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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. No consideration is given herein to interference caused by unwanted radio signals. 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. The curve is often difficult, requiring considerable technical knowledge and experience.

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 power of the transmitting stations and the sensitiveness of the receiving set, but the omnipresent background of electrical disturbances which drown out signals below a certain intensity. This background of electrical disturbances is the underlying reason why reception from near stations is inherently superior to reception from distant stations.

Sparking Apparatus.- Sparks are produced in the normal operation of many types of electrical apparatus (such as motors, motor starters, doorbells, buzzers, oil-burners, automobile ignition systems, X-ray apparatus, violet-ray machines, some forms of battery chargers, rural telephone ringers, thermostats).

Sparks are also sometimes produced at defective insulators, transformers, etc., of electric power lines. Sparks usually give rise to interfering electric waves which travel along the electric power wires. They may be carried along the power wires (sometimes many miles) to radio receiving sets, or, may produce interference by induction in a receiving antenna or lead-in or radio receiving set.

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. In these cases the production of the spark is inherent; 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.

Mitigation of Interference Carried by Power Lines.- 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. In some cases it is desirable to supplement the filter circuit by surrounding the apparatus 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.

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

*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.

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.

It is sometimes possible to reduce the interference by similar measures at the radio receiving set, i.e., by shielding the receiving set and providing a filter circuit where the electric power line is connected to the receiving set.

Mitigation of Induced Interference.- The electrical interference is in some cases not carried into the receiving set by the power lines but is instead induced in the antenna or lead-in or receiving set by interfering devices or power lines nearby. Such interference may be reduced by shielding the receiving set and lead-in and installing the antenna well above the building and away from power lines. However, the shielding of the lead-in is a complex operation requiring specialized technical knowledge. In one arrangement it is done by connecting the antenna as a doublet, using a twisted-pair conductor as a lead-in from the doublet antenna to the receiving set, and supplying a matching transformer between the receiving set and the lead-in; this method is generally applied for the high frequencies (short waves). For the ordinary broadcast frequencies (550 to 1500 kilocycles), a feasible method is to connect a shielded lead-in wire to the ordinary broadcast receiving antenna by means of a transformer, and to the receiving set by means of a transformer.

Location of Source of Interference.- The first thing to do in tracing the source of trouble is to make sure that there are no loose connections or defective parts in the receiving set itself. The next thing is to determine whether the source of trouble is in electric devices in the house; this is done by completely disconnecting all electric cords and appliances from the sockets or outlets, and removing all lamp bulbs or else screwing them in tight. Tight contacts in all electric equipment are essential. 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.

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.- Articles frequently appear in technical magazines on the mitigation of electrical interference. The following list, arranged chronologically, gives representative references to such articles. Except where noted, they are not issued by, and are not available from, the National Bureau of Standards. These publications can be consulted in public libraries which maintain files of periodicals, or copies may be secured from the publishers at the following addresses:

Bell Laboratories Record. 463 West St., New York, N.Y.

Chemical & Metallurgical Engineering. McGraw-Hill Bldg., 330 West 42d Street, New York City.

Electric Journal. 530 Fernando St., Pittsburgh, Pa.

Electrical World. 330 West 42nd Street, New York City.

Electronics. McGraw-Hill Bldg., 330 West 42nd St., New York City.

Iowa Engineering Experiment Station. Iowa State College, Ames, Iowa.

Journal of the American Institute of Electrical Engineers. 33 West 39th St., New York City.

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 St., New York City.

QST. American Radio Relay League, West Hartford, Conn.

Radio. 7460 Beverly Blvd., Los Angeles, Calif.

Radio Branch, Dept. of Marine and Fisheries, Ottawa, Canada.

Radio Craft. Techni-Craft Publishing Co., Mount Morris, Ill.

Radio Manufacturers Association. 1317 F St., Washington, D.C.

Radio News. Teck Publishing Corp., Dunellin, N.J.

Sherwood Press. Box 552, Edgewater Branch, Cleveland, Ohio.

Tobe Deutschmann Corp., Canton, Mass.

Wireless World. Iliffe & Sons, Ltd., London, England.

Wireless World & Radio Review, Iliffe & Sons, Ltd., London, England.

In each reference below, unless otherwise indicated, the first number (underscored) is the volume of the periodical; the numbers following indicate pages and the year of publication. Names of periodicals abbreviated can be found in full in the list of addresses above.

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

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

Interference. N.W.McLachlan. Wireless World and Radio Rev. 16, 79-81, 201-203, 391-394 (1925); and 17, 84-87 (1925).

The radio interference problem and the power company. L. J. Corbett. Jnl.A.I.E.E.,44, 1057-1063 (1925).

Correction of radio interference from Cottrell precipitators. J. J. Jakosky. Chem. & Met. Eng., 33, 221-226 (1926).

Radio interference caused by poorly grounded cable sheath. F. Krug. Elec.Wld. 87, 718 (1926).

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

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

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

Location of radio interference (equipment used, procedure followed, etc.) B. E. Ellsworth. Elec. Wld. 89, 810-811 (1927).

Man-made static - High voltage overhead electrical transmission lines and radio interference. R. L. Smith-Rose. Wireless Wld. & Radio Rev. 24, 476-480 (1929)

Radio interference. J. C. Allen. Proc.I.R.E. 17, 882-891 (1929).

Radio noises and their cure. Pamphlet with advertising. Tobe Deutschmann Corp. Price 50 cents. (1932).

The location and elimination of radio interference. J. K. McNeely. Iowa Eng. Exp. Sta. Bulletin 105 (1931).

Reduction of radio interference from telephone power plants. J. M. Duguid. Bell Labs. Record 10, 124-126 (1931).

Radio interference. Radio News 13, 560-561 (1932).

A balanced wave trap. W. S. Percival. Wireless Wld. 31, 274 (1932).

Radio interference. M. D. Hooven, Jr. Sec. 26, pp.96 to 129, Standard Handbook for Electrical Engineers, 6th ed. (1933). McGraw-Hill Book Co., price $7.00.

Reducing man-made static. G. H. Browning. Electronics 5, 366-368 (1932). Radio Craft 4, 412 (1933).

Avoidable interference. A.L.J.Bernaert. Wireless Wld. 33, 4-5 (1933).

Wireless under way -- Suppressing radiation from car electrical systems. Wireless Wld. 33, 18-19 (1933).

Suppression of radio interference with capacity type filters. C. V. Aggers and W. E. Pakela. Elec. Jnl. 30, 337-339 (1933).

Problems of electrical interference. A. Morris. Wireless Wld. 33, 144 (1933).

Reducing radio interference from commutating machines. C. V. Aggers and W. E. Pakela. Elec. Jnl. 30, 423-427 (1933).

Radio noise. E. H. Scott. Radio News 15, 278-279 (1933).

Suppressing auto radio noise. G. Browning. Radio News 15, 410-427 (1934).

The interference of electrical plant with the reception of radio broadcasting. A. Morris. Jnl.I.E.E.(London) 74, 245-263 (1934).

Radio interference from synchronous converters. C. V. Aggers and W. E. Pakela. Elec. Jnl. 31, 121-122 (1934).

Suppression of radio interference using tuned choke coils. C. V. Aggers and R. N. Stoddard. Elec. Jnl. 31, 305-307, (1934).

Plan to eliminate radio interference. Electronics 7, 370-371 (1934).

Diathermy interference. R. L. Haskins. Radio Eng. 15, 20-21 (1935).

Electrical interference with broadcasting. Jnl. I.E.E. (London) 79, 206-212 (1936).

Good radio reception. R.M.A. Engineering Bulletin 19. Radio Manufacturers Association. (1936).

Radio interference and its suppression. J. H. Reyner. The Sherwood Press. Price $4.00.

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Washington, D.C.