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# THE HYDROFOIL CORPORATION

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TECHNICAL MEMORANDUM † No. HM-14

[redacted]

## HENDY BOAT AUTOMATIC CONTROL CIRCUIT

PREPARED FOR OFFICE OF NAVAL RESEARCH
Washington, D. C.

CONTRACT NONR-13601

August 31, 1951 Copy No. 60

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THE HYDROFOIL CORPORATION

TECHNICAL MEMORANDUM HM - 14

# HENDY BOAT AUTOMATIC CONTROL CIRCUIT

Prepared for

Office of Naval Research
Washington, D. C.

Contract Number Nonr 13601

by

Robert L. Miller

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THE HYDROFOIL CORPORATION

TECHNICAL MEMORANDUM No. HM-14 August 31, 1951

Subject: Hendy Boat Automatic Control Circuit

Prepared for: Office of Naval Research, Washington, D. C.
Under Contract No. Nonr 13601

By: Robert Lee Miller

In order to obtain automatic control for the hydrofoil boat, it is necessary to obtain information as to the position of the hydrofoil struts in the water, and to utilize this information to control the angle of attack of the various hydrofoils to maintain stable and level flight. In the Hendy boat, the information as to strut position is obtained from a set of eight pitot tubes on each forward strut. Each individual pitot connects to a bellows operated contact such that each submerged pitot closes its associated bellows contact. This information is then utilized in automatic circuits to stabilize the boat.

To achieve control, the operation is divided into two sections. First, there is a servo system to obtain stabilization in roll, and secondly there is a separate section to achieve stabilization in pitch.

Figure 1 is a simplified circuit diagram to illustrate the principle of operation of the roll stabilization circuit. There are two individual circuits of this type, one for the starboard hydrofoil, and one for the port hydrofoil. Operation of the circuit is such as to attempt to maintain a stable fixed depth of the strut in question. Operation of the circuit can best be understood by assuming a stable condition with, say, four pitot tubes submerged and four pitot tubes above water. If the system has been properly adjusted, the angle of attack of the hydrofoil will be correct for this speed, and the follow up potentiometer will be in such a position that the voltage difference between A and B will be zero. If the strut submerges one more pitot tube, an unbalance voltage will be produced which will close either $K_1$ or $K_2$ depending upon the polarity of the unbalance, since these relays are so arranged by means of rectifiers that they are polarity sensitive. The relay contacts operate the drive motor, which is so arranged to increase the angle of attack of the hydrofoil. The change which is produced by a variation in depth of the strut thus initiates a change in the angle of attack of the hydrofoil to compensate for the change. This correction operates for either an increase or decrease in depth, and automatically seeks to maintain an equilibrium condition.

In Figure 2 the stabilization circuit for the boat in pitch is shown. Once more, the principle is straightforward. The only

unique portion is the method of checking up so that correction in pitch can occur only when the boat is stable in roll. Reference to the diagram will show that the circuit for correction will be completed only when both sets of pitot tubes are either high or low. If one set of pitots is low and one high, the pitch stabilization circuit will be inoperative until the roll stabilization corrects the situation.

Although the behavior of the roll stabilization circuit and the principle of operation is relatively simple, the mechanical design of the system is quite critical. For example, in order to have the system operate properly, the variation in angle of attack necessary under operation conditions must be known in order to properly adjust the mechanical linkages from the control motor to the hydrofoil such that the range of the follow-up potentiometer is properly proportioned with relation to the motion of the hydrofoil. Also, it becomes quite difficult to predict the stability of the system as to hunting without precise knowledge of the overall system.

Robert Lee Miller

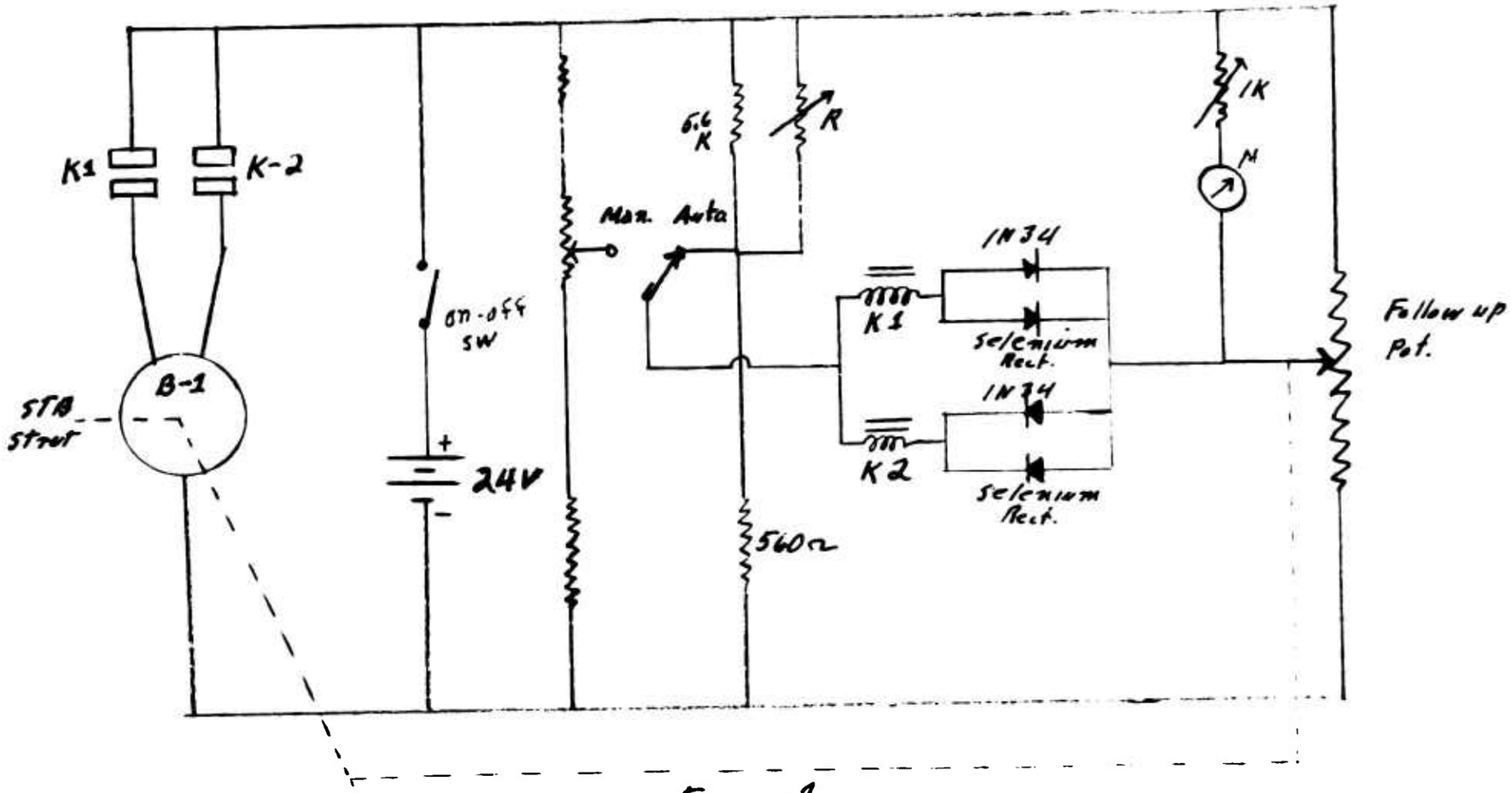


Figure 1.

Simplified Schematic of Roll Stabilization Circuit.

R – Variable in steps.

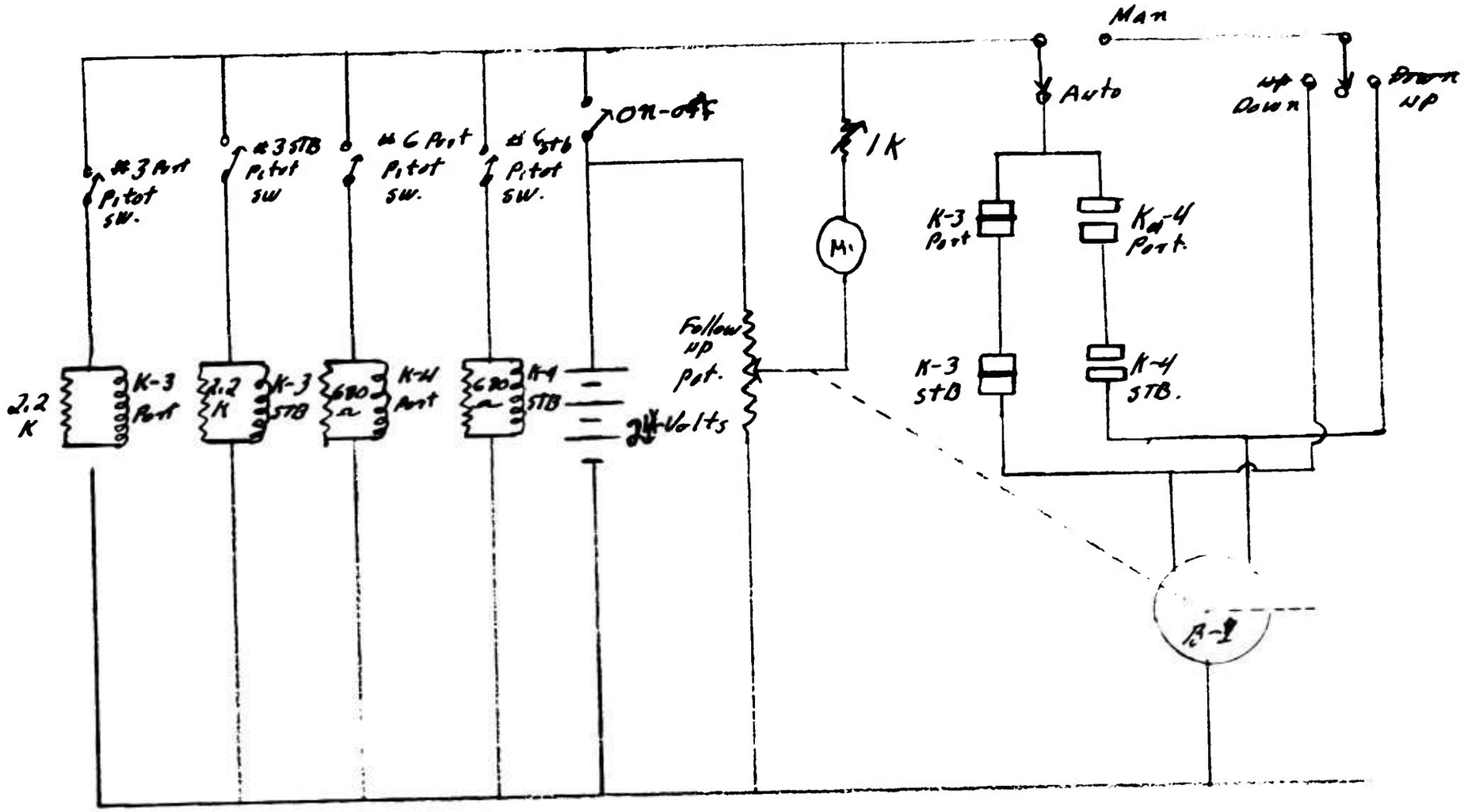


Fig-2
Simplified Schematic of Pitch Stabilization Foil.