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DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON

Letter
Circular
LC-415

May 25, 1934.
(Replaces Letter Circulars 182 and 394)

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. No consideration is given herein to interference produced by radio apparatus. 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 primarily the distance and the power of the transmitting stations and the sensitiveness of the receiving set, but 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. 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 or loud speaker. 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. A receiving set of good selectivity and well shielded should be used.

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; it is therefore 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* will serve the same purpose. A choke coil in each side 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

*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.

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 disconnect the various electric appliances in the house; if the interfering noise is still heard in the radio receiving set, 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 noticeable 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 materials 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 walls 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 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, arranged chronologically, gives representative references to articles which can be consulted in public libraries which maintain files of periodicals, or copies may be secured from the publishers at these addresses:

Bell Laboratories Record, Bell Telephone Laboratories, 463 West Street, New York, N.Y.
Chemical & Metallurgical Engineering, McGraw-Hill Publishing Co., 330 W. 42nd St., New York, N.Y.
Electric Journal, 530 Fernando St., Pittsburgh, Pa.
Electrical World, McGraw-Hill Publishing Co., 330 W. 42nd St., New York, N.Y.
Electronics, McGraw-Hill Publishing Co., 330 W. 42nd St., New York, N.Y.
Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa.
Journal of the American Institute of Electrical Engineers, 33 West 39th Street, New York, N.Y.
Journal of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2, England.
National Electric Light Association, (now Edison Electric Institute), 420 Lexington Ave., New York, N.Y.

Proceedings of the Institute of Radio Engineers, 330 West 42nd Street, New York, N.Y.
QST, American Radio Relay League, W. Hartford, Conn.
Radio, Pacific Bldg., San Francisco, Calif.
Radio Branch, Dept. of Marine and Fisheries, Ottawa, Canada.
Radio Craft, Techni-Craft Publishing Co., Mount Morris, Ill.
Radio Manufacturers Association, Inc., 11 W. 42nd St., New York, N.Y.
Radio News, Teck Publishing Corp., Dunellin, N.J.
Tobe Deutschmann Corp., Canton, Mass.
Wireless World, Iliffe & Sons, Ltd., London, England.
Wireless World & Radio Review, Iliffe & Sons, Ltd., London, Eng.

1. Radio interference. (Serial Report of the Inductive Coordination Committee, 1924, 1925). Publication No. 25-63, National Electric Light Association, 1925.

2. Radio inductive interference. Bulletin No. 1, Radio Branch, Dept. of Marine & Fisheries, Ottawa, Canada. (Price 15 cents). 1925.

3. Interference. N. W. McLachlan. Wireless World and Radio Review, vol. 16, pp.79-81, 201-203, 391-394, 1925, and vol. 17, pp.84-87, 1925.

4. The radio interference problem and the power company. L. J. Corbett. Journal American Institute of Electrical Engineers, vol. 44, pp.1057-1063, 1925.

5. Correction of radio interference from Cottrell precipitators. J. J. Jakosky. Chemical and Metallurgical Engineering, vol. 33, pp.221-226, 1926.

6. Radio interference caused by poorly grounded cable sheath. F. Krug. Electrical World, vol. 87, p.718, 1926.

7. Radio interference from power lines. P. S. Donnell. Radio, vol. 8, pp.31-32 of June, 1926.

8. Radio interference (man-made interference largely controllable - test equipment described by Southern California Edison Co.) R. B. Ashbrook and R. W. Wight. Electrical World, vol. 88, pp.851-853, 1926.

9. Cures for power leaks. R. S. Kruse. QST, vol. 11, pp.9-14 of March, 1927.

10. Location of radio interference (equipment used, procedure followed, etc.). B. E. Ellsworth. Electrical World, vol. 89, pp.810-811, 1927.

11. R.M.A. Better Radio Reception Manual (home-made static and how to avoid it). 1929. Radio Manufacturers Association.

12. Man-made static - High voltage overhead electrical transmission lines and radio interference. R. L. Smith-Rose. Wireless World and Radio Review, vol. 24, pp.476-480, 1929.

13. Radio interference. J. C. Allen. Proc. Institute of Radio Engineers, vol. 17, pp.882-891, 1929.

14. Radio noises and their cure. Pamphlet with advertising. 1929. Tobe Deutschmann Corp., price 25 cents.

15. The location and elimination of radio interference. J. K. McNeely. Iowa Engineering Experiment Station Bulletin 105, 1931.

16. Reduction of radio interference from telephone power plants. J. M. Duguid. Bell Laboratories Record, vol. 10, pp.124-126, 1931.

17. Radio interference. Radio News, vol. 13, pp.560-561, 1932.

18. A balanced wave trap. W. S. Percival. Wireless World, vol. 31, p.274, 1932.

19. Reducing man-made static. G. H. Browning. Electronics, vol. 5, pp.366-368, 1932. Radio Craft, vol. 4, p.412, 1933.

20. Avoidable interference. A.L.J.Bernaert. Wireless World, vol. 33, pp.4-5, 1933.

21. Wireless under way -- Suppressing radiation from car electrical systems. Wireless World, vol. 33, pp.18-19, 1933.

22. Suppression of radio interference with capacity type filters. C. V. Aggers and W. E. Pakela. Electric Journal, vol. 30, pp.337-339, 1933.

23. Problems of electrical interference. A. Morris. Wireless World, vol. 33, p.144, 1933.

24. Reducing radio interference from commutating machines. C. V. Aggers and W. E. Pakela. Electric Journal, vol. 30, pp.423-427, 1933.

25. Radio noise. E. H. Scott. Radio News, vol. 15, pp.278-279, 1933.

26. Suppressing auto radio noise. G. Browning. Radio News, vol. 15, pp.410-427, 1934.

27. The interference of electrical plant with the reception of radio broadcasting. A. Morris. Jnl. Institution of Electrical Engineers (London), vol. 74, pp.245-263, 1934.

28. Radio interference from synchronous converters. C. V. Aggers and W. E. Pakela. Electric Journal, vol. 31, pp.121-122, 1934.

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Washington, D.C.