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INTERNAL REPORT

A 10-CHANNEL AUTOMATIC SCANNER WITH INDIVIDUALLY SELECTABLE CHANNEL TIMES

BY

J. R. McVey

BRANCH Laboratory Services

PROJECT NO. 7751

DATE October 1968

AMARILLO, TEXAS

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ILLUSTRATIONS

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J. R. McVey[1/]

ABSTRACT

A 10-channel automatic scanner has been developed to automate a thermal conductivity apparatus used in the direct analysis of helium-nitrogen and helium-hydrogen gas samples from a phase equilibria apparatus. The unit uses unijunction transistors to provide a separate programable time of 1 to 99 seconds for each individual channel. Individual channel timing allows the user to program measurements and/or command functions at will. The unique features of the unit are its individually programable channel time and its compatibility with commercial digital voltmeters and printers. These features permit the scanner to completely automate the sequence of events from sample injection to the printing of the final sample results from the thermal conductivity apparatus.

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INTRODUCTION

The 10-channel automatic scanner shown in figure 1 was designed

FIGURE 1. - Complete Measurement System.

to program the sample sequence of a special thermal conductivity apparatus to permit direct analysis of helium-nitrogen and helium-hydrogen gas samples taken from a phase equilibria apparatus used in a research project dealing with phase equilibria determinations at temperatures to 5° Kelvin. This unique type of scanner was needed to provide a broad band of timing for each individual channel and yet be compatible with a commercial digital voltmeter and printer to permit programing command functions and signal measurements in the sample sequence and a digital printout of the results.

The scanner is the only known unit of this type. The 10 individually timed channels permit the user to program a sequence of measurements and commands with individual timing for each event of 1 to 99 seconds. The scanner is unique in that all known commercial units compatible with digital voltmeters and printers have the same time delay on each channel which is usually controllable to approximately 12 seconds. The disadvantage of the same time delay on each channel is that different delays are usually required during command functions such as sample injection, autozero, signal measurements, etc. Other control units such as cam-operated microswitch timers used in most gas chromatographs cannot provide the broad repeatable timing of 1 to 99

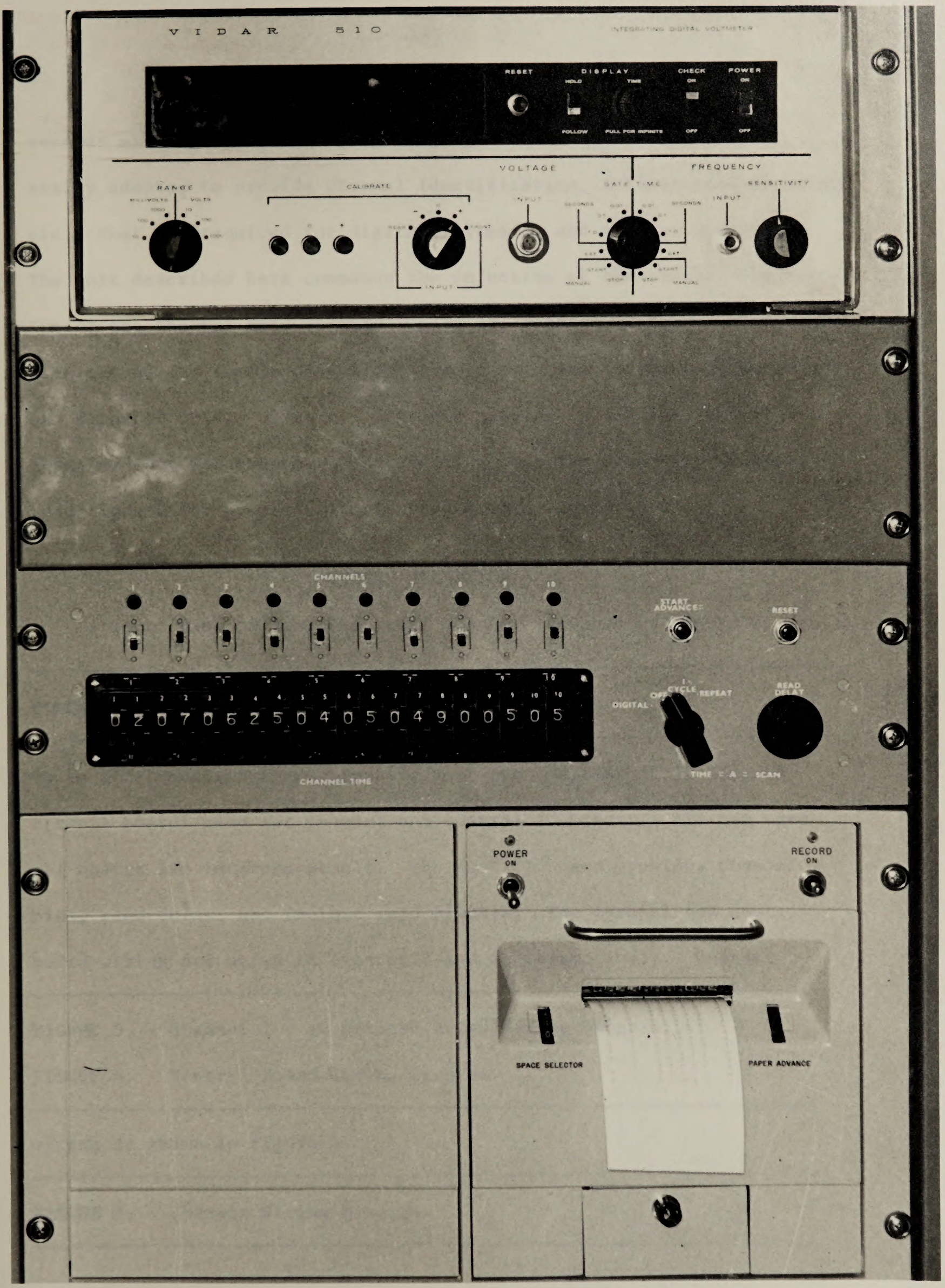

FIGURE 1.– Complete Measurement System.

seconds without the use of complex ganged timers, and they are not easily adapted to provide channel identification, inhibit-read signals, etc., that are required for digital voltmeter and printer operation. The unit described here commands the injection of the sample, the zeroing of the thermal conductivity apparatus, and the measurement and printout of the sample peak area, sample pressure, barometric pressure, and detector bridge voltage. The unit provides a 10-line, 1-state negative code for channel identification plus the necessary inhibit-read signals for proper voltmeter and printer operation.

SYSTEM OPERATION

A front view of the 10-channel scanner is shown in figure 2. It

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FIGURE 2. - Front View.

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is an all-transistorized automatic unit and consists of 11 plug-in circuit boards used for channel and control functions. All ten channel boards are interchangeable. The control board provides channel bias, read delay, and inhibit read signals. The channel and control board wiring are shown in figures 3 and 4, respectively. Chassis

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FIGURE 3. - Channel 1 - 10 Printed Board Wiring Diagram.

FIGURE 4. - Control Board Wiring Diagram.

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wiring is shown in figure 5.

FIGURE 5. - Chassis Wiring Diagram.

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FIGURE 4. - Control Board Wiring Diagram.

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FIGURE 5. - Chassis Wiring Diagram.

FIGURE 2. - Front View.

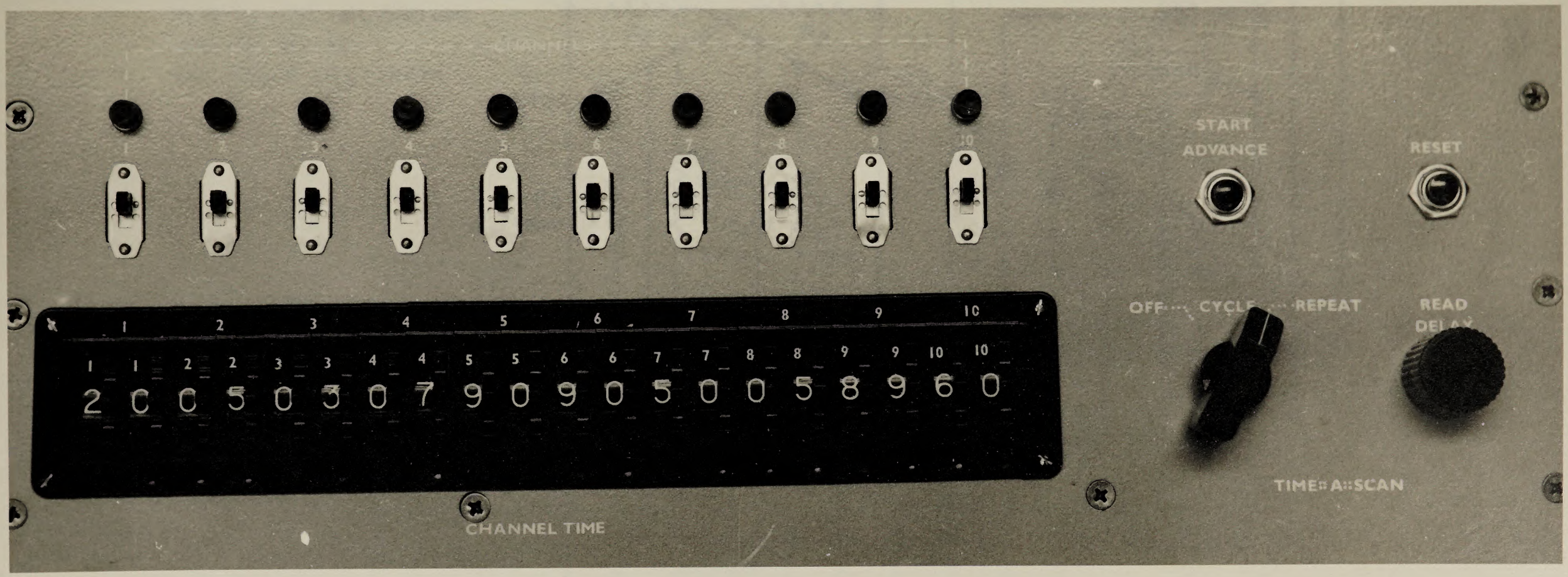


FIGURE 2.- Front View.

BOARD PINS:

A = ground
L = −22 volt supply
Auto- reset- jumper K & E
Transfer pulse D to C next board
Recycle pulse D to C last board to first board.
All resistors ½ watt except where noted.

K_1 & K_2 = 24 volt, 500 ohm coil, GE-SC-33
CR_1, CR_2 & CR_3 = IN474

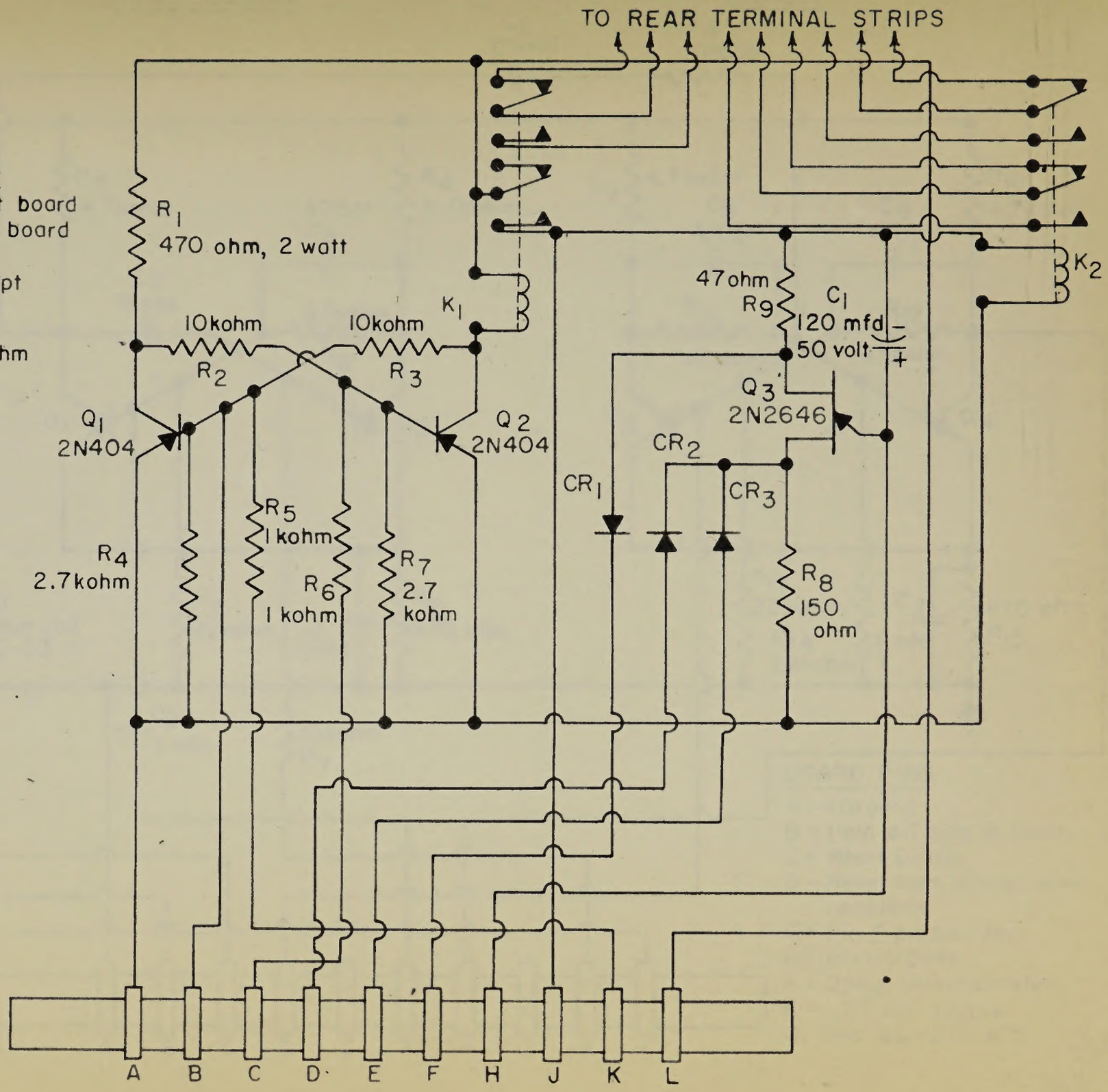
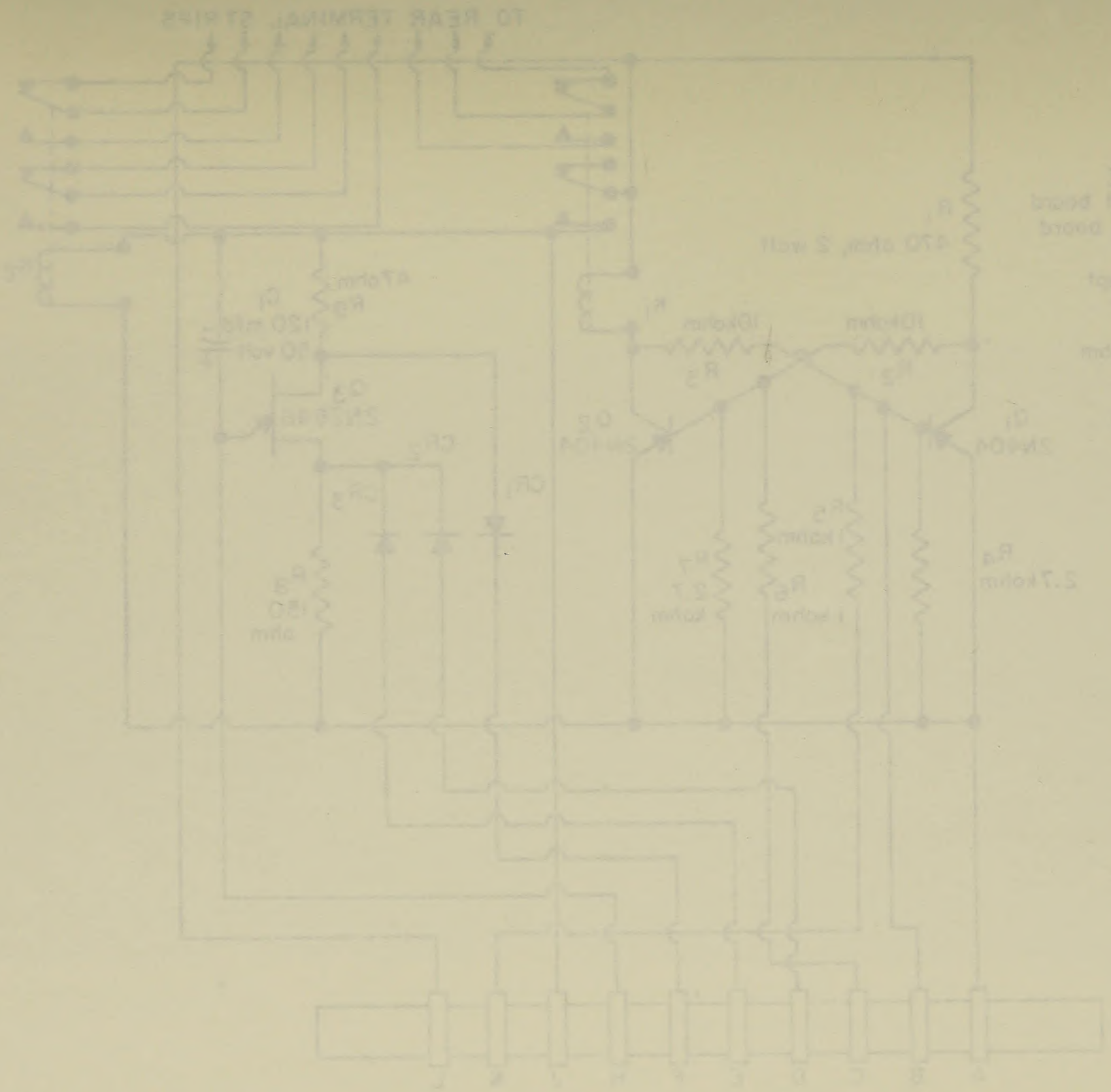


FIGURE 3.- Channel 1-10 Printed Board Wiring Diagram.



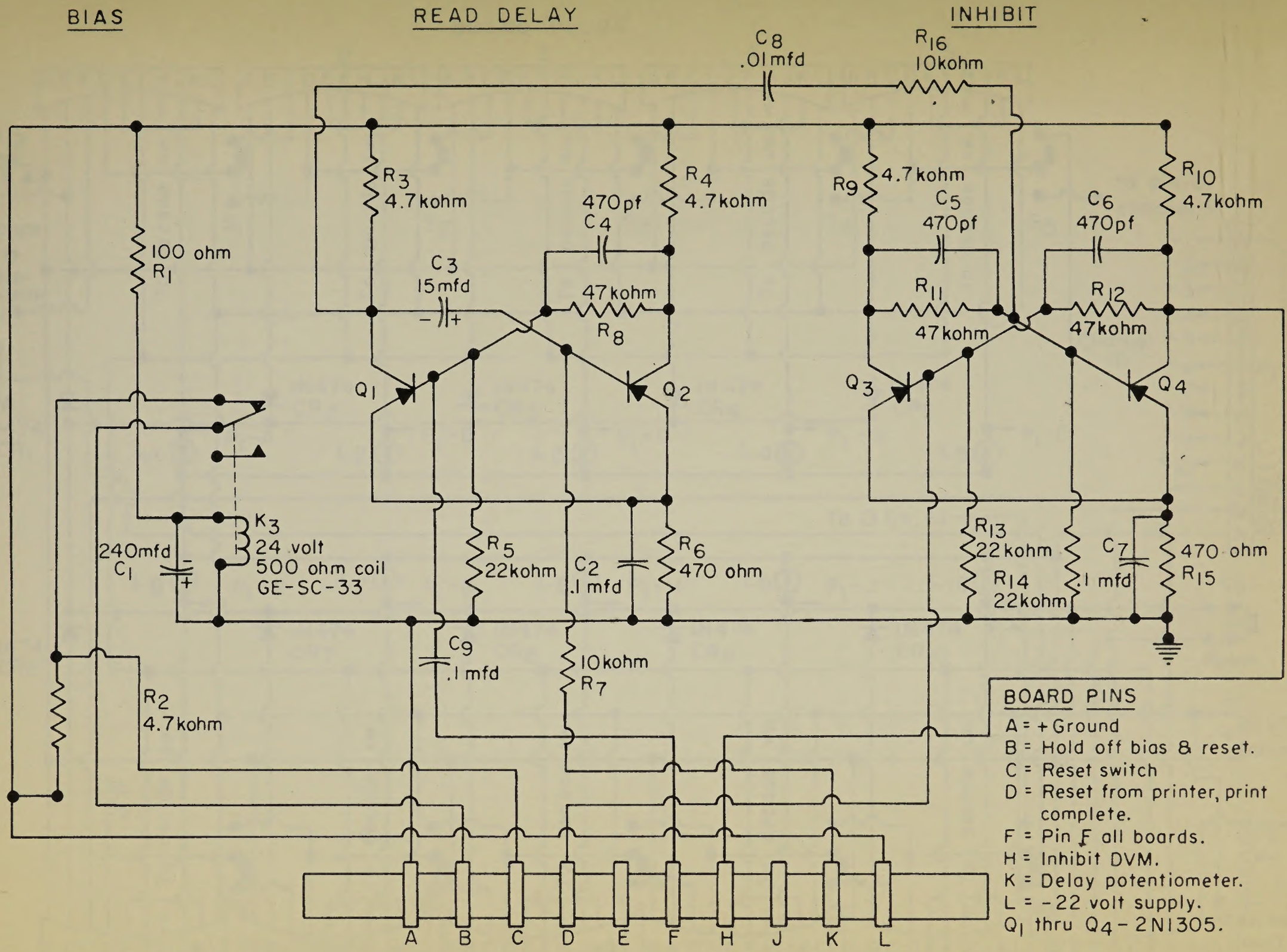
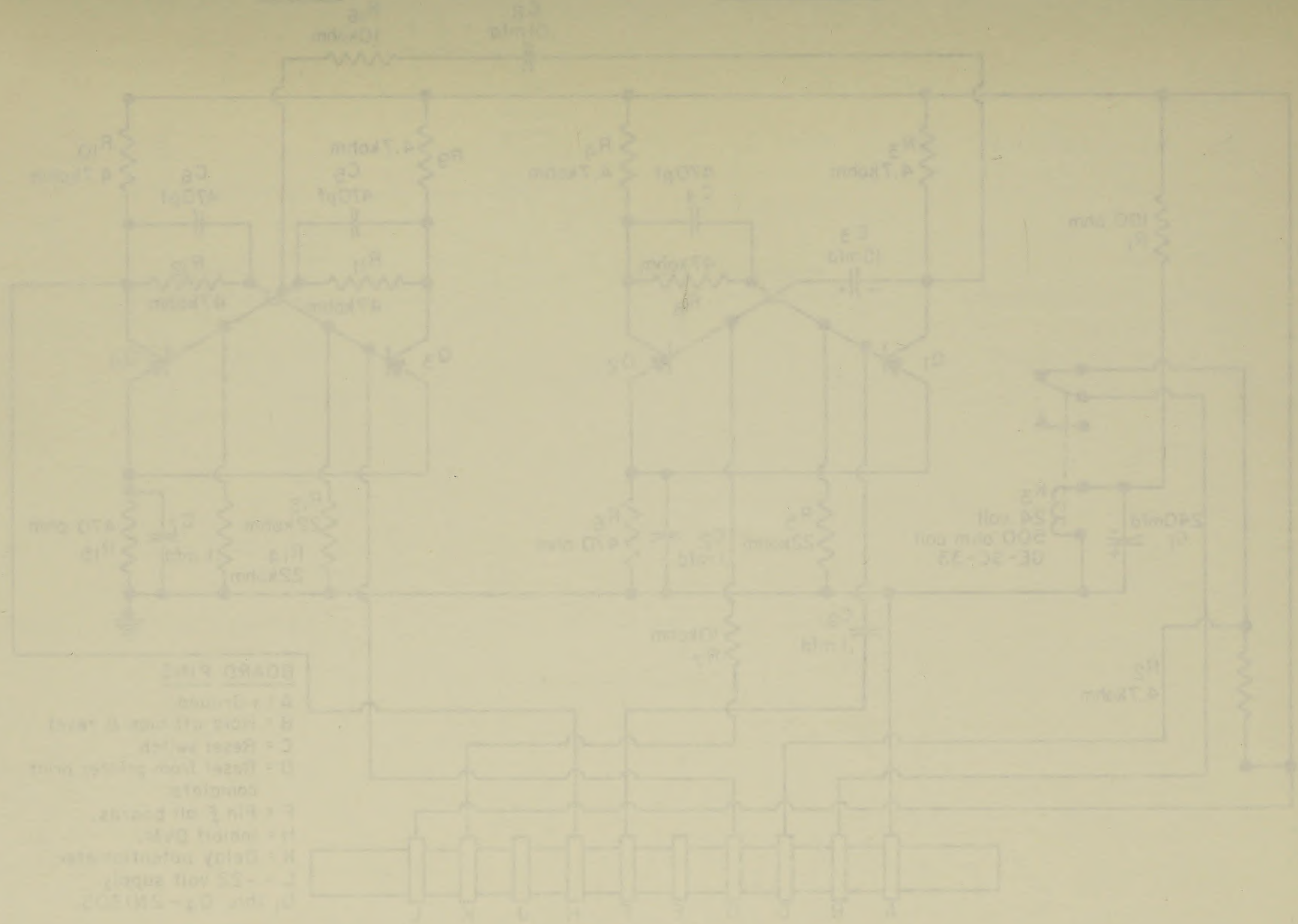


FIGURE 4.- Control Board Wiring Diagram.



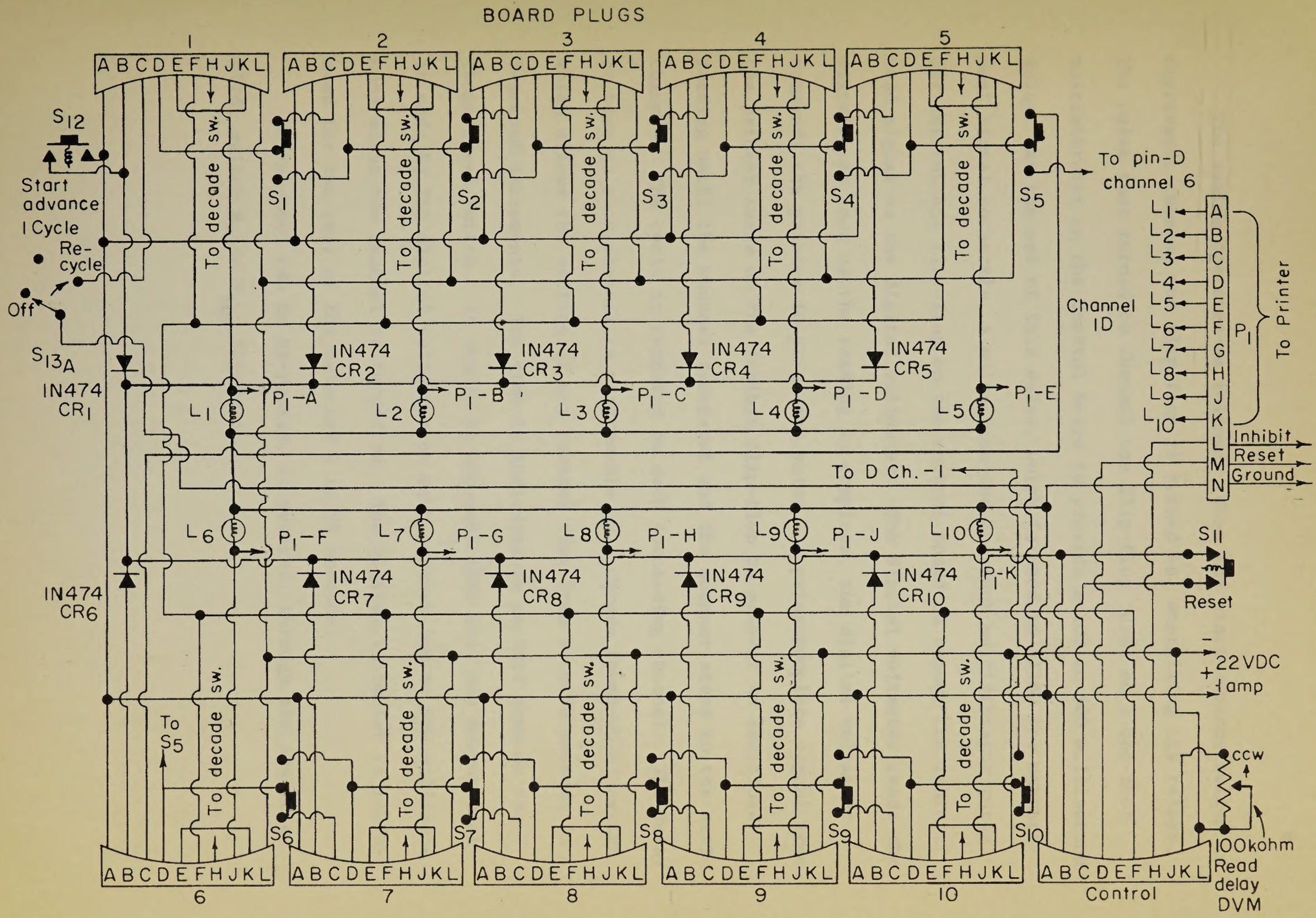
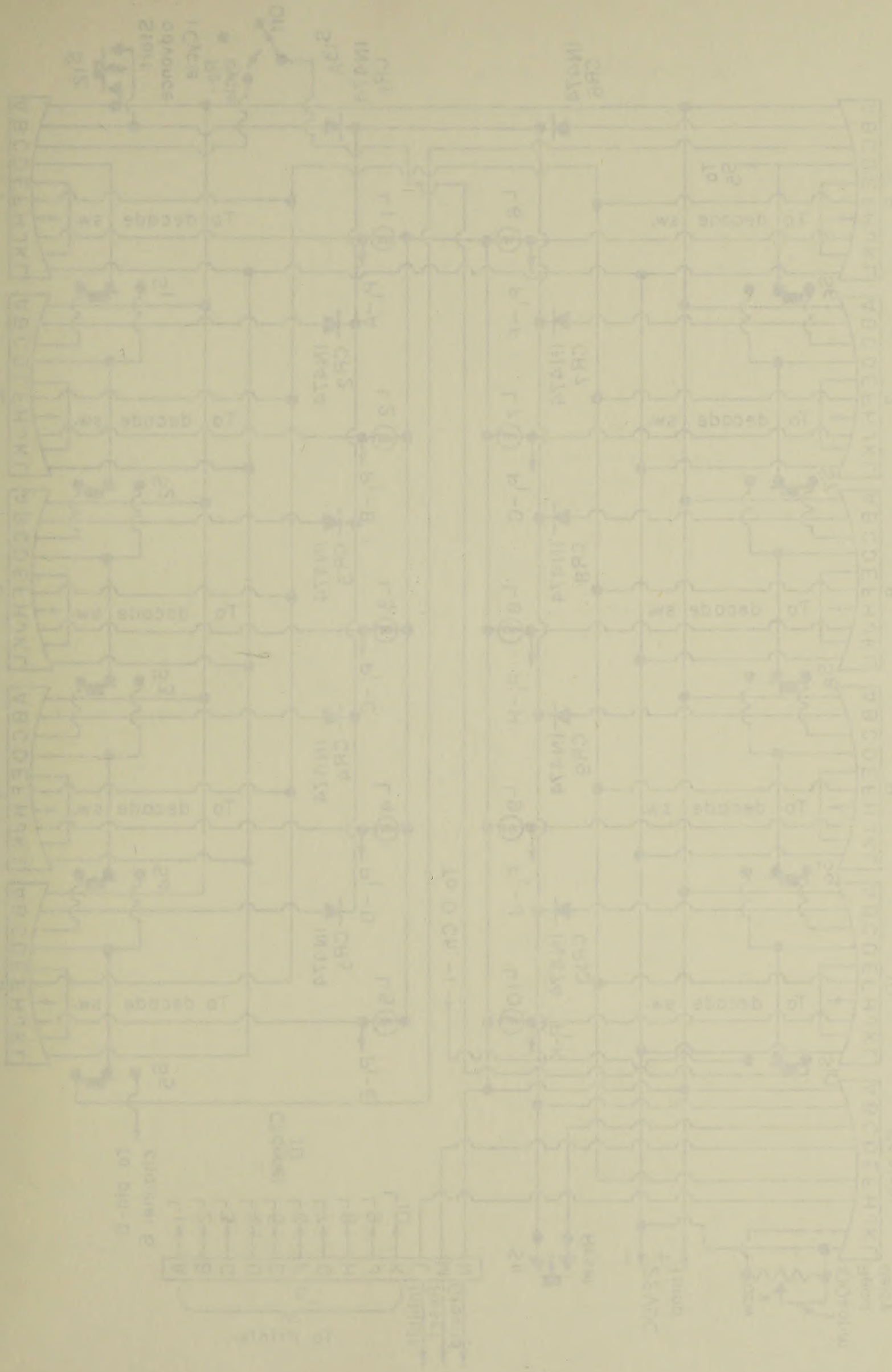


FIGURE 5.– Chassis Wiring Diagram.



The system operates as follows. When the start-advance switch is depressed, channel one flip-flop is turned on, energizing its relays. The pulse that turned on channel one flip-flop turns on a one-shot multivibrator on the control board to provide a 100 to 500 millisecond delay. At the end of this delay, which is used to allow the measurement signal to settle, a pulse from the one-shot multivibrator turns off the inhibit flip-flop on the control board to remove the inhibit read signal to the digital voltmeter. The digital voltmeter reads the signal. As soon as the reading is complete, the digital voltmeter commands the printer to print the value. A print-complete signal from the printer turns on the inhibit flip-flop to prevent an additional reading until the channel times-out and the scanner steps to the next channel. The cycle is repeated on each succeeding channel. The delay or time on each channel is programable by a decade thumb-wheel switch which allows the setting of any channel time from 1 to 99 seconds in 1-second increments. The time is indicated in decimal form on the thumb-wheel switch. It should be apparent that only one measurement is made by the digital voltmeter on each channel 100 to 500 milliseconds after the channel is turned on. The digital voltmeter is inhibited for the rest of the selected 1 to 99 seconds.

Any channel can be by-passed, if desired, through the use of a slide switch S_1 to S_{10}, figure 5.

CHANNEL BOARDS 1 - 10

The channel board is illustrated in figure 3. All channel boards are identical in wiring and are interchangeable. The circuit consists of a flip-flop with inexpensive 2N404 transistors having a miniature 24-volt, 500-ohm relay K_1 as a collector load in one side. When the transistor is turned on, the relay energizes, giving 2-pole, 2-throw contacts for command functions. An additional slave relay was used to provide 4-pole, 2-throw action. Because the circuit is a flip-flop, one simply turns the flip-flop on or off to provide a switching action.

The unijunction transistor, an inexpensive 2N2646, is controlled by an RC time-constant circuit which consists of the 120 MFD capacitor and 18 resistors (figure 6) decaded in the thumb-wheel switch to allow

FIGURE 6. - Decade Time Selection Switch.

obtaining 1 to 99 seconds delay. When the flip-flop is turned on, the relay energizes, applying -22 volts to the unijunction transistor and the RC circuit. When the capacitor has charged to the intrinsic stand-off ratio, the unijunction turns on and discharges the capacitor. The capacitor discharge pulse turns off the flip-flop, removing the -22 volt supply from the unijunction. This action turns on the flip-flop on the next selected channel board. The unijunction also supplies the pulse to turn on the one-shot multivibrator on the control board which, in turn, controls the inhibit flip-flop to allow a digital voltmeter measurement to be made after a 100 to 500 millisecond time delay.

NOTE:

Channels 1 thru 10 are identical.
All units resistors 6040 ohm 1%.
All tens resistors 54kohm 1%.
All resistors ½ watt.
Switch is a Tech. Lab Model B-5575 (1N10-20).
Resistors numbered consecutively 1 thru 180.

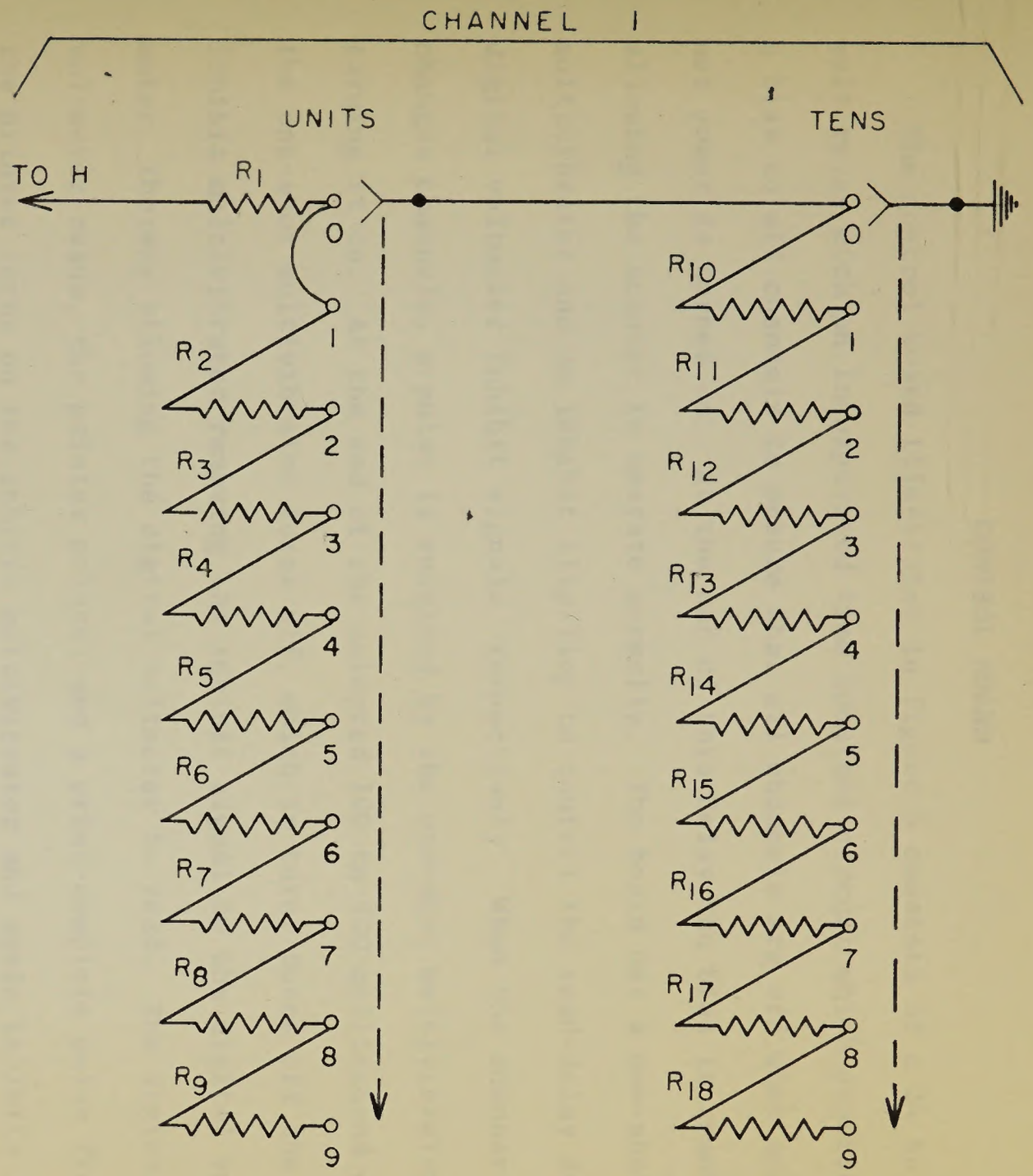
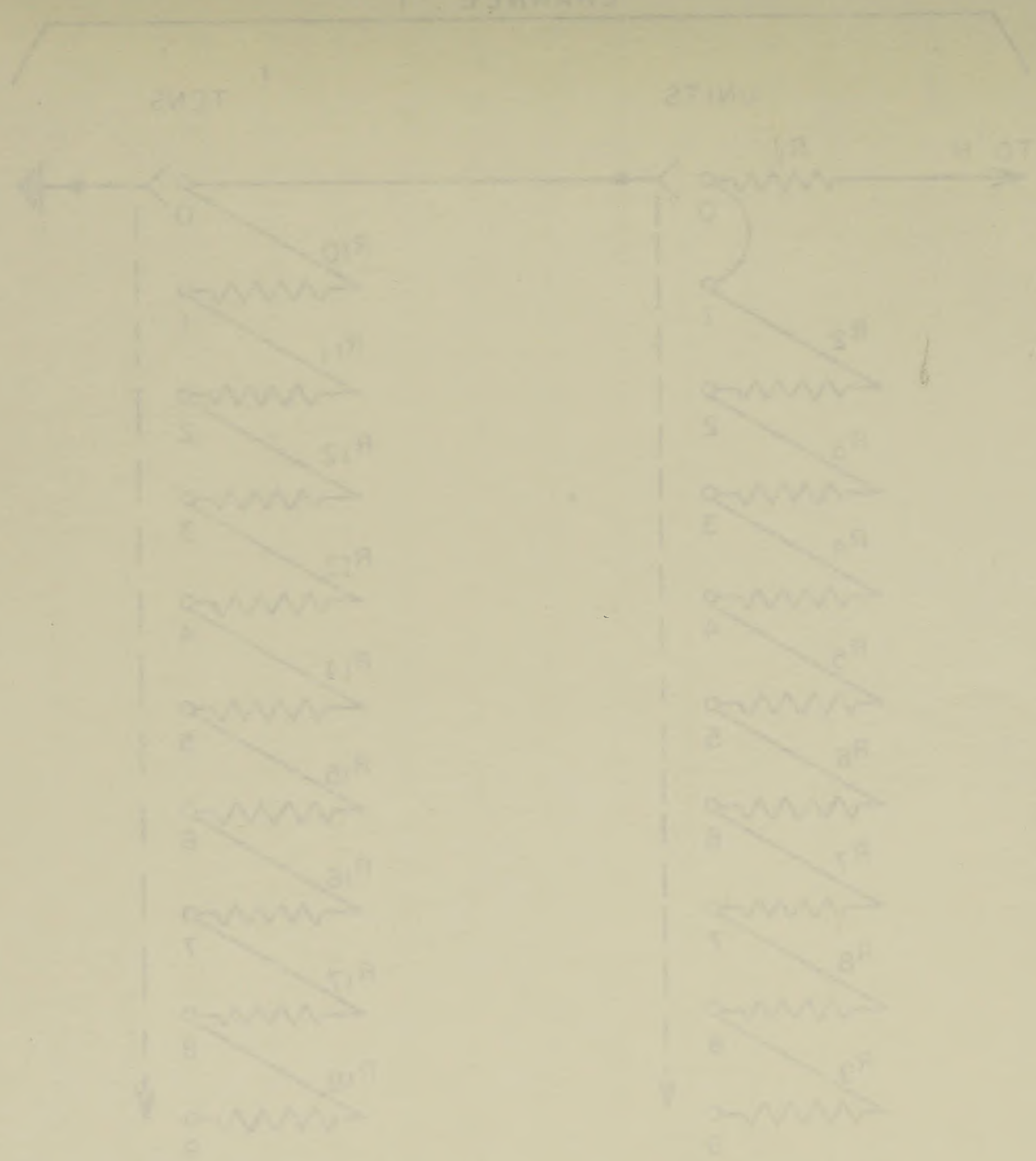


FIGURE 6.- Decade Time Selection Switch.



CONTROL BOARD

The control board illustrated in figure 4 consists of a 24 to 28 volt relay with an incorporated time constant circuit which provides a bias to all channels to ensure that all channels are off when scanner power is turned on. At the end of this delay the bias is removed, allowing the scanner to operate normally. The board has a one-shot multivibrator and an inhibit flip-flop to control the read-delay and digital voltmeter inhibit signals, respectively. When the scanner changes channels, a pulse is received by the one-shot multivibrator, turning it on. At the end of the selected 100 to 500 millisecond delay the one-shot multivibrator turns off, which in turn, turns off the inhibit multivibrator removing the inhibit signal to the digital voltmeter, thereby allowing the digital voltmeter to read. The digital voltmeter reads, the printer prints, and a print-complete pulse from the printer turns on the inhibit multivibrator and again inhibits the digital voltmeter, preventing any additional reading until the scanner steps to another channel. Stepping to a new channel sends a new pulse to the one-shot, starting another such cycle.

POWER SUPPLY

The scanner is powered by a -22 volts at 1 amp from a full-wave bridge type rectifier, illustrated in figure 7. The voltage is

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FIGURE 7. - -22 Volt Power Supply.

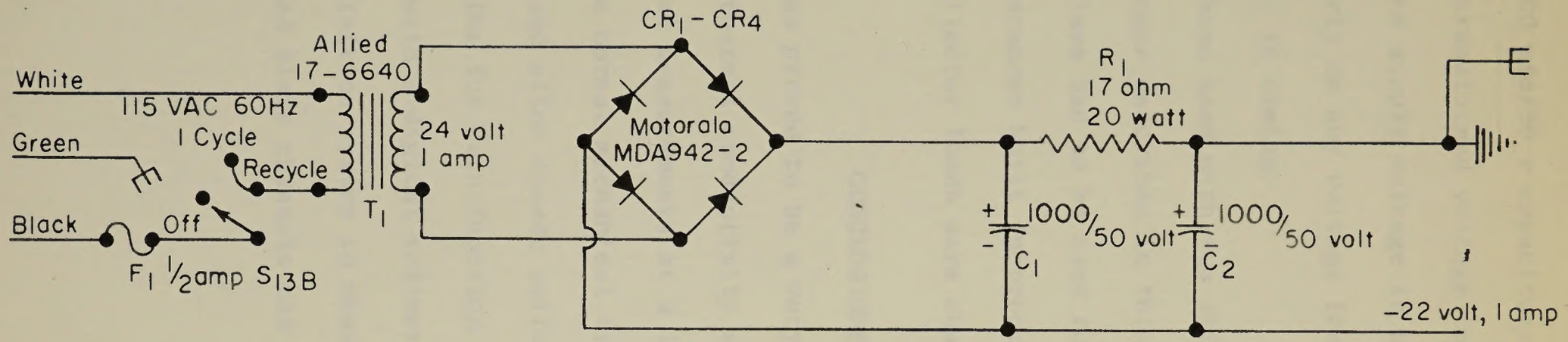
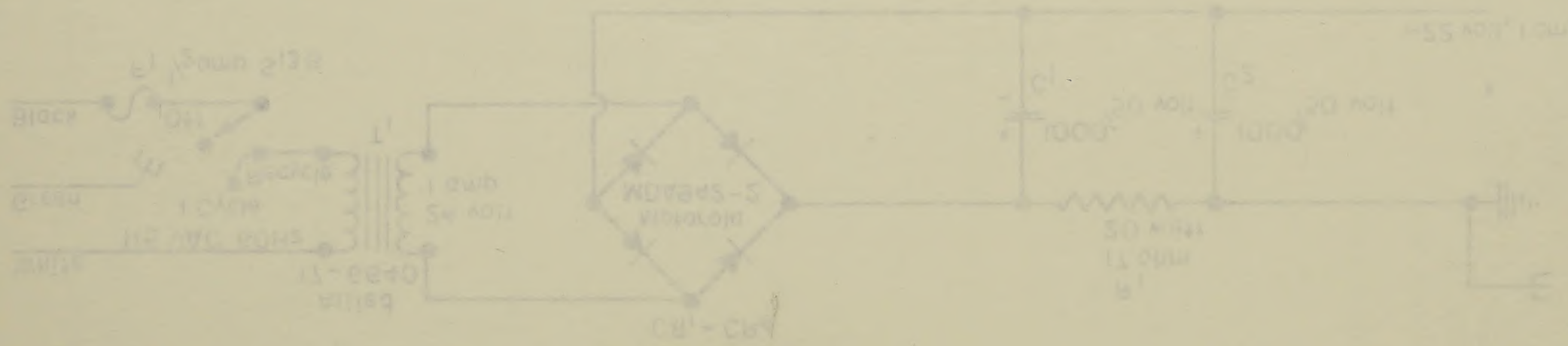


FIGURE 7.--22 Volt Power Supply.



filtered by two 1000 mfd/50 v capacitors. The 17-ohm, 20-watt resistor drops the 24-volt transformed voltage to approximately -20 to -22 volts for V_{cc} supply. The supply voltage is not critical, and the scanner will operate properly on any voltage from -14 volts to -30 volts with only a slight error in timing.

The unit has been used with two different digital voltmeters and printers. The scanner described in this paper was built using surplus relays, and two relays had to be used to provide 4-pole, 2-throw action. The second scanner built incorporated single 4-pole, 2-throw relays, and the collector loads were changed to 680 ohms.

CONCLUSIONS

The scanner has proved to be a very reliable instrument in the automation of the thermal conductivity apparatus, and will provide reliable multisignal measurements at a low cost. The scanner can be used to replace the normal mechanical timer and cam system used in a gas chromatograph and allow decade switch selection of the exact timing sequence and the time for each function in the sequence or is readily adaptable for use with a digital voltmeter and printer to make up a complete data acquisition system to measure 10 different signals sequentially. Added slave channels can easily be added if desired.