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UPPER ATMOSPHERE RESEARCH REPORT NO. 2

PART 2 IONIZATION EXPERIMENTS IN THE V-2

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RADIO DIVISION I

ROCKET-SONDE RESEARCH SECTION

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UPPER ATMOSPHERE RESEARCH REPORT NO. II -PART II-

by

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Report R-3031

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ABSTRACT

This report continues the description of studies of the attenuation experienced by 10,000 mc. radiation in the V-2 exhaust. Particular emphasis falls upon the measurements made in connection with the October 10 firing, and the improvements incorporated into the installations for that flight are given in detail. The experimental data are discussed and the value of 14 db/meter is found to be in general agreement with the results obtained in the first cycle of V-2 firings.

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PART II

IONIZATION EXPERIMENTS IN THE V-2

by

M. Becker, R. E. Bourdeau,
and T. R. Burnight

1. Introduction. The studies of the attenuation of 10,000 megacycle radiation by the exhaust of a V-2 rocket during flight are continuing. The experimental installations employed in the first cycle of V-2 firings, and the results obtained, were given in detail in Upper Atmosphere Research Report No. I, Part II*. These findings were extended in some particulars by measurements made during the first of the flights which comprised the second cycle of V-2 firings. The equipment used differed in several respects from that employed in the first series of experiments. The important additions and changes incorporated into the October 10 flight are described in the following paragraphs.

2. Instrumentation. Experience obtained in previous flights showed that the primary difficulty was excessive sensitivity of the equipment, particularly the klystron, to changes in the level of the supply voltage. It was then the practice to operate the klystron in a single mode by applying a fixed d.c. bias, of the order of 300 volts, to the klystron repeller. An a.c. modulation of approximately 15 volts, peak to peak, amplitude was superposed upon this level. The bias was applied by means of dry batteries and potentiometers, but the arrangement could not be depended upon to supply exactly the same amount of bias at all times. It was not unusual for the bias voltage to change sufficiently, during the period of operation directly connected with a firing, to cause a drop of 40% in the power output of the klystron. A 15 volt (5%) change in repeller voltage would completely detune the oscillator. In the October 10 flight, the fixed bias was eliminated and an a.c. modulation of 200 volts, peak to peak, amplitude was applied to the repeller, causing the klystron to pass through three to five modes of oscillation per cycle. With this design a 15 volt decrease in the modulation voltage caused a drop of only 25% in output power. This arrangement was clearly less sensitive to repeller voltage fluctuations than was the previous one. A further increase in reliability was obtained by replacing the dry batteries with a 24 volt dynamotor.

*Naval Research Laboratory Confidential Report No. R-2956(1 October 1946).

The gain of the system was increased materially, making it possible to place an attenuator pad between the klystron and the wave guide system. This latter change was important, since it served to isolate the klystron and its monitor from the external system in general, and specifically from variations in effective output impedance caused by changes in the amount of radio energy reflected by the flame.

The electronic equipment, comprising the klystron, monitor, receiver, and voltage regulator tubes, was mounted on a single chassis. The circuit diagram is given in Fig. 1, and photographs of the chassis and the warhead mounting appear in Figs. 2 and 3. The dynamotor was shock mounted and located separately from the electronics.

A test unit was developed which greatly facilitated the maintenance of the equipment. It enabled one to check telemetering outputs, regulated voltages, and filament and dynamotor voltages.

3. Experimental Results. The telemetering record indicated that the equipment operated properly during the first twenty-five seconds of flight. The telemetered receiver voltage then decreased, over a period of 8 to 10 seconds, to the Edison effect value. It continued at this level for the remainder of the flight. The output of the klystron was monitored and had a constant value throughout the flight, indicating that the klystron operated properly and that the correct filament and plate voltage levels were maintained.

The data obtained during the first twenty-five seconds show that the signal experienced an attenuation of about 11 db, with a modulation of ±2 db, in the jet exhaust flame of the V-2. Fig. 4 is a reproduction of a portion of the telemetering record of the October 10 firing corresponding to the period immediately before takeoff. The attenuation caused by the igniter flame may be clearly seen. An attenuation of 13 ±2 db was measured in the July 30 firing. The data gathered in the two experiments are plotted in Fig. 5. Since the flame is approximately 80 cm. in diameter at the point of measurement, the attenuations may be expressed in decibels per meter by multiplying the values there given by 5/4.

4. Conclusions. As can be seen, the same sequence of events occured at both firings. The igniter flame caused a very severe attenuation, of magnitude greater than 30 db, as well as some bursts of modulation. The attenuation then diminished, approaching a constant level as the rocket started to rise from the ground. The values of attenuation measured on the two flights agree as to order of magnitude. Since, however, information concerning the temperature of the flame is not available in either case, they are actually not readily susceptible to direct comparison*.

*Op. cit., p. 4.

It was found, by comparing the records obtained from the two firings, that the insertion of the attenuator pad eliminated most of the fluctuations in the klystron output level. This implies that the jet exhaust flame reflects a portion of the energy incident upon it. The fact that the monitored output of the klystron remained almost perfectly constant also shows that this tube was not subject to microphonic effects when operated in the V-2. It was not possible to ascertain whether the receiver was also free from these effects.

5. <u>Future Research</u>. The present series of measurements of the attenuation of 10,000 mc. radiation in the exhaust flame of the V-2 will continue. They are to be supplemented by experiments designed to determine the attenuation of radiation at the frequencies presently used for telemetering purposes. These include the frequencies in the range from 1020 to 1040 megacycles.

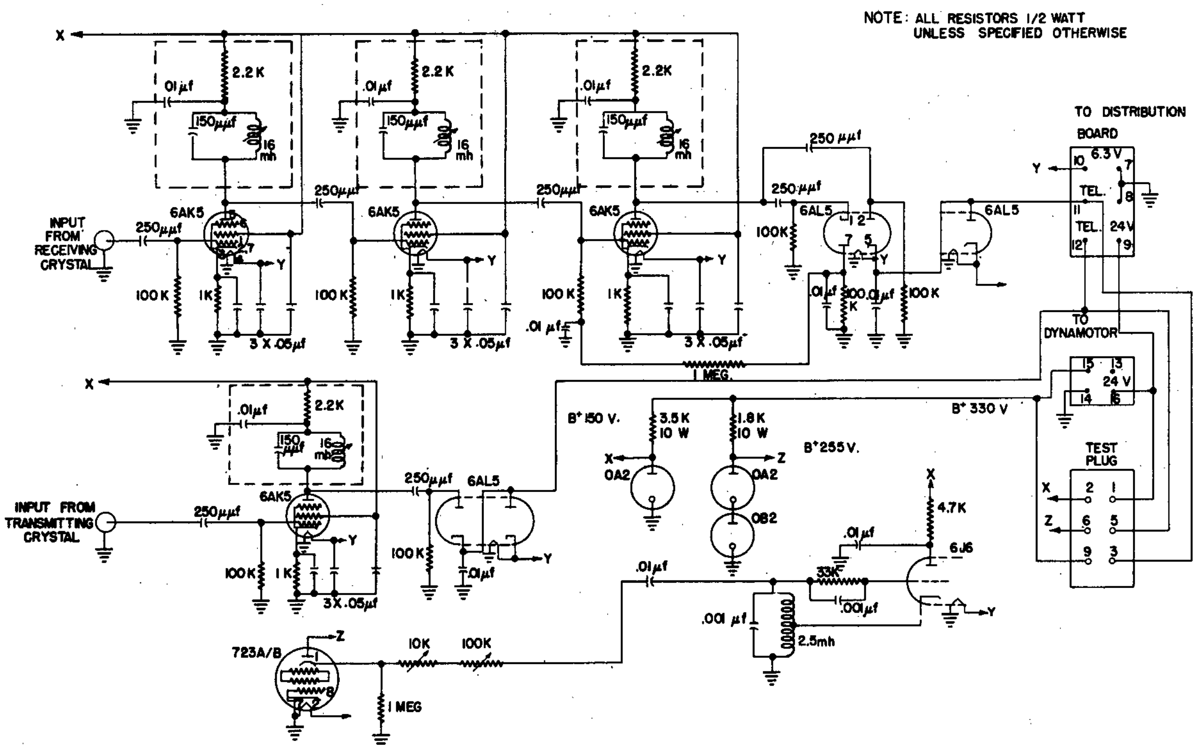

Fig. 1 Circuit Diagram of Transmitter, Klystron Monitor, Receiver and Power Supply

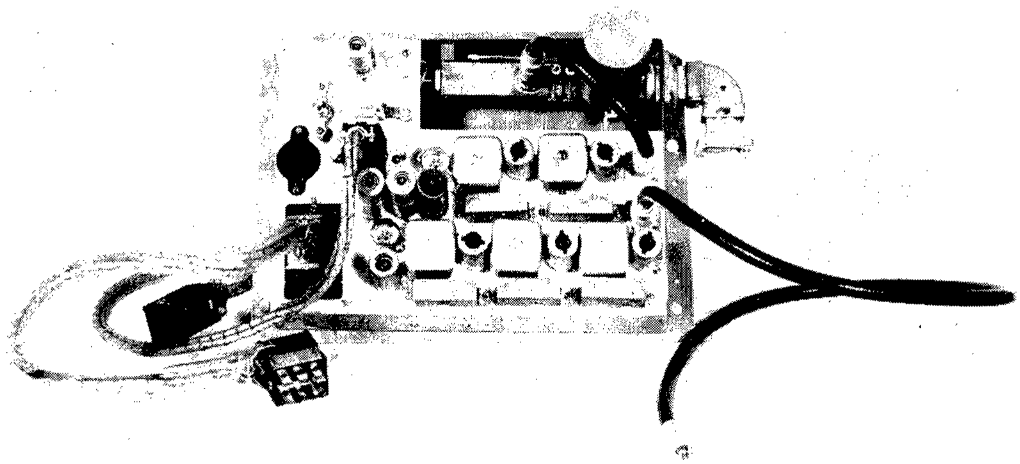

Fig. 2 Ionization Electronic Equipment

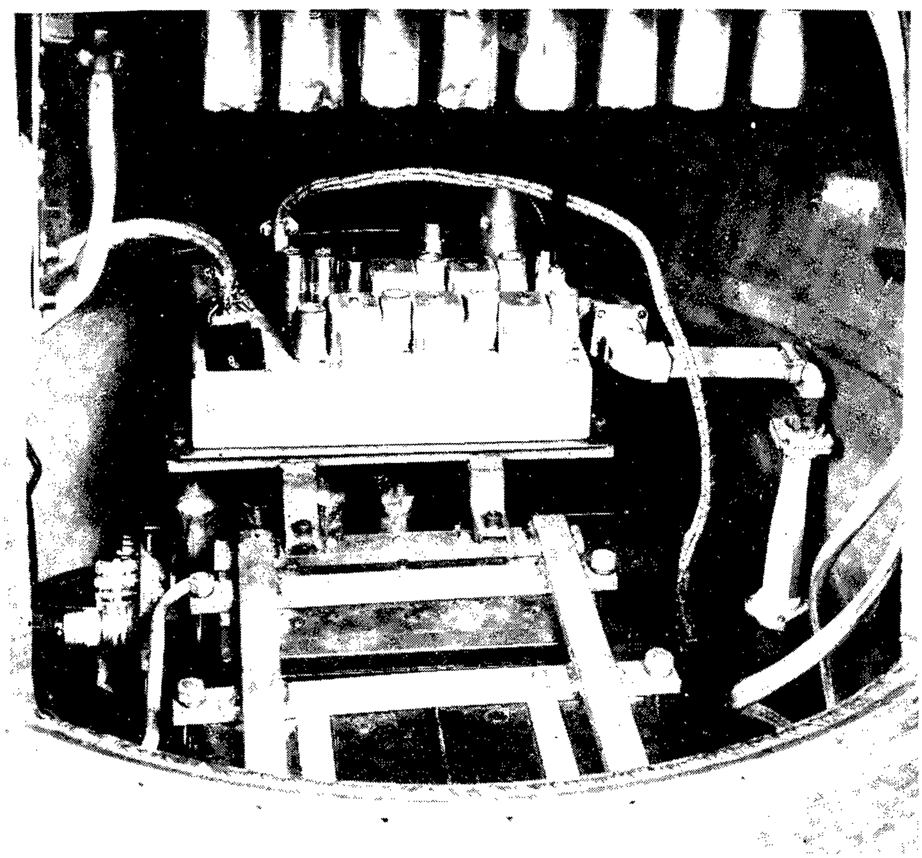

Fig. 3 Warhead Installation Showing Electronic Equipment and Waveguide

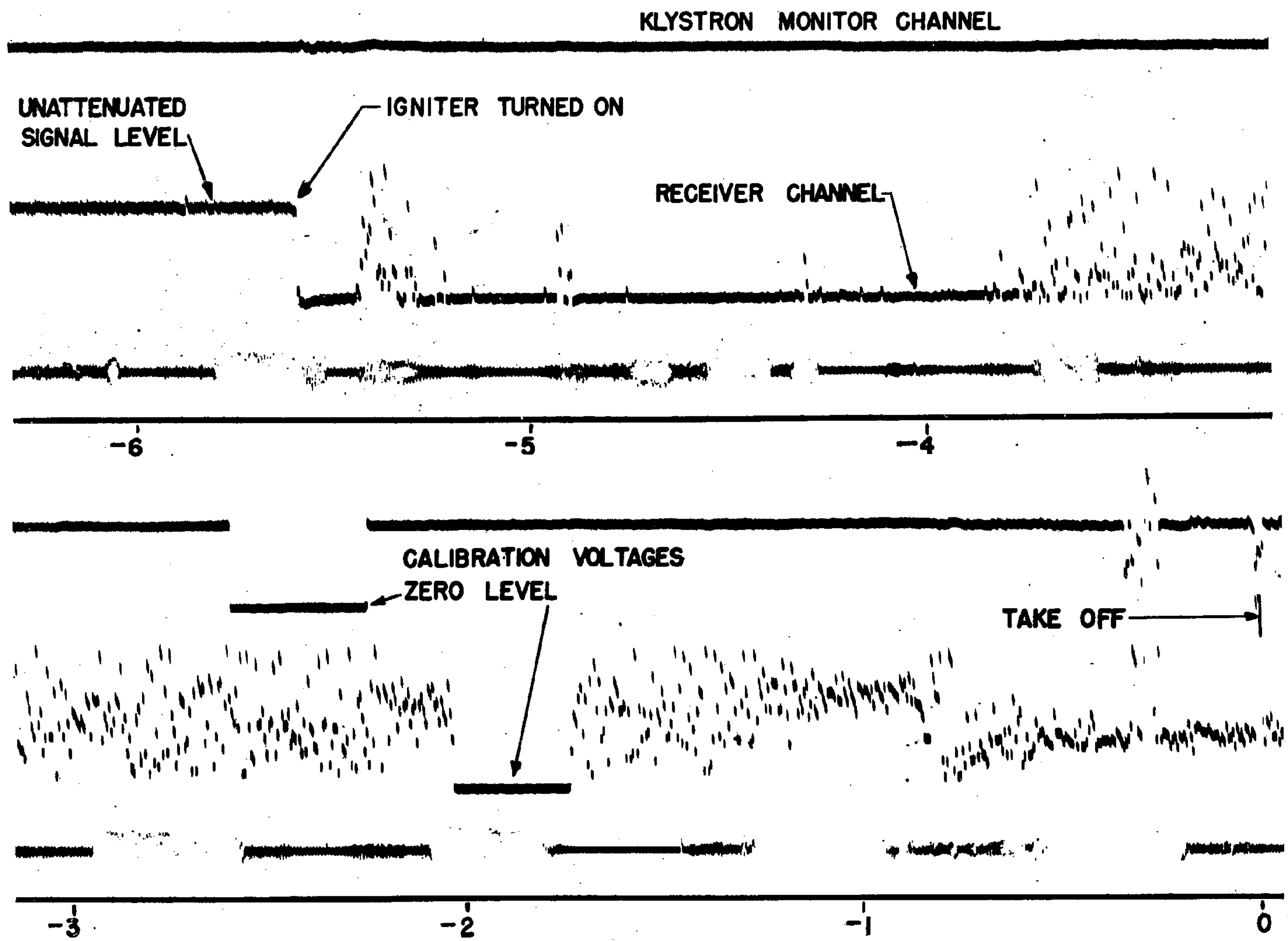

Fig. 4 A Section of the Telemetering Record. The Features of Interest have been Labelled, and a Scale Indicating Time in Seconds before Takeoff has been Added

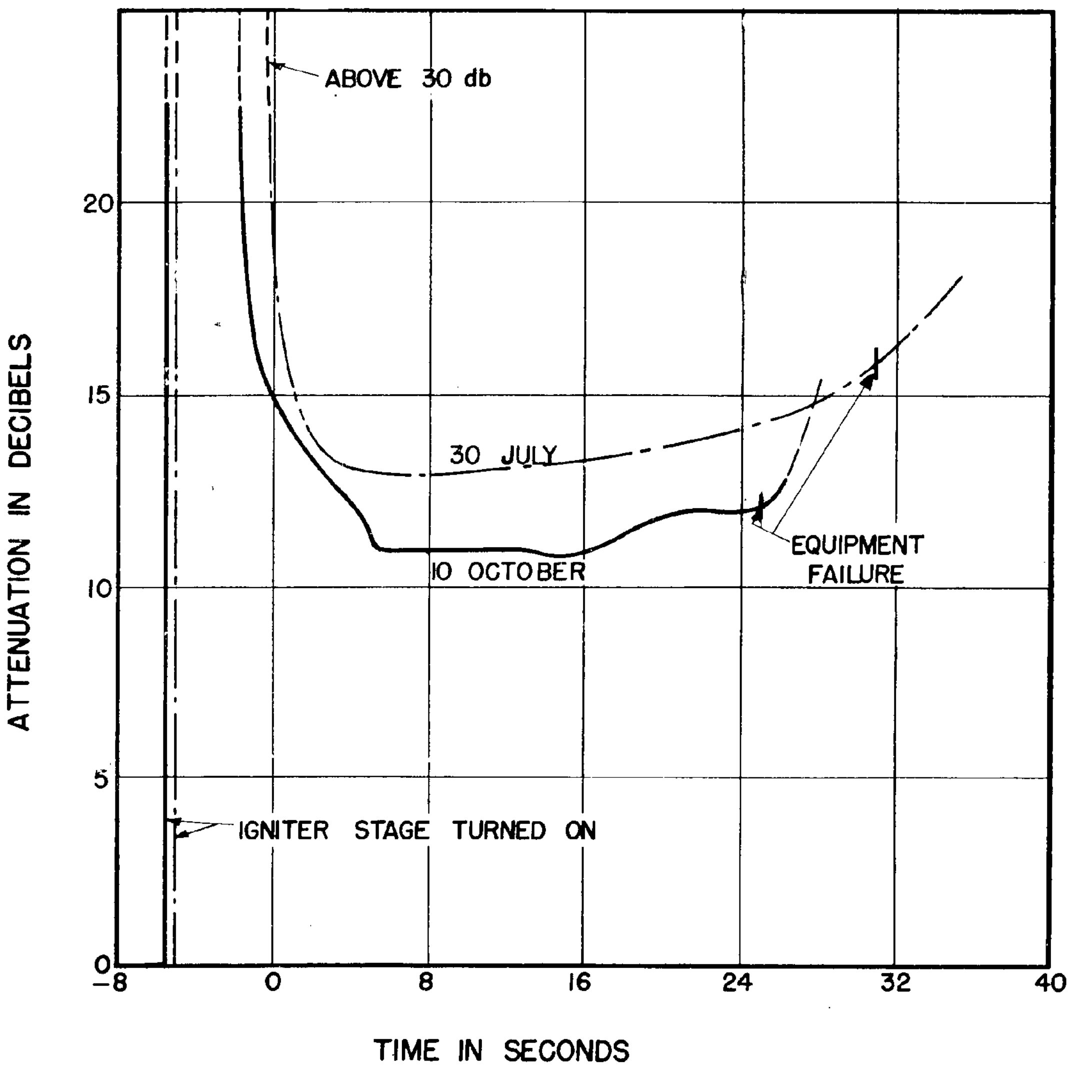

Fig. 5 Attenuation of 10,000 mc Radiation in the Exhaust of the V-2 as a Function of Time

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