How to Synchronize

One of the Problems Which Still Confront ing and, Once Obtained, the Maintenance of Receiver Scanning Disc and the Transmitter Outlines Some Practical Systems Which

***By D. E.**

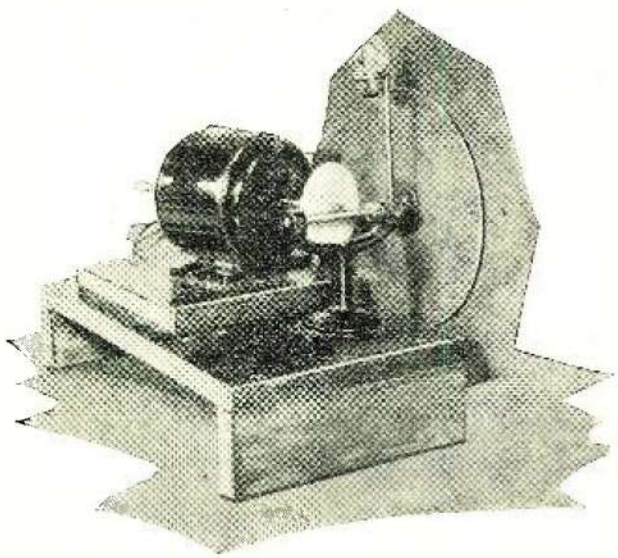

Fig. 1. Televisor with an adjustable friction drive motor to vary the speed of the disc. See Fig. 7 for schematic layout

IF you have been one of those whom the television "bug" has bitten, you have built up your television receiver and have been able to get the characteristic buzz-saw signals of the television picture on your loud speaker. If so, the next thing in line is your televisor. If you are on the same power system as some television broadcasting station and you have plenty of money, the easiest thing to do is to buy a complete televisor unit or a kit-televisor, both of which are now on the market. If, however, there are no broadcasting stations on the power system to which you could connect, or if you happen to be supplied by direct current, you will naturally be at a loss to know how to synchronize a scanning mechanism or a disc with any transmitter you wish to receive.

Synchronization, of course, is obtained when the scanning mechanism runs at exactly the same speed as the scanning mechanism at the television transmitting station, but we must go even farther and obtain what is called "isocronism." By this is meant that the receiving and transmitting scanning mechanisms are not only running at the same speed, but are in phase with each other, namely, that each light impulse at the receiving end is made to appear in its correct position in the picture and that the whole mechanism has been corrected for any phase displacement between the transmitter and receiver.

Synchronizing means—There are three general methods of obtaining synchronism for television. The first requires some sort of manual adjustment to vary the driving speed of the receiver scanner. The second method can be called semi-automatic synchronism which requires no manual adjustment but can be used in limited territories only. The third is full automatic synchronism which requires no manual control to maintain synchronism, it merely being necessary to push a button and tune in the signal. In general two types of power supply also have to be considered, namely, direct current and alternating current and we will consider each of the three methods of synchronizing in respect to the two types of power supply available.

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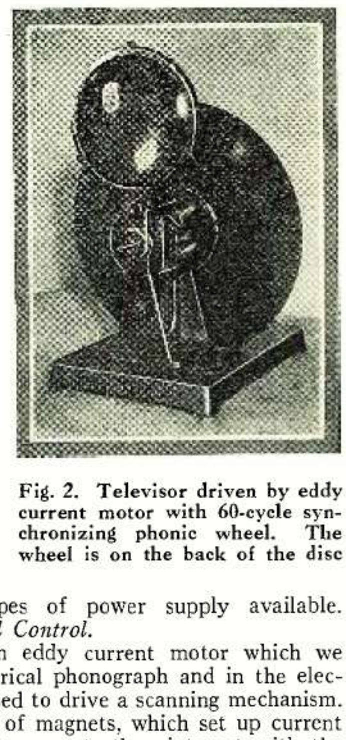
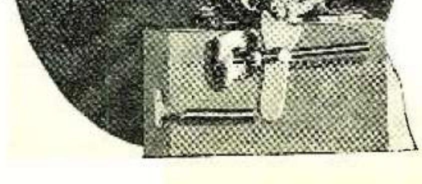


Fig. 2. Televisor driven by eddy current motor with 60-cycle synchronizing phonic wheel. The wheel is on the back of the disc

1. *Variable Method—Manual Control.*

(a) Using this method an eddy current motor which we have met before in the electrical phonograph and in the electric watthour meter can be used to drive a scanning mechanism. This motor consists of a set of magnets, which set up current in an aluminum disc. These currents then interact with the magnetic field of these magnets or others to furnish driving torque. By proper design its speed can be controlled by varying the current through the motor, by varying the phase relationship between the magnets either electrically or by mechanical means, or by varying the gap between the magnets and the driving disc. Its speed can also be varied by friction on the disc. Fig. 2 shows a televisor driven by an eddy current motor as described above. The eddy current motor will only operate on alternating current.

(b) A direct current or Universal motor can be used to drive the disc with a manual control which varies the applied voltage. This is most usually accom-



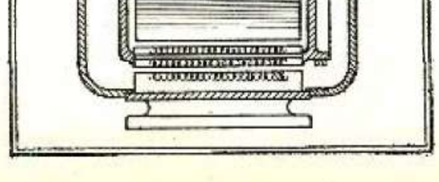


Fig. 3. The scanning disc is driven by a universal motor. Its speed can be controlled by shifting the brush position, which varies the back voltage generated by the armature

Fig. 4. Diagram showing two motors in one. The inner motor is a synchronized motor and its field is rotated backward or forward to control the overall speed

for TELEVISION

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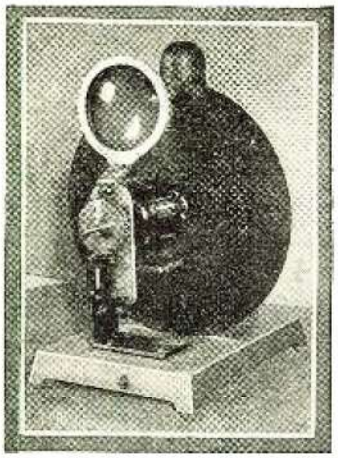


Fig. 5. Televisor driven by a d.c. motor and held in synchronism by the phonic wheel shown in the foreground. Synchronizing pulses are obtained at picture line frequency, 720 cycles

plished by means of a resistance in series with the motor supply. The back voltage generated by a motor may also be used to vary its speed by shifting the angle of the brushes (see Fig. 3), shifting an adjustable third brush, or changing the resistance of the field by means of a rheostat. This method can be used on a.c. or d.c. voltage supply, depending upon the type of motor selected.

(c) An induction or d.c. motor which has nearly constant speed can be used to drive a scanning disc in the manner shown in Fig. 1. Here the motor is mounted on an adjustable base and the power is applied to the scanning disc by means of a light rubber disc mounted on the motor shaft. By shifting the position of the motor at right angles to the disc this rubber drive will touch the scanning disc nearer or farther from its center and thus vary the speed at which the disc is driven. A very fine adjustment of speed can be obtained by a small movement of the motor base. The scanning disc load is usually light and hence varying its speed does not appreciably change the speed of the motor and as long as the voltage supplying the motor remains fairly constant, very accurate speed control can be obtained by this method.

(d) On both a.c. and d.c. motor drives a flutter type of contact governor can be arranged to throw in or short-circuit a series resistance if the speed is too slow or too fast. These

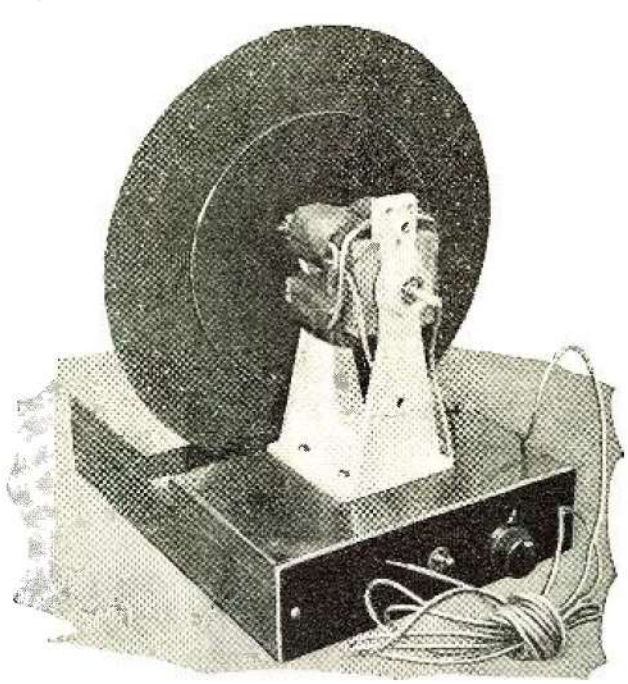


Fig. 8. Home televisor made from the Jenkins kit. A magnifying lens is also supplied as optional equipment

devices maintain an over-all constant speed but there is considerable hunting or fluctuation in speed which is usually experienced even with the most carefully designed governor.

The phonic wheel or simplified synchronous motor has offered a means of manually obtaining constant speed. Power can be applied to this wheel from a tuning fork through a suitable amplifier which is usually constructed using vacuum tubes. The period of vibration of the tuning fork can readily be changed by varying its length or its inertia through the use of a weight. The power to drive the phonic wheel may be supplied by another motor and it can be held in step by means of a tuning fork generator.

Still another method is by using a d.c. motor to drive an alternator. A d.c. motor field should be supplied by rectifying the alternator output through an adjustable tuned filter and by adjusting this tuned filter the speed of the system can be maintained fairly constant.

A still further variation is to use one synchronous motor, the field of which is driven by an easily variable speed induction motor so that by changing the speed of the induction motor by a large amount, only a small variation will result in the compensated speed of the synchronous motor. A sketch of such a motor is shown in Fig. 4.

2. *Semi-Automatic Motors.*

Among semi-automatic motors we have the synchronous motor which, when connected to (*Continued on page* 184)

Fig. 6. A schematic layout of a d.c. motor-driven televisor synchronized by a phonic wheel (immediately to right)

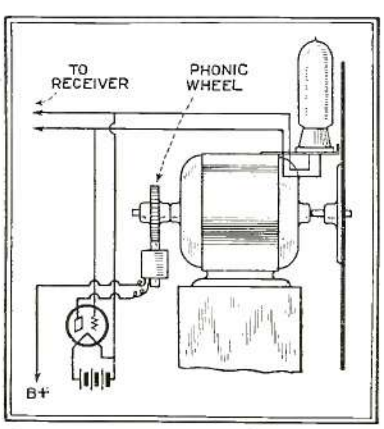
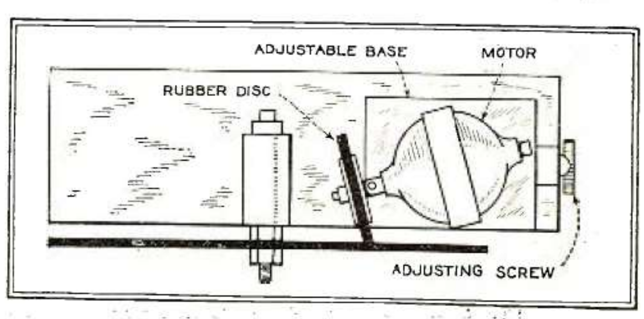


Fig. 7 (extreme right). Schematic layout of a televisor with motor being adjustable on a sliding base to vary the disc speed



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(*Continued from page* 135)

the same power system as the transmitter, will maintain the speed of the Radiovisor at the same speed as the transmitter. The limitation here, however, is that the supply must be a.c. and from the interconnecting power system. Under these conditions this method of synchronizing is ideal if the proper precautions are taken. Adjustments are made necessary by differences in phase angle between the receiver and the transmitter. This phase angle at times is variable, although in 90 per cent. of the cases it remains constant throughout residential districts. For this, compensation means must be provided to shift the field of the synchronous motor through a 90-degree arc.

Another variation of the synchronous motor may be a phonic wheel driven by any means of power. In the Jenkins Model 100 Radiovisor this means of power is an eddy current motor as shown in Fig. 3, or a direct current motor as shown in Fig. 8. All of the power necessary to drive the mechanism is thus supplied by an external force. The phonic wheel for receiving 60-cycle impulses from the interconnected power system acts merely as a break or speed control on the whole device. It is obvious that the semi-automatic systems of synchronizing described above will not operate on d.c. and can only be used where the same interconnected power system is available between the receiver and the transmitter. If these devices are used on other power systems the television picture will be found to drift from side to side, sometimes slowly and sometimes swiftly, depending upon the variations between the frequencies of the power systems.

3. Fully Automatic Synchronizing Means

Fully automatic synchronism is obtained when an impulse sent out simultaneously with the picture is used to control the speed of the receiving mechanism. This impulse can be a separate frequency which controls the speed of both receiver and transmitting mechanism. It can be an impulse generated by the transmitter and sent out separately to control the receiver or it can be a frequency which is part of the picture frequency which occurs with sufficient strength and regularity in the television signal itself to control the speed of the receiving mechanism. In Fig. 5 is shown a Jenkins Model 100 Radiovisor with a synchronizing device. The power is supplied by a driving motor which may be either an eddy current motor or a direct current motor and the speed of the whole mechanism is controlled by the frequency which is applied to the coil shown in the immediate foreground. This coil controls the speed of the phonic wheel and hence that of the whole mechanism.

In every picture which has 48 lines and 15 frames per second as sent out by the Jenkins transmitters, there is a very strong 720-cycle component. This frequency can be used to drive a resonant tuned circuit feeding a vacuum tube amplifier. The output of this tube can then be used to supply the braking power on the phonic wheel. This has been tried out very thoroughly and works very satisfactorily for the type of picture we are now transmitting by television.

Another type of fully automatic device is a d.c. or a.c. motor driving a generator. This generator can then be loaded with a vacuum tube circuit. The vacuum tubes act as rectifiers and when the grids are excited with the proper frequency they will maintain the motor system at constant speed.

General Considerations—Of the above systems that which is by far the most inexpensive and simplest is shown in Fig. 1 where the position of the motor is varied. This, however, requires manual control. If you are fortunate enough to be located on an a.c. power system which supplies a television transmitter, then the simplest way to obtain good pictures is to secure a televisor which will operate on the a.c. systems and which can be made to maintain synchronism throughout the television program. If you are located on a d.c. system or on some other a.c. power system from that supplying the transmitter, you are advised to secure a televisor which has a full automatic synchronizing mechanism with it. This will require the use of the phonic wheel with other driving means and a special adapter for your receiver for the necessary phonic wheel control. This, however, can be made to give full automatic synchronism on any picture signal which has enough power to modulate the usual television lamp.

Synchronism will probably continue to be a problem for some time, but the methods outlined above, especially the latter ones, have been found to be entirely satisfactory and there is no reason why any experimenter, by adopting one of these methods best suited to his needs, cannot solve this problem.

It is recognized that as the detail of the pictures increases this problem of synchronism will become more important and it is possible that the use of 60 cycles for synchronism will not be sufficient to prevent blurring of the images due to phase shift and other variations in the mechanism. It has been estimated that for a 100-line picture at least a 1,000 cycles per second synchronizing signal be utilized to maintain correct synchronism. We have not, however, yet reached the 100-line stage and 60 cycles per second synchronizing impulses are amply sufficient to bring in really good and clear pictures in the televisor.

The amateurs will be very much interested to know that the Bureau of Standards is planning to put on the air a 5,000-cycle synchronizing note with 10 kilowatts of power on 10 meters, from Washington. It is entirely possible that the future may see a powerful station sending out a synchronizing frequency to which receivers and transmitters alike can be tuned.

Let me say in conclusion that if this television "bug" has bitten you, you will find it extremely fascinating, for into this art enters not only electricity but much more in the realm of physics, as it deals with mechanical, optical and intricate electrical problems. What more can the experimenter ask?