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POST OFFICE ENGINEERING DEPARTMENT

RADIO REPORT No. 427

Short Wave "Unirad" Receivers, Burnham Radio Station

OFFICE OF THE ENGINEER-IN-CHIEF,
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SHORT WAVE "UNIRAD" RECEIVERS, BURNHAM RADIO STATION

E-in-C. Case No. 2095

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(Sgd.) G.A. Struthers
Asst. Staff Engineer
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24th January 1938

Office of the Engineer-in-Chief,
(Radio Branch),
G.P.O.,
London, E.C.1.

Rota 289 W/38.

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GENERAL.

This Radio report describes a receiver designed and constructed by Messrs. Union Radio Co., Croydon, in accordance with the Post Office Specification W. 1060, three of which were installed at Burnham Radio Station in October 1937.

The Memo P & D No. 317 describes investigations carried out at Burnham Radio Station in connection with inter-receiver oscillation between Eddystone "All World Four" receivers, and the results clearly demonstrated that the use of receivers with oscillating detectors, utilising one common aerial or array, caused serious interference with each other. With these conditions prevailing and calling for urgent consideration, Messrs. Union Radio Co., Croydon were consulted and they agreed to try to produce an experimental receiver at Burnham Radio Station embodying the principle described in this report. As the tests carried out proved satisfactory Messrs. Union Radio Co. were given instructions by contract to proceed with manufacture of three receivers.

The receivers are designed to cover the following mobile wave bands:-

18 metre	16400 - 17750 Kilocycles per second
24 metre	12300 - 13350 Kilocycles per second
27 metre	11000 - 11400 Kilocycles per second
36 metre	8200 - 8900 Kilocycles per second
48 metre	6150 - 6675 Kilocycles per second.

In order to facilitate the use of the receivers for searching quickly each band, single dial tuning and waveband switching is incorporated and the design has received particular attention to enable the three receivers to operate without interaction when connected to the same aerial and in close proximity to each other.

Each receiver is identical in design and is arranged as follows:- one signal frequency stage followed by a triode hexode mixer with fixed oscillator on each wave band arranged to give a first intermediate frequency between 1.0 and 3.0 megacycles per second. This variable

frequency/

frequency IF stage consists of a high frequency amplifier followed by another mixer with variable oscillator to give a final fixed IF of 465 Kilocycles. Then follows one stage of amplification leading into a double diode working as third detector and providing A.V.C. The third detector is coupled to one low frequency stage before the output pentode. The radio frequency stage, variable IF and second variable oscillator tuning condensers are ganged and the fixed oscillator frequencies controlled on a five position switch.

Each receiver comprises two panels mounted on a table rack 3 ft. by 19 inches and a power rack mounted independently, each finished in black crystalline with copper screening covers.

The controls are as follows:- tuning ganged as mentioned above to an Admiralty type dial with extended spindle for left hand operation. A five position switch which controls the fixed oscillator over the required wave bands.

A beat oscillator control giving approximately $\pm$ 5 Kilocycles per second beat note for heterodyne reception of C.W. signals, and a low frequency gain control.

The output of the receiver is jacked for high and low impedance matching through transformers from either of the low frequency stages.

The receivers are intended for use on 230V alternating current mains and all valve heaters are at present of the 4 volt type. An extra 6.3 Volt heater winding is provided on the mains transformer should the use of international type valves become standard. In each mains supply circuit fuses have been fitted and indicating lamps to show when the supply is switched on.

The H.T. supply to the various stages is fed via keys permitting insertion of a 0 - 1 milliamp meter with appropriate shunts for checking purposes and also a condition is provided whereby the meter may be used as a tuning indicator, by a key switching it into the cathode circuit of the third detector.

The/

The single radio frequency stage, employing a variable mu HF pentode, has an aperiodic input capable of matching a balanced 600 ohm transmission line or alternatively a line of 70 ohms with one side earthed.

The anode circuit of this stage is tuned to signal frequency and is inductively coupled to the grid of the first mixer or frequency changer valve. This valve is a triode hexode Mazda Type AC/TH 1 the oscillator section of which is preset so that frequencies over the band in question appear in the output anode circuit between one to three megacycles per second.

The output of this valve is amplified in a stage using a variable Mu pentode and tuning over the range indicated above. This stage is followed by the second mixer or frequency changer, again using a triode hexode, the oscillator section of which converts frequencies of one to three megacycles per second on the input to the second intermediate frequency of 465 kilocycles per second.

The output of the second frequency changer is amplified by one stage using a variable Mu pentode before the double diodes which provide signal rectification for low frequency and automatic volume control purposes. The diode is also coupled to the output of a beat frequency oscillator variable over a range of $\pm$ 5 kilocycles per second for heterodyne reception. Automatic volume control is applied to the various stages via a switch which if necessary removes this facility.

Two stages of low frequency amplification follow the diode each having an output matching arrangement for high or low impedance termination.

From the foregoing it will be noted that the first beat oscillator is fixed for each waveband, it is therefore possible to design the first frequency changer circuit so that, while obtaining the necessary oscillator volts for satisfactory conversion conductance of the first frequency changer, radiation which would cause interference to adjacent receivers can be eradicated. Also by choice of frequencies of the first beating oscillator it is possible to arrange that any interference, due to harmonics of the fixed oscillator, lies outside the required bands.

Actually/

Actually, the harmonics of the variable beat oscillator could theoretically cause unwanted whistles and some were observed during the tests with the experimental receivers but, by attention to screening and harmonic reduction in the variable beat oscillator circuit, the interference level in the final models has been reduced below the set noise.

Since the signals are tuned by the ganged R.F. and variable I.F. the two very desirable facilities of single dial tuning and very generous band spread are obtained.

The results of preliminary tests carried out at Messrs. Union Radio Co's Works prior to installation are shown in following:-

Image response.

Average attenuation over all wave bands 65 dbs.

Selectivity and Sensitivity better than called for in Specification No. W. 1060.

Audio frequency amplification.

Approximately 36 dbs.

Power Consumption.

110 watts for each receiver.

Drawings and Photographs. Drawing WL 20628 shews the wiring diagram, and attached photographs indicate the front view and layout of the apparatus.

CONCLUSION.

The tests on site during installation proved that the receivers easily comply with the specification and give promise of very satisfactory results. However, it was found that the oscillator frequency continues to drift for approximately one hour after the receivers are switched on, until the valve and circuit temperatures reach some degree of constancy. This effect should not introduce any serious inconvenience as it is expected that the receivers will be operating continuously over long periods.

Reports received since the above was written shew that the new receivers are now working satisfactorily and no troubles from mutual interference when working on identical wavebands has been encountered.

This/

This installation has called for improved internal aerial wiring over the existing arrangements at Burnham Radio Station. The replacement of the existing internal aerial wiring by low loss twin screened cable having a surge impedance of approximately 140 ohms is now under consideration and such replacement will no doubt improve the general reception at the Station especially on the short wave bands.

APPENDIX I.

Considerations of "Whistles" which can be produced with Triple detection Variable I.F. Receiver

Drawing WL 15807 can be used to illustrate how, by proper choice of working frequencies, the number of whistles which can theoretically be produced may be reduced to a minimum. Further reduction in the intensity of these whistles may be made by attention to screening and reduction of the harmonic content of any oscillators concerned.

In WL 15807 the ranges which the receiver was desired to cover are shewn shaded, i.e. from

6.15 to 6.68 megacycles per second
8.20 to 8.90 ditto.
11.0 to 11.4 ditto.
12.3 to 13.4 ditto.
16.4 to 17.75 ditto.

although the design of the receiver is such that the tuning scale from 0 to 100, actually gives a coverage of two megacycles, embracing the desired band.

The second intermediate frequency is fixed at 465 KC and so does not vary with the position of the tuning dial. However the first intermediate frequency varies from one to three Megacycles according to the position of the tuning dial, and the harmonics of the second beating oscillator (which beats with the first intermediate frequency signals to give 465 kilocycles per second intermediate frequency signals) vary in sympathy. The frequency of any harmonic up to the 12th has been graphed on WL 15807 as a function of the dial reading.

Now if the tuning scale of any range cuts a harmonic graph, then the receiver is especially prone at this point to give a whistle, since it responds to the harmonic frequency, and is itself generating a certain amount of energy at this frequency. Hence if a signal - which could be produced by a similar receiver tuned to the same point and range, - is impressed on the receiver, and if the magnitude of the harmonic voltage reaching the grid of first valve is of sufficient magnitude, a "whistle" is produced.

There/

There are hence several ways of reducing whistles from this source.

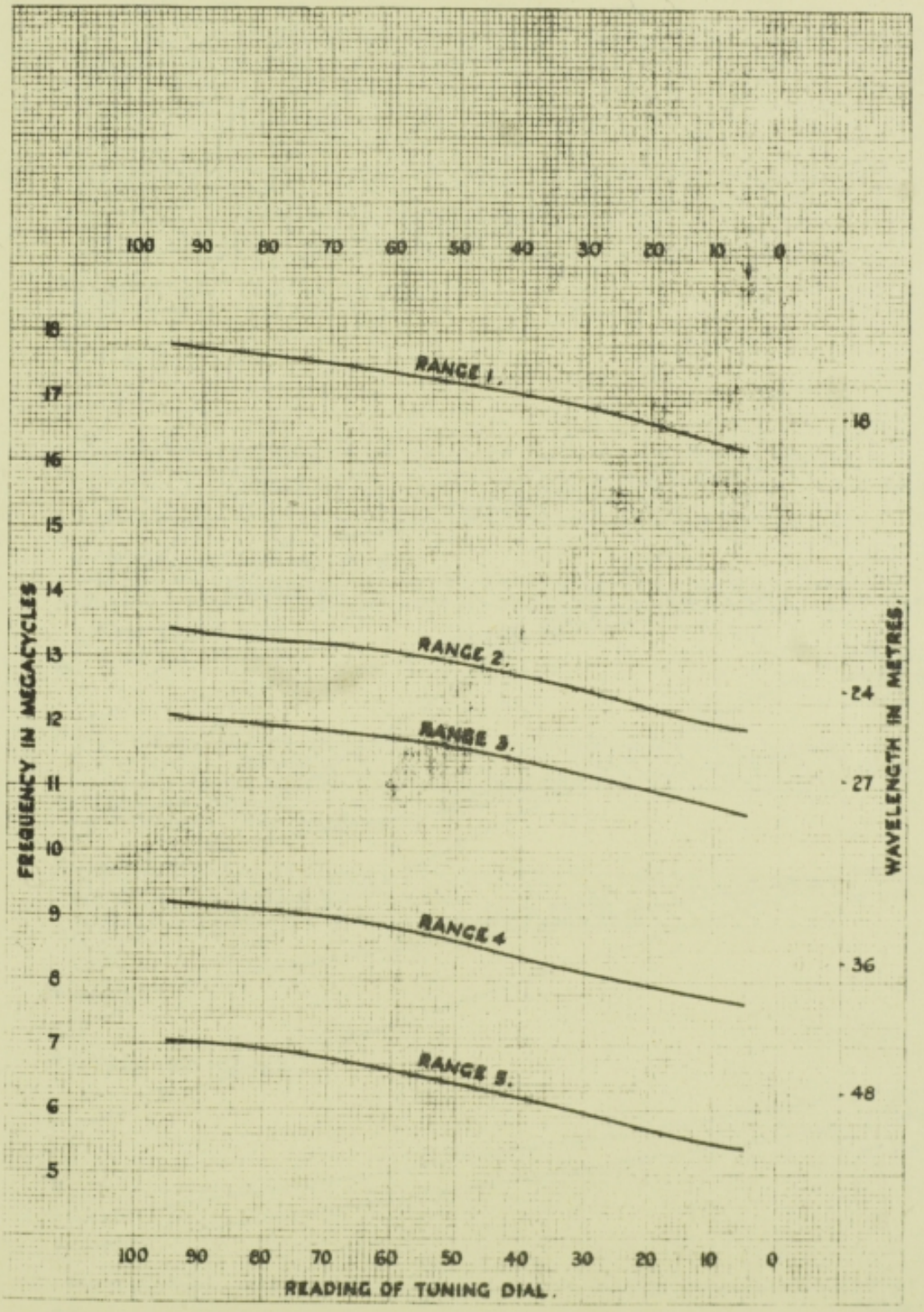
(1) Use the higher frequency of the two possible second beat oscillator frequencies, and hence reduce the total number of harmonics which can occur up to 18 megacycles per second.

(2) Arrange that as far as possible the upper frequency of the required range tunes at the highest possible point of the tuning dial, since this reduces the possibility of a harmonic graph intersecting a tuning scale. This may not always be necessary as for example in the case of Range 1 where considerable latitude is permissible in the arrangement of the tuning scale without danger of introducing unwanted whistles. Again other considerations such as interference due to a station on one of the frequencies of the first intermediate frequency band, may influence the positioning of the tuning scale, for such interference could quite conceivably be at a higher level than the "whistles".

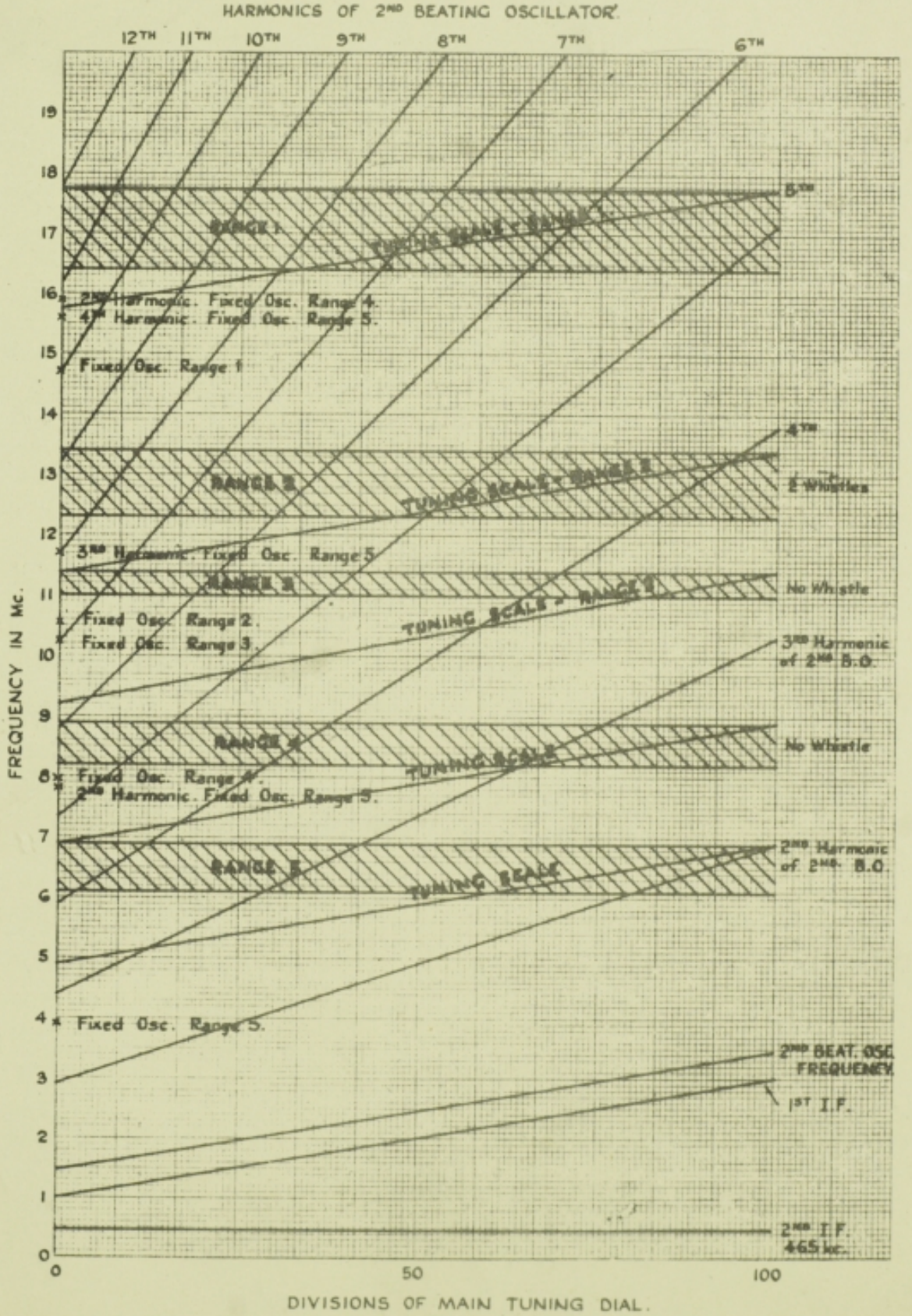
(3) Arrange that as far as possible the second beat oscillator is as free from harmonics as possible, and that screening of the second intermediate frequency amplifier is as complete as possible. A further form of interference might arise if a harmonic of the fixed oscillator i.e. first beating oscillator falls in any of the desired ranges. This is however obviated by closing either the upper or lower of the two possible frequencies, such that no harmonic falls in these ranges.

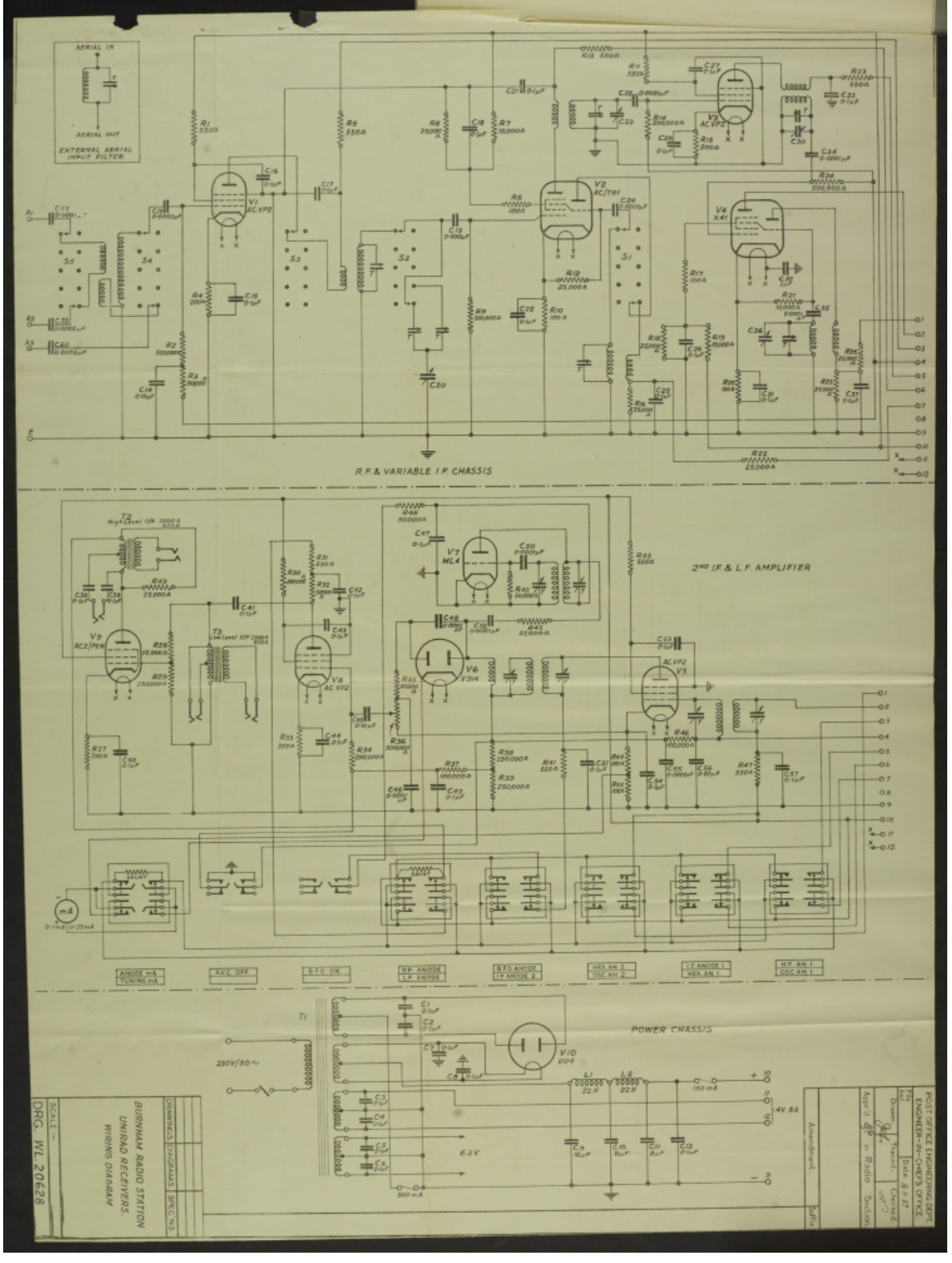
Thus it is possible by attention to the frequencies used, and by attention to design to reduce the number of whistles which may occur due to harmonics, or fundamentals of the oscillators used in these receivers, to negligible proportions. In three ranges there need be no whistles due to this cause, and in the other two ranges, only two whistles each.

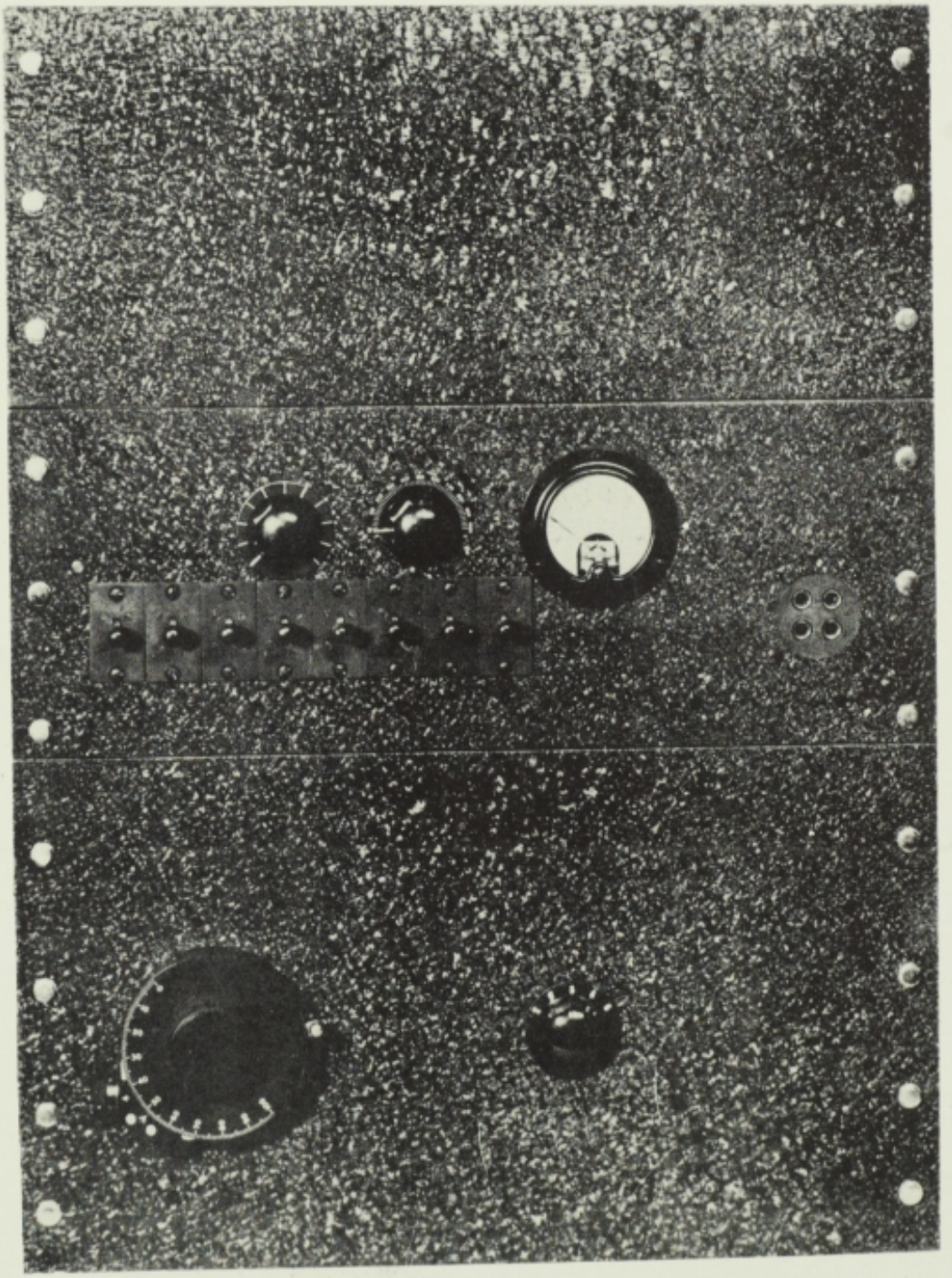
CALIBRATION CURVES OF 'UNIRAD' RECEIVER TUNING



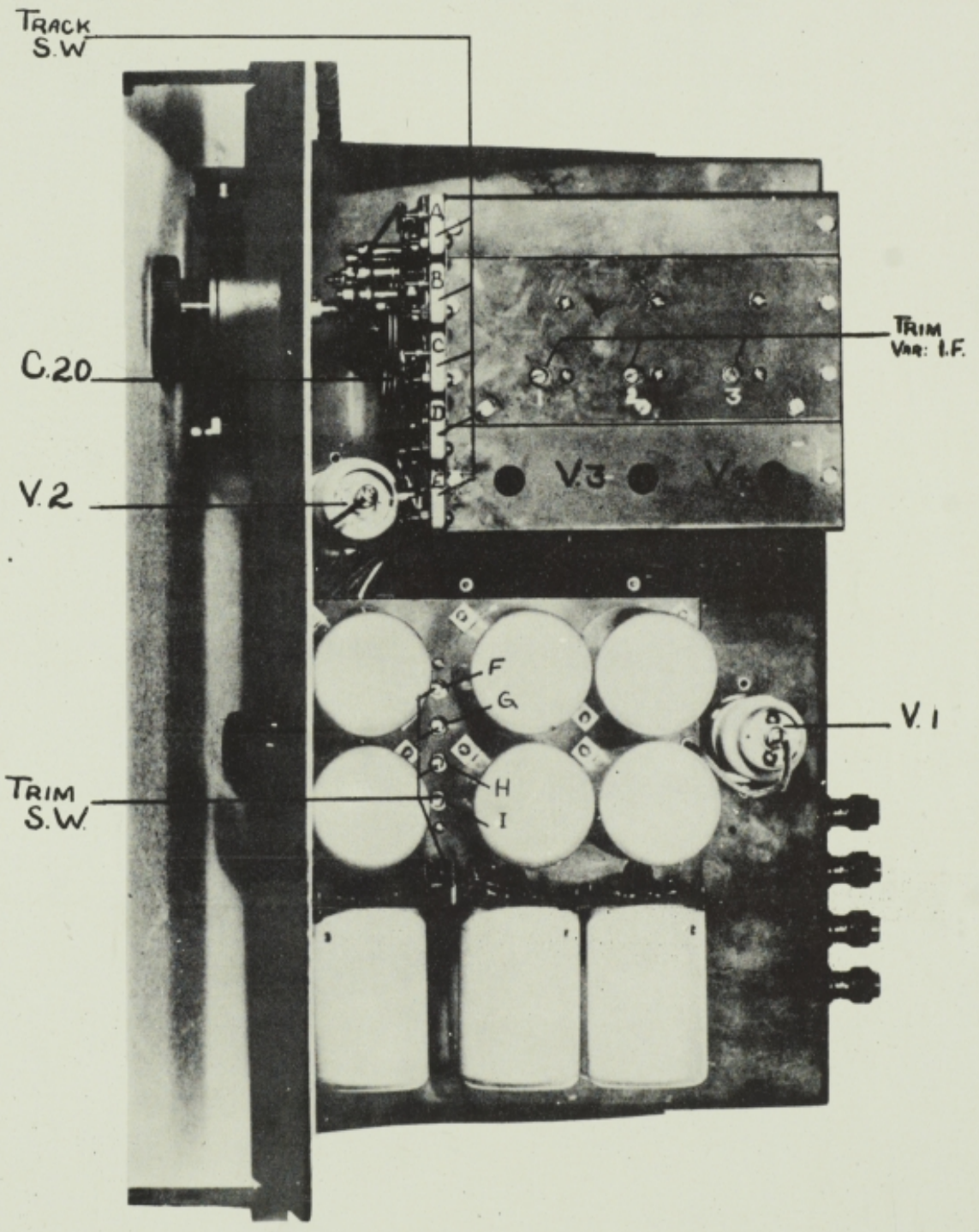
WHISTLES DUE TO OSCILLATOR HARMONICS IN TRIPLE DETECTION VARIABLE INTERMEDIATE FREQUENCY RECEIVERS.



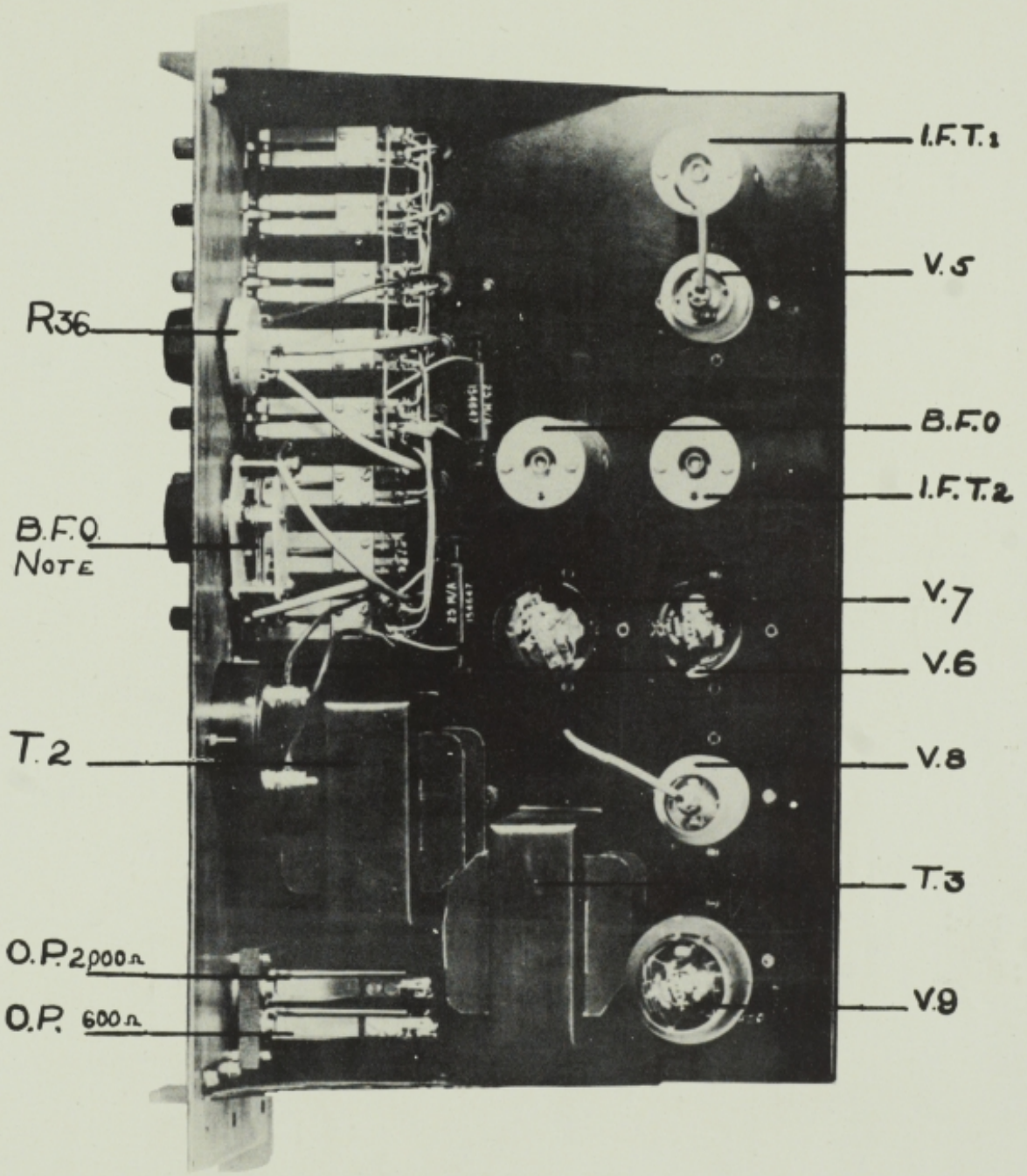

AERIAL IN
AERIAL OUT
EXTERNAL AERIAL INPUT FILTER
R.F. & VARIABLE I.F. CHASSIS
2ND I.F. & L.F. AMPLIFIER
POWER CHASSIS
230V/50~
6·3V
4V. 8A
150 mA
500 mA
ANODE mA TUNING mA
AVC OFF
BFO ON
RF ANODE I.F ANODE
BFO ANODE I.F ANODE 2
HEX AN 2 OSC AN 2
I.F ANODE 1 HEX AN 1
H.F AN 1 OSC AN 1
BURNHAM RADIO STATION UNIRAD RECEIVERS. WIRING DIAGRAM
DRG. WL 20628
POST OFFICE ENGINEERING DEPT ENGINEER-IN-CHIEF'S OFFICE
Radio Section



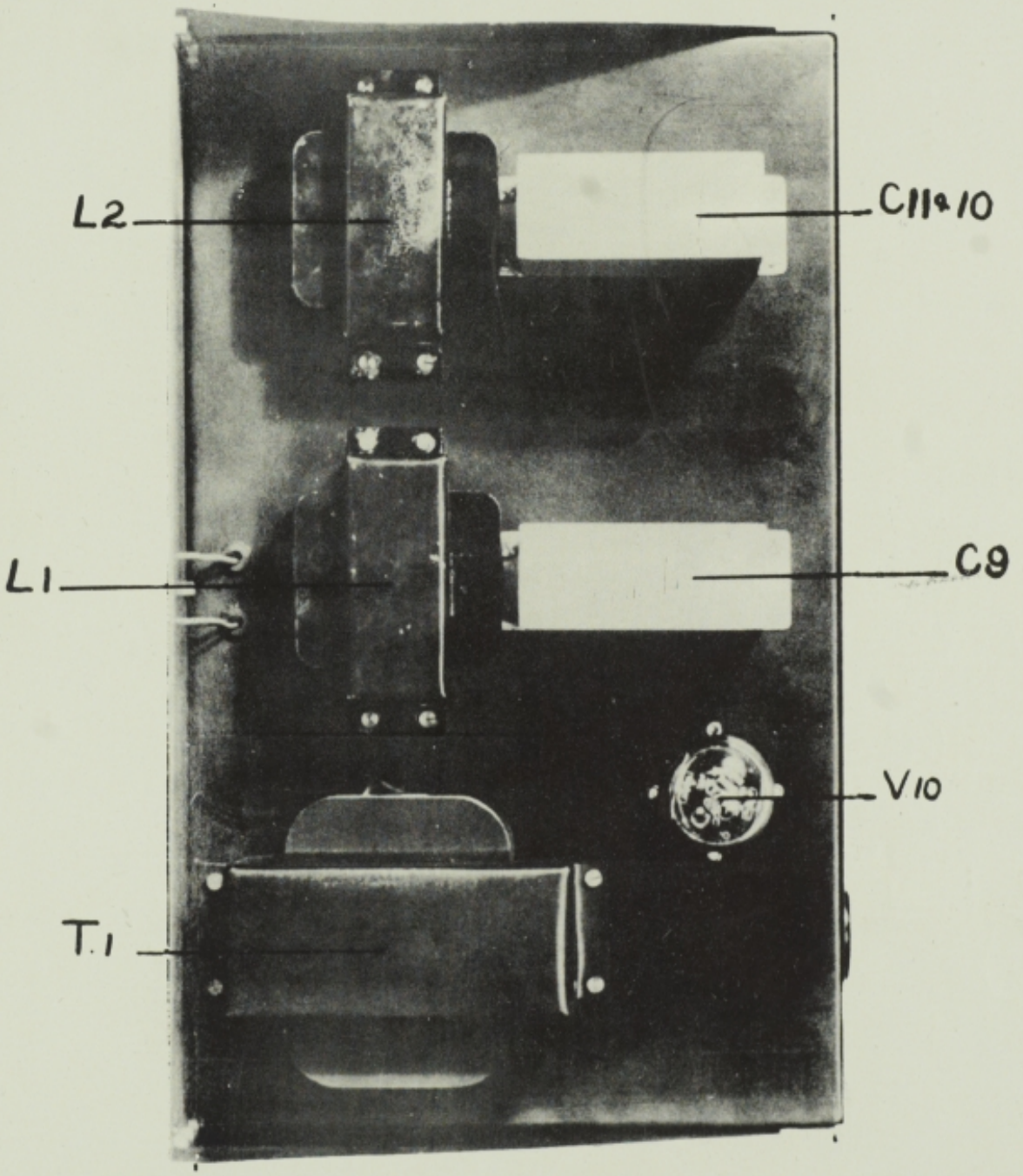
Union Radio Receiver.
Front View.



R.F. AND VARIABLE I.F. CHASSIS.



2ND I.F. AND L.F. AMPLIFIER.



POWER CHASSIS