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A TRANSISTORIZED BUOY FLASHER

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OTTAWA

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ABSTRACT

Battery-operated buoy lights are normally flashed periodically by a motor-driven cam and switch. The motors are expensive, and must be overhauled periodically to check and replace worn bearings and contacts.

At the request of the Department of Transport an inexpensive reliable flasher that might replace the motor-driven flasher mechanism was developed. The flasher circuit employs transistors, and the only moving part is the flasher relay. Current consumption is equivalent to that of the motor-driven flasher.

CONTENTS

TEXT

FIGURES

PLATE

A TRANSISTORIZED BUOY FLASHER

- H. Ross Smyth -

INTRODUCTION

Battery-operated buoy lights are normally flashed periodically by a motor-driven cam and switch. The motor operates on approximately four milliamperes at six volts in order to conserve battery capacity for its primary function of producing light. The cost of the motor and the necessity for overhaul and replacement of parts prompted a search for a suitable substitute.

Replacement of this motor-driven switch was accomplished by designing a transistorized multivibrator with a period suitable for buoy-flashing frequencies. The multivibrator output controlled a relay to operate the flasher circuit.

A practical buoy flasher is described below.

METHOD OF OPERATION

Transistors have many advantages over vacuum tubes. They are much more compact, have a much longer life, require less power at lower voltage and, of course, no heater or filament power is needed.

However, they do have some disadvantages. Signal power is needed to drive them, whereas the vacuum tube requires very little signal power. This requirement for signal power imposes an undesirable load on the signal source, which is generally another transistor. Secondly, the d-c current through a transistor cannot be completely cut off by a signal, and this minimum current may be troublesome. Again, the transistor is very temperature-sensitive, and a ten-degree temperature change may cause faulty operation unless electrical compensation is included in the circuitry.

The transistor, therefore, is not a direct replacement for the vacuum tube but must be used with circuits designed for its characteristics. In general, these are low-resistance circuits arranged to include temperature compensation to a degree imposed by project specifications.

In the case of the buoy flasher circuit, it was necessary to design a system that operated from the six-volt battery supply and did not require more than a few milliwatts of power. A transistor multivibrator with a period similar to that of the light flash was designed. The output of the multivibrator was fed to a transistor amplifier with a sensitive relay in its collector circuit. The contacts of the relay were suitable for the one ampere flasher circuit which operated the light. The complete circuit, except the light, drew an average current of six milliamperes at six volts.

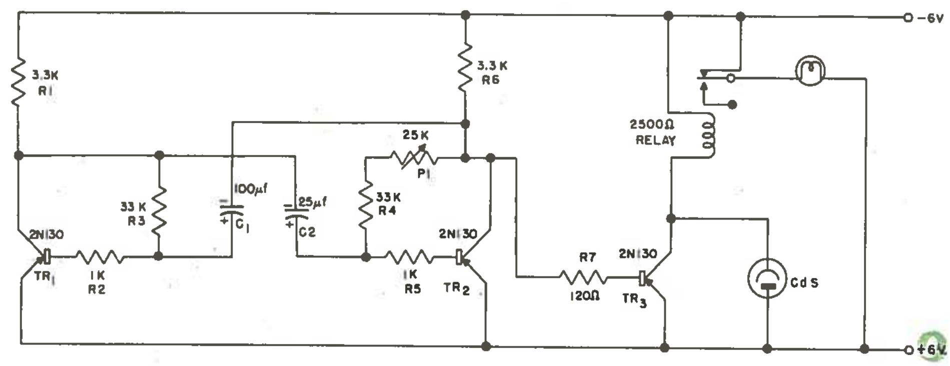

FIG. 1 CIRCUIT DIAGRAM OF TRANSISTORIZED BUOY FLASHER

As in vacuum tubes, a polarity reversal occurs between input and output. That is, if the base of a transistor is driven negative by a signal, the collector goes towards positive. Now, referring to the circuit diagram of Fig. 1 we may observe the following facts. When two transistors are cross-coupled by capacitors, as TR1 and TR2 in the circuit, each transistor acts as a signal source for the other. An extreme "see-saw" action results. Signal polarities throughout the circuit are such that it is very unstable electrically, and oscillation occurs. At one time, TR1 will draw full current while TR2 draws very little, and at another time TR2 draws full current and the current through TR1 is very small. Output voltages are thereby developed across the collector load resistors R1 and R6.

The interval of current cutoff is determined by the time required by the coupling capacitor to discharge through its base bias resistor. As the bias resistors are fixed within rather narrow limits by consideration of transistor characteristics, timing is accomplished by selecting appropriate values for the coupling capacitors C1 and C2.

In general, C1 and R3 determine the length of flash, but the value of the amplifier base resistor, R7, also has some effect. The values shown result in a flash about 1/3 second long; if, however, R7 is increased from 120 ohms to 500 ohms, the flash persists for ½ second.

The off-time is a function of C2 and R4. A rheostat, P1, is included in series with R4 to permit a small variation in off-time. This circuit may provide a variation of off-time between three and six seconds, sufficient to cover the variety of flash periods required on different buoys. A curve showing the approximate range of control of P1 appears in Fig. 2.

During the flash period, when TR2 conducts, TR3 is cut off. Current ceases to flow through the relay and its back contacts close to complete the buoy light circuit.

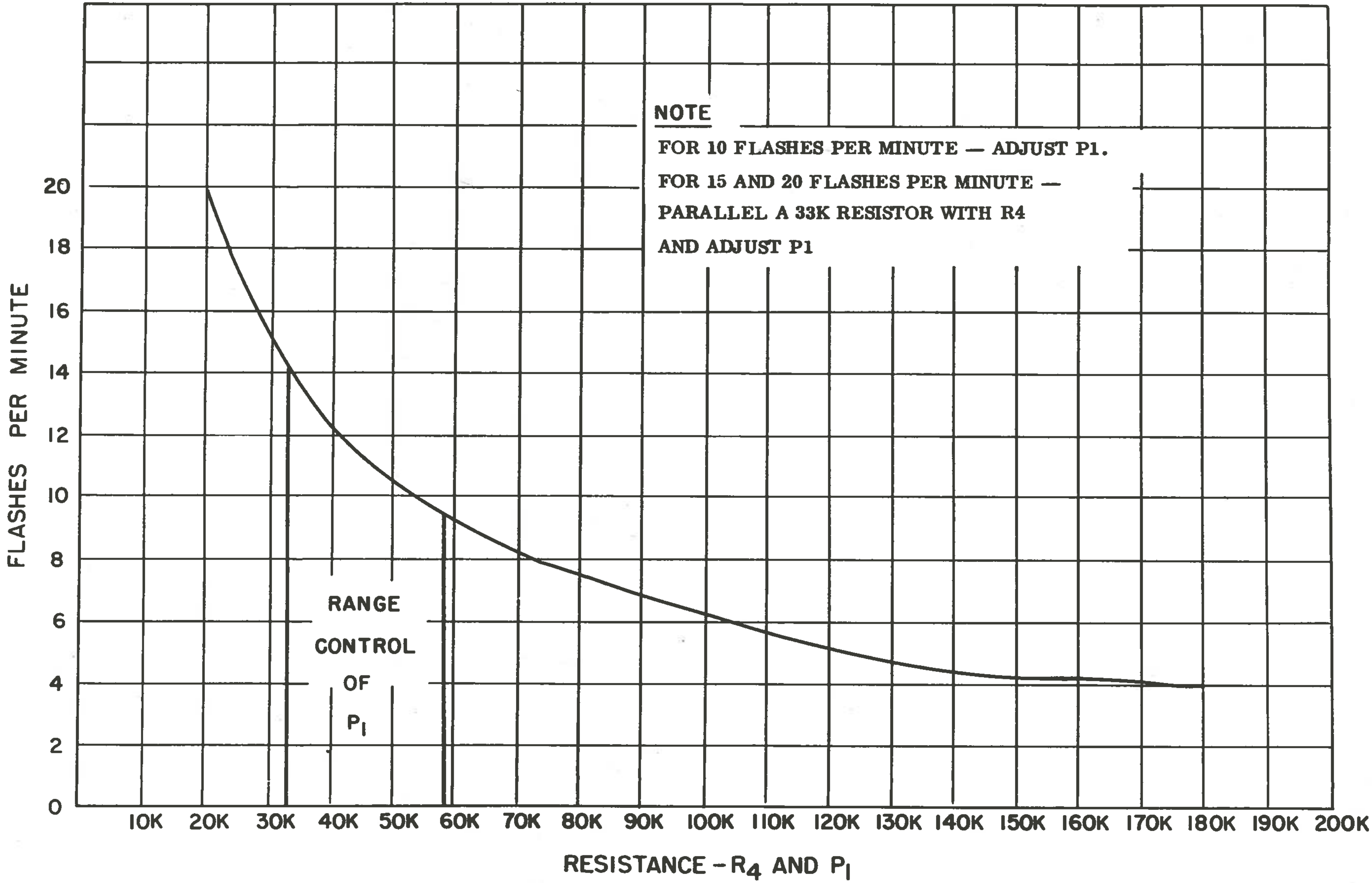

FIG. 2 RANGE OF FLASH CONTROL

Resistors R2, R5, and R7 protect the transistors against transient currents which occur as the circuit flips from the "flash" to "off-time" status. Resistor R7 also reduces the loading of TR3 on the timing circuit. Temperature compensation is accomplished by the use of low resistance values throughout the circuit and by returning bias resistors to their respective transistor collectors rather than directly to the supply voltage. Connecting the bias resistors in this manner provides sufficient d-c degeneration to compensate for extreme temperature variations. The length of the flash cycle does not change significantly over the range of ambient temperatures from -40°F to +100°F.

A very simple daylight switch was included in the circuitry of the flasher. A cadmium-sulphide photoconductive cell was inserted between the emitter and collector of TR3. The resistance of the photoconductive cell in daylight is approximately 2000 ohms, under which condition it keeps the flasher relay closed and independent of the slowly oscillating flasher circuit (multivibrator). As darkness approaches, the resistance of the photoconductive cell increases to the value where it is ineffective and the relay responds to the flasher circuit. The daylight switch has been designed to operate about 15 minutes before the daylight level reaches a value when it is considered desirable that navigational buoys should be illuminated.

ACKNOWLEDGEMENT

The assistance of Mr. W.M. Cameron on this project was most valuable.

PLATE I BUOY LENS ASSEMBLY
WITH TRANSISTORIZED BUOY FLASHER TURRET (at left)