A RADAR WAVEFORM TEST EQUIPMENT

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SUMMARY

An equipment for generating some of the important waveforms commonly used in radar systems is described here. The equipment can be used for testing as well as for demonstrating the operation of many of the important circuits and also for studying the pulse and square wave response of simple networks. Oscillograms obtained with some of the typical radar circuits are given here.

INTRODUCTION

Square and pulse waveforms are the basis for the generation of all the other waveforms employed in typical radar systems. A test unit must therefore generate these two waveforms as well as a synchronised linear time base for display on an oscillograph. It is desirable to be able to adjust the phase of the time base waveform in order to move the signal waveform to any part of the scan. Details of such a time base arrangement may be found in a paper[1] dealing with the transient testing of networks. In the equipment described here, the time base arrangement is different. Instead of the phase of the time base being varied, its duration is increased so that the signal waveform appears near the centre of the oscillogram. Also by prolonging the duration of the time base, more than one signal wave can be made to appear on the oscillogram.

DESCRIPTION OF EQUIPMENT

A block schematic of the test equipment is shown in Fig. 1. An r.c. oscillator operating at 1000 c/s provides the sinusoidal wave from which all the other waveforms are derived. The sine wave is converted into a square wave with steep edges in the clipping and the pulse sharpening stages. The square wave is then differentiated by an r-c circuit, and the output applied to the grid of a pentode amplifier which is biased to cut-off. Only the positive portion of the signal on the grid will be able to produce any change in the plate current of the amplifier. The output of this stage will therefore consist of sharp negative going pulses at the frequency of the r-c oscillator. These

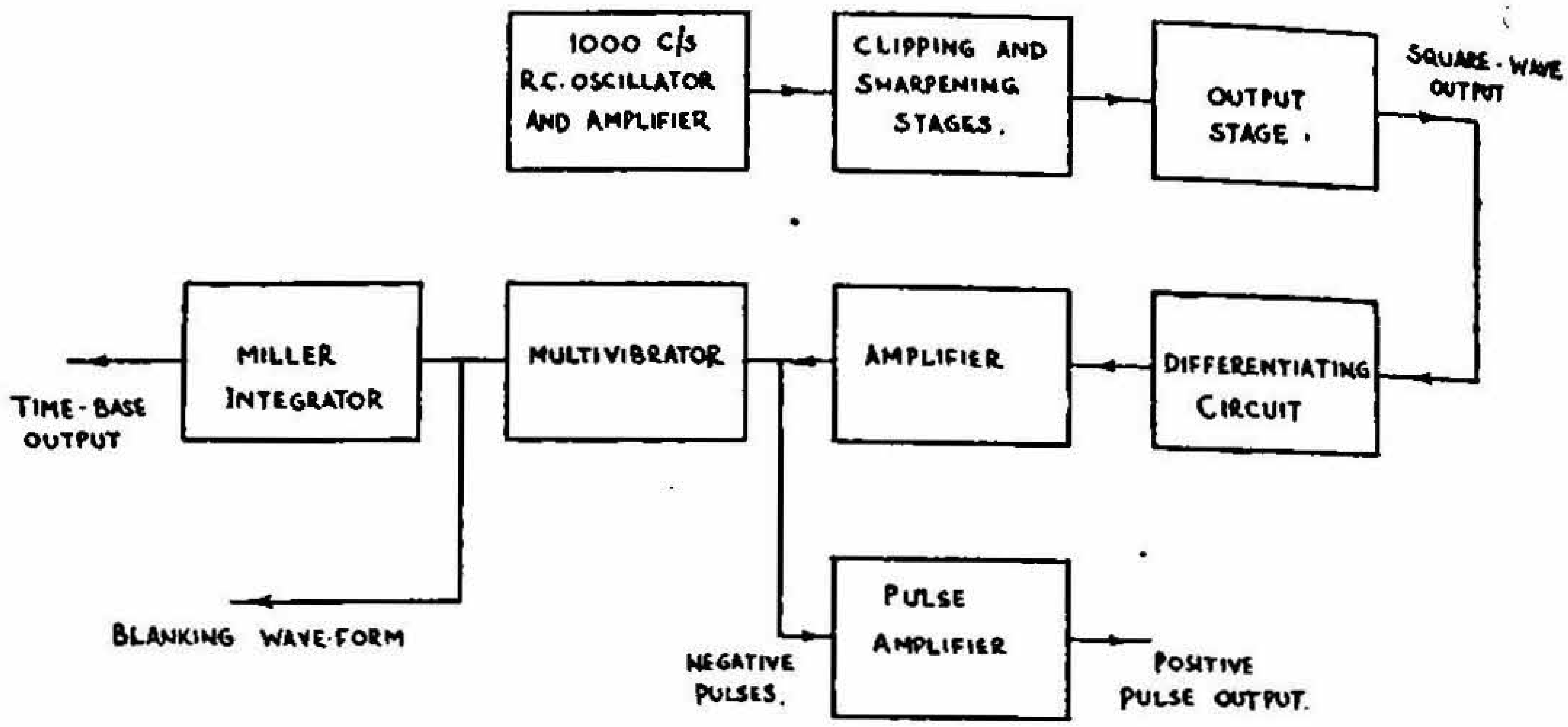


FIG. 1

negative pulses or "pips" are used to trigger a multivibrator stage consisting of two triode sections. The pips are amplified in the first section and the output is capacitively coupled to the grid of the second section. The potential to which the grid of this section is returned determines which pip will trigger the multivibrator and hence the duration of the cut-off period of the section. The time constant of the grid r-c circuit of the first section will determine the duration of the conducting period of the second section. By properly adjusting these two factors, the duration of the positive and negative parts of the rectangular waves at the anode of the second triode section may be made to correspond to two, three or four times the original square wave. Fig. 2 (*a*) shows the square wave and the multivibrator waveforms. It is seen that the number of square waves corresponding to the positive and negative portions of the multivibrator waveform are three and two respectively.

The output of the multivibrator is then applied through a condenser to the suppressor grid of a pentode which is connected as a Miller Integrator.[2] In order to ensure that the positive part of the applied waveform will always correspond to the zero potential and the negative part to a value beyond the cut-off, a diode is connected between the suppressor grid and the ground. The instant at which the suppressor voltage rises from the cut-off to zero will mark the beginning of the linear fall in the anode voltage of the Miller Integrator. Fig. 2 (*b*) shows this waveform along with the multivibrator waveform. The time base waveform along with the original square waveform may be seen in Fig. 2 (*c*). The square waveform seen with the Miller Integrator output used as time base is shown in Fig. 2 (*d*).

APPLICATIONS

Some of the applications of this test equipment will now be dealt with. Considering first the delay line which is used to such a great extent in radar circuits, the response to a step wave can be studied by applying a square wave of duration very much longer than the delay time of the line. The delay line is connected as the cathode load of a power pentode and the square wave applied to the control grid. The results obtained are shown in Figs. 2 (*e*), 2 (*f*) and 2 (*g*). The effect of short circuiting the farther end of the delay line with the near end terminated by the tube impedance is shown in Fig. 2 (*e*). The effect of terminating the near end with the characteristic impedance and keeping the farther end short circuited is shown in Fig. 2 (*g*). Fig. 2 (*f*) shows the effect of open circuiting the farther end with the near end properly terminated.

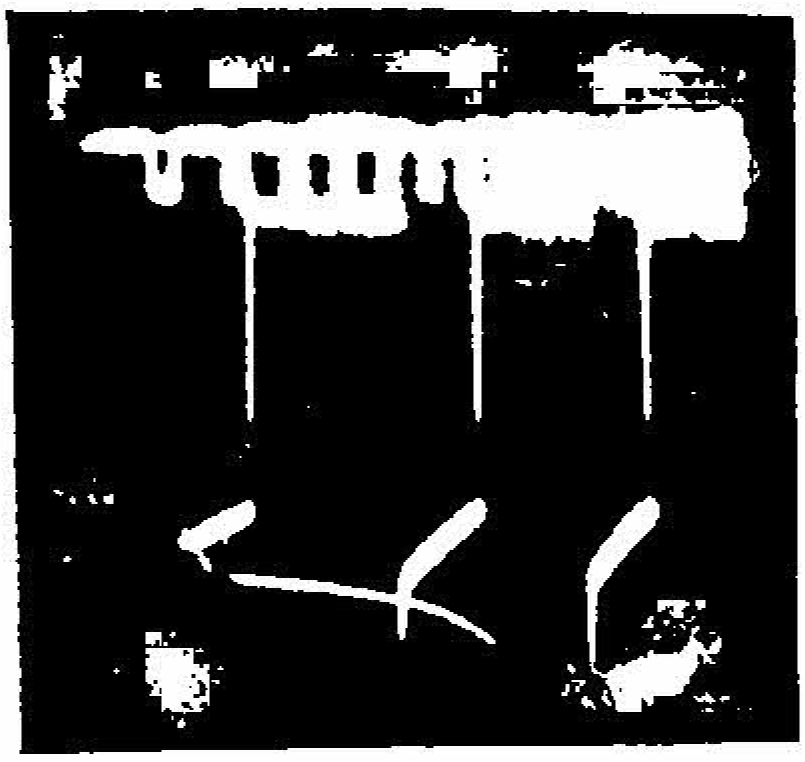
Next, the ringing circuit which is generally used for producing range markers will be considered. Here a parallel resonant circuit having a suitable time constant is connected as the cathode load of a pentode. When a square wave is applied to the control grid of this tube, the current in the tube is cut-off at the trailing edge of the square wave and this will start the damped oscillations shown in Fig. 2 (*h*). The effect of increasing the damping of the resonant circuit may be seen in Fig. 2 (*i*). By increasing the damping sufficiently it will be possible to produce sharp negative pulses as can be seen from Fig. 2 (*i*).

The generation of strobe pulse will next be considered. Here, the square wave is applied to the control grid of a pentode which has a load consisting of a resistance in parallel with a capacitance. The resulting waveform at the anode may be seen in Fig. 2 (*j*). This waveform is seen to consist of an exponential rise followed by an exponential fall. For generating strobe pulse, this waveform is applied to the control grid of a sharp cut-off pentode which is connected as an amplifier having a cathode bias adjustable over a wide range. With a given setting of the cathode potential, the tube remains cut-off until its grid voltage which is rising exponentially with time reaches a value nearly equal to its cathode potential. When this occurs, the tube anode current rises sharply to its limiting value and the anode voltage falls and remains down until the grid voltage again falls below the cut-off value. Thus a rectangular negative pulse, the leading edge of which can be moved by the cathode bias setting, is obtained. This negative pulse is differentiated and the resulting negative and positive pulses are applied to an amplifier where the negative input will produce a sharp positive pulse. This is the strobe pulse and it is shown in Fig. 2 (*k*). The above circuit can be modified to produce position modulated pulses by applying the modulating voltage along with a positive bias voltage to the cathode of the second pentode referred to above.

Another application which may be considered is in the study of the operation of a regenerative pulse driver circuit. The output waveform obtained with such a driver circuit is shown on a reduced voltage scale in Fig. 2 (*l*). There are a number of other interesting circuits the performance of which can be studied with this equipment. However, only a few typical examples are taken up here.

REFERENCES

1. Espley, D. C., Cherry, E. C. and Levy, M. M. .. "The Pulse-Testing of Wideband Networks," *Jour. I. E. E.*, 1946, 93, Part III-A, No. 7, 1176.
2. Williams, F. C. .. "Introduction to Radar Circuit Technique," *Jour. I. E. E.*, 1946, 93, Part III-A, 289.



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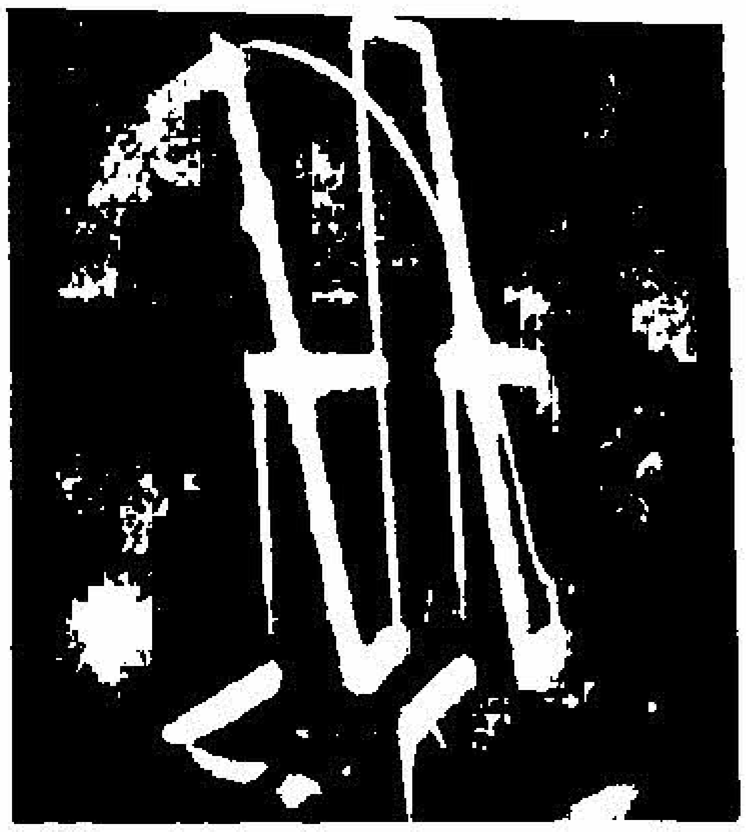

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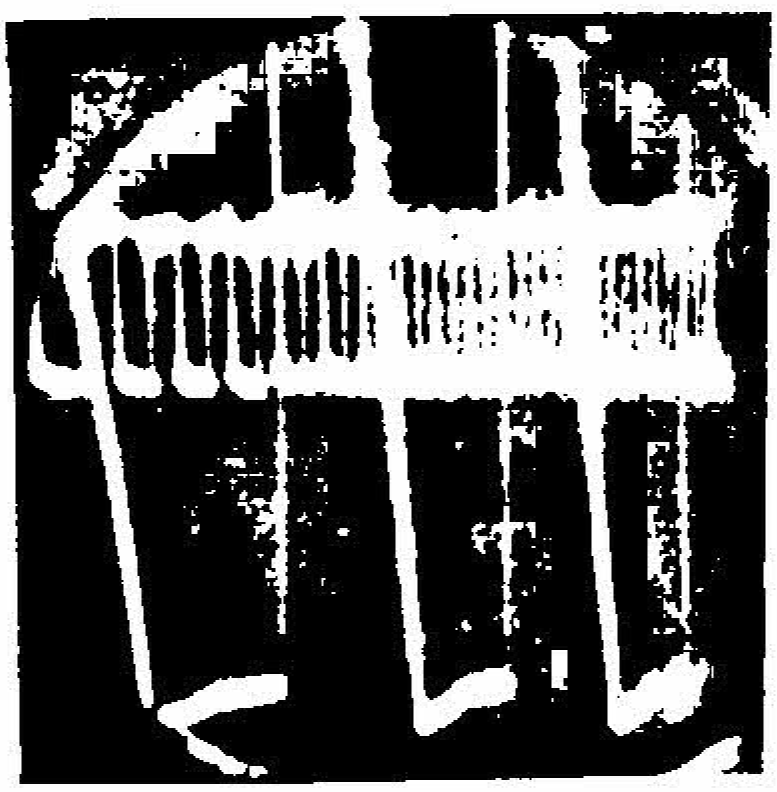

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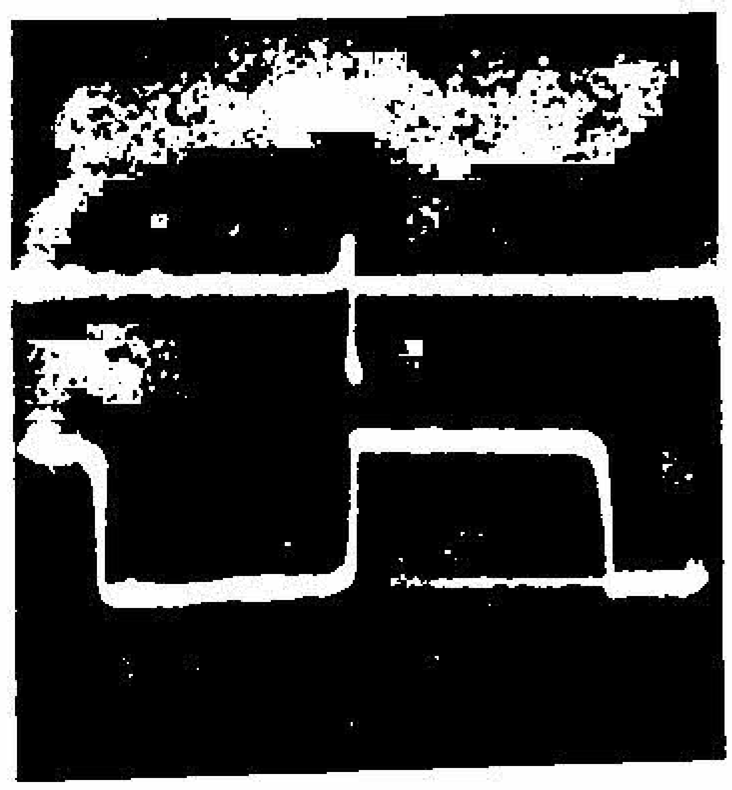

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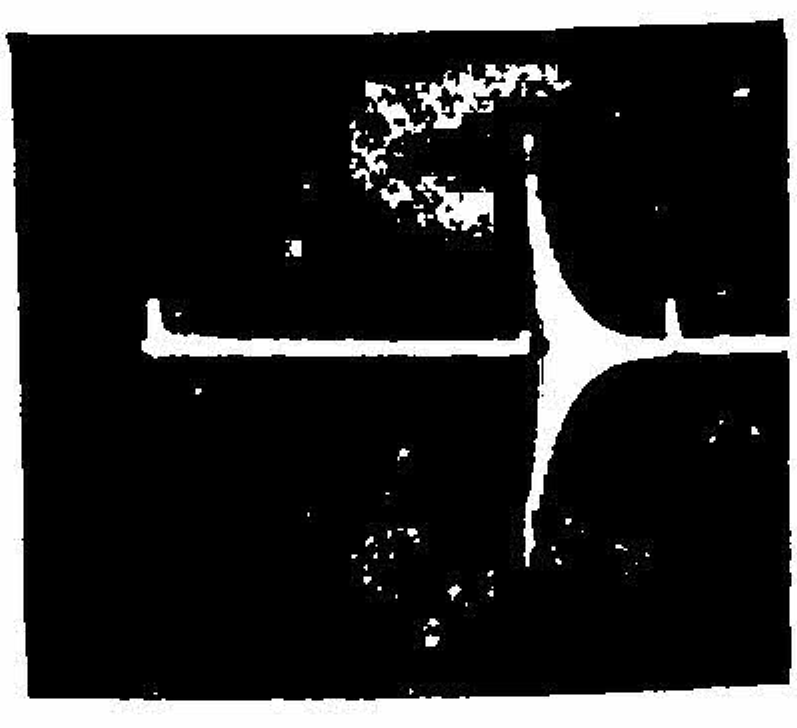

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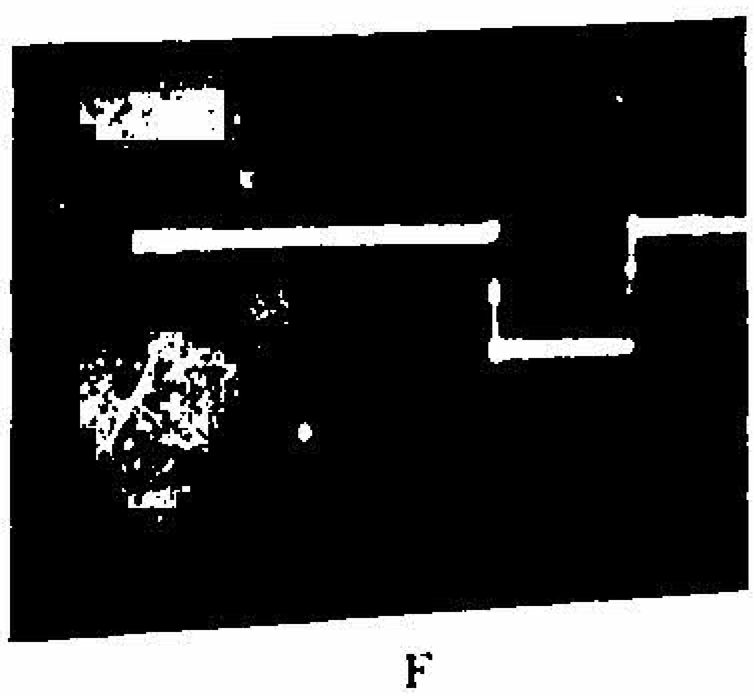

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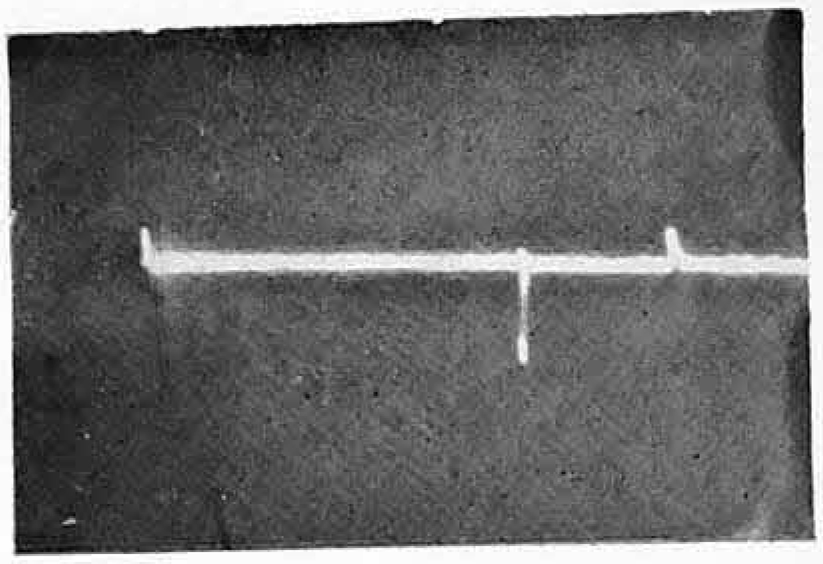

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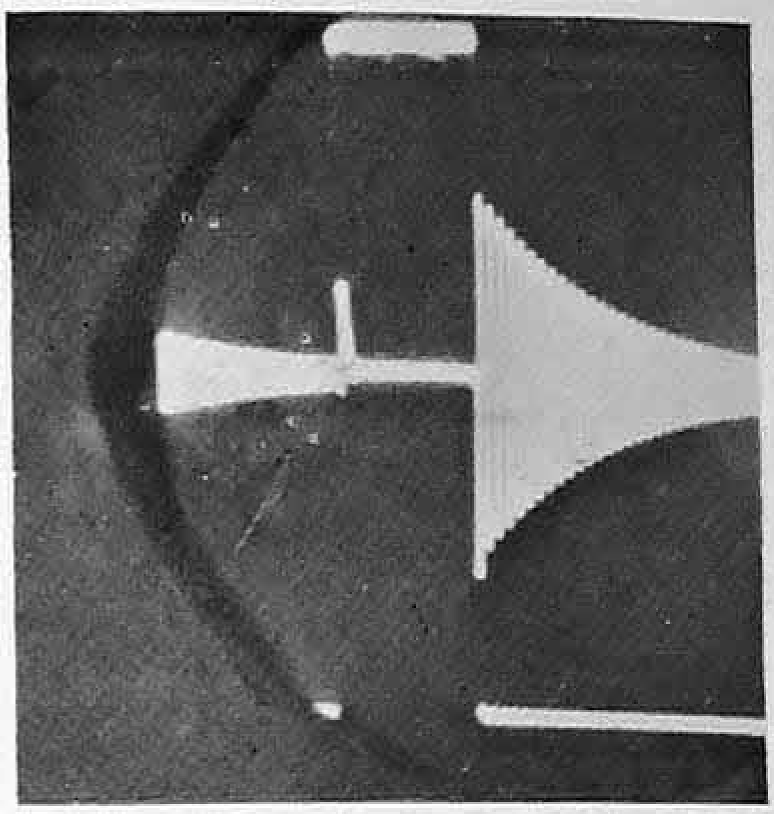

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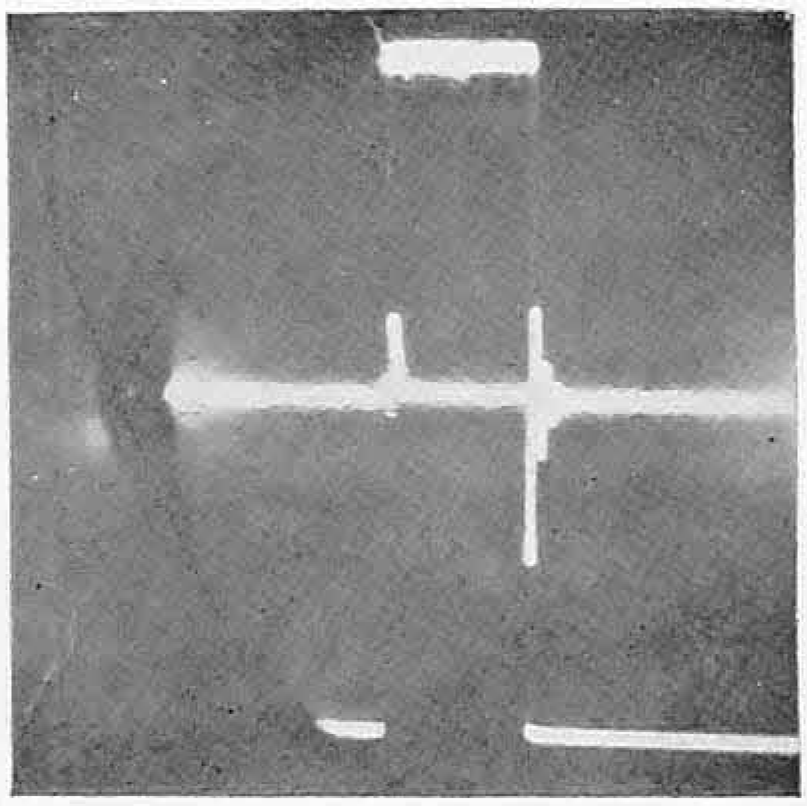

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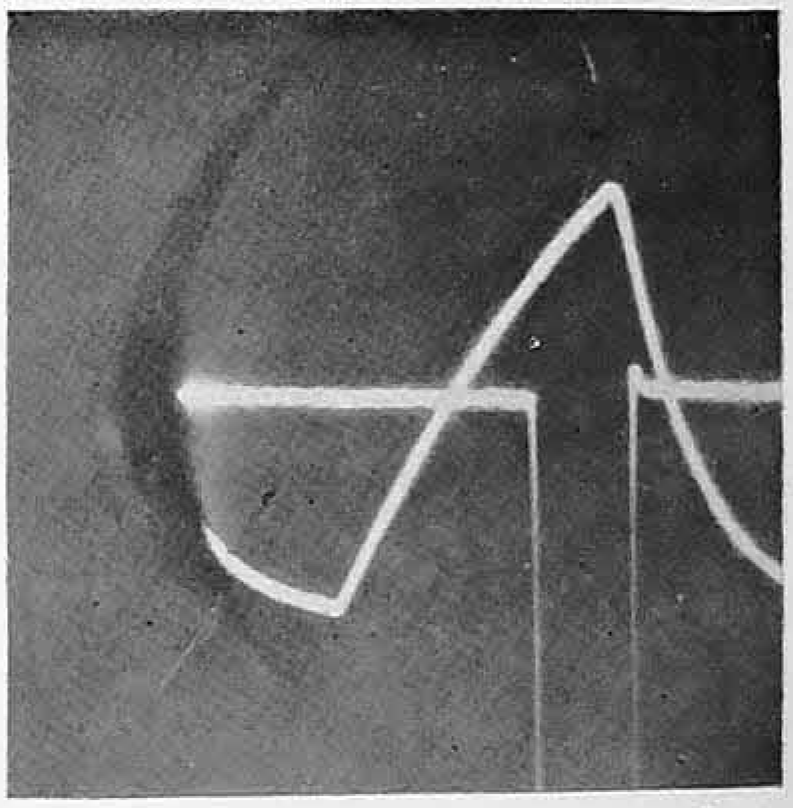

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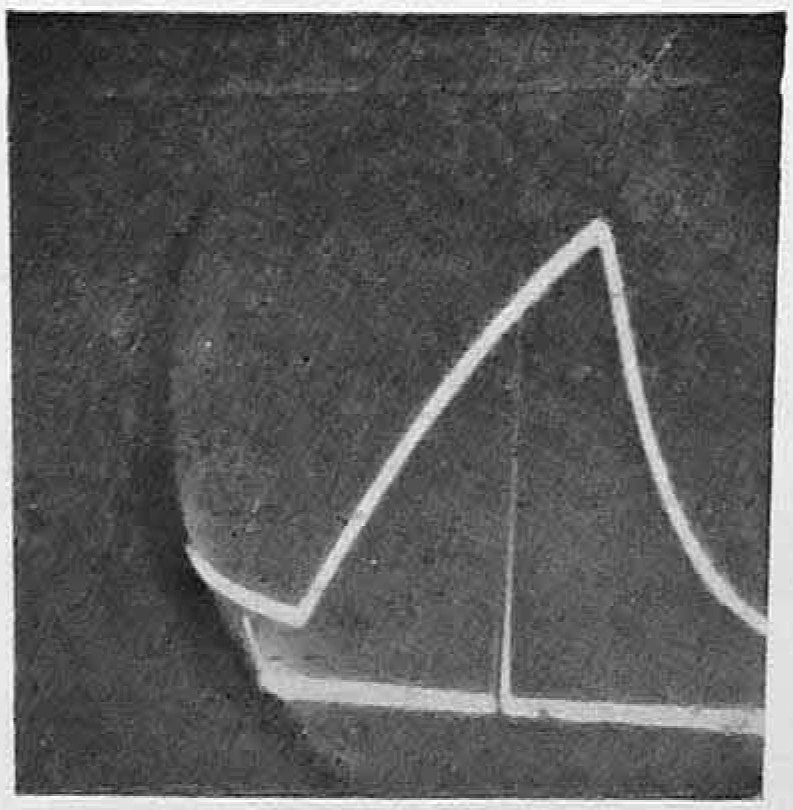

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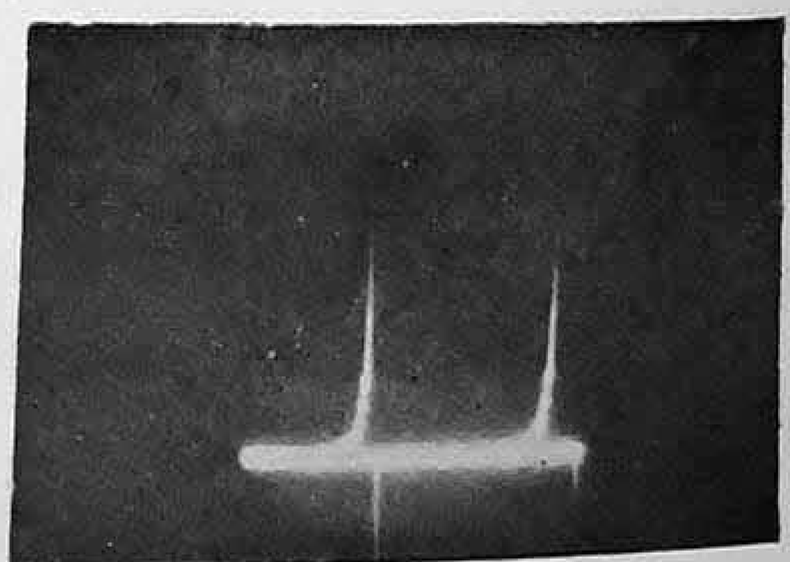

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