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BI-IMAGE TRANSIT TIME RECORDING SYSTEM

R. F. Roberts

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ABSTRACT

By displaying only the beginning and end of the transit time pulse on an expanded sweep, the time resolution of the raster recording system can be extended.

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BI-IMAGE TRANSIT TIME RECORDING SYSTEM

I. INTRODUCTION

In general, the degree of time resolution that can be achieved is dependent on the time interval over which the measurement is to be made. The raster system of recording inherently provides equal time resolution over the entire recording period. If the total recording time is substantially increased, the time resolution is decreased.

The information required in transit time measurements is the time interval between functions (in the order of 100 μsec). Intelligence appears as a pulse transmitted by a telemeter; the length of the pulse is the transit time. In measuring the pulse length, the beginning and end must be accurately determined in reference to the same time base. Therefore, the recording system need not provide as good a time resolution during the long time interval of the pulse as is required at the start and finish of the transit time pulse.

II. DESCRIPTION

BITTS is intended to be used in conjunction with the raster transit time recording station to provide time resolution measurements beyond the capability of the raster system. The basic idea is to expand the sweeps at the beginning and end of the received pulse in the case of the long pulse modulator telemeter. When the two pulse telemeter is used, each pulse is displayed on an expanded sweep. Instead of expanding two of the sweeps in the raster presentation, an auxiliary oscilloscope is used.

Block Diagram

The block diagram of the system is presented in Figure 1. Both the video and trigger signals from the receiver are generated by the same pulse from the transit time telemeter; the video pulse contains the information and the trigger - actually a differentiated video pulse - starts the recording system. The video signal is delayed sufficiently to allow the sweep to be triggered before the video appears on the vertical deflection plates of the oscilloscope.

The trigger pulse fires the oscilloscope sweep, and the positive gate, which is generated at this time, is used as a trigger for the time delay generator and the auxiliary circuit (to be discussed later). The time delay generator produces a trigger to fire the sweep at a predetermined time after the start of the initial

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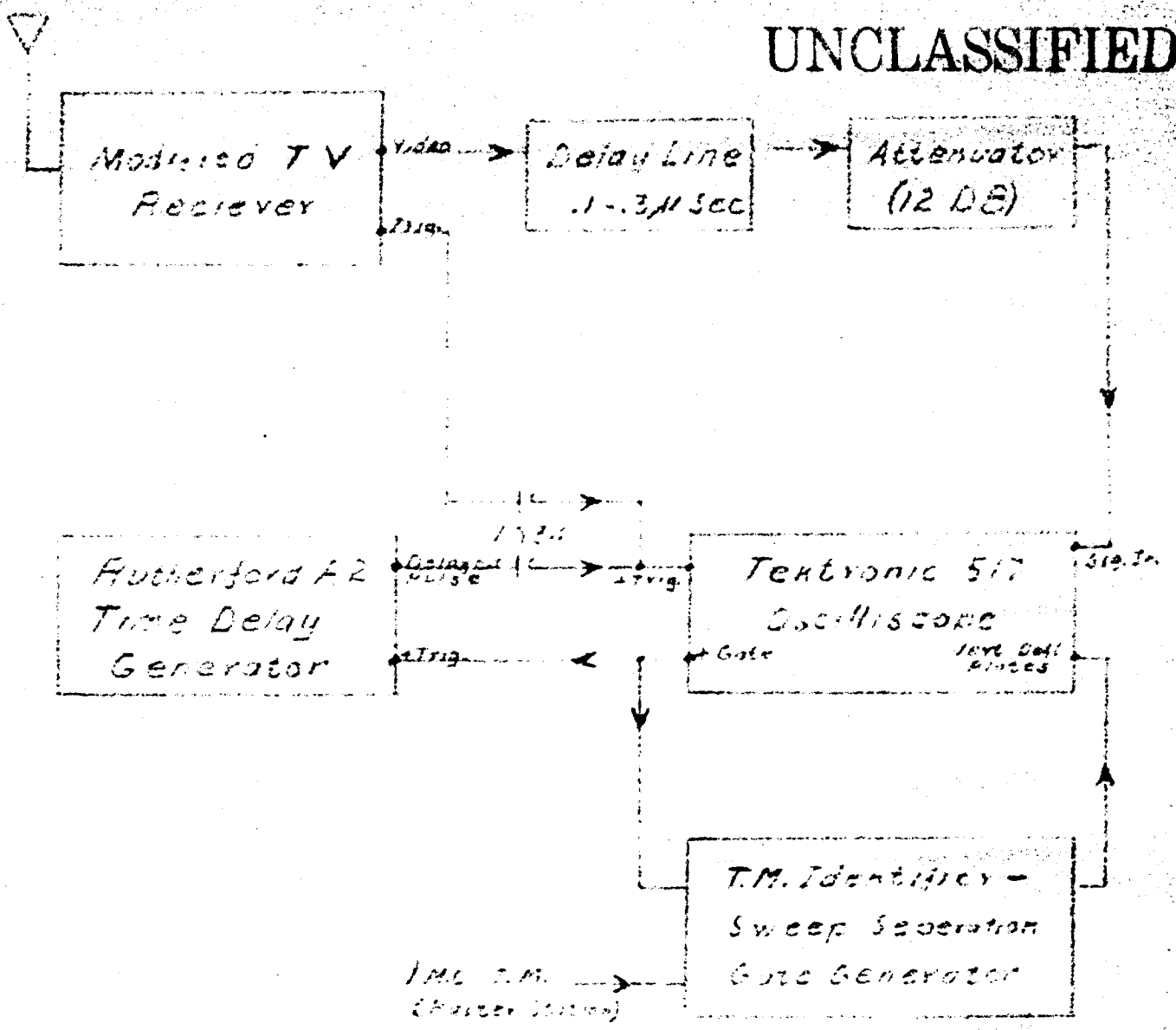

Fig. 1

BLOCK DIAGRAM FOR BITTS

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sweep. The crystal diodes in the trigger inputs are used to prevent interaction.

An accurate one megacycle time base is supplied by the raster station providing timing pips one microsecond apart. A simulated record as would be produced by the long pulse telemeter is shown in Figure II. Since the pulse decays slightly the two sweeps do not overlap, so the pulse and the time pips are well defined. In the case of the two pulse system, the sweeps would overlap making for more difficult record evaluation. Further, there are delays in triggering the sweeps, so it is conceivable that the total delay could be in error by a microsecond. A circuit was devised to separate the sweeps and identify time pips.

Time Pips Identifier and Sweep Separation Generator

The circuit diagram is given in Figure III and voltage waveforms in the circuit are given in Figure IV. The length of the input positive gate is equal to the sweep length. A positive and a negative pulse occurring at the start and end of the sweep, respectively, is achieved by differentiating the positive gate. V2 is a one-shot multivibrator triggered by the negative pulse. The 1N34 diode blocks the positive pulse and isolates the multivibrator from further triggers for the duration of the cycle (approximately 250 μsec).

The positive gate from V2 is passed through the high pass filter composed of the 0.01 μf condenser and the 20K resistor in the grid circuit of V3. The gate is amplified and inverted by V3 and is as shown in Figure IV. With this type of gate the sweeps will be horizontal, but sweeps initiated by false triggers will be displaced vertically from the normal traces, provided, of course, there is sufficient time separation.

V1 is a free-running, blocking oscillator synced by the timing pips from the raster station. The blocking oscillator generates a positive pip at the cathode and this pip is mixed with the incoming timing pips. The positive pips are fed back to the raster but produce no ill effects. The frequency of the blocking oscillator can be varied by adjustment of the capacitor in the grid circuit. Any pip from the first to the fifth may be accentuated.

III. FIELD OPERATION

The system was conceived, developed, and made operational shortly before and during the Upshot-Knothole test at Nevada in the Spring of this year. The performance of the system in the field was quite satisfactory - equable to the accepted raster station. Three records were obtained out of a possible five; the reasons for failure are understandable.

On the first test an attempt was made to obtain an immediate figure for transit time by using a polaroid land camera to photograph the scope traces.

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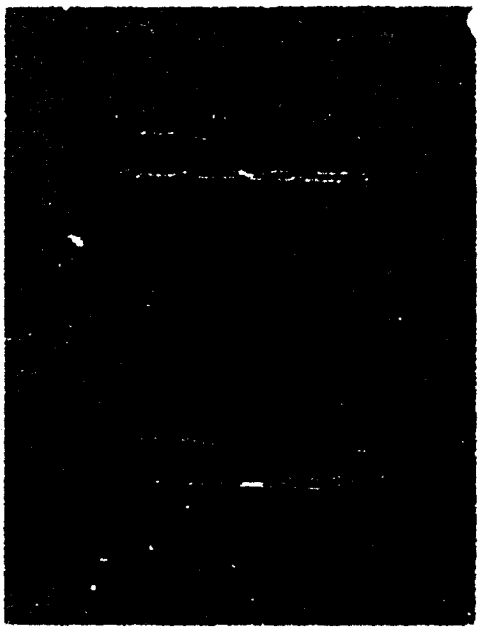

Fig. II

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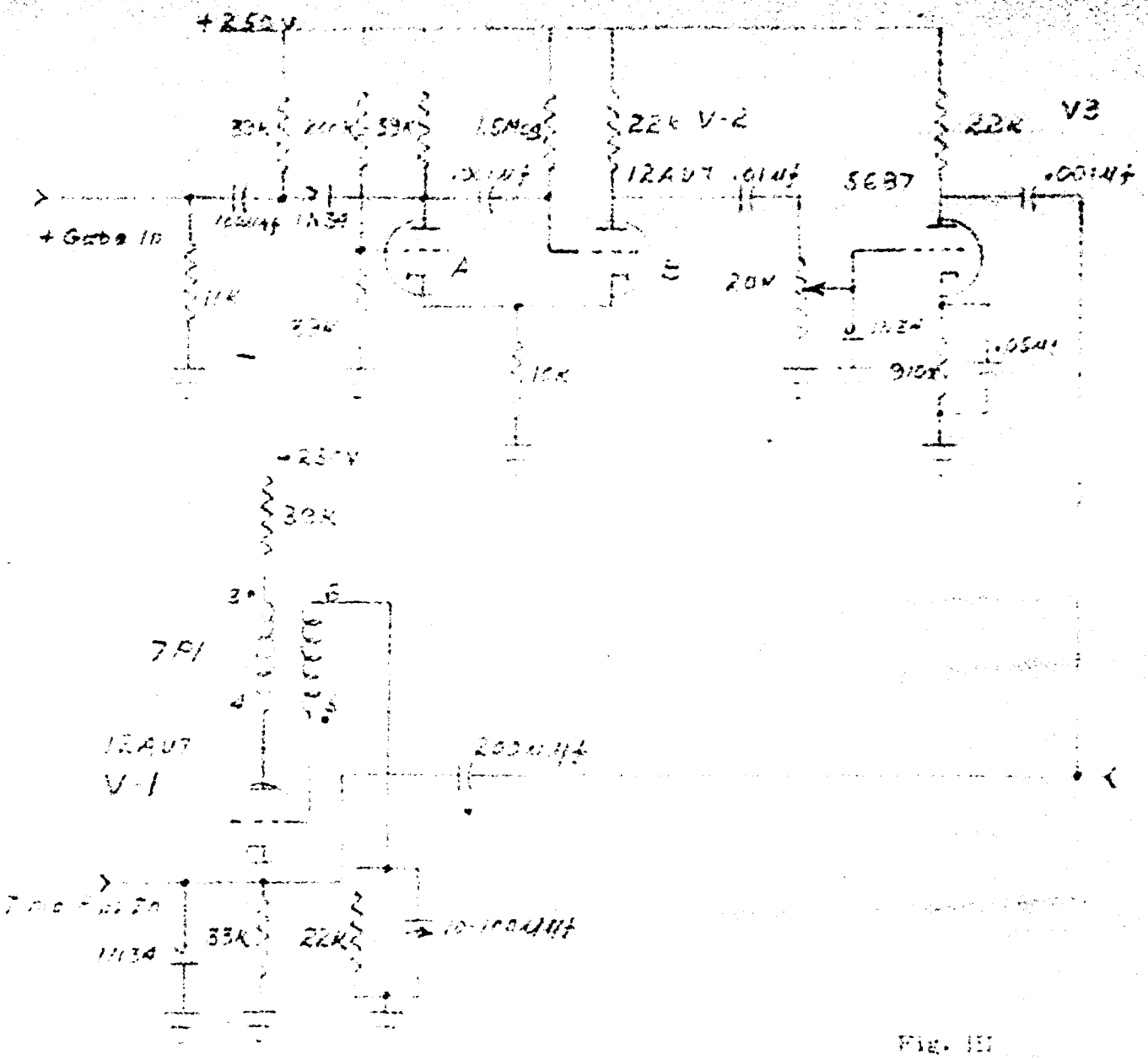

Fig. III

Sweep Generator
Gate Generator
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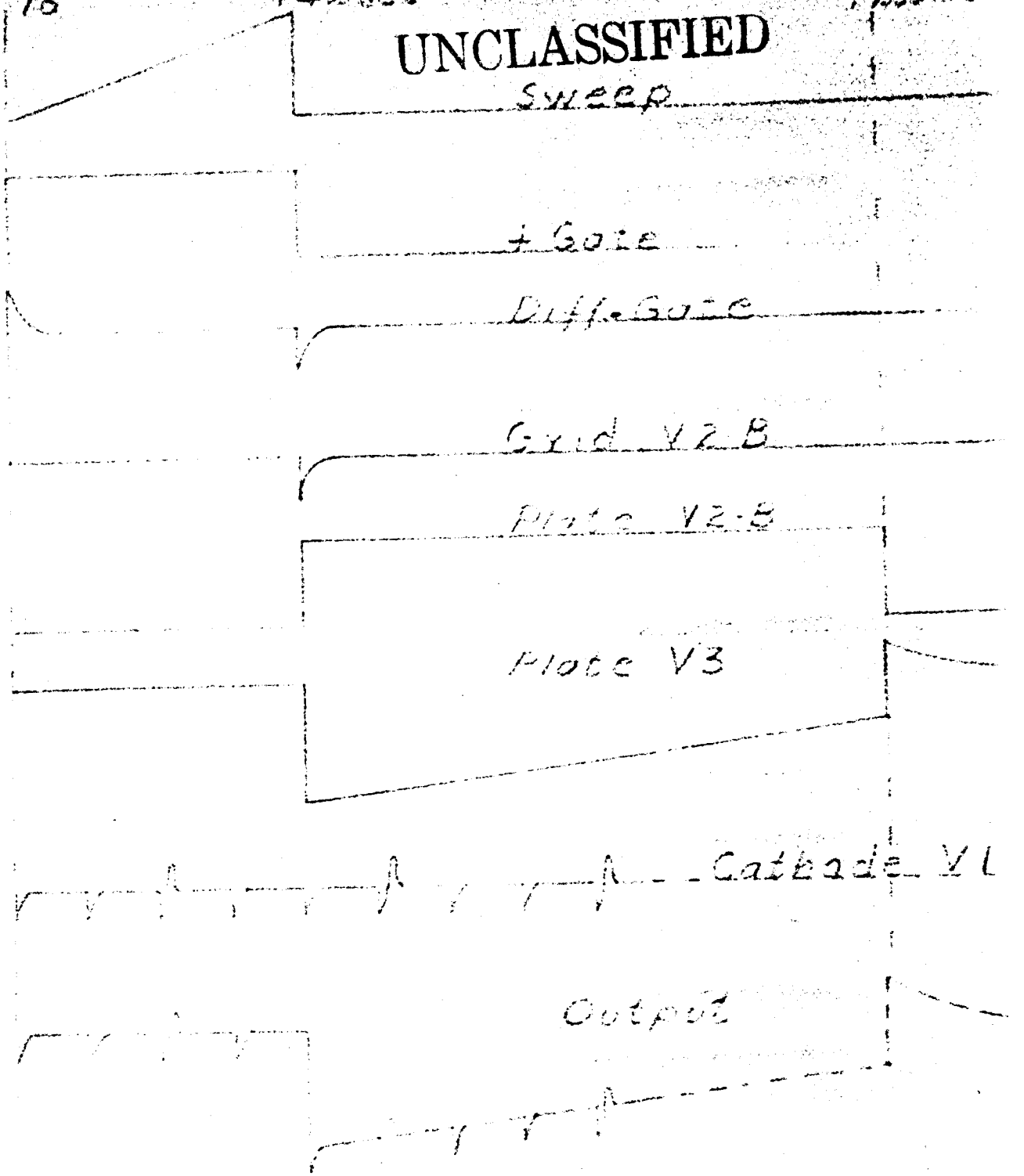

Waveforms

Fig. IV

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The camera shutter was opened manually at minus one second and closed after the shot. There were several noise triggers, presumably after the shot, which made the record non-readable. The other failure was an air drop; however, no transit time records were obtained on this test.

Two actual records are included. Figure V is a record of the long pulse telemeter and Figure VI is a record of the short pulse - 20 watt cutoff telemeter. The time pips are one microsecond, but the time between traces will not be stated for security reasons. Figure VI shows how every third time pip is accentuated.

IV CONCLUSIONS

One of the main attributes of the system is the use of commercially available equipment, namely the Rutherford time delay generator and the Tektronix type 517 oscilloscope. The receiver is a modified TV receiver and rather easily obtained.

The ultimate time resolution of the system - ignoring frequency response of receiver and amplifiers - is limited by the accuracy of predicting transit time. The fastest sweep available is one shake (0.01 μsec) per centimeter with a usable length of 8 cm. In order to utilize this sweep the transit time would have to be predicted to a $\pm$ 4 shake accuracy. By using several recording oscilloscopes and delaying the start of the second sweeps by different amounts, thereby bracketing the predicted transit time, the same resolution could be obtained with a less accurate prediction of transit time. One master delay generator could be used with different length delay lines carrying the trigger to each oscilloscope. It would be necessary to either pre-calibrate the sweeps or provide a time base of higher frequency (approximately 10 mc.) than one megacycle.

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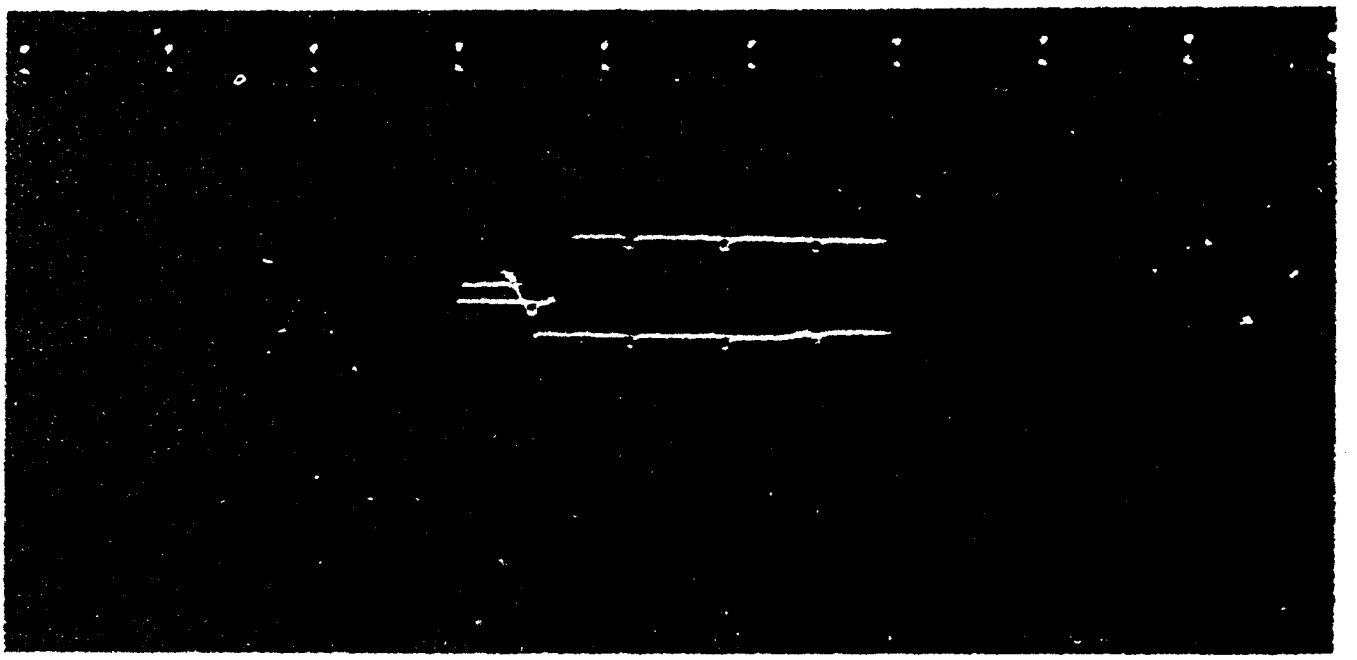

Fig. V

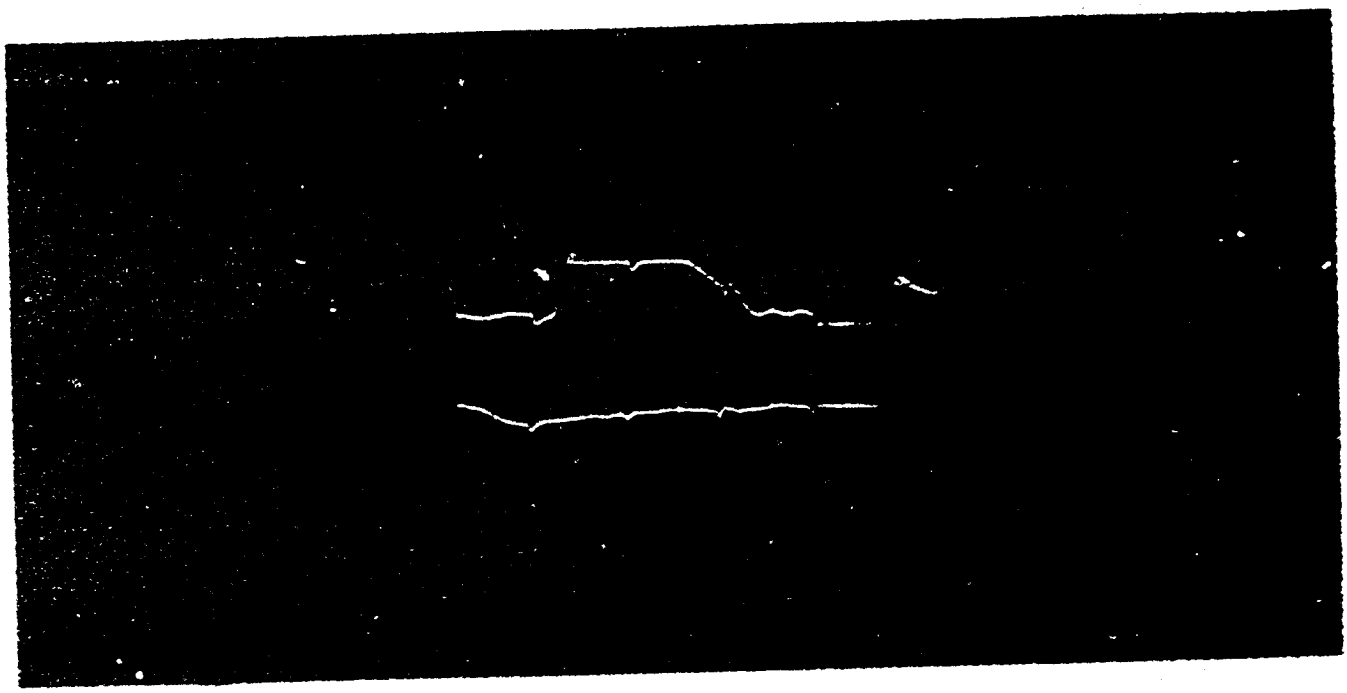

Fig. VI