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ELECTRICAL INTERFERENCE WITH RADIO RECEPTION.

Radio reception is, in some localities, seriously disturbed by interference arising from electrical apparatus in the vicinity. A brief outline of the sources of such interference and the methods usually used in mitigation is given herein, together with references to further information. The only general remedy for electrical interference is cooperative effort, on the part of users of radio and users or owners of the electrical sources of disturbance, to reduce or eliminate the causes of the trouble.

Much of the work in mitigation of electrical interference results in an improvement in the operation of the electrical devices or supply lines and is thus a double gain. There are, however, some electrical devices which, even when in perfect working order, cause disturbances which result in interference with radio reception. In many cases it is possible to provide filters, shields, chokes, etc., either at the source of disturbance or at the receiving set, which do much to relieve the difficulties.

Part of the disturbance from electrical devices is practically inevitable and must be regarded, like atmospheric disturbances, as part of the inherent limitation of radio reception. In other words, the limitation upon radio reception is not only the distance and the power of the transmitting stations and the sensitiveness of the receiving set, but also the omnipresent background of slight electrical disturbances which drown out signals below a certain intensity. This background of electrical disturbances is the underlying reason why reception from local stations is inherently superior to reception from distant stations.

Power-Line Induction.-- A frequent cause of interference is the presence of alternating-current power wires near the antenna or receiving set. Low-frequency voltages (usually 60 cycles) are induced and the resultant current flowing in the receiving circuit causes a "humming" sound in the telephone receivers. The low pitch of the hum will usually identify this source of interference. A method of eliminating or at least reducing the magnitude of this interference is to place the antenna as far as possible from the wire lines and at right angles to them. When the interference can not be eliminated by such means, the proper choice of a receiving set may help. An inductively-coupled (two-circuit) receiving set is less susceptible to such interference than a single-circuit set. The use of one

or more stages of radio-frequency amplification should also help to filter out the audio-frequency interference. It has been suggested that audio-frequency interference might be shunted around a receiving set having a series antenna condenser by connecting between the antenna and ground terminals of the set a high resistance, which will offer lower impedance to the audio frequency than will the receiving set itself.

Sparking Apparatus.-- Sparks are produced in the normal operation of many types of electrical apparatus (such as motors, doorbells, buzzers, gasoline engines, x-ray apparatus, violet-ray machines, some forms of battery chargers, rural telephone ringers, heating pad thermostats). Sparks are also sometimes produced at defective insulators, transformers, etc., of electric wire lines. Sparks usually give rise to electric waves which travel along the electric power wires and by them are radiated out and are then picked up by radio receiving sets. The noise thus produced in a radio set may come from a disturbance which has traveled many miles along the electric power wires.

One remedy for such types of interference is to eliminate the spark. This is possible if the spark is an electrical leak and not necessary to the operation of the device in which it occurs. Many very useful electrical machines, however, require for their operation the making and breaking of electrical circuits while they are carrying current and whenever this happens a spark is produced. It is impossible to eliminate these machines so that it is necessary to make the spark of such nature or so arrange the circuits that the radio-frequency current is reduced or prevented from radiating.

To prevent the radio-frequency current produced by a spark from getting on to the lines connecting the sparking apparatus some form of filter circuit is necessary. A condenser (1 microfarad, more or less) connected across the sparking points will short circuit a considerable amount of the radio-frequency current, or, a condenser connected from each side of the line to ground[1] will serve the same purpose. A choke coil in each side

1 When any connections are made to the power line, in order to avoid fire and personal injury, only apparatus that is carefully tested as to voltage and current-carrying capacity should be used, and the power company should be consulted before making the installation. Additions to the power lines should be made only by qualified persons.

of the line in addition to the condensers connected to ground forms a simple filter circuit which should prevent frequencies in the broadcast range from getting on the line. A high inductance (choke coil) or high resistance connected in each side of the line changes the characteristics of the circuit so as to reduce the amount of power radiated. If such a filter

circuit is not effective or is impractical, the apparatus may in some cases be surrounded by solid metal sheet or wire screen which is thoroughly grounded. The screen should completely surround the apparatus. This may be difficult. For example, in shielding the ignition system of a gasoline engine the spark coils and all wires and other parts of the system must be enclosed in metal shields and these must be very well grounded.

Location of Source of Interference.--The first thing to do in tracing the source of trouble is to make sure that it is not in the receiving set itself. The next thing is to open the electric switch at the house meter; if the interfering noise is still heard in the radio set, the source is then known to be outside the house. It is then desirable to report the situation to the electric power company. Many of the companies have apparatus for the purpose of following up complaints of this kind. Usually a receiving set with a coil antenna is used to determine the direction from which the interfering noise comes, and this outfit is taken from place to place until the source is found. The location of such sources is often a very difficult and baffling undertaking. It sometimes requires that the power be cut off of parts of the line, in order to trace down the part of the line where the trouble arises. The trouble sometimes comes from a spark discharge over an insulator to ground, or between a pair of wires, or it may be that the wire is touching some object such as a tree, pole, guy wire, etc. Such a spark discharge is a loss of power to the operating company and a potential source of serious trouble, and for these reasons the company is probably more interested in finding and eliminating this type of trouble than the radio listener. Large leaks and sparks may be observed at night, especially in wet weather. However, sparks which are too small to be readily noticed may cause serious interference to radio reception.

Commutators.--Where d.c. motors are in operation near a radio receiving set, interference is sometimes caused, especially when the brushes on the motor are sparking badly. The sparking should be reduced as much as possible by cleaning the commutator and proper setting of the brushes. The remaining interference is sometimes overcome by placing two condensers (about 2 microfarads each) in series across the power supply line and connecting their midpoint to a good ground system. This is substantially as outlined above under "Sparking Apparatus."

Bell Ringers.--Another source of interference is the ringing machine used in rural telephone exchanges. Telephone engineers can reduce or eliminate interference by connecting a filter between the machine and the ringing keys; constants of a suitable filter are given on page 44 of Radio Broadcast, May, 1924.

Precipitators.--Many cases of radio interference have been caused by electrical precipitators which are used to prevent smoke and noxious fumes or material from leaving the chimney. The precipitator operates by establishing a highly charged electric field inside the chimney of such a nature and direction that particles going up the chimney are charged and driven against the

falls where they stick. Precipitators cause interference for the reason that the high voltage used in their operation is obtained from a rectifier which produces sparks and generates radio-frequency alternating currents as well as the direct current which the precipitators need. If the precipitator is so designed and arranged that the distance between the rectifier and the chimney is only a few feet or if the entire apparatus including all leads is housed in a metal building there is usually no trouble. But if the rectifier is separated from the chimney the wire which joins them forms a good antenna which will radiate and cause interference for 20 miles or more. Interference from these precipitators can be eliminated by placing a grounded wire screen entirely around these wires and thoroughly grounding the wire screen and the rectifier. If complete screening of the various parts is impracticable, damping resistances can be inserted at various points in the wire line which will reduce the amount of power radiated. Tuned circuits connected across the spark gap of the rectifier will assist by absorbing the radio-frequency power.

Sources of Further Information.--Numerous articles have appeared in the technical magazines in the last few years on the mitigation of electrical interference. The following list gives representative references to articles which can be consulted in public libraries. A particularly full and valuable treatment is given in the "Publication No.25-63, National Electric Light Association," cited below. Additional articles are listed as they appear, under classifications R170 and R430 in the monthly list of references to radio literature given in the Radio Service Bulletin, a monthly publication of the Department of Commerce. This Bulletin may be obtained from the Superintendent of Documents, Government Printing Office, for 25 cents per year.

Radiation from transmission lines. C.Mannebach. Journal American Institute of Electrical Engrs., 42, pp.95-105; Feb.,1923.

Cornering that buzzing interference (experiments at Hartford, Conn.). P.O.Briggs. QST, 7, pp.34-35; March, 1924.

Complaint that ringing subscribers interfere with radio. Telephony, 84, pp.26-29; March 31, 1923.

A power company cuts out static. E.C.McCain. Radio Broadcast, 4, pp.466-467; April, 1924.

Man-made static. A.F.Van Dyck. Radio Broadcast, 4, pp.461-466, April; pp.43-46, May, 1924.

Eliminating interference from commercial power lines. J.L.Bernard. Wireless Age, 10, p.58; March, 1923.

Local interference. L.S.Graham. Popular Radio, 6, pp.12-16; July, 1924.

Ringing machine radio interference. H.R.Fritz. Telephony, 87, pp.18-19; July 26, 1924.

Investigation of power circuit interference in radio; Report of Radio Subcommittee, Inductive Coordination Committee. National Electric Light Association Bulletin, 11, pp.511-513; August, 1924.

Radio interference from electrical precipitators. Radio Service Bulletin, No.88, p.9, Aug. 1, 1924.

The elimination of radio disturbances caused by the Cottrel precipitators. R.E.Boehler. Electric Journal, 21, pp.432-434; September, 1924.

The Augusta case (radio interference by power lines existing in Augusta, Ga.) P.C.Herault. QST, 8, pp.42-44; September, 1924.

How to locate interference from power lines. W.Van Nostrand, Jr. Popular Radio, 6, pp.458-462; November, 1924.

Inductive interference with communication circuits. A. Russell. Journal Institution Electrical Engineers (London), 62, pp.941-946; November, 1924.

How to stop local interference from machinery. Popular Radio, 6, pp.517-518, Nov., 1924.

A kit for the radio detective (how to use a sensitive portable receiver to find interference of all sorts). R.H. Marriott. Radio Broadcast, 6, pp.463-469; Jan., 1925.

Locating power leaks by radio. QST, 9, p.13 of Sept. 1925.

Radio inductive interference. Bulletin No.1, Radio Branch, Dept. of Marine & Fisheries, Ottawa, Canada. (Price, 15 cents).

Interference - I. (Describes methods of reducing interference due to d.c. machines and discusses the problems of atmospherics). N.W.McLachlan. Wireless World & Radio Review, 16, pp.79-81; Feb. 25, 1925.

Interference - II. (Discussion of a type of interference set up by local high power stations). Wireless World & Radio Review, 16, pp.201-203, Mar. 18, 1925.

Interference -III. (An examination of some miscellaneous cases of interrupted reception). Wireless World & Radio Review, 16, pp.391-394, Apr. 29, 1925.

Radio Interference. (Serial Report of the Inductive Coordination Committee, 1924, 1925.) Publication No.35-63. National Electric Light Association. July, 1925. (Copies may be obtained by writing to the Association at 33 West 39th St., New York, N.Y. Price 60 cents.)

Interference (artifices and their functions in reducing disturbances.) McLachlan, N.W. Wireless World and Radio Review, 17, pp.84-87; July 15, 1925.

Smelter interference elimination. O.A.Redfern. Radio Journal, 6, p.35; August, 1925.