An extract of pages from

THE INSTITUTION OF
POST OFFICE ELECTRICAL ENGINEERS

The Electrical Control of Time Services in the British Post Office.

BY

A. O. GIBBON, M.I.E.E.

A PAPER

Read before the London Centre of the Institution on December 9th, 1930.

and collimators. Frequent observations of the clock stars are made through a telescope and from these observations the Standard Mean Time is derived.

The mechanism at the Observatory has been supplied by the Synchronome Company under the personal direction of Mr. Frank Hope-Jones. It consists of a " Free " pendulum, a slave clock, and a signal transmitter. A special chamber, free from vibration, and maintained at an even temperature, has been adapted at the Observatory for the accommodation of the apparatus: Fig. 15 gives a view of this chamber.

In order to avoid the loss of energy inherent in the behaviour of clock mechanism as generally designed, a Free pendulum, designed by Mr. W. H. Shortt on the Synchronome system and known as the " Shortt " clock, is used on the Rugby service. The Free pendulum is associated with the subsidiary clock called a " slave "; rightly so named because the slave undertakes all the work and yet is so accurately controlled by the Free pendulum, that perfect synchronism between slave and Free is maintained. The slave clock is the standard synchronome master clock. The Free pendulum is made of Invar and is enclosed in an airtight case, the air pressure therein being reduced from normal atmospheric pressure to a suitable working point.

A comprehensive skeleton diagram of the mechanical and electrical arrangements, from the Free pendulum to the Rugby aerial, is shown in Fig. 16; and a first impression of such a complicated network makes one wonder how such scientific accuracy as has been so consistently recorded is possible of attainment.

The pendulum of the slave clock, in swinging to the right, rotates the count wheel and, after each revolution, the arm A engages the small trigger B. The trigger is opened and allows the impulse lever C to fall, thus giving a push to the pendulum by sliding down the inclined plane. At the end of the fall of lever C, the contact D is closed. The electrical circuit is from D, through the electromagnet and armature E, the battery, the electromagnet F of the Free pendulum, to the dial connections S of the slave clock. The current in passing through the electromagnet E attracts its armature and re-sets the lever C. The current also releases the trigger which holds the lever G of the Free pendulum, and so moves forward the finger of the slave dial

INTERNATIONAL TIME SERVICE.

Wiring Diagram.

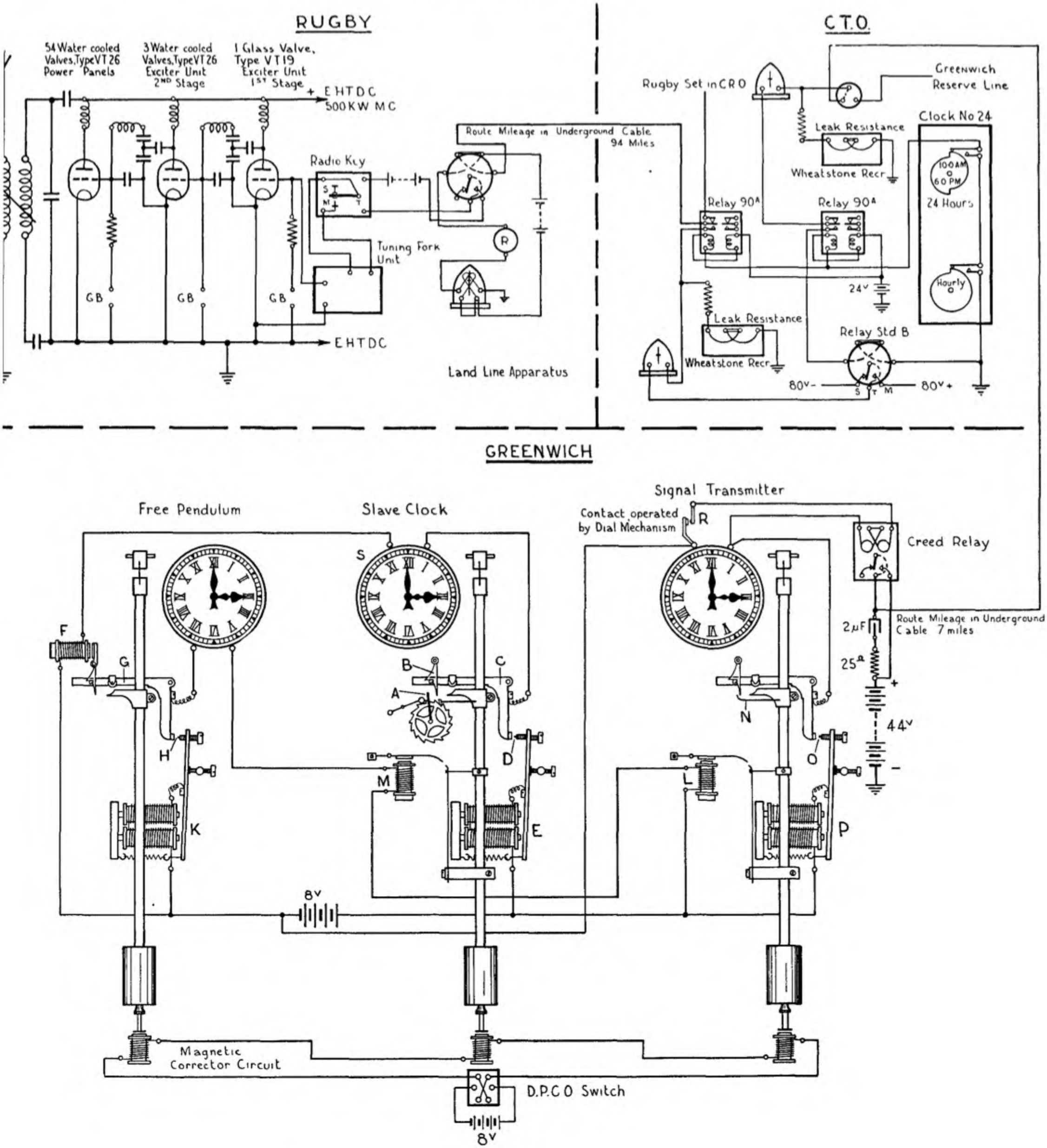

FIG. 16.

synchronizer M of the slave clock: completing the circuit through the dial mechanism of the free pendulum. Synchronizing in this manner is required in order to keep the three mechanisms in phase. The signal transmitter receives an impulse at every alternate swing of its pendulum, through the click N, which releases the trigger in a similar manner to that of the slave clock. The electrical circuit in the signal transmitter—after the impulse has been given—is through the impulse lever, the contact O, the armature and electromagnet P, and the battery, to the dial mechanism of the signal transmitter: also, if the contact arm R is closed, through the transmitting relay, from the local contacts of which the C.T.O. line is operated.

At the G.P.O. there is a special master clock fitted with two cams, the front cam revolving once every hour and the rear cam once in every 24 hours. Slots in the cams, close contacts at appointed times in the morning and evening of each day and operate two relays, which act as locking devices, joining the Greenwich Observatory line direct to the Rugby Radio Station. The time signal passes through a standard B relay and, on the local contacts of this relay, suitable voltages are applied to operate the land line apparatus of the Rugby radio transmitter. The normal arrangements for wireless transmission at the Rugby Radio Station are shown in skeleton form in Fig. 16.

The normal lag of the whole of the mechanical and electrical network has been very carefully measured and an allowance of 30 milli-seconds has been found to be sufficient to cover it. The lag, which has remained practically constant for three years, is compensated for by sending out the time signal from the Observatory 30 milli-seconds in advance of exact time.

An arrangement has been made at the Royal Observatory whereby each outgoing signal is recorded on a tape receiver and also, on the same receiver, a registration is made of the time of emission of the same signal at Rugby. In this way the data given on Fig. 13 has been built up.

The calculated allowance of 30 milli-seconds may vary from time to time within very small limits. There may, for example, be minute differences in the adjustment of relay contacts, or the setting of the master clock at the Observatory may not always be 100% accurate, or again, the tape record-

ing arrangements at Greenwich, associated with both the outgoing and incoming signals, may be concerned with a very small portion of the error. It will probably be agreed that it is difficult to apportion the blame for any portion of a " lapse " of the order of 3 milli-seconds in such a complicated network !

The time signal is of the rhythmic type and consists of 306 beats 0.1 second in length in 300 seconds, or at the rate of 61 beats per minute. The commencing signal, and also that at the end of each minute, is sent in the form of a dash 0.4 second in length, exactly on the zero or O of GMT.

The signal is sent twice daily, at 09.55.00 GMT and 17.55.00 GMT. These times have been selected as the most suitable for reception in all parts of the world. A printed notice is issued monthly by the Admiralty giving particulars of the corrections required to the standard master clocks controlling the emission of wireless telegraphy time signals in different parts of the world. These corrections are made as the result of observations carried out on the transit circle at Greenwich. The notice for October, 1930, is reproduced in Fig. 17 and the details given provide a useful comparison between the performance of the different master clocks, and, incidentally, pay the highest of compliments to the work of the British station.

The B.B.C. Time Signal.

An important and universally popular feature of the B.B.C. programme is the regular broadcasting of Greenwich Mean Time by means of the " six pips " signal. Although the Post Office is not responsible for the signal, there is a partnership of interests in the matter, in that the Mean Time Clock at Greenwich Observatory used for B.B.C. purposes, is the same clock from which the hourly synchronizing signal is sent to the G.P.O. This clock is synchronized by the *Master* Mean Time Clock, a Free pendulum clock on the Synchronome system. The physical circuit between the Observatory and the studio at Savoy Hill is rented from the Post Office.

A skeleton diagram of the Mean Time Clock circuit at the Observatory, showing also the manner in which the B.B.C. time signals are transmitted, is given in Fig. 18. The three electrical contacts shown in diagrammatic form are operated from the escape wheel of a single

DIAGRAM OF THE GREENWICH MEAN TIME CLOCK CIRCUIT FOR THE B.B.C. TIME SIGNALS. "SIX DOT SECONDS."

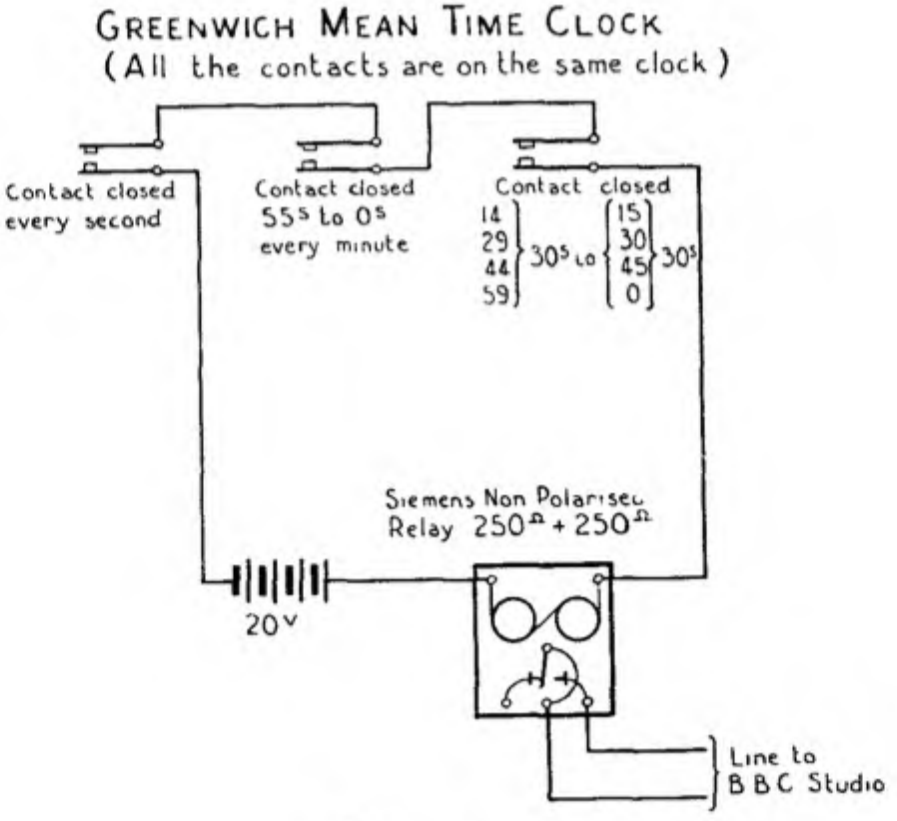

FIG. 18.

clock mechanism, and the signals are fully automatic. A Siemens relay is brought into circuit for one minute every fifteenth minute during the 24 hours, whilst a second contact closes from 55 seconds to 0, *i.e.*, 60, seconds, every minute during the 24 hours. A third contact is closed every second. By means of this arrangement, a succession of six beats can be transmitted from 55 seconds to 0 second, the beginning of successive beats being separated by intervals of one second, and the duration of each beat being approximately one-tenth of a second. The last or final beat denotes zero, that is to say, if the broadcast signal is emitted at the hour, the last beat of the series would denote the exact hour. The selection of suitable times for the broadcasting of the time signal is controlled at Savoy Hill. The musical note of the signal is obtained through the agency of a valve, oscillating at audio frequency, in the studio. The six beats from the clock at the Observatory are made to control the grid circuit of the oscillating valve, so causing the familiar six "pips."