Dr. E. D. GRIESS, Ph.D.

GHANA SHORT-WAVE BROADCASTING STATION

INTRODUCTION

THE FORMER GHANA BROADCASTING SERVICE, now the Ghana Broadcasting and Television Corporation, made plans in 1962 to improve the internal coverage of their short-wave service and to extend their overseas broadcasting facilities, augmenting the service already supplied by the four 100-kW Marconi transmitters installed in Tema during 1961.[1]

The first requirement virtually decided the location of the new station, since an overseas service could equally well be implemented from any point in Ghana. The internal service required good coverage of the whole of Ghana and thus it was decided to find the nearest suitable spot to the geographical centre of the country. This would enable high-angle radiation on various selected frequencies to cover the whole country to the best advantage.

A suitable location was found near the village of Ejura some 60 miles north-east of the Ashanti capital of Kumasi and on the edge of flat land overlooking an escarpment running more or less east–west, the land falling away to the south. Apart from being centrally situated, this spot had the advantage that it was near the television station at Jamasi, where the microwave link ended and required only one further hop to carry signals to Ejura.

The Ejura site is on the edge of a forest reserve and hundreds of trees had to be pulled down to make way for both aerial systems and associated transmission lines. A continuous clearing operation will be required to keep down the rapid growing undergrowth in the station confines. The ground adjacent to the station had already been cleared by the Agricultural Board who had established an experimental farm concerned with the best methods of growing the *Urena lobata* plant from the fibres of which jute is obtained.

STATION PLAN

The station building is approximately in the form of the letter T. The left-hand section of the top of the T being the internal services transmitter hall, housing the six 10-kW transmitters, and the right-hand section of the top of the T being the overseas transmitter hall, containing two 250-kW steam-cooled transmitters. This hall is flanked by rooms containing the cooling equipment, modulation and power supply components.

At the intersection of the horizontal and vertical parts of the T is the control room, in which is situated audio input and monitoring equipment together with selector panels for the aerials of both the internal and overseas service.

Leading off the control room is the copper-lined screened room housing the drive and phasing equipment, together with the emergency tape and disc players, the latter for use in case of failure of the microwave link from Accra. This screening was provided to eliminate the possibility of any feedback into the low level drive and audio equipment from the 250-kW transmitters.

The vertical of the T contains the workshop, stores and administration offices in addition to a second copper-lined screened room which houses the microwave terminal equipment providing five programme channels from the main programme originating centre

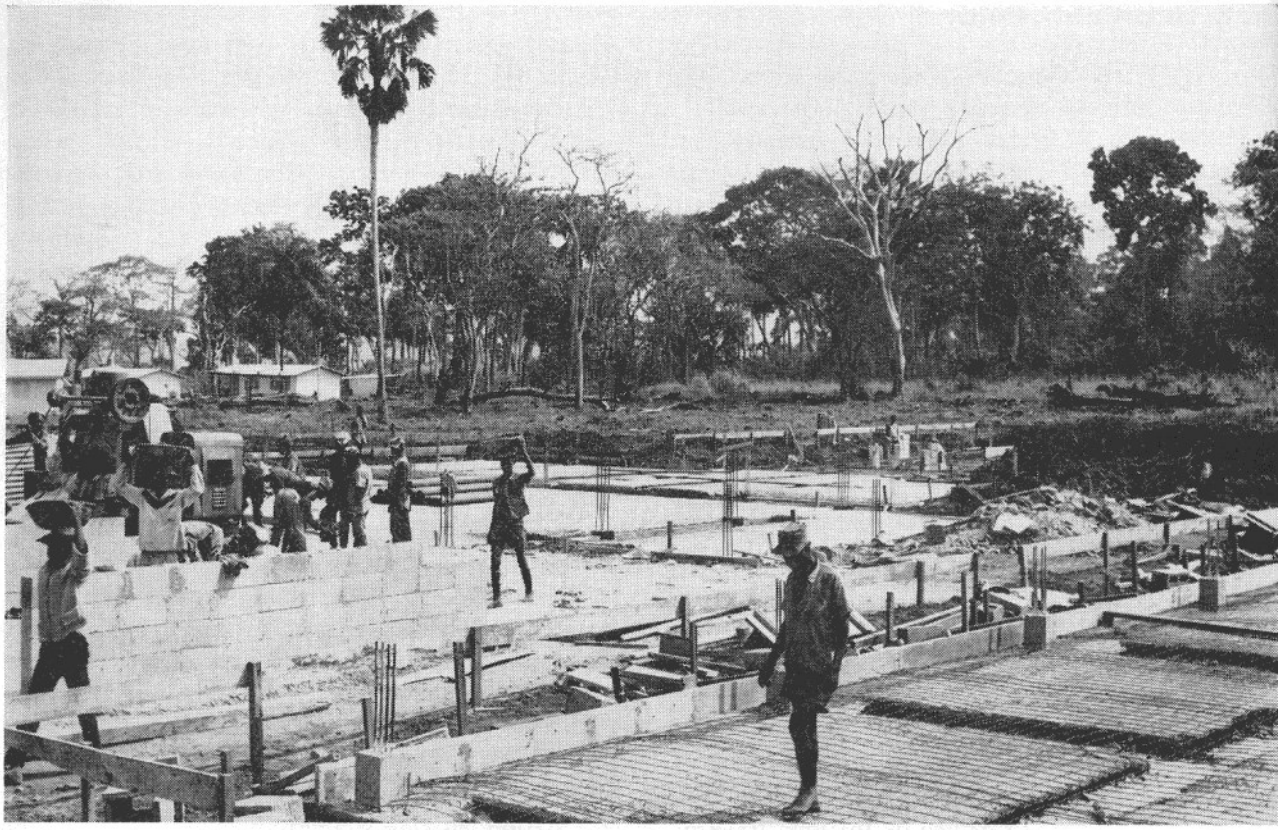

Fig. 1. An early stage in the building at Ejura. The foundations of the power house are in the foreground with those of the transmitter hal behind. The living bungalows are seen in the background.

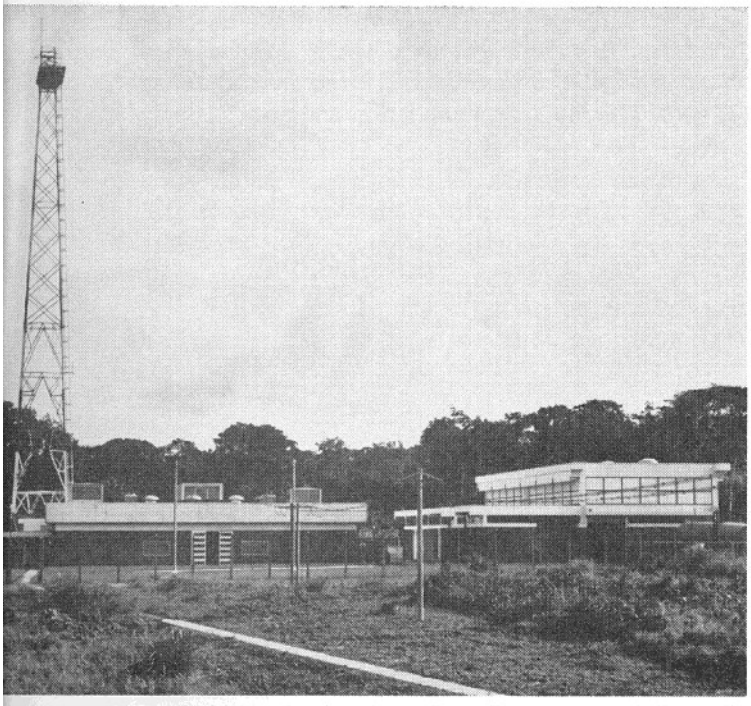

Fig. 2. The completed station at Ejura. The transmitter hall is in the foreground with the power house behind.

in Accra. Parallel with the top of the T is the power station[2] (Fig. 1).

At a distance of a quarter of a mile from the station buildings the Corporation has built four bungalows to house senior staff and eight for the junior staff, enabling all technical personnel to live on site. Only locally employed persons are required to live in Ejura. Power for these buildings is provided via underground cable from the station generating plant, and the senior quarters are connected to the station by extensions to the private automatic exchange housed in the administration block.

10kw-TRANSMITTER HALL

The internal service was planned to be radiated in three of the vernacular languages at any one time with the possibility of this number being increased to four in the future.

Three separate transmission circuits each terminating in two 10-kW short-wave transmitters capable of operating between 2·2 Mc/s and 12 Mc/s were provided, and space was left for a fourth pair of transmitters.

Two transmitters are operated on the same frequency for each service and fed to separate aerials, zero phase difference between them being maintained at all times. The advantage of having two 10-kW transmitters in parallel, rather than a single 20 kW, is mainly to ensure continuity of programme should any transmitter failure occur. It also enables extra services to be run at short notice by operating transmitters separately on two different frequencies but at the loss of the standby facility. Each pair of transmitters is excited from a single crystal-controlled drive, followed by a phasing amplifier providing two separate outputs, the relative phases of which can be adjusted. Standby crystal drives plus a synthesizer and a phasing amplifier are available in case of failure of the main units.

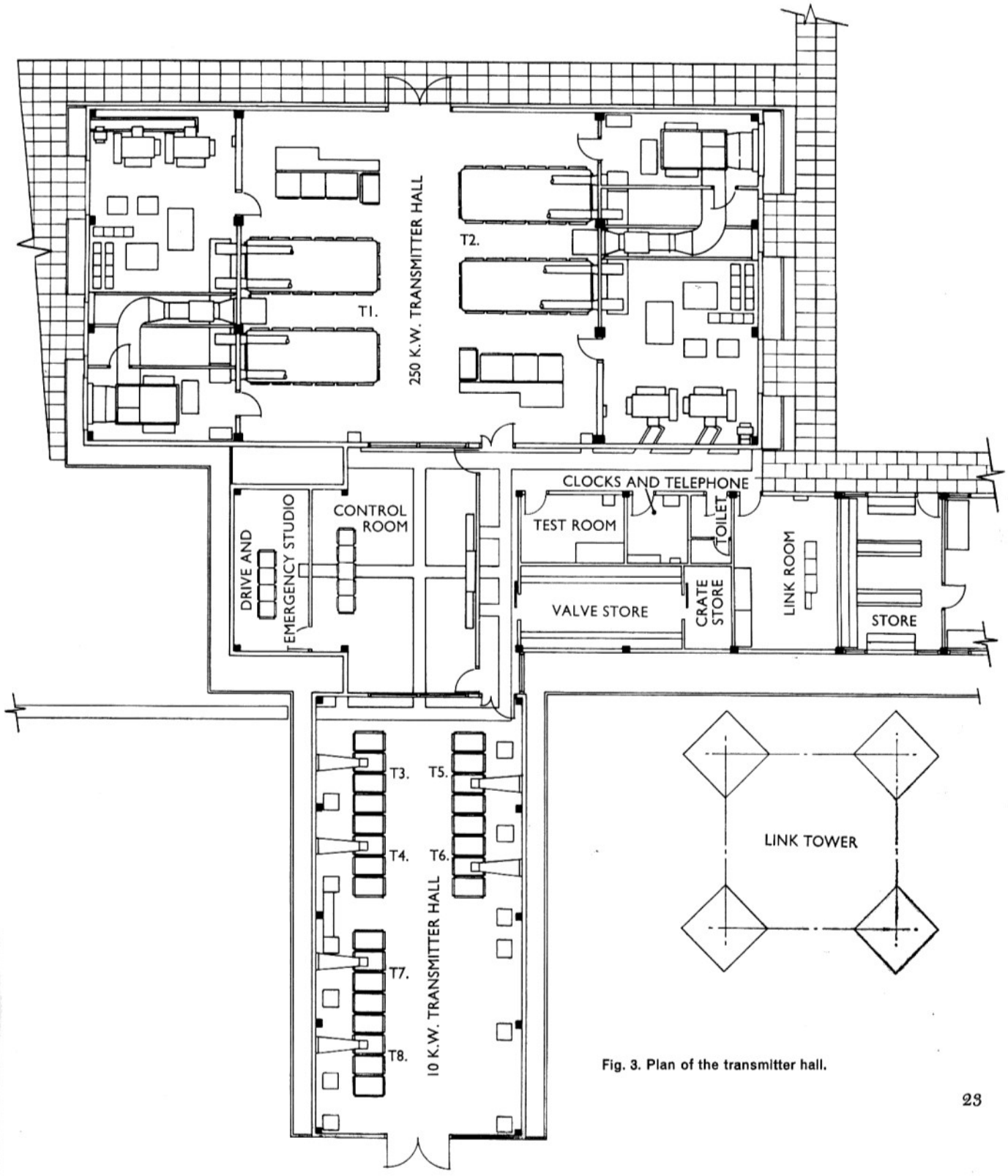

Fig. 3. Plan of the transmitter hall.

Current transformers on the transmission line at the outputs of the transmitters provide signals to the phase comparator units, which give an indication of phase difference on meters contained in the drive-unit cabinets, thus allowing necessary phase correction to be applied at the phasing amplifiers. The lengths of transmission line to pairs of aerials have been carefully equalized to ensure that the phase relationship between aerials is the same as that between the transmission line inputs.

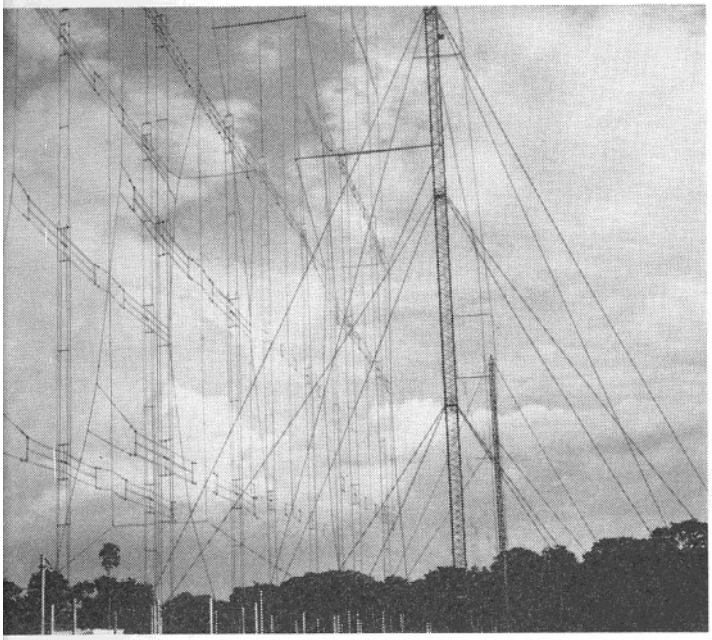

Fig. 4. One of the aerial arrays at Ejura.

250-kW TRANSMITTER HALL

The two transmitters[3] face one another from opposite sides of the hall. Each transmitter consists of three free-standing separate units comprising from left to right:

(1) Power distribution unit and modulator.
(2) Radio frequency and feeder coupling unit.
(3) High voltage mercury arc rectifier and r.f driver unit.

Rising from each of units 1 and 2 above is a 6-in. diameter lagged copper pipe in which the steam produced by the valve power dissipation rises and is then piped rearwards through the smoothing enclosure to the top of the air-blast interchange cooler.

All interwiring between units and to the smoothing room is effected via overhead cable trays mounted on the roof of the cabinets and bridging between them. The r.f output from each transmitter is taken via a 220-ohm line contained in a screening trunking through the roof, thence to a twin-wire 220-ohm feeder leading to the aerials.

The transmitter hall is cooled by three ceiling fans pulling 7,700 cu.ft per min of air through vents in the outer wall across the hall and out through the roof.

Behind each transmitter are two separate rooms, one containing the distilled water storage tank and associated pumps for supplying the cooling water to

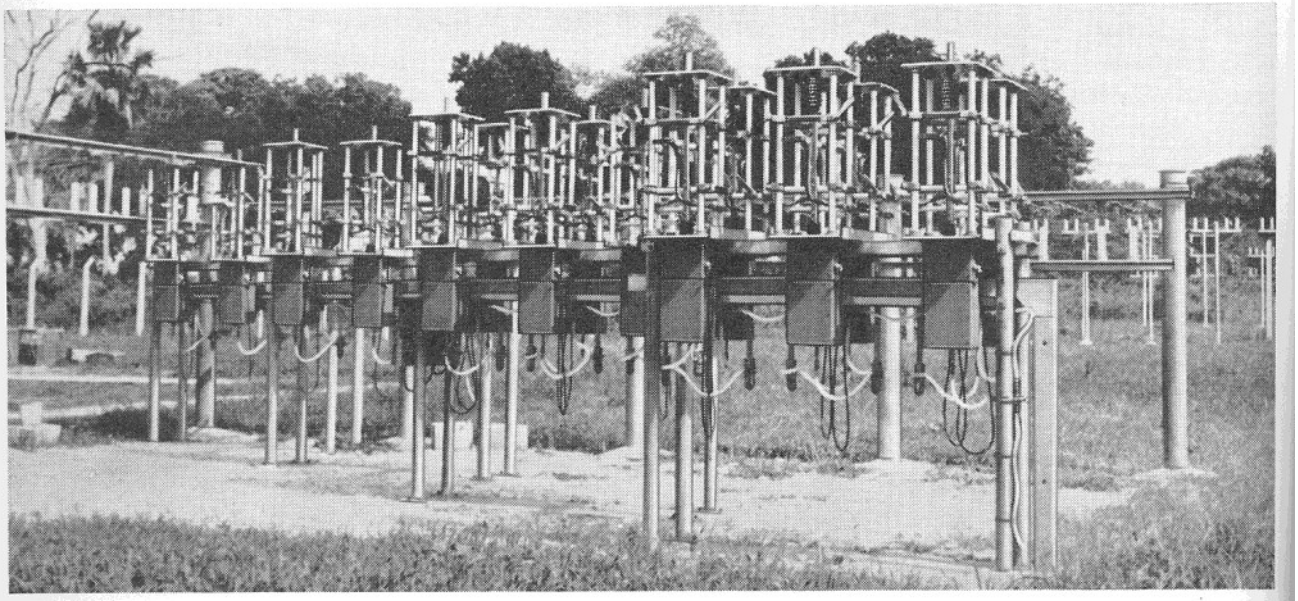

Fig. 5. The 10-kW aerial switching equipment.

the transmitter. In addition, the room contains the air-blast interchange cooler for condensing the transmitter exhaust steam back to water. The second room houses the high-voltage transformers, smoothing equipment and the heavy modulation components, besides a refrigeration unit which cools the air fed to the mercury-arc rectifier cabinet in the transmitter hall. There is also a complex of air ducting blower and air filters, supplying filtered air to the transmitter for cooling purposes, and an additional fan supplies air for ventilating the two rooms. This room has an interlocked door associated with an earth switching mechanism which prevents access while the transmitter is powered and also ensures that all circuits are connected to earth before the room can be entered.

CONTROL ROOM

The control room contains the 10-kW and 250-kW aerial switching control panels, audio input equipment for 10-kW and 250-kW transmitters, audio monitoring and test equipment, frequency measuring equipment and the power distribution board for house services.

10-kW Aerial Switching

The 10-kW aerial selection panel allows each transmitter to be connected to any one of three preselected aerials. This is achieved by operating a key in the lock associated with the aerial in question. This not only causes a compressed-air-operated aerial selection switch to operate in the switching station, but also completes the interlocks in the transmitter control circuit and allows the transmitter to be powered.

The remaining three aerials in each line can only be made available to each transmitter by hand operation of links in the field which change the preselected aerials appearing on the control panel. This simplification is intended to provide for the infrequent seasonal changes in daily operational frequencies which occur perhaps once or twice a year and is also an economy measure in that only three transmission lines per transmitter are required instead of six, and the number of compressed-air switches is halved.

250-kW Aerial Switching

Each of the 250-kW transmitters is capable of being switched to any one of the twelve directional aerials. The selector system consists of a metal slide for each aerial, which uncovers only one lock at a time associated with one or the other transmitter. Having selected the transmitter to be connected, the key is inserted in the uncovered lock and turned to operate

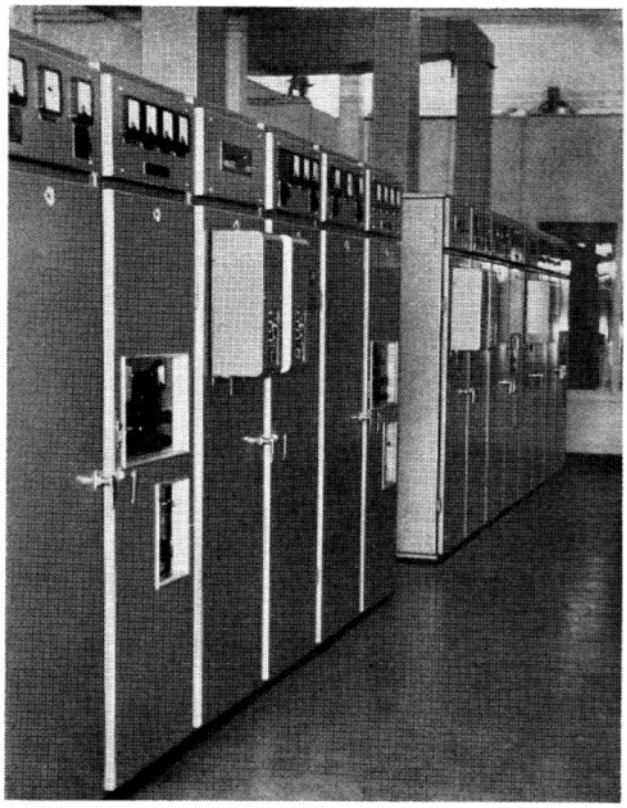

Fig. 6. Part of the 10-kW transmitter hall, which contains six transmitters, later to be increased to eight.

the desired aerial selector switch and complete the appropriate interlock circuit via the aerial switch. Since one key only is available per transmitter it is impossible to select more than one aerial at a time and the mechanical interlock of the slide mechanism prevents two transmitters being connected to one aerial. Every r.f switch is fitted with interlock contacts at each end of its travel so faulty operation of a switch breaks the interlock circuit and prevents the transmitter being powered.

Audio Input and Monitoring Equipment

The five programme lines from the microwave link from Accra are fed directly to five programme input panels, and an extra panel is included as a spare. In the case of the first three units, the output is split into two in order to feed the paralleled 10-kW transmitters. The remaining programme input panels feed directly to the individual 250-kW transmitters.

A monitor selector panel enables a monitoring amplifier and associated loudspeaker to be switched to:

(a) Any of the five incoming programme lines.
(b) Emergency studio output.

(c) Any of the six programme input equipment (p.i.e) outputs.
(d) Any of the six panel-mounted demodulators which are fed with r.f from the six 10-kW transmitters.
(e) Either of the outgoing audio signals derived from inbuilt demodulators of the 250-kW transmitters.
(f) The output from the general radio a.m monitor, which is in fact a standby demodulator for any of those mentioned above, as r.f from any transmitter can be applied to the equipment via an r.f patch panel.

A programme line-up switch controlling an 8-dB attenuator is included in the monitoring circuit to equalize the monitoring levels under the two conditions of 'line up' and 'programme'. This is necessary because the input to the p.i.e is increased on programme by 8 dB with respect to line-up level in order to get a higher average modulation. This means that the input line level is now about 8 dB below the level of the monitoring levels at the p.i.e output and the transmitter output.

Microsensitive frequency measuring equipment is provided to enable all drive frequencies to be checked, as well as providing a means of receiving standard frequency transmissions.

A general radio a.m monitor, a noise and distortion meter and a low distortion oscillator are provided for normal audio checking purposes.

Fig. 7. One of the two 250-kW transmitters.

DRIVE ROOM

This room is completely lined with copper and special precautions have been taken to earth all cable screens at their entry to the room. R.f filtering has been provided for the incoming mains supply to the room. A separate earth was provided for this room alone and the metal screening of the Pyrotenax cable feeding power to the room was earthed only at the entry to the room, special care being taken that this screen did not touch the earthed parts of the power board, situated in the control room whose earth is the separate power station earth.

This separation of earths was maintained throughout the station, the various individual earths being as follows:

(a) Power station
(b) 10-kW transmitters
(c) 250-kW transmitters—one each
(d) Control room
(e) Drive room
(f) Microwave link room.

The equipment consists of nine ten-way crystal drive units, together with four phasing amplifiers, in each case one unit being a spare. A frequency synthesizer, with its associated 1 Mc/s crystal oscillator, is also provided, and the complement of equipment is completed by three phase indicator meters, which are associated with the three phase comparators used with the pairs of 10-kW transmitters.

The drive room also contains the 'emergency studio' equipment comprising a Ferrograph tape player, disc reproducer and portable mixer. These units were installed in the screened room to avoid the high r.f pick-up encountered in all unscreened sections of the building. Tapes and records only may be played from this equipment in the event of a complete failure of programme from Accra.

10-kW AERIALS AND TRANSMISSION LINES

The aerials for the internal services consist of folded dipoles mounted at such a height that the radiation is

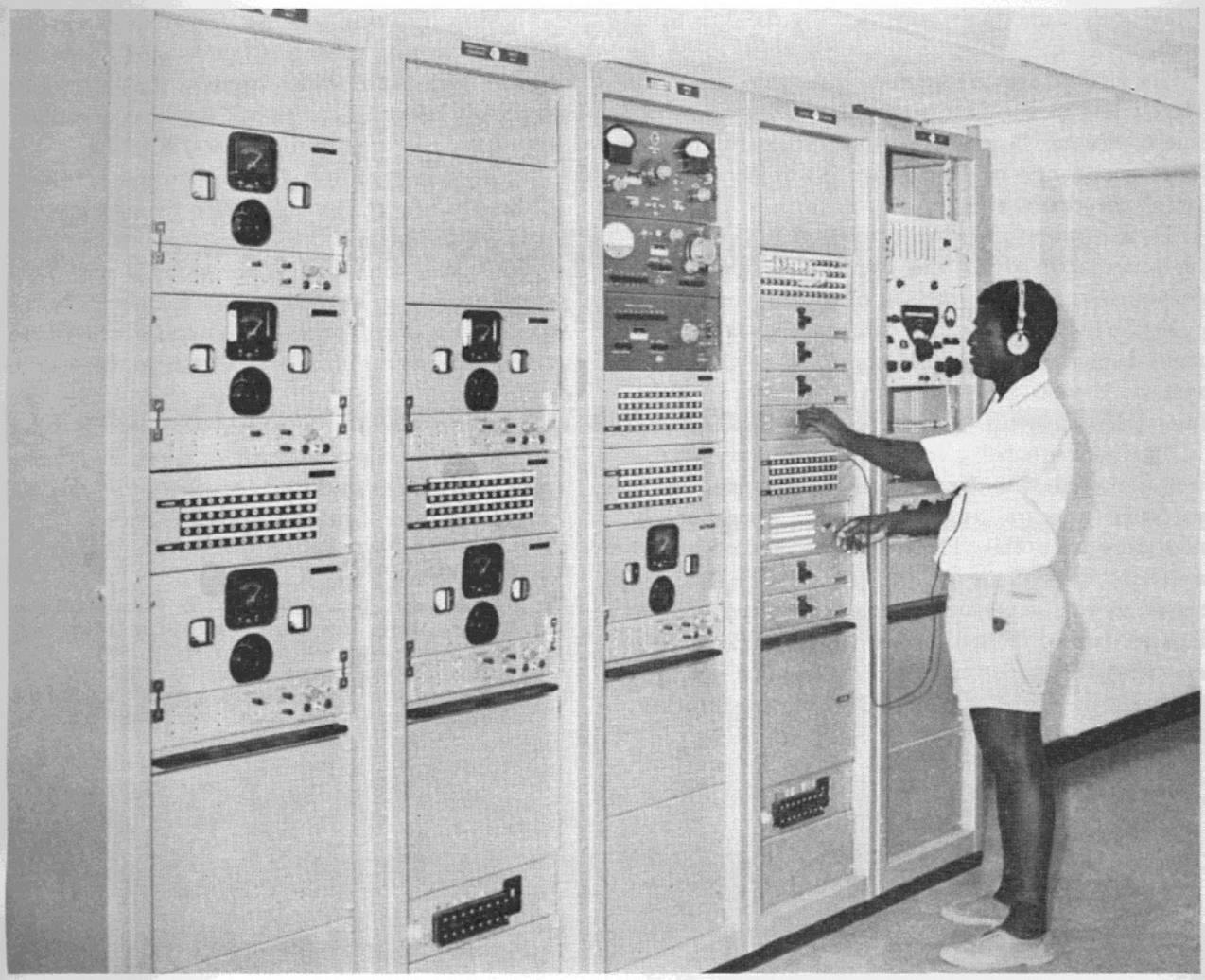

Fig. 8. The control room at Ejura.

predominantly vertical, and two adjacent aerials are tuned to the same frequency. The whole aerial assembly consists of two lines of aerials spaced approximately a quarter of a mile apart. Each line consists of six pairs of aerials tuned to the six broadcasting bands between 3·3 and 12·0 Mc/s.

One line of aerials is accessible by means of switches to transmitters, T3 to T6, whereas the second line is available to T7 and T8 only. In future, when T9 and T10 are installed they will also be capable of being connected to the second line of aerials.

250-kW AERIAL AND TRANSMISSION LINES

Two trunk transmission lines run northwards for a distance of some 1,800 ft from the transmitter building terminating in a six-way switching station containing in all twelve compressed-air-operated switches. A second similar station is interposed in the lines some 600 ft from the building.

The nearer station serves the six directional aerials which are suspended in a north–south line and which can be made to fire in either easterly or westerly directions. The six aerials cover one frequency in each broadcast band from 6 Mc/s to 21 Mc/s with the exception of 7 Mc/s.

Each aerial is in the form of two bays of three stacks together with a similar reflecting curtain. The two curtains are identical and the direction of fire of each aerial can be reversed by the operation of a manual changeover switch at the base of the aerial. This acts to change the feed point from one curtain to the other

while at the same time changing over the directional stub.

The furthest switch station provides selection to the second line of six similar directional aerials whose line of fire can be either north–west or south–east. The same range of frequencies is provided as the aerials mentioned above.

These two switching stations are, in view of the high power involved and the torrential rain encountered in Ghana, protected by an aluminium roof.

However, experience so far has shown that the main danger to the correct operation of the feeder system is not the rain, but two other natural hazards.

The Ejura site, being adjacent to a forest reserve, is well endowed with birds of all description and in particular appears to be a resting place for the migratory white ibis. These birds unfortunately take a delight in perching on the transmission line and should they be so perched when power is applied their legs are burned off and the transmitter reflectometer operates. When power is already applied and they approach the feeder, arcing takes place before they touch and away they fly, again with burned legs.

The smaller birds are also dangerous as was discovered when two owls at dusk, perched on the opposite legs of the feeder, caused a flash-over which completely burned through half the wires of one line, necessitating a rerun of some 1,200 ft. of line.

The second hazard is due to the habit of burning off the dry vegetation just before the new growing season. The carbon particles floating in the air settle on the feeder wires and when power is applied get sufficiently hot to scintillate until completely burned away. The fear is that the wire may be softened due to the local generation of heat. The same phenomenon occurs when the local silk cotton trees release their multitudinous seeds, each contained in a ball of silky material, which clings to the wire cages. In each case it was necessary to organize a brushing party to clean every inch of the high-power feeder system.

REFERENCES

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3 D. F. BOWERS and H. E. BARTLETT: A New 250-kW H.F Broadcasting Transmitter; *Sound and Vision broadcasting*, Vol. 4, No. 1, Spring 1963.

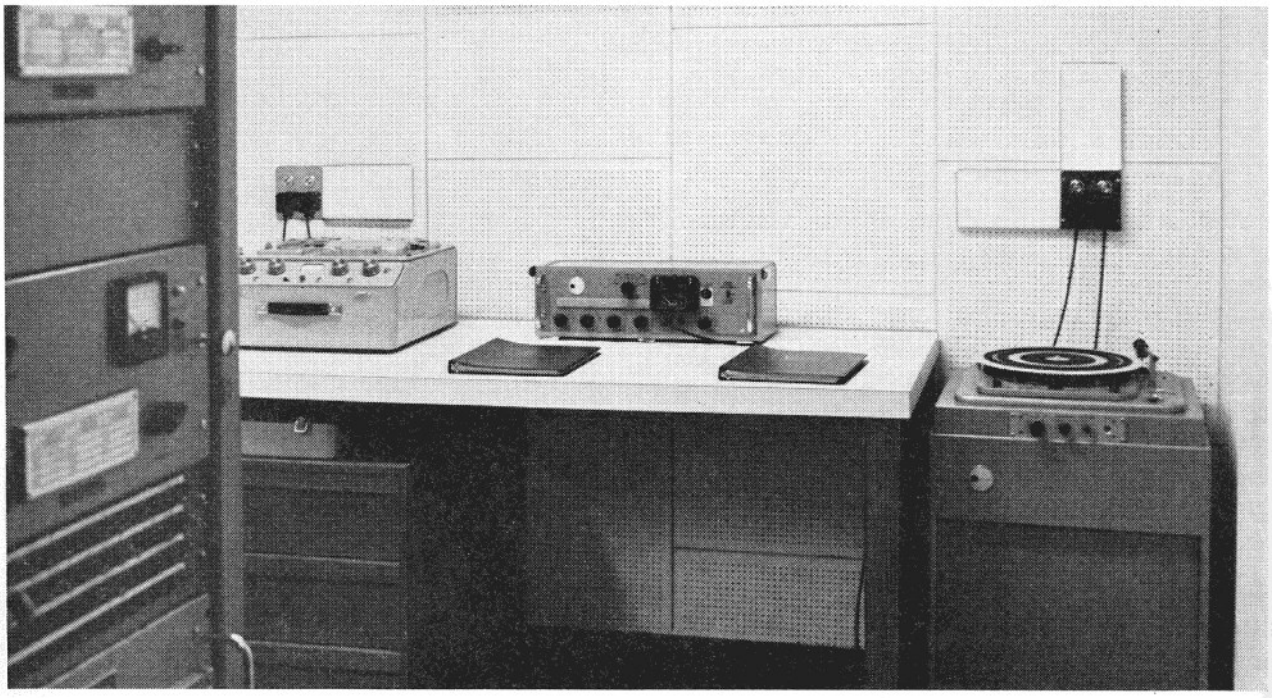

Fig. 9. In the event of any interruption of the link between the studios at Accra, Ejura can originate programmes from this small control room.