

NOTE CONCERNING A DIRECT READING ELECTRICAL CHRONOGRAPH FOR ACCURATE READING OF VERY SHORT INTERVALS OF TIME

NOTE BY MM. RAYMOND DUBOIS AND LOUIS LABOUREUR.

(Extract from the *Comptes Rendus des Séances de l'Académie des Sciences*, Paris, 9th. May, 1932).

If a previously discharged electrical condenser be connected to a source of constant tension through a resistance, the tension at the terminals of the condenser starts from 0, at the instant $t = 0$, and increases in accordance with an exponential law as a function of the time. The measurement of the charge acquired during an unknown interval of time allows the duration of the charge to be determined. Earlier methods used for this purpose entailed the use of an electrometer which was too delicate for industrial purposes, or the use of a galvanometer with the same failing, besides it caused the quantity to be measured to disappear, which does not allow prolonged registration of the result of the observation.

In the present device the problem was solved by the use of a high insulation triode valve, to the grid of which the tension reached by the condenser is applied to the negative extremity of the filament in the direction which renders the potential of the grid yet more negative. In these conditions, the valve acts as an electrometer which does not shunt any current and does not alter the charge of the condenser, though it produces an anode current of several milliamperes, which is easily measured by pivotal appliances. The variations of this current are quite definite and stable as a function of the tension reached by the condenser while being charged.

At the very earliest stages an improvement of great importance was introduced in the chronograph by suppressing the relays and making use of a neon lamp as a make-and-break free of inertia and possible bad contact. Further, by using the one-directional conductivity of the filament-grid space the charging of the condenser can be carried out very easily leaving it permanently connected both to the filament and to the grid in its position for measuring the charge, whilst retaining its perfect insulation, thus permitting permanent readings to be obtained. In this new apparatus the interval of time to be measured is that during which the neon lamp is alight, the lighting and extinction being caused by the beginning and the end of the phenomenon. Then the plate current assumes a value which corresponds to the charge acquired by the condenser and this value is maintained for several minutes or several hours according to the quality of the insulation. When the reading has been made, the condenser is short-circuited for an instant in order to prepare for the next measurement.

The value of this apparatus for aerial and submarine sounding is evident: it allows very short intervals of time to be measured with an accuracy within 1 per 1000, without relays, without coupling and without any movable mechanical organs. Oscillograms show that the phenomena inside the neon lamp do not show any lag in themselves and it has been possible by this method to measure directly the interval of time taken by sound to travel about 100 metres with an accuracy of about 1 decimetre. Further the energy necessary to obtain extinction is very small and during the trials which were made for determining height, in spite of the noise of aeroplane engines, it was possible regularly to read the echo distance from 8 m. to 450 m.

For this purpose, the equipment carried by the aeroplane consisted of a compressed air apparatus which gave a shrill note for about 1/100th of a second directed towards the ground by means of a cone in the interior of the craft, the opening of which, which is slightly within the covering of the fuselage, is protected by a light deflector. The receiver is a special electromagnetic microphone which is selective and sensitive to the echo, but the proper period of which does not coincide with the note used in order to avoid that transitory vibrations should have the same frequency as the signal itself. A very highly selective amplifier is tuned to the signal and the out-going current caused by the echo extinguishes the lamp which charges the chronographic condenser. The lighting of this lamp is caused by the actioning of the transmitter.

The milliammeter of the chronograph is fitted with two altitude scales, one from 5 m. to 70 m. and the other from 20 m. to 500 m. The change of scale is obtained instantaneously by means of a switch which modifies the value of the resistance in series with the condenser and governs the rate of charging. The use of several milliammeters in series allows the readings of the soundings to be repeated at the various pilot or navigation control stations without any additional device. One of them may consist of an ink recorder which gives the profile of the course in linear co-ordinates, for the speed of unrolling of the paper may be made proportional to that of the plane.

In the same way submarine soundings may be taken by using a transmitting apparatus which transmits to the water short musical vibrations, using a microphonic receiver similar to that used for aircraft connected with the same chronograph.

