The Manchester-Edinburgh Television Radio Relay System

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THE main Scottish television broadcast transmitting station now under construction at Kirk O'Shotts, a point about midway between Edinburgh and Glasgow, is being connected to the television relay network by means of a radio system linking Kirk O'Shotts and Manchester. Invitations to tender for this radio system were issued by the Post Office early in January last year, the contract being placed with Standard Telephones & Cables in June, 1950.

The route, shown in Fig. 1, was influenced to some extent by the requirement that it should pass reasonably close to Newcastle to enable a short spur to be provided at some future date for the proposed B.B.C. television station for that area, and also by the desirability of passing near Leeds and Edinburgh so that programmes could be injected at the intermediate relay stations near these towns—a new requirement for television relay systems. In fact, this facility will be provided at all relay stations. The longest link will be some 46 miles, and the total mileage nearly 250.

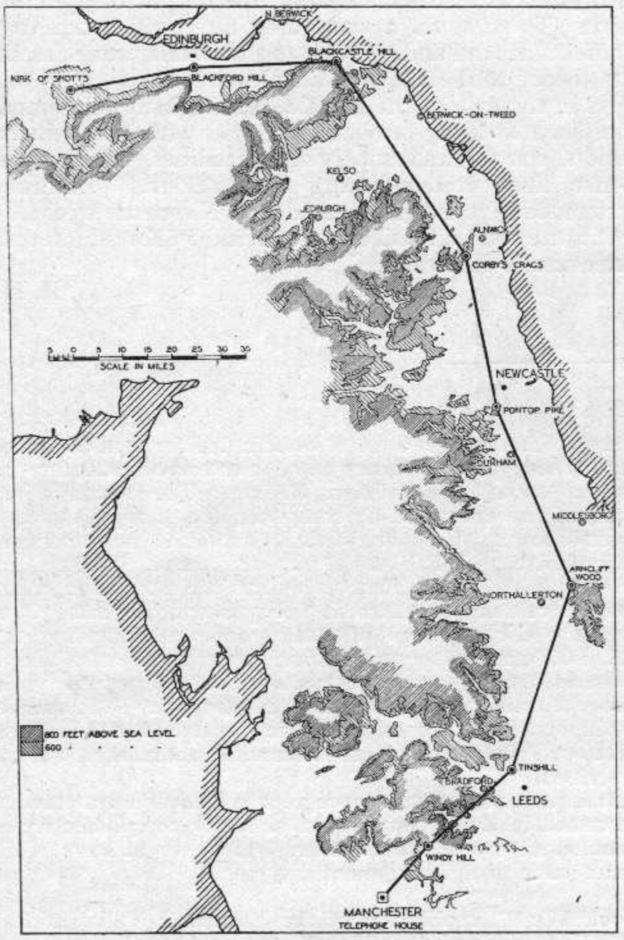

FIG. 1.—ROUTE OF MANCHESTER-EDINBURGH BROAD BAND RADIO RELAY LINK.

Before detailing the radio equipment, it may be of interest to indicate the main respects in which it will differ from the London-Birmingham radio system which has already been described[1] :—

(i) It will operate at the much higher frequency of 4,000 Mc/s.

(ii) Although it will provide for two-way simultaneous operation, only two carrier frequencies will be used throughout the system compared with the four required for the full two-way installation between London and Birmingham. Both frequencies will be used alternately throughout each channel, but any one link in the chain will use different frequencies in the two directions.

(iii) The equipment will all be housed in a single building at each station, and only the aerial system will be located at the top of the masts.

(iv) A travelling wave amplifier is used as the output stage of each repeater and terminal transmitter, this being the first commercial application of this technique.

(v) The receivers and transmitters will be connected to their respective aerial systems by means of waveguides, the first commercial use of these by the Post Office.

Since it is too early to give more than a brief description of the equipment, the main points of difference will be emphasised and details having a resemblance to the existing radio system omitted.

A typical mast may be 50 ft. or so in height and carry four paraboloid aerials, each some 10 ft. in diameter, and connected to the radio equipment at the base of the mast by waveguide transmission lines, the lines being filled with dry nitrogen under a pressure of about $\frac{1}{2}$ lb. per sq. in., to prevent internal corrosion. The paraboloids will have a gain of about 40 db. relative to a half-wave dipole, and an angular beam width of about $2\frac{1}{2}$°. At Blackcastle Hill, a 220-ft. mast is required to provide the necessary clearance over the difficult terrain on the two links radiating from it.

A schematic of a typical transmitter for use at a terminal station is shown in Fig. 2. The incoming video signals from the B.B.C. switching centre are applied to the reflector electrode of a klystron (MOD/OSC) oscillating at the radiated frequency. This produces a frequency modulated signal, the mean frequency of which is stabilised by an automatic frequency control loop (AFC). This loop derives its controlling action from a frequency comparison (FC) of the radio frequency oscillator (OSC) with that of a stable reference signal derived from a harmonic generator (HG) which is driven by a 20 Mc/s crystal-controlled oscillator (O). The output of the klystron oscillator is amplified by the travelling wave amplifier (TWA). The novel features of this valve are its aperiodicity, that is, its ability to amplify signals over a very wide range of frequencies, its relatively high gain, and its relative simplicity. The gain of the wave amplifier is some 17 db., and its output power 1 W.

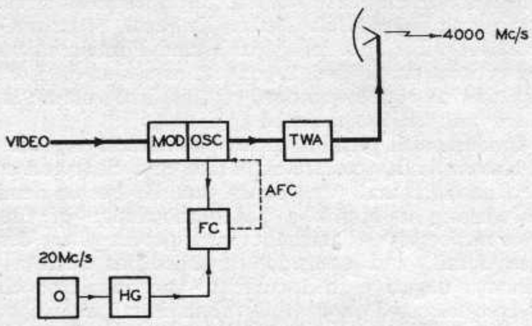

FIG. 2.—BLOCK SCHEMATIC DIAGRAM OF TERMINAL TRANSMITTER.

[1] *P.O.E.E.J.*, Vol. 43, p. 23.

The output of the amplifier is connected by a waveguide to the focus of the paraboloid reflector.

The probable arrangement of equipment at a relay station is shown in Fig. 3. It will be seen that the incoming signals are applied to a crystal frequency changer (FC_1), converted to an intermediate frequency of 60 Mc/s, and amplified. The frequency of the coaxial line oscillator (LO_1) is stabilised by an automatic frequency control loop (AFC) using a reference frequency derived from a harmonic generator (HG), driven from a crystal oscillator (O) having a frequency of 20 Mc/s. The frequency of the outgoing signals has to differ by some 37 Mc/s from that of the incoming signals. This is achieved by applying the I.F. signals to a hybrid mixer unit (T), which includes a balanced crystal frequency changer, and mixing them with the output of a local oscillator (LO_2) whose frequency has been stabilised to the appropriate value by the second A.F.C. loop. This second A.F.C. loop is controlled by comparing the frequency output of the oscillator (LO_2) with that of the oscillator (LO_1) which, as already mentioned, is continuously stabilised by comparison with the 20-Mc/s crystal oscillator. By this means frequency stability throughout the system is assured. Finally, the output of the crystal mixer (T) goes via a waveguide filter which selects the wanted sideband and passes it to a travelling wave amplifier and thence to the outgoing aerial waveguide.

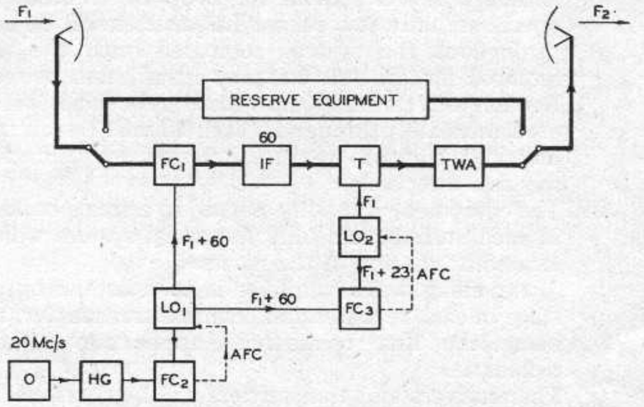

Fig. 3.—Block Schematic Diagram of Typical Repeater.

As in the case of the London-Birmingham link, standby equipment is being provided, together with comprehensive remote control and supervisory facilities, which uses a 4-wire line interconnecting all stations. Additional accommodation is being provided at Newcastle to cater for the future spur extension and at Kirk O'Shotts for a future extension to Aberdeen.

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