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BETTER RADIO RECEPTION MANUAL

Home Made Static and How to Avoid it

Compliments of
ATWATER KENT MANUFACTURING COMPANY

RADIO MANUFACTURERS ASSOCIATION INC.

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Better Radio Reception Manual

Home Made Static and How to Avoid It

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Radio Manufacturers Association, Inc.

Manual on Better Radio Reception

THIS MANUAL on Better Radio Reception is produced by the Radio Manufacturers Association, Inc., which is the national organization of the manufacturers of radio devices.

It is, obviously, their desire to promote those things which will be of benefit to the radio listening public.

It is only by improving the reception and programmes that the industry can grow and be mutually beneficial to the public and to the manufacturers.

Already, in its six years of existence as a trade organization, it has been of real service to the listeners in countless ways such as legislation, standardization and in the technical fields.

In the survey of interference problems, we have received very valuable information and assistance from power companies throughout the United States, from the National Electric Light Association, from many member companies of the Radio Manufacturers Association, Inc., and from individual radio engineers.

SECTION ONE

IT is natural that the Radio Listener attribute to the radio set or some accessory all sounds emitted from the loud speaker other than those apparently intended for entertainment. This opinion is not generally correct, since a radio set properly designed and properly installed, is free from such noises.

No doubt, one of the reasons for this mistaken opinion is the lack of ability to analyze the noise and locate the source.

It may well be mentioned here that the proper analysis of interference noises, with respect to their originating points, constitutes the greater portion of interference elimination or reduction. The actual correction of the condition causing the interference is usually a simple matter.

Interference "trouble shooting" is, in itself, a careful study requiring actual practice by contact with the different kinds of interference to develop effectively and rapidly a high percentage of successful results.

It is our intention in using the term "interference" to include under this one head, all noises which are commonly referred to as "Static," "Strays," "Leaks," etc.

General Classification of Interference

General interference may be classified in the two following divisions:

CLASS 1 Interference caused by atmospheric disturbances and conditions considered beyond Man's control.

CLASS 2 Interference caused by electrical and mechanical devices controlled by Man.

It is the opinion that "CLASS 1" interference is not controllable and cannot be eliminated successfully, although, under some circumstances, it can be reduced in intensity.

"CLASS 2" interference can be eliminated or reduced in all cases, providing the source and cause is correctly determined.

Since "CLASS 1" interference is considered beyond man's immediate control, it will be eliminated from this discussion.

"CLASS 2" interference, which, you will remember, is considered controllable, may be divided into the following groups:

GROUP 1 — **Power Circuits**

a. Lines
b. Insulators
c. Lightning arresters
d. Transformers
e. Generators and motors

GROUP 2 — **Industrial Applications**

a. Arc light circuits
b. Telephone and telegraph lines
c. Pole changers and converters
d. Street cars and electric railroads
e. Smoke and dust precipitators
f. Motors
g. Sign flashers

GROUP 3 — **Household Appliances**

a. Electric pads or any similar thermostat controlled devices
b. Violet ray machines or any high frequency apparatus
c. Flat irons or any type of resistance heaters
d. Door bells, light switches and motors such as used on vacuum cleaners, washing machines, electric fans, etc.

GROUP 4 — **Miscellaneous**

a. X-Ray machines
b. Storage battery chargers
c. Annunciator systems
d. Stock tickers
e. Ignition systems
f. Electric elevators
g. Electric furnaces
h. Moving picture equipment
i. High voltage test equipment

A further and more elaborate group of "interference" is given below:

Arc lights
Electric heaters
Electric irons
Electric heating pads
Automatic railway signals
Electric curling irons
Marcelling outfits
Soldering irons
Waffle irons
Shaving mug heaters
Percolators
Vibrating rectifiers
Mercury arc rectifiers
Flash signs
Elevator controls
Leaky cables
Bad connections in lighting system
Small motors
Violet ray machines
X-Ray machines
Electric vibrators
Electric meters
Doorbells and buzzers
Annunciators
Dishwashers
Dough mixers
Soda mixers
Electric typewriters
Electric addressing machines
Electric computators
Farm lighting systems
Corroded or loose connections in radio set
Printing presses
Dust precipitators
Hair clippers
Automatic towels
Oil burning devices
Electric refrigerators
Vacuum cleaners
Motor brushes
Starting commutators
Telephone dials
Telephone magnetos
Electric cigar lighters
Street car switches
Breaks in third rails
Leaky transformer fuses
Defective light sockets

This list of "Interference Producers" is given to explain why all interference should not be attributed immediately to trouble with your radio set, your neighbor's radio set, or some fault of the power company, telephone company, etc.

The most important step in eliminating or reducing interference is to trace it to a definite point or device. The means for accomplishing this are not always within the province of the radio set owner and the course must be pursued as follows:

a. If your radio set is of the type which uses an antenna system (aerial and ground) the wire connecting to aerial and the wire connecting to ground should be removed from their respective

binding posts and a small piece of wire substituted. Connect this wire directly across the aerial and ground posts.

Such procedure then leaves the radio set effectively without an antenna system, which is the collector of energy for the set. The result is that any interference which is being picked up outside the radio set itself, is reduced or eliminated when the collector system is removed.

If the case is such that the interference is reduced or eliminated you may decide immediately that it is from an outside cause and not due to your radio set.

If, however, the interference continues with equal volume, a careful analysis of the radio set should be made. (A reputable radio service organization will make this examination for a reasonable fee.)

b. When it is decided that the noise is due to outside causes and your local radio service organization has carefully checked the source, having found it due to electric light or transmission wires, you should call the local power company and ask for assistance in reducing or eliminating the interference.

c. If your radio set is of the loop type and variation of loop position changes the strength of interference, it may be considered as coming from a source outside the radio set itself.

NOTE: Your local power or electric light company is endeavoring constantly to correct conditions upon their lines and equipment which might cause radio interference. You may be assured of their cooperation where the source is shown to be due to their lines or equipment. In fairness to the power company do not complain to them until a competent service man has made tests and concluded that the difficulty is power line interference.

Tuning

Improper tuning of your radio set may cause many kinds of interference. This kind of interference bothers you, your neighbor, and in some instances radio sets a considerable distance away. Follow, carefully, the instructions accompanying the radio set. If none are included secure the service of a competent radio service organization. The resulting satisfaction derived from a radio set properly tuned and operated, pays many times the cost of such assistance.

Due to the selectivity and sensitivity of some radio sets and to the frequency allocation of broadcasting stations, interference between

stations may be noted upon certain nights and at certain hours. This condition, which is dependent upon the factors mentioned above, is not always preventable; however, proper knowledge of your set and its operation may materially assist in reduction or elimination.

The usual manifestation of this heterodyning of broadcast stations is a "howl," "squeal," or "gurgle" usually of constant intensity and tone. The Federal radio control agencies are continually endeavoring to reduce this type of interference.

Types of Radio Receivers

Radio sets carry many circuit names which may be misleading to the layman. There are but a few fundamental circuits in use today. These may be listed as follows:

1. Regenerative
2. Tuned Radio Frequency including Neutrodyne
3. Super Heterodyne

All of the receivers including types 2 and 3 may employ regeneration to some degree.

A simple analysis of the term "Regenerative" may be considered that ability a circuit possesses to utilize over again the energy which is received by passing it through one or more tubes a second time, thus increasing the sensitivity without additional tubes.

"Tuned Radio Frequency" receivers often make use of "controlled regeneration." This type receiver may consist of one, two, three, or more tuned stages of radio frequency prior to the detector, the sensitivity of which is controlled by adjusting the effective "Regeneration."

The "Neutrodyne" and other "balanced circuit" receivers are fundamentally tuned Radio Frequency, consisting of one, two, three or more stages of tuned radio frequency amplification prior to the detector. The excess regeneration is controlled by neutralizing its effects by means of balancing condensers and other methods. In operation it is similar to other tuned radio frequency receivers.

The "Super Heterodyne" receiver employs, generally, tuned radio frequency, regeneration, and an extra unit known as an "oscillator." The signal received is rectified by a first detector and changed in frequency by "beating" with the oscillator circuit, again

amplified at frequencies, lower than the original, again rectified by a second detector and the resultant audio frequency amplified in the conventional manner. Such receivers make use of tuned radio frequency and regeneration.

Conclusions

1. An improperly installed radio set may be responsible for much unsatisfactory reception and interference.

2. All radio sets should be inspected regularly by a competent service man at least once in three months.

3. The set owner must be instructed properly in the use of his set, otherwise much damage and dissatisfaction may result.

4. All set owners, unless thoroughly familiar with radio apparatus, should use caution with regard to tinkering or installing additional accessories.

5. All interference is *not* controllable. That due to storms, rain, dust, clouds, snow and many similar natural sources may be thus classified.

6. All controllable interference, or man made interference, is not necessarily due to the other fellow's set, the power companies' lines or equipment, the telephone company, the industrial organizations nearby, our neighbor's battery charger or electrical appliances, etc. It may originate in our own house or premises. Let's clean up our own backyard first.

7. Appliances in the home such as heating pads, doorbells and buzzers, motors on washing machines, vacuum cleaners, electric refrigerators, dishwashing machines, etc., are prolific interference producers unless properly maintained and protected against it.

8. Interference can generally be reduced or eliminated when the source is determined. Experience is an efficient teacher of this subject. Many electric appliances are now manufactured free from interference production characteristics. They sometimes cost more but prove more satisfactory in the radio home.

9. Power companies are constantly alert to interference actually caused by their lines or equipment since such conditions represent loss to them, unless remedied.

10. Electrolysis due to improper bonding of street car or interurban lines, is rapidly being overcome. It most generally prevails in the smaller municipalities. Here, too, the railway company is anxious to remedy such a condition since it represents considerable loss.

11. The nature of telephone communication is such that interference which affects your radio set will generally affect the communication system. The answer, obviously, is a quick remedy of conditions by the telephone company.

12. Telephone dialing systems, now coming into general use, do not cause continuous interference. Probably a remedy is now under way to eliminate the intermittent interference they produce.

13. Every X-ray machine, electro diathermy apparatus and high frequency apparatus, does not always produce interference. The physician who realizes that interference is originating with his equipment is quite likely to want it corrected immediately, for the good will of his local practice.

14. If a filter be used, be sure the condensers exceed, in working voltage, twice the voltage of the lines across which the condenser is used. The inductance or choke coil used should be wound with the proper size wire in accordance with the table shown on page 19.

15. Never attempt any interference protection unless properly authorized and instructed by a competent service man or power company representative. Due caution here will save much inconvenience and possible injury or loss of life.

16. All service men dealing with interference problems are conscientious but may make mistakes in analyzing the source of interference. Bear with them, please. The very character of radio and electricity with its changes daily in theory and practice, make it necessarily a business requiring a wealth of experience to accomplish results.

It is intended that Section One of this Manual on Interference be entirely elementary for the lay radio enthusiast and that it point the way to better radio reception through better knowledge of the possible contributory interference producers.

Section Two, which follows, is intended for the more advanced Radio Enthusiast, Radio Service Organizations and Radio Interference "trouble shooters."

SECTION TWO

In Section One is listed the most prominent types of "interference producers." All of these produce interference for the same reason, i. e., an electrical spark of greater or lesser magnitude.

It has been suggested, heretofore, that the primary difficulty in interference "trouble shooting," is due to lack of proper analysis of the cause and source.

Classification

The kinds of interference manifested through the loud speaker may be classed as follows:

A. Crackles { Irregular / Regular

B. Hums { Irregular / Regular

C. Whistles and Squeals { Irregular / Regular

D. Clicks { Irregular / Regular

Irregular crackles or hums may generally be traced to power lines which are grounding, broken down or leaky condensers in set or power pack, or in the case of seasonal electrical storms, it may be due to discharge across lightning arresters.

Regular crackles and hums may be due to motor generators of any description or to thermostatic devices and flashers, or to leaky or defective condensers and wiring in the radio set or power pack.

Whistles and squeals, either regular or irregular, are generally due to heterodyning of carrier waves of two or more broadcasting stations, which are on nearly the same frequency, or to a receiving set which is being operated at the oscillating or regenerating point. (Note:—This can also be traced to improper operation of the receiver in which the interference is noted.)

Clicks, either regular or irregular, may usually be traced to telephone dialing systems or the operation of switches in or near the region of the radio receiver.

The foregoing classifications must of necessity be quite general, since contact with the men and organizations specializing in interference elimination and prevention shows that many noises of entirely different characteristics may be emitted from the same kind of devices.

Analysis of Interference Origin

It is of extreme importance that the source of interference be correctly analyzed. Thorough consideration of all possible interference producers and conditions will save much labor and time.

Operation

A

—

Battery

Operated

Radio Set

1—Check all batteries for loose connections, corrosion or dust accumulation which might cause leaks and noise.

2—Check all connections to radio set.

3—Check relay (if used) for poor contacts.

4—Check antenna system

Aerial— for swinging grounds or contact with other objects

Ground—for poor electrical or mechanical connections.

5—Check all tubes for loose elements, poor contact to sockets.

6—Check all connections in radio set. If set is several years old, look for poor electrical contact of soldered joints, loose lugs and terminals on sockets and condensers and dust in locations where leakage may occur.

7—Check all by-pass condensers for leaks or breakdown.

8—Check all jacks or switches for poor contact due to oxidized contacts or sprung leaves.

9—Check all possible connections, electrical or mechanical.

10—Check "C" Battery voltages. (A "B" or "C" battery may cause much interference due to internal action as result of long use or faulty construction.)

11—Check "B" battery voltage.

Operation B — Socket Powered Set Using "A," "B" and "C" Eliminators or Equivalent

1—Proceed as suggested in "Operation A."

2—Check all contacts and connections in "A," "B" and "C" power supplies.

3—Check all condensers in power supplies. (Much interference has been known to originate from condensers which have been leaking or broken down.

4—Check rectifying devices.

- A—Liquid Type
  - 1—Acid
    - Electrodes
    - Solution
  - 2—Colloid
    - Electrodes
    - Solution
- B—Ionization Type
  - Poor tube contact
  - Low rectified output
- C—Filament Type
  - Poor tube contact
  - Low rectified output
- D—Dry Type
  - Low rectified output
  - Poor contacts to rectifier

5—Check all resistors
- Fixed
- Variable

6—See that units are free from dust and moisture which might cause leakage.

Operation C — A. C. Tube Electric Set or D. C. Tube Electric Set (All power devices built in)	1—Follow operation A and B where applicable.
	2—Check all condensers, fixed and variable.
	3—Check all tubes carefully.
	4—Check all power developing devices such as transformers used for filament, plate, dynamic speaker supply, etc. (Follow regular procedure for checking "B" and "C" power units.)
	5—If dynamic speaker is used, check "voice coil" connections.

When satisfied that the radio set is clear of interference production, proceed to check carefully all lights, sockets, switches and electrical appliances in the house.

The list of interference producers shown on preceding pages is sufficient to permit a thorough investigation and analysis of the problem.

Experience teaches that common sense and careful elimination of each probable interference producer will bring very satisfactory results.

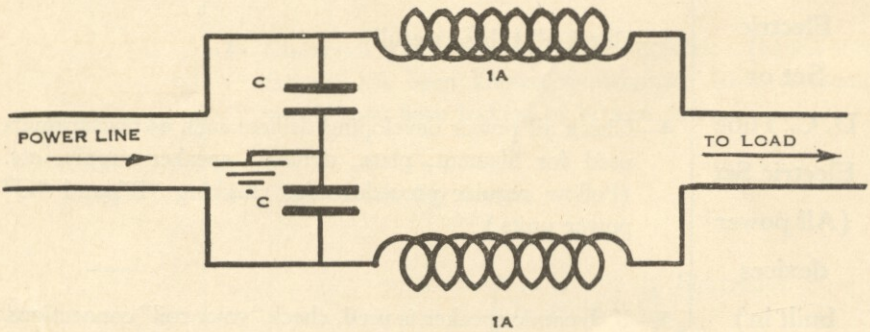
Much assistance can be gained in the elimination or reduction of interference if the men who are in contact with this work will advise of their findings. The result of such cooperation will point a very definite procedure for future distribution of such information.

NOTE: All filter diagrams shown will affect only the device to which they are attached. Interference originating outside the house and transferred to the lighting circuits through the regular house wiring, can only be effectively reduced, or eliminated, by a symmetric filter at the house meter.

This subject should be discussed with your local power company before any attempt is made to install such devices.

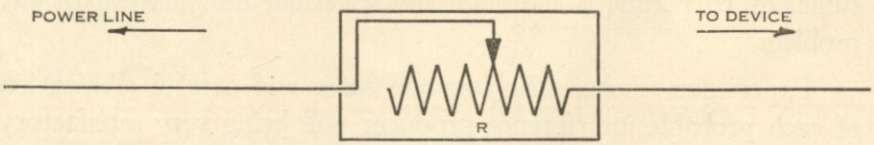
Diagrams of Filter Systems

For Doorbells, Buzzers and Annunciator Systems.

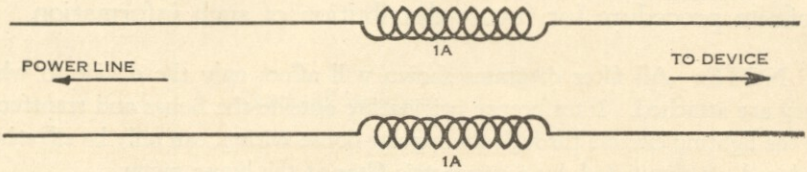


C —Condensers 1 Microfarad.
1A—Choke Coils (See sketch Pages 18 and 19)

For Heating Pads and Thermostatically controlled devices.



R—Variable resistance such as "Dim-A-Lite" socket. Adjust to point where thermostat does not operate but device may be kept at a satisfactory temperature. THIS IS A LAST RESORT FOR PROTECTION OF HEATING PADS ONLY.

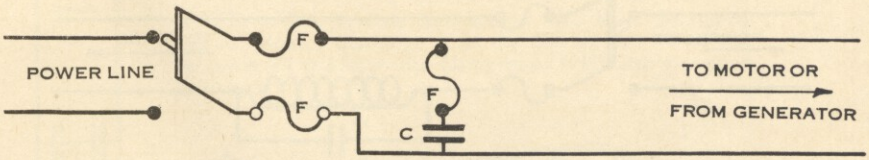


1A—Choke Coils (See sketch Pages 18 and 19)

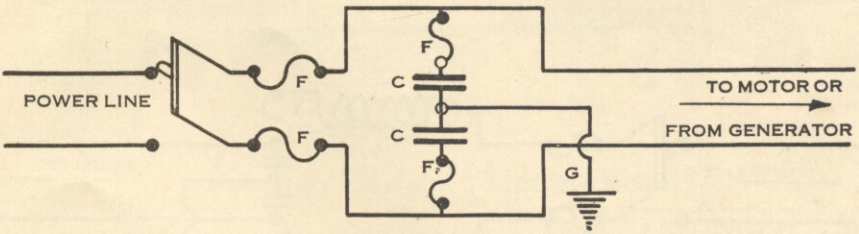
NOTE:—*For conservation of space, honeycomb coils may be used in applications where wire size is sufficient to carry current required.*

Diagrams of Filter Systems

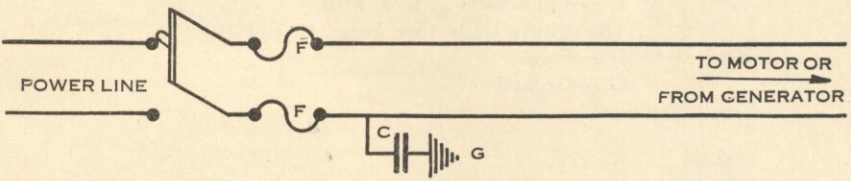
For Motors and Generators



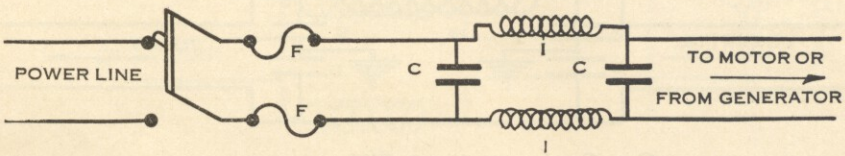
C —Condenser 1. to 4. Mfd.
F —Fuses



G —Ground
C —Condensers .1 to 5. Mfd.
F —Fuses



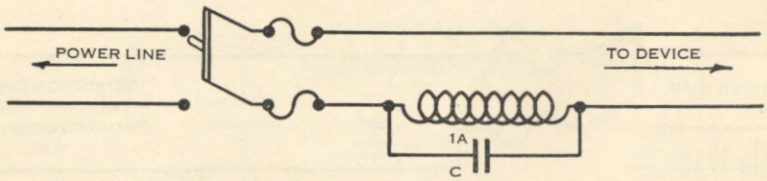
C —Condenser .5 to 4. Mfd.
G —Ground



I —Choke Coils (See Pages 18 and 19)
C —Condensers .5 to 4. Mfd.

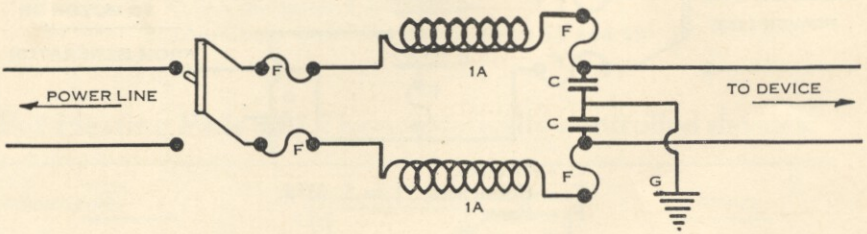
Diagrams of Filter Systems

For Miscellaneous Devices



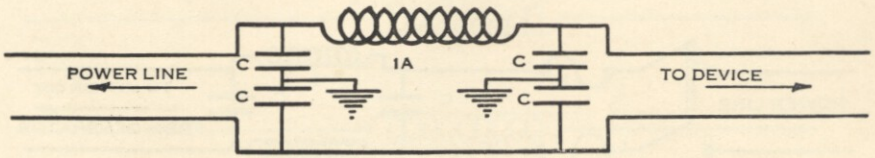
C —Condenser .02 to .5 Mfd.
1A—Choke Coil (See Pages 18 and 19)

NOTE:—*This method is advisable where it has been found impossible to clear interference in any other way. The effect is to tune the interference to a frequency which does not fall within the receiving band.*



C —Condensers .1 to 5. Mfd.
1A—Choke Coils (See Pages 18 and 19)
F —Fuses
G —Ground

For Oil Burners that use constant operating Igniter Plugs.

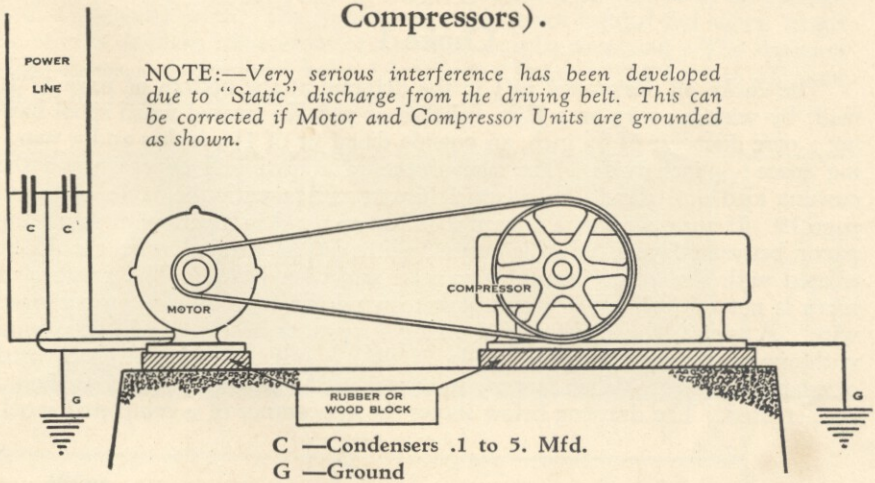


C —Condensers .1 to 5. Mfd.
1A—Choke Coil (See sketch Pages 18 and 19)

NOTE:—*Motor Frame and Furnace Casting should be properly grounded.*

Diagrams of Filter Systems

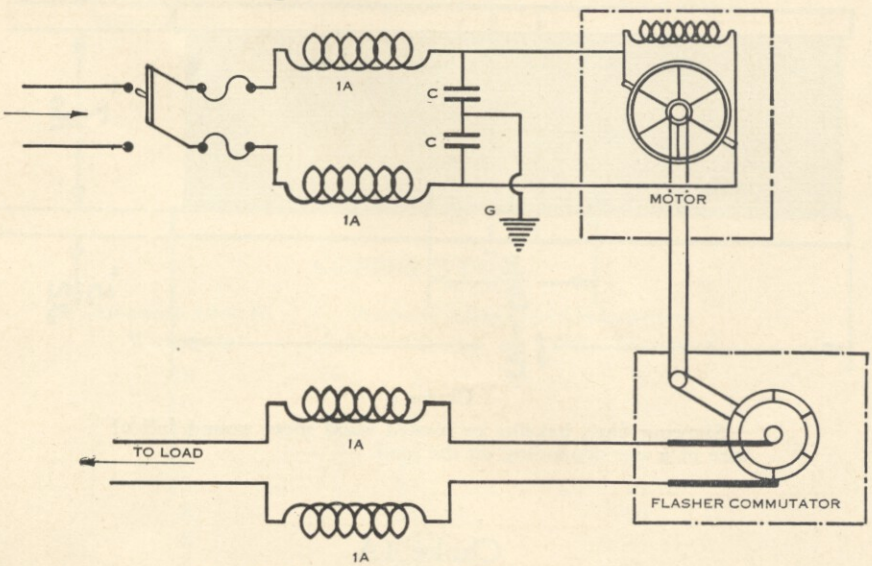
For Electric Ice Machines (Refrigerators using Belt driven Compressors).



NOTE:—*Very serious interference has been developed due to "Static" discharge from the driving belt. This can be corrected if Motor and Compressor Units are grounded as shown.*

C —Condensers .1 to 5. Mfd.
G —Ground

For Sign Flashers (Motor Driven).



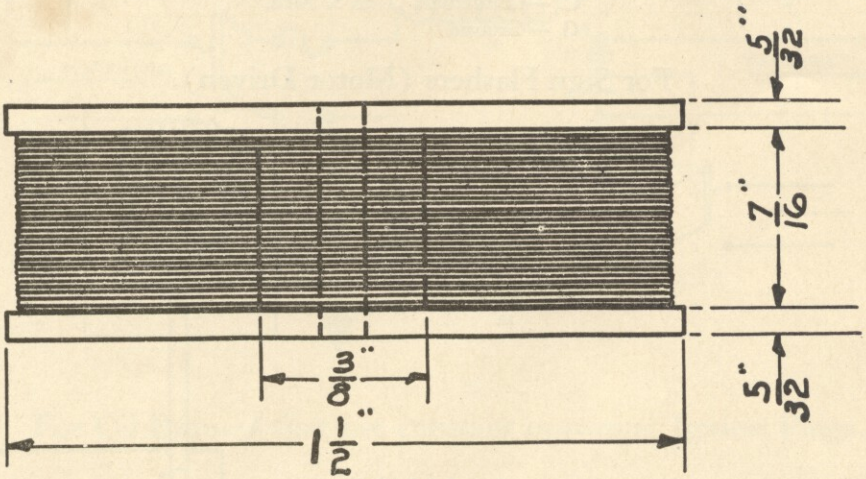
C —Condensers .1 to 5. Mfd.
1A—Choke Coils (See sketches Pages 18 and 19)
G —Ground

Choke Coils for Motor and Generator Filters.

(Referred to in sketches as Choke 1 and Choke 1A)

Choke 1

The choke oil designated as I in the diagram at the bottom of page 15 is made by winding wire on a fibre, bakelite or paraffin treated wood spool having a core diameter of 3/8 inch, an outside diameter of 1½ inches and a winding space 7/16 inch wide. The size of the wire used will depend upon the current load and should be selected in accordance with the table given on page 19. If enamelled wire is used it is best to wind in layers with insulating paper between layers. Spools wound with cotton covered wire should be treated with shellac or insulating varnish and then baked. The number of turns is not critical, it being sufficient to wind the form full of proper sized wire. A typical choke for a load taking 5 amperes or less would be wound with approximately 560 turns of No. 18 B & S gauge double cotton covered or enamelled wire. When larger size wire is used the spool dimensions should be increased. The drawing below shows the appearance of a completed spool.



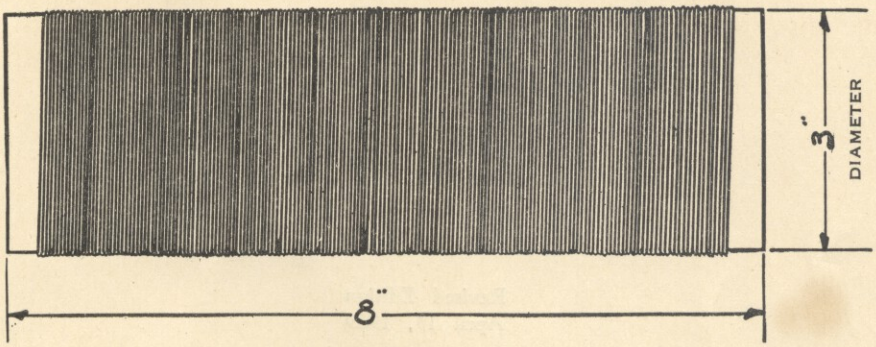
Choke 1

Showing fibre, bakelite or treated wood spool wound full of wire of a size depending on the load.

Choke 1A

The coil designated as Choke 1A in the filters on pages 14, 16 and 17 consists of a fibre, bakelite or porcelain tube 3 inches in diameter and approximately 8 inches long. Only one layer of wire is wound on it. The wire size

will depend on the load conditions and should be taken from the table below. If double cotton covered wire is used the layer should be treated with shellac or insulating varnish. A typical choke for circuits where the current does not exceed 5 amperes will be wound with 150 turns of No. 18 B & S gauge D. C. C. magnet wire. The number of turns is not critical but when larger size wire is used the dimensions of the tube may be increased. The drawing below shows a completed Choke 1A. Both Choke 1 and 1A are air core and no iron should be placed in the spool or tube.



Choke 1A

Showing fibre, bakelite or porcelain tube wound with a single layer of wire.

TABLE

Current Carrying Capacity

COPPER WIRE

American (B & S) Wire Gauge	Amperes Allowed by Underwriters	
	Rubber Covered	Other Insulation
18	3	5
16	6	10
14	15	20
12	20	25
10	25	30
8	35	50
6	50	70
4	70	90
3	80	100

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