BRITISH TELEVISION

The television receiver which is discussed below, was first described in our contemporary, "Wireless World." There are few points of similarity in British and U. S. design practices, and, as our author points out, the differences seem to favor the American system.

DESPITE THE INTEREST and activity in television in the United States, almost nothing has been written on the subject of television receivers. In fact, the description of the Farnsworth receiver, in RADIO ENGINEERING for September 1936, is to the writer's knowledge, the first published description of a modern television receiver.

In England, however, the situation differs greatly from that in the U. S. due to the control of television transmission by the B B C, and much information has been released through the press during the last few months—particularly since the institution of daily test broadcasts. These broadcasts, which began at about the same time as RCA's Empire State emanations, are conducted for those who care to purchase or construct receivers as well as for the benefit of transmitter and receiver engineers.

In the belief that information on practical receivers will be of interest to the fraternity, at this time, we shall attempt to analyze the design of a recent television receiver described by *Wireless World* of December 18, 1936. Also, a comparison between this English receiver and the Farnsworth unit may be of interest.

Of primary interest is the statement that this receiver was designed to operate on a "single sideband," an idea recently advocated by Epstein of RCA at the Rochester IRE convention. This is a misnomer, of course, as both sidebands are transmitted; the low-frequency end of one sideband is utilized in addition to the other complete sideband. The term sesqi-sideband, originated by Harold Wheeler, of Hazeltine Corporation, would seem more accurate. This method of reception is of interest because it reduces the receiver passband required for high definition, making its design simpler. The ultimate goal, of course, will be the suppression of the second sideband at the transmitter, thus doubling (approximately) the number of available channels.

To return to the English receiver, this was designed to operate from either a doublet or Marconi antenna, the latter to be capacitively coupled to the grid of the converter tube. Experience seems to indicate that a vertical doublet, well in the clear and with a well-designed transmission line to the receiver, is necessary in any location to obtain favorable signal-noise ratios.

Next, is the frequency changer, which employs a triode-pentode (similar to the 6F7, but with twice its conversion transconductance). This type of frequency

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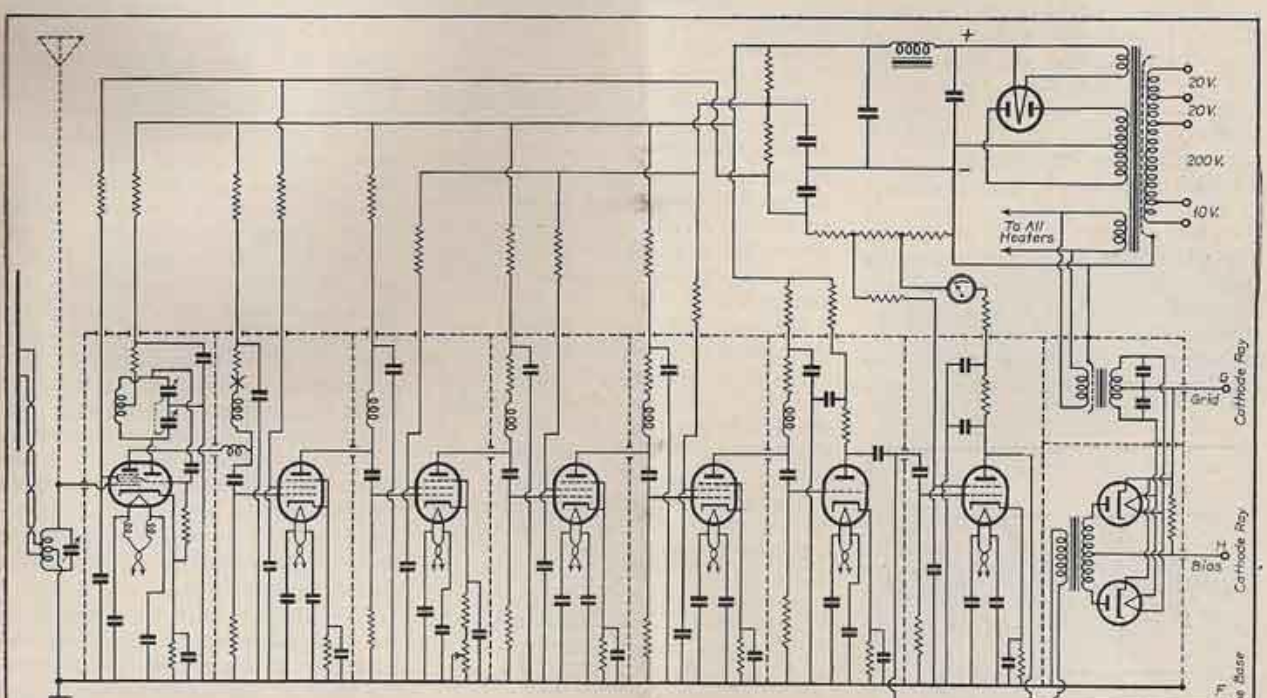

Fig. 1.

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changer was chosen because of its freedom from interaction, although it would seem that for complete isolation between the two functions of the converter, the 6L7 mixer and triode oscillator should be more satisfactory. Farnsworth makes use of this design principle by utilizing the Acorn pentode as first detector, and a triode as oscillator. This should give not only greater freedom from "pull-in," but the receiver noise level should be materially lower due to the fact that the r-f grid resistance of the Acorn may be as high as 75,000 ohms at 50 mc, while it is probable that this quantity may be as low as five to ten thousand ohms in the conventional tube. This difference in input conductance should result in an improvement in conversion transconductance of 5/10 to one. Also, if the diagram (Fig. 1) is compared with that of the Farnsworth receiver, it will be noted that the signal frequency circuits of the former are not loaded with resistors as are those in the American receiver. This is doubtless due to the load imposed by the low grid resistance of the converter tube which should be sufficient to allow fairly uniform transmission of the modulation frequencies although it would seem advisable to use resistors for this purpose—when practicable.

The next point of note is that no attempt is made to gang the two controls in the English receiver. This is unimportant, however, because but one transmitter is in operation in England at this time. Also, this receiver was designed to permit of duplication by the advanced experimenter, who usually lacks the precision laboratory equipment to undertake such a job with confidence. However, a similar tuner was recently described in the same journal (W.W.-7/24/1936) in which these controls were ganged for single control.

Before considering the i-f amplifier, it might be of interest to mention that the designers of the English receiver chose the Colpitts oscillator because of its freedom from parasitics at the very high frequencies, while, Farnsworth makes use of the Hartley circuit, although his use of the 955 Acorn in this circuit may be partially responsible for its success.

It will be noticed that no provision for sound reception is shown in the diagram. This is due to the fact that the designers were probably of the opinion that many of its builders were already equipped with sound receivers or adaptors for use on those frequencies. They suggest, however, the sound i-f may be "picked off" the mixer plate circuit and fed to its own amplifier. Little need be said about this amplifier, as its design is entirely conventional. A point of difference, however, between English practice and American is that the English recommend the sound i-f be taken from the converter plate while Farnsworth makes use of two mixers, both 954 Acorn, fed from the input tuned circuit feeding their respective sound and picture amplifiers. In both systems, a common oscillator is employed.

It would seem that the American receiver embodies much better design in its input and frequency-conversion circuits. The i-f amplifiers, however, should be equally effective. The advantages possessed by the English system are, largely, ease of construction and freedom from many adjustments; also, greater stability (freedom from incipient regeneration) should result from this system.

In discussing the two i-f amplifiers, it will be seen that the Farnsworth amplifier is quite conventional—3 stages coupled by double-tuned over-coupled circuits using 954 pentodes. The only departure from the usual lies in the shunting of each tuned circuit with resistance in order to give a 6-mc flat-topped resonance curve. The foreign receiver, however, employs 5 i-f stages. Conventional variable-mu pentodes are employed in connection with impedance coupling. The plate loads for these tubes consist of inductance (200-400 μh) and resistance (3-5000 ohms) which gives a slightly rising gain/frequency characteristic. This type of coupling was described by Cocking in W.W. (4-26-1935 & 5-3-1935) and also by von Ardenne in his recent book "Television Reception." By suitable design, any reasonable gain/frequency characteristic may be obtained, which with freedom from the complications of multiple-tuned circuits with their usual inherent regeneration, should prove very attractive to the designer of commercial television receivers.

Because this impedance-coupled i-f amplifier transmits uniformly a band width of 5 mc, the advantages of sesquisideband reception are not evident, inas much as a total bandwidth of only 5.5 mc is required for normal reception of a 450-line picture (Engstrom-IRE). However this point is stressed, so that single sideband reception (so-called) is apparently advantageous from other viewpoints.

To improve the stability in this five-stage amplifier, i-f gain control is effected by bias control of but one tube, instead of the more normal method of passing cathode current from several stages through a common resistor. This latter method might cause feedback, due to the resistance common to several cathodes.

It will be of interest to note that the fifth i-f amplifier employs a triode of the low plate resistance, semi-power output variety. This tube feeds both the synchronizing tube and the second detector—a linear demodulator—via an untuned "iron dust" core transformer.

The second detector differs greatly from that in the Farnsworth receiver, as the latter is a plate detector (954 pentode) while the former is a full-wave diode looking into a load resistance of approximately 12,000 ohms. As very little i-f should be present across the output of a full-wave diode, no carrier frequency filtering is resorted to, other than stray capacities. This rectified signal is then fed directly to the cathode-ray tube control-grid (no coupling condenser used).