NATIONAL BUREAU OF STANDARDS REPORT

5781

A Redesign of the Switching Mechanism
of the
Type FMF-6B Channel Marker Light

By
R. T. Vaughan

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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ABSTRACT

This report describes the development of a fluorescent lamp unit which simplifies the switching operation of the FMF-6B buoy-mounted channel marker light.

1. INTRODUCTION

The current design of the FMF-6B channel marker light requires the actuation of mechanical switches for energizing and de-energizing the fluorescent lamp circuit of the unit. The switches are manipulated by striking a treadle on the pedestal assembly of the light, a procedure usually accomplished from a service boat by a crewman employing a boat hook. This somewhat cumbersome, time-consuming operation, requiring the service boat to stop at each buoy, is made more difficult in rough or choppy water and has resulted in damaged and lost buoys. A redesign of the circuit is desirable, therefore, to enable this operation to be accomplished more easily and rapidly with resultant savings in time and cost.

2. DESIGN REQUIREMENTS

The revised switching mechanism must conform to the following requirements.

1. The manipulation of the switch should require a minimum effort on the part of the service crew.

2. The operation must be such as to minimize damage to the buoys.

3. The switching mechanism must not be actuated by wave action.

4. It must not advance on-off-on-off-- with unintentional repetitive physical contact with the switch.

5. It must not place an appreciable additional load on the batteries of the light.

6. It must be readily adaptable to the back fitting of existing lights.

7. Any external fixtures or components added to the lamp subassembly which hinder the servicing, handling, or storage of the units would be undesirable.

8. Due consideration should be given to cost.

3. METHODS CONSIDERED

The switching methods considered can be listed under the following headings.

1. A mechanical switch requiring a smaller actuating force.

2. A remote control unit.

3. A photoelectric device.

4. A mechanism requiring a light, momentary contact with an electrically conductive rod.

Proposed methods falling under the first three headings were considered undesirable because of one or more of the operational requirements listed. Methods described by the fourth heading were investigated, and a successful design conforming to all of the operational requirements was developed.

4. METHOD DEVELOPED

4.1 Design Details.

Schematic drawings of the present circuit and the modified circuit are shown in figures 1 and 2 respectively. Sketches of the present and the modified light subassemblies are shown in figures 3 and 4 respectively.

4.2 Description of Operation.

The modified circuit allows the lamp to be turned on or off by a momentary contact between a squirrel-cage antenna on the light assembly and a lightweight rod held by an operator in the service boat. A battery supply and a switch in the insulated handle of the rod permit the operator to turn the lamp either on or off by changing the polarity of the voltage applied to the rod through the switch from the batteries.

A ground lead from the switch is clipped to some part of the boat that is in good electrical contact with the water. When the antenna on the light is touched with the rod, the appropriate electrical circuit is completed through a ground plate on the light, back through the water to the grounded portion of the boat. To turn the lamp on, the on-off switch on the handle of the rod is thrown to the "on" position, making the rod positive with respect to the water. The antenna is then touched with the rod. The positive voltage on the antenna energizes the "on" relay through its rectifier; at the same time the "on" condenser is charged. The time constant of the condenser and relay coil is large enough to keep the relay energized for a short period after the external energizing voltage is removed from the antenna. This period is long enough to allow the lamp filament to become heated. When the current through the relay coil decreases to the drop-out value, the relay contacts open and the voltage induced across the lamp by the inductor causes the lamp to light. The "off" rectifier has a sufficiently high resistance in the reverse direction to prevent the "off" relay from becoming energized when a positive voltage is applied to the antenna. To turn the lamp off, the on-off switch on the handle of the rod is thrown to the "off" position making the rod negative with respect to the water. The operation is as described above except that the "off" relay, rather than the "on" relay, is energized, and the lamp circuit opens, turning the lamp off. The small capacitors in parallel with the relay contacts retard the formation of arcs between the contacts when the contacts are opened. Unless the dissipation of power in the arcs is minimized, the starting of the lamp will be unreliable.

5. PERFORMANCE

5.1 Laboratory Tests.

The circuit did not fail to operate properly at any time during laboratory tests at room temperature. At 0°F both the present circuit and the modified circuit failed to start the lamp approximately 4% of the trials. During the tests it was necessary to attach the ground wire from the rod to the case of the light since there was no water path to complete the circuit. Appropriate resistance was included in the ground circuit to approximate the resistance of the water path.

5.2 Field Tests.

Prototype circuits and components were constructed, and two lights were modified and delivered to the Naval Air Test Center, Patuxent River, Maryland, for field testing. The buoys carrying the two lights were anchored in Chesapeake Bay, but before the testing began heavy winds caused one of the buoys to drag its anchor and the antenna was smashed against an obstruction. Since it became necessary to replace the antenna, it was decided to modify the unit further and provide a V-shaped double antenna and a double rod, the two legs of the V being insulated from each other. Insertion of the double rod into the V with rod "A" contacting the "A" leg of the V and rod "B" contacting the "B" leg of the V would turn the lamp on. Reversal of the rod with respect to the V would turn the lamp off. This eliminated the need for a return path through the water.

The testing of the lights is reported in the NATC Report on Project TED No. PTR AE 100.27, 12 December 1957. The lights were operated twice a day by service crews for four months and detailed observations were made. The light employing the single rod with ground return through the water was operated in a fresh-water pond during part of this period. The results of the tests indicated that both units were superior to the present units employing the mechanical treadle switches. The method employing the single rod (light No. 1) was preferred. The V-antenna of light No. 2 was bulkier, somewhat more hazardous and more difficult to engage than that of light No. 1.

6. RECOMMENDATIONS

The following suggestions are proposed for consideration in further improvement of the single-pole unit.

1. A DPDT momentary-contact switch should replace the DPDT switch on the handle of the rod, and the switch should be located in such a position that it can be readily operated by the thumb.

2. The rod should be made in sections to facilitate packaging.

3. The battery supply in the handle of the rod should be easily removable.

4. Tantalum capacitors and silicon rectifiers should be considered as replacements for the capacitors and rectifiers in the prototype circuit in order to save space.

5. A 0.01 microfarad capacitor should be placed in parallel with the "off-relay" contacts.

6. Packaging of the components in the lamp circuit can be improved to provide for easier replacement of the amperite and relays.

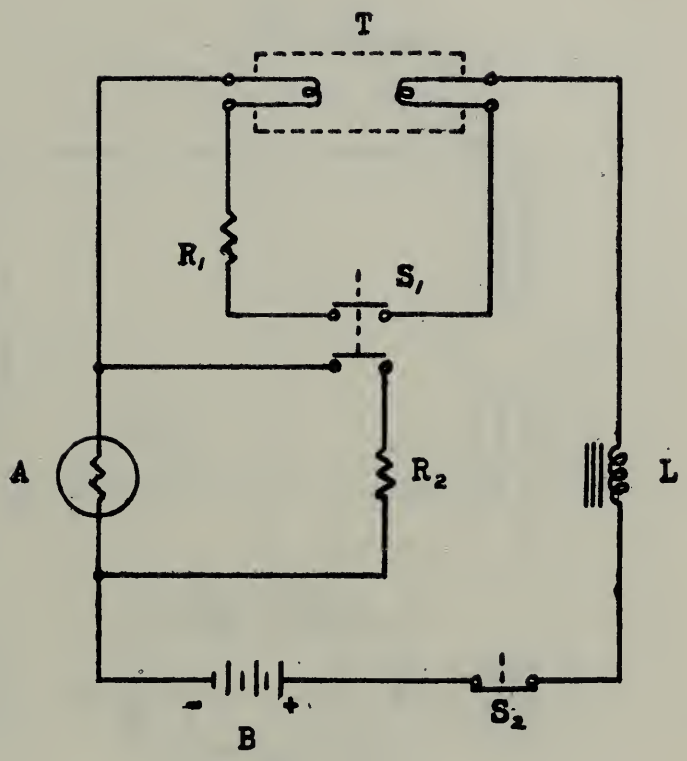
7. The grounding plate on the light should be identified as such so as to reduce the possibility of having it painted during periodic servicing.

8. The ground circuit of the lamp should be connected to the pedestal and carried through a strap to the battery container. This will facilitate the removal of the lamp assembly from the pedestal for servicing.

9. A 1000-ohm resistor should be placed in series with the rod to reduce the shock hazard of accidental contact with the rod when energized.

10. Retroreflectors or retroreflective material should be affixed to the buoy to aid the service crew in locating it.

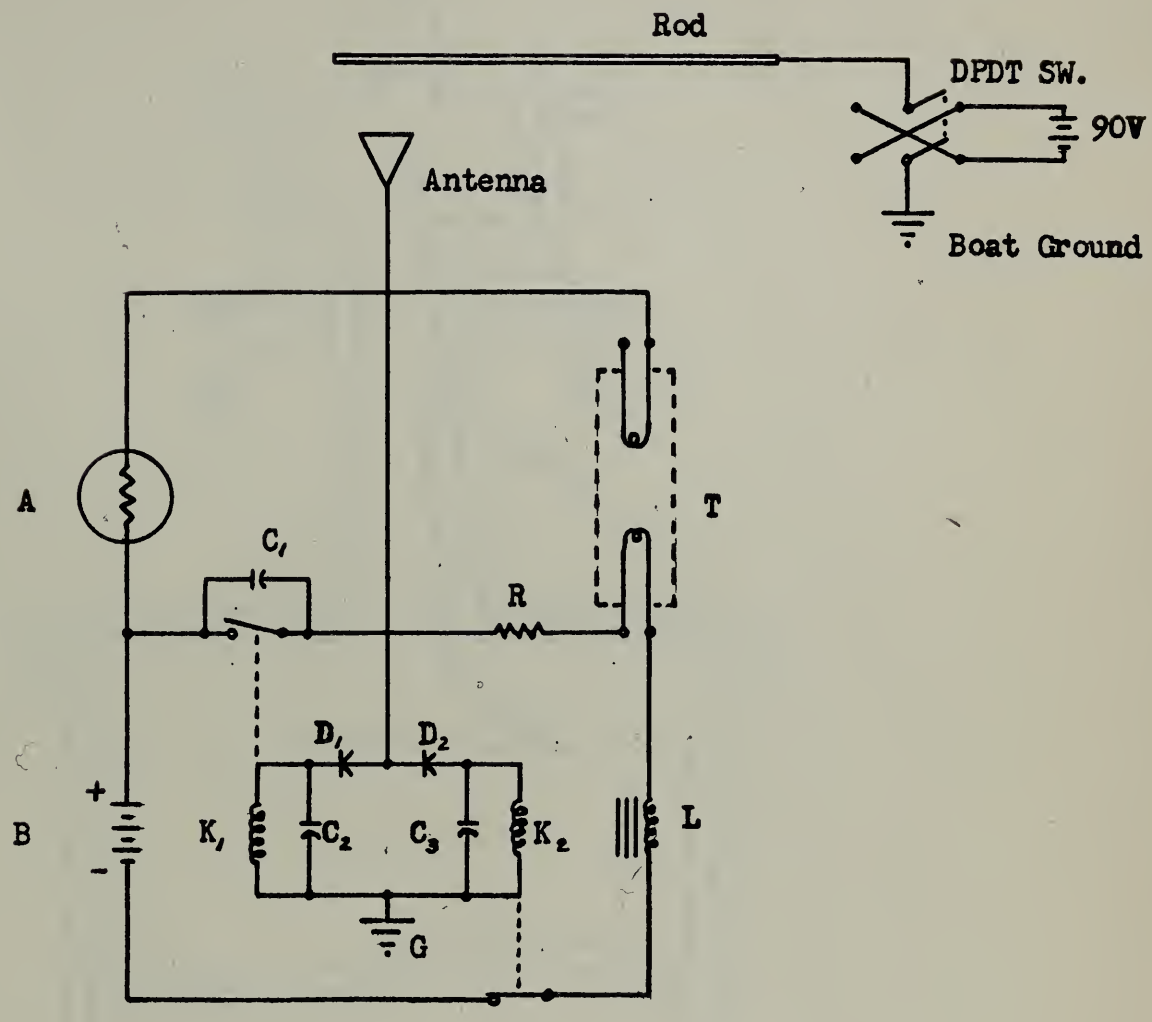
SCHEMATIC DRAWING OF PRESENT CIRCUIT



A	Amperite, No. 1-15
B	Batteries, 90V
L	Inductor, 25-40 Ω-1.7 Hy
R_1, R_2	Resistors, 200Ω
S_1	"On" Switch, DPST
S_2	"Off" Switch, SSST
T	Fluorescent Lamp, 6 Watt

Figure 1

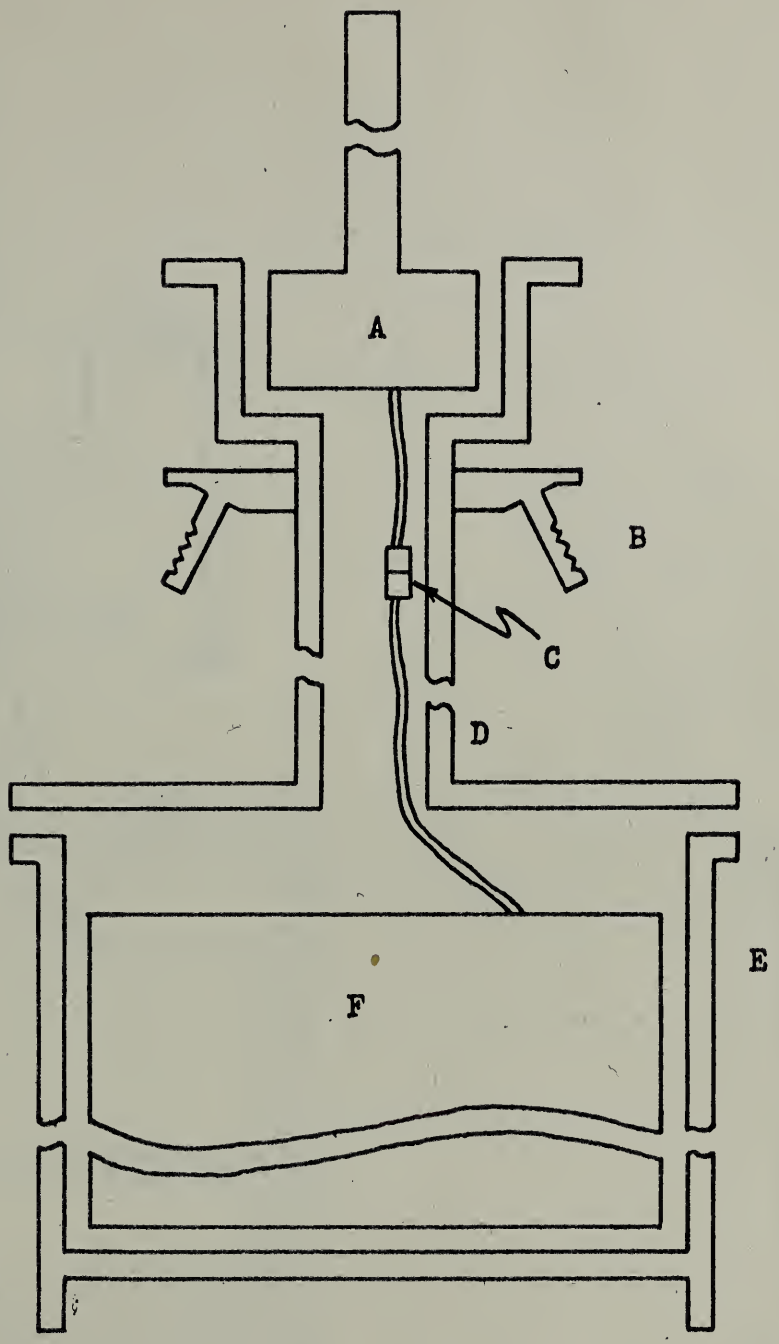
SCHEMATIC DRAWING OF REVISED CIRCUIT



A	Amperite, Type ITF15
B	Batteries, 90V
C_1	Capacitor, .01µf
C_2, C_3	Capacitors, 50µf, 50WVDC
D_1, D_2	Selenium Rectifier, 75ma., 20 Volts RMS, Federal Catalogue 1001
G	Buoy Ground
K_1	N.O. "On" Relay, Potter & Brumfield Type PW5LS, 10KΩ, 24V
K_2	N.C. "Off" Relay " " " " " "
L	Inductor, 1 HY, 20-24 Ω
R	Resistor 300 Ω , 10 Watt
T	Fluorescent Lamp, 6 Watt

Figure 2

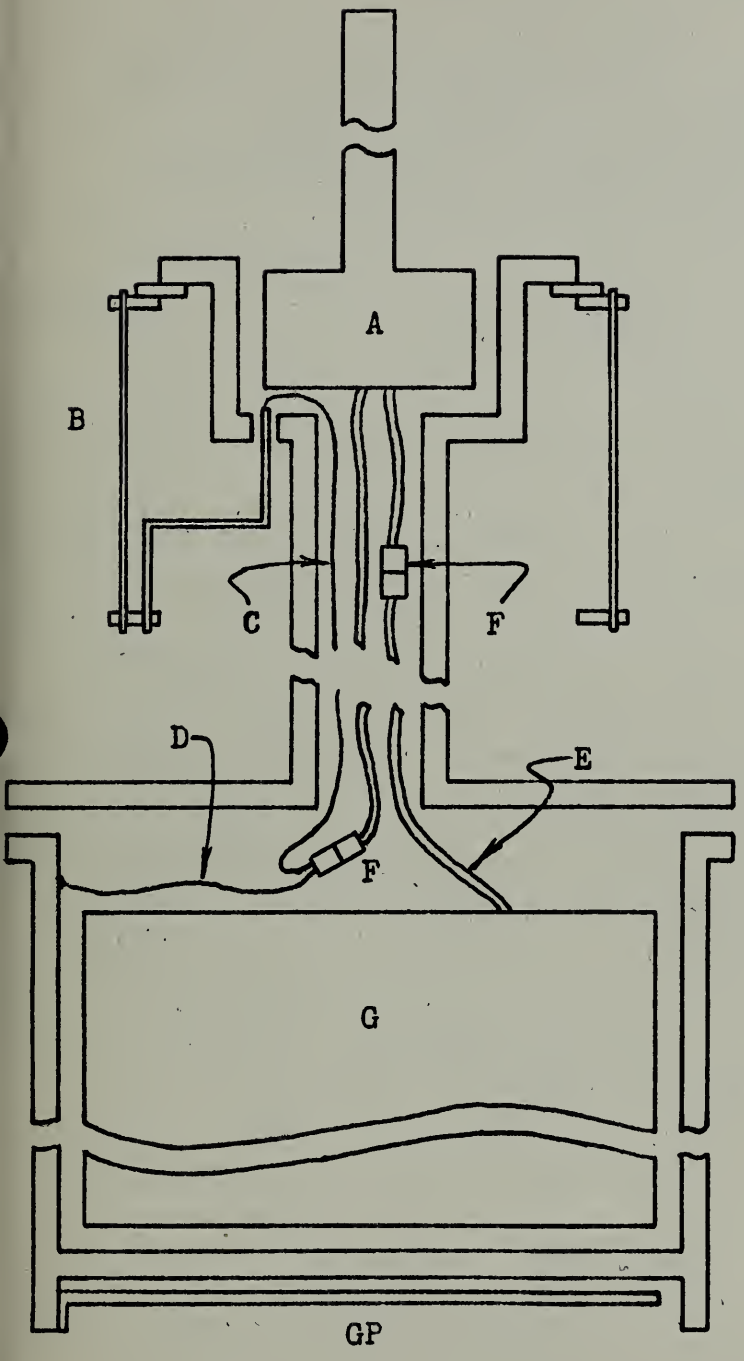
SKETCH OF PRESENT LIGHT SUB-ASSEMBLY

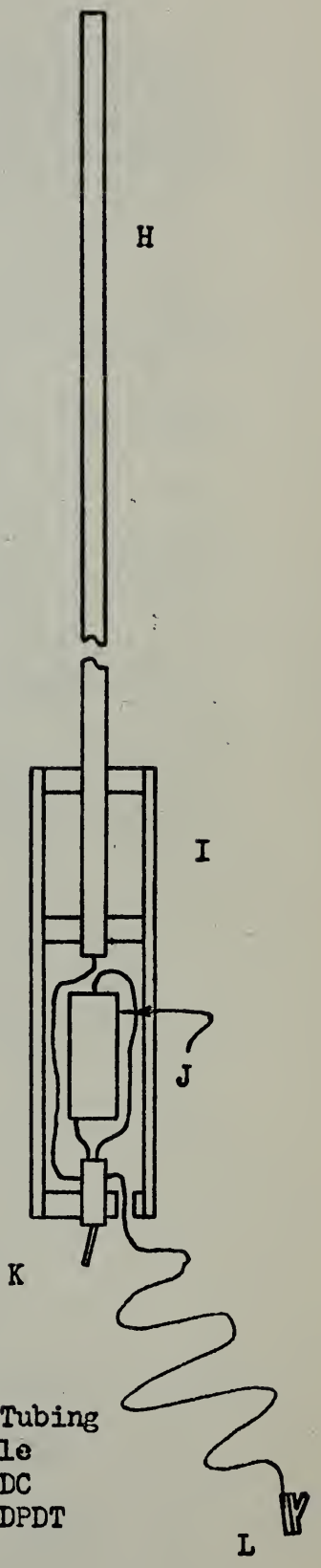


A Lamp Assembly
B Treadle Switch
C Cable Connector
D Pedestal Assembly
E Battery Container
F Battery Rack

Figure 3

SKETCHES OF MODIFIED LIGHT SUB-ASSEMBLY AND ROD





A Lamp Assembly
B Antenna
C Antenna Lead
D Ground Lead
E Battery Cable
F Cable Connectors
G Battery Pack
GP Ground Plate

H Rod: Aluminum Tubing
I Insulated Handle
J Batteries 90V DC
K On-Off Switch DPDT
L Ground Clip

Figure 4

U. S. DEPARTMENT OF COMMERCE
Sinclair Weeks, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

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Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Engine Fuels. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Nuclear Physics. Radioactivity. X-rays. Betatron. Nucleonic Instrumentation. Radiological Equipment.

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• Office of Basic Instrumentation.

• Office of Weights and Measures.

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