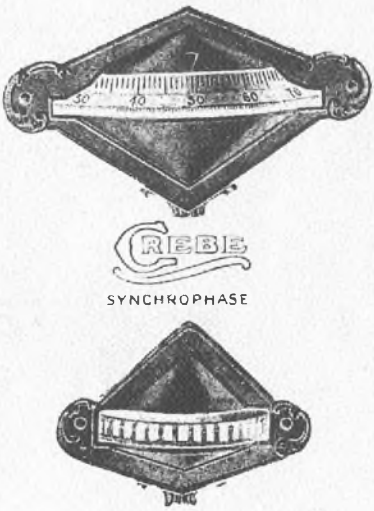
GREBE

SYNCHROPHASE

INSTRUCTION MANUAL



IT is a significant fact that nearly all radio receivers are operated by laymen—by owners, who, in the great majority of cases, have little or no practical experience with things mechanical and electrical.

While it is not imperative, it is, however, highly desirable that every Synchrophase owner should thoroughly understand pertinent facts on its care and operation. With such knowledge at his command, economical operation, prolonged usefulness and more pleasure will be derived, for it is a true maxim that the more one knows about a thing the more one enjoys it.

THE Synchrophase in the Home. Always in perfect accord with its surroundings, harmonizing with every setting.

Foreword

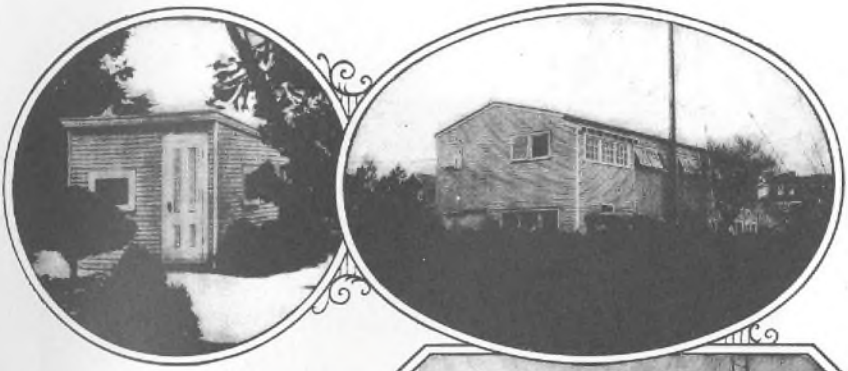
THE Grebe Synchrophase exemplifies the finest in Radio Engineering achievement and precise manufacture which is to be found in this modern art.

It is the desire of A. H. Grebe & Company that every purchaser receives the complete satisfaction and service of which the Synchrophase is capable. With this thought in mind, this booklet has been prepared and we have endeavored to make it as interesting, elementary and instructive as possible. An index on the last page facilitates ready reference to the contents.

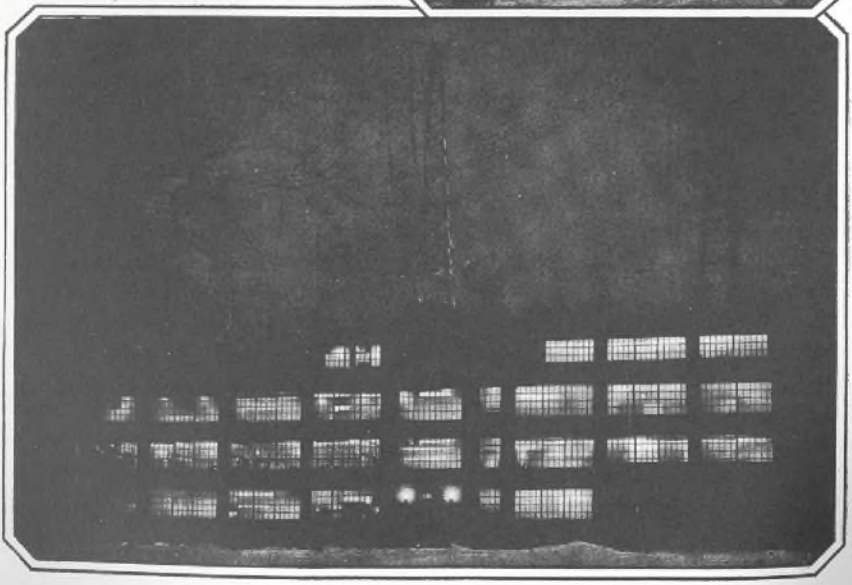
We feel it will repay the user many times over to read carefully the following pages of this Manual, and you are urged to follow our recommendations which are made in the light of long experience and extensive research in the field and laboratory.

Operating instructions are contained on the instruction cards accompanying each receiver. They are sufficiently detailed to enable the user to obtain satisfactory results. Due to the large number of variations possible because of different batteries, current supplies, aerials, etc., additional information and diagrams are shown in this booklet. It is obvious that the operating instructions which may be given on a card are limited to essentials and therefore it is in connection with installation, maintenance and operating instructions that this booklet will be found of particular value.

Properly installed and operated with suitable accessories, the Synchrophase will faithfully reproduce transmitted radio programs. In tone quality, selectivity, sensitivity, ease of control and upkeep economy the Synchrophase will be found eminently satisfactory.



These pictures illustrate the modest beginning of Grebe Radio in 1909; the Grebe factory as it appeared in 1920, in 1922, and the large, modern plant of today, atop of which are the Company's broadcasting stations — WAHG and WBOQ



Brief History of A. H. Grebe & Co., Inc.

MANY years before the first radio broadcasting station was opened, A. H. Grebe & Company were building precision radio apparatus. The pictures to the left of this page show the various stages of factory expansion. True, the quantity of apparatus possible to manufacture in the small building shown in the earliest picture, was limited. It must be remembered, however, that the radio enthusiasts at that time were extremely few in number. The science was so fascinating and the Grebe units so far superior to contemporary material, that by 1914 the modest factory had materially grown in size and issued its first catalog, and was supplying the greater part of the apparatus used by amateur operators who composed the American Radio Relay League, a group of experimenters to whom radio owes much of its advancement. During the World War, we find Grebe apparatus on U. S. war vessels, and in the naval service of many of our allies.

Later came radio telephony, and broadcasting, and with it a host of manufacturers entered the radio field. It is important to note that during this long period, the efforts of the Grebe Company have been directed *solely* in the field of radio.

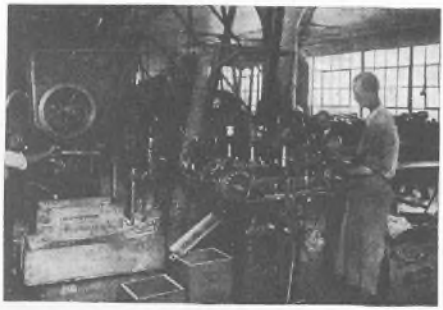
It is a noteworthy and significant fact that the manufacturing standards originally set by Grebe and many of the original designs, have been adopted by the entire industry. A majority of the outstanding achievements in receiver design had their inception in the Grebe laboratories. The present widespread imitation of these designs serves to illustrate the continued leadership of the Grebe Company in radio. The practice of panel mounting, the automatic filament control, the now familiar Tapered Grip Dial and the Tangent Wheel Vernier, with the popular metal shielding and moulded bakelite, along with many other features, are all examples of Grebe craftsmanship, and had their inception in the earlier models of Grebe radio apparatus.

In 1922 the first tuned radio frequency amplifier available for amateur radio experimentation and which, incidentally, was the forerunner of the modern tuned radio frequency receiver, was produced by Grebe. The true value of such contributions is reflected in the ease of control and simplicity of Grebe receivers.

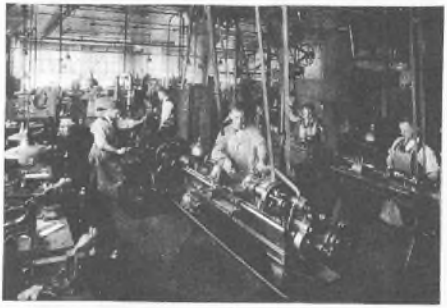
With a well-equipped, modern factory in 1922, devoted exclusively to the manufacture of radio receivers, and with many skilled workers expert in the use of special radio machinery, Grebe radio receivers at the very beginning of broadcasting were

Screw Machines

Bakelite Moulding Presses



Automatic Punch Presses



Tool Making Department

Synchrophase Parts Assembly

Synchrophrase Wiring Assembly

Final Inspection and Testing

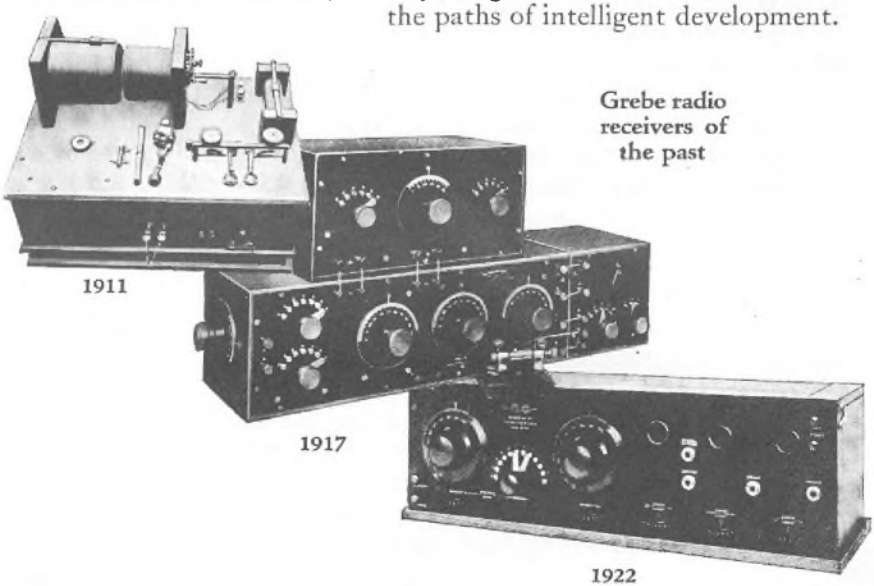
Shipping Department

advanced far beyond the early accepted standards, makeshift contrivances of cardboard, fibre and wire. This organization today numbers among its members executives who have grown up with the Company from its earliest stages.

The Grebe Company, because of its steadfast tenacity to its policies in the manufacture of dependable apparatus, now enjoys an enviable position with the trades it serves. Throughout the manufacture every single step is an effort to make each Grebe instrument a masterpiece. These are the reasons for the leadership attained by Grebe apparatus.

In this age of intensive mechanical and electrical development, it is a significant fact that the manufacturers of long standing, the pioneers of the automobile, aeronautical, marine, and other industries are now the leaders in their particular lines of endeavor.

"By the past we may judge the future" is a maxim that holds as true for the radio industry as for any other. The careful and conservative buyer looks first to the reputation of the manufacturer and is not willing to risk purchasing a new and untried model whether it be an automobile or a radio set. He knows that the long-established and time-tried producer is more certain to avoid the many hazardous pitfalls of incorrect design than are his younger competitors. It is therefore logical to believe that the radio industry will be moulded and standardized by those whose intimate association with its early history has given them the vision to seek the paths of intelligent development.



The Grebe Radio Factory at Richmond Hill, N. Y.

THE manufacture of Grebe radio apparatus is carried on in one of the finest radio factories in the world, and one which is devoted exclusively to the research, designing and building of this apparatus. The entire factory built for the specific purpose represents and embodies the latest known in radio manufacturing efficiency.

All parts of the Synchrophase are made from raw material in the Grebe factory. By this means, their design and construction are rigidly controlled and high qualities throughout invariably maintained. A glance into the interior of the Synchrophase will impress even those least mechanically inclined with the superior workmanship apparent in every detail.

A battery of automatic screw machines, with almost human intelligence, turns from brass and copper rods countless screws, washers, nuts, and sundry parts necessary for use in various elements which make up the parts of the receivers.

Barrels of powdered bakelite are used in making the sockets, knobs, dials, and other parts used in the Synchrophase by a battery of the most modern bakelite moulding machines, electrically heated, thermostatically controlled and with a pressure of 2000 pounds to the square inch.

Punch presses, stamp from various kinds of sheet metal, transformer core laminations, S-L-F condenser, rotor and stator plates, socket prongs, by-pass condenser casings, etc.

It is necessary to maintain a fully equipped tool room, manned by skilled tool makers in turning out the various dies, jigs, and special machinery necessary in the manufacture of radio apparatus.

Making the Synchrophase Parts

Only a few of the many delicate and complicated operations necessary in fashioning the tooled parts into completed elements which are later wired together are illustrated. The parts assembly work, as it is termed, consists of making the fieldless Binocular coils, Grebe S-L-F (straight line frequency) tuning condensers, rheostats, Colortone elements, by-pass condensers, etc.

The research and design of Grebe radio apparatus is carried out by a staff of expert engineers each of whom has made notable

contributions to the radio art. At their command are the facilities of a completely equipped and modern radio laboratory. Refinements added to Grebe receivers have passed through a series of exhaustive tests to fully determine their practicability under actual operating conditions before the idea is passed along through the factory to the hands of the ultimate purchaser. Such a system of rigorous laboratory and practical tests ensures satisfaction to the owner of the completed instrument. The Synchrophase is a complete assembly of co-ordinated units, designed and proportioned to synchronize with each other.

The Grebe Synchrophase is the cumulative result of sixteen years' experience in radio manufacture, supplemented by constant research in the laboratories of the Grebe Company. The rapid increase in broadcasting stations has made efficient receiving sets a necessity. To get controlled volume, distance, quality and selectivity requires refinement in design and construction unknown to receivers of past years. The Synchrophase has been evolved to meet these modern radio conditions. As at every other stage of radio progress, this Grebe receiver is far in advance of present-day radio receiver development.

The upkeep will be economical if the correct accessories are used. It is, however, necessary that the apparatus be correctly installed and operating instructions carefully followed. To insure the longest possible service of the Synchrophase all of the mechanical and electrical parts are constructed of the highest grade material obtainable and are cleverly designed to last for many years if properly cared for. Panels, dials, knobs, sockets, and other parts are made up of the best grade of bakelite. Metal parts are of brass, copper and phosphor-bronze, nickel plated or lacquered.

The Synchrophase for sensitivity, volume, clarity of signal, has a minimum number of tubes of low current consumption type, yet is sufficient to produce the desired results. It will be found that the electric current consumed in the operation of this instrument is trivial when compared to the satisfaction derived from it.

Assembly of the Synchrophase

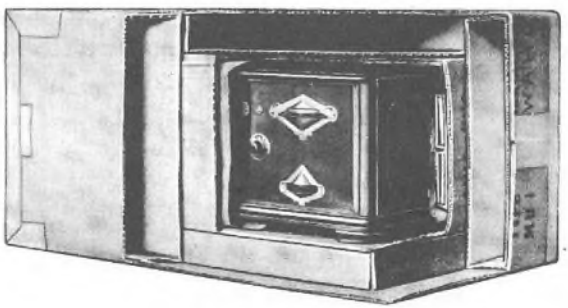
Unusual in radio factories is the automatic belt conveyor used throughout the Grebe factory. At the start of wiring operations the instrument moves on a belt conveyor throughout its entire course of manufacture, mechanical and electrical tests, and ending finally in the packing and shipping room. It is only re-

moved by the various operators as it reaches them for their respective work.

It has been our object in the various views shown of the manufacture of the Synchrophase to give you some idea of the activity which is ever going on throughout the Grebe factory. Extreme care is given in the factory to each instrument, throughout its course of manufacture. Not merely is the finished receiver subjected to a most critical test and examination, but each part as it progresses through the various assembly stages receives the same attention. Every sixth man is a trained inspector specializing in this particular work. This serves to give some idea of the care taken to insure a perfectly finished product, dependable in action and characteristic of all Grebe radio apparatus.

Each instrument is individually tested on a number of wavelengths under actual operating conditions. They must meet a degree of established standards during this test. The testing is done only by experts skilled in the art of radio receiver operation. Passing from this operation the instrument moves from the testing into the packing and shipping room, where it is prepared for shipment to all parts of the country.

The shipping and transportation of delicate radio apparatus has been one of the problems to be coped with. Every modern precaution has been taken to ensure the delivery of the Synchrophase in a perfect condition. Below is shown a detailed view of the type of packing container adopted by the Grebe Company. The receiver, you will note, rests in the center of the carton with a blank air space on either side so that shocks and blows met in transportation cannot be immediately transmitted to the receiver itself, thus ensuring that the instrument will be received in an undamaged condition.



Specifications and Component Elements

Circuit Specifications

THE Synchrophase receiver employs a five-tube system consisting of two stages of tuned synchronized radio frequency, a non-regenerative detector and two stages of transformer-coupled audio frequency amplification. In the Synchrophase these specifications have been executed in a remarkably effective manner. Many exclusive features are embodied in its design, each contributing to its remarkable powers of reception. On the following pages there will be found a brief description of these inventions. They are not mere details of refinement but improvements that add immeasurably to the performance of this receiver, and thus to the pleasure of the listener.

Tuning Indicators or Dials

A distinct departure from the usual tuning indicators is provided by horizontally mounted dials projecting through escutcheon plates of ornamental design. The original Grebe Tangent Wheel Vernier used on many earlier Grebe receivers, but in an improved form, has been retained.

Flexible Unit Dial Control

While a single control receiver is highly desirable, a sensitive instrument should retain some of the flexibility of a multiple control. Flexible Unit Dial Control is a method employed so that the dials may be controlled from the master, or center dial, or by releasing thumb nuts, the dials may be operated individually. This arrangement is more particularly designed for the reception of local or moderately distant stations. Further details on page 34.

S-L-F (Straight Line Frequency) Condensers

The S-L-F condensers used to tune the various stages of amplification are one of the features of the Synchrophase. Due to their scientifically shaped plates all broadcasting stations are found spaced at equal intervals along the dial scale. By this arrangement the tendency of crowding of stations along the lower end of the dials is materially avoided.

Binocular Coils

The tuned radio frequency stages employ the fieldless Binocular coils which originated in the Grebe laboratory. Absence of external magnetic field due to the use of Binocular coils affords extreme selectivity and stability of tuning under all conditions, without shielding, over the entire broadcast range.

Low Wave Extension Circuit

The Low Wave Extension Circuit permits efficient reception over and below the entire broadcasting wave bands. This feature is automatically controlled from the center or master dial, which operates a specially constructed wave-changing switch. The high range reaches from 550 down to 240 meters. The low range overlaps the high and extends down to 150 meters. This change is accomplished by moving the center dial past zero as far as it will go. More efficient operation throughout the lower broadcasting range is accomplished when in position for low wave reception since low wave stations which generally crowd the lower numbers on the dial are then received on the higher dial settings. This feature prepares the owner of a Synchrophase for the future should wavebands be lowered as well as covering present conditions. Refer to page 34.

Volume Control

The Volume Control is designed and placed in the filament circuit in such a manner that it provides a complete and continuous range of volume control without, in the least, changing the character or naturalness of the sound, also acting as an "Off" and "On" switch.

Compensated Audio Frequency Amplification System

The one serious drawback to transformer coupled audio frequency amplification has been finally overcome by the unique audio amplifying system designed in the Grebe laboratory and now used in the Synchrophase receiver. Engineers have been striving for many years to design amplifiers which will reproduce all the useful frequencies in broadcast reception, and at the same time maintain a high degree of amplification for the number of tubes used. Mainly, the effort has been to improve the amplification of low frequencies and it is true that in this respect

recent efforts have met with considerable success. In designing a transformer to reproduce the low frequencies, however, the engineer has heretofore been obliged to fall short of his goal in this direction because he would find that improvements beyond a certain point in the low frequencies were only to be had at the expense of losing some of the very desirable high frequencies. Therefore, generally speaking, the high quality transformers up to this time have not been all that could be desired in reproducing either the low or high frequencies. The usual practice is to sacrifice a little at both ends of the audible frequency range. We find if we are to build a two-stage amplifier, using two transformers, the situation will be considerably different. Provided we are always to use the two stages together it will be possible to design one of them to take in extremely low frequencies and the other the extremely high frequencies and co-ordinate the middle range characteristics in such a manner that the net resultant amplification through the two stages will be to all practical purposes equal throughout the entire range of the combined transformers.

It must be borne in mind that in such a combination it will no longer be possible to use a single stage of this two-stage amplifier because the reproduction in that case would be over emphasized in that part of the frequency range to which that particular transformer is more partial. We feel that the broadcast listener will readily accept this limitation in flexibility because of the superior performance of the combined two-stage compensated amplifier.

It would appear that this system of compensated audio frequency amplification solves the problem of *Quality* which is of paramount importance in present day radio reception.

Colortone

To meet varying characteristics of loud speakers and the diverse preference of tone quality by many individuals, the Colortone feature is particularly effective when used in conjunction with the compensated audio frequency amplifier such as described on page 12.

By means of this Colortone control numerous advantages and possibilities in the matter of tone color may be had, and it is possible to alter the timbre or depth of the voice or instrument with great effectiveness to suit the listener's particular taste or to

suit the needs of the particular type of broadcasting which is being received. Adjustment of the Colortone switch will bring out or suppress excessive high or low frequencies as desired.

Power Tube Output

A standard type power tube is recommended to be used in the second stage of audio frequency amplification. This is the socket on the extreme left of the instrument. Additional binding posts are provided so that separate "B" and "C" battery voltages to the power tube may be used, resulting in improved quality of signal being delivered to the loud speaker.

Non-Microphonic Sockets

Cushion sockets have been provided, eliminating any microphonic tube noises which might occur due to lack of rigidity in construction of tube elements.

Protective Fuse Lamp

A small flash light bulb used as a Protective Fuse, in the rear of the set, guards against short circuiting of the "B" batteries through the use of defective vacuum tubes and further safeguards the internal wiring of the instrument from damage. More completely described on page 36.

Dial Light

A Dial Light operating from the receiver storage battery illuminates the main dial control by indirect lighting permitting the dial numbers to be read even if the set is in a dimly lighted corner. It also serves as a visual indicator that the set is in operation, and as a warning against leaving the tubes burning.

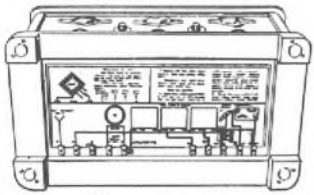
Aerial Selectivity Link Switch

This switch is located in the left rear part of the instrument on the mounting board directly behind the second audio frequency tube socket. Its purpose is to increase the selectivity of the receiver when an oversized aerial is used or whenever additional selectivity is desired.

Aerial-Loop Link Switch

The Aerial-Loop Link Switch is located on the instrument board directly behind the first radio frequency tube serving as a means of making the Synchrophase adaptable to operation on either aerial or loop antenna. The correct position for aerial or loop is clearly engraved in the switch base and instructions are given on the chart inside of the cabinet as well as on pages 42 and 43.

Connecting Terminals



All connecting terminals are arranged under the receiver to eliminate unsightly wiring and are readily accessible. By merely tilting the instrument all of the necessary connections, such as aerial, ground, loud speaker, "A", "B" and "C" batteries are clearly shown in diagram form on the instruction chart under the receiver. For your convenience and study the chart is reproduced on page 19.

Cabinet

The instrument is mounted in a richly finished mahogany cabinet which may be used with or without a readily adaptable Grebe battery base or console table. The panel is made of bakelite finished with natural wood grain to match the cabinet. When the instrument has been unpacked it may need polishing or rubbing on the outside due to the oily deposit made by the special paper in which the instrument has been packed to avoid damage to the finish from moisture or climatic changes. A soft cheese cloth with lemon oil, or a good furniture polish will restore the original lustre.

Locating the Receiver and Accessories

THE locating of the receiving set and radio speaker deserves your serious consideration from the standpoint of practical and operating efficiency. It is desirable that the receiver be located so that connections from the aerial, ground and batteries may reach the instrument in the most direct manner and that the receiver should be readily accessible for tuning.

If consoles or tables other than those available from Grebe dealers are purchased, they should be selected with thought for adequate battery space, at the same time harmonizing generally in design and finish with the Synchrophase.

In order to help you select a place to put your receiver we suggest you consider the location of receivers which you have noticed installed in your neighbors' or friends' homes.

Approach of Aerial and Ground Leads

The receiver should be so arranged that the aerial and ground leads approach the set from the left or rear. If this cannot be conveniently arranged, the leads from the antenna and ground should be run in such a manner that they will be at least two feet away from the right of the receiving instrument. Aerial and ground leads may be neatly brought up to the instrument from the cellar.

Location of Loud Speaker

The loud speaker may be located in any part of the room in which the receiver is installed and not necessarily close to the receiver. Distant or weak reception can usually be heard, with an efficient speaker, some distance from the set. To obtain the best natural acoustical properties, or for convenience, it is advisable to try various locations for the loud speaker in the room in which the receiver is located or in other parts of the house.

The use of extension cords from the receiver to the loud speaker from one room or one floor to another, does not materially affect the quality or volume of reception.

Additional loud speakers may be employed if desired, either in the same room or in widely separated rooms in different parts of the house. This may be readily accomplished by moving speakers to other rooms where outlets have been provided for, plugging them in. The correct wiring and switching arrangement is all that is necessary. Speakers should be connected in parallel; i. e., all

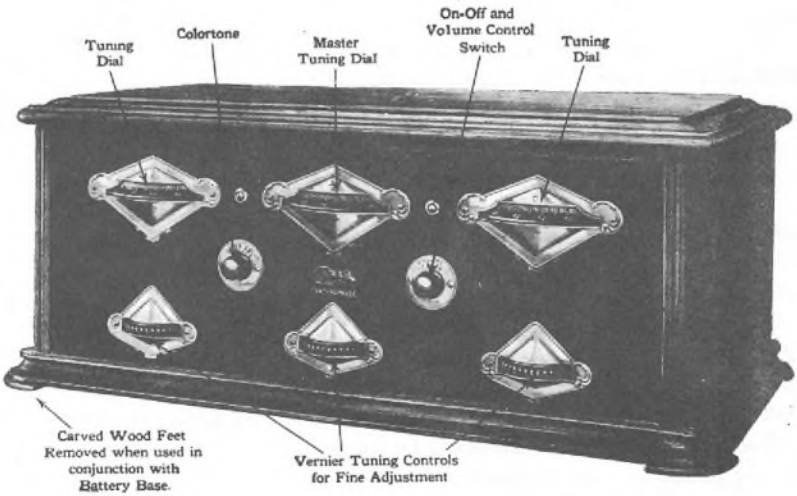
tracer wires should go to one binding post of like polarity on the receiving set.

Location of Batteries or Power Supply Units

Necessary batteries or units to supply the plate, filament and grid voltage for the Synchrophase may be located in any convenient place, either close to the set or at a distance. Where possible, they should be arranged directly under the receiving set to eliminate the necessity of excessively long battery leads.

The battery or current supply units may be concealed in numerous places, such as consoles, battery tables, of which many sizes and designs may be obtained, or they may be conveniently located in a closet.

If the battery compartment or console table is not to be used, a neat installation may be arranged by locating the batteries in the basement and leading the wires up through a small hole in the floor or after the fashion of wall or baseboard electric outlets.



Pointing out the operating controls of the Synchrophase. When the above type cabinet is used with a battery base the carved wood feet should be removed from the four corners to fit the cabinet properly into the top of the battery base

Installation and Connecting of Receiver

ASSUMING that the proper location of the receiver has been selected and that all necessary accessories and equipment have been obtained and are in the desired location, the receiver is ready to be connected. For your guidance two installation arrangements are shown on page 23. Connections to receiver terminals may all be readily made by merely tilting the receiver. Connections to receiver when console is used may be conveniently made either before or after set has been placed in the console.

Precautionary Measures

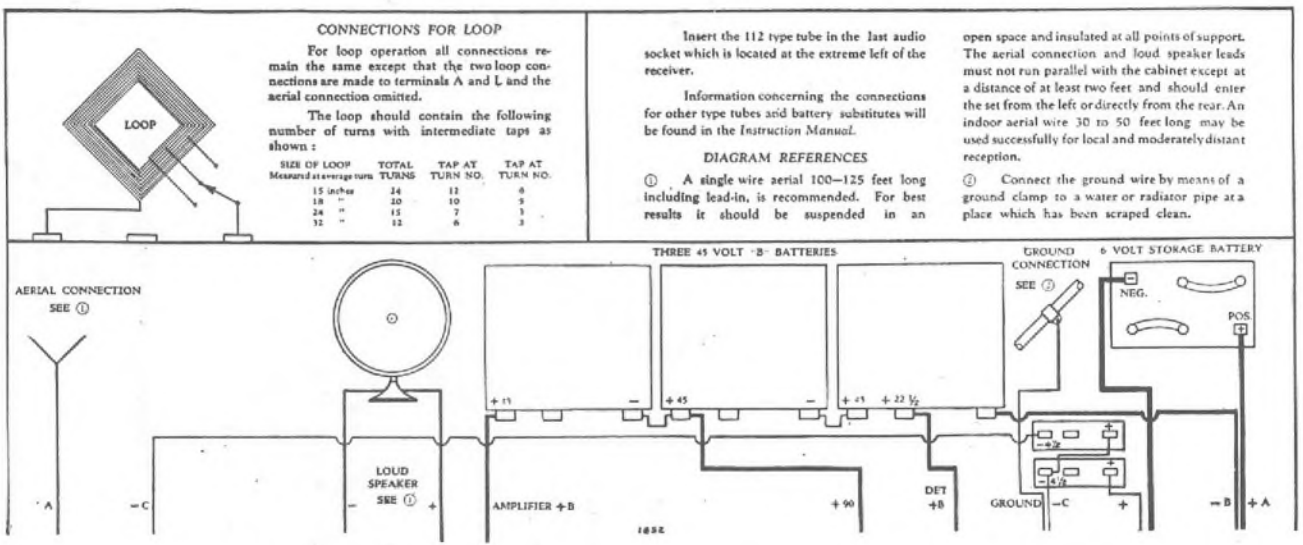
No vacuum tubes should be in the receiver until the instrument has been completely connected, and battery voltages and polarities at the connecting terminals tested.

The protective fuse lamp in the rear of the receiver should be unscrewed and removed. This cuts off the plate voltage until the tubes are in the sockets ready to operate, safeguarding them against accidental damage.

Dials or Colortone knob may be in any position. The volume control knob, however, should be in "Off" position.

Battery Connecting Cable

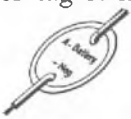
A battery connecting cable containing all battery wires is recommended for connecting the batteries. These may be obtained in various lengths but excessive length is not advisable. If too long, the additional cable may be coiled up at the battery end of the installation (never at the receiver end). In purchasing cables make certain that the type of end tip can be used in the receiver connecting terminal posts and at the battery end. Cables should also have a sufficient number of leads to accommodate all A, B and C battery connections. In battery cables, the strands are usually proportioned to the load they must carry. The two heavier wires go to the "A" battery or filament supply leads. Each strand in a battery cable is of a distinctive color, assuring correct connection between instrument and battery; therefore, when connecting a battery cable all connections should first be made to the receiver. Reference to the particular color lead going to a definite receiver connecting terminal will immediately show the correct battery terminal to which it should be correspondingly connected.



Reproduction of wiring chart mounted on under part of the Grebe Synchrophase

Battery Connecting Wires

If a cable is not used a sufficient number of connecting wires of the proper length extending from the set to the various batteries should be prepared. Scrape the wire clean and bright a distance of about ½ to ¾ of an inch and carefully twist this end by rolling the thumb and forefinger over it in one direction a few times to twist the wire up to a solid end so that no difficulty will be experienced in putting it through the eyelet of the connecting terminals. These terminals on the Synchrophase are operated by pressing down the top. The pared end of the wire is then slipped through, letting up on the top closes the eyelet securely, gripping the wire. Using wires for connections, the safest method is to make one connection at a time, that is, connect one wire to the terminal connecting post of the receiver and connect the other end of that wire to the proper terminal on the battery, as individual wires unlike battery cables have no different color schemes to readily distinguish them from each other, although it is possible to tag or mark each one if desired.



Where separate battery connecting wires are used, and no color scheme or method of marking definite wires is available, a simple method of identification is here suggested.

The tags should be used at the end where the battery connections are made, so that they may be readily seen when battery changes and replacements are made. A small metal rimmed tab slipped over the battery end of each connecting wire will help prevent errors. The tag, of course, should be marked designating the particular connecting terminal to which it should be connected.

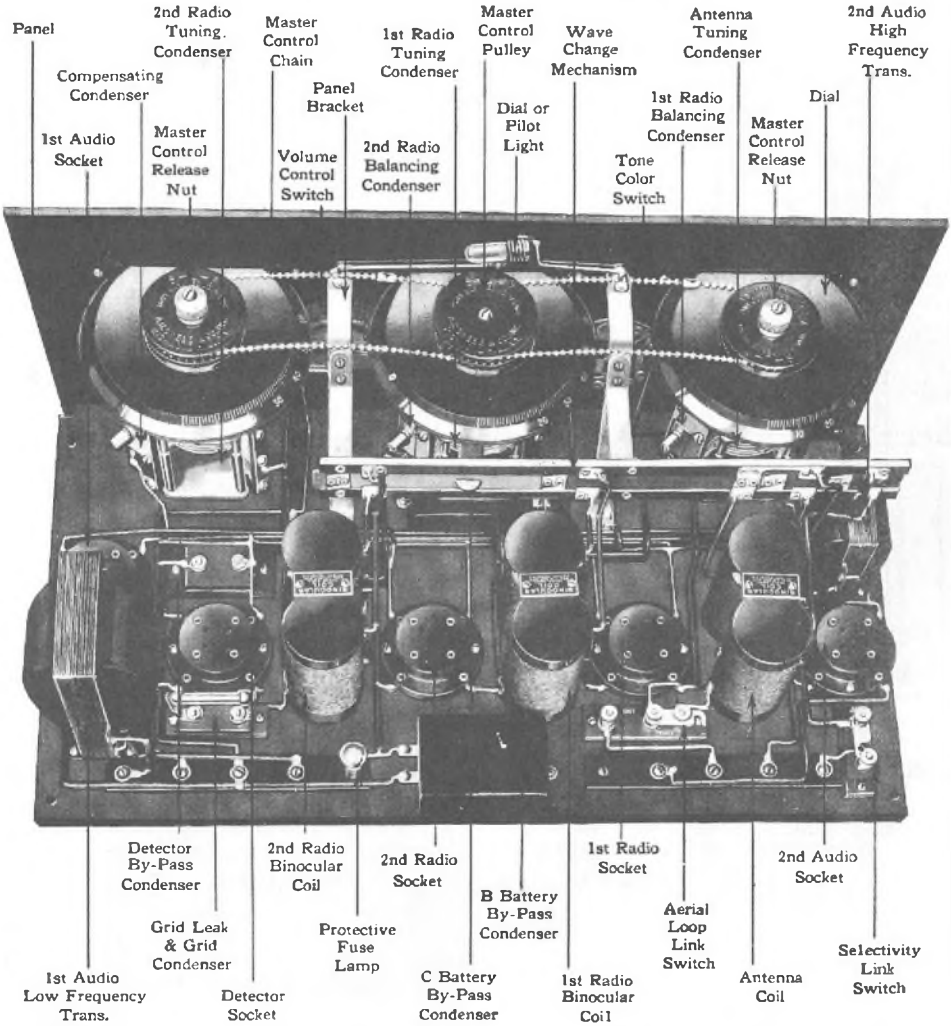
Connecting Aerial and Ground

Run the aerial and ground leads to the receiver as recommended on page 16, fastening them to their respective connecting terminals under the receiver. Installation sketches, pages 40 and 41, give information on the aerial, lead-in and ground approach.

Connecting the Loud Speaker

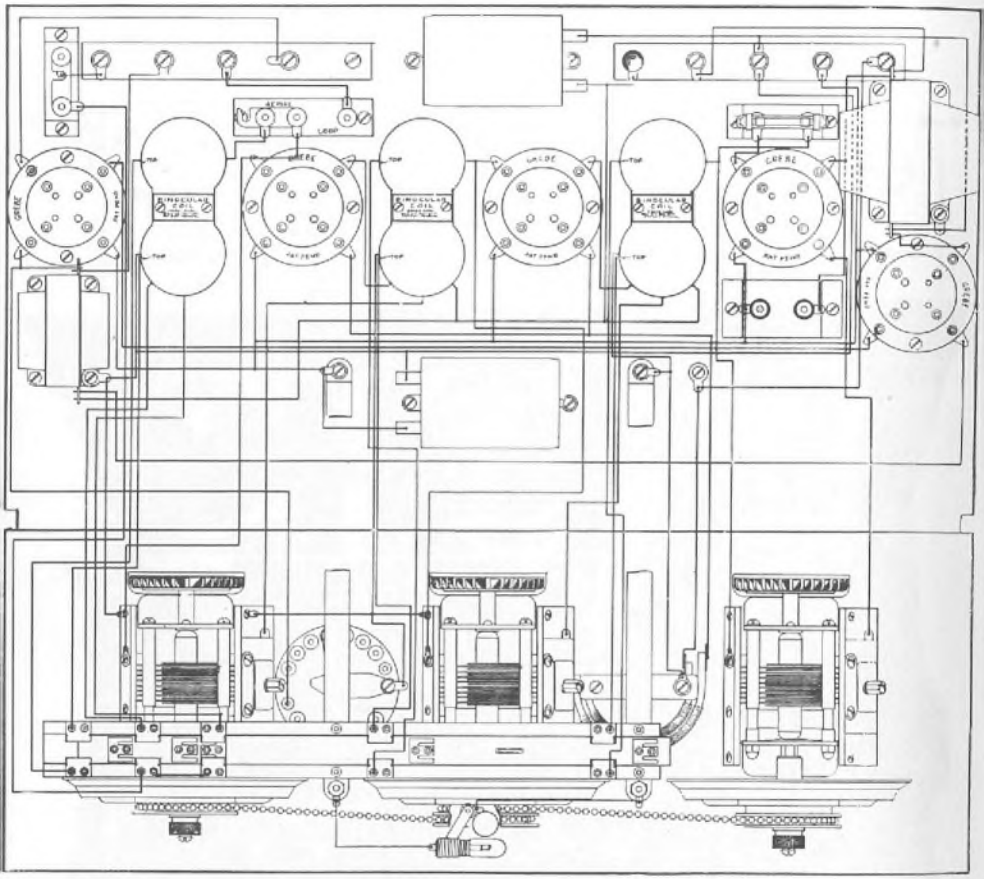
The loud speaker should be connected to the connecting terminals marked "Loud Speaker" on the receiver. These posts are marked "—" and "+". It is important to attach the connecting cords to the receiver binding posts with the correct

polarity. This is always specified by the manufacturer of the particular type of loud speaker used, generally by means of a colored tracer thread in the positive (+) terminal. The proper connection can be determined by reversing the terminals; the connection giving the loudest and clearest signal is correct.



The complete Grebe Synchrophase removed from cabinet and pointing out the component parts which are referred to in the text of this manual

Diagrammatic Wiring Lay Out
of the Grebe Synchrophase—Broadcast Receiver Type MU-1



It will be noted that in this diagram the panel on which the condensers, etc. are mounted is laid flat with the mounting board in order to show wiring hookup clearly

Grebe Synchrophase MU-1

With Battery Base

THE Synchrophase receiver may be used as is shown with battery base. This base will hold three 45-volt "B" batteries (although not of the extra heavy duty type) together with two 4½-volt "C" batteries. In this manner all long wiring is eliminated, the only necessary leads to the set being those of the aerial, ground, and storage battery and, of course, the leads from the set to the loud speaker. The base is provided with three eyelets in the rear, whereby the various leads may be conveniently and neatly led into the receiver connecting terminals. Battery bases are equipped with a set of battery connecting leads.

Grebe Synchrophase

Console Model

THE MU-1 Synchrophase receiver may be had, installed in attractive console models. A roomy compartment is so arranged that all batteries or equipment necessary to operate the set are enclosed. The complete console is shown on page 2.

Accessories and Additional Equipment

CERTAIN additional equipment is necessary to make a complete radio receiver installation. The various accessories required to be used in conjunction with the Grebe Synchrophase are listed below. Further data on each individual item may be obtained by referring to the page mentioned following that particular subject. A Synchrophase receiver is worthy of only the highest grade of accessories obtainable as these will have a great deal to do with the successful operation of your radio installation. For this reason we strongly urge that you use the utmost discretion in choosing parts.

List of Suggested Material

ACCESSORIES

No.		Page No.
4	X Base 201-A Amplifying Tubes	55
1	X Base 112 Power Tube	56
1	Cone or desired type of Loud Speaker	37
3	45-volt Heavy Duty "B" Batteries	52
	or 1 "B" Battery Eliminator	53
1	6-volt 100–120 Ampere-hour Storage Battery	47
	or 1 "A" Trickle Current Supply Unit	49
2	4½-volt Tapped "C" Batteries	54
1	A. C. or D. C. Storage Battery Charger	49
1	Battery Connecting Cable, or Wires	18-20
1	Antenna Equipment	44
1	Ground Equipment	46

The above list includes the items listed on the instruction card attached to the set except "A" trickle current supply unit and "B" battery eliminator.

TESTING EQUIPMENT

1	Storage Battery Testing Hydrometer	48
1	0–50 Voltmeter	52

A Directory listing American Broadcasting Stations showing Wave or Frequency Assignments and Power and charts for recording dial settings of stations received will give you all of the necessary operating equipment.

Preliminary Operating Procedure

ASSUMING that you have placed the receiver in the desired location and followed the previous instructions, it is advisable to check over the installation to avoid minor errors that may develop into trouble sources. Trace all the battery, aerial, and ground, and speaker leads carefully. See that they are firmly connected and running directly away from the set, etc. as previously mentioned. It is advisable to test the polarity or direction and voltage of the various battery leads at the receiver terminals to avoid mistakes in wiring. If the particular loud speaker you use requires some preliminary adjustment, follow its instruction literature carefully. With the fuse lamp still out insert one of the 201-A type tubes in the extreme right-hand socket and turn the volume control to about 2 to insure that it lights (the silver coating in some tubes may make it difficult to see the light). Proceed to insert the 201-A tubes, starting at the right. The last tube on the extreme left is the 112 power tube. Insertion of this tube (if the tubes are still lighted) will produce a click in the speaker. Now screw the protective fuse lamp down firmly, which should produce another click. If the fuse lamp burns out with a flash, a defective tube will probably be found in sockets 2 or 3 from the left.

Advance the volume control knob to point 4. An observation of the interior will show that the tubes are lighted but to varying degrees of brilliance. Most of the 112 type tubes are designed to give only a very dull red glow. The 201-A's in sockets 2 and 3 and in 4 and 5 will be at different degrees of brilliance due to the volume control design, the first two dimming more rapidly as this control is turned down. The panel light should be lighted but it is not necessary to operation. The fuse lamp, of course, will not light. A faint rushing sound in the speaker will be an indication that the set is "alive."

Refer to a list of broadcasting stations for some station nearby. It is advisable to select a time of day when one or a number of local stations are transmitting. The broadcasting station's call-letters, location, wavelength in meters, and time of their transmission can generally be found in your local newspaper. Almost regardless of your location a number of nearby stations should be found transmitting signals sufficiently loud to be tuned in readily and classed as reliable for regular reception during the day.

A station falling within the limits of the "High Wave Range" should be chosen if possible and the high range dial settings used. To ensure that the wave-changing mechanism (switch) in your receiver is set to the high wave range rotate the master dial to the 100 degree mark and as far beyond this as it will go. Use the center dial and not the center dial vernier in all cases when operating the switching mechanism. When changing from high range to low range, or vice-versa always apply sufficient pressure on the dial to ensure moving the wave-changing switch all the way over.

The three dials of your receiver should be lined up so that they will all read alike. The master control is normally set in this position at the factory. Slight variations of a degree or so may be compensated for by the degree of slack allowed in the chain coupling. Excessive dial variations are corrected by resetting dials with the aid of the thumb-nuts on top of the extreme right and left-hand tuning dials.

The normal operating position of the volume control switch is at point "4" but this will, of course, depend on the volume desired, closeness to a particular station, etc. The Colortone knob should be left at the extreme right for the present.

Having decided on receiving some particular station which you know to be transmitting and whose wavelength you have noted, rotate the master dial to the point on the dial corresponding to the wavelength of the station you desire to hear. This may be readily computed by referring to the wavelength calibrations on the instruction card in the back of your receiver on which have been noted eight dial settings for eight standard wavelengths, four in the high and four in the low range. For example:—On the instruction card in the rear of your receiver is listed 315.6 meters, and the dial setting which should be turned to for the reception of stations using that wavelength. This is the wavelength on which WAHG, the Grebe station, broadcasts. Now, supposing you desired to receive KDKA, operating on 309 meters, although no particular dial settings for this station are given it is natural to assume that a lower wave broadcasting station will be received on a lower dial setting and since the wavelength of KDKA is only a few meters below WAHG (the Grebe station) KDKA should be received on dial settings a few degrees lower. Stations on higher waves will then naturally be received on higher dial settings. With the aid of the dial settings given for definite wavelengths on the instruction card, it should be an easy matter from

this information to compute the approximate dial settings for reception of stations whose wavelengths fall above those already given in either wavelength range. Recording of further dial settings from other stations which you receive and whose wavelengths you know, will further facilitate tuning.

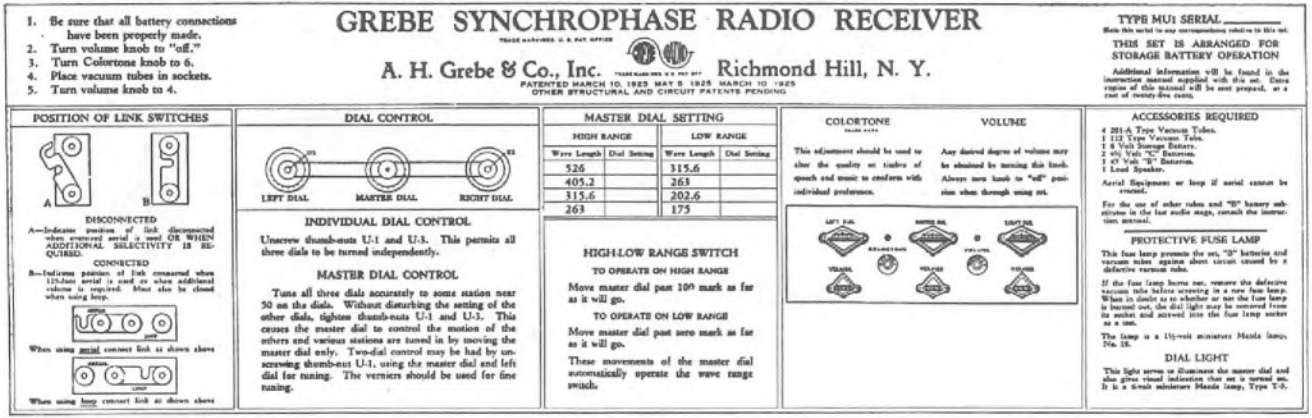
A method of tuning which you might find more simple would be to start with the dials at 10 degrees. Turn the master dial slowly a few degrees, gradually rotating toward the 100 degree mark. Local stations transmitting should be heard readily when the dials are turned to their wavelength. If necessary, to clear up reception, fine tuning adjustments can be effected by slightly moving to the right or left the vernier wheels of the outer dials.

Slight differences in the settings of the dials may be corrected in this way. The operator will quickly become accustomed to the relation of the different dials and stations will be readily found. If dial settings given are not exact this is not an indication of any error in adjustment or construction of the set. Variations of the left-hand aerial tuning dial from the master or right-hand dial will be influenced by the dimensions of the particular antenna system being used.

Always move dials slowly when tuning, as a single degree or so will frequently tune in and out some faint station.

The volume of the signal heard may be controlled by advancing or reducing the volume control knob. This, under normal conditions, seldom needs to be advanced beyond 4 and local reception is often satisfactory on 2.

Obviously, when unfamiliar with and first attempting to operate the Grebe Synchrophase receiver, maximum sensitivity and operating efficiency will not be possible. To become familiar with the instrument's operation, it is advisable to pick up, first, several nearby stations and observe the effect on the reception of each control in order that its purpose may be clearly understood before attempting to bring in distant stations or to obtain the utmost of the set's ability.



1. Be sure that all battery connections . . have been properly made.
2. Turn volume knob to "off."
3. Turn Colortone knob to 6.
4. Place vacuum tubes in sockets.
5. Turn volume knob to 4.

GREBE SYNCHROPHASE RADIO RECEIVER

A. H. Grebe & Co., Inc. Richmond Hill, N. Y.

PATENTED MARCH 10, 1925 MAY 5 1925 MARCH 10 1925
OTHER STRUCTURAL AND CIRCUIT PATENTS PENDING

TYPE MU1 SERIAL _____

Mein this serial in any correspondence relative to this set.

THIS SET IS ARRANGED FOR STORAGE BATTERY OPERATION

Additional information will be found in the instruction manual supplied with this set. Extra copies of this manual will be sent prepaid, at a cost of twenty-five cents.

POSITION OF LINK SWITCHES

A B

DISCONNECTED

A—Indicates position of link disconnected when oversized aerial is used OR WHEN ADDITIONAL SELECTIVITY IS REQUIRED.

CONNECTED

B—Indicates position of link connected when 125-foot aerial is used or when additional volume is required. Must also be closed when using loop.

When using aerial connect link as shown above

When using loop connect link as shown above

DIAL CONTROL

LEFT DIAL MASTER DIAL RIGHT DIAL

INDIVIDUAL DIAL CONTROL

Unscrew thumb-nuts U-1 and U-3. This permits all three dials to be turned independently.

MASTER DIAL CONTROL

Tune all three dials accurately to some station near 50 on the dials. Without disturbing the setting of the other dials, tighten thumb-nuts U-1 and U-3. This causes the master dial to control the motion of the others and various stations are tuned in by moving the master dial only. Two-dial control may be had by unscrewing thumb-nut U-1, using the master dial and left dial for tuning. The verniers should be used for fine tuning.

MASTER DIAL SETTING

HIGH RANGE		LOW RANGE	
Wave Length	Dial Setting	Wave Length	Dial Setting
526		315.6	
405.2		263	
315.6		202.6	
263		175	

HIGH-LOW RANGE SWITCH

TO OPERATE ON HIGH RANGE

Move master dial past 100 mark as far as it will go.

TO OPERATE ON LOW RANGE

Move master dial past zero mark as far as it will go.

These movements of the master dial automatically operate the wave range switch.

COLORTONE

This adjustment should be used to alter the quality or timbre of speech and music to conform with individual preferences.

VOLUME

Any desired degree of volume may be obtained by turning this knob. Always turn knob to "off" position when through using set.

ACCESSORIES REQUIRED

4 201-A Type Vacuum Tubes.
1 112 Type Vacuum Tube.
1 6 Volt Storage Battery.
2 45½ Volt "C" Batteries.
1 45 Volt "B" Batteries.
1 Loud Speaker.

Aerial Equipment or loop if aerial cannot be erected.

For the use of other tubes and "B" battery substitutes in the last audio stage, consult the instruction manual.

PROTECTIVE FUSE LAMP

This fuse lamp protects the set, "B" batteries and vacuum tubes against short circuit caused by a defective vacuum tube.

If the fuse lamp burns out, remove the defective vacuum tube before screwing in a new fuse lamp. When in doubt as to whether or not the fuse lamp is burned out, the dial light may be removed from its socket and screwed into the fuse lamp socket as a test.

The lamp is a 1½-volt miniature Mazda lamp, No. 18.

DIAL LIGHT

This light serves to illuminate the master dial and also gives visual indication that set is turned on. It is a 6-volt miniature Mazda lamp, Type T-3.

Reproduction of operating chart mounted inside of Grebe Synchrophase cabinet

Advanced Operating Procedure

THE effect of the Colortone may be noted by rotating this adjustment while listening to the received music and noting the change of tone quality thus produced. A detailed explanation of the Colortone will be found on page 13.

When you have become familiar with the various controls on the panel, you may tune in other local and moderately distant stations without difficulty. By following the same procedure certain refinements may now be attempted. If receiving conditions are good long distance reception may also be had late in the evening, but do not expect extremely distant reception until you are thoroughly familiar with the set and its operation.

Stations on the low wave range are received by moving the master dial below zero (as you turned it beyond 100 for the high range). Referring to the low wave column of the wavelength chart in your receiver you will find that broadcast stations between 200 and 350 meters are tuned in approximately between "30" and "95." Since this is the most crowded region of wavelengths it is preferable to use the low range for these stations since greater selectivity (ability to separate stations from interference) is had by this adjustment. Usually it is necessary to advance the volume control somewhat more on the low range than is necessary on the high range, for the same volume.

The use of long aerials or the proximity of powerful broadcasting stations may be compensated for by the use of the Selectivity Link Switch. The instruction card inside of the set shows the two positions which are used. Position "A" indicates link disconnected when over-sized aerial is used, or when additional selectivity is desired. Generally a slight reduction in volume will be experienced when the link switch is open. A fine readjustment of No. 1 tuning indicator (aerial dial) will often compensate for this variation. When aerials of certain dimensions are used the link in position "A" may be found advantageous when tuning on the low range for stations below 300 meters.

Position "B" indicates link connected for regulation aerial and when additional volume is desired. It is suggested that this position be used when tuning for distant stations. It is necessary that the link be in position "B" when using a loop aerial.

Besides varying the quality of received voice or music the Colortone is used to advantage on distant reception. When turned to the right, the greatest volume will be heard for distance work,

but when static and noises are present they may be eliminated to a great extent by the use of the lower settings.

Although reception of local stations will be obtained with the volume control adjustment as low as positions "1" and "2", position "4" must be used for reception of distant stations. It should not be necessary to advance the Volume Control much beyond "4" if batteries, tubes and other accessories of the installation are in proper condition.

For extreme distant reception it may be advisable to release the dials from the unit control, by loosening the thumb-nuts on top of the right and left hand dials a few turns, and operate them individually, permitting the adjustment of each dial to the exact position for best reception of any extremely weak signals. In returning to unit control it is only necessary to tune some station near 50 on the dial and with the dials set in the best position tighten the thumbnuts firmly.

A further suggestion is offered when additional volume on distant reception is desired. This may be obtained by increasing the "B" Battery voltage being applied to the intermediate amplifier connecting terminal (under the receiver) which is marked + 90. If possible this should be increased gradually or in steps of about 10 volts each noting the effect on reception. Generally it will only be possible to increase by advancing this lead to the next higher battery terminal making an increase of 22.5 volts, bringing the total intermediate voltage to 112.5. Occasionally on distant reception it will be found possible to increase this voltage to 135 which is the same as that being applied to the power tube. It will probably be found necessary then to increase the intermediate amplifier "C" voltage. An increase of the "B" and "C" voltages mentioned above often necessitates a slight readjustment of the volume control.

The use of a gas or soft type detector tube, such as the 200-A type, might be found advantageous when increased sensitivity is desired. See page 56.

Radio Terms and Definitions

1. Tuning—
Process of adjusting a radio receiver to receive with maximum intensity a definite wavelength of signal from a certain station.

2. Wavelength—
Term generally used to represent the tuning adjustment of the various transmitting stations (and that required to receive them). It does not refer to the distance over which a signal is heard, although it is often misinterpreted as such by radio beginners.

3. Frequency in Kilocycles—
The frequency in kilocycles of a station is often given instead of the wavelength in meters. Rather than indicating the length of the wave radiated from the sending station, it expresses the number of electrical impulses (cycles) per second required to produce this wavelength. The kilocycle, equal to 1000 cycles, is the unit. American broadcasters are assigned definite frequencies between 550 and 1500 kilocycles (i. e. 550,000 to 1,500,000 vibrations per second) and the individual assignments are ten kilocycles apart to prevent interference with one another. Refer to your wavelength and frequency list on pages 32 and 33 (Station Log List).

4. Selectivity—
The measure of the ability of a receiver to select desired stations and reject others, producing reception without interference.

5. Sensitivity—
The degree of response to the desired radio signal, especially to very weak signals. In the Grebe Synchrophase, the sensitivity is brought up to the desired degree by the volume control rheostat.

6. Amplification—
Process of increasing the strength of the received signal or sound. The amount of amplification is the degree to which the strength is increased.

7. Audio Amplification—
Increases the strength of audio frequencies to a point where sound is made audible to the human ear. The upper limit lies around 10,000 cycles. Quality is the degree of faithfulness with which an amplifying system reproduces the signal put into it. Distortion (in an amplifier) is the degree to which a signal is changed from a true reproduction of the original.

8. Radio Amplification—
Amplifies radio frequencies, i. e. those above the audible range. They are so called because at such frequencies power or electro-magnetic disturbances are radiated through space, the basic principle of radio or wireless communication. In the Synchrophase and other tuned radio frequency broadcast receivers, each stage of the amplifier is tuned to the frequency (or wavelength) being received, somewhere within the broadcast band (550 to 1500 kilocycles).

9. Detection—
Detection is the process of converting the received radio frequency signal into audio frequency, which is in turn converted into sound by the loud speaker.

10. Noises—
Noises heard on a radio receiver are variously classified. Atmospherics, generally called "Static" are noises caused by natural electrical phenomena. Induction or electrical noises are those caused by electrical machinery, power lines, etc. Internal noises are noises caused by conditions in the receiver or accessories, which are not brought in from the aerial and ground.

11. Radio and Wireless—
The terms radio and wireless are synonyms, the latter being a much older term which has been supplanted almost entirely by the modern term "Radio."

12. Radio Telephony—
Applies to transmission of voice or music, Radio Telegraphy to manipulation by means of a telegraph key to produce the letters of the telegraphic code.

13. Radio Transmission—
Radio transmission may be in the form of *broadcasting* from one point to many listeners, or two-way communication between stations.

14. Fading—
A rise and fall in received signal strength due to some conditions existing between the transmitting station and the receiver and not due to any fault of the apparatus at either end.

15. Polarities—
The negative and positive poles are referred to as polarities. The direction of current in an electrical circuit.

Logging the Stations Received

In the manufacture and installation of radio receivers slight variations occur, which make it impossible for dial settings for every wavelength to be identical with every receiver. This, however, in no way affects the efficient operation of the instrument. Rather than merely say certain wavelengths will be found with the dials on certain specified numerals and that there is likely to be a variation of a few degrees plus or minus, the settings for eight different wavelengths, four on the high and four on the low range, are listed on the operating instruction card in the set.

The particular settings of these standard wavelengths on your instrument have been in-

Station	Location	Master Dial Setting	Meters	Kilocycles	Station	Location	Master Dial Setting	Meters	Kilocycles
			201.2	1490				239.9	1250
			202.6	1480				241.8	1240
			204	1470				243.8	1230
			205.4	1460				245.8	1220
			206.8	1450				247.8	1210
			208.2	1440				249.9	1200
			209.7	1430				252	1190
			211.1	1420				254.1	1180
			212.6	1410				256.3	1170
			214.2	1400				258.5	1160
			215.7	1390				260.7	1150
			217.3	1380				263	1140
			218.8	1370				265.3	1130
			220.4	1360				267.7	1120
			222.1	1350				270.1	1110
			223.7	1340				272.6	1100
			225.4	1330				275.1	1090
			227.1	1320				277.6	1080
			228.9	1310				280.2	1070
			230.6	1300				282.8	1060
			232.4	1290				285.5	1050
			234.2	1280				288.3	1040
WBOQ	Richmond Hill, N. Y.		236.1	1270				291.1	1030
			238	1260				293.9	1020

The chart gives the values of kilocycles corresponding to values of wave length in meters, and was determined by using the factor 299,820 meters a second as the speed of the electromagnetic wave.

dividually made, and may be relied upon for assistance in locating stations. There is no necessity for additional settings other than those given. After locating a few stations on the high and low wave ranges by referring to the operating chart, it is an easy matter to compute the approximate dial settings for stations whose waves fall above or below those already given.

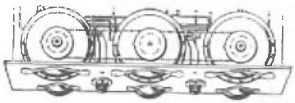
The station record chart gives the radio frequency channels assigned to radio broadcast stations in the United States and Canada. Every broadcast station must operate on some one of these channels. To accommodate the great number of stations now licensed, certain channels have several stations assigned, with consequent interference when they operate at the same time.

Station	Location	Master Dial Setting	Meters	Kilocycles	Station	Location	Master Dial Setting	Meters	Kilocycles
			296.6	1010				389.4	770
			299.8	1000				394.5	760
			302.8	990				399.8	750
			303.9	980				405.2	740
			309.1	970				410.7	730
			312.3	960				416.6	720
WAHG	Richmond Hill, N. Y.		315.6	950				422.3	710
			319	940				428.3	700
			322.4	930				434.5	690
			325.9	920				440.9	680
			329.5	910				447.5	670
			333.1	900				454.3	660
			336.9	890				461.3	650
			340.7	880				468.5	640
			344.6	870				475.9	630
			348.6	860				483.6	620
			352.7	850				491.5	610
			356.9	840				499.7	600
			361.2	830				508.2	590
			365.6	820				516.9	580
			370.2	810				526	570
			374.8	800				535.4	560
			379.5	790				545.1	550
			384.4	780					

The values as specified were developed by the United States Bureau of Standards and are convertible. That is, wherever a value of frequency or wave length appears it is interchangeable with the value associated with it. In other words, where 315.6 meters is equal to 950 kilocycles 950 kilocycles is equal to 315.6 meters.

Detailed Information

Flexible Unit Dial Control



While a single control is highly desirable, a receiver to be sensitive must retain some of the flexibility of a multiple control. The chain and pulley system used to link the dials of the Synchrophase for unit dial control gives this flexibility while still retaining the correct mechanical design to insure reliable operation.

The principle of operation and manner of adjustment will be evident upon examination. The two pulleys on the center dial are rigidly attached and move with it, but those on the right and left-hand dials may be released by the thumb-nuts and the dials rotated independently. To avoid slipping, the chains are permanently attached to the pulleys by means of "cups" (small moulded projections to be found on the end of each pulley). These cups grip one ball of the chain securely.

There should be a slack in the left-hand chain sufficient to permit the moving of this No. 1 dial about three degrees without moving the center dial. The slack in the other chain coupling the left-hand or No. 3 dial should amount to a movement of about two degrees.

Low-Wave Extension Circuit Switch

The Low-Wave Extension Circuit, or double wave-length range of the Grebe Synchrophase gives it a distinct advantage over other receivers. In order to cover the entire range of wave-lengths now assigned to "broadcasting," a receiver must tune efficiently all the way from 550 to 200 meters, or, in other terms, from 550 to 1500 kilocycles.

If the whole range is to be covered and logged on one dial, even with the S-L-F condenser the stations would be crowded less than one degree apart on the dial, too close for practical tuning. More serious than the apparent crowding of the stations on the dial is the fact that the electrical design of the circuits for the complete range would not permit full efficiency.

A practical solution to the problem has been found and is applied in the Synchrophase, by providing two ranges of tuning. In the "high range" the set tunes from 550 to 240 meters, or 550 to 1250 kilocycles. This is the practical tuning range of most re-

ceivers. Turning the master (or center) dial past zero as far as it will go shifts to a range from 360 to 150 meters. Turning the master control past 100 returns the receiver to the high range. This gives the effect of two sets, each designed to cover efficiently its own range, yet without the addition of unsightly switches and knobs on the panel to confuse the user.

The low wave feature operates automatically from the center or master dial. Its action will be readily understood by observing the movement of the slide switch (directly in front of the Binocular coils) when the master dial is moved beyond zero or beyond the hundredth division. It will be noted that when the hundred mark is approached a slight inertia to the movement of the dial is felt and at the same time it will be observed that a metal lever extending out from under the master dial is moving in the direction in which the dial is rotated. The lever in turn is transmitting the motion to the slider of the wave change switch, causing the spring contacts associated with each coil to make contact.

As to what actually happens, it will be noted that the upper section of each half of the Binocular coil has been connected together at about mid-point. The action of a shunted coil section in the case of the Binocular coil is quite different from that which would be the case in any single layer of toroidial coil; in fact, at the present time we are unaware of any other type of coil which is as completely adaptable to the low-wave circuits as is the Binocular coil.

It is important to note that not only has the inductance of the Binocular coils been reduced but the antenna coupling tap has been changed also; this assures a very desirable gain in selectivity on the low-wave range. This may be demonstrated by receiving a station first on the high range setting in the neighborhood of ten or fifteen on the dials and then on the low range setting corresponding to 50 or 60 on the dials. It will be noted that the tuning on the low range settings has been sharpened to a remarkable degree, and that this has been accompanied by somewhat decreased volume. The relation is directly proportional, however, so that the volume has been decreased only to the extent that the selectivity has been increased. Increasing the volume control adjustment slightly will increase the signal intensity.

The following suggestions should facilitate operation of the low-wave circuit:

Tuning on the low range will often be found to be advantageous in connection with station wavelengths which may be re-

ceived on both the low and the high ranges; for instance, a station operating in the neighborhood of 280 to 300 meters may be received with a great deal more freedom from interference on the low range than on the high range.

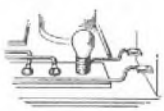
If no signal, or a very weak signal is received when on the low-wave settings, it may be due to the wavechanging switch not being thrown far enough to close all connections. Turn master dial to past zero and use just a little pressure. Pushing the wave-change switch as far as it will go by hand should prove if this is the trouble.

It is necessary to use the dial rather than the vernier wheel in changing the wavelength range, as the vernier friction will not be strong enough to insure moving the wavelength switch all the way. Nearby stations may be heard very faintly even though all the contacts of the low wave switch are not touching. This will also cause one dial to read low and the others high, when they are controlled separately.

A cause of weak signals on the low range may be due to the substantially different setting of the antenna dial (left) when using very large or small aerials; in such instances when this variation is greater than the slack allowed in the coupling chain this dial will have to be released and operated separately.

The selectivity link switch, at the extreme left, to the rear of the receiver has the same effect of increasing selectivity, when open, and volume when closed, on the low range as the high. Opening the link will cause the dials to line up more closely, and may overcome the variation mentioned in the paragraph above.

Protective Fuse Lamp



The Protective Fuse Lamp which is the small flash light bulb in the rear of the Synchrophase receiver was designed and incorporated to protect certain internal elements against damage and short circuiting of the "B" batteries which would result from the use of defective, or improper handling of the receiver or tubes.

A momentary touching of the grid and plate elements of the vacuum tubes in the radio frequency sockets would cause this lamp to burn out. The touching of the internal grid and plate element in the vacuum tubes could be caused by the set receiving a heavy jar, the cover being accidentally dropped or carelessly closed, while the receiver is in operation or with the Amplifier

"B" voltage connected. The difficulty is entirely due to the lack of rigidity in construction of tube elements so that a jar as mentioned above would cause these elements to vibrate and touch each other. The cushion sockets in the Synchrophase eliminate the greater portion of this difficulty, and even with tubes of loose construction the condition will seldom be experienced. In reference to the above it is advisable that care be exercised in changing or inserting vacuum tubes in the sockets and for that reason we recommend that the volume control be turned to "off" position and the fuse lamp be unscrewed.

The touching of the tube elements will cause a direct short circuit of the radio frequency amplifier "B" voltage which would if of long enough duration either result in burning out the radio frequency transformers or ruin the "B" batteries.

The receiver should always be handled carefully during operation. On a sudden stopping of reception or if no signal is heard, an inspection of the fuse lamp is one of the first that should be made. The trouble may be due to a defective lamp or improper contact in the fuse lamp socket.

To test the fuse lamp light it with an ordinary dry cell 1.5-volt battery. The lamp recommended and supplied with the instrument is an ordinary 1.25 or 1.5-volt flash light bulb. It is not necessary that this identical type of lamp be used and any flash light lamp which will fit in the miniature socket will serve perfectly as a protective fuse.

As previously mentioned the panel light is not essential to operation of the instrument and it may be used in the fuse lamp socket as an auxiliary fuse lamp if one is needed.

The fuse lamp is not supposed to light up, for actually if this lamp is subjected to the radio amplifier "B" voltage its lighting will be for the very brief period required for this excess voltage to burn it out. This would probably happen without being observed.

The action of the fuse lamp is identical to the action of a wire fuse in an electrical circuit which if a short circuit develops will cause it to burn out—thereby opening the electrical circuit, preventing further damage until the difficulty has been removed.

Loud Speakers

A loud speaker is a device which converts the electrical output of the set being received into audible reproduction of the program transmitted from the broadcasting station. It is very

important to use a good loud speaker, capable of handling sufficient volume of sound.

There are numerous designs and shapes of loud speakers, such as cones, horns, or units suitable for attachment to victrolas or other devices.

Recently the cone speaker has become popular and generally accepted as the most efficient for obtaining the purest reproduction, for it is more uniform in efficiency throughout the audible range of frequencies. A better balance of treble, bass notes and overtones which produce beauty of musical tone and personality of voice are carried by the cone speaker, whereas they are generally lost in the table type horn.

Loud speakers vary in their quality of tone reproduction. Some are more faithful in the reproduction of low tones, others in the reproduction of the higher tones.

A demonstration by the dealer is the most satisfactory method of determining the suitability of a particular type of loud speaker.

It is important, as previously mentioned, that definite polarities of the speaker connecting cords be properly connected to the receiver loud speaker binding post. Improperly connected, a poor loud speaker or loose diaphragm will reproduce poor quality of speech and music with objectionable distortion and unsatisfactory operation.

Power Type Loud Speakers

With the power tubes now available and the Synchrophase especially adapted for their use, increased volume can be clearly reproduced. The capabilities of the set are therefore such that the use of additional amplifying units for power type speakers is not recommended or necessary for use in the home.

When additional amplifying units are used they require considerable care in their installation. The output of the second stage of audio amplification will generally be in excess of that required and difficulties will be experienced such as howling, whistling or squeals at audio frequencies which are difficult or impossible for the average listener to control or overcome.

It is usually necessary to place the units at a considerable distance from the receiver and to use separate "A" and "B" battery supplies.

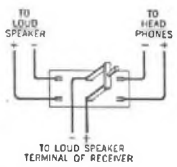
No attempt should be made to obtain the output of the first

audio amplifier. Due to its particular design the removal of an audio stage will unbalance the entire amplifier system and an objectionable preponderance of low frequencies will be had which no Colortone control variation will correct.

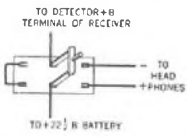
Headphones

No provisions have been made in the Synchrophase for headphone operation inasmuch as the receiver is capable of reproducing with loud speaker volume any station which is transmitting signals of sufficient strength to overcome the effect of interfering noises.

If desired, earphones may be connected directly to the loud speaker binding posts of the Synchrophase or by connecting a simple double pole double throw switch to the loud speaker binding posts with earphones connected to one outlet of the switch and the loud speaker to the other outlet; either may be used but not simultaneously. In using this method reduce the volume control adjustment to a minimum. Use of the headphones with excessively loud signals may destroy their magnetism and cause them to become "dead" making them useless for reception.



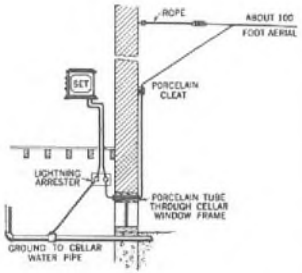
By connecting headphones in series with the detector "B" battery lead the output of the two radio and detector tubes is obtained; using this method for headphone operation the volume would not be excessive and headphones and loud speaker can be operated simultaneously.



Antenna Systems

EVERY receiving set requires some form of antenna, and efficient operation of the receiver depends on the aerial used for interception of the radio waves. The unique design of the Grebe Synchrophase makes it adaptable for practical operation with various outside, indoor, or loop aerials, according to the choice of the users or the demands of location.

Outside Aerials



The ideal aerial for present-day instruments is an outdoor aerial, consisting of a single wire not exceeding 125 feet in length, including the lead-in. It should be erected in the most advantageous location obtainable. This means as high as practical and in as clear an open space as can be found, away from closely surrounding objects, which would tend to decrease its efficiency. An aerial of this type will usually bring in signals with more strength than outside aerials of shorter lengths, indoor aerials or loop aerials and will give the receiver greater volume and greater range of reception.

At times the above mentioned type of aerial may possess certain directional properties. For example, if it runs North and South, it may pick up signals from stations North and South more efficiently than it will from stations to the East or West.

Along with its ability to intercept greater reception current, the larger aerial will also bring in atmospheric disturbances with more strength; such as static, strays, induction from local power and high tension lines. The static disturbance feature need not be considered during the Fall, Winter and Spring months of the year. In the larger cities, close to a number of powerful stations, an aerial of this type may make selectivity harder to obtain, so it is often desirable to shorten an outdoor aerial to sixty or seventy-five feet in length. When the above disadvantages are not to be considered remember that the large outdoor aerial is most desirable for increased range and volume for distant reception.

A short outside and an indoor aerial in certain locations may be very satisfactorily used for local and moderately distant reception. In general there is no comparison between the results

obtained with a set operating under these conditions as against the results obtained by a set operating from a large well-constructed outdoor aerial.

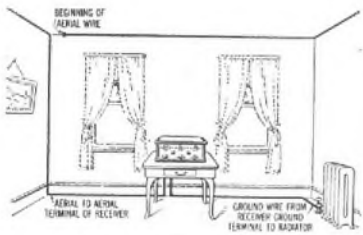
Very often, however, excellent results from distant stations are obtained when using the shorter and indoor type aerials, and in a great many cases this type of aerial is all that is necessary.

Because of the fascination and desire of many to tune to extremely distant stations, we are giving the necessary instructions for installation of both kinds of aerials.

Indoor Aerials and Substitutes

Next in efficiency for the Synchrophase is the use of indoor aerials which may consist of multitudinous designs, such as antenna plugs, and electro-static coupling to the telephone system. The three best and commonly used methods are here suggested.

1. Insulated Wire



Insulated wire strung around the moulding or baseboard of the room or through a number of rooms is a highly desirable type of indoor aerial. This may vary from 30 to 100 feet in length depending on the particular location, convenience of installation, the distance from local stations, and the degree of volume desired.

2. Antenna Plugs

There are various makes of these attachments on the market which are usually sold under trade names. They consist of an ordinary electric plug in a convenient outlet making connection with one side of the electric house wiring with a condenser in series to prevent shortcircuiting of the electric circuit. Only a standard approved antenna plug should be used. It is advisable to use one so constructed that either side of the line may be used. In certain locations, antenna plugs have been found to work especially well. However, at times a considerable amount of crackling and sputtering induction noises on the line may be induced into the receiver causing noisy operation.

3. Antenna-Phone Connections

Regulations do not permit the connecting of the aerial wire directly to any part of the telephone, but electro-static coupling may be used safely by placing a metal plate under the telephone stand as illustrated. The radio wave energy picked up by the telephone system is conducted to the set through the electrostatic coupling, similar to the use of an aerial series condenser, and forming an excellent substitute for the outside aerial.

Loop Aerial

Oftentimes, it is desirable to use a loop aerial because of the advantages of its directional effect which sometimes assists to increase the selectivity of the instrument, particularly when close to broadcasting stations using considerable power. While a loop has these advantages, it should be remembered that they do not receive signals with volume comparable to outside aerial reception.

Unsatisfactory operation on a loop may be due to a number of natural conditions beyond control, such as attempting to operate a set from a loop in steel framed buildings where losses are due to the shielding effect of iron or steel girders within the building walls or in stucco houses where wire mesh, metal lath or metal reinforcement of some kind is used. Large amounts of metal tend to entirely absorb the radio waves, preventing them from reaching the loop, or to weaken them considerably.

In such locations the loop will usually point to a steel girder of the building and not necessarily to the actual direction of the station. The large mass of metal picks up energy like an aerial and reradiates it to the loop. If the loop must be pointed toward a window to get results, it is not because the signals are coming from the outside through the window but because the metal window frame and steel wall beams pick up energy in the way just described and transferring it to the loop.

The Grebe Synchrophase is provided with a link switch for the purpose of cutting out the antenna coupling coil and connecting directly to a loop aerial. For most efficient results it is important to use a loop properly designed for this receiver. It should follow closely the specifications as given on the instruction card beneath the set and on the opposite page.

In tuning, when a loop is used, dual control rather than master control should be used; that is, the first or left dial should be released and operated separately, as there will be a variation greater than allowed in the coupling chain between the settings of this dial and those of the other two. This is caused by the substitution of the loop for the antenna binocular coil. The tuning of this No. 1 condenser cannot be made to match with the other coil and condenser settings due to the fact that a loop has a wide difference in distributed and extraneous capacity. To keep this dial variation small a tapped loop is recommended allowing the use of fewer turns on the lower wavelengths.

It is evident from the foregoing that loop operation should not be used unless it is inconvenient or impossible to provide an outside or suitable indoor aerial. However, where there is no alternative, the users may be assured that a loop in connection with a Synchrophase will produce as satisfactory results as may be obtained within the limits of the particular location.

Connections for Loop

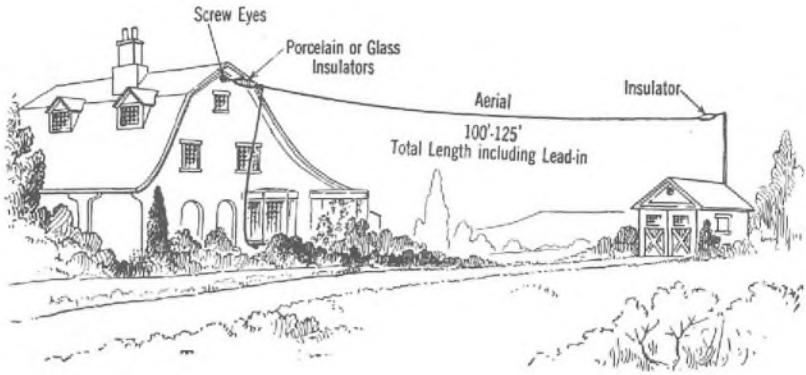
For loop operation all connections remain the same except that the two loop connections are made to terminals A and L and the aerial connection is omitted.

The aerial-loop link switch in the rear of the instrument is changed for loop operation.

The loop should contain approximately the following number of turns with intermediate taps provided by a switch.

Size of Loop Measured at average turn	Total Turns	Tap at Turn No.	Tap at Turn No.
15 inches	24	12	6
18 inches	20	10	5
24 inches	15	7	3
32 inches	12	6	3

Equipment for Outside Antenna Installation



Aerial Wire

100 to 150 feet of No. 14 single or stranded copper wire, tinned or enamel being suitable for a good aerial. Hard drawn wire is recommended as it is less liable to stretch or sag and has greater tensile strength.

Lead-In and Ground Wire

50 to 100 feet No. 14 rubber-covered, stranded wire is preferred for the lead-in of sufficient length to reach from antenna to lightning arrester, thence to receiver. The ground wire runs from receiver to arrester then to the ground clamp. Have the ground wire as short as possible.

Ground Clamps

Use either one or two ground clamps as desired. One must be used for grounding the receiver; the other for possibly more conveniently grounding the lightning arrester and another can be used if it is found more convenient to ground the lightning arrester.

Lightning Arrester

Use one lightning arrester bearing the approval of the Fire Underwriters Laboratories for radio installations, outdoor or indoor type, depending on which type aerial is used.

Insulators

For the aerial use a sufficient number of glass or porcelain insulators to properly insulate the particular type of aerial selected.

Where the lead-in wire passes into the building it should run through porcelain tubes or some other good form of insulation.

Porcelain cleats or knobs to hold the lead-in and ground wires running to the receiver from touching walls or other objects is recommended.

NOTE:—Additional miscellaneous items may be necessary to properly erect the antenna in your particular location.

Equipment for Indoor Antenna Installation

Sufficient length of insulated wire, desired to be run in house to complete No. 1 type indoor aerial, should be obtained. The wire may be either single or stranded. It is not necessary to use wire as heavy as that needed for outside aerial construction. Cotton or silk-covered wire, of various colors, can be obtained and in this manner a color in likeness to the moulding or furnishing scheme of the room may be used, resulting in an invisible indoor aerial not in the least unsightly.

For No. 2 type indoor aerial, an approved type of antenna plug to be used in the electric mains should be obtained. Sufficient wire to run from this plug to the connecting terminal on the receiver, is necessary.

No. 3 type indoor aerial, antenna-phone connections. Suitable plates with a clip for attaching aerial wire may be obtained from various radio dealers or one may be simply constructed from a piece of sheet copper.

Loop Aerials—Obtain one containing a sufficient number of turns and having an arrangement for varying the number of turns to be used.

Information regarding ground equipment is given on page 46. A ground is always used with the Synchrophase regardless of the type aerial you decide to use.

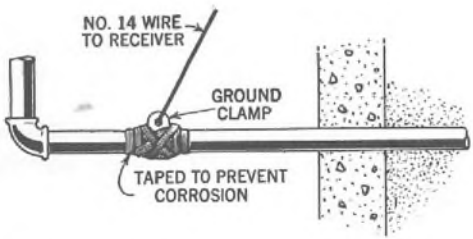
Fire Underwriters Certificate of Inspection

A Fire Underwriters Certificate of Inspection should be obtained in order to be certain that your radio installation may not in any way affect the validity of your fire insurance policies. It is recommended that when your installation is planned you follow the information as given in the Board of Fire Underwriters recommendations for radio installations and, when completed, you secure a certificate of approval from the Fire Underwriters having jurisdiction in your locality. Refer to page 67 for information on this subject.

Grounds

Obtaining a good ground connection is as essential for efficient operation of a receiver as the antenna. Poor operation of a receiving set is often traced to a faulty ground connection. Almost any metallic circuit leading to the earth will generally give satisfactory results, provided a good clean and tight connection is made at the point of contact with the ground wire from the receiving set. It is advisable, however, to try several ground connections, if they are available, selecting the one giving the best results.

A ground clamp is of great aid in making a good connection and one should always be used. The National Board of Fire Underwriters for radio installations specify that an approved ground clamp shall be used where the grounding conductor is connected to pipes or piping. A No. 14 wire should be soldered to the clamp and this clamp securely fastened to a cold-water pipe, preferably where it enters the house. Before fastening the clamp, brighten the pipe all around with a file or coarse sandpaper. After the clamp has been securely attached wrap it with electrician's tape to protect the connection from corrosion. In all cases it is advisable to have the ground lead as short and direct to the receiver as possible. Remember that a good ground should always be used with the Synchrophase regardless of type of aerial used.



An ideal ground connection on the inlet of the cold water system.

Batteries and Battery Accessories

Storage "A" Batteries

THE Synchrophase type MU-1 was designed for operation with 5-volt tubes. For their proper and economical operation a six-volt rechargeable storage battery should be used. The storage or "A" battery, as it is commonly termed, used to heat the filament of the tube, is a low voltage, high amperage battery and should have about a 100-ampere hour capacity.

It is advisable when a storage battery is used that either a high rate or trickle battery charger, operating from the house electric supply current, be provided.

Always keep the storage "A" batteries sufficiently charged if good results are expected. It is very important that information on the care of a storage battery be followed. A good storage battery, with proper care and attention, may last several years without replacement. When neglected, the individual cells will quickly deteriorate and eventually make the battery useless.

When standing for long periods, even without being used, batteries will gradually lose their charge and will not deliver enough current to properly light the tube filaments to which they are connected resulting in weak signals, which become weaker and weaker and gradually fade away entirely. This condition can, of course, be remedied by recharging the storage battery.

Never allow a battery to stand in a discharged condition.

Old or discharged storage batteries often produce undesired hissing, frying and sputtering noises, frequently due to loose and corroded battery lead contacts. Examine the battery occasionally for corrosion at the terminals. Keep all metal parts well cleaned; a slight coating of vaseline or lemon oil will aid prevention of corrosion at the battery terminals. Where removable binding post tops are marked to indicate polarity of the battery, care must be exercised to see that they are replaced in their proper positions. Very often improperly replaced binding post tops or wires, when charger leads are connected, result in the storage battery being discharged instead of charged. This is often sufficient to ruin a good storage battery. Battery leads reconnected incorrectly will seriously affect reception or prevent reception altogether.

A Synchrophase receiver, using four 201-A (¼ ampere) tubes and one 112-type power tube (drawing ½ an ampere) will draw a total of one and a half amperes of current from the

storage battery. If this battery is of, say, 100 ampere-hour capacity and fully charged, we might expect a total of about 70 hours of service.

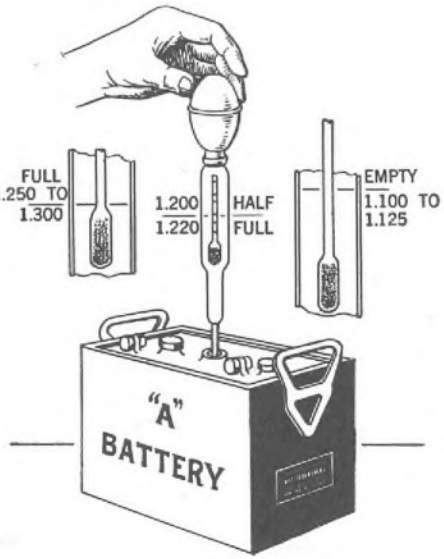
The intervals then at which it is necessary to charge the storage battery will depend on the ampere-hour capacity of the battery, the number of hours the set is in use, and somewhat upon the type of tubes.

The most practical method of determining whether the battery needs charging is to take frequent readings by means of a hydrometer.

Storage Battery Testing with the Hydrometer

A hydrometer is recommended for determining the state of charge of the storage battery. A radio battery type hydrometer may be purchased at radio, hardware and electrical stores, or battery service stations.

A hydrometer is a glass tube or float closed at both ends, and somewhat enlarged at the lower end. It is suitably loaded at its lower end so that it will float in a vertical position in a sample of the battery solution (electrolyte) which is drawn up into the syringe barrel. Inside the hydrometer float stem is a paper scale, graduated from 1.300 at the bottom to 1.100 at the top. It is also



Illustrating the use of the hydrometer with a simple explanation of three specific gravity readings

generally marked with three red bands indicating three conditions of charge of the battery. These are generally "Fully Charged" "Half Charged" and "Dead."

The reading is taken by noting where the level of the solution in the syringe crosses the hydrometer scale. Care should be taken that excessive solution is not taken up in the syringe, otherwise the hydrometer will not float freely in the electrolyte. If there is not sufficient electrolyte (solution) in any of the cells to obtain a reading, add distilled water to bring the solution in each cell to at least ¼ to ½ inch above the tops of the plates. A true reading of the batteries' condition cannot be obtained immediately after adding a quantity of water. Battery should never be put on charged unless the water in each cell fully covers the plates. Never allow any metallic objects to get into the battery cells during test or refilling. A fully charged storage battery cell will show a specific gravity reading of approximately 1.275–1.300 depending on the age of the cell or battery. When the reading drops to 1.175 or 1.150 immediate charging is necessary.

In using a hydrometer exercise care not to allow acid to be spilled over the top or sides of the battery. If acid is accidentally spilled on the floor or furnishings, its effect may be counteracted by applying liberal quantities of common household ammonia.

Battery Chargers

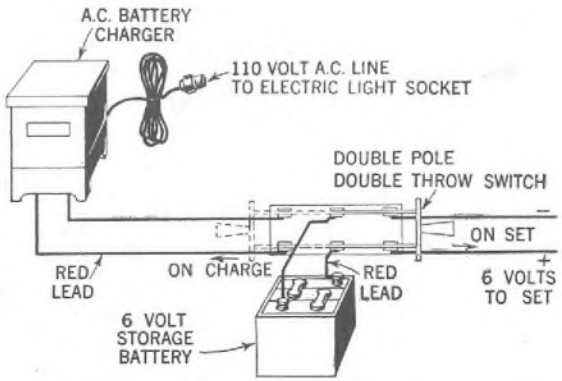
For the most satisfactory and economical operation the user should provide himself with battery charging apparatus.

The charging of the storage battery may be done in two ways. One method is to charge the battery occasionally with a charging device which will deliver a fairly heavy charging current—two to five amperes. The other method is to employ what is generally called a trickle or low rate charger, which gives a small current and is left to function all the time when the set is not in use. Either method is satisfactory, the first possibly more economical and the second more convenient. Under any circumstances the type of charger will in no way greatly affect the amount of current consumed. Other factors in determining the type of charger would be to consider whether or not noise would be an objectionable feature; if so, a tube or electrolytic type charger is recommended. If storage "B" batteries are used as well as a six-volt storage "A" battery the charger should also be adaptable to charging the high voltage "B" batteries at their proper charging rate. Be sure to consider whether the charger will operate on the

particular type of house current available in your locality.

High rate chargers employed for radio batteries usually supply from two to five amperes. A five-ampere charger, it will be seen, would recharge a 6-volt, 100-ampere battery in about twenty hours. A two-ampere charger would take fifty hours to do the same work. It is advisable with a low ampere charger, that the battery be charged during the idle periods when the receiver is not being used, rather than wait until the battery has become entirely discharged, as it would take too long a period to charge back to its original condition during which time some desired broadcast program might be missed, whereas with the high rate charger the battery would charge over-night and the next morning would be ready to use again.

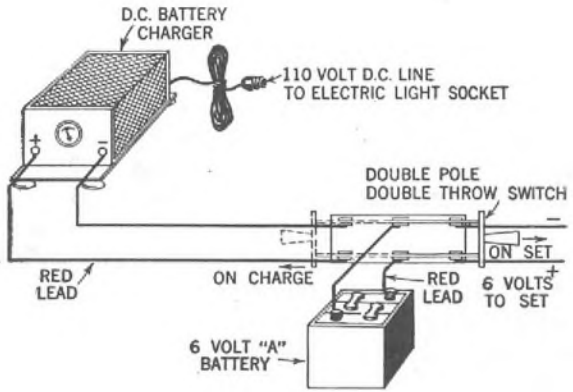
The battery chargers, whether for A. C. (alternating) or D. C. (direct) current are simply plugged in a convenient outlet. The two leads marked positive and negative are connected to the correspondingly marked posts on the storage battery. Always exercise extreme care in the installation and use of battery chargers. It is always advisable to disconnect both wires running from the battery to the receiving set from the storage battery before connecting the battery charger wires to the storage battery and turning on the charger. Always shut off the electric current at the charger socket before reconnecting the battery to the receiving set. An excellent method of connecting common types of chargers is shown in Figures 1 and 2. The arrangement is accomplished by means of a double pole double throw (two-way) switch reducing all chances of error to a minimum since when the battery is in charging position both battery leads to the receiver are disconnected.



A practical hook-up of an alternating current battery charger

The chemical action which takes place in a storage battery during charge and discharge causes absorption and release of the acid, and as the exact proportions have been adjusted by the battery manufacturer, any addition of acid will upset the proper proportion. If part or all of the electrolyte has been lost through accidental spilling or leakage, consult a storage battery service station. If the electrolyte leaks from the joints or wood sides of a battery case, one or more of the hard rubber cells may be cracked or broken.

Manufacturers of storage batteries usually supply their customers with full information as to the proper care and maintenance of their batteries. Be sure to get their printed instructions and read them carefully.



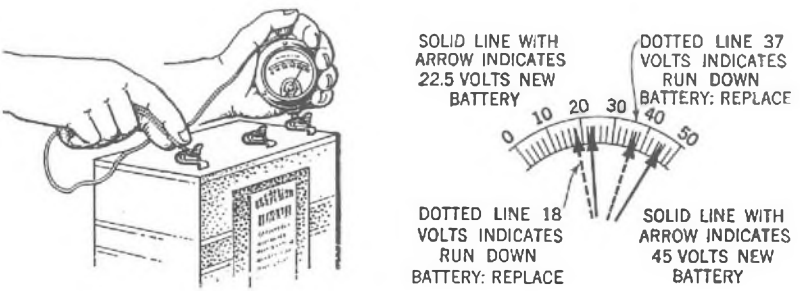
A practical hook-up of a direct current battery charger

"B" Current Supply Equipment

Dry Cell "B" Batteries

THE "B" batteries are used to supply positive voltage to the plates of the vacuum tubes. They are of high voltage and low amperage, furnishing current to the plates of the tubes which require very little current if operated properly; therefore these batteries last a comparatively long time. With a multi-tube set, such as the Synchrophase, it is advisable to purchase the largest type dry batteries because of their longer operating life and economy.

"B" batteries of the dry cell type, when new, should show an open circuit voltage of 22.5 volts for the 22.5 volt unit and slightly over 45 volts for the 45-volt units. As the batteries are used the voltage drops gradually until a certain voltage is reached, whereupon it drops very rapidly and the batteries become useless. Before batteries start to deteriorate rapidly, an active chemical decomposition takes place within them. This decomposition manifests itself by causing poor reception generally traceable to popping and sputtering noises or a high pitched whistle in the loud speaker. Replacing with new "B" batteries is the only remedy for completely eliminating these noises. To avoid trouble it is advisable to replace the "B" batteries when the voltage drops to 17 or 18 volts in the case of 22.5-volt unit, or to 35 volts in the case of the 45-volt unit. A voltmeter reading from 0 to 50 volts is recommended as additional equipment so that readings may be readily taken to determine immediately if difficulty is due to faulty "B" batteries.



Illustrating a standard battery being tested with a voltmeter and a simple explanatory reading of the voltmeter scale

Alternating Current "B" Battery Eliminators

Of late the tendency has been toward the elimination of the dry "B" batteries in favor of the use of house lighting current as a source of plate voltage supply for the vacuum tubes.

The frequency and line voltage in some localities is different, possibly being 60 cycle, 250 volts, 60 cycle, 110 volts or 25 cycle, 110 volts. It is quite essential that your particular type of current supply be determined before purchasing a "B" eliminator. All eliminators that we are aware of are manufactured for operation on 60 cycle, 110 volt current supply.

No changes in the internal wiring of the Synchrophase should be attempted in an effort to use an attachment of this type, as there are a sufficient number of reliable makes which require no modification of the receiving set.

It is at times advisable that the battery eliminator you intend purchasing be given a trial to determine its practicability, operating with your particular instrument in your particular location, as devices of this kind sometimes give rise to humming sounds in the loud speaker.

A battery eliminator which will deliver at least 25 milliamperes at 135 volts is necessary.* Care should be exercised in installing any "B" eliminator to avoid running the A. C. supply lines in close proximity to the antenna lead or in parallel to the cabinet. Considerable A. C. (alternating current) hum may also be introduced by careless location of the eliminator when it is too close to the receiving instrument. In some instances it may be found that the A. C. hum from the "B" eliminator will be quite persistent and difficult to overcome until special remedies or corrective measures are applied. Do not connect "B" batteries in series with an eliminator to boost the voltage.

Direct Current "B" Battery Eliminators

Do not attempt to use a "B" eliminator designed for A. C. current if the supply in your home is direct current. Direct current filters or eliminators used with the Synchrophase must have special provisions incorporated in connecting, otherwise short-circuiting may result. These devices may be grounded through the power line ground and when used with radio receivers may cause trouble. A large fixed condenser of between ¼ to 1 Mfd. capacity, connected in series with the ground wire to the receiver, is generally all that is necessary to prevent trouble.

*Refer to "Power Tubes (171 type)" page 57.

"C" Batteries

The Synchrophase employs the use of a specified "C" battery. This is used to a three-fold advantage. (1) It maintains a negative bias on the grids of the radio frequency and audio frequency tubes. (2) Prevents distortion when high "B" voltages are used. (3) The "C" battery used in this manner effects an enormous saving in "B" battery current, by greatly reducing the energy drain on the "B" batteries. As this "C" battery is used simply for the purpose of maintaining the proper potential on the input circuit of the vacuum tubes and furnishes only a minute current, it will last for a long time. It is advisable, however, to replace these batteries about every four to six months for best results.

Tubes

THE Synchrophase is designed and adjusted for tubes of the standard UX201-A or CX301-A type with the X base 112 power tube in the last (2nd) stage of audio amplification. Tubes of this type, having characteristics varying considerably from the standard makes, should not be used, for they will cause the set to become unbalanced.

Tubes present one of the biggest difficulties experienced in the present-day radio sets, and to them a great deal of trouble can be traced.

Vacuum tubes vary somewhat in general characteristics. Tubes sometimes happen to be better for radio frequency than for audio frequency amplification. Therefore, it is advisable to change them around until maximum results and satisfactory balance are obtained. In most instances the tubes will be found to be sufficiently uniform in both respects.

Before changing tubes about in the set unscrew the fuse lamp and then turn off the filament rheostat to prevent damage to the delicate vacuum tube filaments and to any of the receiver windings.

Tubes should be carefully tested before using. Very often tubes light up but do not amplify. One such defective tube is sufficient to prevent the instrument from functioning properly.

Poor tubes in the radio frequency sockets will often ruin distant reception and yet will have no apparent effect on the reception of local stations. It is essential, of course, to have good tubes throughout and this illustration is mentioned merely so that some idea may be obtained as to the extent of unsatisfactory operation that inferior tubes will cause.

It is recommended that a spare tube or tubes be kept so that if tube difficulty is experienced a ready comparison may be made of those in the set against the spare tubes which you know to be in perfect condition.

Tubes will become bad after continued periods of operation even though they be operated normally and the volume of the set will diminish so gradually that the operator may not realize the trouble is with the tubes. Excessive filament voltage will cause tubes to quickly lose their filament emission. If, with a fully charged storage battery, it is necessary to advance the filament rheostat considerably beyond the normal setting shown on the instruction chart in the rear of the set for increased signal

it can generally be taken for granted that one or more of the tubes have become defective. This, of course, provided the A and B batteries are delivering the necessary voltage and capacity.

Tubes generally become ruined by advancing the filament rheostat too high, as a result of not reading the instruction charts, and trying to bring in stations more strongly by forcing the tubes. With one defective tube in a set, to make it function properly it is necessary to advance the rheostat, giving this poor tube slightly more filament voltage. Where the tube filaments are controlled from one rheostat, this excessive voltage is applied to and is therefore forcing all the other tubes. It is impossible to pick out a defective tube by appearance. The only positive test is the use of the regulation test rig by a dealer or by comparison with tubes you know to be in A-1 condition.

Detector Tubes

As a detector tube, we recommend the standard "hard" 201-A type of tube in preference to any special types.

For the information of those who desire to try special types of tubes in the detector socket, there is nothing in the design of the Synchrophase to prevent such experimentation. The grid return is to the positive filament. The grid leak has a resistance of approximately three megohms.

The 200-A Type Detector tube may be used in the Synchrophase without changing the present circuit. The manufacturers specify 45 volts of "B" battery on the plate, but improved operation is often obtained if this voltage is reduced to 22½ volts. Approximately three minutes is required for the tube to warm up sufficiently to liberate the gases upon which the operation of the tube depends.

The 200-A tube is more sensitive than the 201-A type and therefore is liable to be a trifle noisy in operation. The sensitivity of the receiver and volume on distant stations will generally be improved with its use.

Power Tubes (112 type)

The 112 type of medium power tube is well adapted to the needs of the Synchrophase in the home, and we recommend this tube for use in the last stage. Ample power will be delivered to operate properly any high quality horn or cone speaker with a minimum of distortion. The tube will stand voltages up to 150 with appropriate "C" battery (grid bias), and the ability to de-

liver undistorted volume increases as the voltage is increased. (If not over 90 volts is available there will be only a slight gain in clarity.)

Power Tubes (171 type)

The 171 type super-power amplifier tube is not generally necessary in the Synchrophase. This tube is only useful where exceptional volume in excess of that generally desired for home operation. Dry cell "B" batteries will not suffice as a source of economical current supply since this tube demands 10 to 20 milliamperes plate current, depending on the "B" voltage. Many "B" eliminators will not supply sufficient current. A device must be chosen, capable of supplying 35 to 50 milliamperes and maintaining the desired voltage.

To prevent burn out of the loud speaker it must be protected by a D. C. filter arrangement as specified by the instructions accompanying this tube.

Vagaries of Reception

Distant Reception

THE query, "What distance may I expect from the Synchrophase receiver?" is a natural one. Before offering any concrete figures as to the mileage to be expected, it is well to consider a few simple fundamentals which strictly bear upon this question.

The Synchrophase is a highly sensitive receiver; in fact, its properties in this respect are as high as it is possible to make it. The factors which more strictly influence distant reception are the atmospheric strays and noise caused by various electric machinery such as motors, X-ray apparatus, power lines, etc. In certain localities where such forms of interference produce disturbances equal to the intensity of a received signal from a broadcast station no distant reception at all can be expected. The limit of satisfactory reception depends upon the natural atmospherics which are continually prevalent in a greater or less degree and it is this so-called "static level" which governs the distance to be received.

The Synchrophase receiver has repeatedly received signals directly across the country, a distance of 3,000 miles; but it is obvious that this is only possible during an exceptionally clear evening. Points midway can, in the majority of instances, be readily received. At this distance reception will frequently be marred or interfered with by static interference except in unusually clear atmospheric conditions. As the distance received is decreased to, let us say, 250 miles, clear reception can generally be expected from stations using 500 watts or more.

Be assured, however, that when all accessories with which the Synchrophase is used are in proper operating condition that the instrument will readily respond to any broadcast signal which may penetrate this natural "barrage," which to date the skill of the radio engineering fraternity has not been successful in eliminating.

Poor Distant Reception

Poor distant reception can be attributed to numerous reasons. It is difficult to explain, as a large number of variable elements, such as location, receiver, aerial, ground, accessories, atmospheric conditions and skill of operator, etc., must be considered.

There is no reason why a set capable of bringing in local and

moderately distant stations should not bring in extreme distant stations such as an identical set in similar locations. If the receiver tests in A-1 condition and all circuits tune, bringing in local stations with the proper degree of amplification, the set is capable of receiving very distant stations providing the remaining conditions for the successful operation are favorable.

(1) Good standard tubes.
(2) Fully charged batteries of the proper value.
(3) A good aerial and ground connection.
(4) Favorable location of receiver.
(5) Good weather or atmospheric conditions.
(6) Proper operation of the instrument.

If you are not entirely satisfied with the degree of distant reception you have been obtaining, it is essential that you consult your dealer so that the entire apparatus may be thoroughly inspected by a competent radio man. The essential requirements for distant reception as previously mentioned, especially tubes and batteries, should be checked carefully, preferably making a further comparison with the operation of a similar type instrument under similar conditions, using the same location and accessories, if practical.

Weak Signals

If weak signals are heard, after checking over carefully the other suggestions, the trouble may be a simple one, and could be located by making a minute examination inside the instrument without removing it from the cabinet. Close attention should be given to the wiring, making certain every connection is securely made and that none are broken or loose, and that the instruments appear to be functioning properly. Weak signals may be due to:

(1) Run down A or B batteries.
(2) Weakened tubes or reversed storage battery connections.
(3) Insufficient antenna.
(4) Unfavorable atmospheric conditions.
(5) Receiver not properly tuned.
(6) Partially broken aerial or lead-in. Defective insulation.
(7) Poor location or dead spot for reception.
(8) Low power or faulty transmission from the station.
(9) Poorly designed or constructed loud speaker.
(10) Wrong direction of flow of current in the loud speaker.
(11) Faulty audio frequency transformer.
(12) Defective radio frequency transformer.

Noisy Operation

Noisy operation may be due to a variety of causes. Most of the difficulty is due to external conditions, generally beyond your control and results from static, strays and induction. Other noises result from a defective condition of the accessories or instrument. It is only natural that a multi-tube super-sensitive set, capable of bringing in very distant stations with sufficient volume to operate a loud speaker, will bring in considerable static and induction, when adjusted for distant reception and maximum volume. This interference generates from local power and high-tension lines, leaky insulation, trolley or electric train feed wires, electrical household appliances, doctors' violet and X-ray machines, telephone lines and a variety of other devices too numerous to mention. Disturbing noises at a considerable distance from you may be carried to your location by certain types of wire lines.

When interference is experienced it is advisable to run the aerial at right angles to the power, light or telephone lines, in your vicinity.

To accurately determine if the noisy operation is in the receiver, or is being picked up from some outside source, remove the aerial and ground connections from the receiver binding posts, moving the aerial and ground leads some distance from the instrument so that these noises will not be received in the set through induction from the aerial and ground leads. A more careful observation can be made by connecting a set of head phones in place of the loud speaker. All that should be heard is the soft constant tube hiss.

External Noisy Operation

Noisy operation may be evident with the aerial and ground connected, due to poor connections in the aerial or ground wire or lead-in grounding at some point on the way to receiver, or noisy transmitting station, generator hum, noises picked up by the microphone and relay lines other than that broadcasted or noises due to imperfections in transmitting apparatus.

Interstation Heterodyne Interference

Frequently broadcasting stations (generally distant ones) near in wavelength to each other or to the wavelength of some local broadcasting station to which you are listening, will produce a heterodyne whistle or beat note. When this occurs the most selective broadcast receiver is incapable of differentiating between

the two broadcasting stations that are close enough to each other in wavelength to produce this audible beat note. Very fine critical tuning will sometimes better the condition, but, as a rule, the trouble cannot be overcome unless one of the stations shifts its wavelength or signs off.

Radiating Receiver Interference

Whistling noises, squeals and howls varying in intensity when listening to some broadcasting station is usually due to some regenerative receiver being improperly operated in your immediate vicinity, and tuned to the wavelength on which you are listening. Regenerative receivers, usually of the single-circuit type, when improperly tuned or adjusted, act as miniature transmitters and cause a heterodyne or beat note similar to the carrier wave of a broadcasting station. The action is almost similar to that mentioned under heading—"Interstation Heterodyne." This interference can only be eliminated by the person operating the offending receiver obtaining its proper adjustment, or tuning to some other wavelength. Grebe Synchrophase receivers do not radiate or interfere in this manner and thus do not annoy neighboring listeners.

Telegraph-Code Interference

Interference from code transmitting stations, contrary to general belief, is not due entirely to radio amateur stations. In most cases interference of this nature is due to commercial ship and shore stations operating on wavelengths within or close to the bands assigned to broadcasting stations.

Interference of this nature is usually distinguishable, being intermittent, tooting, humming and peeping noises, often varying in intensity and the irregularity sounding like dot and dash code characters.

This annoyance to broadcast listeners is rapidly being remedied by re-allocating these stations to wavelengths out of and higher than the broadcasting waveband. Ultimately, all spark stations (which cause the maximum of interference) will be replaced by C. W. (continuous wave) radio transmitting apparatus, almost entirely eliminating this objectionable interference.

Internal Noisy Operation

If crackling or sputtering noises of some nature are evident with the aerial and ground connections removed some distance from the set, the difficulty may probably be traced to one or more of the following conditions:

(1) A defective condition of "B" batteries may be evident by popping, crackling or high pitch howling, or whistling noise in loud speaker. One dead or high resistance cell in a "B" battery is sufficient to block the flow of current through the rest of the batteries. This condition can be overcome and satisfactory operation secured if the defective section is shorted out of circuit or the battery replaced with a new one. A run-down condition of "B" batteries is often noted by a high pitch whistling when the Colortone switch is turned on full in a clockwise direction.

(2) Fading signals and sputtering noises may be due to run-down, or exhausted condition of the "A" battery, loose or corroded connections. Tighten connections and see that they are all bright and clean.

(3) Fading and distorted signals may be due to run-down or exhausted "C" battery or possibly too much "C" bias (voltage).

(4) The difficulties mentioned above, or an alternating current hum, may also be due to trouble with "A" or "B" battery eliminators operating from the house lighting electric current. Possibly due to eliminator not passing sufficient or steady voltage with receiver current consumption. Defective rectifying element, or filter, etc.

(5) Defective grid-leak, leaky or partially shorted grid or detector by-pass condenser. Try a similar tubular type grid-leak of three megohms.

(6) Noises may be due to defective vacuum tubes, or tubes making poor contact in socket. Oxidized tube terminals should be cleaned from time to time with fine sandpaper.

(7) Partially broken, corroded or poorly made connections in wiring of batteries or apparatus, or damaged elements. A close observational inspection of the internal wiring and elements should be made.

(8) Continued roar or hum due to loud speaker placed too close to receiver; try removing speaker away from receiving instrument and note whether noise stops.

(9) Loud roar or hum, due to a detector or amplifier tubes having microphonic characteristics. Try changing tubes around in

the detector socket until one is found where this condition disappears or is not so objectionable.

(10) A. C. (alternating current) hum, due to defective house lighting current ground or house electric wiring going to lamps, etc. passing close to, or parallel with aerial, ground, receiver or battery wires.

Fading

Fading is a radio phenomenon which manifests itself particularly in the reception of signals from a distant broadcast station. The action is a variation of signal intensity and changing quality. The received signal may for a short period be extremely loud and then suddenly diminish in intensity with a loss of quality, in a few moments returning to its former intensity and then fade away and even become inaudible. The variation may be quite rapid or gradual. This cannot be classed as poor reception. The condition is found to exist certain nights with certain stations, while broadcasting from other stations equally distant, the same nights, may be received without any noticeable fading or intermission.

There are many and varied reasons assigned for fading. It is generally attributed to atmospheric conditions that are more or less localized and does not affect all broadcast reception on a certain night (being by no means general). This phenomenon is beyond your control. When fading occurs your receiver has not become detuned. Tuning the dials to restore the station will be of no avail. Leave the dials alone and the station will probably return to its normal intensity.

Microphonic Tube Noises and Audio Frequency Feed-backs

Microphonic Tube Noises and Audio Frequency Feed-backs, which often cause howling or a low audible roar, is generally caused by what is termed a microphonic tube in the detector socket. This is a tube in which the filament element is loose. The minute vibrations of this element are greatly amplified in the audio amplifier, causing a bell-like ring or low audio howl in the loud speaker most noticeable when the instrument is tuned critically or when using maximum amplification or volume. It is evident with new tubes and often disappears after a short period of use due to contraction of the filament wire after having become heated.

Feed-backs due to the lead-in, battery or loud speaker leads, running parallel, or in inductive relation to the wiring of

the receiver, frequently cause this howling condition, especially if the detector tube is at all "microphonic." Changing the position of the loud speaker or these leads tends to overcome the condition. Console cabinets are often bad offenders, due to the bunching of the wiring, position of the various batteries and loud speaker.

Having outlined a few of the various causes for bad reception condition, let us mention a few constructive suggestions for eliminating this annoyance. Keep in mind, however, that the difficulty is not inherent in radio receivers, but is caused by the connecting leads, position of and the various accessories being used, and can always be eliminated.

Generally the trouble will be eliminated after trying the above suggestions; if not, it will be necessary to resort to changing the position of the various battery wires, and loud-speaker leads so they do not come in such close inductive relation to the instrument.

Unbalanced or Oscillating Receiver

Synchrophase receivers are tested and adjusted in a manner designed to meet all conditions which may be encountered in operation after the receiver has been shipped from the factory.

In only a very few instances have we been advised of unbalanced conditions having been encountered in the operation of this receiver. Investigation has shown, almost without exception, that conditions external to the set were accountable for the difficulty. Therefore, the factory balance adjustment of the balancing condenser screws should not be changed.

An unbalanced condition of the receiver can generally be noted by the following action: If, when tuning critically with all dials in resonance, a distinct whistle or howl, or blotting out of signal is heard when tuning in distant or even local stations, this would generally indicate an unbalanced or oscillating condition. It should not be confused with a whistle emanating from a local oscillating receiver, or the steady heterodyne whistle sometimes heard in the receiver due to two stations transmitting at frequencies which are almost alike.

Here are the most likely reasons for this unbalanced condition; check them carefully, making certain that they do not apply in your particular case:

(1) Faulty ground connection. Although almost any metallic circuit leading to the earth will generally give satisfactory

results, provided a good clean connection is made at the point of contact with the ground wire from the receiving set, it is advisable to try several ground connections, if they are available, selecting the one which gives the best results.

(2) The aerial wire connection should *not* run along the top or the back of the cabinet, but arranged to approach the cabinet from the rear left or from below. The loud speaker leads should be kept clear of the aerial connections, battery leads, and the receiver wiring.

(3) Excessive intermediate "B" battery voltage, or excessive filament voltage, due to advancing the filament rheostat, or volume control switch too far, newly recharged storage battery, use of brand new tubes, which, for a short period of operation may have an especially high degree of filament emission, will tend to cause oscillation or a regenerative action.

(4) Variations in the characteristics of standard vacuum tubes used in the set will in some instances be sufficient to unbalance the circuits. It is usually possible to change the tubes about in the sockets until a combination is found with which a perfect balance is obtained.

(5) While the factory balance adjustment is sufficiently flexible to allow the use of tubes varying considerably from the standard X base 201-A type, there are occasionally a few of these tubes and certain other types of tubes which will necessitate a readjustment of the balancing condensers.

(6) A very strong signal from a nearby broadcasting station will often force oscillations in a properly balanced receiver. The remedy to avoid this is to slightly detune the dials, which besides eliminating the oscillating action results in an improvement of the quality of reception.

Some Characteristic Noises

With Suggestions as to Their Possible Causes

Bell-like ring or low audio howl—Usually microphonic noises from vacuum tubes, due to a lack of rigidity in the supports of the elements, often noted with new tubes in which this condition will disappear after three or four hours of use.

Since the microphonic noises originate most always in the detector tube, various tubes should be tried in this socket, until one is found in which this condition is not experienced, or is not objectionable.

Another very effective method to overcome this is to reduce the "B" battery voltage on the detector tube to 22½ volts, if 45 volts are being used.

A hum without reception—An open circuit.

High-pitched whistling—Radio waves from two different stations transmitting on nearly the same wavelength, a wave from a neighboring radiating receiver, defective tube in audio amplifier, or low "B" battery.

Rasping or Scratching—Imperfect contacts and connections.

Steady hum during reception—Often due to proximity to light, telephone and power lines.

Clicking at regular intervals or spluttering dots and dashes—Flashing electric sign or other device that causes automatic sparking, or periodic disturbances; telegraph transmission from local high-powered radio station.

Squealing, Howling or Whistling—Internal oscillation or unbalanced receiver. (See page 15.)

Frying, Crackling or Sizzling Noises—Static, induction from household electrical appliances, X-ray or violet-ray machines (likely to produce pronounced and continuous noises). Battery trouble.

Popping or Bubbling—Leakage, in nearby high-power transmission lines; electric train, trolley, "L" train, third rails, etc.

The above list is not complete, but includes the noises which are most commonly heard. There are many varieties caused by electric devices of all kinds used in the home.

"Fire Underwriters' Recommendations"

This data applying to receiving stations only embodies the best and safest of current practices and should be followed as carefully as possible.

1. Aerial and counterpoise outside buildings shall be kept well away from all electric light or power wires of any circuit of more than 600 volts, and from railway, trolley or feeder wires, so as to avoid the possibility of contact between the aerial or counterpoise and such wires under accidental conditions.

2. Aerial and counterpoise, where placed in proximity to electric light or power wires of less than 600 volts, or signal wires, shall be constructed and installed in a strong and durable manner, and shall be so located and provided with suitable clearances as to prevent accidental contact with such wires by sagging or swinging.

3. Splices and joints in the aerial span shall be soldered unless made with approved splicing devices.

4. The preceding paragraphs, 1, 2 and 3, shall not apply to light and power circuits used as receiving aerials, but the devices used to connect the light and power wires to radio receiving sets shall be of the approved type.

5. Lead-in conductors shall be of copper, approved copper-clad steel or other metal which will not corrode excessively, and in no case shall they be smaller than No. 14, except that bronze or copper-clad steel not less than No. 17 may be used.

6. Lead-in conductors on the outside of buildings shall not come nearer than 4 inches to electric light and power wires unless separated therefrom by a continuous and firmly fixed non-conductor which will maintain permanent separation. The non-conductor shall be in addition to any insulating covering on the wire.

7. Lead-in conductors shall enter the building through a non-combustible, non-absorptive insulating bushing slanting upward toward the inside.

8. Each lead-in conductor shall be provided with an approved protective device (lightning arrester) which will operate at a voltage of 500 volts or less, properly connected and located either inside the building at some point between the entrance and the set which is convenient to a ground or outside the building as near as practicable to the point of entrance. The protector shall not be placed in the immediate vicinity of easily ignitible stuff, or where exposed to inflammable gases or dust or flyings of combustible materials.

9. If an aerial grounding switch is employed it shall in its closed position form a shunt around the protective device. Such a switch shall not be used as a substitute for the protective device.

It is recommended that an aerial grounding switch be employed and that in addition a switch rated at not less than 30 amperes, 250 volts be located between the lead-in conductor and the receiver set.

10. If fuses are used they shall not be placed in the circuit from the aerial through the protective device to ground.

Fuses are not required.

11. The protective grounding conductor may be bare and shall be of copper, bronze or approved copper-clad steel. The grounding conductor shall be not smaller than the lead-in conductor and in no case shall be smaller than No. 14 if copper, nor smaller than No. 17 if of bronze or copper-clad steel. The grounding conductor shall be run in as straight a line as possible from the protective device to a good permanent ground. Preference shall be given to water piping. Other permissible grounds are grounded steel frames of buildings or other grounded metal work in the building, and artificial grounds such as driven pipes, rods, plates, cones, etc. Gas piping shall not be used for the ground.

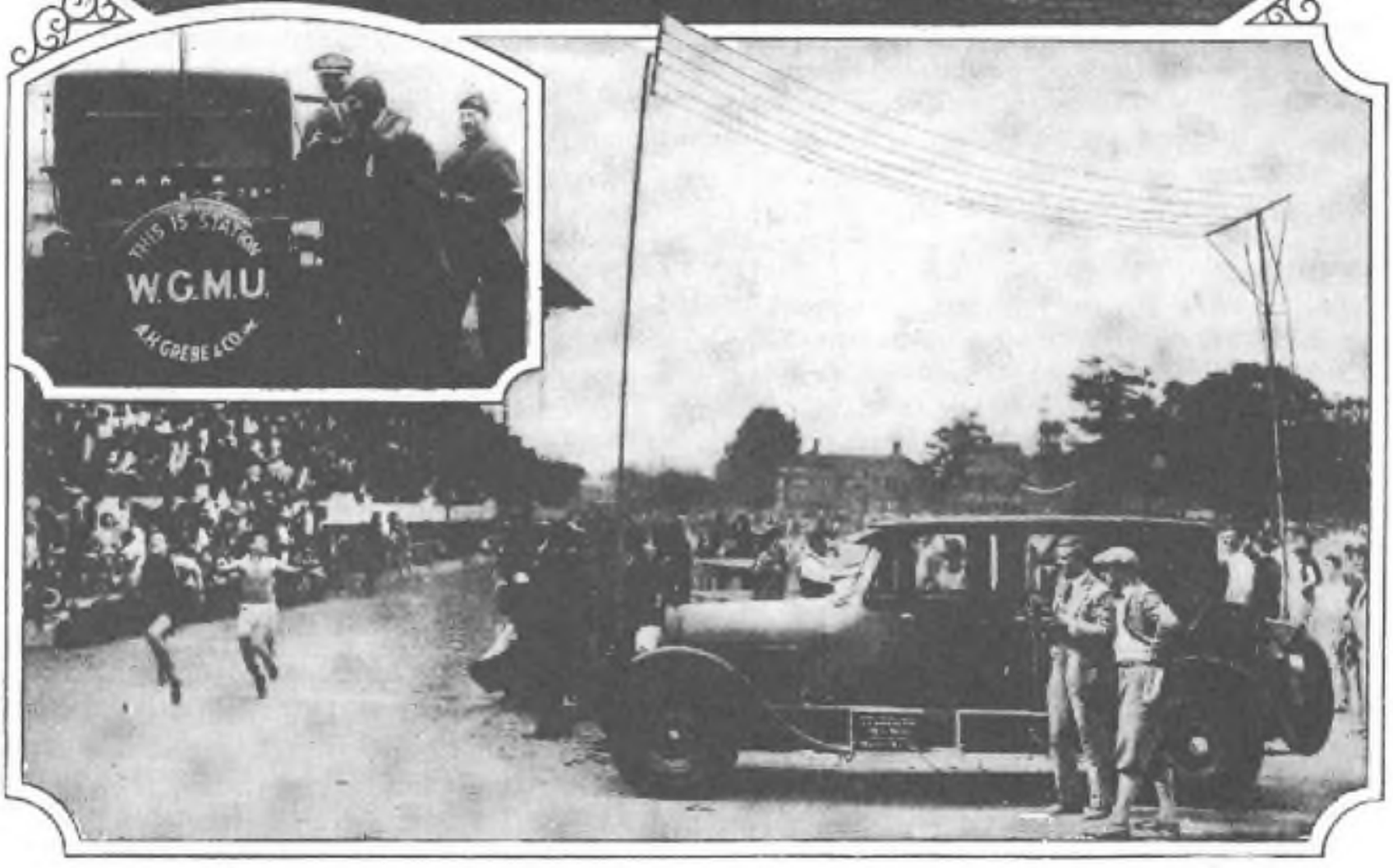
12. The protective grounding conductor shall be guarded where exposed to mechanical injury. An approved ground clamp shall be used where the grounding conductor is connected to pipes or piping.

13. The grounding conductor may be run either inside or outside the building. The protective grounding conductor and ground, installed as prescribed in the preceding paragraphs 11 and 12, may be used as the operating ground.

It is recommended that in this case the operating grounding conductor be connected to the ground terminal of the protective device. If desired, a separate operating grounding connection and ground may be used, the grounding conductor being either bare or provided with an insulating covering.

14. Wires inside buildings shall be securely fastened in a workmanlike manner and shall not come nearer than 2 inches to any electric light or power wire not in conduit unless separated therefrom by some continuous and firmly fixed non-conductor such as porcelain tubes or approved flexible tubing, making a permanent separation. This non-conductor shall be in addition to any regular insulating covering on the wire. Storage battery leads shall consist of conductors having approved rubber insulation.

It is recommended that the circuit from the storage battery be properly protected by fuses as near as possible to the battery.


THIS IS STATION
W.G.M.U.
A.H. GREBE & CO.

Grebe Broadcasting Stations

THE broadcasting activities of the Grebe Company began several years prior to the present era. Speeches and music were first broadcast through experimental stations 2XE and 2ZV. Later WAHG and WBOQ, with regularly organized programs, were put into service from the studio at Richmond Hill.

The transmitting and studio equipment of WAHG and WBOQ has been developed to perfection. Intricate controls and automatic mechanisms contribute to the smooth operating technique of the stations. Studios are located both in New York and at the factory with wire line connections to various other points supplementing the studio service.

More recently the Mobile Station WGMU and Marine Station WRMU have been broadcasting in their own particular fields. Both WGMU and WRMU are equipped with integral power plants making them independent of power supply on location.

These stations operate on a normal broadcast wavelength of 236 meters and in addition are capable of transmitting on low wavelengths for re-broadcast purposes, through WAHG and WBOQ.

Outstanding aquatic events such as the Yale-Harvard Boat Race and the American Power Boat Association Gold Cup Regatta have been covered by WRMU.

WGMU has been heard from in connection with interscholastic track meets and Pulitzer Trophy Aircraft Races at Mitchell Fying Field, Long Island.

As a part of the research program important experiments are conducted by our amateur and experimental stations 2ZV and 2XE on extremely short wavelengths, in the 20, 40, 60 and 100 meter bands. Through the medium of its numerous stations we find A. H. Grebe & Co. contributing liberally to the general advancement of the broadcasting art.

The illustrations opposite show in order from top to bottom the transmitter control room of WAHG, and a corner of the main factory studio. The interior and exterior of marine station WRMU. Two views of mobile station WGMU in action at aircraft races and interscholastic track meet.

Service

IT will almost invariably be found that unsatisfactory operation, poor reception, disturbing noises and other forms of trouble are not due to any defect in your Grebe Synchrophase receiver, providing it has been properly installed with the various accessories in A-1 condition and that the instrument has been in no way tampered with since leaving the factory. All parts used in the assembly of the instruments have been thoroughly tested, and the completed set subjected to a rigid examination under actual operating conditions.

If trouble of any kind is experienced in operating your set, first study over your installation, starting with the batteries, wiring, tubes, aerial, ground, loud speaker, etc., checking everything thoroughly against the data furnished in this instruction manual. If, after you have carefully examined and tested the entire installation, and you are convinced the faulty operation lies somewhere internally in the instrument, do not attempt to locate and remedy the trouble yourself, but get in touch with the Grebe dealer from whom you purchased this set for service examination by his service repairman. If the dealer's service and repairman does not feel sufficiently competent to overcome the difficulty, our various distributors have expert service men, instructed in all phases of service and repair on Synchrophase receivers by experienced service engineers direct from our factory.

A repair department is maintained at the factory. If instruments have been seriously damaged through accident or misuse so that replacements of internal elements of an extensive nature are necessary to recondition the receiver the set should be returned to our factory at Richmond Hill, N. Y. In repacking a set for reshipment it should be packed carefully, preferably in the original shipping carton. This is essential in order to avoid liability of damage in transportation. Sets returned to the factory for adjustment and repair are subject to a service handling, labor and material charge, depending on the nature of the repairs and condition of the set upon arrival at our plant. The instrument should always be shipped via American Railway Express, prepaid.

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Illustrations

A COPY of this Instruction Manual is packed with each Grebe Synchrophase Broadcast Receiver before shipment from our factory. Additional copies may be obtained at a cost of fifty cents each from authorized Grebe dealers or direct from A. H. Grebe & Co., Inc.

The

Grebe Synchrophase

TRADE MARK REG. U. S. PAT. OFF.

Patented March 10, 1925, May 5, 1925
Other structural and circuit patents pending

A. H. GREBE & CO., Inc.

Steinway Hall, 109 West 57th Street, New York
Factory: Richmond Hill, New York
Western Branch: 443 S. San Pedro St., Los Angeles, Cal.

THE GREBE
GUARANTEE

WE guarantee every Grebe Radio Instrument to be free from mechanical and electrical defects in manufacture.

We will repair or adjust without charge, at our factory, any apparatus or part thereof which becomes inoperative or otherwise defective in ordinary use.

A. H. GREBE & Co., INC.

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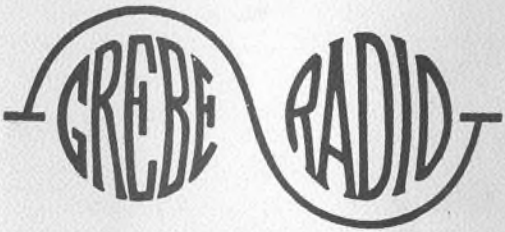

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