Proceedings of the Institute of Radio Engineers
Volume 19, Number 3 *March, 1931*

A RADIO METHOD FOR SYNCHRONIZING RECORDING APPARATUS*

By

T. Parkinson† and T. R. Gilliland‡

(†Formerly Bureau of Standards, Washington, D. C.; at present, University of Michigan, Ann Arbor, Michigan; ‡Bureau of Standards, Washington, D. C.)

Summary—*A method is described for running two radio fading recorders at the same speed when it is necessary to have one of the recorders portable so that it can be moved to various distances from the other. In the work reported each of the recorder drums was propelled by a synchronous motor of the type used for clocks. Since wire connections were not practicable the portable recorder was controlled by a radio transmitter placed at the fixed station. The same 60-cycle source of power used to drive the synchronous motor at the fixed station was used to modulate the transmitter, the signal of which was received at the portable station and amplified sufficiently to drive the synchronous motor there. With the transmitter working on low power it was possible to drive the recorders at the same speed when separated by a distance of 16 km. A method is described for marking the two records simultaneously so that they can be superposed.*

THE need of synchronizing duplicate recording mechanisms when widely separated in space and when placed in situations which prohibit wire connecting circuits, resulted in the development by the Bureau of Standards of a simple radio method which may be of interest in other lines of research. When it became desirable to compare graphic fading records of the same radio transmission as measured at two points of varying separation, it was found that no recorders were available which could be depended upon to run independently, and at the same time insure equal speeds of the recording tapes. Where wire connections were permissible, synchronous motors driven by a common power supply were satisfactory, but for the projects in hand it was necessary to have one receiving station complete in itself on a laboratory car, which could be moved to any desired distance. Experiments with spring-driven apparatus and with governor-controlled electric motors showed that only at accidental intervals was there sufficient agreement in their speeds to produce pairs of records which could be superposed for comparison. Even slight discrepancies in speed were serious since the changes studied were often very rapid, sometimes having periods as short as five seconds.

Because synchronous motors of the type used for clocks had given very satisfactory results when supplied by wire from the same source

* Decimal classification: 365.3. Original manuscript received by the Institute, November 21, 1930. Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

of alternating current, it was thought possible to arrive at the same result by radio. Initial experiments verified this belief, and the system hereinafter described was developed and found satisfactory.

The general method consists of the transmission from a transmitter of the half-wave, self-rectifying type with 60-cycle plate supply, and the reception and amplification of this transmission in such a manner that the output is sufficient to drive the 6-watt synchronous clock motor, which in turn propels the recorder drum through a system of gears. The same 60-cycle supply which is stepped up in voltage to sup-

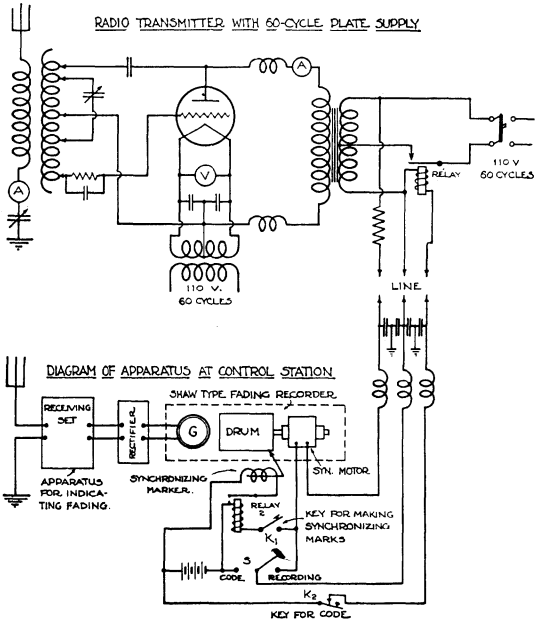

Fig. 1.—Schematic diagram of apparatus at control station.

ply the plate of the transmitting tube is also used to operate directly a second synchronous motor and recorder near the transmitter, suitable reactors and condensers being used in the connecting lines to prevent these conductors from introducing a strong field at the point where receiving measurements are to be made.

Figs. 1 and 2 show the connections used at the control station and at the portable station, respectively.

In order that the records might be superposed for comparison, it was necessary that some method be devised for marking them simultaneously. This was accomplished by attaching a small relay, *B*, (Fig. 2) to the iron yoke of the synchronous motor at the portable station in

such a manner that the relay is held open as long as alternating current flows in the motor circuit. When the flow is stopped the relay closes the battery circuit, causing a magnetically-operated pencil to

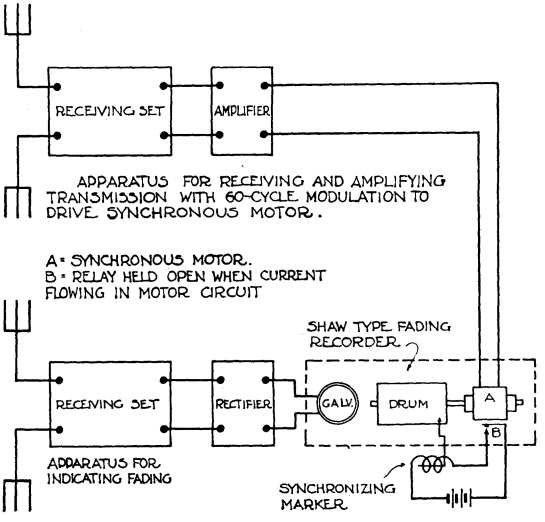

Fig. 2.—Schematic diagram of apparatus at portable station.

make a mark on the record. With the circuits as shown in Fig. 1 the closing of key K_1 with switch S in the recording position, causes relay 1 to open the alternating-current supply, thus stopping the transmitter and the motor at the control station. The closing of K_1 also oper-

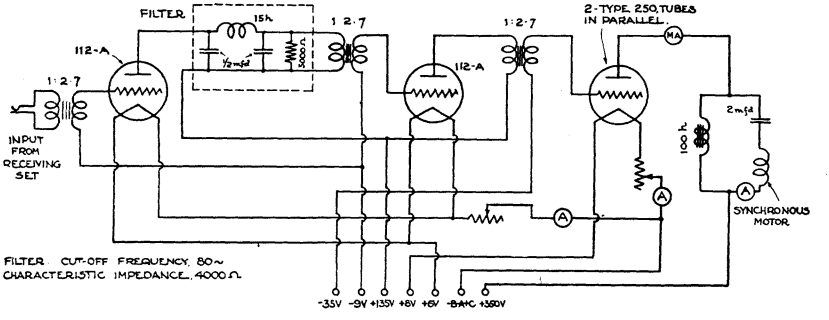

Fig. 3.—Circuit diagram of amplifier used for driving synchronous clock motor.

ates relay 2, thus causing the marker to make a mark on the record. But the stopping of the transmitter also stops the motor at the portable station and causes a mark to be made upon the record there. Thus the closing of K_1 stops the recorders at both stations and causes marks

to be made simultaneously on both records. Both recorders will start out together when K_1 is opened.

It is possible to use the same transmitter to communicate by telegraph with the portable station merely by throwing switch S to the left position and operating K_2.

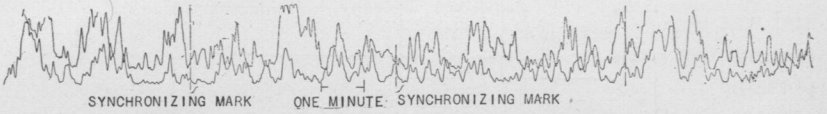

Fig. 4.—A pair of radio fading records made simultaneously on transmission from WJZ, Boundbrook, New Jersey. Record shown with solid line made at field station near Kensington, Maryland. Dotted record made in laboratory car at 0.7 km distance from field station.

Fig. 3 is a diagram of the amplifier used for driving the synchronous motor at the portable station. Best results were obtained when the condenser in the output circuit was of the size which tuned the series circuit including the condenser and motor to 60 cycles. For the motor

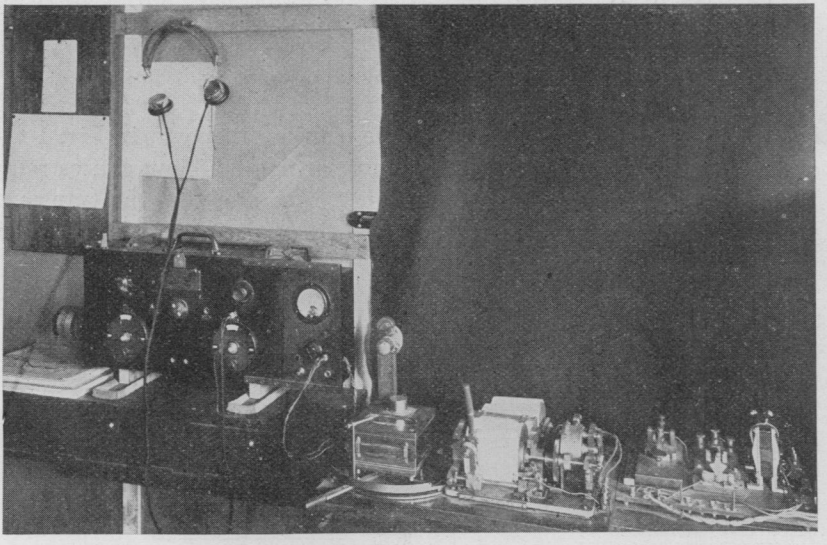

Fig. 5.—Photograph of apparatus at control station. Receiving set on the left with galvanometer and recorder in center. Control switches and keys at right. Synchronizing marker can be seen at right edge of recorder drum.

used, a 2-μf condenser gave best results. Although it was possible to drive the motor by using only one type 250 tube in the output circuit, more stable operation resulted when two tubes were used in parallel. In testing out the amplifier it was found, by means of an oscillograph,

that the motor would operate better as the wave-shape of the current approached pure sinusoidal form. In order to eliminate higher harmonics a low-pass filter with a cut-off at 80 cycles was placed between the first and second stages.

A single 250-watt tube was used in the Hartley transmitter circuit arrangement shown in Fig. 1. The frequency used was near 1700 kc, and was adjusted so that it would not interfere with the near-by receiving measurements. No trouble was experienced in controlling the portable recorder at a distance of 16 km when the transmitter was operating with small output. If necessary, it should be possible to work at much greater distance.

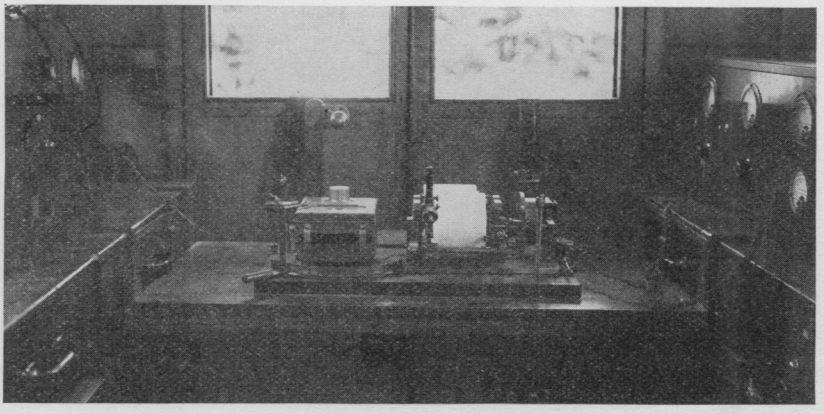

Fig. 6.—Photograph of apparatus at portable station in laboratory car. Receiving set for fading measurements at left. Galvanometer with recorder in center. Set for receiving 60-cycle transmission at right below. 60-cycle amplifier at right above.

Fig. 4 shows a pair of typical records which have been superposed. The record shown with the solid line was made at the control station, while the dotted record was made at the portable station in the laboratory car at a distance of 0.7 km. Both are records of transmission from WJZ, Boundbrook, New Jersey. (760 kc), and were made at 9:00 P.M., E. S. T., December 13, 1929, near Kensington, Maryland. The tape speed used was 4.75 cm per minute.

Although in the arrangement described one of the recording stations was placed near the transmitter and power lines, it would be possible to make it similar to the portable outfit and place it in any desired position. Any number of recorders of the type described might easily be controlled by the same transmitter.

Fig. 5 is a photograph of apparatus at the control station, while Fig. 6 shows apparatus of the portable station set up in the laboratory car.

The writers wish to acknowledge the valuable assistance given by W. H. Doherty and G. L. Davies in the design and construction of the apparatus.