This sequence of changes takes place only when the circuit can oscillate. To follow the complete sequence it is necessary either to shunt the galvanometer heavily or to substitute for it a milliamperemeter.

A set of observations so obtained is given in Fig. 2, which represents the apparatus in the best adjustment for our purpose. To obtain this linear form of curve

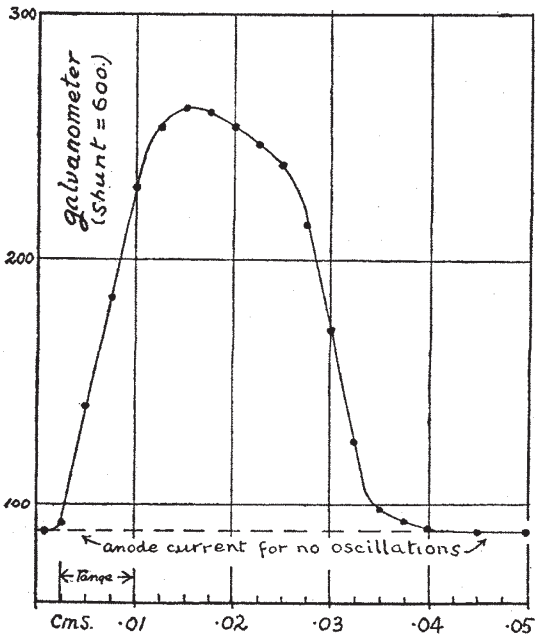

FIG. 2.

the relative positions (" coupling ") of the coils must be altered, and the most suitable plate voltages (V) ascertained by trial. With some valves it may be necessary to apply a negative potential to the grid between the points g_1 g_2, Fig. 1. I have used several common makes of " R Type," hard valves, and have never found any difficulty in obtaining the condition shown.

The function of the " zero-shunt " is to by-pass an amount E/R of the anode current *j*, so that, if R is large compared with the resistance of the galvanometer, the current through the latter is approximately $j - E/R$. When E and R are chosen so as to make this difference small, a sensitive galvanometer can be employed, unshunted, which will then give large deflexions, when the plates of the condenser suffer minute displacements. In view of the *linear* form of the curve (Fig. 2), it will be clear that the galvanometer reading is proportional to the plate displacement. Also, calibration is readily obtainable by shunting the galvanometer, say ten times, and then observing the deflexion obtained when the micrometer screw is turned through, say 1/1000 cm.

A resistance *r* up to 1000 ohms may be introduced into the oscillation circuit to reduce the sensitivity and widen the range of the plate movement. This resistance also renders it easier to obtain the linear adjustment. The large black dots in Fig. 1 represent the terminals on the case of the instrument; the batteries, galvanometer, and condenser plates are external and are connected to these terminals. The actual resistances, coils, etc., are mounted beneath the ebonite top of a small box, about one foot square and a few inches deep. Rigid connexions are employed to eliminate vibrational effects.

In the use of the apparatus for recording small displacements, movements, etc., one of the condenser plates is caused to partake of the movement to be measured by direct attachment, if possible, to the moving member. The other plate may be mounted, as already described, on a micrometer screw device to facilitate calibration. For steady working, at all times great care must be taken to employ batteries that are in perfect condition, and have an adequate current capacity. It is advisable to use cells of the same type for E as for V. Temperature changes must naturally be avoided in view of expansion and other effects. For " super " sensitivities (above 10^{-7} cm.) screening and other precautions become necessary.

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University College, Dublin, May 7.

A Permanent Image on Clear Glass.

THE interesting observation described by Mr. Eric Robinson in NATURE of April 28, p. 569, and commented upon in the same issue by Dr. J. W. French, is an excellent example of the ease with which the surface of glass may suffer modification and retain it over a long period of time. The present writer has studied a number of phenomena connected with " breath figures," and an account of the work will be found in the *Philosophical Magazine* for October last.

If the tip of a small blowpipe-flame is drawn rapidly across a sheet of glass it can be shown in various ways that the surface of the glass along the flame-track has been considerably modified. Flames of coal-gas, carbon monoxide, and hydrogen produce identical results. When moisture from breath condenses on the glass it is in the form of a misty deposit of minute hemispherical droplets, except along the flame-track, where it collects as a continuous transparent film. The contrast between the two types of condensation is most marked and constitutes a " breath figure." These flame-tracks are revealed when silver is chemically deposited upon the glass and they can also be traced by the greatly increased friction which manifests itself when a chemically cleaned watch-glass, which is being dragged across the plate, encounters one of the tracks. The insulation of the glass surface is also less along a flame-track than it is on those parts which have not been exposed to the action of the flame.

It is not possible in the space available to give the evidence in favour of the conclusion reached by me that at least two causes operate in producing the modification of the glass surface which leads to a " breath figure." One of these is that the flame removes the extremely thin film of contamination which certainly covers all glass which has not been subjected to a rigorous chemical cleansing process, and the other is probably a physical change in the surface of the glass itself. The latter is very persistent and can be detected for many months after the passage of the flame across the glass. I am inclined to attribute Mr. Robinson's effect to a physical change in the glass surface. Is it not possible that the gelatin of a photographic print which has been squeegeed upon glass may, when dry, exercise a considerable force on the surface in contact with it and that this force may have different local values depending upon the density of the photographic image? Such local differences in tension may impress upon the glass corresponding differences in surface structure which would then be capable of detection as a " breath figure " or by deposition of silver.

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May 7.