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Post Office Engineering Department

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Subject

Interference with Reception of Broadcasting

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(*Continued on page* iii *of Cover.*)

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FOR OFFICIAL USE.

INTERFERENCE WITH RECEPTION OF BROADCASTING
(C. 2.)

(*Substitutes pp.* 57 et seq. *of P.W.—C.* 1.)

The following Pamphlets in this series are of kindred interest:

A.1. Magnetism and Electricity.
A.3. Technical Terms.
B.1. Elementary Principles of Telegraphy.
C.1. Wireless Transmission and Reception.

TABLE OF CONTENTS

INTERFERENCE WITH RECEPTION OF BROADCASTING

Part I of this pamphlet gives information relative to the maintenance of sets, their tuning and the types and sources of such interference as will most frequently be encountered.

Part II describes methods used for dealing with the commoner types of electrical interference.

Certain of the diagrams in both parts of the pamphlet will be found to bear reference numbers. Where these numbers are ringed, similar ringed numbers are used in the text referring to the diagram under consideration.

Diagrams of the official portable receivers, particulars of choke coils, and a schedule of suitable condensers for use in electrical interference cases are given in appendices.

PART I.

The Department as the licensing authority investigates complaints of interference experienced by broadcast receiving stations. This interference may be classified into three main types: firstly, interference from other broadcast receiving stations; secondly, interference from power circuits and plant used in connexion with power circuits, and thirdly, interference from wireless transmitting stations.

Interference is sometimes alleged when the trouble exists in the complainant's receiver, due either to bad construction or faulty maintenance. The first step to be taken in investigating a complaint, therefore, is to check that the complainant's receiving set is in a satisfactory condition.

In Fig. 1 the possible sources of interference are set out in tree form and these are dealt with in detail below.

Fig. 1 (1) Faulty Receiving Apparatus.

It should be appreciated that good reception can only be obtained when the receiving equipment is in good condition. For instance, a well-constructed home-made 2-valve receiver can quite easily give better results than a 3-valve receiver which has been ill used or neglected.

Faulty receiving apparatus may be the cause of a complaint, simply because its user suffers poor reception and assumes this to be due to outside sources. It is essential, therefore, to be sure that the complainant's receiver, batteries. or eliminator, aerial and earth circuits are in good condition.

Portable receiving sets are supplied to the Districts for use during the investigation of complaints of interference. They are provided either with an aerial and earth jack, or aerial and earth terminals. To test a complainant's receiver, having

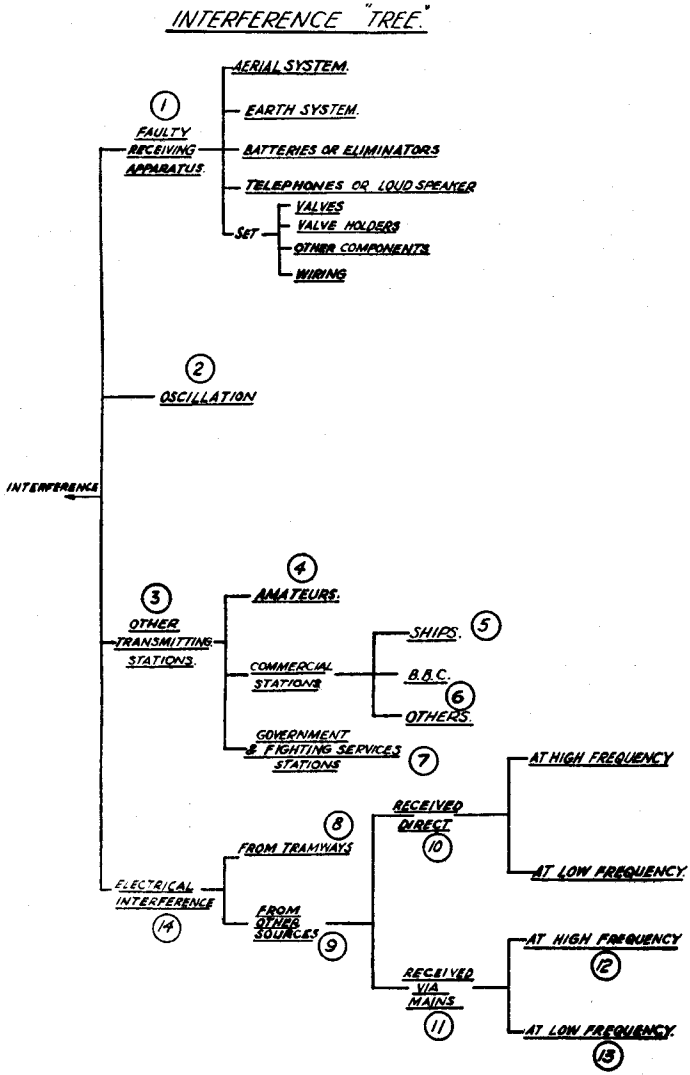

INTERFERENCE "TREE."
INTERFERENCE
1
FAULTY RECEIVING APPARATUS.
AERIAL SYSTEM.
EARTH SYSTEM.
BATTERIES OR ELIMINATORS.
TELEPHONES OR LOUD SPEAKER
SET
VALVES
VALVE HOLDERS
OTHER COMPONENTS.
WIRING
2
OSCILLATION
3
OTHER TRANSMITTING STATIONS.
4
AMATEURS.
COMMERCIAL STATIONS
5
SHIPS.
B.B.C.
6
OTHERS.
GOVERNMENT & FIGHTING SERVICES STATIONS
7
ELECTRICAL INTERFERENCE
14
8
FROM TRAMWAYS
FROM OTHER SOURCES
9
RECEIVED DIRECT
10
AT HIGH FREQUENCY
AT LOW FREQUENCY.
RECEIVED VIA MAINS
11
AT HIGH FREQUENCY
12
AT LOW FREQUENCY.
13

Fig. 1.

first ascertained that proper reception is not obtained when using it, the aerial and earth on his set should be disconnected and then plugged or connected (according to the portable used) to the official portable. (It is assumed that the official portable will have been tested before being taken out on the investigation.) The portable set should then be switched on and tuned in to some convenient broadcasting station, the enquiry officer bearing in mind that the tuning is altered by the use of an exterior aerial, as compared with the frame aerial normally used with the set, and that dial settings used on the portable in its normal condition will no longer bring in the same stations at their usual strength. If reception on the official set is satisfactory, the complainant's apparatus is obviously faulty and the question of interference should not be pursued until the faulty apparatus has been rectified. The fact that the portable set can be used for good reception, while the complainant's set cannot, should be demonstrated to him, as sufficient evidence of the need for overhaul of his receiver. Overhaul of the set should not be undertaken by the enquiry officer, but he may give any advice that the case appears to justify.

If good reception is obtained on the official portable set when used alone, but bad reception results when it is connected to the complainant's aerial and earth, either there is interference from an outside source or there are faults on the complainant's aerial and earth system. This latter possibility should not be overlooked. The ideal procedure would be to test the official portable set on other nearby aerial and earth systems or to lower and examine the complainant's aerial, but this course will not always be convenient or advisable. Inspection of any aerial earthing switch which is in circuit should, however, be made, and attention paid to the cleanliness of the contacts, and condition of the connections. A short length of insulated wire may be run indoors as a test aerial in some cases. The nature of the sounds heard when such faults as loose or frayed connections, dry joints or a poor earth exist in the complainant's aerial-earth system usually takes the form of "plops," bangs or scraping noises. There is no possibility of confusing such noises with, say, the noise produced by an electric motor. Faults on the complainant's lighting mains, however, could cause similar noises.

As regards earths in general, it is undesirable to use hot water pipes or gas pipes. For separate buried earths, riveted joints are preferable to soldered connections on account of the deterioration of the latter with time.

If the complainant's receiver is of the portable type, testing it against the official set (used without aerial and earth)

will usually show whether it is in good condition or not, but it should be borne in mind that receivers differ in sensitivity. That is, it is possible that a set employing more valves or more high frequency stages than the official set may pick up interference which is not heard on the official set.

Diagrams of the connections of the official portable sets are given in Appendix No. 1. Fig. 18 gives the wiring diagram of the earlier type of official four-valve receiver; Fig. 19 that of the official two-valve receiver, and Fig. 20 that of the later type of four-valve receiver.

Fig. 1 (2) Oscillation.

Oscillation occurs when the reaction on a receiving set is increased beyond a certain limit. Under these conditions the receiving set acts as a transmitting station of low power and short range. Nearby aerials will be energized and reception on the sets used with them will be impaired. Bearing in mind that an oscillating receiver is a miniature transmitting set, it is easy to see that its "transmission," *i.e.*, the oscillation, is tunable. Thus, if the tuning of the affected receiver is altered, the strength (but not the pitch) of the note from a nearby oscillating receiver will alter. This process forms an immediate means of proving that interference which is thought to be oscillation is from an outside source. On the other hand, if a whistle or squeal which is comparable to interference by oscillation is heard, and this changes in note when the receiver tuning is altered, oscillation of the receiver which is being tuned is indicated.

Certain receiving sets are what is known as "unstable," that is, their design is not of the best, with the result that oscillation is readily set up—perhaps even while the set is not being touched. For example, a nearby receiver oscillating momentarily may cause an unstable receiver to break into oscillation and to remain so until adjusted; or body capacity of a person near the set may set up the same conditions. Even a change in strength of the programme being received may cause oscillation in a poor receiver. There are also receivers in use which can only be tuned when oscillating.

Enquiry officers investigating oscillation interference should consider the stability of the receiver they are inspecting. If the sets are home made, modifications in design or layout may be suggested. If a manufactured set is concerned it should be suggested to the owner that he should consult his local agent on the point.

Criticism of any set inspected should be limited to a demonstration to the owner of what stations can be obtained at loud speaker or headphone strength, according to the method of reception in use, and he should be informed that

any attempt to obtain other stations than those demonstrated would result in interference.

The task of locating an oscillator may be difficult, as listening on the complainant's set may give meagre results, but it should be borne in mind that the " volume " of interference varies with distance, and that if in several adjoining houses the interference volume decreases steadily, the offender is immediately placed as being nearest to where the volume is greatest. The best method of investigation, however, is for the officer first to interview the complainant, satisfy himself that the set is in good condition and not oscillating in itself, and determine (if the questionnaire does not give the information) whether the trouble takes the form of " howling," " wipe-out " or " boosting." A strongly oscillating receiver will often cause changes in the volume of reception in nearby receiving sets by " boosting " up the signals in some, and " wiping out " reception, totally or partially, in others. If interference of this form takes place, it will nearly always be found that the oscillator is very close, say within 20 yards. Listeners sometimes confuse " wipe-out " with the fading which frequently occurs when attempts are made to receive stations outside the normal range of their sets. " Howling " is the common result from a receiver anywhere within about 200 yards being worked in an oscillating condition. In difficult cases location tests should be carried out by two officers, one listening at the complainant's while the other witnesses the tuning operations of other licence holders in the vicinity, both officers logging their experiences. As a general rule, it is advisable to ask the licensees to operate the sets themselves, in order to ascertain whether the correct tuning method is being employed. Tuning by first making the receiver howl, and then reducing reaction until the howl disappears, does not necessarily remove the interference that the initial howl has caused to neighbours. Nor does it give good reception in the individual receiver, and this method of tuning should be deprecated. It should be particularly noted that a receiver operating on the " silent point," *i.e.*, when movement of the condenser in either direction causes a howl, is giving rise to interference. In particular, interference of this type gives no directly audible indication of oscillation to the offender, and as it usually occurs when attempts are made to receive distant stations with a set of low power, it is one of the most frequent sources of oscillation. Wrongly conducted tuning operations should always be pointed out and the operator of the set warned. A correct method of tuning is as follows :—

1. Set the tuning condenser to a position corresponding to a wavelength lower than that of the required station, and

such that that station is not heard. The lower wavelength will be obtained by decreasing the tuning capacity, *i.e.*, by reducing the amount of meshing of the condenser plates.

2. Adjust the reaction control until the set is just not oscillating. This is an easy matter since the required station is not heard. Do not touch the reaction control any more.

3. Tune in the station by means of the aerial tuning condenser.

The above method of tuning is based on the fact that a receiver which is adjusted to one wavelength and is not oscillating will not oscillate on a higher wavelength so long as the reaction is untouched.

If, on a set which is believed to be oscillating, the aerial tuning condenser is altered to give greater capacity (more meshing of plates) to an extent such that the local broadcasting station is just not heard, and a click is heard in the loudspeaker or headphones, when the aerial terminal is touched, this is definite proof that the set was oscillating in its previous condition of tune.

If a receiver is tuned in the correct method, outlined above, and a whistle is heard which stops when the aerial is disconnected, this is definite proof that there is oscillation from some outside source. Similarly, a howl of varying note, which occurs while a receiver is not being touched, clearly indicates oscillation from another source.

Reaction is sometimes alternatively labelled " Volume Control," " Intensifier," " Strengthen," etc.

In some cases deliberate oscillation takes place. It is perhaps not appreciated by the offender that he is disturbing more listeners than one. It will be appreciated that such cases require more than the usual amount of tact in handling. Prompt attention to the cases is of first importance. In addition, it is extremely desirable (as in all cases) that no indication should be given during inspections as to the source of the original complaint.

Fig. 1 (3) Other Transmitting Stations.

Interference from transmitting stations other than broadcasting stations arises at times. It is to be expected that the possibility of this type of interference will be greater on sets which are near to shipping routes or commercial or other transmitting stations. At the same time, when interference of this character is reported, due record should be made of the selectivity and condition of the complainant's set. Obviously, it would be possible to pick up interference on a badly constructed or badly maintained set which would be unheard on a good one.

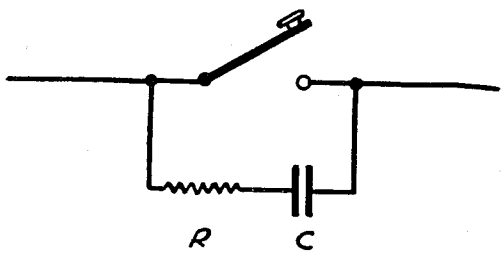
The selectivity of the complainant's set can be ascertained roughly by noting the number of divisions on the set tuning dial over which a station can be heard before another one begins to come in.

Fig. 1 (4) Amateur Transmitting Stations.

Amateur transmitters are not restricted to times of transmission. They are, however, usually ready to restrict their times of transmissions to outside of broadcasting hours if it is pointed out to them that they are causing interference.

Interference from an amateur transmitting station may be either morse or telephony and may be due to a broadcast receiver of low selectivity. Tests should be made with the Departmental sets and enquiries made of other licensees. Such tests will determine whether the fault is with the receiver and, if this is so, advice should be given as to improving its selectivity. If the complaint is general and not due to the receivers the matter should be reported.

Another possible type of interference from an amateur transmitting morse would be what is known as " key clicks." Key clicks may be due either to sparking at key contacts, or to a shock effect produced by the sudden rush of current into the amplifying and aerial stages of a transmitter as the key is operated. They will be identified as a series of clicks, closely resembling morse (quite possibly capable of being read by a morse operator) and very often of a " clipped " character. If they are readable the call sign of the station causing them should be watched for as a means of its identification. Interference from key clicks may sometimes be eliminated by the use of a " key click filter." A suitable filter is illustrated in Fig. 2.



R = a few hundred ohms.
C = 0·5 μ.F.

FIG. 2. KEY CLICK ABSORPTION CIRCUIT FOR TRANSMITTING STATIONS.

Crystal receiving sets in close proximity to short-wave transmitting sets may be susceptible to interference from key clicks, since the crystal sets are of poor selectivity. In particular, crystal sets which are tuned by an inductance only will be most affected. The addition of a condenser of ·001 μF capacity in parallel across the tuning inductance is recommended to improve selectivity. It may be necessary to reduce the value of the tuning inductance in order to tune the receiver.

Fig. 1 (5) Ship Stations.

Interference from ship stations may be pronounced in coastal localities, as the use of spark transmission is still permitted, although the effect of international regulations will be the gradual elimination of transmitters of this type.

The nature of a spark transmission is such that transmission takes place on a wide band of frequencies in which the allotted frequency of the station is approximately at the middle. Thus spark transmission may seriously affect reception even on selective sets.

Fortunately, since stations using spark are mobile, *i.e.*, ships, interference of this nature is infrequent, except near heavy shipping routes. If persistent interference is found to be due to particular ships, which may be off their allotted wavelength, the facts should be reported.

Fig. 1 (6) B.B.C. and other Commercial Stations.

Interference due to other broadcasting or commercial stations can usually be eliminated by making the receiver more selective (*e.g.*, by loose coupling or by the use of a wavetrap).

If a selective receiver is troubled by interference from other stations, the investigating officer should report the approximate wavelength of the interfering station and its code call sign. Prolonged interference normally points to the use of receivers of low selectivity.

Certain commercial stations using interrupted continuous waves (I.C.W.) sometimes cause interference and a wavetrap may be necessary. This is inserted between the aerial and aerial terminal on the receiving set, and consists of a coil and variable condenser as shown in Fig. 3. A simple wavetrap may be made by using a variable condenser and an ordinary receiving coil. If this is moderately successful it may be found that the substitution of a tapped coil, as shown in the alternative scheme of Fig. 3, and connecting the aerial to each tap in turn will lead to a combination which gives best results.

"STOPPER CIRCUIT" WAVETRAP.

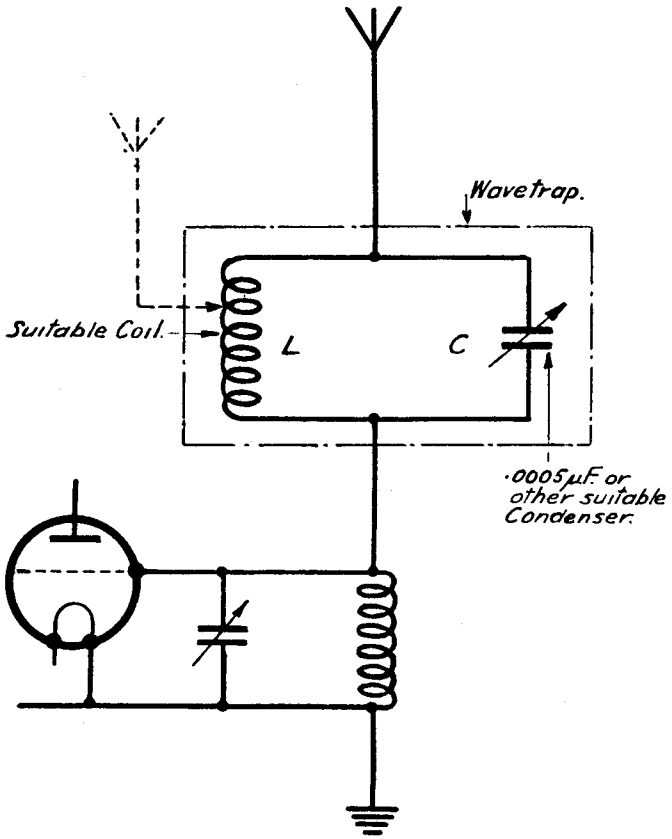


FIG. 3. ALTERNATIVE SCHEME SHOWN DOTTED. (*See* Text.)

An alternative form of wavetrap (usually known as a "drain circuit") consists of an inductance and condenser in series connected between the aerial terminal and earth, as shown in Fig. 4.

Alternatively, the use of loose coupling, as illustrated in figures 5, 6 and 7, may be sufficient. In pronounced cases loose coupling together with a wavetrap in the aerial side may be necessary.

" DRAIN CIRCUIT " WAVETRAP.

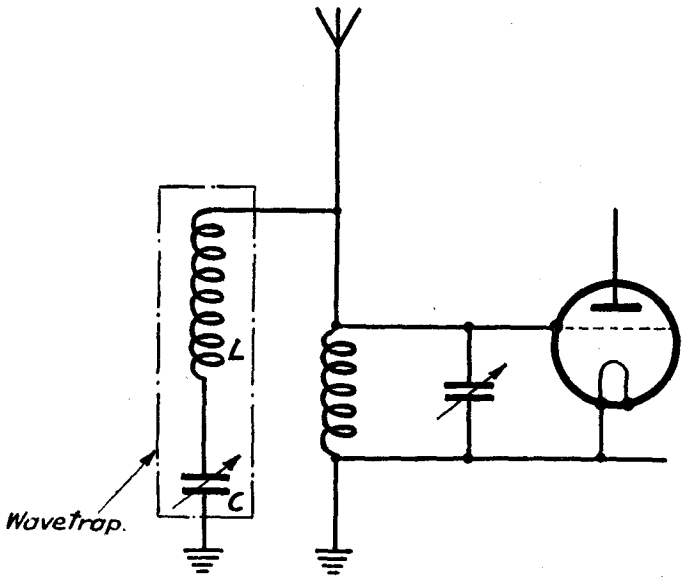


FIG. 4.

Wavetraps for use over certain wavelength bands can be purchased or the requisite values of coil and condenser for either of the above types can be derived from the following formula :—

$$\lambda = 1885 \sqrt{L\,C}$$

where λ is the wavelength of the offending station in metres,
L is the inductance of the coil in μH.
C is the capacity of the condenser in μF.

The inductances of various British Standard coils are given in the following table, and by using a variable condenser and calculating on the basis of its maximum capacity a suitable coil will be readily found.

British Standard Designation of Coil.	Standard Inductance (Microhenrys).
S 40	20
S 50	30
B 10	53

British Standard Designation of Coil.	Standard Inductance (Microhenrys.)
B 20	80
B 30	120
B 40	180
B 50	270
M 10	480

Example : Wavelength to be cut out = 600 metres.

Assume a ·0005 μF variable condenser will be used.

$$600 = 1885\sqrt{\cdot 0005L}$$

$$\therefore \frac{600}{1885} = \sqrt{\cdot 0005L}$$

$$\therefore \cdot 3183 = \sqrt{\cdot 0005L}$$

$$(\cdot 3183)^2 = \cdot 0005L$$

$$\therefore \cdot 1013 = \cdot 0005L$$

$$\therefore L = \frac{\cdot 1013}{\cdot 0005} = 202 \cdot 6 \text{ microhenrys.}$$

∴ British Standard coil No. B 50 (inductance 270 μH) will be suitable since the condenser value will now be less than ·0005 μF and therefore within the range of the variable condenser.

By suitably varying the condenser when the wavetrap is in circuit a position will be found such that the interference is cut out. (The use of a wavetrap alters the normal tuning positions of the receiver.)

Fig. 1 (7) Commercial Stations.

The approximate wavelength of the interfering station and its code call sign should be reported.

Fig. 1 (8) Interference from Tramways.

Interference due to the above is usually the subject of separate enquiries and cannot be dealt with in this pamphlet.

Fig. 1 (9) Electrical Interference from Power Plant.

Breaking the complainant's house wiring at the main switch while listening on his receiver (or on a portable set in the case of a mains driven private receiver) will indicate whether the interference is propagated via the house mains. If it is, the noise should cease with the breaking of the switch.

If the interference is not considerably reduced when the switch is broken the interference is directly radiated.

Fig. 1 (10) Electrical Interference which is directly Radiated.

This cannot be remedied except at the source, although alteration of direction of the complainant's aerial, and/or the use of a counterpoise earth may reduce the interference.

A counterpoise earth is a wire (preferably run parallel to and beneath the actual aerial) which is connected to the " earth " terminal of the set. The wire is insulated from earth, and there is no direct connection to earth on the set. Normally a counterpoise earth will be some distance above the earth, up to a maximum of about 30″, but a temporary counterpoise can be made by running a length of insulated wire along a hall or passageway, or under a floor covering.

Regarding counterpoise earths, used in association with mains driven sets, it is pointed out that mains units usually require an earth connection (which is normally arranged by connecting the earth terminal of the mains unit to " earth " on the receiver). Such conditions will necessitate a separate earth (water pipe or buried earth) for the mains unit and no connection between the mains unit earth and the counterpoise connection on the receiver. In the case of a receiver in which the mains unit is self contained, the same principle should be followed, *i.e.*, a separate earth for the mains unit (if normally provided) and no metallic connection between the earth and the counterpoise.

Fig. 1 (11) Electrical Interference received via the Lighting or Power Mains.

This takes either of two forms, electrical interference at high frequency Fig. 1 (12) (characterised as a fairly continuous high-pitched crackling) or electrical interference at low frequency Fig. 1 (13) (characterised as a low hum). These may be remedied by suitable filter circuits either at the complainant's or at the source. In the case of low-frequency interference, however, such filter circuits become expensive.

Details of suitable filters are given in part II but endeavour should be made to remedy at the source of the interference rather than at the complainant's.

Endeavour to cure at the complainant's should be made, however, if other remedies fail, or if cure at the offending source is difficult (*e.g.*, high voltage machines running almost continually and the number of complainants is small). Curing at the complainant's should generally be deprecated since an untreated interfering source will always be a potential cause of further complaints.

Electrical Interference (Remedies).

There are many potential sources of electrical interference. Fig. 1 (14), and Section II of this pamphlet is devoted to suggested remedies for the common types.

General.

In investigating complaints first make sure that no fault exists in the aerial, earth, or receiver.

Where only one person is affected by interference, trial of aerial alterations and/or loose coupling should be made.

Various types of loose coupling for improving selectivity are illustrated in Figs. 5, 6 and 7, while the usual direct coupling is illustrated in Fig. 8.

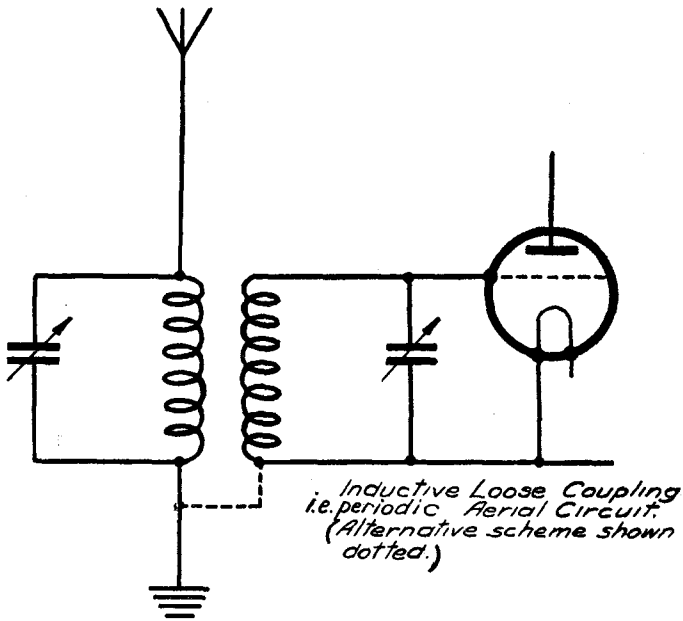


FIG. 5.

The possibility of alleged interference being in reality due to the use of poor-quality battery eliminators should not be overlooked. Such interference would possibly be characterised by a low continuous hum.

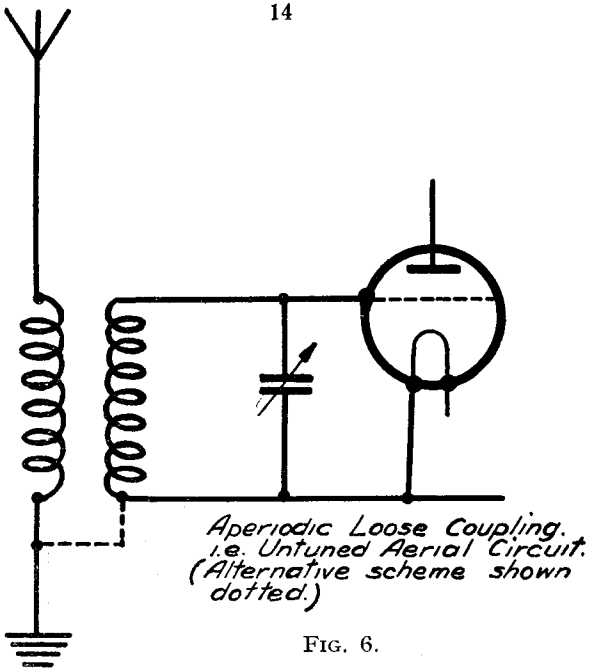

Aperiodic Loose Coupling.
i.e. Untuned Aerial Circuit.
(Alternative scheme shown
dotted.)

FIG. 6.

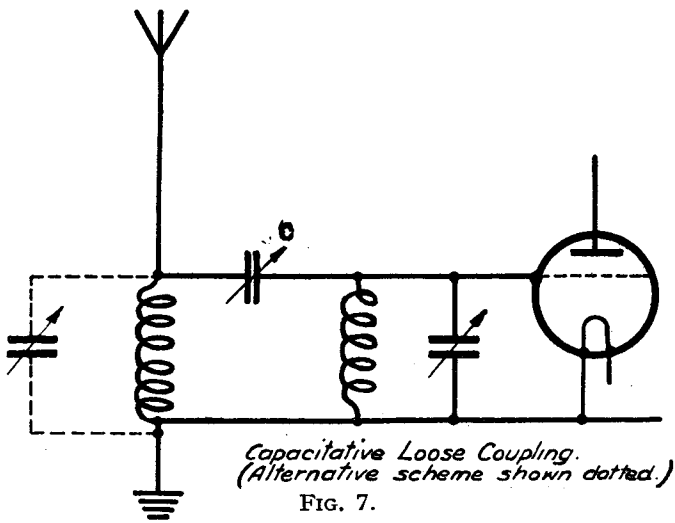

Capacitative Loose Coupling.
(Alternative scheme shown dotted.)

FIG. 7.

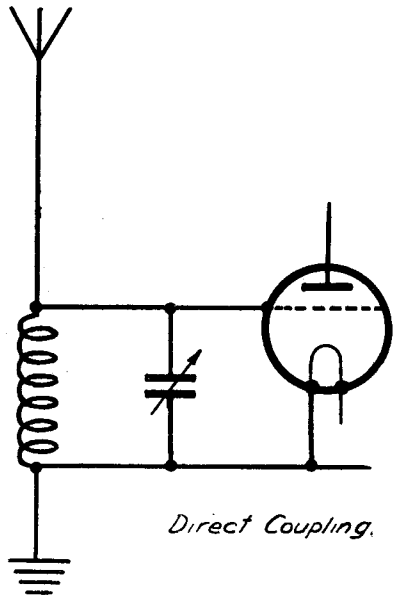


FIG. 8.

The minimum value of the coupling condenser C (see Fig. 7) should not be greater than 2 $\mu\mu$F.

A neutrodyne condenser would be suitable.

PART II.

SUGGESTED REMEDIES.

Line diagrams illustrating remedies which have been successfully employed are given in this section. They cover types of interference which, from past experience, are known to be most usual.

In general the following points should be borne in mind :—

(1) It will be appreciated that individual cures will be dependent upon various local factors, such as geographical situation, proximity of overhead lines, etc. For example, certain localities in Cornwall and Wales are known to be affected by local conditions to such an extent that reception on certain wavelengths is poor compared with reception in other localities at equal distances from the broadcasting stations concerned. Also, it has been established that an overhead route (whether power, telephone or telegraph) will affect the receiving conditions of a nearby aerial to an extent dependent upon the size, direction and length of the route, and the height and direction of the aerial.

As a further example, certain instances have arisen in which an established cure for interference from a certain type of machine has needed modification when used on an identical machine situated in different surroundings.

The remedies suggested cannot therefore be regarded as definite, but are to be regarded as an indication of the lines upon which particular cases should be investigated.

(2) In the diagrams it will be seen that 2 μF condensers are general. This value of capacity is very usual, but other values should be tried if necessary. In some cases it will be found that while 2 μF condensers nearly eliminate interference, 1 μF, 4 μF or condensers of other value will be found to complete the cure.

(3) Similarly, as regards choke coils, 100 μH coils have been found to be very successful in the past. Where the interference is mainly prominent on the long wave band, however, *i.e.*, on Daventry 5 XX, and Radio Paris, etc., rather than on the band in which the regional and relay stations are to be found, 600 μH choke coils may be more successful.

(4) It will be seen that chokes or condensers are shown dotted on certain of the diagrams. This should be taken as an indication that the remedies should first be tried without the apparatus shown dotted. If unsuccessful the next experiment should be to try the apparatus shown dotted as an addition.

(5) A schedule giving particulars of suitable condensers is given in Appendix No. 2.

(6) The inductance of the choke coils used in the remedies, *i.e.*, 100 μH, does not appear to be critical. Twenty yards of wire of suitable current-carrying capacity, and wound to a diameter of about 9 ins. (18 to 25 turns) has approximate inductance to 100 μH, and is normal. By increasing the length of wire to about 50 yards the inductance will be increased to about 600 μH. Further particulars of the inductances are given in Appendix No. 3.

Standard two-condenser units provided with fuses and terminal for an earth connection are available in 2 μF and 4 μF sizes as "Units, Condenser, Nos. 1B and 1A" respectively. They are mounted in metal cases and are designed to permit of permanent connection to circuits.

(7) Small portable apparatus such as fans, barbers' clippers, etc., may be sources of interference. One 0·5 μF condenser connected across the mains as near to the apparatus as possible is suggested as a possible remedy. Other values of condensers should be tried if necessary, as should the usual arrangement of condensers across the mains, with their mid-point earthed.

As regards fitting these condensers, if difficulty is experienced in finding a suitable point of attachment close to the apparatus, it is suggested that the connection of the fans or clippers, etc., to the mains should be by a bayonet plug. Then by using a two-way socket the interfering apparatus may be connected to one socket, and the condenser arrangement attached to a bayonet plug and plugged into the other socket. If this method is used it should be ascertained by first plugging a lamp into the extension socket that the two-way socket is in good condition and that current is being fed to both sockets.

(8) All devices fitted by the Department are to be fitted temporarily for trial and demonstration purposes only.

Where a remedy is to be adopted, which includes the installation of apparatus to existing plant or mains, the owner should be informed that the permanent installation should be protected by suitable fuses (unless the apparatus consists of Units 1A or 1B) and that the leads used should be of low resistance and as short as possible; also that inspection by the local supply undertaking may be necessary.

(9) *No attachments, removals or modifications should be made to electrical plant without first isolating that plant from the mains by the opening of the appropriate switches, or circuit breakers.*

Any apparatus which is to be attached to electric plant or mains must conform strictly as regards current-carrying capacity, insulation and breakdown voltage, to the wiring of the installa-

H.F. Mains Filters for Connection at the Interfering Source.

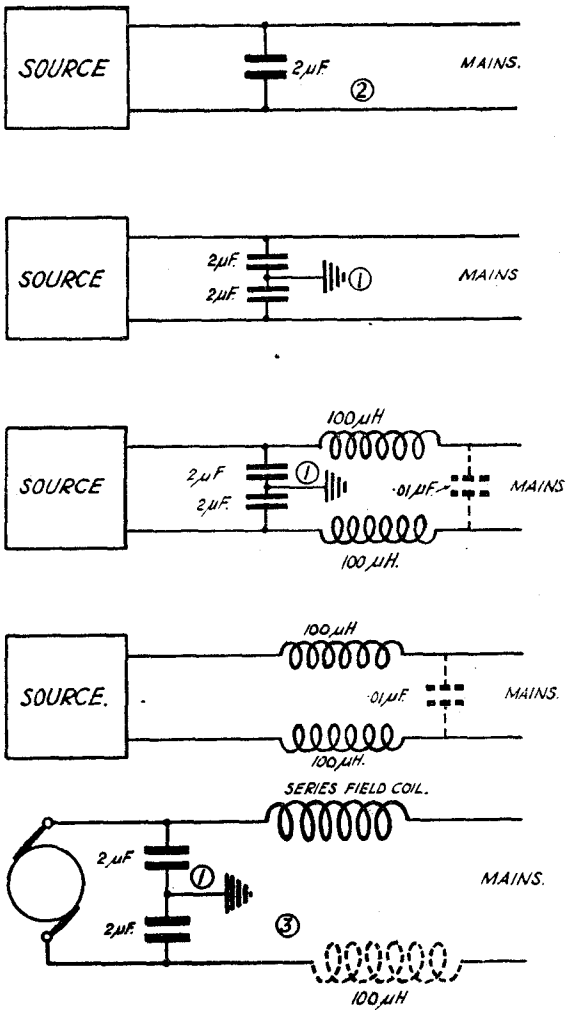


Fig 9.

tion to which it is to be temporarily connected. In this connection particulars of the A.C. or D.C. voltage and current limitations of various condensers and chokes are given in the appendices.

Before removing condensers from a circuit (after the circuit has been isolated as described above) the condensers should be discharged by placing an insulated conductor between their terminals—the blade of a wooden-handled screwdriver is usually effective.

High Frequency Mains Filter for Connection at the Interfering Source.

The frames of machines are usually earthed. Attention to existing bonding, or the bonding of insulated frames, may remove interference, but the latter should only be carried out with the approval of the engineers of the local supply undertaking.

Where indirectly coupled machines are used, or direct coupling is by means of an insulated coupling, it may be necessary to earth all frames and bedplates.

H.F. MAINS FILTER FOR INSTALLATION AT A COMPLAINANT'S PREMISES.

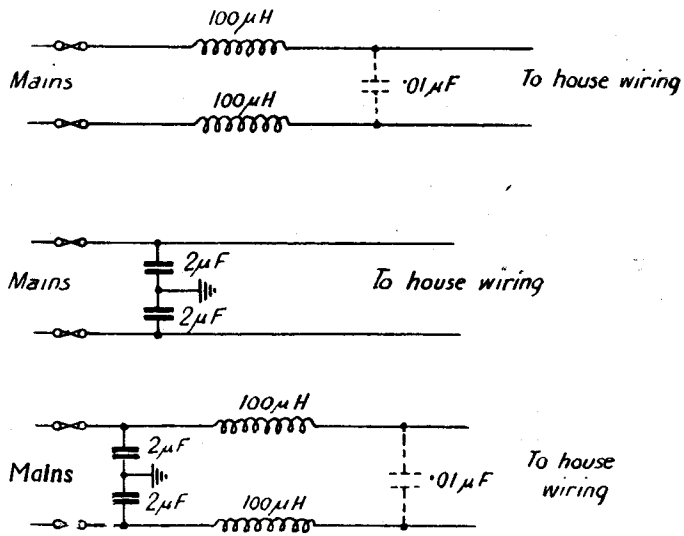


FIG. 10.

Various circuits for removing interference are shown in Fig. 9. Attention is drawn to the following :—

The two-condenser arrangement shown in Fig. 9 (1) should be tried even if one main is at earth potential. The condenser attached to the live-main in this case carries the full mains voltage. (*See* Appendix 2.)

A single condenser across mains as shown in Fig. 9 (2) is occasionally successful. Where one main is at earth potential the success of this arrangement can sometimes be improved by earthing the machine frame to the earthed main through a second condenser.

Fitting condensers on the machine side of the field coil, if this part is accessible, sometimes enables the field coil to be used as a choke in the line—*see* Fig. 9 (3).

High Frequency Mains Filter for Installation at a Complainant's Premises (*see* **Fig. 10**).

Various devices are shown in Fig. 10. All apparatus should be fitted as near to the incoming mains as possible.

As a general rule the fitting of filters to a complainant's power supply should only be done when it is not practicable to remedy the interference at its source.

Flashing Signs with Single Contacts (*see* **Fig. 11**).

The co-operation of the installing or maintenance engineers should be sought before carrying out experiments on flashing signs.

Owing to their exposed positions, sign mechanisms may rapidly fall into bad condition. Cleaning of contacts and the replacement of faulty contacts and wiring should be attended to.

High frequency interference (which is directly radiated from the sign leads) may be present. To cure this the leads should be run in metallic conduits which should be earthed.

Interference from the flasher contact can usually be prevented by one of the devices shown in Fig. 11. The resistance shown should be of the order of a few hundred ohms. It should be mentioned that the devices shown at Fig. 11 (1) will also tend to prevent burning of the sign contacts.

Flashing Signs with Multiple Contacts (*see* **Fig. 12**).

The remarks on flashing signs of the single contact variety are applicable. In addition, the following points should be borne in mind :—

(*a*) Should the drum or contact arm be electrically rotated, the driving motor (Fig. 12 (2)) may need separate treatment on the lines shown in Fig. 9.

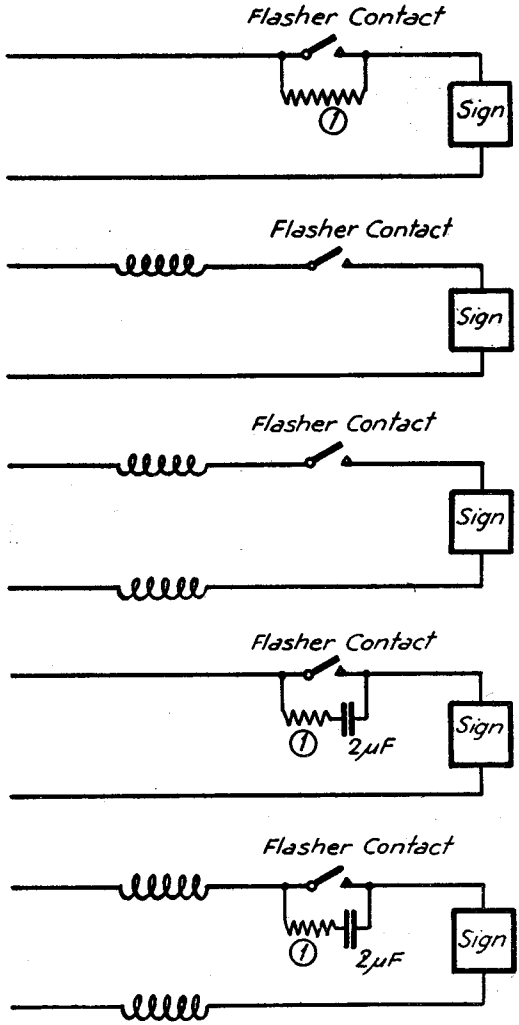

Flasher Contact
1
Sign
Flasher Contact
Sign
Flasher Contact
Sign
Flasher Contact
1
2μF
Sign
Flasher Contact
1
2μF
Sign

FIG. 11.

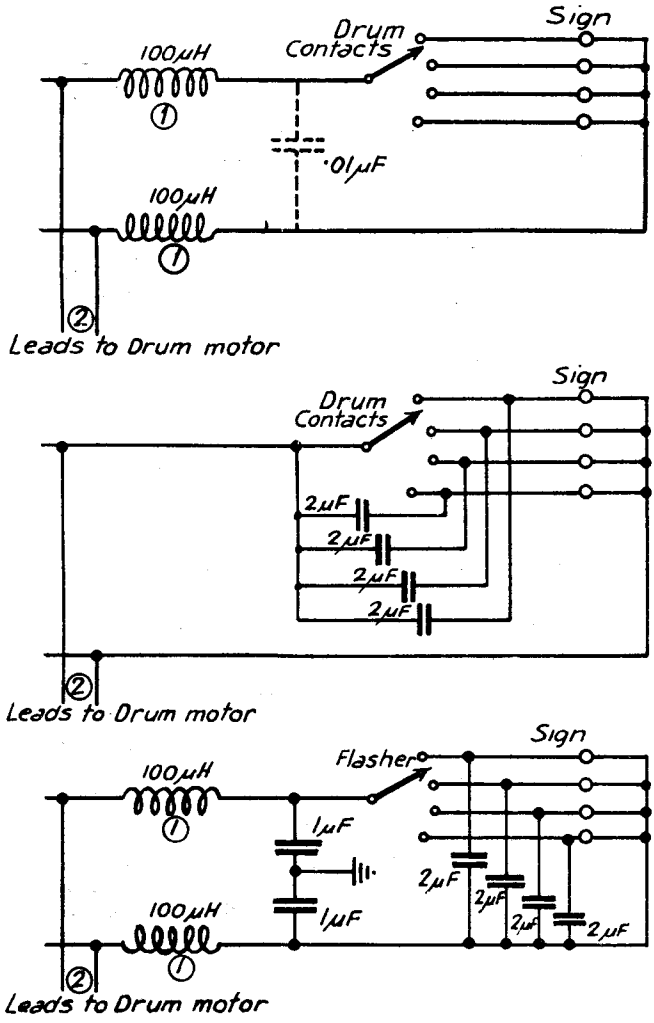

Drum
Contacts
Sign
100μH
·01μF
100μH
Leads to Drum motor
Drum
Contacts
Sign
2μF
2μF
2μF
2μF
Leads to Drum motor
Flasher
Sign
100μH
1μF
2μF
2μF
2μF
2μF
100μH
1μF
Leads to Drum motor

FIG. 12.

(*b*) Chokes, if used, should be inserted on the sign side of any teed leads to the drum motor—*see* Fig. 12 (1).

(*c*) One of the devices shown in Fig. 11 may be necessary across each of the multiple contacts also.

Neon Signs (*see* **Fig. 13**).

Neon signs are of two types, viz., the high frequency type and the high voltage type. Both will cause directly radiated interference.

Screening of all leads and of the sign itself by the use of fairly open copper or iron mesh (say $\frac{3}{8}$ in. mesh) is suggested. If iron mesh is used instead of copper it should be connected to earth at several places.

Mains interference can be eliminated by one of the filter circuits shown in Fig. 9.

Direct radiation decreases rapidly with distance from the sign. In cases in which direct radiation causes interference on sets situated in a room immediately behind the sign, a sheet of earthed iron or copper mesh between the sign and the set may effect an improvement. The mesh should be fairly close and mounted behind the tubes of the sign.

Where Neon signs of the high-voltage type are operated from D.C. Mains, an A.C. generator is used for the supply to the sign transformer. The generator may itself cause H.F. interference, and should be treated as shown in Fig. 13.

NEON SIGNS.

Sign transformers.

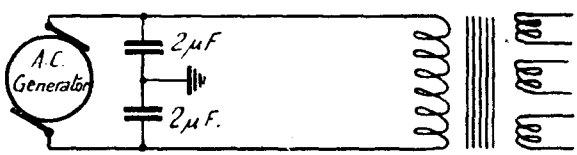


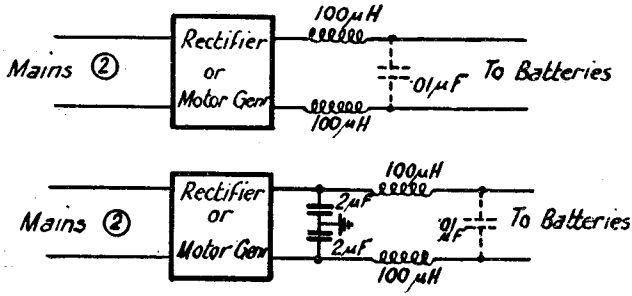
FIG. 13.

Battery Charging Plants (*see* **Fig. 14**).

Interference from charging plants will mainly be high frequency radiation from the D.C. battery leads. To avoid this, the suggested remedies indicated in Fig. 14 (1) should be tried. Mains interference, if present, should be cleared by inserting one of the filter circuits given in Fig. 9 at the incoming mains (Fig. 14 (2)).

Rotary rectifiers should be treated by the application of condensers as shown in Fig. 14 (3).

Battery Charging Plants ①



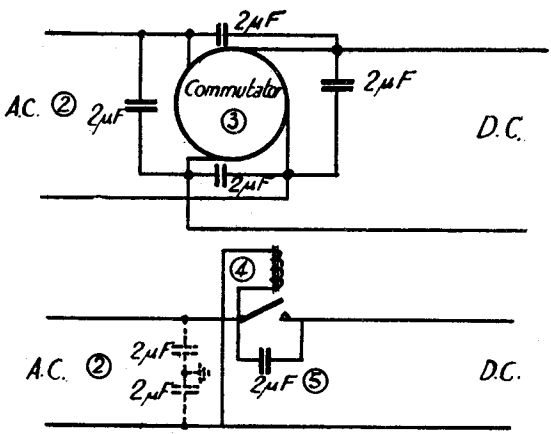


FIG. 14.

A vibrating reed rectifier is illustrated diagrammatically in Fig. 14 (4). This type of charging plant is not prominent in this country, but a remedy of Canadian origin is illustrated. The condenser shown (Fig. 14 (5)) may be as low as 0·5 μF, however.

One particular type of charging plant has been the subject of special tests (*see* Radio Report No. 147). The remedies suggested in the report referred to may be tried on other types if the above devices do not remove the trouble.

Interference picked up by the lead-in.

It will be appreciated that interference may be picked up by the wire connecting the aerial to the receiving set, and conveyed to the receiver by this means. It is for this reason that the necessity for a short lead-in system, well spaced from surrounding walls, is usually stressed.

The use of a long lead-in is sometimes unavoidable, with added risk of introducing interference from nearby sources. It has been established, however, that a screened lead-in will minimise the effect of local interference if used under the following conditions :—

The receiver should be loosely coupled, and tuned on the aerial side as illustrated in Fig. 5. A single wire lead-covered lead-in should be used and the lead sheathing earthed. Under these conditions interference which would normally be picked up by the lead-in wire will be considerably reduced in volume. There will be a slight loss in signal strength, however, due to the method of lead-in used, and the remedy is therefore applicable only when there is a margin of power available in the receiver.

Telephone Apparatus (*see* Figs. 15 and 16).

Remedies which have been tried in specific cases are given in Figs. 15 and 16.

Ringing Apparatus in C.B. Exchanges.

The following devices should be tried in turn :—

(*a*) Coils, Retardation, No. 24A in the input side of the ringer (4 or more coils in series will be necessary, depending upon the voltage conditions).

(*b*) A H.F. choke in the earth lead to the interrupter drums consisting of 200 turns of 22 S.W.G. D.S.C. Copper Wire, wave wound to a mean diameter of 2¼ ins. (such a coil has 3,400 μH inductance and 1·9 ohms resistance at 800 p.p.s.). A coil of this wire, straight wound with 200 turns, should first be tried.

(*c*) One 500-ohm resistance and ·01 μF condenser in series between the ringing tone brush and earth.

(*d*) One 0·5 μF Condenser across the interrupted earth spring set if this is fitted.

(*e*) One 500 ohm resistance in series with a 4 μF condenser between the dialling tone brush and earth. (This is for use at automatic exchanges.)

(*f*) If possible a new earth wire of short length and heavy gauge should be used for the ringer and connected to the nearest earth. The apparatus given in (*c*) and (*e*) above should be connected to this earth.

TELEPHONE APPARATUS.

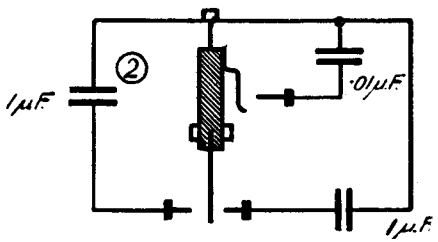


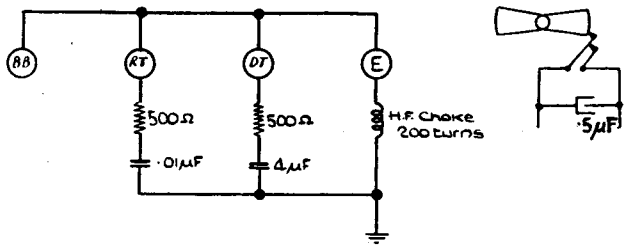
FIG. 15.

Vibrators Nos. 1, 2A and 3A (used in C.B.S. Non-multiple and Magneto Exchanges).

(*a*) Interference from the motor generator can be remedied by the use of condensers across the input and/or output terminals.

TELEPHONE APPARATUS (*contd.*)

Tone Drums (6)



Power Driven Dynamotors (7)

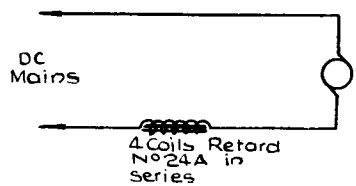


FIG. 16.

(*b*) Interference from the vibrator itself can be remedied by removing the 2 μF condenser across the terminals of the transformer, and fitting 1 μF condensers across the make and break contacts, and a 0·01 μF condenser across the driving contacts as shown in Fig. 15 (2).

(*c*) A wireless receiving coil having 250 to 350 turns should be tried in series with the main battery lead to the vibrator also.

Ringing Machines of the Pole Changing Type.

A small resistance across the interrupter contact, and a condenser resistance arrangement across the pole changer arm may be tried.

Tone Drums.

When the tone drums are the cause of interference, first test with ringing and all tones disconnected, and then connect up in the following order, testing at each stage :—ringing, int. earth, dial tone, ringing tone, busy tone, in order to locate the source. Suggested cures are indicated in Fig. 16 (6).

Power Driven Dynamotors.

It may be necessary to insert 4 Coils, Retardation, No. 24A in series in the input as shown in Fig. 16 (7).

Telephone Extensions in Subscribers' Houses.

The elimination of the battery wiring between extensions and the substitution of separate batteries at each extension will remedy.

Note.—In general a resistance-condenser arrangement may be regarded as necessary to reduce arcing. Complete screening has, however, been necessary in certain cases.

Telegraph Apparatus (*see* Fig. 17).

Various types of telegraph apparatus may cause interference. Remedies which have been successfully tried are described below.

Teleprinters No. 3A (D.C. Type) are indicated in Fig. 17 (1).

Interference is caused by the governor (80 per cent.) and motor (20 per cent.) and the condenser arrangement shown in Fig. 17 (2) will cure.

Teleprinters No. 3A (A.C. Type).

Ordinarily, 2 μF + 2 μF condensers across the mains as shown in Fig. 17 (3) are sufficient to eliminate interference.

Teleprinter No. 3A (Duplex Circuit).

Interference due to the transmission side of a Teleprinter No. 3A duplex circuit (Fig. 17 (5)) can be cured by inserting a " Filter, Frequency, No. 4A " in the transmitting line as shown in Fig. 17 (6).

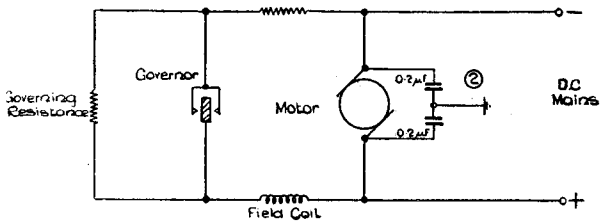
Teleprinter No. 3A (Two-line Simplex Circuit).

Insert a " Filter, Frequency, 4A " in the transmitting line as shown in Fig. 17 (7). In the special case in which two loops are used (one " Go " and one " Return ") the arrangements at the termination of each loop will involve the use of two " Filters, Frequency, No. 4A," as shown in Fig. 17 (8).

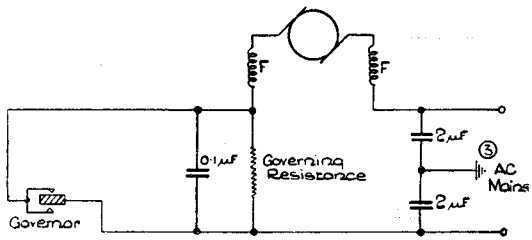
Out Office Central Battery Telegraph Set.

Insert a " Coil, Bridging, No. 1K 50 ohms " between the lower contact of the key and earth as shown in Fig. 17 (4).

Teleprinter Nº 3A (DC Type) ①



Teleprinter Nº 3A (AC Type)



Out-Office Central Battery Telegraph Set

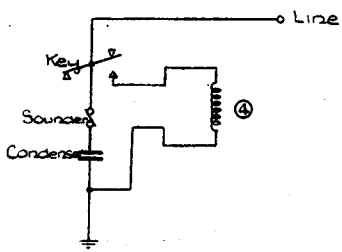
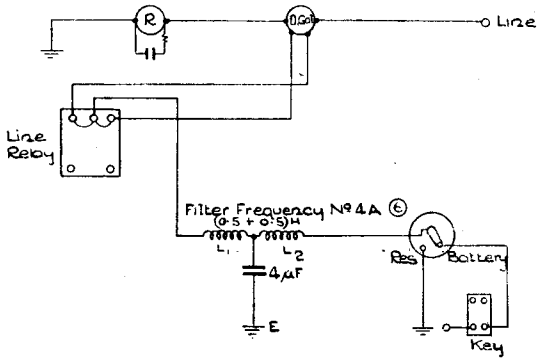
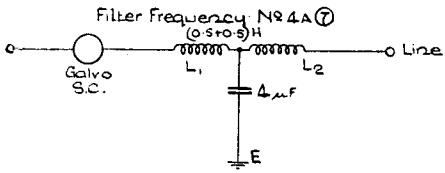


FIG. 17.

Teleprinter Nº 3A Duplex Circuit (5)



Teleprinter 3A two-line simplex circuit



Teleprinter 3A two-line simplex circuit

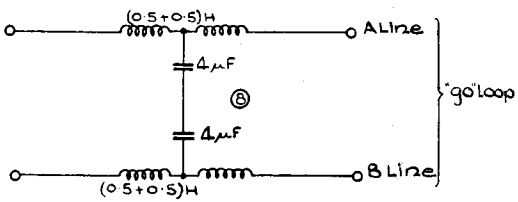
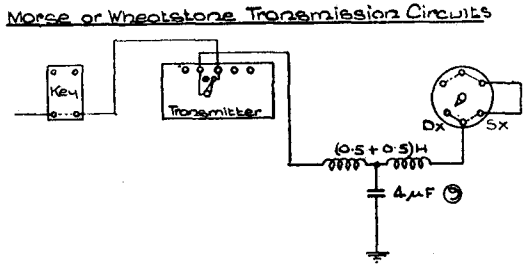
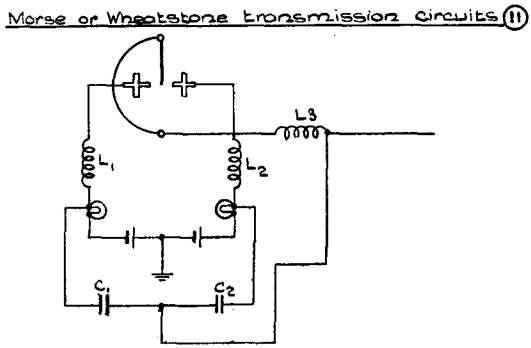


FIG. 17 (cont.)


Morse or Wheatstone Transmission Circuits
Key
Transmitter
Dx
Sx
(0·5+0·5)H
4μF (9)


Morse or Wheatstone transmission circuits (11)
L3
L1
L2
C1
C2

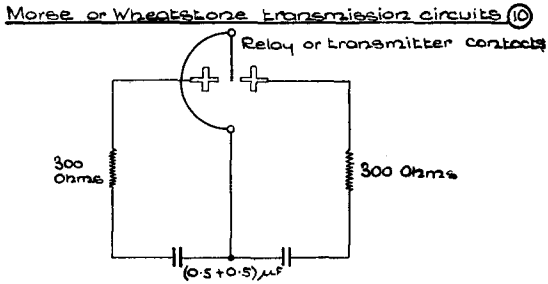

Morse or Wheatstone transmission circuits (10)
Relay or transmitter contacts
300 Ohms
300 Ohms
(0·5+0·5)μF

FIG. 17 (cont.)

Morse or Wheatstone Transmitting Circuits.

Insert a " Filter, Frequency, No. 4A " between the transmitting contacts (key or transmitter) and the DX-SX Switch as shown in Fig. 17 (9). Occasionally in addition to the " Filter, Frequency, No. 4A " it is necessary to add a spark quench circuit, at the relay or transmitter contacts as shown in Fig. 17 (10).

Where the circuit conditions are so critical that it is not possible to use a " Filter, Frequency, No. 4A " without reducing the speed of the circuit below the working standard, the additions shown in Fig. 17 (11) have given successful results, *i.e.*, insert coils L1, L2, L3, and condensers C1, C2 as shown. Each coil should have an inductance of about 130 μH, and British Standard Coils, designation B30, and 0·1 μF condensers are suggested.

APPENDIX No. 1.

WIRING DIAGRAM OF OFFICIAL PORTABLE SET.

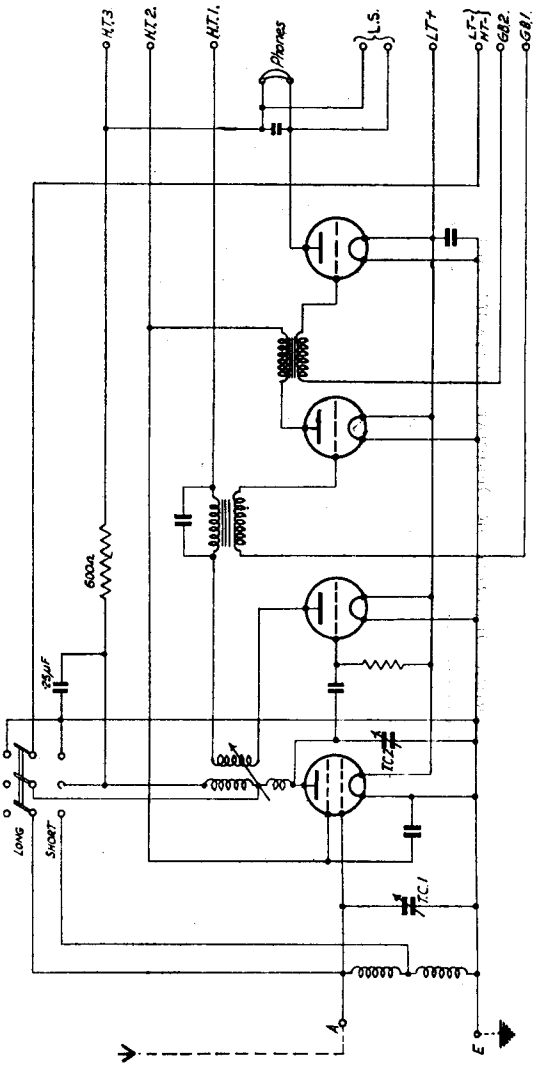


FIG. 18.

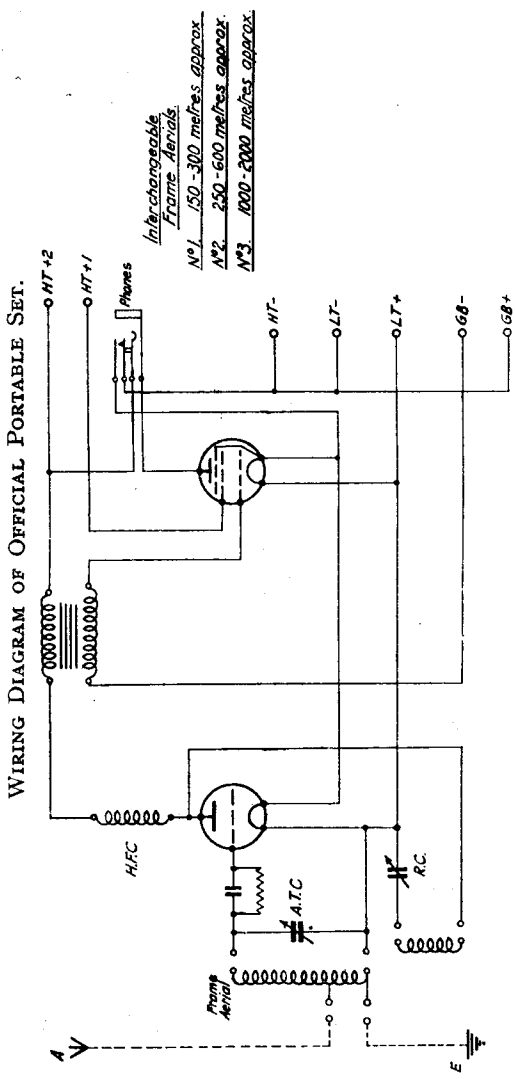

WIRING DIAGRAM OF OFFICIAL PORTABLE SET.
HT+2
HT+1
Phones
Interchangeable Frame Aerials
No1. 150-300 metres approx
No2. 250-600 metres approx
No3. 1000-2000 metres approx
HT-
LT-
LT+
GB-
GB+
H.F.C
A.T.C
R.C.
Frame Aerial
A
E

FIG. 19.

WIRING DIAGRAM OF OFFICIAL PORTABLE SET.

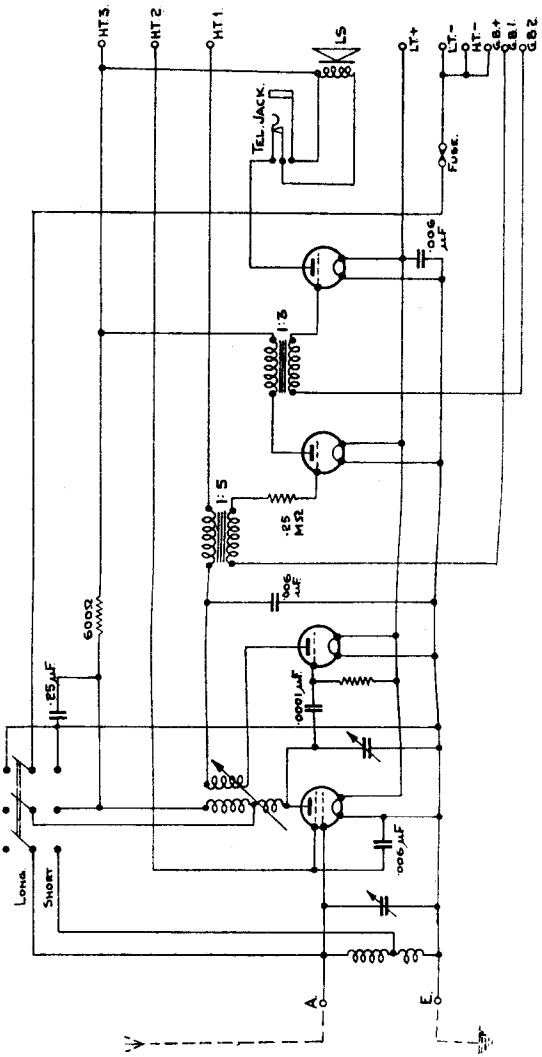


FIG. 20.

APPENDIX No. 2.

SCHEDULE OF CONDENSER PARTICULARS.

Rate Book Description.	Capacity μF.	For use singly across voltages up to	
		D.C.	A.C.
M.C. No. 46 ..	2·0	200	135 (RMS)
,, 81 ..	·5		
M.C. No. 100 ..	·5	150	100 (RMS)
,, 101 ..	1·0		
,, 102 ..	2·0		
M.C. No. 108 ..	2·0	350	250 (RMS)
,, 109 ..	4·0		

Note.—

1. For use, two in series without earthed mid-point, the working voltages shown in the table should be doubled.

2. For use, two in series with earthed mid-point, the working voltages shown should be,

(*a*) doubled, if neither main is at earth potential;

(*b*) taken as shown if one main is at earth potential.

3. Condensers M.C. No. 94 (·5 + ·5 μF) are for use with earthed mid-point, on D.C. or A.C. circuits,

(*a*) up to 270 volts when neither main is at earth potential;

(*b*) up to 135 volts when one main is at earth potential.

They can be used on voltages up to 270 volts, irrespective of the mains condition, provided no earth is used on the mid-point.

4. Units, Condenser, Nos. 1A and 1B are equipped with condensers M.C. Nos. 109 and 108, respectively. They can be used on all A.C. or D.C. circuits up to 250 volts.

APPENDIX No. 3.

Choke Coils (100 μH) for use when interference is on the lower Broadcast Band.

These coils should be made by winding 20 yards of " Cable Power, 660 V, Black " of suitable current carrying capacity into a coil of about 9″ diameter. The number of turns will be approximately 25. The turns should be bound together by insulating tape and the ends bared to facilitate connecting.

Choke Coils (600 μH) for use when the interference is on the Higher or on both Broadcast Bands.

These coils should be made in the same way as the 100 μH coils but 50 yards of wire will be required for each coil. The finished coils will then comprise about 65 turns.

Cable to be used.

A table showing the safe current carrying capacity of wires of various gauges is given below.

Cable Power 660 Volts.	To carry
·0045 sq. ins.	4·5 amps.
·007 ,, ...	7·0 ,,
·0100 ,, ...	10·0 ,,
·0225 ,, ...	22·5 ,,
·0400 ,, ...	40·0 ,,

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LIST OF
Technical Pamphlets for Workmen

(Continued).

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3. Automatic Telephony. Keysending "B" Positions.

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2. Subscribers' Apparatus C.B.S., Part I—C.B.S., No. 1 System.
3. Subscribers' Apparatus Magneto.
4. Private Branch Exchange—C.B.
5. Private Branch Exchange—C.B. Multiple, No. 9.
6. Private Branch Exchange—Magneto.
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2. Power Plant for Telegraph and Telephone Purposes.
3. Maintenance of Power Plant for Telegraph and Telephone Purposes.
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2. Open Line Construction, Part II.
3. Open Line Maintenance.
4. Underground Construction, Part I.
5. Underground Construction, Part II.
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