The shooting-star radar system: IV amplifier and gate circuits for the photoelectric meteor detector

Bourne, B.E.

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THE SHOOTING-STAR RADAR SYSTEM

IV. AMPLIFIER AND GATE CIRCUITS FOR THE PHOTOELECTRIC METEOR DETECTOR

B. E. BOURNE

OTTAWA

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AMPLIFIER AND GATE CIRCUITS FOR THE PHOTOELECTRIC METEOR DETECTOR

by

B.E. Bourne

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ABSTRACT

The correlation with the radar record of the information obtained from a battery of multiplier phototubes is achieved by photographing continuously two cathode-ray-tube displays, each having the same range sweep, "seconds" markers, and range calibrations. The radar display tube is intensity-modulated by the output of the radar receiver, and the photoelectric display tube by the output of the phototubes. This report describes the technique of gating the light signals to assign the output of each phototube to a selected portion of the range sweep.

AMPLIFIER AND GATE CIRCUITS FOR THE PHOTOELECTRIC METEOR DETECTOR

INTRODUCTION

The photoelectric meteor detector in its present form consists of a battery of multiplier phototubes, each of which covers a small area of the sky. A more complete account of this part of the system will be included in a later paper on the purpose and results of the experiment. This report is confined to a description of the circuits used to gate the information obtained from the phototubes and to present it in such a manner that it can be compared with the data on the radar record.

The radar sweep, approximately 260 kilometers long, is applied to two identical cathode-ray tubes located side by side, whose displays are photographed on continuously moving film. The "seconds" pulses appear on each display to assist in the precise timing of the phenomena obtained on the two records. Twenty-kilometer range markers are impressed on the sweeps as well, which serve the conventional purpose on the radar display, but on the photoelectric display they are used as channel markers to identify the outputs of the phototubes. In practice, the first 40 kilometers of the sweep on the phototube display is reserved for the "seconds" pulses, then the output from Phototube (a) appears as intensity-modulation of the sweep in the interval 40-50 km, that of Phototube (b) in the interval 50-60 km, and so on.

CIRCUIT DESCRIPTION

Figure 1 is a schematic diagram of the first two channels of the system. (In the diagram lower case letters (a) refer to the channel designation, whereas upper case letters (A) are used only to identify a particular half of a dual diode or triode.) The trigger pulse that initiates the range sweep is also applied to the Kipp circuit, $V_1 - V_2$, which delays all the gates for 40 kilometers to accommodate the "seconds" pulses. The positive square wave from V_2 is differentiated and used to trigger the Kipp circuit $V_3(a)$. The positive square wave output of $V_3(a)$, adjusted to a width of 10 kilometers, is applied to the suppressor grid of the biased-off gate tube, $V_5(a)$, the diode $V_4(a)$ being used to clip the gate pulse at ground potential.

The signal output from Phototube (a) is amplified by $V_9(a)$, limited by the diode $V_8(a)$, and applied to the control grid of $V_5(a)$. From $V_5(a)$ the gated signal proceeds through the isolating diode, $V_6A(a)$, to the amplifier V_{10} and cathode follower V_{11} for application to the intensity-grid of the cathode-ray tube.

The gate pulse for Channel (b) is produced by using the back edge of the 10-km square wave produced by V_3(a) to trigger an identical Kipp circuit V_3(b) which is also adjusted to have a 10-km positive square-wave output. Channel (c) is tripped in turn, and so on until all 20 channels have been selected. The gate pulses and the corresponding phototube outputs are combined for each channel as described above for Channel (a), and the sum total of the gated outputs is applied to the cathode-ray tube through the common channel V_{10} - V_{11}. Thus, the output from any given channel will appear only in the interval on the range trace selected for it by the gating system. In actual fact the light signal from a given phototube is sampled for only 67 microseconds (10 km) every 1/120 of a second (sweep recurrence frequency = 120 cps) but the successive sweeps overlap on the film so that the light intensity record appears continuous. Variations in light intensity occurring in less than 1/100 second could not be resolved, but the technique is quite adequate for timing comparisons of the order of 1/20 second.

The gating and amplifier circuits are housed in a cabinet set out in the field away from buildings or obstructions. The battery of phototubes is mounted on top of the cabinet and each phototube is connected to its appropriate channel by a short coaxial cable. Apart from provision of 110-volt 60-cycle power, the only connections between the phototube observing site and the displays are two coaxial cables, one to supply the synchronizing pulse to the gating circuits and the other to transmit the combined signals to the remote display.

CONTROLS

The operator should note that each channel has two controls: P_2, which adjusts the 10-km width of the channel, and P_3, which determines the level of the individual gating pulse. P_1 is the control that delays all the gates for 40 kilometers. The capacities to ground in the coupling circuits between V_3(a), V_4A(a) and V_5(a) cause the square-wave output from V_3(a) to slope when it reaches the grid of V_5(a). Adjustment of the bias on the suppressor of V_5(a) by means of P_4 will thus delay the opening of the gate very slightly so that the gates will have a small "dead space" between them which is useful in practice to identify the gates.

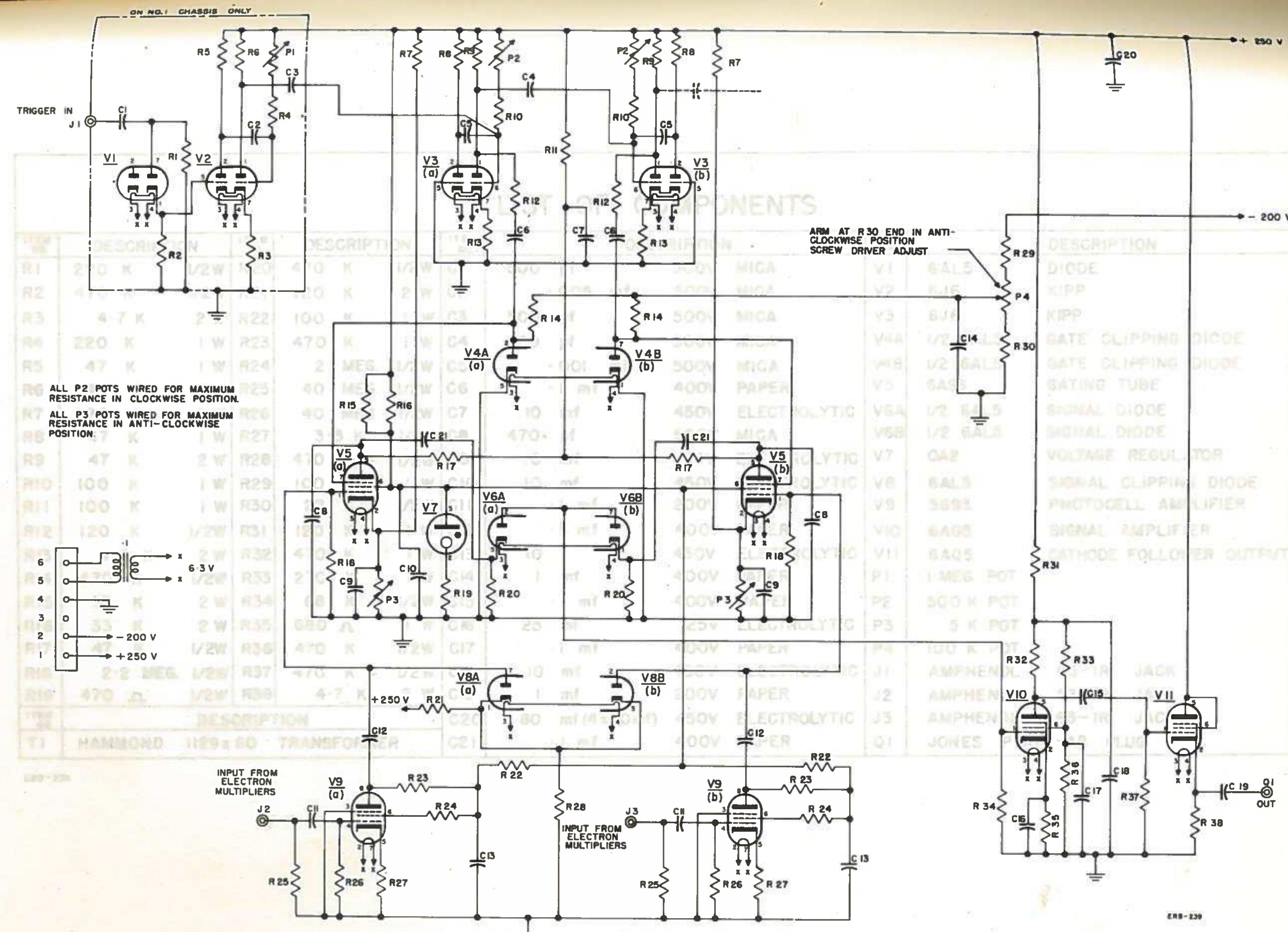
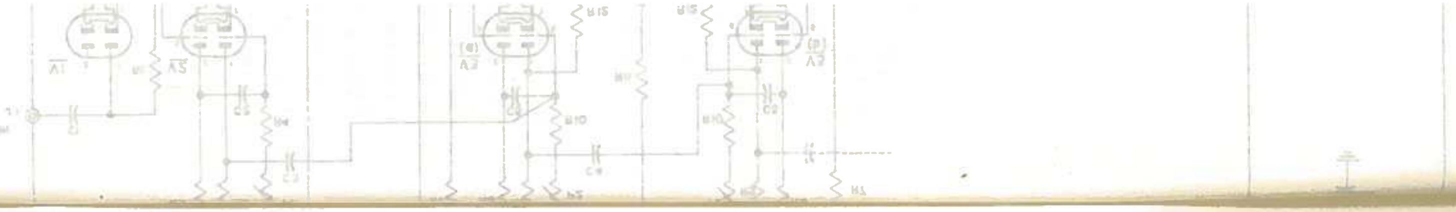


FIG I

PHOTOELECTRIC METEOR DETECTOR

GATE AND AMPLIFIER CIRCUITS



LIST OF COMPONENTS

ITEM NO.	DESCRIPTION			ITEM NO.	DESCRIPTION			ITEM NO.	DESCRIPTION			ITEM NO.	DESCRIPTION	
R1	220 K		1/2W	R20	470 K		1/2W	C1	500 pf	500V	MICA	V1	6AL5	DIODE
R2	470 K		1/2W	R21	120 K		2 W	C2	·005 mf	500V	MICA	V2	6J6	KIPP
R3	4·7 K		2 W	R22	100 K		1 W	C3	500 pf	500V	MICA	V3	6J6	KIPP
R4	220 K		1 W	R23	470 K		1 W	C4	500 pf	500V	MICA	V4A	1/2 6AL5	GATE CLIPPING DIODE
R5	47 K		1 W	R24	2 MEG.		1/2W	C5	·001 mf	500V	MICA	V4B	1/2 6AL5	GATE CLIPPING DIODE
R6	47 K		2 W	R25	40 MEG.		1/2W	C6	·1 mf	400V	PAPER	V5	6AS6	GATING TUBE
R7	120 K		2 W	R26	40 MEG.		1/2W	C7	10 mf	450V	ELECTROLYTIC	V6A	1/2 6AL5	SIGNAL DIODE
R8	47 K		1 W	R27	3·3 K		1/2W	C8	470 pf	500V	MICA	V6B	1/2 6AL5	SIGNAL DIODE
R9	47 K		2 W	R28	470 Ω		1/2W	C9	10 mf	25V	ELECTROLYTIC	V7	0A2	VOLTAGE REGULATOR
R10	100 K		1 W	R29	100 K		1 W	C10	10 mf	450V	ELECTROLYTIC	V8	6AL5	SIGNAL CLIPPING DIODE
R11	100 K		1 W	R30	22 K		1/2W	C11	·1 mf	200V	PAPER	V9	5693	PHOTOCELL AMPLIFIER
R12	120 K		1/2W	R31	120 K		1 W	C12	·5 mf	400V	PAPER	V10	6AG5	SIGNAL AMPLIFIER
R13	4·7 K		2 W	R32	470 K		1 W	C13	10	450V	ELECTROLYTIC	V11	6AQ5	CATHODE FOLLOWER OUTPUT
R14	470 K		1/2W	R33	270 K		1 W	C14	1 mf	400V	PAPER	P1	1 MEG. POT.	
R15	33 K		2 W	R34	68 K		1/2W	C15	·1 mf	400V	PAPER	P2	500 K POT.	
R16	33 K		2 W	R35	680 Ω		1 W	C16	25 mf	25V	ELECTROLYTIC	P3	5 K POT.	
R17	47 K		1/2W	R36	470 K		1/2W	C17	·1 mf	400V	PAPER	P4	100 K POT.	
R18	2·2 MEG.		1/2W	R37	470 K		1/2W	C18	10 mf	450V	ELECTROLYTIC	J1	AMPHENOL	83-1R JACK
R19	470 Ω		1/2W	R38	4·7 K		2 W	C19	1 mf	200V	PAPER	J2	AMPHENOL	83-1R JACK
ITEM NO.	DESCRIPTION							C20	80 mf (4x20mf)	450V	ELECTROLYTIC	J3	AMPHENOL	83-1R JACK
T1	HAMMOND	1129x60	TRANSFORMER					C21	·1 mf	400V	PAPER	Q1	JONES P 306-AB	PLUG

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FIG. 2