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A PORTABLE ELECTRONIC RECORDER FOR FIELD USE IN GEOPHYSICS

The object of this contribution is a brief description of portable recording instruments the author developed, sometime ago, for field investigations and similar applications in Australia. In general, portable equipment can be assumed to be subject to relatively rough treatment under adverse conditions. This means that all mechanical parts should be of robust and permanent construction,

as far as this is possible in view of the sensitivity required. One method is the replacement of any mechanical amplification by electronic conversion or amplification. Several electronic apparatus developed and published by the author during the last few years seem to offer ideal possibilities in this respect, in as much as they are adaptable to such applications.

The mechanical parts of the recorders under discussion being restricted to the actual recording mechanism and to the galvanometer itself, much attention must obviously be paid to their rigidness and reliability, rather than to the electrical sensitivity of the galvanometer. If a continuous record is required, a good method appears to be the use of a sharp point mounted to the galvanometer pointer, and a smoked metal foil as recording chart. As is generally known, other types of chart material can also be used but metal presents a minimum frictional resistance to the sharp point. If a point record suffices, the record may be produced on normal paper by ink or by a coloured ribbon. With reference to the former, the usual method of producing the appropriate dip of the pointer by its weight meets the requirements of simplicity with portable recorders, but is not very satisfactory. A somewhat different and extremely simple point-recorder has been tried by the author. This consists of a normal moving-coil galvanometer of sufficient sensitivity and small physical size (a diameter of upto 8 cm). The galvanometer case is equipped with short shafts at two opposite ends, such that an imaginary line through both shafts and the centre of gravity of the galvanometer would be perpendicular to the pointer in the mid-scale or end-scale position. In practice, two metal screws are quite suitable for this purpose. By means of the two shafts, the instrument rests on two simple metal brackets mounted on to the base plate or the recorder cabinet at appropriate points. Thus the entire galvanometer is allowed to move about the line perpendicular to the direction of the pointer, which consequently moves upwards and downwards. The pointer having been lengthened by a thin

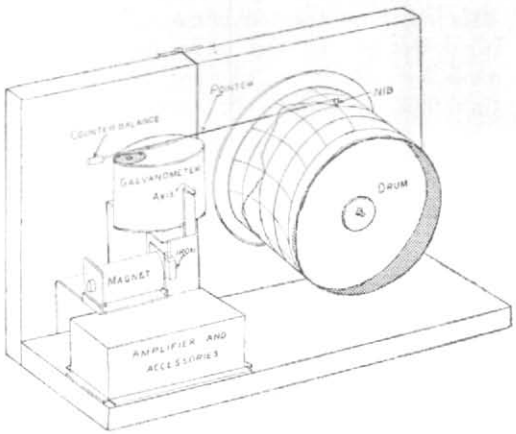

Fig. 1

strip of aluminium foil or other light material (*e.g.* grass) with a pen at its end, a downward movement results in a point on the chart, which is rotated by a recording drum in the ordinary fashion. The optimum length of the pointer is obviously given by the rigidness and weight of the piece added to the original pointer. Another limitation may be the dimensions of the recorder, as portable equipment must necessarily be of compact size. The downward movement of the galvanometer at given intervals is achieved by electro-magnetic means, *i.e.*, a piece of iron is fixed to the galvanometer case at a point on the 'pointer-line' at maximum distance from the centre of gravity. Directly underneath, a simple electro-magnet is mounted to the base plate and its circuit is closed at intervals given by a contact-clockwork or by an electronic multivibrator of normal design (Fig. 1).

The electronic part of the recorder consists of a direct-coupled amplifier. Junction transistors have proved to be very reliable and constant in their operation and thus offer unique possibilities for records over long as well as short periods. In addition, only transistors enable direct-coupled amplification to be obtained with sufficient precision. A multi-stage temperature-compensated amplifier with these features has been developed by the author some time ago (Albercht 1956).

This may be connected between the measuring detector and the galvanometer. The overall-sensitivity of the entire recorder is, therefore, comparatively large.

If, however, one of the author's ultrasensitive bolometers, *viz.*, capacitance bolometers (Albrecht 1955. 1957a, 1957b) or transistor bolometers (Albrecht 1957c), are used as measuring detectors, the electronic part of the recorder has to be of different design. In this case, accurate indication of a frequency variation has to be achieved in the most reliable way. A suitable indicator for this recorder combination is a temperature-compensated very-low-frequency receiver which the author developed sometime ago in Australia for his research on psycho-meteorological effects of atmospherics and also on their propagation by the lower region of the ionosphere, in other words on ionization of this ionospheric region. For the reasons pointed out above, the receiver consists of transistors throughout, and is useful for the applications just mentioned and as bolometer indicator, if the bolometer-output frequency is about 27 kc/s, *i.e.*, the frequency used for measuring atmospherics. With this frequency, linear indication can be obtained over about 7 kc/s. Should different characteristics be desired, this range as well as the bolometer-output frequency can easily be changed. Following two tuned stages in common-emitter connection, both compensated for temperature variations by resistance stabilization, a silicon diode is utilized as detector in order to ensure optimum stability in this stage. The output stage consists of two transistors in a bridge-output circuit similar to that used for the direct-coupled amplifier described before (Albrecht 1956). In this way, the entire unit is stabilized on a stage-by-stage basis.

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