ARMY SET — Type R107

Communications Receiver, Embodying Variable Selectivity, High Sensitivity and Covering a Wave-band of 1.2 Mc/s to 17.5 Mc/s

ALTHOUGH much Army wireless equipment is of a highly specialised kind, some of the apparatus represents an obvious development from civilian prototypes, and so is of much more general interest. A good example in this category is the Type R107, one of the Army's best communications receivers.

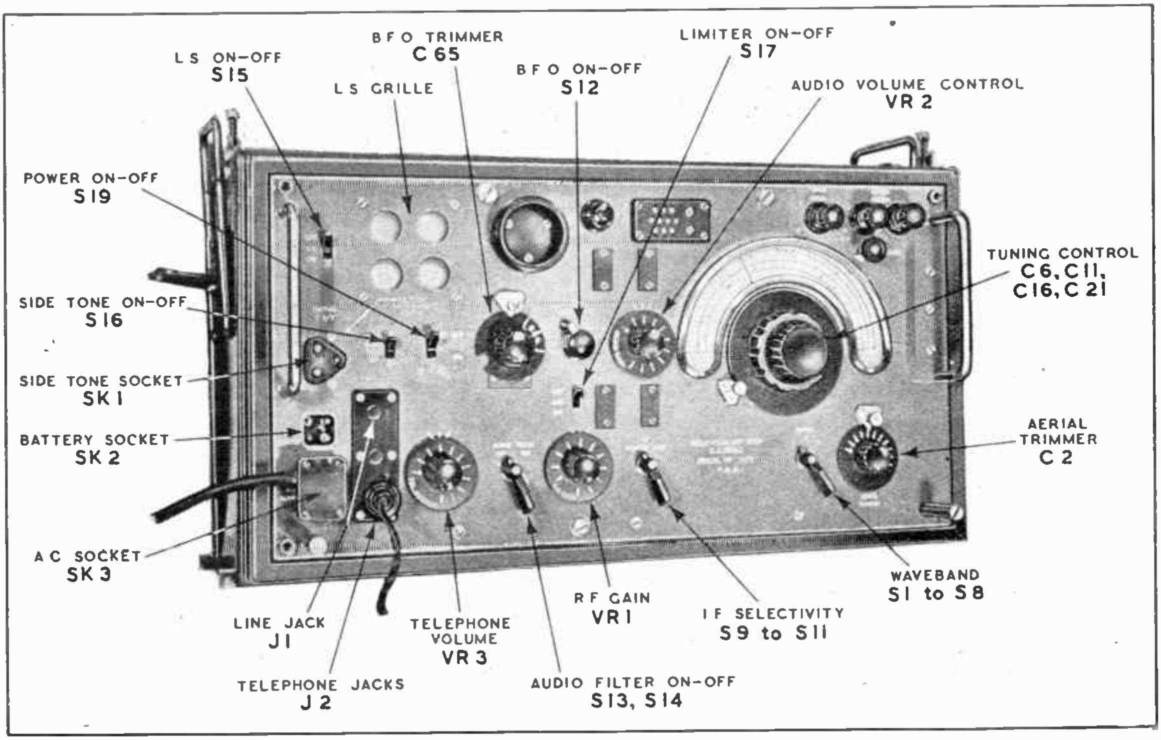
Referring to its circuit diagram reproduced here it will be seen that eight valves are used, they perform the following functions. V1 is a signal-frequency RF amplifier which is coupled to a frequency changing valve V2 by a pair of link-coupled tuned circuits. There is a separate local oscillator valve V3 and then come two IF amplifiers V4 and V5. These are followed by a duo-diode-triode V7, one diode of which functions as a detector with its companion diode providing delayed AVC and the triode section giving a stage of AF amplification. The valve V6 is a beat-frequency oscillator for CW reception and, finally, there is a low-power triode output stage in the form of the triode section of another duo-diode-triode valve V8. Outside this receiving chain is one other valve V9, a full-wave rectifier for HT supply, which will be found in the power unit.

The first interesting feature one notices is the pair of link coupled tuned RF circuits, which form the coupling between the RF amplifier V1 and the frequency changer V2. Their function is to give good second-channel discriminatory powers to the circuit as at the higher signal frequencies a total of two tuned circuits only ahead of the frequency changer does not provide a very high ratio of signal to second channel interference, even with an IF of 465 kc/s.

The IF amplifier next claims attention if only for the imposing array of the eight tuned circuits it contains. A single pair couples the frequency changer to the first IF amplifier V4, but two pairs in tandem couple V4 to V5, the second IF amplifier. Coupling between the secondary circuit of one and the primary circuit of the next is, in this case, by means of a 2.2 μμF capacitor C44.

The selectivity provided by this chain of circuits is such that at 3 kc/s off resonance the signal attenuation is about 6 db. This is quite satisfactory for modulated CW morse transmissions and tolerable for R/T where inter-

The front panel of the R107 receiver carries no fewer than fourteen controls. The annotation is the same as used on the circuit diagram.



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ference is very bad, but under less stringent conditions a broadening of the IF response will have its advantages. This also can be done, provision being made for opening out the IF response to a bandwidth of ±7.5 kc/s.

This variable selectivity feature is obtained by augmenting the normal inductive coupling in the IF transformers by inserting capacity coupling in the low-potential ends of the first three transformers. The capacitors used for this purpose are C31, C42 and C50, each of 0.05 μF capacity and the necessary circuit rearrangement is effected by the three ganged-switches S9, S10 and S11.

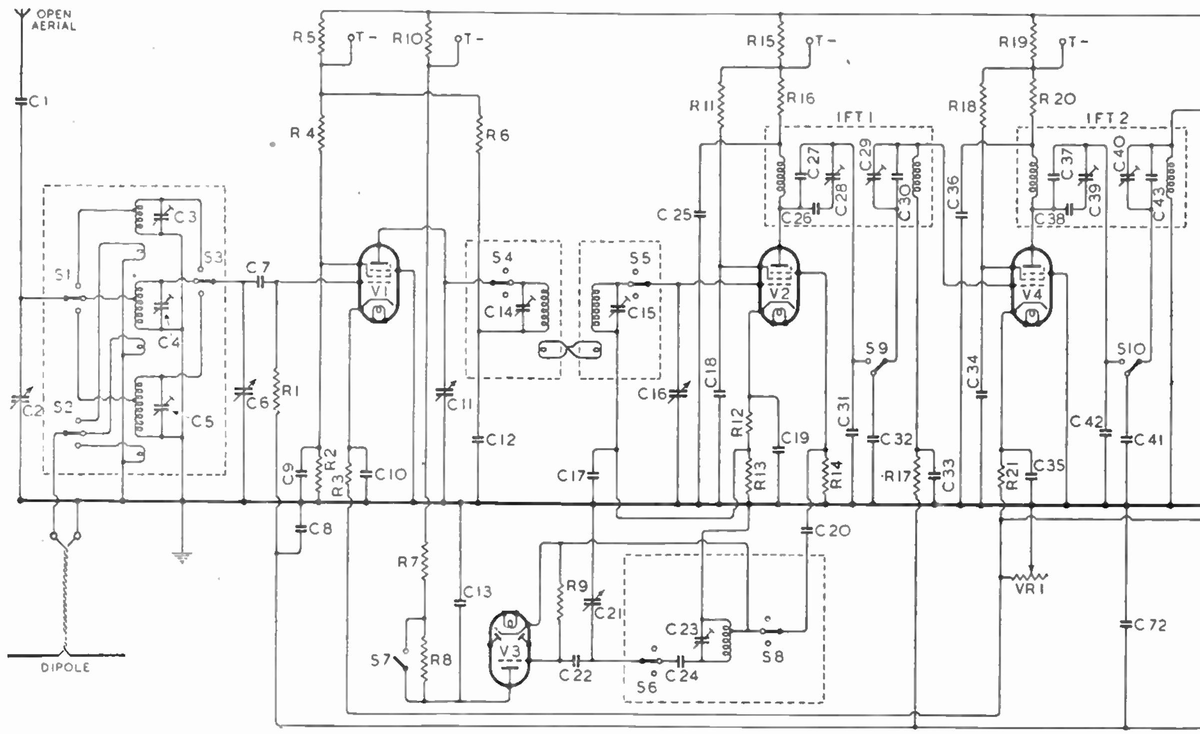
When interference is really bad and still higher selectivity is needed (it can be utilised only for CW transmissions) an audio filter tuned to 900 c/s and having a bandwidth of ±150 c/s can be inserted between the penultimate and output valves, V7 and V8, giving a frequency coverage of 1.2 Mc/s to 17.5 Mc/s, which in wavelength is 250 metres to 17 metres approximately. The individual coverages of these ranges are 1.2 to 3 Mc/s, 2.9 to 7.25 Mc/s and 7 to 17.5 Mc/s respectively. Tuning is by a four-gang variable condenser, each section of which has a capacity of 300 μμF. these being marked C6, C11, C16 and C21 in the circuit. The latter is the oscillator tuning section.

Unit Construction

It might be advisable to explain that the circuit diagram given here has been much simplified. In actual fact the receiver is an assembly of three independent units interconnected by twelve-way tag boards and the medley of leads so produced is most confusing when endeavouring to follow a circuit. These interconnections were accordingly omitted, as were two of the three sets of signal frequency coils in the RF intervalve coupling and appropriate ones are brought into circuit by a three-way waveband-switch which in reality is a ganged assembly consisting of the separate switches S1 to S8 inclusive, plus those for shorting out the idle coils and not included in the diagram.

In the general outline of the function of the various stages in the set V2 was described as the frequency changer. Actually this function is shared by V2 and V3, the former being the mixer, which in the early days of the superheterodyne was often, and with some justification, described as the first detector, while the latter is the local oscillator.

The locally generated oscillations are injected into the suppressor grid of V2 via C20. This grid, being joined to the earth line via the resistor R14, receives a negative bias derived from the flow of cathode current through R12 and R13 in series, whereas the control grid gets its negative bias from the voltage drop across



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by the linked switches S13 and S14.

Reverting now to the input end of the receiver we see that there are three tuning ranges in the oscillator circuit. All three coils are included, however, in the input circuit in order to emphasise their existence. The R12 only. In this case the bias on the suppressor grid is about ten times the control grid bias. Switch S7, which is embodied in the waveband switch, is used to bring an extra anode resistance R8 into circuit, for limiting the amplitude of oscillations on the lowest frequency range.

Although there is a small loudspeaker built into the set its use is generally limited to stand-by occasions, normal traffic work-ing being carried out with head-phones. These are plugged into the jack J2—which, incidentally, is in duplicate in the actual re ceiver.

As the set is primarily designed for headphone reception a signal strength limiter, described as a "crash" limiter, and comprising the two metal rectifiers D1 and D2, is included. Switch S17 brings it into use when needed.

Provision for remote control via the socket SK1 tends to complicate the output end of the receiver, particularly as it also brings "side tone" from the transmitter into the receiver's telephone circuit for the purpose of monitoring the transmission.

COMPONENT VALUES

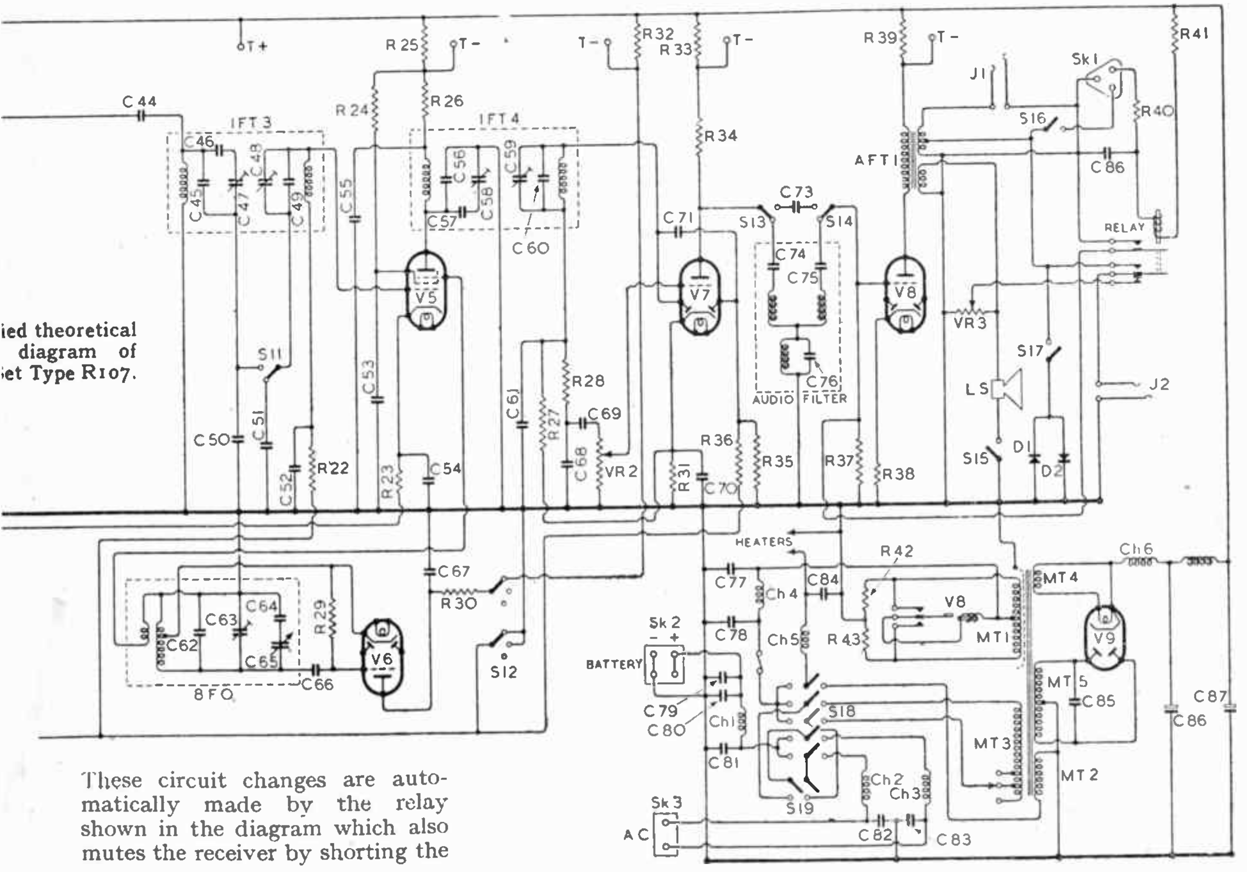
Value	Circuit Positions
2.2 μμF	C44
20 ,,	C1
25 ,,	(Pre-set) C3, C4, C5, C14, C15, C23
50 ,,	(Variable) C2
80 ,,	C22
100 ,,	C64, C66, C70
200 ,,	C7, C20; C61, C62
300 ,,	(Variable ganged) C6, C11, C16, C21
750 ,,	C24
0.001 μF	C26, C38, C46, C57, C80, C81
0.005 ,,	C72, C73
0.01 ,,	C13, C63, C71, C75, C76, C77, C85
0.05 ,,	C8, C9, C10, C12, C17, C18, C19, C31, C32, C41, C42, C50, C51
0.1 ,,	C25, C33, C34, C35, C36, C52, C53, C54, C55, C67, C68, C69, C74
1.0 ,,	C78, C79, C82
4.0 ,,	C86
8.0 ,,	C83, C84
100 ohms	R40
150 ,,	R42, R43
300 ,,	R3
400 ,,	R12
500 ,,	R21, R23, R38
1,000 ,,	R31
3,000 ,,	R5, R10, R15, R19, R25, R32, R33, R39
5,000 ,,	R6, R13, R20, R26
15,000 ,,	R41
20,000 ,,	R2, R34
25,000 ,,	R4, R7, R16
30,000 ,,	R30
50,000 ,,	R9, R14, R29
80,000 ,,	R8, R11
100,000 ,,	R18, R24, R37
250,000 ,,	R1, R17, R22, R28, R36
500,000 ,,	R27, R35
500 ,,	VR3
4,000 ,,	VR1
500,000 ,,	VR2

output valve grid leak, R37, to earth.

A combined AC/DC power unit embodied in the set supplies all working voltages. DC is derived from a 12-volt accumulator bat-tery and either AC or DC opera-tion is obtainable simply by throwing over the switch S18 to the appropriate position and, of course, connecting up to the right form of supply. No harm can befall the set if the switch is thrown to DC with an AC input and *vice versa*.

Vibrator HT Supply

Whether battery or AC operated HT for the valves is obtained from an orthodox rectifier circuit fitted with a 6X5G full-wave rectifying valve V9 and the associated transformer windings MT4 and MT5. When battery operated the transformer gets its input via the primary winding MT1 which is energised by the vibrator unit VB. The valves (with the exception of V9) being



...ied theoretical diagram of ...et Type R107.

These circuit changes are auto-matically made by the relay shown in the diagram which also mutes the receiver by shorting the

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connected in a combination of series and parallel, then draw their filament supply from the battery via a "mush" filter consisting of the choke Ch5 and capacitor C84.

With AC operation the filament supply comes from a 12-volt AC winding, MT2, on the transformer, while another winding, namely MT3, now becomes the primary. Under both conditions of operation V9 gets its filament supply from winding the MT4 on the transformer.

The arrangement of the vibrator circuit is of interest as its contacts do not make and break the DC supply, but they merely serve to short-circuit first one then the other half of the primary winding, both of which are in parallel so far as the DC supply is concerned. As there is no abrupt interruption of relatively heavy currents, which in vibrator circuits produce very high peak voltages in the secondary circuit of the transformer, very simple filtering suffices in this case. The small current needed to energise the operating coil of the vibrator is, of course, rhythmically interrupted, but its magnitude is too small to produce any troublesome surges.

The only filtering required for this unit is provided by the choke Ch4, capacitors C77 and C78 assisted by the suppressors R42 and R43. Any residue that might get into the rectifier circuit is taken care of by Ch6 and C85.

Provision is made for monitoring the various stages in the set by measuring the voltages dropped across resistors R5, R10, R15, etc., to R39, which carry the HT feed currents of the various valves. All these test points, which are marked T in the circuit, are brought out to a small test panel on the front of the set.

As the annotated photograph of the set shows an extraordinary number of controls are assembled on the panel. These include controls for RF and for AF gain, as well as all the switches except S18.

DEFINITION IN THE CINEMA

Assessment of Optical Standards for Television

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SINCE the question has recently been raised as to the number of scanning lines required in television to produce a picture having the same standard of definition as the picture projected on the cinema screen it is worth while first to try to assess that standard and express it in terms of lines per picture.

For the purpose of calculation the dimensions of the film picture are taken as 0.600in. × 0.825in. We have to decide how far definition is affected by (1) the film, (2) the camera, (3) photographic technique, (4) the taking lens, (5) processing, (6) the projector and (7) the projection lens.

(1) The Film.—Three films are mentioned in the Kodak Data Book as suitable for cinematography, viz., a normal very high speed emulsion with a resolving power of 30 lines per mm.; i.e., 450 horizontal lines to the picture; a new very high speed emulsion of moderate contrast with a resolution of 45 lines per mm.; i.e., 675 lines per picture; and the normal high-speed emulsion of fairly high contrast which resolves 50 lines per mm., or 750 lines per picture.

(2) The Camera.—No data are available as to the standard of workmanship. Perforations have a tolerance of 0.0004in. in size and 0.0005in. in pitch. It would thus seem that about 0.001in. error is considered allowable in all, and probably a similar standard is aimed at in manufacture. This demands a precision of a few ten-thousandths of an inch in the individual parts of the film transport mechanism and is attainable in precision engineering. This gives 600 lines per picture.

(3) Photographic Technique.—This includes possible blurring of the image through variations in focusing and the requirements of field depth. It will be supposed that a 2in. f/2 lens is used in the camera. Experience shows that it is impossible to be sure of focus closer than 0.002in. even with the refined tools of the opticians testing room. It is unlikely that precision in the studio will be high. An error in focus of 0.002in. is thus possible. At f/2 this produces a blurr of 0.001in., which is 1/600 picture height.

A guide to the limit set by depth of focus can be obtained by considering a close-up of a head nearly filling the screen. The reduction will be about 1/20. Now a depth of ± 1in. on either side of the part upon which attention is focused (usually the eyes) must be allowed without the image becoming perceptibly blurred. Therefore the depth of focus will be ± 1/400in. at the film; at f/2 a blurr of 1/800in. is produced. If this is tolerable, so is a standard of 480 lines.

(4) The Taking Lens.—No lens is perfect and generally accepted figures for the usual errors will be quoted for high quality cinema lenses.

(*a*) *Axial.* The definition can be spoiled by axial chromatic and spherical aberrations; even though these are said to be "corrected" there are always residuals which cannot be entirely removed with the glasses at present available. In a lens for spherical aberration it will be found that if zones are isolated they will each give a slightly different focus. This variation will in a good lens amount to 0.004in. per inch focal length; i.e., it will be 0.008in. in