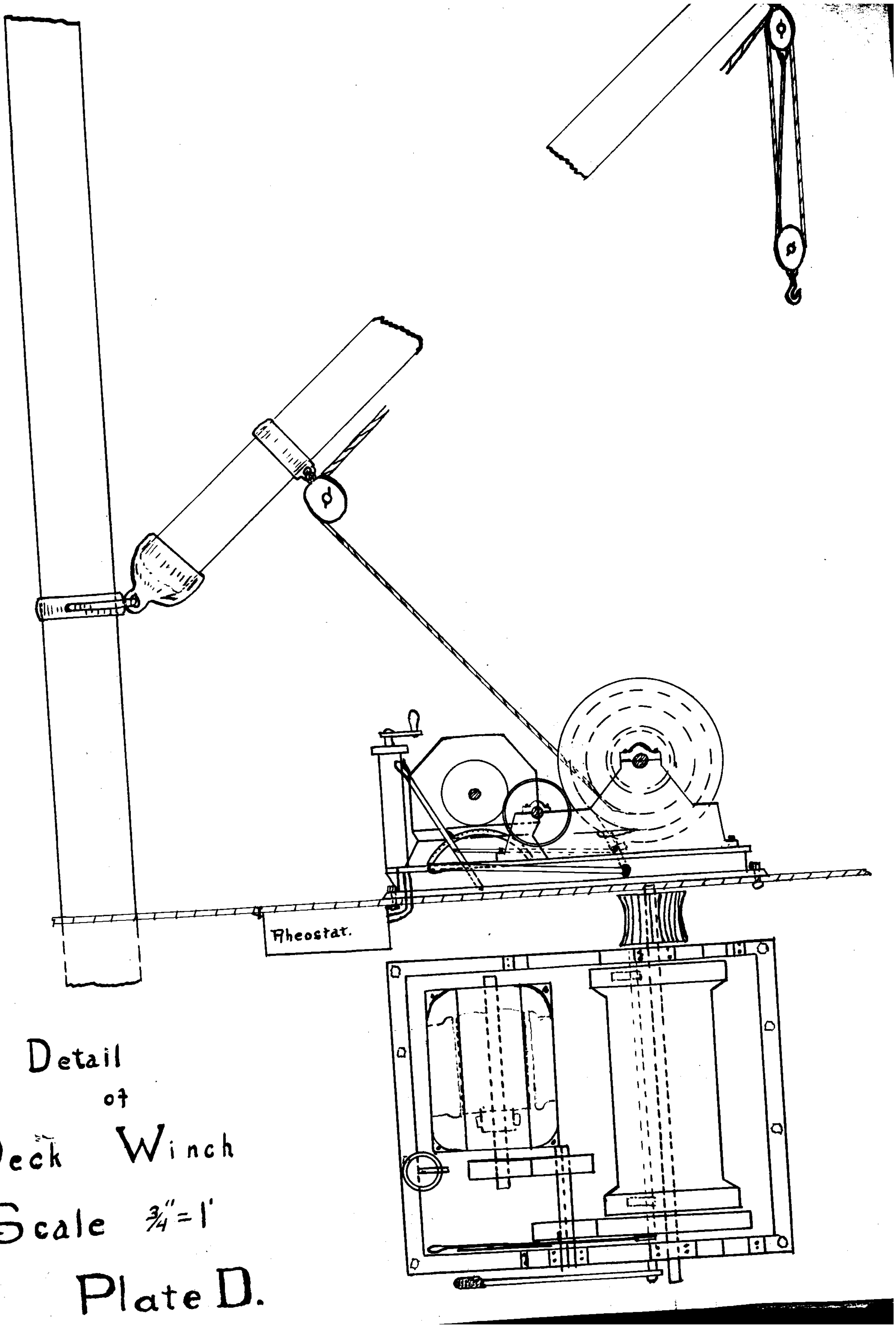


Fig

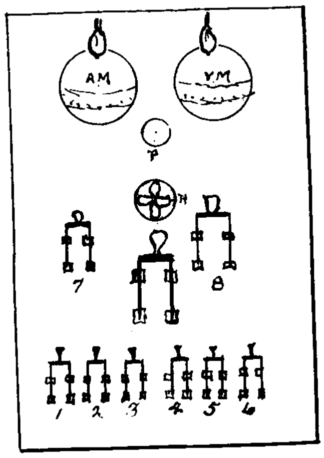
SIZE OF PROJECTOR	A	B	C	D	E	F	G	H	J	K	L	M	FIG
13"	$22\frac{3}{16}$	22	76	98	$30\frac{11}{16}$	$\frac{13}{32}$	$8\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	0	$1\frac{11}{16}$	$2\frac{11}{16}$	

20 amps 45-48 volts at arc

Plate G.



Detail
of
Deck Winch
Scale 3/4" = 1'
Plate D.


AM
VM
P
H
7
8
1 2 3 4 5 6

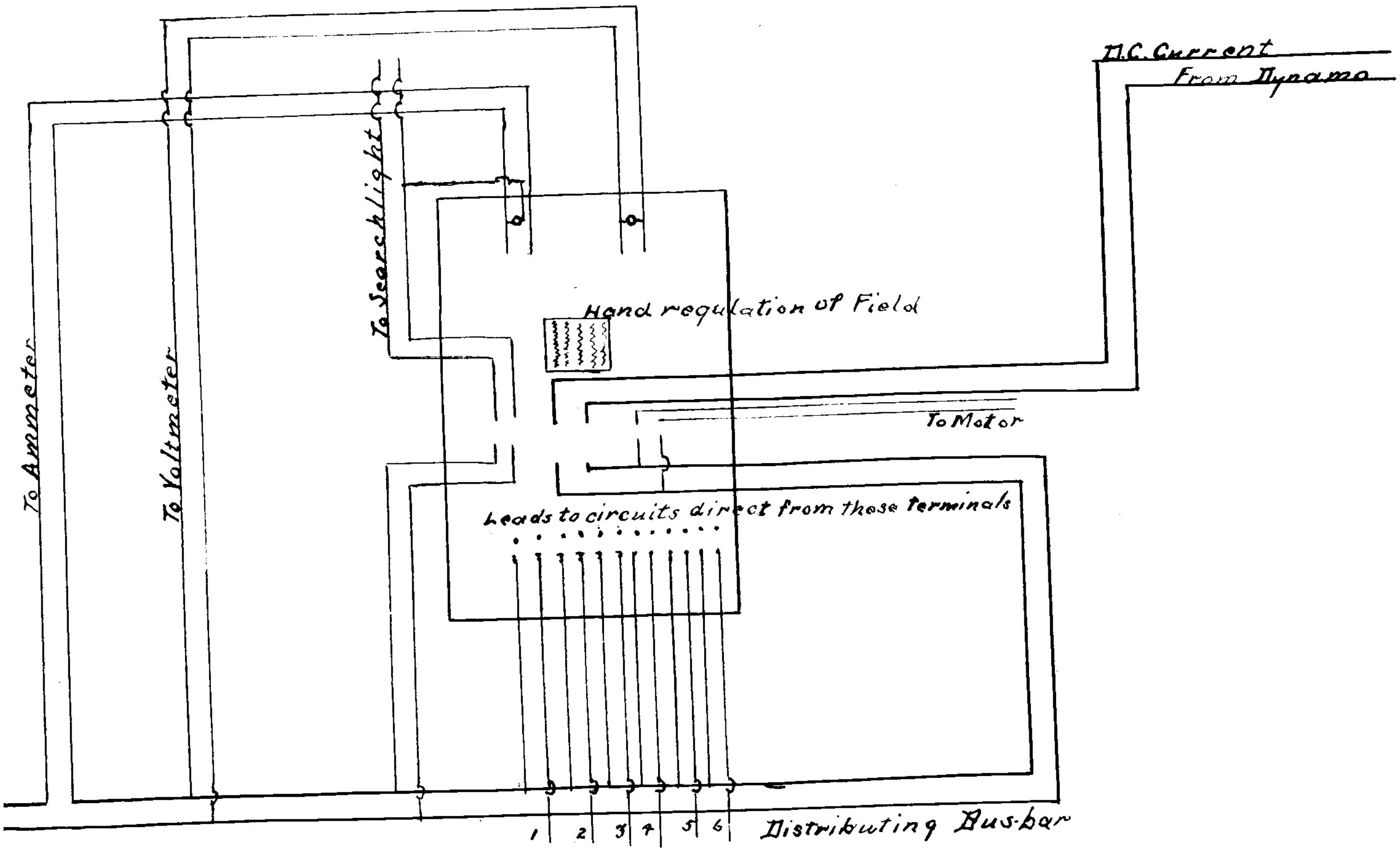

D.C. Current
From Dynamo
To Ammeter
To Voltmeter
To Searchlight
Hand regulation of Field
To Motor
Leads to circuits direct from these terminals
1 2 3 4 5 6
Distributing Bus-bar

Plate E.