The Problem of Synchronism in Television

A Description of the Method which has been Adopted in John L. Baird's Apparatus

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RESULTS OF IMPERFECT SYNCHRONISM

This difficulty has given rise to a common misconception, prevalent even in technical circles, that the difficulty of synchronism in television is due to some extent, overrated.

Quite commonly the statement has appeared that an increase in phase of only one per cent between the transmitter and the receiver is sufficient to spoil the definition of the received image. Were such a statement true, the problem of synchronism would indeed be one of almost insurmountable difficulty.

Fortunately, however, an analysis of the facts shows that if the transmitting and receiving mechanisms are out of phase the image is not blurred, but merely displaced; the clearness is not altered. The effect is that the image of the man's face, instead of being visible squarely in the center of the receiver screen, is displaced to the right or left.

At the end of the transmission of a picture, and before commencing to transmit another, the two remotely separated mechanisms can, if desired, be stopped and simultaneously restarted, thus ensuring that the receiving mechanism starts at the beginning, in step with the transmitter.

In television, however, both mechanisms are running continuously, and sixteen complete pictures are transmitted per second. Under these conditions it is possible that both mechanisms may run at the same speed and still the image will be incorrectly received at the distant receiver.

The distortion, or blurring of a television image, is caused only by differences in speed prevailing at the transmitter and receiver, that is to say, by lack of isochronism. The problem of synchronism is much simpler of solution than that of synchronism. Possibly these words are not familiar to readers, and it is not out of place to define them here.

ISOCRONISM AND SYNCHRONISM DEFINED

When two mechanisms are said to be running in isochronism, what is meant is that they are running at the same speed, but are out of step. For example, if both mechanisms are running at the same rate would be in exact isochronism, although the hands of one might point to 2.00 and the hands of the other to 3.00. In other words, the hands of both clocks must indicate exactly the same hour.

When the first efforts were made to achieve television, attempts were made to obtain isochronism by means of the methods used in telegraphy; i.e., by means of pendulums and tuning forks. Such methods, however, do not lend themselves to television, for they are not sufficiently accurate.

By using synchronous motors, however, perfect isochronism can readily be obtained. In such a mechanical and electrical arrangement the components involved are not so complicated as is the case with the other methods. It was with the aid of such motors that the first successful results in telecasting were achieved by John L. Baird, the British inventor.

One of these motors comprises, essentially, an armature, or rotor, supplied with an alternating current, and a stator supplied with direct current. Or the rotor may be supplied with D.C., while the stator takes the A.C. The speed at which such motors run is dependent entirely upon the periodicity, or frequency, of the alternating-current supply, and upon the number of poles in the rotor or stator, whichever is receiving the A.C.

At first glance it might be supposed that synchronism between two television mechanisms could be obtained by using two exactly-similar motors, controlled by rheostats and run at exactly the same speed, as indicated by a form of speedometer. This can not be done, however, for ordinary electric motors continually vary in speed, due to small variations in the supply current and other reasons. This has been referred to as "hunting" and, before television can be successfully achieved, the hunting properties of at least one of the motors must be brought under exact control. The task of the synchronous motor is to act as controller.

HOW ISOCRONISM IS OBTAINED

At the transmitting end the image-exploring mechanism is driven by an ordinary electric motor, either A.C. or D.C., depending upon the supply available. Mechanically coupled to the same shaft is a small A.C. generator. The periodicity of the output of this machine may have any convenient value; but the higher it is, the better it is, within very reasonable limits.

This A.C. output is then conveyed (as will be discussed later) to the receiver, where it is caused to drive a synchronous motor which is mechanically coupled to the same shaft as the main driving motor which operates the image-exploring mechanism of the receiver. This main driving motor, like the main driving motor at the transmitter, is
for rotation of the mechanism; although it is questionable if any patent involving the use of a synchronous motor as a means of obtaining synchronism can be considered valid, because the synchronizing principle, to use the phraseology of the Patent Office, has been "long known to the art." However, to Mr. Baird belongs the credit of being the first successfully to apply this principle.

**THE TRANSMISSION MEDIUM**

It has been mentioned that the output from the A.C. generator at the transmitter is "conveyed" to the receiver.

It is, of course, impossible at the present time to transmit power by radio or over a telephone line, therefore, some other means must be provided to supply the A.C. impulses to the transmitter and the receiver, and this is the function of the synchronizing mechanism, which is called the synchronizing medium.

The modulating effect, of course, takes the form of a continuous wave of modulated frequency, corresponding to the frequency of the generator output. It can, without difficulty, be carried over the same channel which carries the television impulses, filter circuits being used at the receiver to separate the two sets of impulses.

At the receiving station the synchronizing note, after being filtered out from the transmission channel, is amplified and used to control the supply of the A.C. synchronous motor.

To make the operation clear to our readers, we will describe the apparatus used to make the first public demonstrations, given in London in April, 1925. At this demonstration, which was an early effort with crude apparatus, only shadows were shown, and two separate channels were used, one for the television impulses, and one for the synchronizing impulses. However, the method of synchronism employed was essentially the same as that described above.

The transmitter was connected to two small loop antennas, one of which transmitted the television signals, and the other transmitted the note caused by the A.C. generator. At the receiving station, which was at the other end of the same room, two similar loops were employed to pick up the two sets of impulses.

**BAIRD'S ORIGINAL APPARATUS**

The note, after being picked up by the loop and its associated tuning apparatus, was passed through a 3-tube A.F. amplifier, the output of which was connected to a telegraph relay. The amplified alternating current caused the reed of the telegraph relay to make contact first in one direction and then in the opposite direction. That is to say, the reed was caused to vibrate, or oscillate, between the two fixed contacts set on either side of it. The output of the relay was therefore an alternating current, directly in phase with the alternating current generated at the transmitter.

In order to synchronize the two machines, the receiver's main driving motor was first run up to speed, under the control of a rheostat. The input to the synchronous motor was controlled by means of a double-pole switch, which connected it to the output of the relay. Across the poles of the switch were connected two little lamps.

As the synchronous motor and the output of the relay came into phase the lamps flickered, the flickering becoming less and less as the speed of the synchronous motor (driven by the receiver's main driving motor) approached that of the generator at the transmitter. When the speeds became exactly synchronous the flickering ceased and the lamps went out entirely. At that instant white light was shown on the receiver's relay fed to the synchronous motor. This current was sufficient to prevent the synchronous motor creeping out of phase, which, in turn, prevented the main driving motor from hunting.

The above method is essentially similar to that used by Baird at present, with the exception that the telegraph relay is understood, no longer employed. The output of the last tube of the amplifier is now applied direct to the synchronous motor.

It will be understood, of course, that the synchronizing current is almost infinitely small, but where well-balanced mechanisms are used, only a very small synchronizing current is necessary to keep the main driving motor of the receiver from hunting.

As already explained, any convenient supply may be used to run the main motor. Mr. Baird uses D.C. motors, because the current supply to his laboratory happens to be direct. The A.T. & T., whose synchronizing methods are essentially the same as Mr. Baird's, used A.C. motors, simply because the power supply was in that form.

During the course of his original experiments, Mr. Baird used a synchronizing frequency of 60 cycles; but, as already mentioned, the higher the periodicity used, within limits, the better the results; and I understand that at present Mr. Baird is employing a synchronizing frequency in the neighborhood of 200 cycles. The employment of this frequency enables him to obtain a much finer degree of synchronism, and this improvement, in conjunction with perfectly-fitted and better-finished mechanisms, has resulted in a vast improvement in the quality of the received image.

Whereas his original television images were somewhat lacking in detail and marred by a constant flicker in the picture, results are remarkable for their improved detail and the almost complete absence of visible "grain" and flicker. To these improvements the writer can personally testify, having witnessed both the earliest and the most recent demonstrations given in Mr. Baird's laboratories.

The receiver of Mr. Baird's television system, which is used with great success, is illustrated.