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Summary of the Research Progress Meeting, June 22, 1950

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SUMMARY OF THE RESEARCH PROGRESS MEETING, JUNE 22, 1950

Henry P. Kramer

October 25, 1950

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Henry P. Kramer

Radiation Laboratory, Department of Physics
University of California, Berkeley, California

October 25, 1950

Effects of Altitude on Iron Turnover. Studies in Human Subjects. R. Huff.

Recently an expedition was made to Peru by members of the staff of Donner Laboratory for the purpose of studying polycythemia (an excess of red blood cells) at high altitudes. It was desired to obtain a correlation between the mass of red blood cells in the body and the altitude. Peru was chosen because it is the only country in the Western Hemisphere where a substantial group of people habitually reside at altitudes over 12,000 feet. A laboratory built by the Rockefeller foundation was available for these studies.

Because the turnover rate of Fe in red blood cells is very small, the use of a radioactive isotope of Fe permits the measurement of the volume of red cells in the blood. Moreover, since red cells are produced and mature in the bone marrow, a measurement of the rate of change of quantity of iron tracer in the bones will yield the rate of production of new red cells. The total blood volume is measured by incubating a small sample with P^{32}, reinjecting it into the blood, counting the rate of decrease of P^{32} activity, and extrapolating to time 0. With respect to the distribution of Fe in the body, the entire system is thought of as divided into compartments each of which contains a characteristic fraction of the total and has a characteristic turnover rate. For 80 percent of the iron in the body, the distribution is the following:

Blood Plasma	Bone Marrow	Red Cells
3 mg. Fe	100 mg. Fe	
$t_{1/2} = 4/\text{hr.}$	$t_{1/2} = 0.01/\text{hr.}$	$t_{1/2} = 3 \times 10^{-4}/\text{hr.}$

Although it was not possible to measure directly the change of production of red cells in the bone marrow with altitude, the effect of altitude on the production could be gauged from the change in the concentration and turnover rates in the blood plasma.

Fourteen medical students residing in Lima were studied both in sea level habitat and at fourteen thousand feet. The transfer was effected in 15 hours. Natives who ordinarily lived at high altitudes were studied both at 14,000 feet and at sea level. The results of the measurements are summarized as follows:

Med. Students	Natives	
32 ml/kg	47 ml/kg	Red cell volume
0.50/hr.	0.73/hr.	Turnover rate

The graphs of Figs. 1 and 2 compare the red cell turnover rates for both groups at both altitude levels. The conclusions drawn are that both natives and medical students seem to exhibit the same red-cell lifetime. Natives however have a higher production rate of red cells.

High Resolution Coincidence Circuits. L. Neher.

On the basis of an idea by W. Millet of the California Institute of Technology, a coincidence circuit whose predominant advantages are high resolution and a response of about 10^{10} counts per second has been developed. Fig. 1 gives a schematic of the circuit. The principle of operation of the circuit is essentially that of a Wheatstone bridge. Two of the arms consist of identical resistors and the two other arms of matched diodes. The usual position of the galvanometer is occupied by the detector which is a high frequency pentode. The bridge voltage is applied between cathode and grid. One of the pulses to be detected spans the bridge; it assumes the place of the battery. The other pulse is applied to one crystal diode, which changes its resistance according to the plot of Fig. 2, and throws the bridge off balance causing current to pass through the detector. If only the "battery" pulse were to appear, the bridge would be balanced and the grid voltage on the pentode would be such as to be ineffective in pulling current across to the anode. A pulse applied to one of the diodes has no other effect than to increase the diode resistance and to cause electron to flow from ground through R_2. Thus, in order to achieve a bias on the pentode both pulses are necessary. In order to test this circuit the arrangement which is shown schematically in Fig. 3 was used. Pulses from a Ra source were observed with a stilbene crystal, amplified by a photomultiplier tube 1P21, fed through a limiter, and passed through two cables of equal length (50 in., 125 ohms) into the coincidence circuit, thence to an amplifier and scaler. Changing the length of either cable by 3 in. decreased the coincidence rate from 330 counts per second to less than 50 counts per second. By varying the lengths of these increments in line it was inferred that the 1/e rise and fall time of these pulses was 3×10^{-10} seconds.

High Resolution Coincidence Circuit. L. Wouters.

The principle of operation of the circuit is laid out schematically in Fig. 4. Pulses from two photomultipliers are applied to the two sets of plates of an oscilloscope producing crossed electric fields. As one pulse builds up it deflects the electron beam along one axis on the oscilloscope screen until a maximum deflection is reached at which time the electron beam starts to recede until it reaches its equilibrium position coincident with the origin on the screen. A pulse on the other set of plates produces a similar deflection in the perpendicular direction. The sum of both deflections produces a trace on the phosphor-coated oscilloscope screen that is a variant of a "Lissajous" figure. If both pulses appear at the same time, the trace reduces to a straight line which is, because of the equal strength of the two pulses, inclined at 45° to the horizontal. The oscilloscope screen is masked with the exception of a narrow strip about the 45° line and this 'coincidence' area is viewed by a photomultiplier tube. The unmasked area has an uncertainty of $\pm$ 2 x 10^{-10} sec. delay between pulses. The persistence of the flash in the phosphor of the screen is 60 μ sec. This long persistence does not however limit the resolving power of the circuit since the photomultiplier tube is capable of judging the difference in intensity between a scintillation that has lasted for 2 x 10^{-10} sec. and one that has freshly appeared. The pulses that are detected are sharpened to 1/2 μ sec. by conventional equipment and fed into an amplifier and scaler. An indication of the sensitivity of the apparatus is that it was necessary to account for the delay in deflection occasioned by the transit time of the electron beam between the two sets of deflection plates of the oscilloscope by inserting an additional 7 in. length of line into the cable that feeds the first set of plates.

It is necessary for the operation of the circuit that the pulses produced by the photomultipliers be uniform. Since those produced by stilbene, the customary phosphor, are not, it was necessary to resort to liquid xylene terphenyl.

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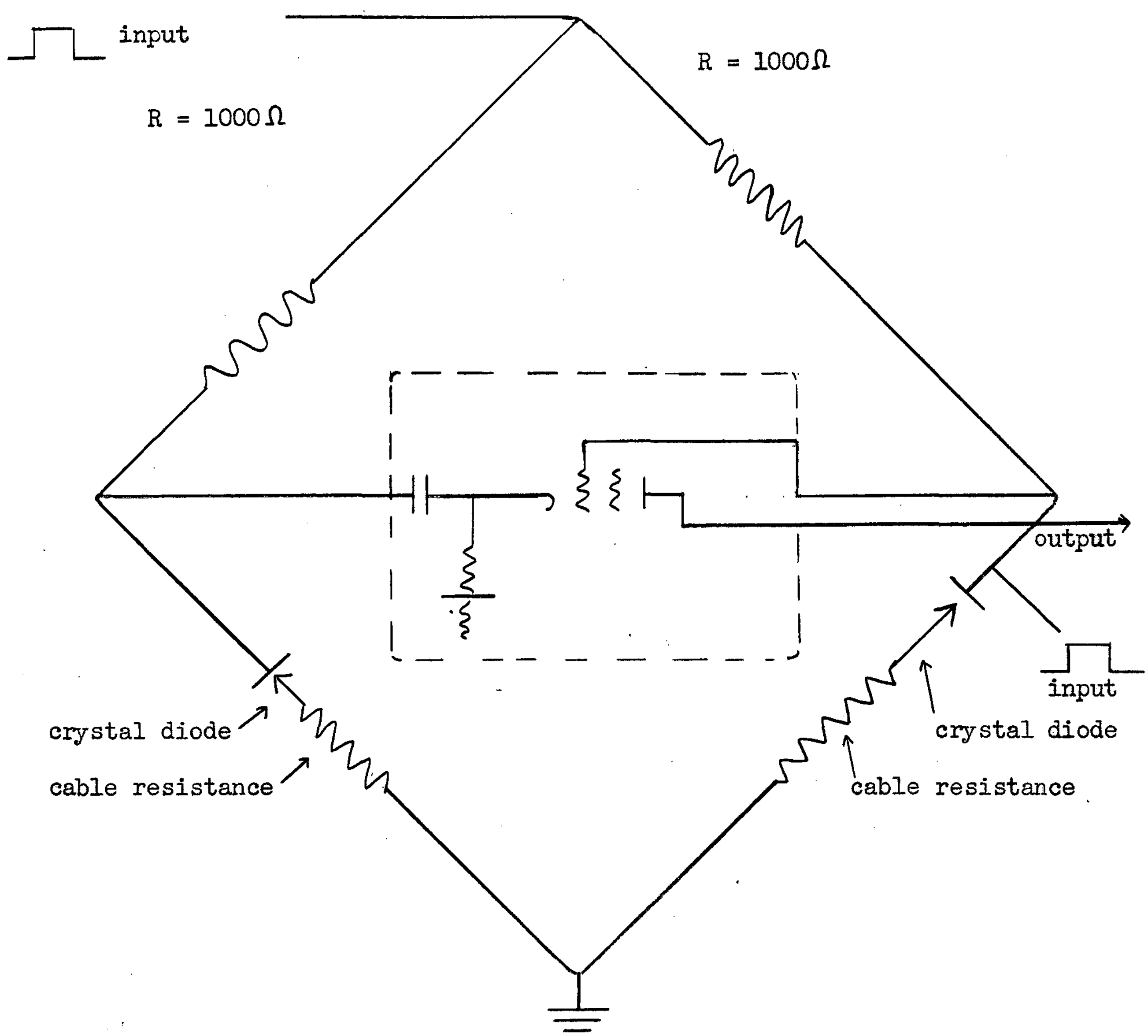
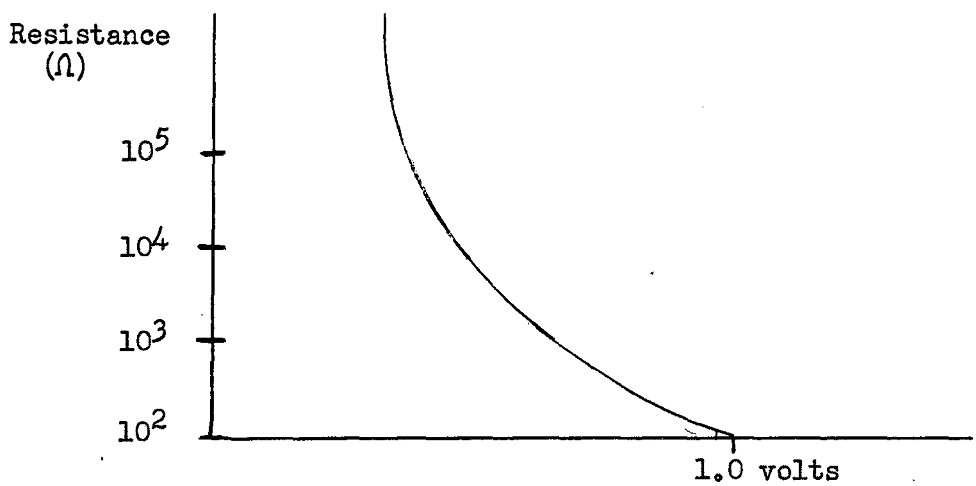


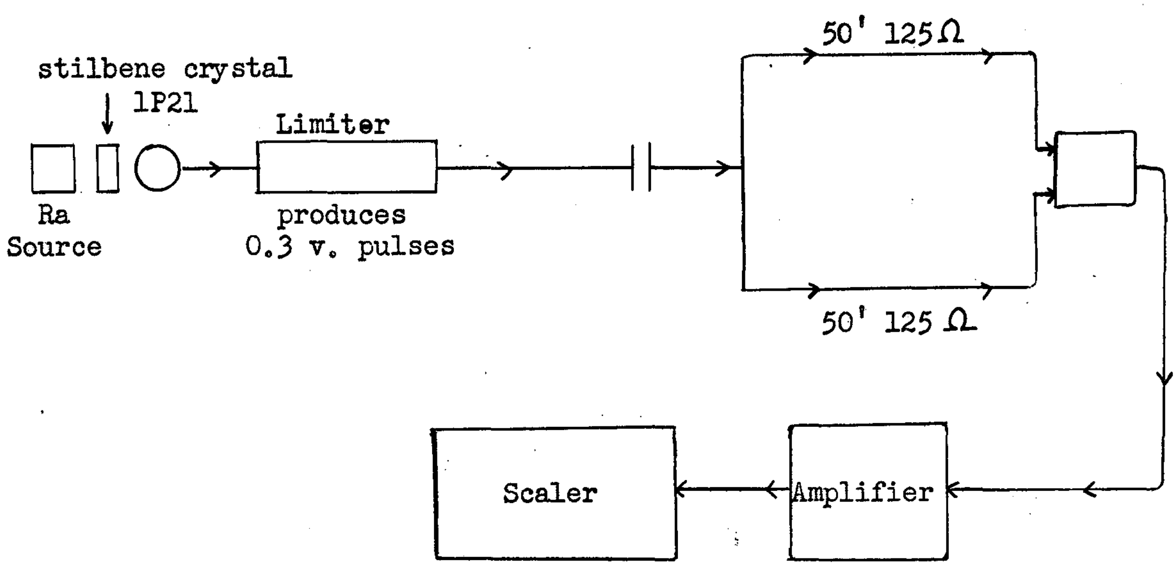
input
R = 1000Ω
R = 1000Ω
output
input
crystal diode
crystal diode
cable resistance
cable resistance

Fig. 1



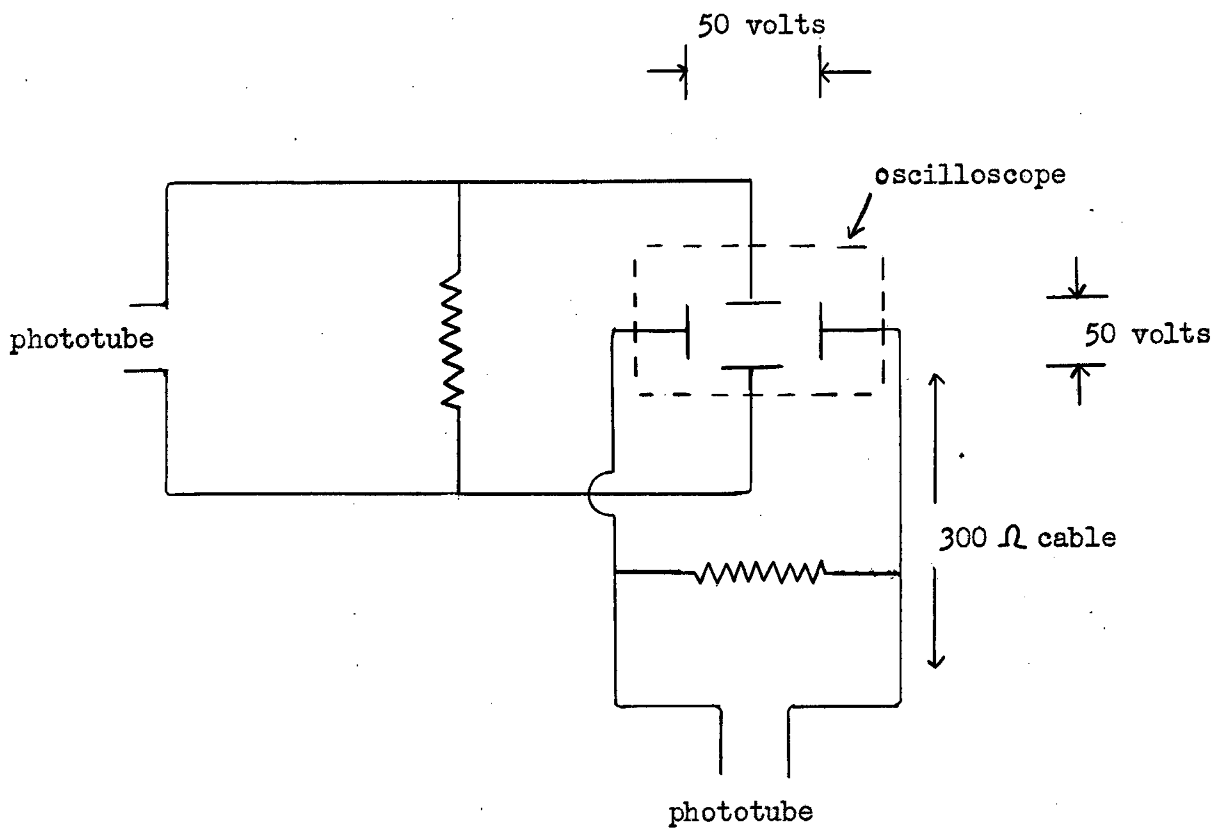
Change in Resistance of Crystal Diodes
with Imposed Voltage

Fig. 2



Arrangement for Testing
Coincidence Circuit on Bench

Fig. 3



Schematic of Coincidence
Arrangement Using Oscilloscope

Fig. 4