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POLICE WIRELESS

The ever increasing facilities for speedy transport have given the modern criminal a means of removing rapidly from the scene of a crime. It is necessary therefore that the Police should have at their disposal a means of disseminating information and instructions at a speed which will discount these facilities.

Wireless communication forms an invaluable aid to the Police Force as it enables information to be given over a widely spread area far more rapidly than is possible by telephone. Road patrols can be instructed to move to any strategic position with a minimum of delay and their efficiency is thus enormously increased. So valuable has radio proved that it is already looked upon as a part of the normal routine of police work.

A new field has been opened up for the radio engineer by the acceptance of wireless communication as an essential part of a police force equipment, as he is confronted in police work with conditions and requirements not heretofore encountered. Low efficiency aerials on moving motor vehicles, in many cases unskilled operators, limited power supplies, etc., make the task of providing a reliable service more difficult.

Wavelengths Available.

THE waveband at present allotted to Police Forces in this country is 2,115 to 2,030 kilocycles (141.84 to 147.8 metres).

This band is extremely limited and, while it is large enough to cover the police wireless schemes in existence at present, it is inevitable that extension of the frequencies available will be required before long. The regional scheme being put into operation at the present time is rapidly filling up all the channels available in the present band. From the foregoing it can be seen that frequency stability is of the greatest importance if interference between two adjacent stations is to be avoided.

In America a number of Police Forces have been using the higher frequencies in the band 30 to 42 megacycles with some success, but little work has been done in this country in this direction as yet. Where a comparatively small area has to be covered these frequencies can be used with success, but regional schemes preclude their adoption at present in this country.

Systems of Working.

At the present time continuous wave telegraphy is used in the majority of established Police Force radio systems. This method of working is favoured in preference to telephony because some degree of secrecy is introduced and a record of each message is automatically taken by the operator.

Telephony, however, possesses several advantages, the greatest being that every member of a force is a potential operator, whereas with telegraphy a considerable amount of training is necessary. Messages can also be passed much more rapidly with telephony.

For small Forces and where the area to be covered is not large, telephony is probably the better system in view of the difficulty of training of personnel. In congested areas and where a large district is to be covered telegraphy is more suitable, and in cities where there is a large degree of electrical interference C.W. telegraphy is definitely more practicable as it can be more easily distinguished through a high noise level.

Service Requirements.

To prove of the greatest value as a Police service it is essential that the wireless system is absolutely reliable and easily maintained. The apparatus must be designed for continuous working under all conditions. The equipment fitted in cars, vans, etc., must also be sufficiently robust mechanically and electrically to withstand any shocks likely to be met with during patrol work.

Transmitters and receivers must be as simple as possible in operation while providing the highest obtainable efficiency. The frequency stability must be of a very high order so that the instruments do not continually require adjustment to maintain the service.

Equipments for cars, etc., must be small in size in order to make fitting a simple matter, and the power consumption must be kept down as low as possible.

From the foregoing it will be seen that the essential features of a Police equipment are :—

1. Great mechanical strength.
2. A high order of frequency stability.
3. The greatest obtainable efficiency.
4. Reliability and ease of operation.
5. In the case of mobile equipments small physical dimensions.

The Marconi Company for many years has been actively engaged in the development of wireless equipments for military, naval and air services. As a result of the experience thus gained, a series of equipments, both fixed and mobile, have been developed and produced to fulfil in every respect the exacting requirements of a Police service.

The equipments are extremely flexible and all classes of Police service are catered for in the range of transmitters and receivers available.

Headquarters Transmitters.

The power output of the transmitter at Headquarters, of course, depends upon the service area to be covered. Two transmitters have therefore been developed to meet different service requirements. These transmitters are known as the Marconi Types T.P.2 and T.P.3. In order to meet demands for transmitters from Forces abroad these sets cover a greater frequency band than that allotted to the Police services in this country.

A crystal drive master oscillator for a pre-selected wavelength is incorporated in both transmitters, thus ensuring the high degree of frequency stability so essential. Both sets provide for the transmission of continuous wave, tonic train and telephone signals. They are simple in operation and are designed for continuous working.

The transmitters are designed primarily for operation from a 50 cycle A.C. supply, but can alternatively be run from suitable motor generators where no A.C. source is available.

The type T.P.2 has an aerial power rating of 100 watts on C.W., tonic train or telephony carrier. The total input power required is approximately 2 kilowatts. The waverange covered is 120 to 180 metres when using a valve drive and the crystal frequency may be selected anywhere in this band.

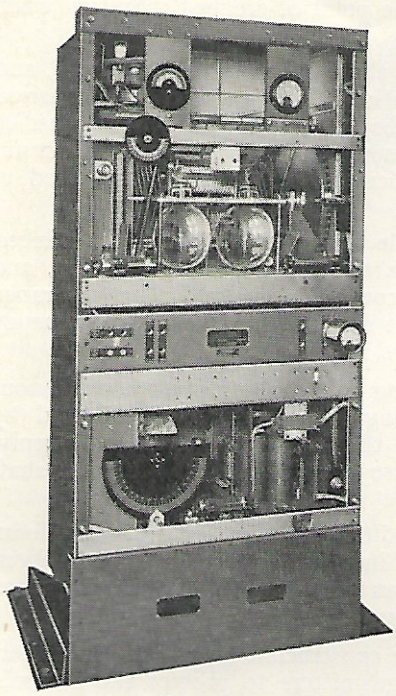

FIG. 1.

Both the crystal and valve drives are thermostatically controlled so that the frequency stability is of a very high order over the whole waveband. When using the crystal the controlled valve drives an isolator stage, which is followed by an intermediate magnifier, and this in turn drives the main magnifier. Modulation is by the choke control method through two modulator valves and the depth on both telephony and tonic train is 70 per cent. Tonic train is provided by means of an oscillator continuously variable from 600 to 1,200 pps.

The transmitter is designed for remote operation and is particularly suited for use in unattended stations, as all circuits are provided with safety trip devices. Thus in the event of a fault occurring on any circuit the transmitter is automatically closed down.

The type T.P.3 is rated at 650 watts to the aerial on continuous wave telegraphy and 250 watts on tonic train or telephony carrier. The total input power required is approximately 3 kilowatts. It is continuously adjustable over the waveband 120—180 metres when using the valve drive.

In the T.P.3 the crystal drive is thermostatically regulated and the frequency stability reaches the high order of one part in 20,000. A spare crystal is also provided for the pre-selected frequency.

The component parts of the transmitter are mounted in a number of cubicles which are carried in a metal framework. The cubicles are provided with removable cover plates at the front and safety switches are fitted to all panels. Fig. 1 shows the T.P.3 with the front cover plates removed.

The radio frequency circuits are similar to those in the T.P.2, but modulation is effected by the D.C. grid method. The depth of modulation on telephony is approximately 75 per cent. and on tonic train 80 per cent. The tonic train is provided by means of a note oscillator and three frequencies are available.

This transmitter can be fully controlled remotely either from an operator's table in the transmitter room or through suitable land lines and amplifiers from a distant control room. The control includes starting up and the selection of telephony

or telegraphy transmission as required. All adjustments to the transmitter are made from the front and after these are completed the tuning controls can be removed, thus preventing interference with the settings by unauthorised persons.

Mobile Transmitters.

The mobile transmitter has imposed upon it the necessity of working under very adverse conditions. It is required to work day after day under conditions of extreme shock and vibration with a minimum of attention. In cars it must usually be placed in the trunk at the rear, and this is the point of greatest vibration when riding over rough roads.

The transmitter must impose little drain on the battery when not in use, and must be ready for operation at a few seconds' notice. Thus no warming up period can be allowed and the frequency stability must be as high as possible. It must be as efficient as possible in order to ensure maximum power output with minimum input. Frequency stability, ruggedness and efficiency cannot be overstressed in this class of equipment.

To meet all requirements two types of mobile transmitter have been produced by the Marconi Company. These are known as the types T.P.4 and T.P.5, and both are rated at 25 watts to the aerial circuit on continuous waves. The waverange in both cases is 100 to 150 metres. A valve drive designed for maximum frequency stability is followed on these sets by a two valve magnifier stage.

The type T.P.4 is designed for operation on telegraphy only by continuous waves or interrupted continuous waves. Keying for telegraphy is effected by simultaneously interrupting the grid circuits and the negative high tension supply. I.C.W. is provided by means of an interrupter disc mounted on the generator shaft and connected in series with the key.

The type T.P.5 provides for telephony in addition to C.W. and I.C.W. Modulation is effected in the grid circuit of the magnifier valves through a microphone transformer and modulation up to 80 per cent. can be obtained. The carrier power on telephony transmission is of the order of 10 watts.

The transmitters are contained in robustly constructed dust-proof containers and covers are fitted over the fronts of the transmitters to protect the controls, which are mounted on the front panels. These controls are provided with locking arrangements to obviate any shifting once the transmitter has been adjusted. The overall dimensions are 9 by $12\frac{3}{4}$ by $8\frac{3}{4}$ inches for the T.P.4 and 9 by $16\frac{1}{4}$ by $8\frac{3}{4}$ inches for the T.P.5. Fig. 2 shows a complete T.P.5 equipment and Fig. 3 the internal arrangement of the components and circuits.

The equipments operate entirely from a 12 volt battery, the high tension supply for the valve anodes being obtained through a rotary converter. The converter unit also contains relays for starting up the machine and for the transmitter filament circuits, smoothing circuits and protecting fuses. The brush gear, fuses and other parts which may require attention are readily accessible, while being well protected against dust, etc. The overall dimensions of the supply unit are $8\frac{1}{2}$ by 11 by $6\frac{1}{2}$ inches.

The sets are controlled from a small control unit which may be mounted in any convenient position in the vehicle. Thus unit contains switches for the control of the high tension and filament circuits through the relays contained in the rotary

converter unit and also switches for selecting the type of transmission required. A main switch changes over from transmit to receive, its functions being to operate the aerial change over relay and the relays controlling the rotary converters. Pilot

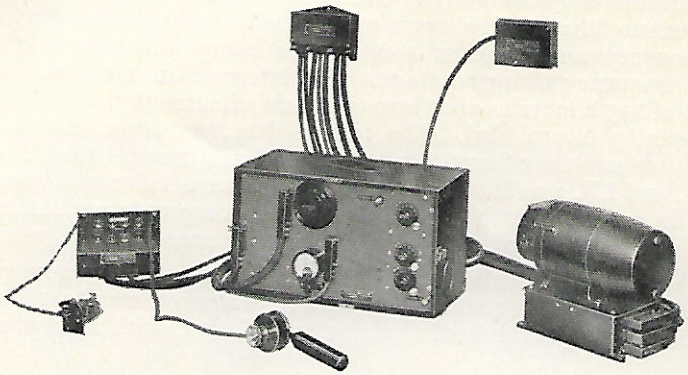

FIG. 2.

lamps are included to indicate the closing of the filament circuits on both transmitter and receiver and sockets are provided for the microphone and key.

Headquarters Receivers.

The receivers used in headquarters stations must combine the highest obtainable order of sensitivity with a good noise discrimination, as, while they can generally be used with an efficient aerial system, they are often of necessity installed in buildings where the electrical interference level is very high.

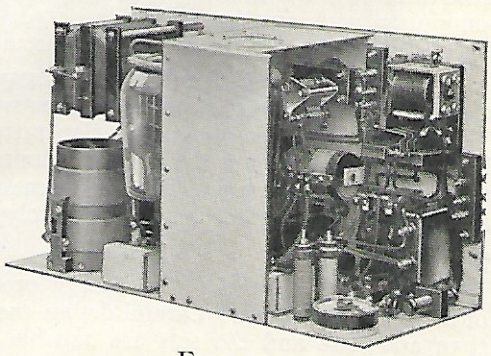

FIG. 3.

Four types of receiver have been produced for fixed station use. Two of these, namely R.P.17 and R.P.25, have been developed for headquarters service, and the others, the R.P.24 and R.P.27, have been designed primarily for use in country Police Stations, etc. These receivers all cover the frequency band 3,000 to 1,500 kilocycles (100 to 200 metres), are provided with single handle control for simple operation and are all capable of receiving telephony or C.W. telegraphy.

The circuit design of the R.P.17 and R.P.25 is practically identical, but whereas the former operates only from A.C. mains, the latter can be used on A.C. or D.C. mains with no changes to the receiver.

In these two receivers full use is made of the latest multiple purpose valve technique and ease of operation is combined with a high order of performance. The audio frequency response is so adjusted that while the speech band of approximately 200 to 3,000 pps. is flat there is an appreciable loss in output outside these

limits. This gives the receivers some additional discrimination against noise interference which is of value when working a telephony service. Adequate automatic volume control is also provided for telephony work.

A conventional superheterodyne circuit is used and careful mechanical design and lay out ensure that the receivers operate with complete stability. One stage of signal frequency amplification is used, this being followed by a single valve "mixer" or frequency changing stage. The intermediate frequency amplification is carried out at 115 kilocycles and three tuned circuits ensure that adequate adjacent channel selectivity is provided. The second detectors are diodes, one providing the audio output and the other the automatic volume control which is operative on both the S.F. and I.F. amplifiers. The audio detector is followed by one amplifying stage, which in turn drives the pentode output. A separate oscillator, which may be switched in or out as required, provides the beat note for C.W. reception.

The receivers are arranged for use with both telephones and loud-speakers. When using the latter an undistorted speech output of approximately 2½ watts can be obtained. The loud-speaker is of the moving coil type with a permanent magnet field.

The performance of the sets is extremely good. The sensitivity is such that a total modulated signal input at the aerial terminal of 6 microvolts will give an output of 50 milliwatts. The adjacent channel selectivity provides an attenuation of at least 35 decibels to signals differing in frequency by more than 12 kilocycles from the wanted signal. The image signal is attenuated by at least 45 decibels with respect to the wanted signal.

The receivers are mounted on aluminium chassis and all components are readily accessible once the sets are removed from their cases. The R.P.17 is fitted in an aluminium case and the R.P.25 in one of cellulosed teak. Both sets are protected by fuses incorporated in the supply circuits.

The R.P.24 and R.P.27 are both straight circuit three valve receivers employing a signal frequency amplifier, a detector with reaction and a pentode output stage. The former has been designed for operation primarily from batteries, but can also be used on A.C. mains with an A.C. eliminator if required. The R.P.27 is arranged to operate direct from an A.C. or D.C. mains supply, and except for the loud-speaker and telephones the receiver is completely self-contained.

Mobile Receivers.

Two types of receiver have been produced to meet the exacting requirements of mobile Police work. Careful design ensures that the mechanical strength is more than adequate and the sets are capable of continuous operation for long periods without attention,

These receivers are the types R.P.20 and R.P.32. Both are superheterodyne receivers covering the waveband 140 to 150 metres with single handle control. The former, however, has two preset controls so that the circuits can be tuned to the frequency required and cannot then be tampered with. In the R.P.32 all circuits are tuned simultaneoutly by the control knob. The R.P.20 is particularly suitable for use with the T.P.4 or T.P.5 as a complete two-way mobile communication equipment. The receiver is small in size and light in weight and is carried in two metal brackets so that it can be mounted in any suitable position in the car or van. Fig. 4 shows an R.P.20 receiver fitted below the dashboard of a car with the loud-speaker

mounted beside it. In the compartment above will be seen the control unit used with a complete transmitting and receiving equipment.

The circuit used comprises one signal frequency amplifier followed by a two valve frequency changing stage. One stage of intermediate frequency amplification at 115 kilocycles follows, and three tuned circuits are used at this frequency. The second detectors are of the metal rectifier type, one providing the audio output and the other the delayed automatic volume control. The control is operative on both

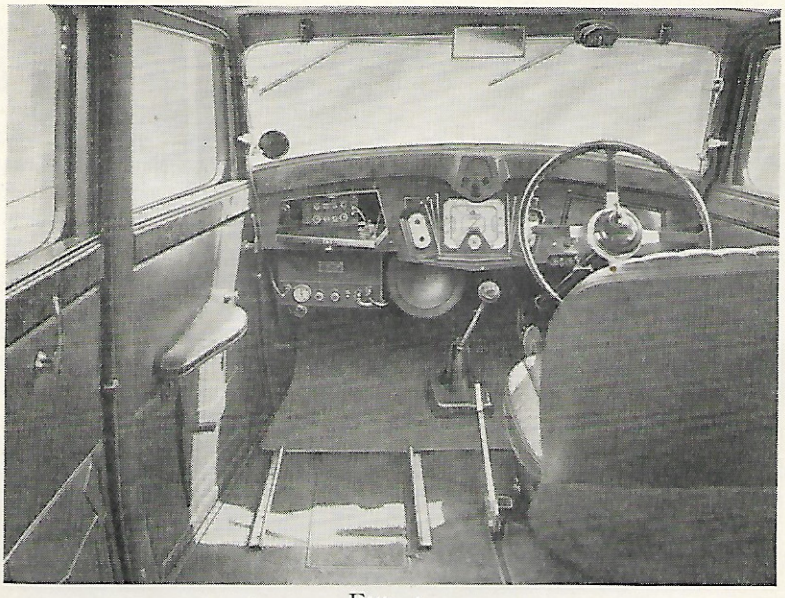

FIG. 4.

signal frequency and intermediate frequency amplifier valves. The audio output is amplified and then passed on to a pentode output stage. For the reception of C.W. a separate beat oscillator is introduced, the triode valve for this purpose being contained in the same envelope with the A.F. amplifier. Reception is on either loud-speaker or telephones and adequate volume is available on the former for use in any car or van,

The performance is of a high order in view of the extremely small dimensions of the receiver. An output of 50 milliwatts is obtained for a total modulated signal input at the aerial terminal of 6 microvolts, The adjacent channel selectivity is such that signals differing by more than 12 kilocycles from the wanted signal are attenuated by at least 35 decibels. The image signal is attenuated by at least 50 decibels by comparison with the wanted signal.

The receiver chassis is strongly constructed to resist vibration on the road and the accessibility of all components is extremely good. Fig. 5 illustrates the robust construction and the arrangement of the coils, all of which are contained in screening pots. The chassis slides into an aluminium case, which has a hinged front flap.

By raising this flap the valves are all visible and can be easily changed if necessary. The overall dimensions of the receiver unit are $8\frac{1}{2}$ in. high by $10\frac{3}{4}$ in. wide by $6\frac{1}{4}$ in. deep.

The receiver operates entirely from a 6 or 12 volt battery through a supply unit. The receiver valves are of the 2 volt directly heated type and are supplied through a suitable dropping resistance contained in the supply unit, while the anode supply is obtained through a rotary converter. The high tension supply is suitably smoothed in the supply unit, which also contains low and high tension fuses and a relay for starting the rotary converter.

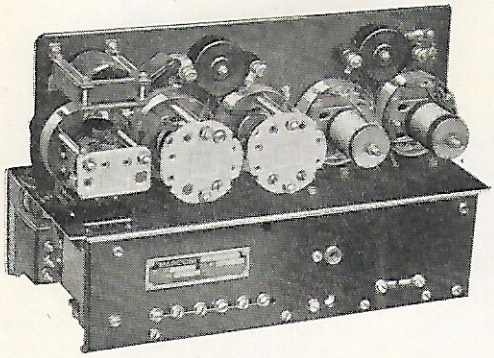

FIG. 5.

The R.P.32 has been primarily produced for installation in vehicles where no transmitter is to be used. It will operate directly from the starting and lighting battery of the vehicle and is extremely compact and easy to fit. The equipment consists of three units—receiver, combined loud-speaker and supply unit and remote control unit.

Indirectly heated universal type valves are used, these being supplied direct from the battery, while the anode supply is obtained by means of a vibrator converter. The remote control unit may be mounted in any accessible position. This unit contains the tuning control, in which is incorporated the C.W./telephony switch and a combined volume control and On/Off switch. The tuning scale is calibrated directly in metres and kilocycles.

The overall dimensions are $8\frac{1}{4}$ by $5\frac{1}{2}$ by $6\frac{7}{8}$ inches for the receiver unit and $8\frac{1}{4}$ by 5 by 7 inches for the loud-speaker and supply unit. The cases are of steel and are mounted by means of two metal straps in the desired position. The receiver chassis can be easily withdrawn from the case while in position in the vehicle. A complete R.P.32 equipment is shown in Fig. 6.

The performance is of the same order as for the R.P.20, but an undistorted output of 2 watts is available. The total consumption from the battery is approximately 4 amperes.

Aerials.

The design of the aerial for a mobile equipment is of primary importance. The aerial on a car must be as nearly as possible invisible or at least sufficiently inconspicuous as not to attract attention to the vehicle. Unfortunately the aerial that is most efficient is invariably too conspicuous to suit the requirements of a Police Force. While, therefore, in any case it will be extremely inefficient and have an almost negligible effective height, every effort must be made to make the aerial on a car as good as possible.

A number of aerials have been used on cars with varying degrees of success. The most efficient type is undoubtedly the rod aerial. This consists of a metal tube 5 feet long mounted in insulators on the side of the car so that about 3 feet of its length projects above the roof when raised. In order to permit the car to be driven

under cover this rod can be lowered when not in use. It can also be provided with a telescopic top section so that the aerial may be lengthened while the car is stationary if required.

Unfortunately the rod aerial is considered to be too conspicuous, and a type known as the "luggage grid" has been adopted as the best compromise between efficiency and invisibility. This aerial consists of a copper tube formed into a

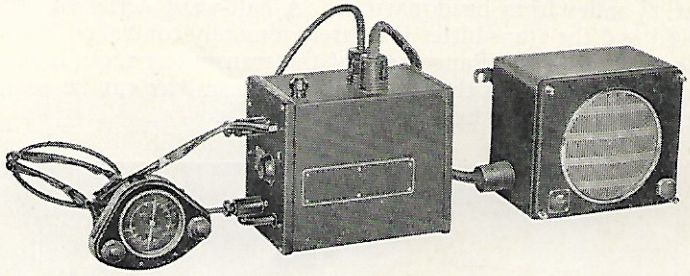

FIG. 6.

rectangle and mounted about 4—5 inches above the roof of the car by means of four or six insulators. It may be shaped to the roof curves, is very inconspicuous and looks exactly like the luggage rail fitted to some large cars. A car fitted with one of these aerials is illustrated in Fig. 7.

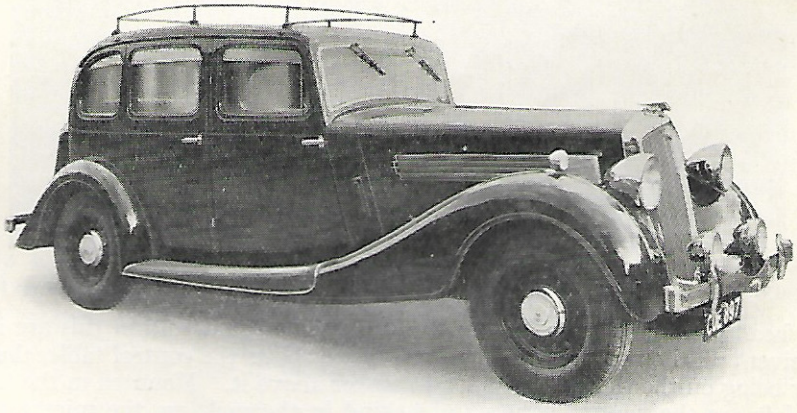

FIG. 7.

These types are the only aerials suitable for both transmission and reception. There are other types which have been used for reception only, where the aerial must be completely concealed. These usually consist of a metal gauze mat or copper sheet mounted beneath the running board or in the roof of the car. They are very inefficient and are much inferior to the "luggage grid" type.

Typical Installation.

The equipment supplied to the City of Glasgow Force by the Marconi Company is an excellent example of a police installation. Here the headquarters station

serves not only the City of Glasgow alone, but under the Regional scheme is the source of information for the surrounding county and burgh forces. Most of the service area to be covered lies within a radius of about 60 miles, but some stations lie as far as 90 miles from the transmitter.

The installation at the Police Headquarters comprises a T.P.3 transmitter and R.P.17 receiver. In order to obtain the best possible aerial the transmitter is situated about 1½ miles from headquarters. A half-wave aerial suspended almost vertically is used and the transmitter is entirely remotely controlled from the control room at headquarters. The arrangement of the transmitter room is seen in Fig. 8. In the event of a breakdown in the landlines the transmitter can be operated locally from the control table in the foreground.

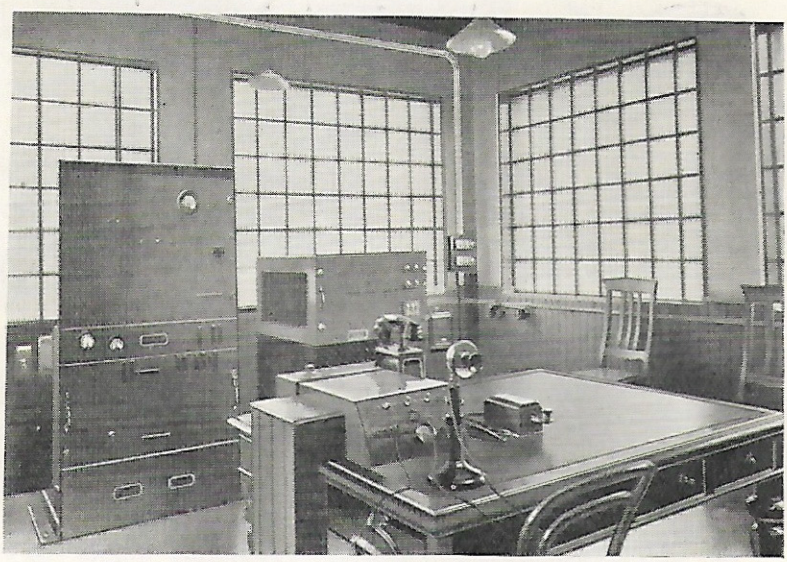

FIG. 8.

At headquarters a sound-proof room has been erected, and in this are installed the receiver and the remote control gear. Fig. 9 shows the control table, the R.P.17 receiver being on the right with its loud-speaker above it. Mounted in the table top on the left are the control panels and behind in the rack are the microphone line amplifier, the tone generator for calling, and the recifier equipment. The complete installation is operated direct from the A.C. mains.

The mobile equipments include a T.P.5/R.P.20 equipment mounted in a van and a number of R.P.20s and R.P.32s. Under the Regional scheme a number of fixed station receivers have also been installed at county and burgh headquarters stations.

Both telephony and C.W. telegraphy working is carried on, telephony being used only for the outward city service, and C.W. for working back to headquarters and also for the Regional scheme. Tonic train is used for calling purposes, the note being so chosen as to be audible through extremely bad electrical interference.

The noise level is very high in Glasgow, but it has been found possible to cover the whole of the City on telephony on the outward service.

Future Developments.

The ultra short waveband around 30 to 42 megacycles has been used to some extent in America. Extremely good results are claimed for services operating on these frequencies. There has, however, been little demand for this system in this country mainly owing to the comparatively restricted ranges that can be obtained.

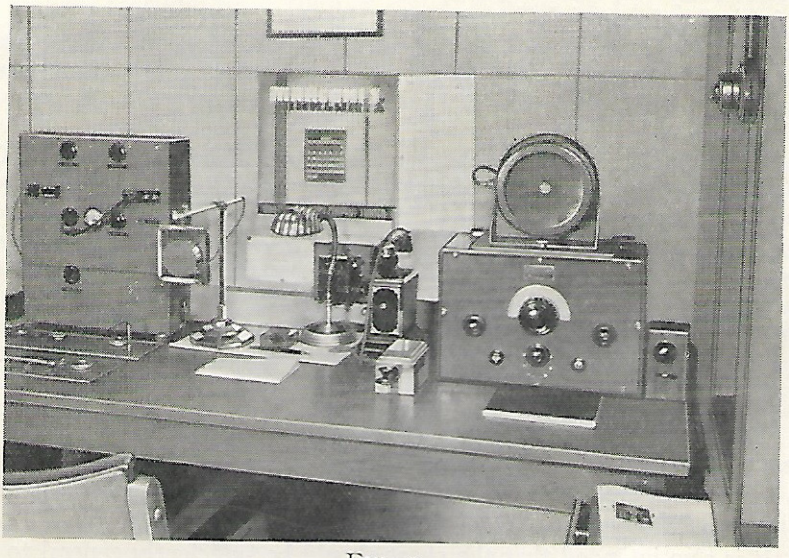

FIG. 9.

The Regional scheme where one central transmitter serves a widely spread area definitely prohibits the use of the 30—42 megacycle band, but there may be a field for equipments operating on these frequencies for local area work only. Owing to the congestion which will inevitably arise before long in the medium waveband any further expansion must of necessity take place on the higher frequencies.

The question of price for local area services is of paramount importance and operating costs must be kept as low as possible. The comparative simplicity of apparatus for the ultra short wavelengths enables equipments to be reduced correspondingly in price.

A further refinement which becomes a comparatively simple matter on ultra short waves is the provision of duplex telephony. The large frequency band available permits the use of many channels without overcrowding and thus facilitates the possibility of duplex working. The use of duplex telephony makes every member of a Police Force an operator without the necessity of any training, since this system is as simple to use as the Post Office telephone.

E. R. BURROUGHES.