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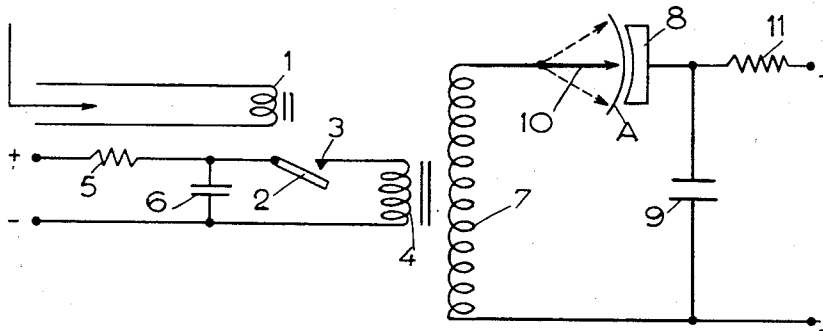
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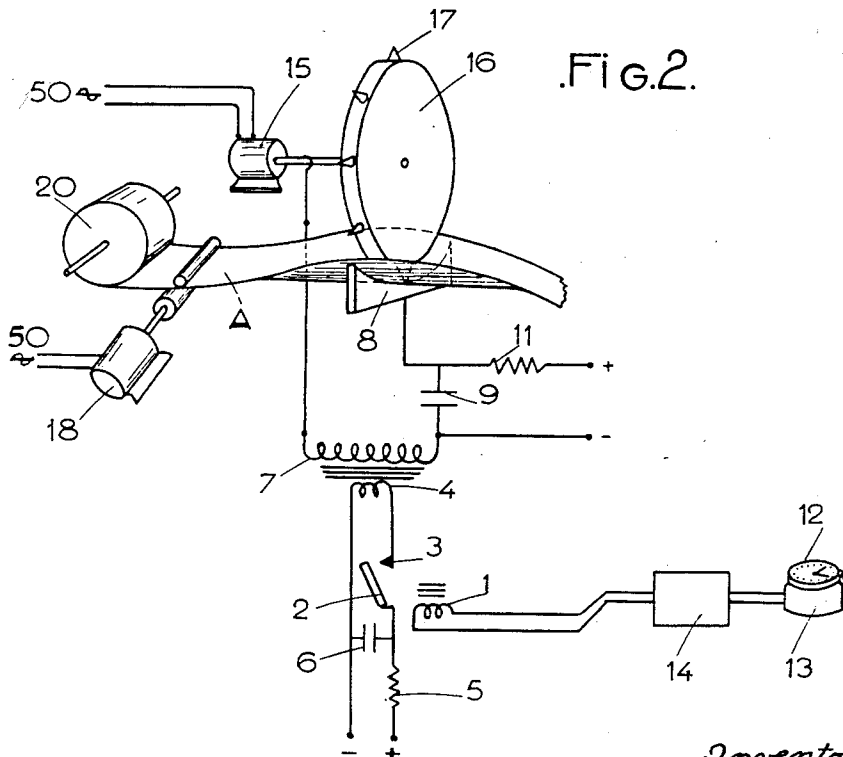
SPARK RECORDING APPARATUS

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.Fig.1.



.Fig.2.



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SPARK RECORDING APPARATUS

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2 Claims. (Cl. 346—74)

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The present invention is concerned with methods of recording according to which a strip of paper is moved between a movable point and an electrically conductive surface and is adapted to be perforated by sparks arcing from one to the other of said parts.

It has been suggested in prior art to use such methods, in particular for the inscription or recording of time signals, in devices provided for controlling the operation of time-keepers.

In some of the devices known for the embodiment of such methods, the time signals, after suitable amplification, cause, through the medium of a relay, closure of the primary circuit of a voltage-increasing transformer, across a charged capacitor. As a result there is suddenly produced a high voltage between the terminals of the secondary circuit, said terminals being respectively connected to the point and the conductive surface which is opposite thereto. Said voltage causes, between the point and the conductive surface, the arcing of a spark which perforates the paper sheet with a regularly shaped but extremely small hole. To render such hole visible, it is necessary to use a specially treated paper sheet, for instance a sheet of paper coated with thin layer of paraffin which melts in the immediate proximity of the hole. Ferric ferricyanide paper may also be used, on which the spark leaves visible traces.

In order to avoid the necessity of using especially treated paper, attempts have been made to use the sudden secondary voltage increase produced by the time signals, in order to initiate a rapid discharge of a strong capacitor through a neon tube, said discharge taking the form of a spark between the point and the conductive surface, which is more intense than in the devices mentioned above. The resulting record is not however any the more apparent.

This invention makes it possible to achieve a very readily apparent record upon a sheet of non-pretreated paper.

The invention consists of using the slow discharge of a strong capacitor through the secondary circuit of the transformer which upon occurrence of the time signal generates between the point and the conductive surface a voltage which allows said discharge to take place.

In the appended drawing given by way of example:

Figure 1 is a circuit diagram of a device adapted to carry the method of the invention into effect.

Figure 2 shows how the device may be applied to the study of the operation of a watch.

Referring to the diagram of Figure 1, the numeral 1 designates the coil of a relay which re-

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ceives current impulses resulting for example from the application of currents generated in a microphone near which is placed a watch to be checked.

The movable armature 2 of said relay controls a contact 3 in a circuit supplied from a source of direct current. Said circuit includes the primary winding 4 of a step-up transformer in series with a resistor 5 and a capacitor 6 shunting the combined contact and primary winding.

The secondary 7 of the transformer is connected on one hand to the conductive surface 8 through the interposal of a large capacitor 9, and on the other hand to the point 10 which is moved at a constant spacing from said surface. By way of indication the capacitance value of capacitor 9 may be 0.1 mf.

The strip A of non-pretreated white paper which is to receive the record is fed between the point 10 and the surface 8 normally to the plane of the drawing under the control of any suitable mechanism.

The electrodes of capacitor 9 are moreover each connected to a terminal of a source of direct current, with the interposal of a resistor 11.

When the relay 1—2 closes contact 3, the capacitor 6 discharges into the primary 4 of the transformer. The current which then flows through said winding induces across the secondary winding 7 a voltage drop which is sufficient for the electrostatic field between the point 10 and the surface 8 to ionize the air which then becomes definitely conductive. This allows a more potent discharge of capacitor 9, and this discharge will occur slowly through the inductance coil formed by the secondary winding 7 of the transformer, then through the spark-gap between the point 10 and the surface 8. Such discharge is of comparatively long duration (in the range of $\frac{1}{100}$ of a second), and is sufficiently powerful to burn the edges of the hole which it forms through the paper sheet, said hole thus becoming clearly visible. The capacitor 9 is then slowly recharged through the resistor 11.

The heat generated by and the duration of the spark may be adjusted by altering the resistance value of resistor 11, the capacitance value of the capacitor 9, and the D.-C. voltage used for loading the latter.

In order to obtain a rapid action without any inertia or time lag, the relay 1 and the related contact 3 may be replaced by a valve-amplifier, the impulses being after adequate amplification directed to the grid of the valve. The variations in the plate current magnitude in this valve through the primary winding 4 produce in the secondary winding 7 of the transformer an in-

duced voltage which is sufficient to perforate the paper sheet A and to produce therein a record according to the desired result.

The device of the invention is particularly applicable to apparatus for the checking of the operation of time-keepers and for the adjustment of the escapement coil springs therein.

An apparatus employing the above described device is embodied as follows (Fig. 2).

A watch to be checked, 12, is placed upon a microphone 13. The microphone output current, produced by the noise of the watch escapement, is amplified in an amplifier 14 and fed to the coil 1 of the above mentioned relay.

There is moreover provided a synchronous motor 15 supplied with alternating current of perfectly defined and stable frequency (e. g. 50 cycles per second). On the drive shaft of said motor is secured a metal disc 16 carrying on the periphery thereof a plurality of points or spurs 17. The disc is electrically connected to one terminal of transformer 7. In the plane of disc 16 there is provided an electrode 3 of arcuate form concentric with disc 16.

A paper strip is fed at a constant rate of displacement from a reel 20, for example by the action of a synchronous motor 18, between disc 16 and fixed electrode 8.

The device operates as follows:

At each "tick" of the watch 12, detected by the microphone 13, there corresponds a hot spark between electrode 3 and one of the spurs 17. This spark perforates and burns the paper 3.

Provided the speed of rotation of disc 16 and the number of spurs 17 have been suitably selected, the successive perforations in the paper strip will be made along a line parallel to the longitudinal axes of said strip. If the frequency of the watch-beats corresponds exactly to the rate of rotation of the disc (as for instance when the watch beats every fifth part of a second and the disc is rotated at five revolutions per second). If however the frequency of the watch-beats is too high (the watch is fast), there is obtained on the strip a series of perforations extending along a line inclined with respect to the center axes to the strip. If the frequency of the watch-beats is too low (the watch is slow) there is obtained a series of perforations extending on a line inclined in a direction opposite to the preceding one. It will thus be an easy matter to readjust (even while the watch is going) the escapement of the watch until there is obtained a line parallel to the longitudinal axis of the strip. The watch is then accurately regulated.

The spark recording system in the device embodied as described above offers essential advantages over all prior recording systems previously conceived to the same end.

This advantage lies in the extreme rapidity with which observations may be made thereby, as a result of the combination of the stroboscopic effect provided by the great brilliancy of the spark, together with the recording action, inasmuch as the operator may at all times observe the record being made on the strip and the arcing of the sparks.

With purely stroboscopic types of devices, it is both difficult and tiring for the eye-sight, by reason of the comparatively low frequency of the beats of a watch escapement which are in the range of five per second or less, rapidly to ascertain the direction of misadjustment and especially the extent of such misadjustment.

In purely recording types of devices on the

other hand, the width of the inking strips permits of reading the record only after a more or less considerable length of time, according to the rate of feed of the paper strip. On the other hand with the sparking system as described above, the observer sees simultaneously both the spark and the record preceding it; he thus may immediately observe how the successive sparks are placed with respect to the record curve which replaces so to speak the operator's visual memory, even for the slightest differences in adjustment. Thus, the "strobo-recording" method of observation with the use of sparks enables several times ten seconds to be gained at each watch adjusting or observing operation, and such gain is extremely desirable.

The method may be applied none the less advantageously to the adjustment of escapement coil springs. It is then simply necessary to replace the watch 12 by the balance-wheel hair-spring assembly which is to be adjusted. It is possible either to listen to the movement of such assembly by means of a microphone as described above, or further to use any other device which enables time signals synchronous with the movement of the balance-wheel to be obtained (such as a photo-cell, a contact between the pivot of the balance-wheel and a fixed part, a contact on the hair-spring or the like).

The application of the device of the invention is not restricted to the construction of apparatus for the checking of the operation of watches and the adjustment of hair-springs, as mentioned by way of illustrative examples, but may be further extended to other types of apparatus, such as medium frequency recorders or voltmeters or milliammeters having a low mechanical torque, by causing arcing of a spark at regularly spaced time intervals from a needle to a conductive surface, between which the record strip is fed.

What we claim is:

1. A recording apparatus for making on ordinary paper a series of perforations carbonized around their edges to be visible by direct viewing which comprises, in combination, means for displacing a recording sheet in function of time, at least one pointed electrode in proximity to one face of said sheet, a conductive surface adjacent to the other face of the sheet, means for displacing said electrode in function of time transversely to the direction of displacement of said sheet, a voltage multiplying transformer of which the secondary is connected at one end to said electrode and at the other end to one pole of the source of direct current, a resistance in series circuit with the other pole of said direct current source and with said conductive surface, and a condenser of large capacity in shunt between said conductive surface and said one pole of said direct current source, the primary of said transformer being connected to two poles of another source of direct current, a resistance interposed between said primary and said second source, and a second condenser in shunt with said primary, an interrupter in the circuit that joins said second condenser to the primary of the transformer, and means under control of a registering signal for operating the interrupter whereby a pilot spark is caused to perforate the paper on operation of said interrupter followed by a hot prolonged flow of current which carbonizes the edge of said perforation.

2. Apparatus as in claim 1 in which the said interrupter is placed under control of a relay

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interposed in a circuit which comprises a microphone translating into an electric signal a sound signal to be registered, and an amplifier of said electric signal.

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