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AN UNATTENDED TELEVISION TRANSMITTING STATION

INTRODUCTION

THE INDEPENDENT TELEVISION AUTHORITY'S transmitting stations at Caldbeck and Selkirk are designed to cover the border area between England and Scotland. The Caldbeck station covers the South Western, and Selkirk the North Eastern part of the area. Fig. 1 shows the coverage achieved by the two stations. Border Television Limited feed their programme to Caldbeck which transmits on Channel 11. Selkirk, some 60 miles (95 kilometres) north, receives this transmission and without demodulation translates it to Channel 13, amplifies it and retransmits it. The Selkirk station is designed for unattended operation. To achieve this, quadruplicated transmission equipment has been installed, together with the necessary sensing and automatic control equipment to change over to standby equipment in the event of fault or failure. Nearly every item of operational equipment has been duplicated, making the sensing and automatic changeover equipment the weakest link. Since this cannot be duplicated, a manual control system operated from the parent station at Caldbeck is superimposed, the signals for this control being transmitted over a telephone circuit. This particular system becomes practical only because it is possible to receive the transmitted signals from Selkirk at Caldbeck.

EQUIPMENT

Although reliability was an important consideration in the design of individual items of equipment, it was decided to augment the reliability by the provision of standby equipment. The scale of standby equipment chosen is dependent on the degree of reliability required and the maintenance arrangements to be adopted. Two possible schemes were considered:

(a) two sets of equipment, one in use, one in standby;
(b) the provision of four sets of equipment, one in use with three sets standby.

The first scheme has the disadvantage that, to maintain the service, a maintenance visit is necessary as soon as the standby set of equipment is brought into use, since a further fault would stop the station's transmissions. The second scheme may seem to be technically extravagant but it is an arrangement that can suffer three major faults and still remain in service. It is only at the third failure that an emergency visit becomes necessary. Maintenance visits can, therefore, be planned on a strict rota basis with intervals of between two and three months between visits, and the maintenance system can, therefore, be integrated into the regular maintenance pattern of other stations and the staff more efficiently employed.

The second scheme in a slightly modified form was adopted. The equipment arrangement is shown in Fig. 2. It will be seen that four translators are arranged in pairs so that any one translator of a pair can feed two vision and two sound RF amplifiers through hybrid units. The outputs of the vision and sound amplifiers are fed to combining units, the output from each combining unit being fed to one half of a split aerial system through an aerial changeover switch. The two vision and two sound RF amplifiers forming one group of equipment are operated in parallel by the use of a split

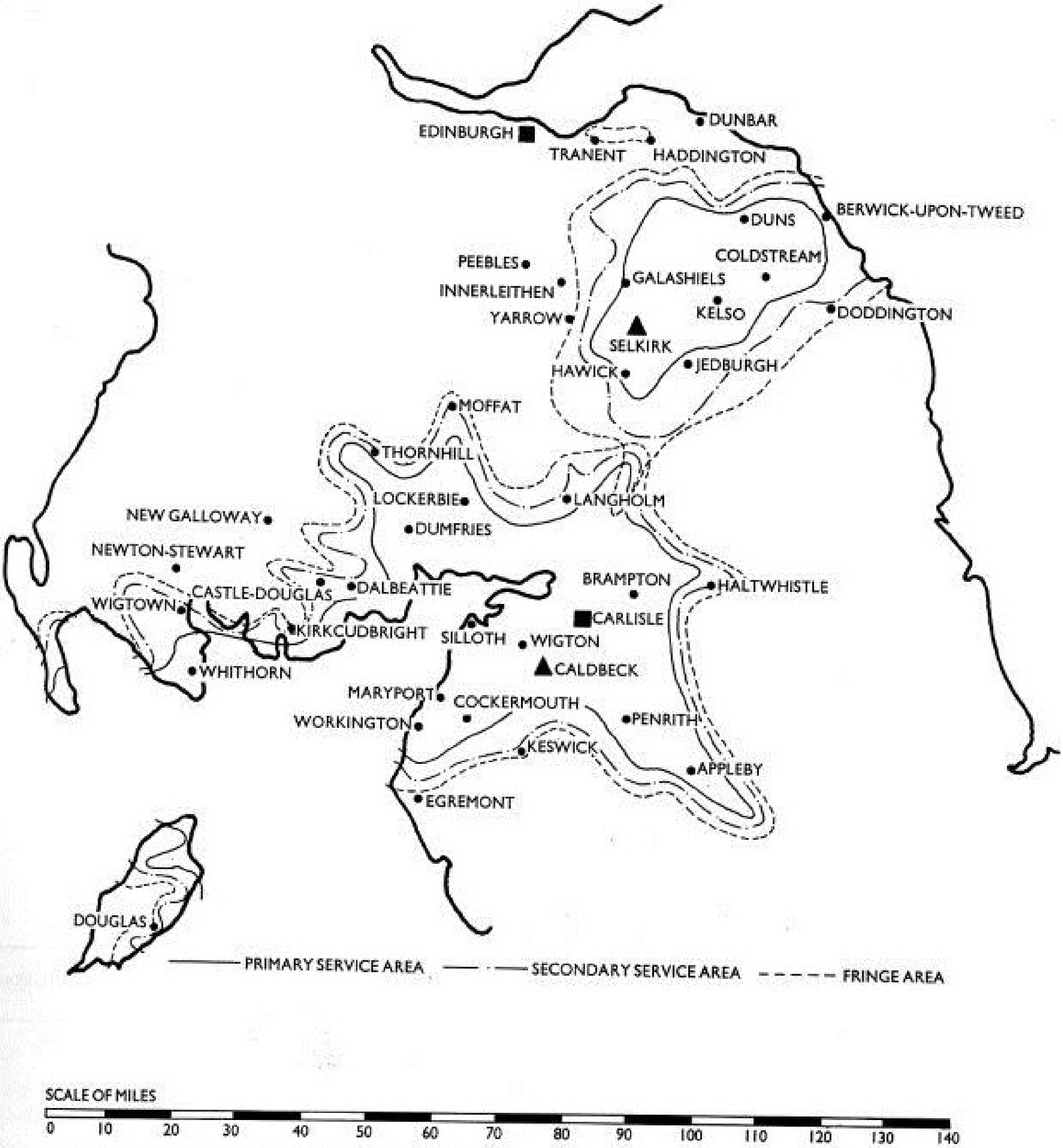

Fig. 1. The coverage area of Caldbeck and Selkirk ITA Transmitters.

aerial and twin feeder system, obviating the need of a diplexer on the ground.

Although four sets of translator equipment are provided, it was decided to provide only two sets of parallel operated sound and vision RF amplifiers. This compromise was adopted since it was considered that the RF amplifiers would be less liable to fault than the translator equipment. Furthermore, it is possible to operate the station with only one vision and one sound amplifier in use, although under this condition the radiated power is reduced by 6 dB. This is considered acceptable as an emergency condition of operation.

An important aspect of the equipment arrangement shown in Fig. 2 is that there are only two RF switches in the system. This is achieved by using hybrid units between the translators and amplifiers and arranging for the individual translators to be brought into service through direct control of their HT supplies.

BUILDINGS

In an endeavour to achieve reliability of the separate halves of the equipment, coupled with the desire to achieve their complete separation and independence, the two halves of the equipment are housed in separate rooms. A central area is allocated to accommodate those services which are necessarily common to both services. Fig. 3 shows the building layout from which it will be seen that a small staff-room and a store are provided in addition to the technical areas.

AERIAL SYSTEMS

The area served by the Selkirk transmitter is extremely hilly, and to achieve the required coverage it was necessary to mount the transmitting aerial on a 750-ft (260-m) mast. The aerial, on Channel 13, is vertically polarized and consists of sixteen half-wave centre-fed dipoles spaced at one wavelength, stacked vertically along one corner of the square mast. The overall aperture is 80 ft (28 m). The aerial is split into two halves, each half being fed by a separate feeder. Felten & Guilleaume $3\frac{1}{8}$-in. (8-cm) semi-flexible feeders are used in order to keep the feeder losses to a minimum. The gain of the aerial in maximum direction is 16 dB, and allowing for losses of $\frac{1}{2}$ dB in the component units and 1·3 dB in the main feeders, 1 kW from the amplifiers gives an e.r.p. of 25 kW.

The horizontal radiation pattern is shaped like the letter D. The presence of the leg member of the mast diagonally opposite the aerial produces a severe null. This happens to be in the direction of the town of Selkirk. Four Yagi aerials have, therefore, been provided and are fed with sufficient power to give an e.r.p. of 300 W in the direction of the town.

The receiving aerial system consists of four separate units, each being a double four-element Yagi mounted at a height of approximately 200 ft (70 m), each connected to one of the four sets of translator equipment and provides approximately 1 mV at the input of the equipment.

TRANSLATOR AND AMPLIFIER EQUIPMENT

A schematic diagram of a translator unit is given in Fig. 4. The incoming vision and sound signals are filtered, amplified and then translated to a vision IF

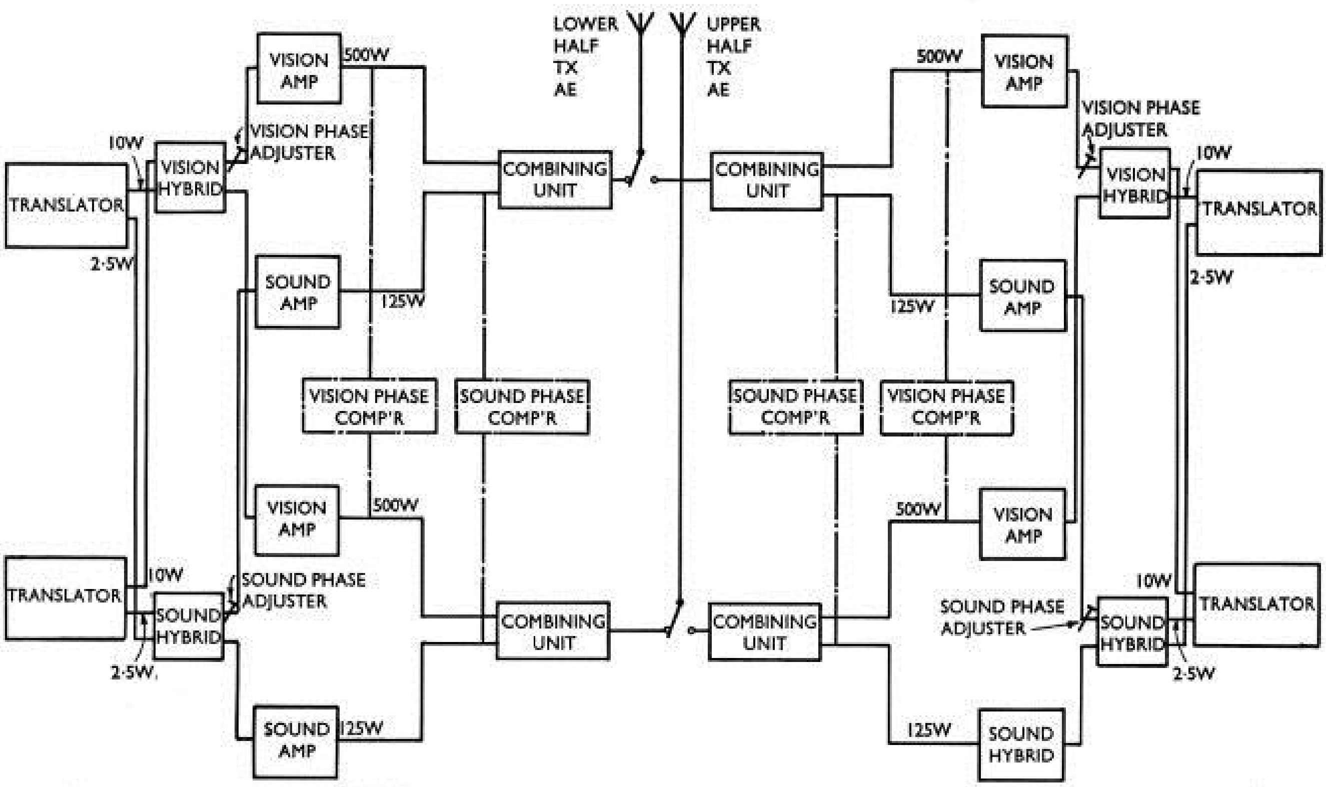

Fig. 2. The equipment arrangement at Selkirk.

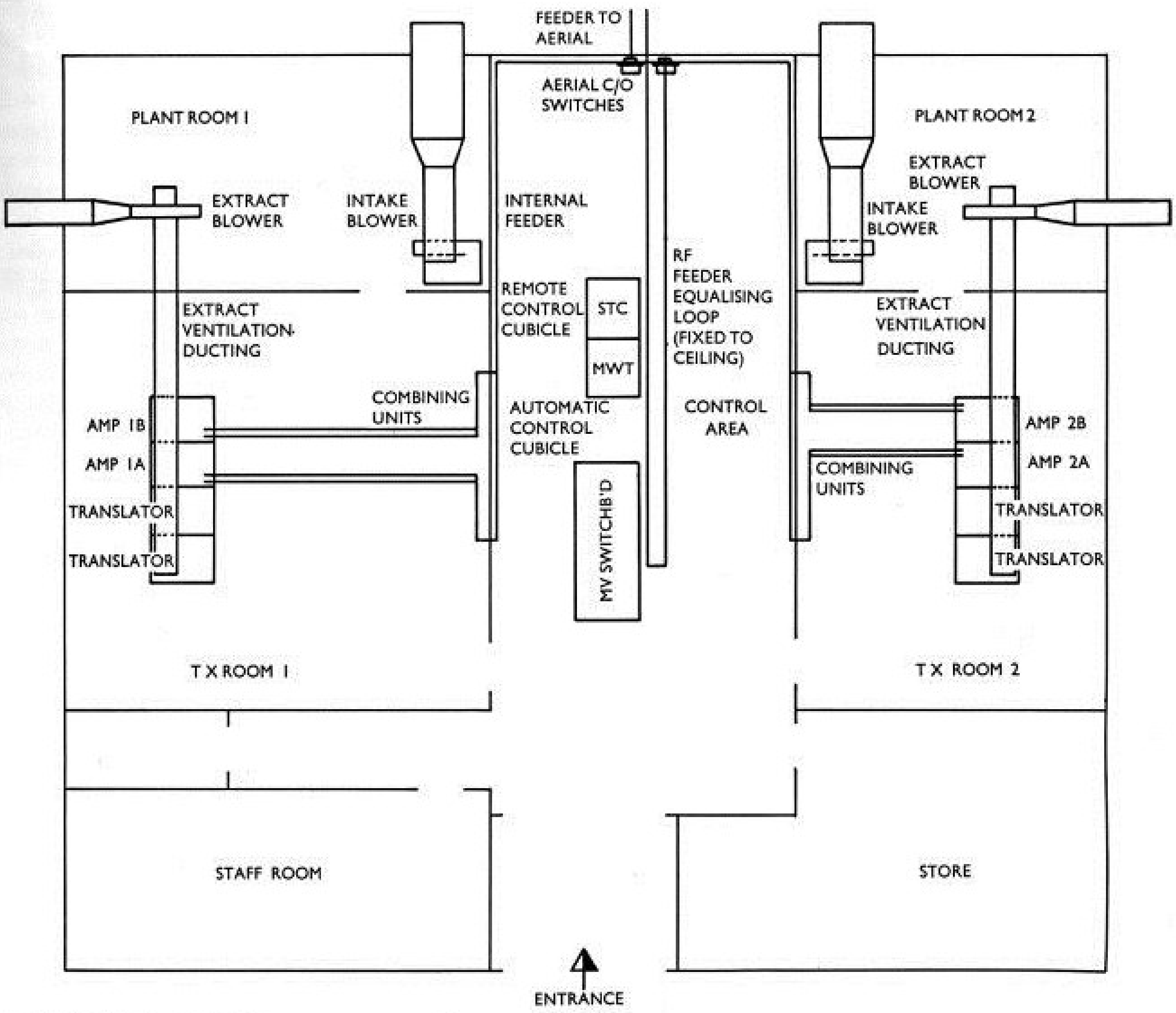

Fig. 3. The building layout at Selkirk.

of 34·65 Mc/s and a sound IF of 38·15 Mc/s. These signals are then separated and amplified in their respective IF amplifiers, separate a.g.c. signals being applied to the two amplifiers. The gains of these amplifiers are approximately 30 dB. Vision a.g.c. operates on the synchronizing pulse amplitude. The range of a.g.c. on both the sound and vision amplifiers is 26 dB. In practice, the operation of the a.g.c. is set so that normal output power is maintained with minimum input signals of 150 mV in respect of vision and 75 mV in respect of sound. These IF signals are then translated to the frequencies of the radiated channel and amplified in linear amplifiers to give a peak white power level of 10 W vision and a sound carrier level of 2·5 W. The heterodyne oscillators used for both the input and output mixers are crystal-controlled units.

Two vision amplifiers each giving 500 W output are used in parallel to give the required power output of 1 kW (peak white). Each amplifier feeds one half of the aerial, care being taken to maintain the signals from the amplifiers in phase at the input to the main feeders.

Similar arrangements are used for sound. The carrier power output from each amplifier being 125 W producing a combined output of 250 W.

These vision and sound amplifiers are of a rugged construction, each contain only two stages of amplification, a valve type QQV 06/40 driving a pair of valves

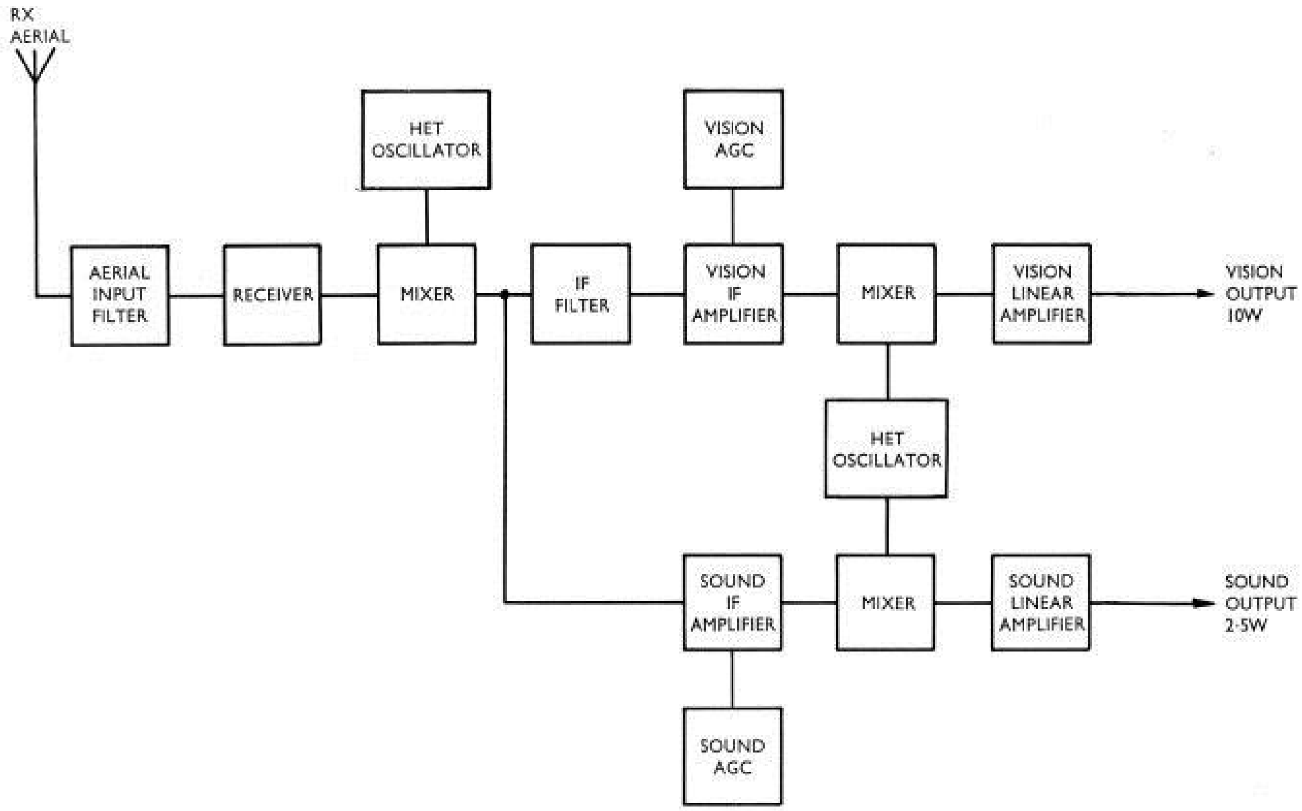

Fig. 4. Block schematic diagram of the translator unit.

type 4CX 250B in push-pull. The RF drive input power required to give 500 W output is approximately half a watt. Although 10 W are available from the translator output there is a loss of 12 dB in the hybrid feeding the amplifiers.

Common power supplies are used for each vision and sound amplifier. These supplies, including the main HT 1800-V supply, make use of silicon diode rectifiers.

COOLING EQUIPMENT

For normal attended operation the amplifier equipment used at Selkirk is fitted with internal blowers, while the translator equipment is cooled by natural convection. To improve the reliability of the equipment in the unattended role, it was decided to increase the flow of air through the amplifiers by one-and-a-half times the manufacturer's design figure and provide forced-air cooling through the translator cubicles. The normal internal blowers are replaced by large external intake and extract fans, the rooms housing the equipment forming part of the ventilation system. The equipment rooms are closed to the outside atmosphere except for the two fan openings. All air entering the rooms is drawn in by the intake fans, which deliver 1200 cu ft (34 m^3) of air per minute after passing through an oil impregnated air filter and over a 9 kW heater bank. The heater bank is designed to maintain the cool air above a minimum temperature of 45°F (7°C) and below a relative humidity of 75%. This reduces the possibility of damp mist entering and damaging equipment. Exhaust fans complete the ventilation system by discharging heated air from the equipment cubicles to the atmosphere. The extract capacity is 1,000 cu ft (28 m^3) of air per minute and therefore the equipment rooms are slightly pressurized. Close mesh nylon filters ensure that the equipment is kept as dust-free as possible.

AUTOMATIC SENSING AND CONTROL EQUIPMENT

Detectors are provided at the output of each translator and amplifier to detect the presence or absence of the vision and sound signals. The automatic control system responds to these and, in the absence of a signal, initiates the shut-down of the defective equipment and changeover to standby. To prevent premature shut-down, various time delays are built into the system to allow the transmission equipment to reach normal operating conditions. Comparator circuits are provided between outputs of the amplifiers and their associated translator equipments to provide indication of failure of the amplifier.

All translator outputs are compared with one another and, if all are satisfactorily operational, the first seizes control and applies an interlock to succeeding units. Absence of signals at the output of all translators, due for example to the absence of any incoming signal, leaves all translators powered and maintaining a watching brief. No executive action is taken. Amplifier equipment not in use is automatically shut down.

When equipment is removed from transmission because of a fault condition, lock-outs are applied to prevent it from subsequently attempting to restore itself to circuit. All locked-out equipment is automatically shut down.

The detectors are essentially "go" or "no go" devices. They only give an indication of the level of the carrier signal at the point of measurement and provide no information on their transmission parameters than carrier level. "Off air" monitoring of the Selkirk transmitter is employed at Caldbeck and it is the responsibility of this station to take over and exercise control of the Selkirk transmitter in the event of aural or visual faults occurring which are undetected by the automatic equipment.

REMOTE CONTROL AND SUPERVISORY SYSTEM

The remote control and supervisory system was developed and designed by Standard Telephones and Cables Ltd. It was designed to operate over normal Post Office telephone circuits using transmission and receiving frequencies of 2·460 kc/s and 2·220 kc/s respectively. The band below 2 kc/s is used as a telephone channel. Control and supervisory information is transmitted in the form of a telegraph code using a frequency shift form of modulation of 60 c/s width centred on the transmission and receiving frequencies. The speed of transmission is 10 pulses per second. This particular system is designed to transmit a total of sixteen control operations between Caldbeck and Selkirk and a total of seventy-two indications in the reverse direction. Normally the system is quiescent and information is transmitted only when indications change or a control command is to be sent.

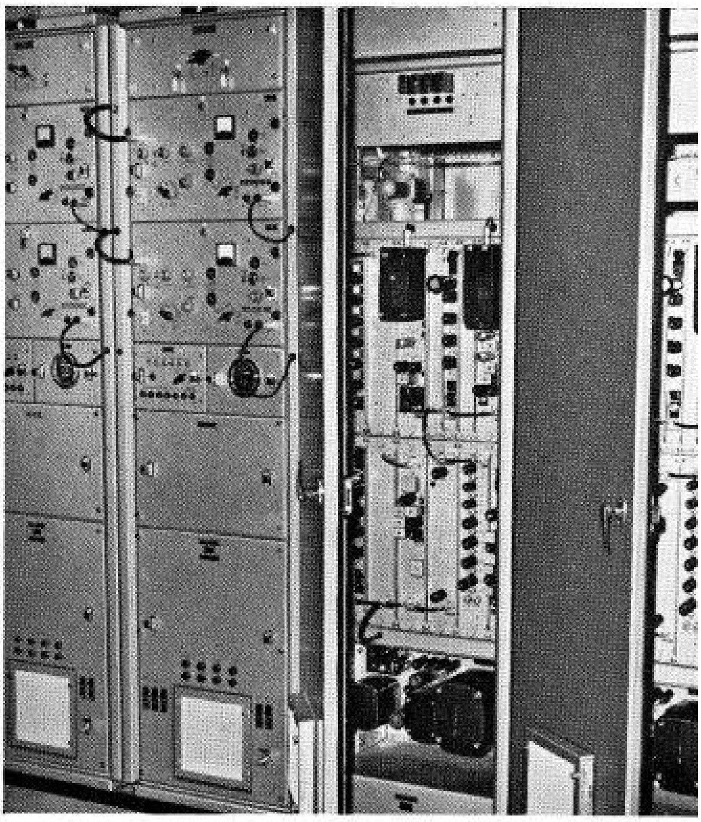

Fig. 5. The translator and amplifier equipment cubicles in one of the transmitter rooms.

At Caldbeck the remote control and supervisory equipment is housed in a 7-ft cubicle. The control diagram is displayed on the front of this cubicle in the form of a mimic diagram of the Selkirk Station equipment, with the control keys and indicator lights positioned on the diagram as appropriate. Control keys are two position devices and the circuits are so arranged that when the key positions correspond with the operating condition of the associated equipment the keys are "dark". Should the position of a key not correspond with the operating condition, then a lamp within the key will flicker until the position of the key is changed. In the event of a fault occurring, the automatic control system at Selkirk takes over.

POWER DISTRIBUTION

Two alternative sources of electricity supply are available at Selkirk, derived from separate sub-stations operating on different sections of the Electricity Board's Distribution Network. Only one source of supply is used at any one time; changeover to the standby supply being automatic upon the failure of the connected supply. The power distribution arrangements within the station are designed to achieve independence of the supplies to the separate halves of the equipment and to the separate items of the equipment as far as this is reasonably possible.

FIRE PROTECTION

The risk of fire at an unattended station may be considered to be greater than at an attended station, if only for the reason that a small conflagration could go undetected and thus possibly build up with catastrophic effects. To safeguard against this risk, CO_2 gas discharge installations are fitted in every area of the building. These installations are separate from each other, so that equipment not in the affected areas would be able to maintain service where practicable. Additional to these CO_2 installations, smoke detectors are fitted in the air extract ducting of each half of the equipment. These smoke detectors are arranged to give warning to the Caldbeck Station of the presence of smoke. In addition they automatically shut off the electricity supply to the affected equipment.

OPERATIONAL EXPERIENCE

The station was first left unattended on the 20th November, 1962. It had been planned to return to Selkirk after a period of 8 weeks, but exceptionally bad weather conditions prevented access until the eleventh week. During this period, no programme time was lost due to failure of the equipment at Selkirk. The first half of the equipment had been taken out of service and the station was operating on the second half of equipment. If a measure of reduced power had been acceptable, the station could still have experienced a further two major breakdowns of equipment, before the service would have been completely interrupted.

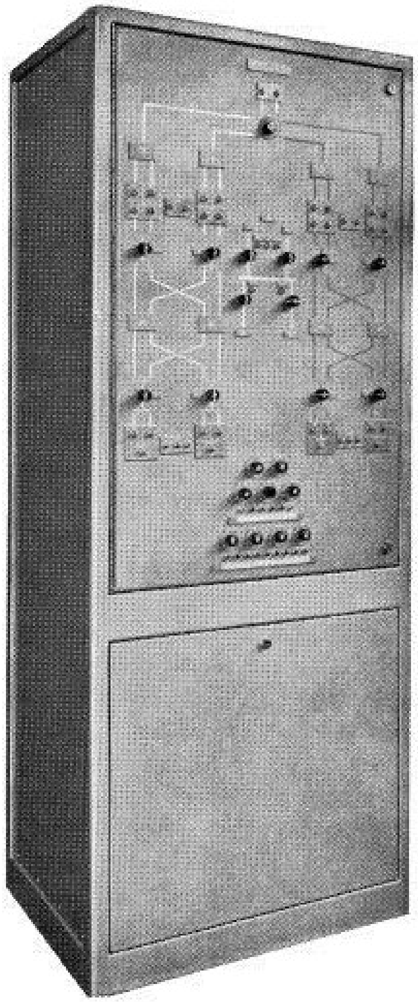

Fig. 6. The control cubicle at Caldbeck.

ACKNOWLEDGEMENTS

The project was planned and designed in full collaboration with The Marconi Company Limited, Standard Telephones and Cables Limited and the Authority's Engineers.

Great credit reflects on the above two Companies for the ingenuity and skill displayed in the design and construction of their respective sections of the project.

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