RADIO EQUIPMENT

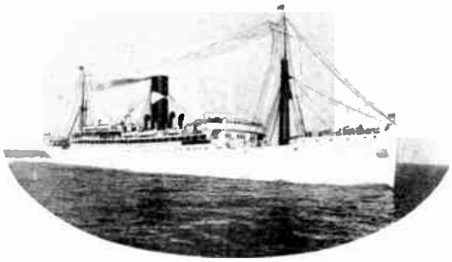
WIRELESS SPECIALTY APPARATUS COMPANY

BOSTON, MASS., U. S. A.

RADIO
TELEGRAPH *and* TELEPHONE
EQUIPMENT

DESIGNED FOR

COMMERCIAL SHIP AND SHORE STATIONS
MILITARY INSTALLATIONS
PLEASURE YACHTS AND CRUISER AUXILIARIES
SCHOOLS AND COLLEGES
PRIVATELY-OWNED RESEARCH AND
EXPERIMENTAL STATIONS



United Fruit Company's Steamship *Pastores*

WIRELESS SPECIALTY APPARATUS COMPANY
ENGINEERS, DESIGNERS, AND MANUFACTURERS
BOSTON, MASS., U.S.A.

Pinkham Press, Boston

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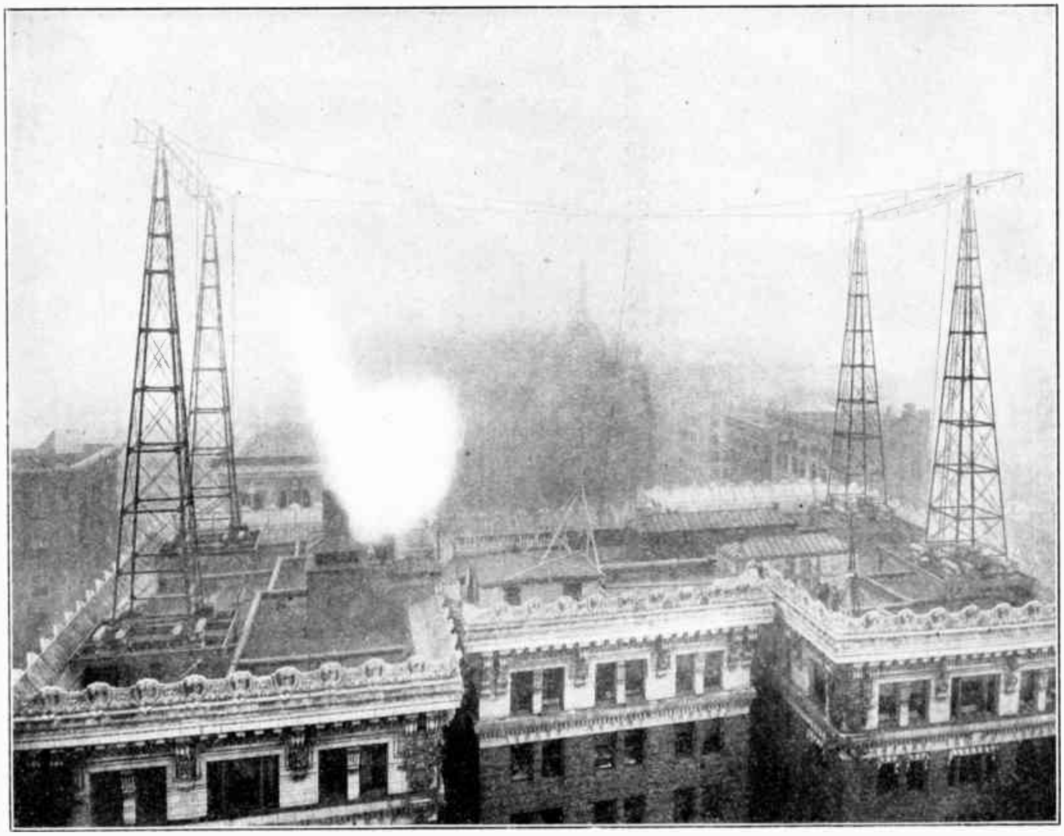
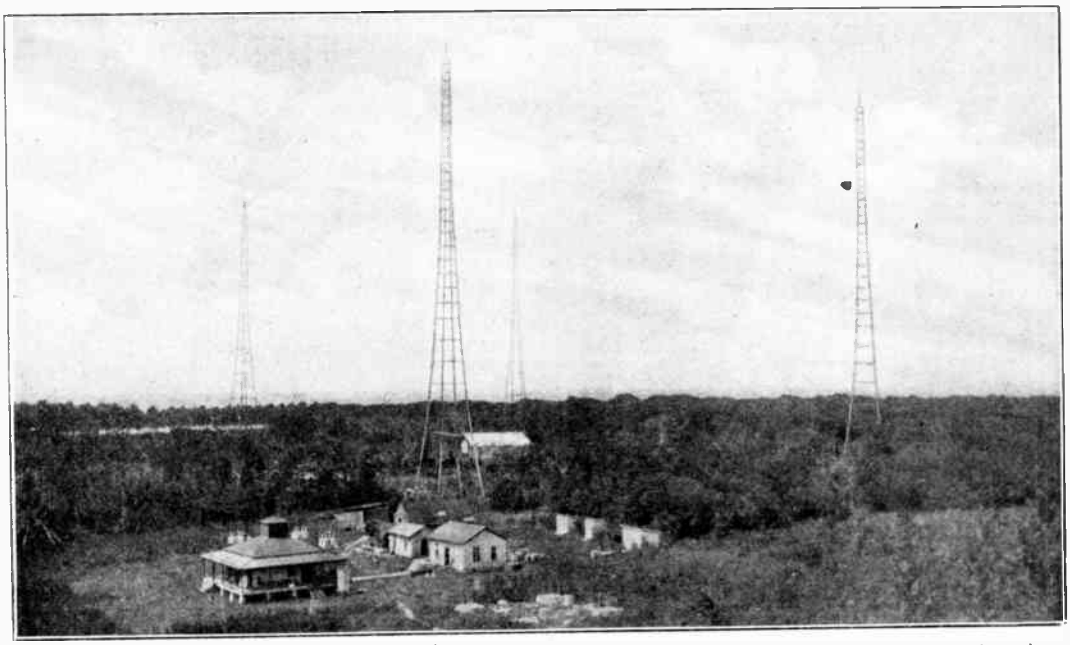


Laboratory Antenna of the Wireless Specialty Apparatus Co. on the Board of Trade Bldg., Boston, Mass.



Swan Island Station of the United Fruit Co., equipped with 5 K.W. Wireless Specialty transmitter and receiver.

I. ORIGIN AND GROWTH

THE WIRELESS SPECIALTY APPARATUS COMPANY of Boston resulted from a partnership formed in 1906, by Messrs. Greenleaf Whittier Pickard and Philip Farnsworth. Mr. Pickard, after years of research, had solved the problem of aural reception of radio signals. His inventions in the field of Radio Detectors and Receiving Apparatus retired the unreliable coherer forever from the art. The purpose of the partnership was a formation of a legal and engineering combination to patent, market, and manufacture the fruits of Mr. Pickard's inventive genius. In 1907, Col. John Firth was admitted to the organization, and the WIRELESS SPECIALTY APPARATUS COMPANY incorporated. At that time its sole capital was the talent possessed by its three partners in their respective fields.

GREENLEAF WHITTIER PICKARD

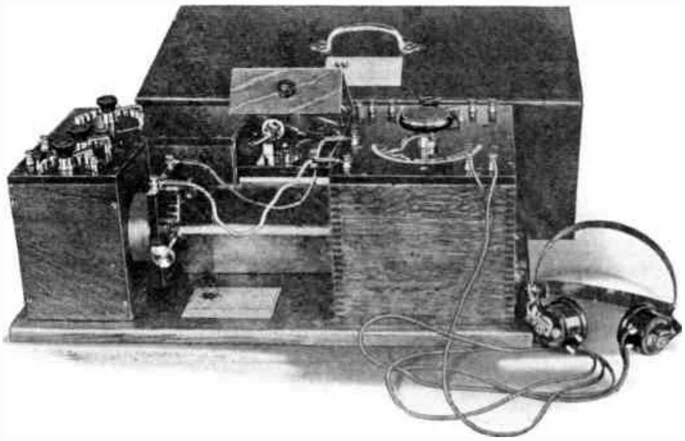
The first order received by the Company was in February, 1907, when the signal corps of the United States Army ordered thirty-five silicon detectors.

Between 1907 and 1912 Mr. Pickard continued his research. He developed and patented all the successful forms of crystal detector apparatus and circuits in use today. He also patented the loop direction finder and radio compass in 1908, and the circuits in use at the present time for static elimination and unilateral direction finding. He patented, as well, a mass of specific manufacturing and design solutions for existing radio problems. The radio pack-set for the United States Signal Corps was designed and manufactured in large quantities during this period. Our I-P-76 Receiver is the most widely known radio receiver in the art.

In 1912, when Colonel Firth disposed of his interest, the Company's engineering, manufacturing, and sales organizations were moved from New York to Boston, Massachusetts, where they, as well as the general offices of the Company, are now located.

The growth of the Company from 1912 on was very rapid, and its business reached a great magnitude. It was during this period that the UNITED FRUIT COMPANY decided to equip all of the vessels of its GREAT WHITE FLEET and its shore stations in Central and South America and the West Indies with radio apparatus designed and manufactured by the WIRELESS SPECIALTY APPARATUS COMPANY.

The UNITED FRUIT COMPANY, as is well known, maintains an extensive radio communication service not only on its great fleet of ships, but in the countries



EARLY FORM OF THE I-P-76 RECEIVER

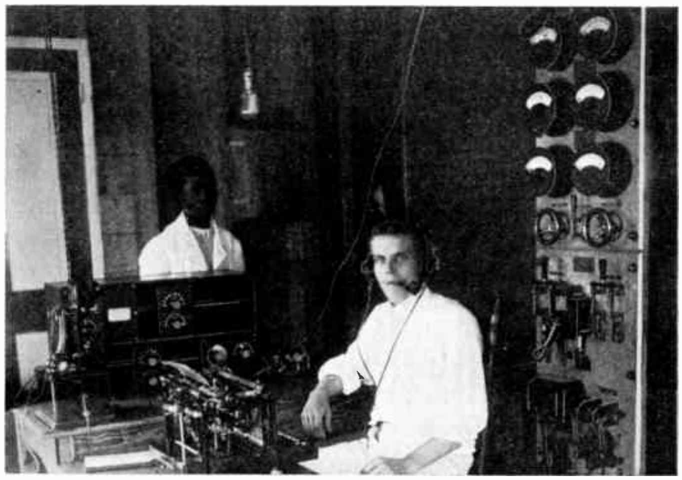
of Northern, South and Central America and the West Indies, where, owing to the severe atmospheric conditions prevailing during nine months out of the year, it is very difficult to maintain reliable radio communication. Radio apparatus for this service must be designed not only to withstand the ravages of tropical heat and dampness, but to function under the most severe physical and electrical conditions imaginable, and still retain the highest possible degree of selectivity in order to "work through" tropical "static."

The WIRELESS SPECIALTY COMPANY's apparatus installed at all of the UNITED FRUIT COMPANY tropical stations and on the steamships of its GREAT WHITE FLEET has successfully met all of these conditions, and more than anything else has contributed to the latter company's success in maintaining radio service of unequalled reliability to and from its ships and between the countries of Central and South America and the West Indies and the United States.

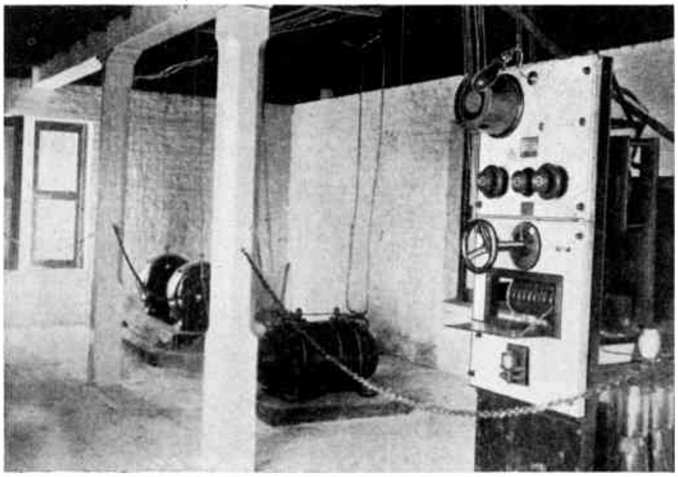
The marked superiority of the UNITED FRUIT COMPANY's radio service, largely carried on through the medium of radio equipment furnished by the WIRELESS SPECIALTY APPARATUS COMPANY, led to our equipment being installed on many other steamships, and the WIRELESS SPECIALTY APPARATUS COMPANY equipment became "standard" radio apparatus the world over.

At the beginning of the war over 95% of the commercial ship and shore stations, as well as the vast majority of experimental and research stations, in the Western Hemisphere were equipped with crystal detecting and receiving apparatus either sold directly by us or licensed under our patent designs. By 1917 the products of the WIRELESS SPECIALTY APPARATUS COMPANY were being used in every country of the Globe.

Then came the world



THE BELIZE (BRITISH HONDURAS) STATION OF THE BRITISH GOVERNMENT, EQUIPPED BY WIRELESS SPECIALTY APPARATUS COMPANY war, and the Company exerted all of its energies towards the design and manufacture of radio equipment for the United States and Allied Governments. The same pre-war superiority of the WIRELESS SPECIALTY apparatus was maintained during the stress of war. Tremendous quantities of high-grade apparatus were developed and built for the United States Navy. Code messages that guarded our crusaders across the submarine-infested Atlantic were continuously transmitted and accurately received during this stirring period by means of the equipment furnished to the Navy Department by the WIRELESS SPECIALTY APPARATUS COMPANY. Our citizen soldiery, when hundreds of miles off the coast of Europe, felt the relief brought by the presence on the misty horizon of United States and Allied destroyers summoned by radio. If they could have looked into the radio rooms of the transport flotilla they would have seen the peace-time product of the WIRELESS SPECIALTY APPARATUS COMPANY functioning smoothly in its new war-dress; guarding lives with the same effectiveness with which it served the commerce of the United States and Central and South America through the medium of the UNITED FRUIT COMPANY'S GREAT WHITE FLEET and this company's chain of radio stations in the countries bordering the Gulf of Mexico and the Caribbean Sea.



POWER PLANT AND RADIO FREQUENCY APPARATUS OF THE BELIZE (BRITISH HONDURAS) STATION

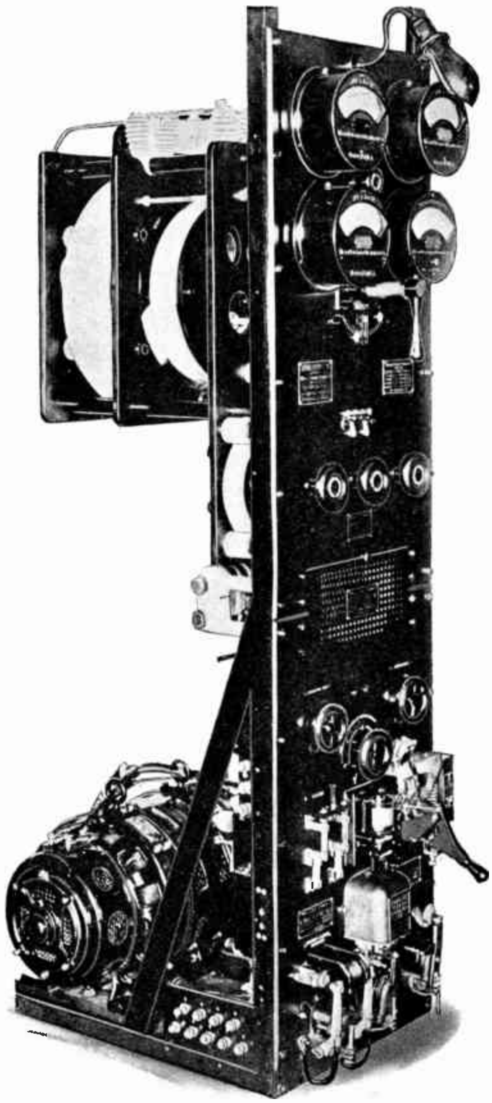
During the war the research and manufacturing organizations passed through another expansion phase. Five additional manufacturing plants were equipped. The total value of the apparatus manufactured by the Company during this period is measured in millions of dollars.

At the present time the WIRELESS SPECIALTY APPARATUS COMPANY is the second largest radio engineering and manufacturing organization in the Western Hemisphere.

One of our special war problems was the solution of the production in quantities of a low-loss power condenser for radio transmitters. The demands of the United States Navy Department for mica condensers could not be met by existing manufacturers. At the Navy Department's request and with the benefit of the Government's experience in producing radio power mica condensers since 1911, and with our own nine years' experience in the manufacture of radio power condensers, previous to the war, the WIRELESS SPECIALTY APPARATUS COMPANY proceeded to equip a condenser plant to meet this urgent demand.

Its agents scoured the world for mica to meet our specifications. Tons of mica were purchased from mines located in South America, Asia, and North America. A quarter of a million dollars was spent on experimental work and the equipping of this plant. Millions of films of mica were tested electrically and mechanically and stacked with metal foil.

The production of the FARADON mica condenser was the result of this work, and during the latter part of the war thousands of FARADONS were supplied to the Navy Department. The .004 mfd. FARADON mica condenser stack is United States Navy standard and is built with a phase angle of less than two minutes and will carry 18 amperes at 1,000 meters, in a circuit whose decrement is such that the maximum potential across the condenser is 21,000 volts, with a resultant temperature rise measured at the case of less than 4°C. after a half hour run, the average being 3½°C. Under actual radio operating conditions, however, the average temperature rise is considerably less, the average being about 1°C. This condenser sold at $32.50, although the raw mica used in this construction was the most expensive ever used for this purpose.



1 K.W. PANEL TRANSMITTER DESIGNED FOR THE TROPICS

The quality of our FARADON mica condensers is second to none in the world. Condensers made two years ago and run continuously eight hours every working day in the primary circuit of our condenser testing department, show at the present time the same performance they gave when initially installed.

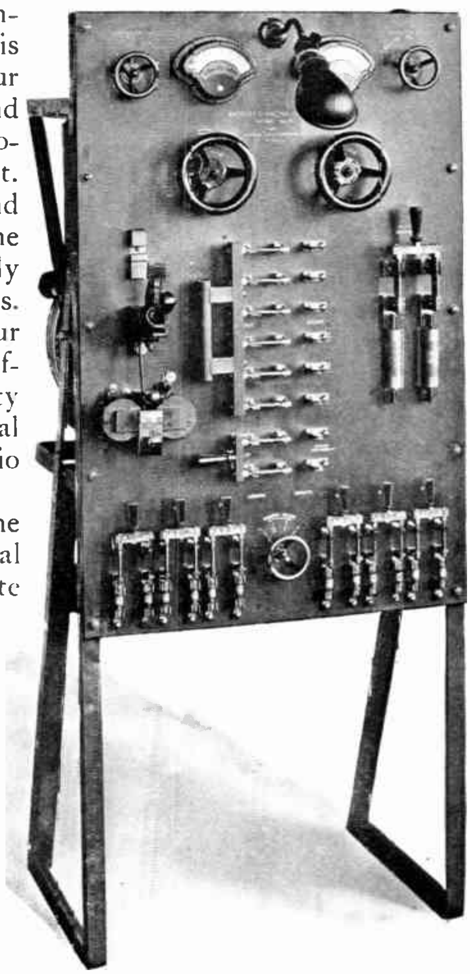
With the signing of Peace and the decreased requirements of the United States and Allied Governments, we are again placing our entire organization at the disposal of national and international commerce, schools and colleges, and private experimenters. We maintain an engineering organization of the finest talent obtainable in the art for the solution of special radio and electrical problems. Our manufacturing methods and facilities are the products of years of growth with its resulting experience.

Apparatus leaves our shops only after careful and minute inspection. It must successfully pass tests which impose conditions far more severe than could be conceivably encountered in actual service. This knowledge, coupled with the fact that all our apparatus is made with the finest materials and workmanship that human ingenuity can provide, enables us to fully guarantee our product.

We are in an excellent position to develop and build special radio telegraph and telephone equipment and condensers. We will gladly quote from your drawings and specifications.

We have listed in the following pages our standard product. This includes complete self-contained transmitters and receivers, a variety of apparatus of educational and experimental character, and several special units for radio installations.

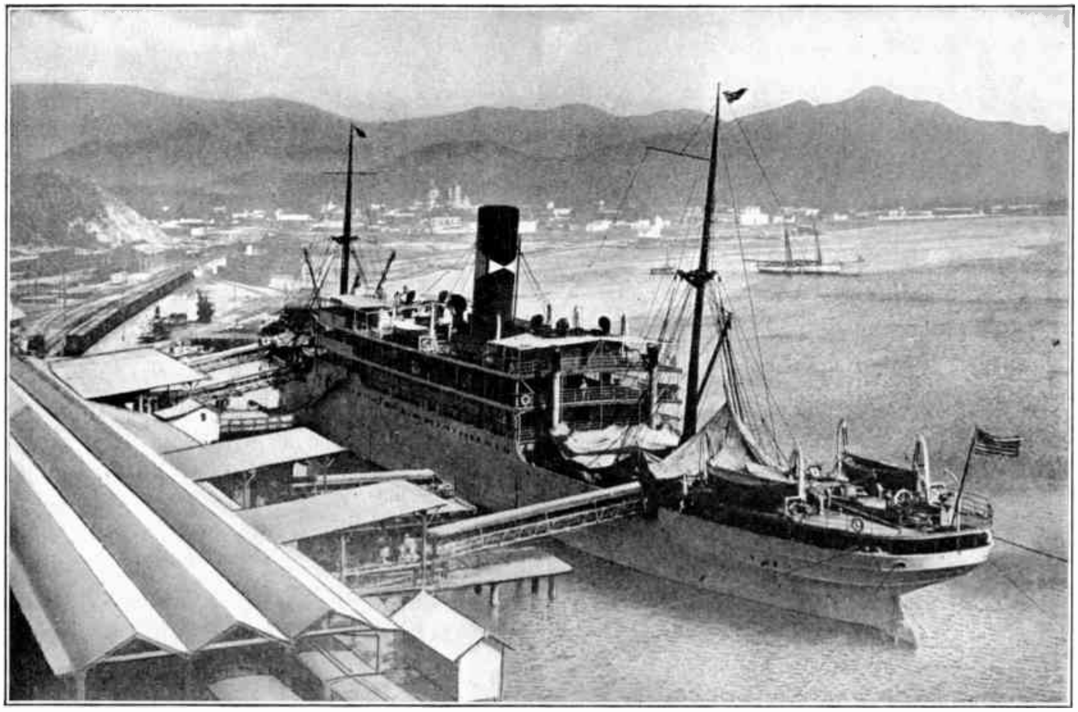
Prices have not been quoted, due to the present varying conditions of the raw material and labor markets. We will be pleased to quote and furnish additional data on any of the equipments listed on the following pages.



BATTERY-CHARGING PANEL
This unit is representative of our special equipment built to meet individual specifications.

This equipment is standard WIRELESS SPECIALTY apparatus, and will be found in successful operation in all parts of the world: on mule back in the Army, in the trim, immaculate surroundings of the ships of the United States Navy, the quiet excellence and luxury of the UNITED FRUIT steamships, and in the research laboratories or lecture rooms of the progressive educational institutions, and in the equipment of private experimental stations, the owners of which have contributed so much in the national emergency.

WIRELESS SPECIALTY apparatus will be found wherever quality and ruggedness are in demand.



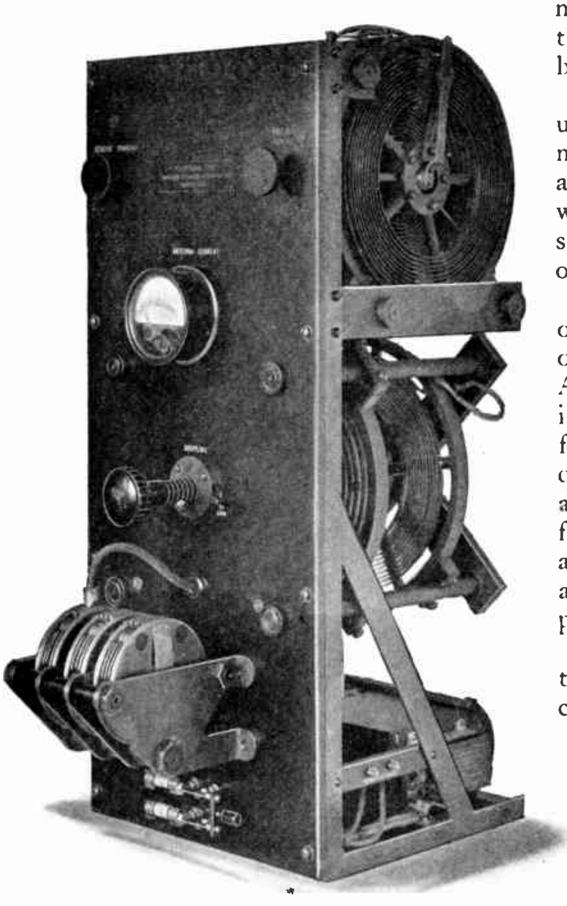
The United Fruit Co.'s Steamship *Turrialba* at Santa Marta, Colombia

WIRELESS SPECIALTY APPARATUS installation on the United Fruit Co.'s Steamship *Turrialba*

II. TRANSMITTERS

IN the six years between 1906 and 1912, the WIRELESS SPECIALTY APPARATUS COMPANY built a series of special transmitters for the needs of its research organization. Along with this work was carried on the development of condensers and the various units which compose a transmitter, such as coils and switch mechanisms.

In 1912, two types of transmitters were offered for commercial and military purposes. These sets were respectively a portable set for field service, and a one-kilowatt panel transmitter for ship and shore stations. The pack set designed by the WIRELESS SPECIALTY APPARATUS COMPANY, combined a complete transmitting and receiving equipment in one chest. At this stage of the radio art it was the practice to install the units comprising the transmitter separately on the walls, ceiling and floor of the operating room, and the one-kilowatt transmitter developed as a result of our experience with pack sets was the pioneer transmitting set in which all transmitting units were combined and permanently located upon a single panel board. This provided a compact unit for centralizing the control of the prime mover, the 500-cycle system, and the radio frequency circuits. With this type of equipment, wave-length could be rapidly changed, and power easily varied. The adjustments thus became greatly simplified. Since this time, practically all radio transmitters have been built on the panel board principle.



SPECIAL ¼ K.W. PANEL TRANSMITTER

Our engineering organization is prepared to undertake the designing of special equipment to meet the specific needs of our customers. The accompanying illustration shows a set which was designed, drawn up, built, tested and shipped within the space of thirty days, to meet one such special requirement.

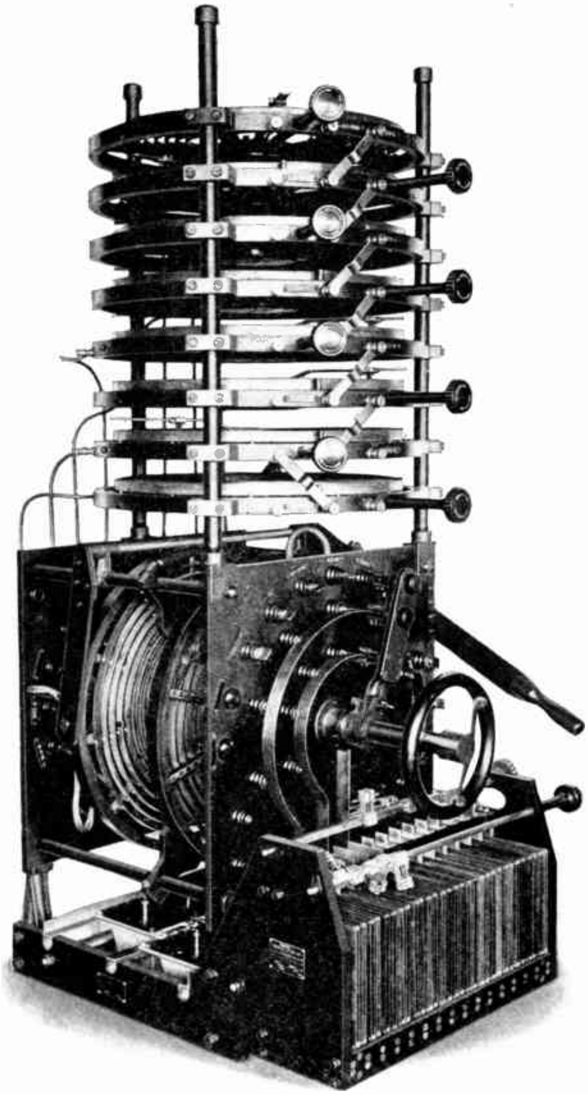
All transmitters listed are arranged to operate on a 110-volt source of supply. Prime movers for other sources of supply will be quoted on request. All transmitters are rated by the power input into the primary of the low-frequency transformer. The transmitters are of the 500-cycle quenched spark type. They are equipped with a wave-changing switch for quickly transferring from one wave-length to another, to avoid interference. Separate controls of coupling and variometer tuning of the antenna are provided.

These transmitters are designed to combine the mechanical features of ruggedness and compactness, with the electrical features of high efficiency, high insulation, and safety factor. They emit a sharp wave of great carrying power. The adjustments are simple, and practically "foolproof."

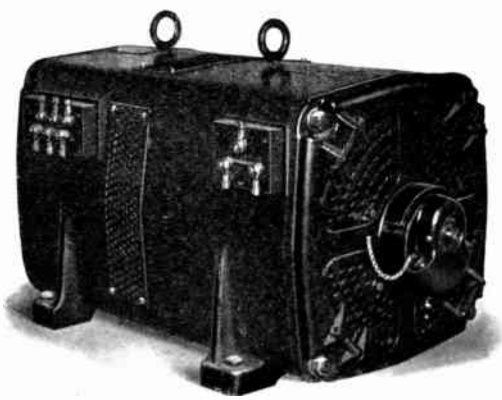
Over one thousand of these transmitters are now giving satisfactory service in all parts of the world.

5 K.W. TRANSMITTER, TYPE Q-S-5000

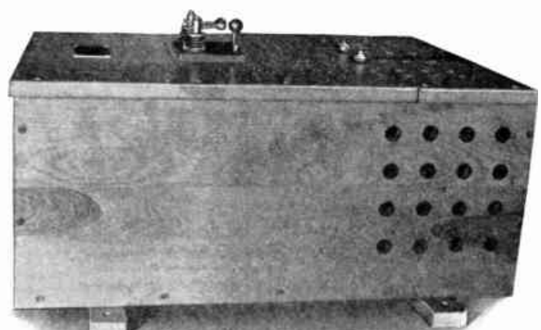
Low-Tension Control Panel



High-Tension Radio Panel



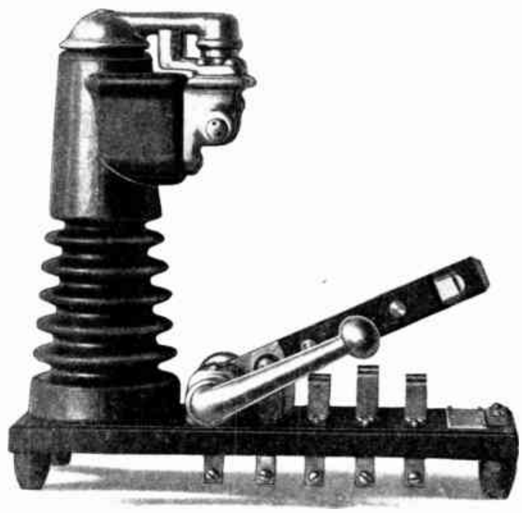
Motor Generator



Transformer

5 K.W. TRANSMITTER, TYPE Q-S-5000

THE 5 K.W. Transmitter has a daylight range of approximately one thousand miles over sea water. It has an overall efficiency of 34.5%. It is arranged to transmit on any one of eight standard wave-lengths, changes being made by a single control mechanism. The apparatus is mounted on two panels. One contains all the high-frequency circuits, the other the low-frequency and prime mover controls and meters. The motor generator, automatic starter, transformer, relay and hand keys, antenna switch, antenna ammeter, and lightning switch are supplied for separate mounting. This feature permits the location of the motor generator outside of the radio room, and allows remote control of the station.



ANTENNA SWITCH, TYPE Q-S-5001

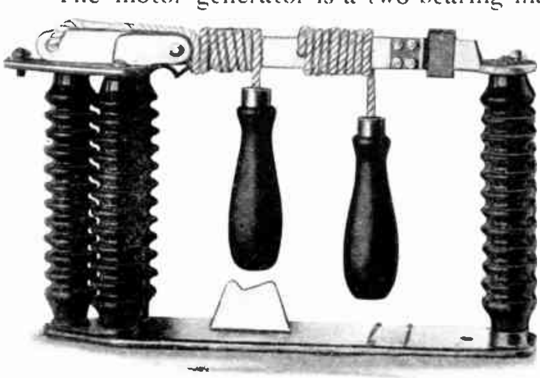
LOW-TENSION CONTROL PANEL

The low-tension control panel is made up of two ebony asbestos panels, mounted upon a suitable angle-iron frame. Upon the upper panel are four A.C. meters indicating the voltage, current, output and frequency of the 500-cycle generator. A pilot lamp is placed on top, lighting the faces of the meters. All seven meters used in this outfit are Weston instruments, accurate to within two per cent of their reading. A power control rheostat is connected in the generator field circuit, and a frequency control rheostat in the motor field circuit.

Upon the lower panel are arranged the D.C. voltmeter and ammeter, the D.C. main line switch and auxiliary switch, the A.C. line switch, D.C. line circuit breaker, and the generator line field contactor. The magnet coil of the latter is fed from the 110-volt line, and is connected in series with contacts on the antenna switch. It opens the A.C. line and the generator field simultaneously when the antenna switch is in the "receive" position.

GENERATOR AND AUTOMATIC STARTER

The motor generator is a two-bearing machine. The prime mover is a 120-volt D.C. shunt interpole motor. This drives a single-phase 250-volt 500-cycle inductor type alternator, at a speed of 1765 R.P.M. The machine is started by an auto starter, which consists of a three-step accelerator, enclosed in a sheet-iron case. The starter and generator are usually mounted in a compartment outside of the receiving room.



LIGHTNING SWITCH, TYPE Q-S-5002

TRANSFORMER AND REACTANCE

The transformer is of the closed core minimum leakage type. Special care is taken in the design of the transformer to secure a high insulation safety factor. The primary and secondary are separated by heavy micanite tubes. The individual sections of the secondary are separated by heavy micanite discs. The reactance is mounted in the same case as the transformer, and is provided with five taps for varying its value, to allow for small changes in the synchronous impedance of the generator.

Further characteristics of the transformer are discussed under "Transformers," on page 48 of this catalog.

RELAY KEY, TYPE Q-S-5003

HIGH-TENSION RADIO PANEL

The high-tension radio panel is a bakelite dilecto panel, and contains primary coils, the primary condenser, quenched spark gap, the coupling coil, and the antenna-loading inductance. These units are assembled with a wave-length shifting mechanism. As supplied, the set is adjusted to the following eight wave-lengths: 300-476-600-756-952-1200-1510-1905 meters.

Wave-length control is obtained by the rotation of a single handle. This automatically varies the period of the primary, the coupling between the primary and antenna, and the antenna inductance. The continuously variable fine control of coupling is provided by means of a handle. Variometer tuning of the antenna on each wave-length is arranged so that the tuning of any one wave-length will not disturb the adjustment of any of the remaining wave-lengths. This is accomplished by the handles projecting from the antenna inductance coils.

The gap consists of a fifteen unit quenched gap of the self-cooling Navy type, with a switching mechanism varying the number of gaps in the circuit.

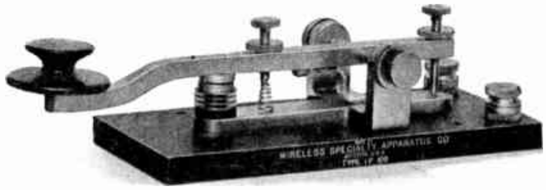
The primary transmitting condenser consists of eight FARADONS of .004 mfd. each.

REMAINING UNITS

The antenna switch accomplishes the following results:

Sending Position

(1) Closes a break in field circuit of alternator.
(2) Closes circuit that operates the solenoid of clapper switch on switchboard (which is a double pole switch and controls alternator field and armature).
(3) Closes circuit that operates detector protective relay.
(4) Closes one spare set contacts.
(5) Grounds the terminal that connects to receiver.
(6) Connects antenna to loading coil of transmitter.



AUXILIARY HAND KEY, TYPE Q-S-5004

In the Receiving Position

(7) Opens contacts of circuits 1, 2, 3, 4, above.
(8) Connects receiver lead to antenna.
(9) The connection (5) above remains closed until the antenna is grounded, just before the switch reaches the final receiving position,

(10) Design is such that contact (2) opens before (1), so that spark at the breaking field will occur at the clapper switch on the switchboard, and not at the antenna switch, unless the clapper switch should fail to open.

The lightning switch is shown in the accompanying photograph. A relay key, a legless Morse key, and an auxiliary hand key are supplied. The antenna ammeter is a Weston Thermo-ammeter, with a scale reading from zero to thirty amperes.

The armatures and field windings of the alternator and motor, and the low-tension winding of the transformer, are protected by FARADON protective condensers against radio frequency surges. A spare-part box is supplied, which contains spare fields for the motor and generator, spare brushes for the motor, spare contacts for the motor starter, and the keys, three spare spark-gap units, spare gaskets for the spark-gap units, and a spare FARADON primary condenser.

While it is not absolutely essential, it is considered advisable to include an auxiliary non-synchronous rotary spark gap, as described on page 60. The spares furnished are sufficient for at least five years' operation.

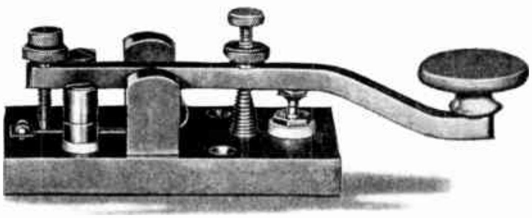
An instruction book accompanies this set, which contains wiring diagrams, photographs, installation data, and instructions for the adjustment of the set, and a list of the parts for replacement purposes.

PERFORMANCE OF 5 K.W. TRANSMITTER

Motor Input	6850 Watts	Combined Transformer and Reactance Efficiency	96%
Generator Output	5000 Watts	Radio Frequency Efficiency from condenser input to antenna external to set	49.2%
Transformer Output	4800 Watts	Overall Efficiency from D.C. line to antenna	34.5%
Antenna Power external to set	2360 Watts		
Motor Efficiency	88%		
Generator Efficiency	83%		

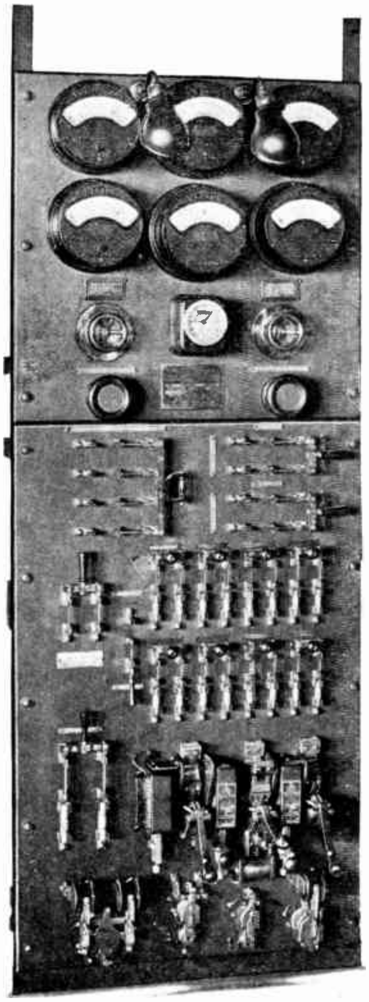
It is important to note that the antenna power and overall efficiency are based solely upon the antenna power useful for the radiation of waves, and do not include the power consumed in the antenna coil systems. Many manufacturers include the latter factor, thus obtaining an exaggerated antenna power and overall efficiency.

Weight of Low-Tension Control Panel, 310 pounds
Weight of High-Tension Radio Panel, 483 pounds
Weight of Motor Generator, 1300 pounds
Size of Low-Tension Control Panel, 9' 1" x 17" x 20"
Size of Shipping Case, 9' 10" x 2' 3" x 2' 5"
Size of High-Tension Radio Panel, 5' 10" x 3' x 2' 4"
Size of Shipping Case, 6' 10" x 4' x 3' 4"
Size of Motor Generator, 36" x 20" x 20"
Size of Shipping Case, 4' x 2' 4" x 2' 2"

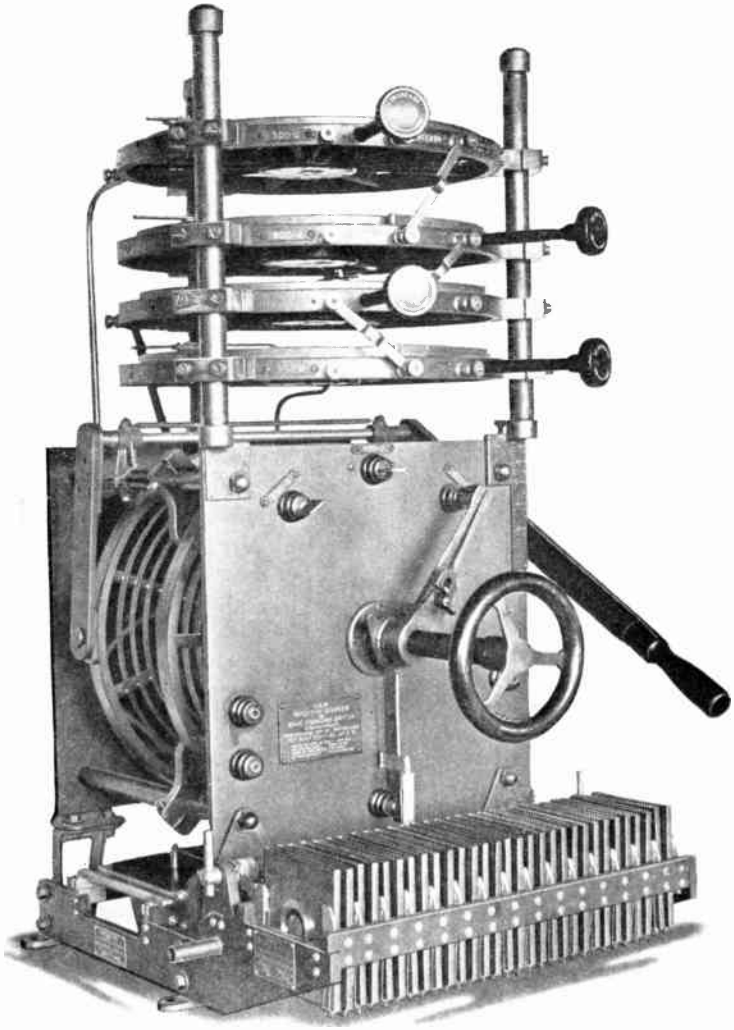


LIGHT HAND KEY, TYPE Q-S-504

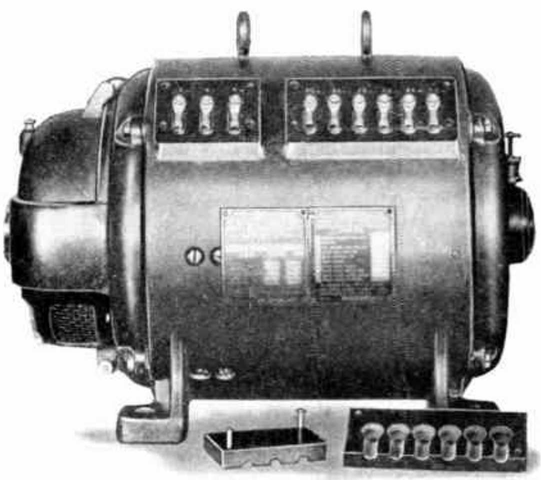
2 K.W. TRANSMITTER, TYPE Q-S-2000



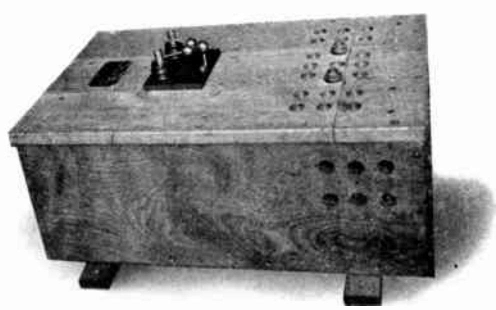
Low-Tension Control Panel



High-Tension Radio Panel



Motor Generator



Transformer

2 K.W. TRANSMITTER, TYPE Q-S-2000

THE 2 K.W. transmitter has a daylight range of approximately seven hundred miles over sea water. It is arranged to transmit on any one of three standard wave-lengths, changes being accomplished by a single-control wave-changing mechanism. This outfit is similar in general design to the 5 K.W. set, with the exception that the low-tension control panel contains in addition to the other controls, all the necessary switches and meters for controlling auxiliary storage batteries. The apparatus is mounted on two panels. One contains all the high-frequency circuits, the other the low-frequency and prime-mover controls, meters, and storage-battery controls.

The motor generator, automatic starter, transformer, relay and hand keys, antenna switch, antenna ammeter, and lightning switch, are supplied for separate mounting. This feature permits the location of the motor generator outside the radio room and allows remote control of the station.

Low-Tension Control Panel

The low-tension control panel consists of two micarta panels, mounted upon a suitable angle-iron frame. Mounted upon the upper panel are seven meters indicating the voltage, current, output, and frequency of the 500-cycle generator, and the voltage, current, and ampere hours of the storage batteries. All seven meters are Weston instruments, accurate within 2% of their reading. A pilot lamp is placed on top, lighting the faces of the meters. A power-control rheostat is connected in the generator field circuit, and a frequency-control rheostat in the motor field circuit.

A voltmeter switch is provided for connecting the D.C. voltmeter across either one of the two storage battery sections during charge, across both in series during discharge, and across the D.C. charging line. An ammeter switch is furnished for connecting the D.C. ammeter in the circuit of either battery during charge, in the discharge circuit, or in the D.C. line. Upon the lower panel are mounted the necessary switches for controlling the charge and discharge of the storage battery, a series of switches controlling various lighting circuits when supplied from the storage battery, a D.C. main-line double-pole circuit-breaker, a single-pole reverse current release circuit-breaker, automatic starter, and a generator line field contactor. The magnet coil of the latter is fed from the D.C. main line, and is connected in series with contacts on the antenna switch. It opens the A.C. line and the generator field simultaneously when the antenna switch is in the "receive" position.

Motor Generator and Automatic Starter

The motor generator is a Holtzer-Cabot two-bearing machine. The prime mover is a 120-volt D.C. shunt interpole motor, which drives a single-phase 250-volt 500-cycle inductor type alternator, at a speed of 2000 R.P.M. The machine is started by an auto starter, which consists of a three-step accelerator enclosed in a sheet-iron case. The starter and generator are usually mounted in a compartment outside of the "receiving" room.

Transformer and Reactance

The transformer is of the closed core minimum leakage type, in which special care is taken in the design to secure a high insulation safety factor. The individual sections of the secondary are separated by heavy micanite discs, while the primary and secondary are separated by heavy micanite tubes. The reactance is mounted in the same case as the transformer. The characteristics of this transformer are discussed under "Transformers" on page 48 of this catalog.

High-Tension Radio Panel

The high-tension radio panel is of bakelite dilecto and contains the primary coil, primary condensers, quenched spark gap, coupling coil, and the antenna loading inductance. These units are assembled together with a wave-length changing mechanism, which, as supplied, adjusts the set to any one of the three standard wave-lengths; 300, 600, or 952 meters.

Wave-length control is obtained by the rotation of a single handle. This automatically varies the period of the primary, the coupling between the primary and antenna, and the antenna inductance. The continuously variable fine control of coupling is provided by means of a lever handle. Variometer tuning of the antenna on each wave-length is arranged so that the tuning of any one wave-length will not disturb the adjustment of any of the remaining wave-lengths. This is accomplished by handles projecting from the antenna inductance coils.

The spark gap consists of fifteen units of the self-cooled type with a switching mechanism for varying the number of gaps in the circuit. The primary transmitting condenser consists of four Faradon .004 mfd. mica units.

General

The antenna switch furnished with this 2 K.W. outfit is similar to that supplied with the 5 K.W. transmitter, and is described in detail on page 58 of this catalog. A lightning switch, relay key, legless Morse key, and an auxiliary hand key are furnished. The antenna ammeter is a Weston thermo-ammeter, with a scale reading from 0 to 20 amperes.

The armatures and field windings of the alternator and motor, and the low-tension winding of the transformer, are protected by Faradon protective condensers against radio frequency surges.

A spare-part box is supplied which contains spare fields for the motor and generator, spare brushes for the motor, spare contacts for the motor starter and the keys, three spare spark-gap units, spare gaskets for the spark-gap units, and a spare Faradon primary condenser. While it is not supplied, unless specified, it is recommended that an auxiliary non-synchronous rotary spark gap as described on page 60 should be taken with this outfit.

The spares furnished are based on five years' operation.

An instruction book accompanies this set, containing wiring diagrams, photographs, installation data, instructions for the adjustment of the set, and a list of the parts for replacement purposes.

Weight of Low-Tension Control Panel, 475 pounds
Weight of High-Tension Radio Panel, 170 pounds
Weight of Motor Generator, 525 pounds
Size of Low-Tension Control Panel, 6' x 2'7" x 1'9"
Size of Shipping Case, 6'10" x 3'3" x 2'5"
Size of High-Tension Radio Panel, 3'11" x 2'11" x 2'4"
Size of Shipping Case, 4'11" x 3'11" x 3'4"
Size of Motor Generator, 26" x 18" x 16"
Size of Shipping Case, 34" x 24" x 19"

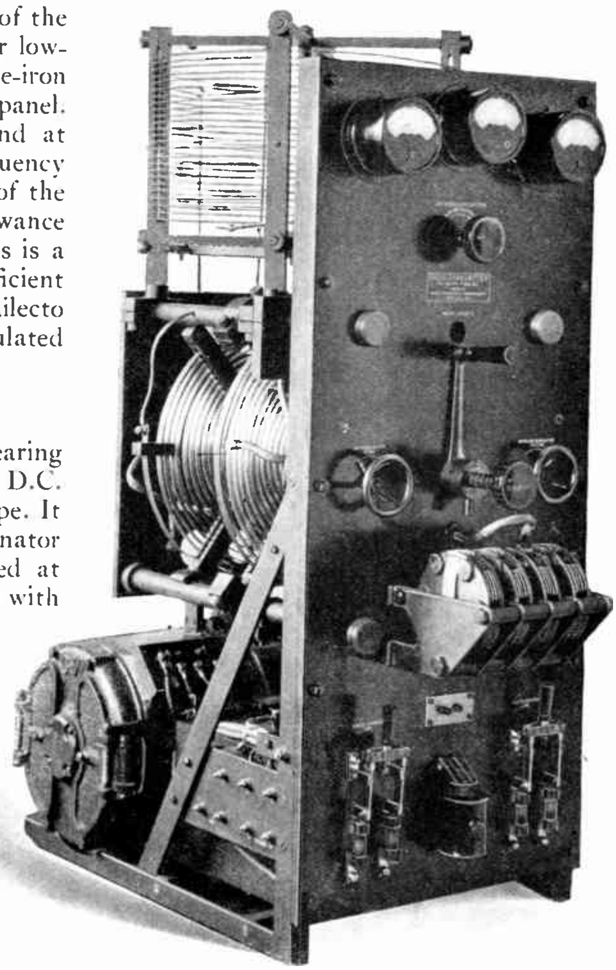
½ K.W. TRANSMITTER, TYPE Q-S-500

THE Type Q-S-500 ½ K.W. Transmitter is a compact single-panel transmitter of the 500-cycle quenched spark type. It combines lightness, simplicity, durability, and high radio efficiency in the most desirable combination. This transmitter has a normal daylight transmission range of approximately 400 miles. At night and under favorable conditions this distance is greatly exceeded. Its extreme simplicity, ruggedness, and high electrical safety factor will be quickly appreciated by the ship-owner who has experienced endless trouble with complicated, short-lived, inefficient equipment. We invite comparison with ½ K.W. transmitters of other makes. This transmitter is an ideal installation for yachts, commercial vessels, colleges, and research laboratories. We have successfully installed the Q-S-500 transmitter on the vessels of a deep-water fishing fleet where the equipment is giving satisfactory service under the extremely rigorous conditions met in this service.

The apparatus is mounted on a bakelite dilecto panel, braced with angle iron. All the controls, the meters, and the quenched spark gap are mounted on the front of the panel. The motor-generator and other low-tension units are supported by the angle-iron frame-work at the lower rear of the panel. Above the low-tension equipment and at the rear of the panel are the radio frequency circuits occupying about two-thirds of the space of the entire set. This liberal allowance of space in the design of these circuits is a big factor in the reliable and efficient operation of the set. Heavy bakelite dilecto tubes furnish a solid and well insulated support for these circuits.

Low-Tension Apparatus

The motor-generator is a two-bearing machine. The motor is a 110-volt D.C. machine of the shunt and interpole type. It drives a 500-cycle inductor type alternator at 2500 R.P.M. A resistance mounted at the rear of the panel is thrown in series with the D.C. armature on starting, and when the machine reaches proper speed is automatically cut out by the one-step starter mounted at the lower center of the panel front. Placed at either side of this starter are double-pole knife switches with fuses, controlling the D.C. Line and the A.C. Generator Line. The motor-generator windings and the lines are thoroughly protected from radio frequency



Front View ½ K.W. Transmitter, Type Q-S-500 surges by Faradon mica protective condensers. The 500-cycle wattmeter, the voltmeter, and the antenna ammeter are mounted at the top of the panel. A voltmeter switch mounted directly above the auto-starter permits the reading of either the D.C. line voltage or the 500-cycle voltage.

Transformer and Reactance

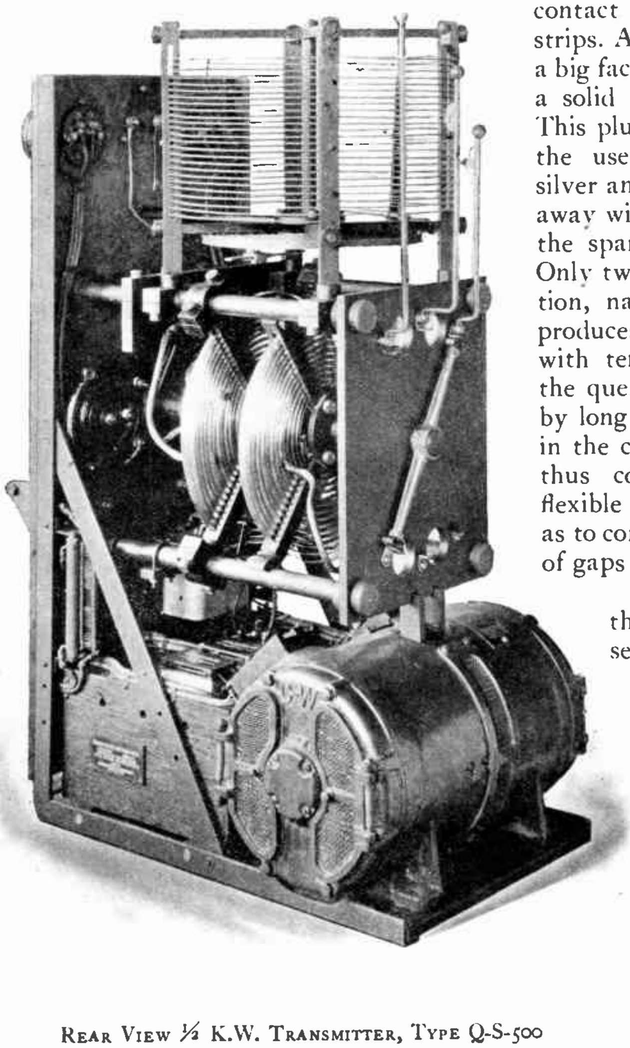
The output of the generator is fed into a combined reactance and minimum leakage transformer. This transformer has a high insulation safety factor and an overall efficiency of 92%.

High-Tension Radio Equipment

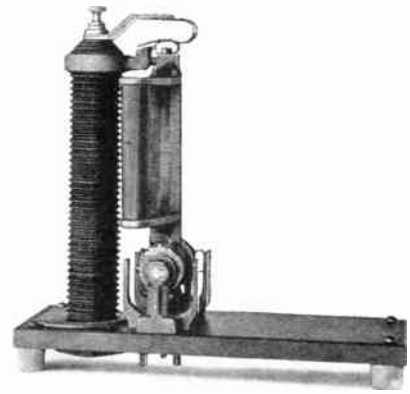
The secondary of the transformer charges a .004 mfd. Faradon mica condenser unit. The quenched spark gap is of a new and highly efficient design. It is of the self-cooled type built in four units of three gaps each. Each of these units is easily removable. Excellent contact is secured by broad phosphor bronze strips. A novel feature of this gap, which is a big factor in its high efficiency, is the use of a solid silver plug for the sparking surface. This plug is welded into a copper disc without the use of solder. This process makes the silver an integral part of the copper and does away with the buckling found in gaps where the sparking surfaces are riveted or soldered. Only two metals are present in the construction, namely, copper and silver. The design produces a gap in which no distortion occurs with temperature changes and consequently the quenching action of the gap is unimpaired by long periods of use. The number of gaps in the circuit may be varied and the power thus controlled through the medium of a flexible copper braid with a clip arranged so as to conveniently connect any desired number of gaps in series.

In the center and directly behind the panel are mounted the primary and secondary coils of pancake type design. A handle projecting through the front of the panel permits continuous coupling variation.

A wave-changer switch is located concentrically with the coupling-coil handle and varies simultaneously the inductance in the primary, the coupling between the primary and secondary circuits, and the loading inductance in the antenna circuit. This arrangement permits instantaneous shifting to any one



Rear View ½ K.W. Transmitter, Type Q-S-500 of three wave-lengths. A wave indicator with wave-lengths engraved upon it shows through a window directly above the wave-changer switch. Each of the three wave-lengths is engraved on a separate piece of sheet dilecto which is easily removable from the indicator. Any one of these may therefore be removed and a new wave-length indicator inserted. This arrangement is greatly superior to the conventional method of engraving wave-lengths directly upon the panel.



ANTENNA SWITCH, TYPE Q-S-501

The loading inductance consists of a pancake coil in series with a helical coil of edge-wise wound copper ribbon. It is located directly above the primary and coupling coils. The lead from the coupling coil to the loading inductance passes through one of the heavy bakelite dilecto tubes supporting the antenna coil system. This effectively prevents this lead from making accidental contact with other high-tension leads, and also adds to the appearance of the set. The amount of inductance in the helical coil necessary for a given wave-length is automatically controlled by the wave-changer switch. Fine tuning is permitted by continuous variation of the pancake coil controlled by a handle on the panel located directly below the meters. This set is suitable for operation on antennae having capacities between .0015 and .0004 mfd. and has a wave-length range of 300—800 meters. Five wave-lengths are calibrated, namely, 300, 450, 575, 600, and 750 meters.

The antenna ammeter is a Roller-Smith radio-frequency thermo-ammeter, located at the top of the panel in the center. It has a scale reading from 0-10 amperes. With 500 watts input into the transformer and at 600 meters on a normal antenna, the radiation is approximately eight amperes.

ANTENNA SWITCH

The antenna switch is furnished with the transmitter. Adequate insulation is afforded by a tall corrugated bakelite dilecto insulator. The base is heavy bakelite dilecto supported by four rubber feet.

In sending position this switch connects the antenna to the transmitter, starts the motor-generator, and short-circuits the detector.

In the receiving position this switch connects the antenna to the receiver, applies a magnetic brake to the motor-generator and thus brings the machine to a quick stop, and opens the short circuit across the detector.

GENERAL

The key is the light hand key described on page 50, and equipped with flexible leads for connection to the primary terminal board. The lightning switch is described on page 59. The terminal board on the lower left side of the transmitter provides easily accessible connection for the ship's mains, key, and the send-receive switch. Both the ground and the antenna connections are taken off at the left of the transmitter. All low-tension wiring is enclosed in lead cable, with the cable cleated to the rear of the panel and grounded.

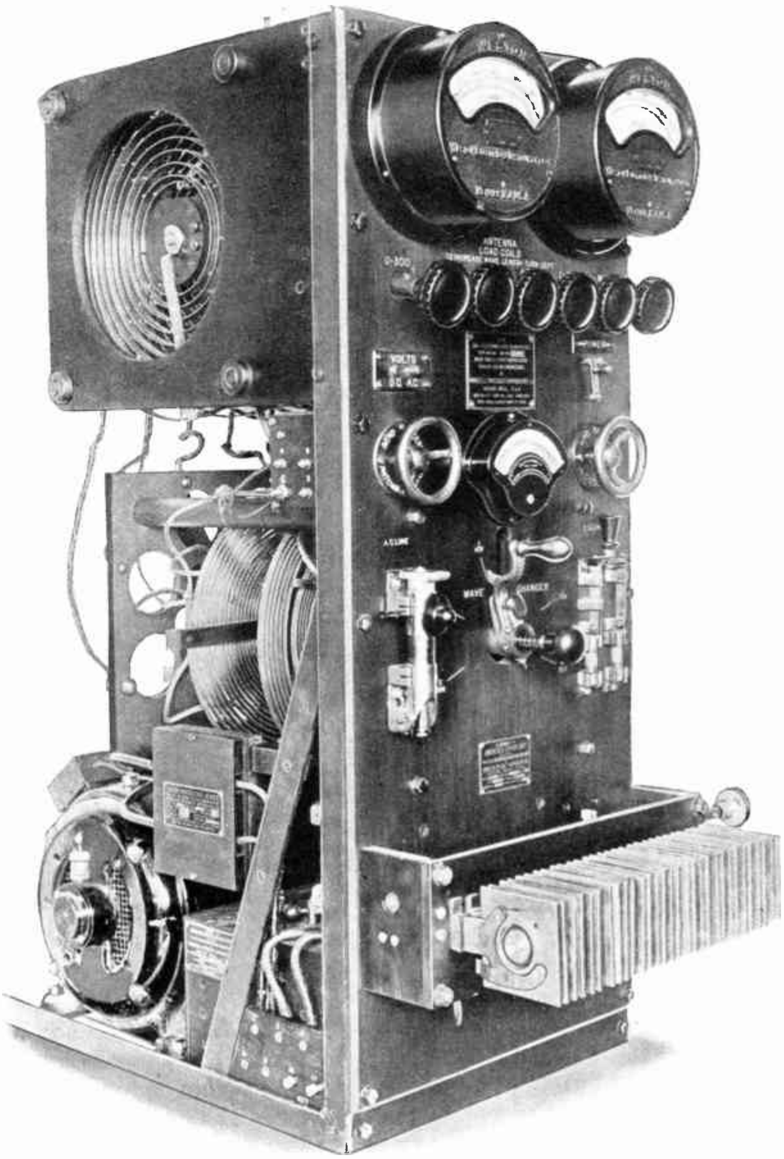
With proper care, the spare parts provided are sufficient for five years' operation. These parts include spare fields for the motor and generator, spare brushes for the motor, and spares for the spark gap and key.

Overall Dimensions, 45"x26"x17" Dimensions of Packing Case, 51"x32"x24" Weight of Transmitter, 425 pounds

½ K.W. TRANSMITTER, TYPE Q-S-A-500

THIS ½ K.W. transmitter is a self-contained unit. All the apparatus, with the exception of the transmitting key, is mounted upon the panel structure. The range of this transmitter is approximately three hundred and fifty miles. This set is designed essentially for small commercial vessels and pleasure yachts. Six standard wave-lengths are provided. The change of wave-length is easily accomplished by a wave-changer switch, mounted in the center of the panel. The set offers as simple a control as is practical without sacrifice of efficiency. Its compactness, coupled with its single unit, panel design, provides extremely simple installation. This feature renders it an attractive equipment for cargo vessels carrying operators with second-class or cargo-grade certificates. Large numbers of these transmitters gave admirable service on the submarine chaser flotilla.

The set is built upon a bakelite dilecto panel, braced with angle iron. On the front of the panel are mounted the meters, controls, and spark gap. The radio frequency circuits are located on the upper rear of the panel, and are attached by heavy bakelite dilecto supports. The heavier low-tension apparatus is mounted on the lower rear of the panel, with its weight distributed directly upon the angle-iron frame.



½ K.W. Transmitter, Type Q-S-A-500

Motor Generator

The motor generator is a two-bearing Holtzer-Cabot machine. A 120-volt D.C. shunt and interpole motor drives a

500-cycle inductor type generator at 2500 R.P.M. A two-step automatic starter for the motor and a circuit breaker for the A.C. line are mounted in an accessible location behind the panel. Continuously variable generator voltage control is provided. The A.C. and 500-cycle sources are equipped with FARADON protective devices, to prevent radio frequency surges from damaging the lines and windings. A Weston wattmeter and voltmeter are mounted on the upper portion of the panel. A switch is provided for reading either the ship's line or the 500-cycle voltage.

TRANSFORMER AND REACTANCE

The output of the generator is fed into a combined reactance and minimum leakage transformer, the efficiency of which is 92%. The transformer has a high insulation safety factor.

HIGH-TENSION RADIO EQUIPMENT

The output of the transformer charges a FARADON .004 mfd. condenser unit. The spark gap is composed of fifteen units, and is of the self-cooled type. It is equipped with a switch for varying the power by changing the number of gaps in the circuit. The power may also be varied by a two-point switch, located on the front of the panel, over the generator field rheostat. This switch cuts in a large resistance in series with the generator field for low-power operation.

In the center and behind the panel are mounted the primary and coupling coils. The handle projecting through the front of the panel permits continuous variation of coupling between primary and secondary coils.

The wave-changer switch, located concentrically with the coupling-coil handle, varies simultaneously the period of the primary, the coupling between the primary and antenna, and the loading inductance in the antenna circuit.

The loading inductance consists of six variometers, located directly above the primary and coupling coils. This permits of separate tuning for each of the six wave-lengths without disturbing the adjustment of any of the other wave-lengths. This set is suitable for operation on antennae having capacities between .001 and .0004 mfd.

The antenna ammeter is a Weston thermo-ammeter, mounted in the center of the panel, directly over the wave-changer switch.

The send-receive switch, mounted to the left of the antenna ammeter, opens the generator field on the receive position, and connects the antenna to the receiver. On the send position, it closes the generator field, and completes the antenna-ground circuit through the transmitter.

GENERAL

The key provided is a flame-proof key, as described on page 51, equipped with flexible leads for connection to the primary terminal board. The terminal board on the side of the transmitter provides accessible connections for the ship's mains and the key. The wiring is in lead cable, cleated to the rear of the panel. The lead sheathing is grounded.

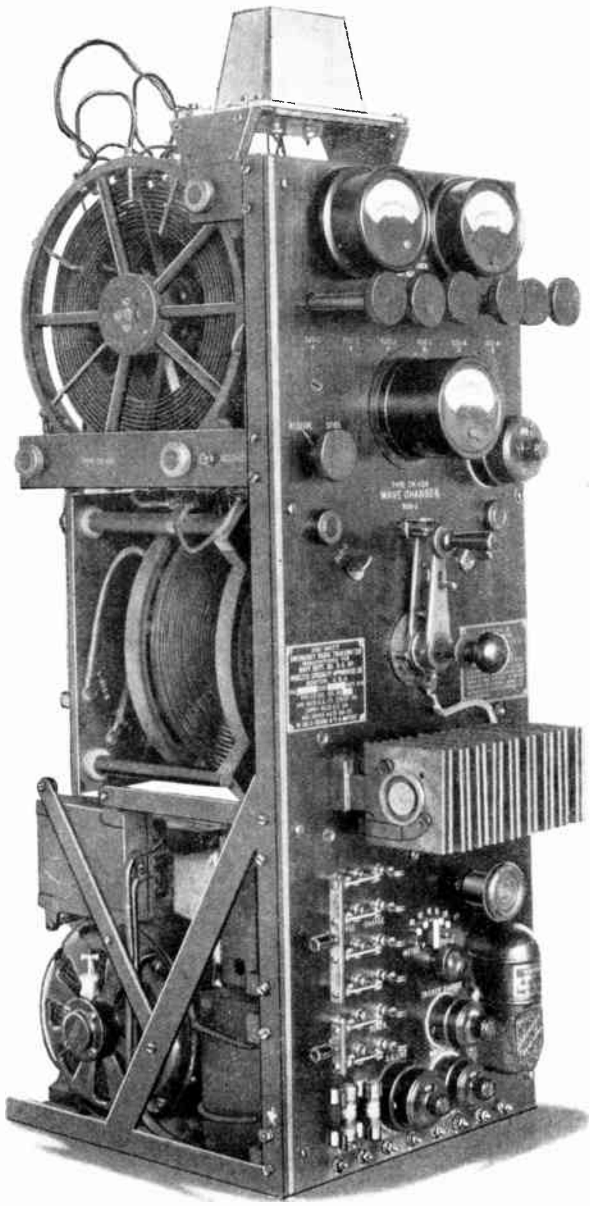
Three spare spark-gap units, spare field coils for the motor and generator, and spare brushes for the motor, are provided. Spares are based upon a five years' operation.

The materials used in this construction are of the highest grade obtainable in conformance with the small space occupied by the design. The set is an attractive and substantial unit.

Overall dimensions, 42" x 32" x 20" Dimensions of Packing Case, 54" x 44" x 32"
Weight of Transmitter, 460 pounds

200-WATT EMERGENCY TRANSMITTER, TYPE Q-S-200

THE emergency transmitter was designed as an auxiliary to the main transmitter, for operation in cases where the 110-volt source is put out of commission through various causes, such as collision at sea, or the bursting of a steam line. It also provides for transmission in cases where the vessel is tied up at dock, and the boiler fires drawn for cleaning or repair. The range of this set is approximately two hundred miles.



200-WATT EMERGENCY TRANSMITTER, TYPE Q-S-200

Since the United States Radio Law requires an emergency transmitter with a range of at least one hundred miles, the equipment described provides an adequate safety factor. The set is likewise suitable as a main set for equipment on small vessels and pleasure yachts.

The self-contained type of construction is used. Since emergency equipment must be operated from a storage battery, switches and rheostats for charging and discharging storage batteries are built into the set. For maximum safety, it is desirable also to provide an additional small single-wire antenna. With this consideration in view, as well as the demand for maximum flexibility, the set is designed so that it will operate on either a main or auxiliary antenna without requiring readjustment when changing over from one to the other.

This set is suitable for operation on auxiliary antennae having capacities ranging from a .0006 to .0008 mfd., and on main antennae having capacities ranging from .001 to .0013 mfd.

A switch is arranged so that the prime mover may be run from either the ship's mains or the storage battery.

The transmitter is built upon a bakelite dilecto panel, supported from an angle-iron frame. The instruments, controls, and spark gap are mounted on the front of the panel.

The radio frequency circuits are mounted on the upper rear of the panel, and fastened to it by rugged bakelite dilecto mountings. The low-tension units are mounted on the lower rear of the panel, being rigidly fastened to the supporting metal frame.

Motor Generator

The motor generator is a two-bearing Holtzer-Cabot machine. The motor is a D.C. 120-volt shunt and interpole machine, with a speed of 3,000 R.P.M., which drives a 200-watt, 500-cycle inductor type generator. The motor is started by a two-step automatic starter, mounted on the lower right-hand side of the panel. Field controls for the motor and generator are provided. Snap switches are used for the D.C. and 500-cycle lines.

A wattmeter and voltmeter are mounted on the upper portion of the panel. A snap switch permits the reading of either the D.C. line or the 500-cycle voltage. The 500-cycle generator contains a protective device to prevent radio frequency surges from damaging the windings.

Transformer and Reactance

The output of the generator is fed into a combined reactance and minimum leakage transformer, the efficiency of which is 89%.

High-Tension Radio Apparatus

The transformer charges a Faradon .004 mfd. mica condenser.

The spark-gap consists of nine units of the self-cooled type.

The primary and secondary circuits are located at the rear center of the panel. Continuous variation of coupling is provided by a control located at the center of the panel. Concentric with the coupler control is the wave-changer switch. Three standard wave-lengths are provided, namely, 300, 600, and 952 meters. The wave-changer switch simultaneously varies the period of the primary, the coupling between the primary and antenna, and the loading inductance in series with the antenna.

An antenna inductance consisting of six variometers is located directly above the primary and coupling coils. Three of the antenna variometers are used for the main antenna, and the remaining three for the auxiliary antenna. Continuous variation of tuning of any wave-length on either antenna without the adjustment of any of the remaining five tunes is thereby provided. A clutch located on the wave-changer switch-handle connects the wave-changer to either the main or auxiliary antenna.

A series antenna condenser is fastened on brackets above the antenna coils, for shortening the main antenna, to obtain a 300-meter wave.

An antenna ammeter is mounted on the upper portion of the panel. A send-receive switch is located above the wave changer on the left of the panel.

Battery Control

The battery-charging equipment consists of a charge-discharge switch, a battery rheostat, and a "trickle" charge switch. A double-throw switch for feeding the prime mover from either the ship's line or the storage battery is located directly under the charge-discharge switch.

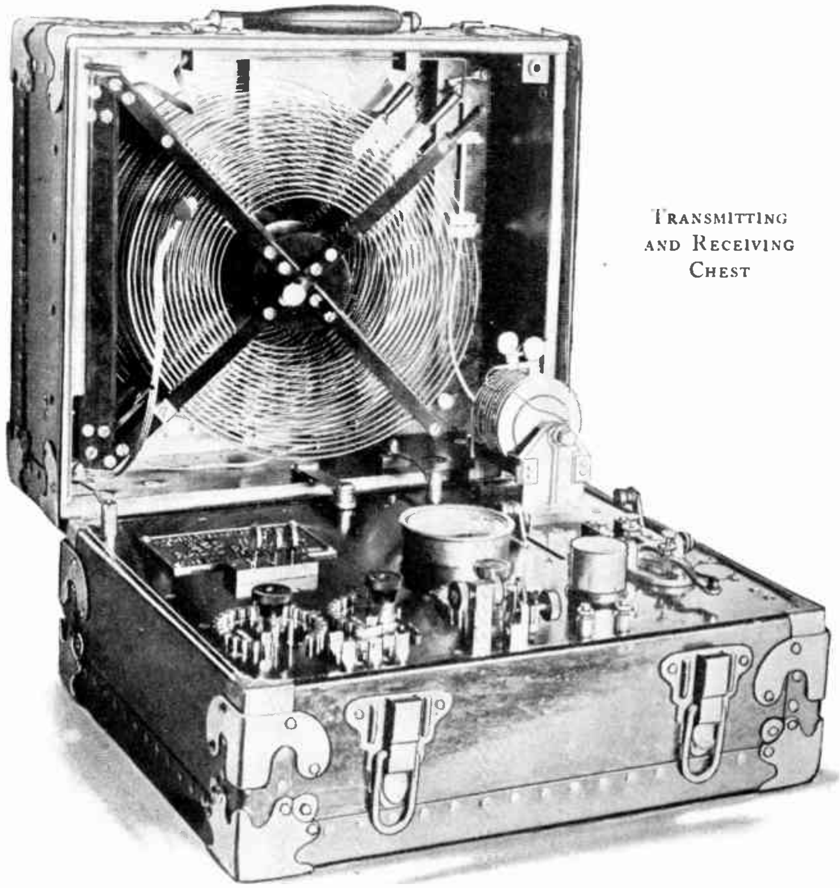
General

All connections to the set are made at binding posts located at the base of the panel. All low-tension wiring on the set is lead covered and cleated to the panel. The lead sheathing is grounded.

The key is of the flame-proof type described on page 51 and is provided with flexible leads for connecting to the transmitter. Special attention has been paid to the provision of a large safety factor in view of the emergency character of this equipment, and its small space factor. The workmanship and finish are the best.

Overall size, 44" x 19" x 15" Dimensions of Packing Case, 43" x 25" x 19"
Weight of Transmitter, complete, 210 pounds

250-WATT RADIO PACK-EQUIPMENT, TYPE Q-S-250



TRANSMITTING AND RECEIVING CHEST

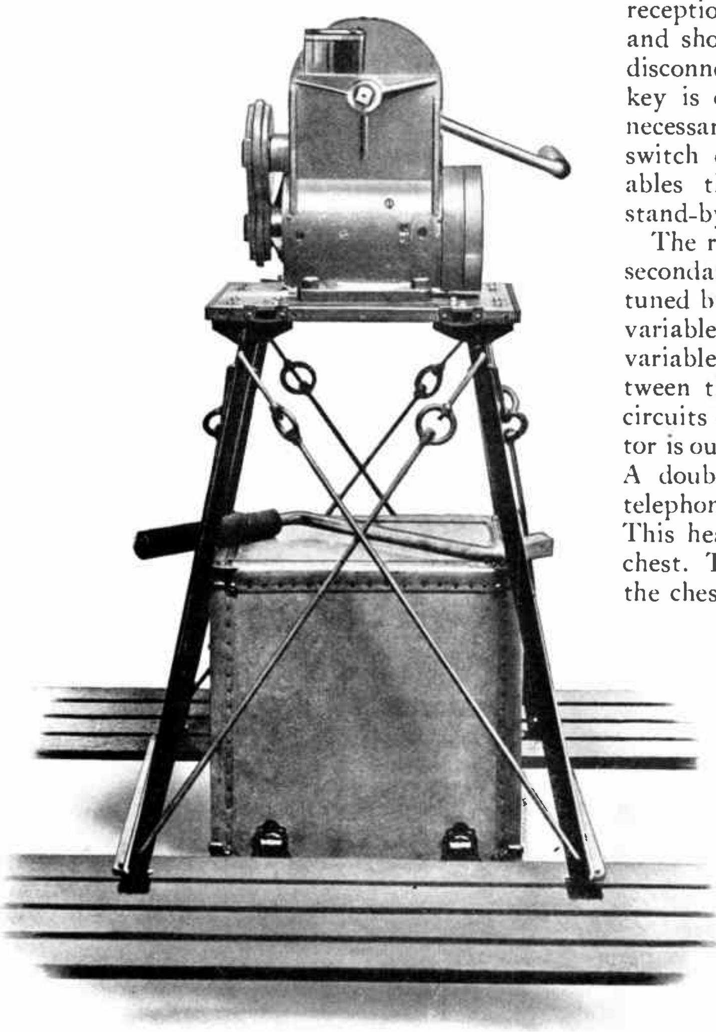
THE portable pack-equipment shown in the accompanying photographs is designed especially for mobile military stations. It may also be used on small vessels and cruising yachts, where only limited range of communication is required. The set is a complete two-way unit, consisting of antenna, radio transmitter, radio receiver, and prime mover, which may be either a small gasoline engine, or a hand-driven generator. The complete set can be arranged for transportation on the back of a mule, and provides an equipment that may be transported over rough trails impassable to the ordinary army wagons. The complete set can be unpacked and completely erected in approximately four minutes. It combines, in the nearest desirable proportions, compactness, ruggedness, weather-resisting qualities, ease and rapidity of erection and transportation, and a high radio efficiency.

THE TRANSMITTING AND RECEIVING CHEST

The transmitting and receiving apparatus, exclusive of the antenna and generator, is mounted in a stout chest of weather-proof fibre sheeting, bound with heavy brass trimmings. The cover may be opened and clamped by a link in this position as shown in the photo. In the cover are mounted the oscillation transformer, the antenna inductance, part of the antenna transfer switch, and the antenna connection socket. The panel of the chest proper is bakelite dilecto. On it are mounted the quenched spark gap, a 0.5 ampere hot-wire antenna-ammeter, the key, the antenna switch, the receiving circuit controls, galena crystal detector, and a switch for changing from the break-in system of transmission to straight transmission.

Under the panel and in the chest are mounted a resonance transformer of the leakage type, a .004 mfd. FARADON condenser, the receiver coils, and the wiring. All the wiring is of rigid copper bus, heavily silver-plated, and firmly cleated to the panel. All the transmitting coils are spirally-wound inductances, which swing on a pivot located at the left of the box, to provide continuously variable coupling between primary and antenna. The primary coil is calibrated so that various standard wave-lengths may be used.

The key is fitted with contacts that provide a break system. This system permits reception when the key is open, and short-circuits the crystal and disconnects the receiver when the key is closed. This makes it unnecessary to throw the send-receive switch during operation, and enables the operator to detect a stand-by signal when sending.



GENERATOR WITH HAND DRIVE, TYPE Q-S-251

The receiver is of the aperiodic secondary type. The antenna is tuned by large and small step-wise variable inductances. Continuously variable coupling is provided between the primary and secondary circuits of the receiver. The detector is our well-known galena type. A double-receiver high-resistance telephone head set is supplied. This head set packs in the radio chest. The overall dimensions of the chest are 17½" x 15" x 10". Its weight is 55 pounds. When closed, it may be carried by a handle, similar to an ordinary suitcase. A plug terminal board is arranged for plugging in the alternator. Two plugs are provided for antenna and ground connections.

THE MAST AND ANTENNA

The antenna consists of an umbrella, the mast being built of eight sections, each eight feet long. The sections are made of wood and are hollow. They have suitable metal fittings at the ends, one end having a projecting metal pin which fits into a socket in the next section. There are also suitable metal plates which are inserted between the sections and are used to connect the guys and antenna wires. Pins are provided, to be used in fastening the guys and antenna wires to the ground. The antenna and counterpoise wires are supplied on reels, which are used in transporting the equipment. A canvas case is supplied, into which the entire mast and antenna is packed.

The Generator

The generator is of the 500-cycle type, and of 250 watts output. It may be driven by a motor for shipboard installation, by a hand generator for field operation, or by a gasoline engine for either field or shipboard installation. When the motor drive is desired, a 120-volt D.C. motor will be provided unless otherwise specified.

In the case of hand drive, the generator is mounted upon a collapsible stand as shown in the photo on the preceding page, and is operated by two men. For the benefit of the men at the cranks, and to obtain a nearly constant speed, a centrifugal type speed indicator is conveniently mounted upon the casing. The weight of the hand-drive generator equipment is 77 pounds.

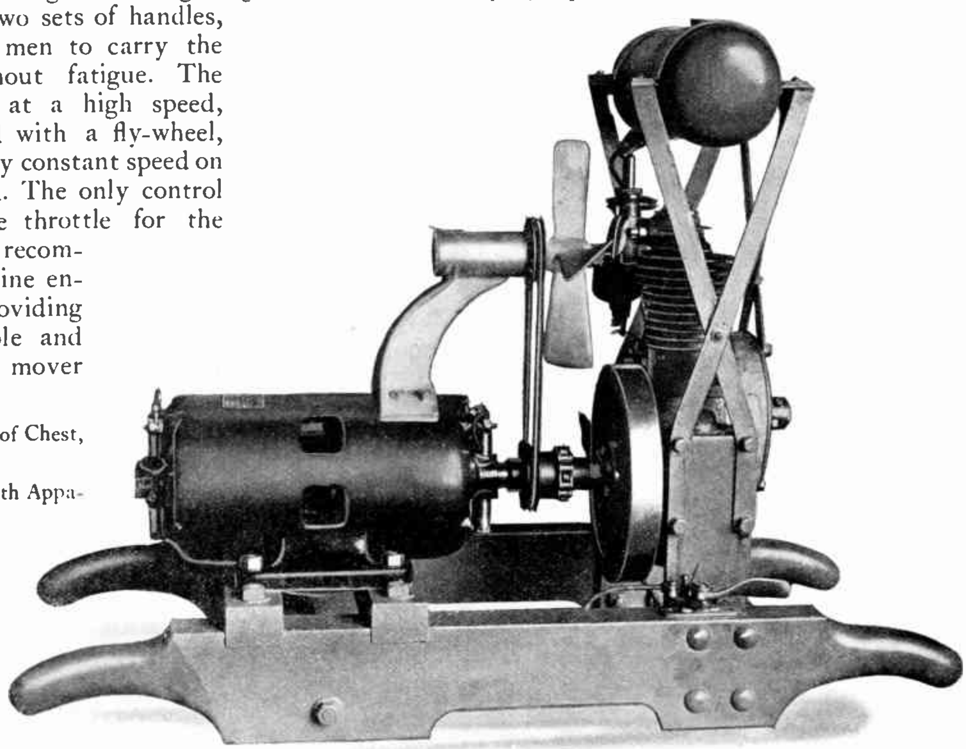
For gasoline engine drive a small single-cylinder four-cycle air-cooled engine is mounted on an oak frame, directly connected to the five-hundred cycle generator and exciter. The gasoline tank, ignition and oiling systems are mounted on the engine frame. The weight of the gasoline engine generator unit is only 130 pounds. Its oak frame is equipped with two sets of handles, permitting two men to carry the equipment without fatigue. The engine operates at a high speed, and is provided with a fly-wheel, giving practically constant speed on telegraphic load. The only control required is the throttle for the carburetor. We recommend this gasoline engine drive, as providing the most flexible and practical prime mover for field use.

Overall Dimensions of Chest, 17½"x15"x10"

Weight of Chest, with Apparatus, 55 pounds

Weight of Hand-driven Generator packed, 77 pounds

Weight of Gasoline-driven Generator, 130 pounds

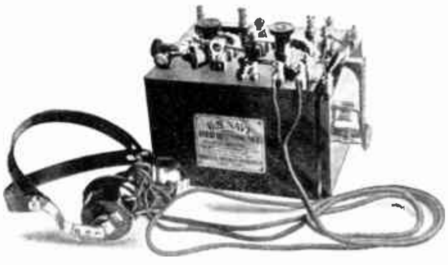


Gasoline Engine Drive, Type Q-S-252

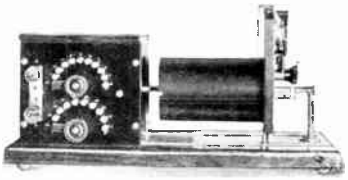
III. RECEIVERS

Historical Development

THE Wireless Specialty Apparatus Company has been the most potent factor in the origination and development of radio receivers. In 1907 our first I-P-76 type of receiver, shown in the accompanying photograph, was offered for sale. This receiver retired the sliding contact tuners from the art. It provided a system in which high efficiencies could be obtained by overcoming the losses occurring in the older types due to short-circuited turns, and inherent leakage between turns. In 1909 the I-P-76 receiver, shown on page 6 of this catalog, was placed on the market. This receiver represented at that time the last word in radio receiver design. The United States Navy adopted it as a standard. These original receivers are in use today, and are still giving very satisfactory service.



1907 Type Receiver



1908 Type Receiver

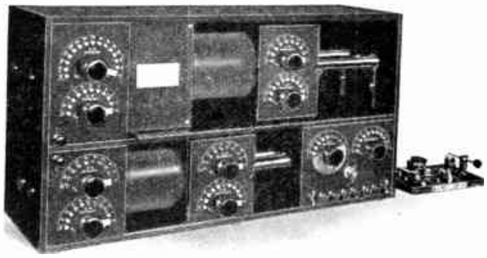
A demand for a receiver that would permit a single operator to listen in on two wave-lengths was fulfilled by our I-P-1914 double-deck receiver. This is shown in the lower right-hand cut. The receiver permitted the operator to listen in simultaneously on both the ship and shore wave-length ranges. This increased the speed of handling traffic and considerably reduced the time required for station calling.

Later Types

Three of our modern receivers are listed on pages 30 to 34. They are the I-P-500, the I-P-501, and the I-P-77. Both damped and undamped detecting circuit apparatus is included in the I-P-500 and I-P-501 types. In the type I-P-500 the battery controls, etc., are on a separate control box. The control box contains a one-step amplifier.

The type I-P-501 is self-contained, including all controls for damped and sustained wave reception. This receiver is a very compact design for installations where space is an important factor. Both types will receive arc, spark, and radio telephone signals.

Our I-P-77 receiver shown on page 34 is the most efficient crystal receiver of the untuned secondary type on the market today. It is extremely simple in operation.

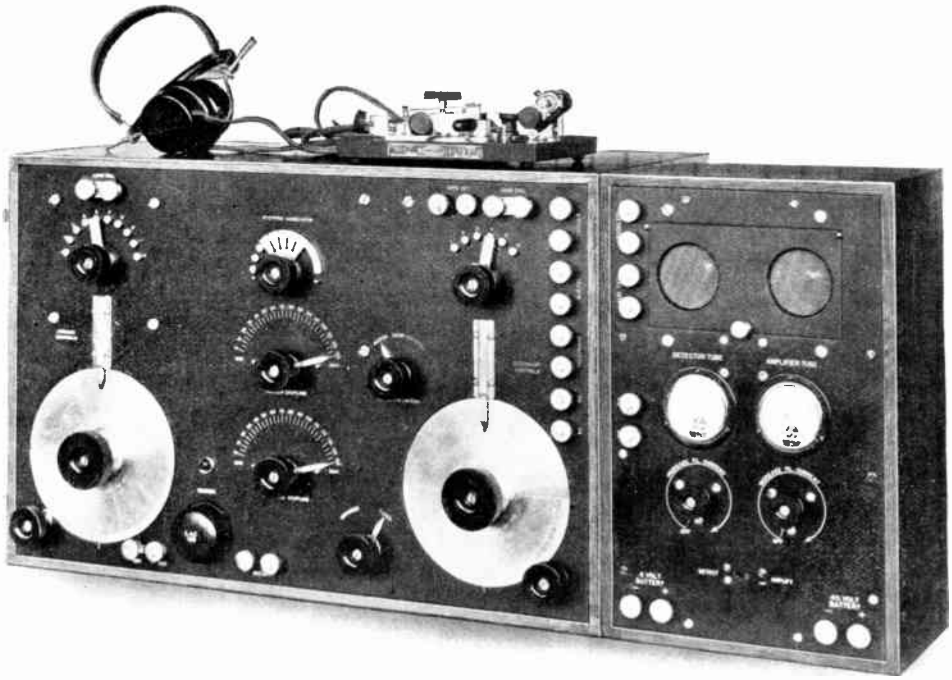


1914 "Double-Deck" I-P-76 Receiver
Originally designed for use in the United Fruit Company's ship and shore stations.

These receivers have the electrical properties of a high audibility, a maximum freedom from interference by static and interfering signals, and a flexible, controllable selectivity. This is obtained by an efficient design of the circuits, the elimination of all capacity coupling between the primary and secondary circuits, the use of high insulation between the active portions of the receiver, and the inclusion of end-portion, disconnecting switches, automatically controlled by the inductance range switch. In the mechancial construction is used the same high precision found in instrument manufacture. Nearly a thousand of I-P-500 and I-P-501 types, manufactured by the Wireless Specialty Apparatus Company, are now in use aboard United States naval vessels alone.

RECEIVER, TYPE I-P-500

(WITH AMPLIFIER CONTROL BOX, TYPE TRIODE A)



THE I-P-500 receiver is the most efficient receiver manufactured. The receiver consists of two separate units, as shown in cut, namely, the radio frequency unit, and the amplifier control unit. This permits the radio frequency unit to be furnished for commercial use independently of the amplifier unit. The circuits are designed to give the highest possible efficiency for both damped and sustained wave reception. The wave-length range of the receiver is 150 to 6800 meters. Longer wave-lengths may be obtained by the insertion of load coils in the circuit. This receiver possesses a high degree of selectivity, and is provided with an untuned or "stand-by" circuit. The receiver is especially adapted for use on commercial ship and shore stations handling a large volume of traffic. It insures reliable daylight reception from transoceanic stations.

A switching mechanism permits the use of either of two tuned circuits on an untuned secondary. The coupling between antenna and secondary is purely electromagnetic and continuously variable, passing from the maximum coupling value through zero to a small reverse coupling. By providing absolute zero coupling between the circuits, desirable low couplings up to zero value are assured. Interference is greatly reduced by this means. The maximum coupling for any wave-length is such that appreciable detuning of the circuits does not occur in going from the zero to the maximum value. The coupling maximum gives a rapid change of coupling per degree on close coupling, and a very small change per degree on loose coupling.

A variable control is provided in the receiver which permits reception of either spark or undamped signals.

The coils used in the receiver are banked-wound inductances of high-frequency cable, wound on threaded bakelite tubes. The assembled coils are impregnated in vacuum and baked. The coils are sectionalized with spaces between the sections. The individual sections are automatically connected, entirely disconnected and opened, or entirely disconnected and individually short-circuited, by a mechanism operated by the inductance switch. By this means every coil in the receiver has a natural period when connected with its leads and switch points which is less than the shortest wave-length in the range of the receiver. This eliminates the reception of parisitic signals, reduces the absorption of the desired signal by the coils, forces the energy into the detector, and minimizes interference on all wave-lengths within the wave-length range of the receiver.

The condensers are of the self-balanced plate type. Insulating bushings are entirely absent in their construction. Their calibration is constant and their losses extremely low. A gearing mechanism connects the condenser shaft to a control which gives a vernier motion of the condenser for adjusting the note.

The condenser dial is engraved with marking from 0 to 180° and with rows of concentric circles. A mechanism operated by the inductance switch moves a pointer to successive engraved bands. On these bands may be engraved the wave-length calibration of the receiver. This will assist in identifying stations and operating a network on wave-length schedules.

The untuned or "pick-up" position can be made as broad or selective as desired by coupling control. In switching from untuned to tuned secondary, no readjustment of the primary is necessary.

Since static or capacity coupling between antenna and secondary circuits causes the receiver to pick up atmospheric disturbances and interfering signals, we have carefully eliminated all capacity couplings by a wide separation of the points in the two circuits of relatively high potential difference, and by the disposition of ground and low potential leads of the two circuits in adjacent locations, to act as barriers and screens for residual couplings.

All the wiring is of rigid copper, encased in varnished cambric tubing. A variable stopping condenser for crystal detector operation is mounted on the panel.

The receiver is mounted under a ½" bakelite dilecto panel. The containing box is of ⅝" oak. The front of the panel contains the control handles and binding posts. A switch is provided for vacuum tube reception, or crystal reception, and also to protect the detector during transmission.

Binding posts and short-circuiting links are included in both the primary and secondary circuits for loading the receiver to any desired wave-length longer than the natural range of the design. This feature renders the receiver a universal solution for all wave-lengths above 150 meters.

This receiver was designed by Messrs. William H. Priess and Lester L. Israel, at that time expert radio aides in the U. S. Navy Department.

Hundreds of these receivers have been manufactured by the Wireless Specialty Apparatus Company for the United States Navy for use in ship and shore station, radio telegraph and telephone installations.

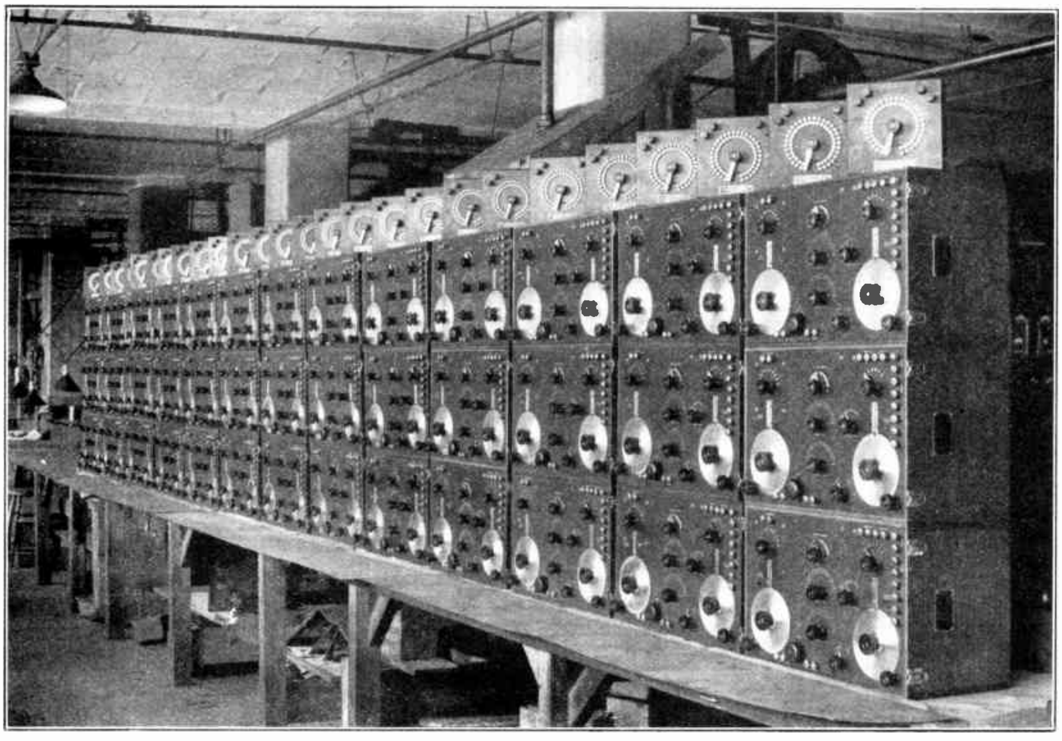
The amplifier control box shown in the illustrations contains the detector and amplifier circuits and their controls. A switch permits the use of either the detector or the amplifier. Continuous control of the detector between the damped and undamped methods of reception is obtained by an adjustment in the receiver itself. Amplification may be obtained by means of a transformer interlinking the detector and amplifier. Separate rheostats and ammeters are provided for each. The degree of amplification is controlled by the amplifier rheostat. The amplifier is of a type entirely new to the radio art, operating on the principle of low-frequency resonance and variable input impedance. This method was developed in 1917 by Mr. W. H. Priess, Chief Engineer, Wireless Specialty Apparatus Company, in collaboration with the radio engineers of the United States Navy. It provides a maximum amplification and is immensely superior for radio reception to the flat amplifying transformer method. This is the type of amplifier standardized by the United States Navy during the war. The detector and amplifier have shock-proof mountings that entirely eliminate "noise" due to mechanical vibration. These in turn are mounted on a bakelite dilecto panel, and the whole encased in an oak box. The controls and binding posts are on the front of the panel. The binding posts are placed in the same relative position as those on the receiver and correspondingly engraved so that no mistake can be made in connecting.

The best of materials and workmanship are employed in the construction of both the receiver and the control unit. They are rugged, and with proper care have an indefinitely long life in service. They present the best solution of modern radio problems, and are designed and manufactured in accordance with the best radio engineering practice.

The silicon-antimony and galena detector combination stand is recommended for commercial use with the I-P-500 receiver. It is described on page 37 of this catalog.

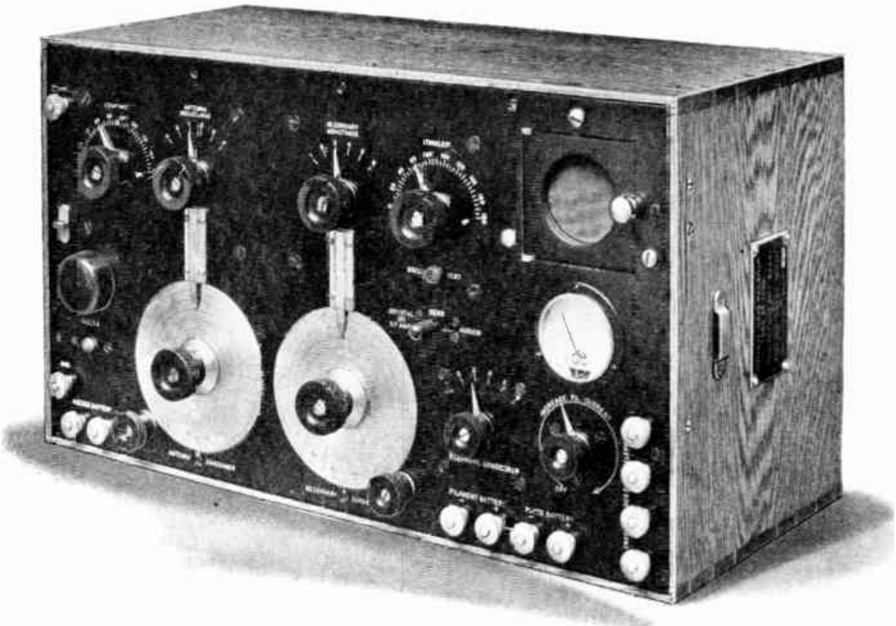
Telephones, vacuum tubes for experimental use, and batteries for the plate and filament circuits of the same are also described in the succeeding pages of the catalog.

Overall Dimensions, Receiver Type I-P-500, 23" x 11" x 14½"
Overall Dimensions, Amplifier Control Box Type Triode A, 14½" x 9½" x 6¼"



Part of an order of five hundred I-P-500 Receivers manufactured for the U. S. Navy by the WIRELESS SPECIALTY APPARATUS COMPANY

RECEIVER, TYPE I-P-501



THE I-P-501 receiver shown in the accompanying illustration is a compact unit containing the radio frequency and detecting circuits in a single case. Its range is 250—8,000 meters. It is suitable for ship and shore installations where cost and space factors are of great importance.

The receiver is similar in mechanical design to the I-P-500, with the untuned circuit omitted. The capacity coupling between primary and secondary circuits is eliminated in this type by heavy sheet-copper boxes separately enclosing the two circuits.

With the exception of the amplifying feature the detector is similar to that employed in the I-P-500. In addition, the I-P-501 contains provision for variation of telephone capacity. A slight departure is made in the disposition of the circuit controls for the satisfaction of the small space requirement.

The panel is of bakelite dilecto. The coils are bank-wound inductances, of high-frequency cable wound on threaded bakelite dilecto tubes, impregnated and baked. The condensers are of the self-balanced plate type. The wiring is of rigid copper encased in varnished cambric tubing. All switch points are located beneath the panel. The detector is mounted on a shock-proof support. The feature of condenser dial pointer control by inductance switch is included in the design. Many hundreds of these receivers manufactured by the WIRELESS SPECIALTY APPARATUS COMPANY are now giving satisfactory service in the United States Navy.

The silicon-antimony and galena detector combination stand is recommended for use with the I-P-501 receiver. It is described on page 37 of this catalog.

Telephones, vacuum tubes for experimental use, and batteries for the plate and filament circuits of the same, are described in the succeeding pages of this catalog.

Overall Size, 20" x 11" x 9"

RECEIVER, TYPE I-P-77

RECEIVER operation is reduced to its most elementary simplicity in this design. Only two variables are required, namely antenna tuning and coupling between antenna and secondary. Its extreme ease of operation renders it highly desirable for commercial ship radio installations.

The primary circuit is tuned by inductance, variable in large and fine steps, by means of two switches, one of which varies taps of tens of turns, and the other single turns. A condenser is switched in series with the antenna on short wave-lengths, and in parallel with the antenna coil on long wave-lengths. The secondary is of the untuned type. The adjustment provides continuously variable magnetic coupling between the primary and secondary. The variation is accomplished by a sliding coupling coil, mechanically connected to a rotary control knob on the panel.

A test buzzer is provided with an inductively coupled intensity adjustment, which permits the detector to be adjusted on oscillations corresponding to weak signal intensities. The crystal detector may be further sensitized by a potentiometer circuit, located in the receiver. Binding posts for operating the potentiometer and the buzzer are located on the lower right-hand side of the panel. A battery box for holding the dry cells, potentiometer, and buzzer is supplied with this receiver. On the panel directly below the potentiometer is a threaded cap which covers a small cylindrical container, for holding spare crystals. Binding posts are provided for the connection of antenna, ground, telephone, detector, and batteries for the buzzer and potentiometer.

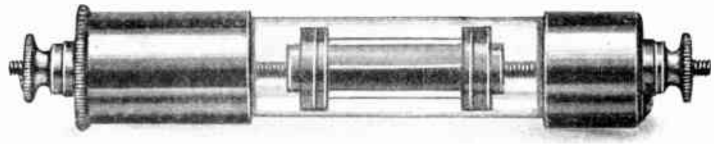
The instruments are mounted on a bakelite dilecto panel. The bakelite dilecto box enclosing the receiver renders it practically indestructible when exposed to rough usage, dampness, and wide atmospheric temperature changes.

The receiver has a wave-length range from 200 meters to 3500 meters. This covers the entire commercial ship and shore station range.

Size, 19¾" x 14¾" x 9½"

IV. CRYSTAL DETECTORS

ONE of the most important achievements of the WIRELESS SPECIALTY APPARATUS COMPANY is linked closely with its origination and development of radio detection devices. The first radio detector in service was the coherer. This device was highly unreliable and recorded strays equally well with signals. An attempt was made to produce an aural method of reception. This led to the development of the magnetic and electrolytic types. Neither was satisfactory.



PICKARD CARBON STEEL DETECTOR, 1902

The former required a mechanical system for its operation, the latter required a corrosive liquid and was subject to "burn-outs." The crystal detector which was invented by Mr. Pickard completely displaced all other types of radio detector and revolutionized the method of radio reception. The discovery of its action came about in an interesting way. In 1899 Mr. Pickard was using his design of carbon-steel detector which consisted of steel needles laid across carbon blocks. On May 29, 1902, he discovered quite by accident that when the local battery was cut out the detector still operated. This caused him to systematically investigate the phenomena, and resulted shortly afterward in the invention of the first practical crystal detector. One of the minerals used in this detector at the earliest date was the iron ore magnetite.

Thousands of minerals and furnace products were procured in a search conducted for the purpose of discovering all the materials that would serve the purpose of rectifiers in radio receiving circuits. This investigation, therefore, was conducted in the same manner as Edison developed the incandescent lamp. Some two hundred and fifty were found to make operative detectors used with metal contacts or in combination with other minerals. Thirty-one thousand two hundred and fifty different pairs were tested. Among these are the well-known silicon and galena, combinations of silicon and antimony, and bornite and zincite (Perikon).

Mr. Pickard first marketed his detector in 1906 when the nearest practical device was the "electrolytic."

Crystal detector reception is universally used, since it is of elementary simplicity, does not require local energy for its operation, and has an indefinite life. The WIRELESS SPECIALTY APPARATUS COMPANY, through the ownership of Mr. Pickard's patents, completely controls the manufacture, use and sale of all operative forms of crystal detectors, their circuits and accessories.

The standard detectors shown in the following pages are those wherein the crystals and mechanical means of adjustment have proved to be best out of the thousands of combinations tested. The mechanical design and finish of these detectors represents twelve years' cumulative experience and technique in the manufacture of this article. The crystals are chosen after careful and exhaustive laboratory tests, confirmed by actual operation on antenna signals. Only a small fraction of 1% of the materials tested actually pass the tests and are offered for sale.

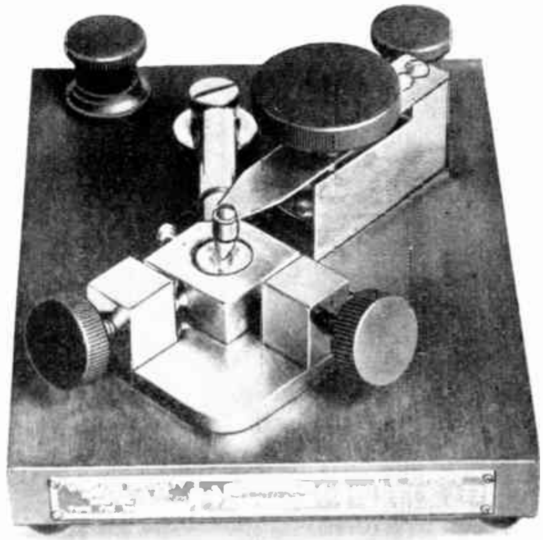
SILICON DETECTOR, TYPE I-P-200

THE principal advantage of the Silicon Detector is the permanence of its adjustment under the influence of high voltages induced across it by static or local transmitters.

The blunt contact point is of antimony. The crystal is of special furnace silicon. The silicon is embedded in soft alloy held in a cup by a set screw. The contact pressure between the silicon and the antimony is obtained by the variation of a spring holding the antimony point and controlled by a hard-rubber-capped thumb screw. The point of contact on the crystal is varied by the motion of two micrometer screws, which slide the face of the silicon crystal under the antimony point.

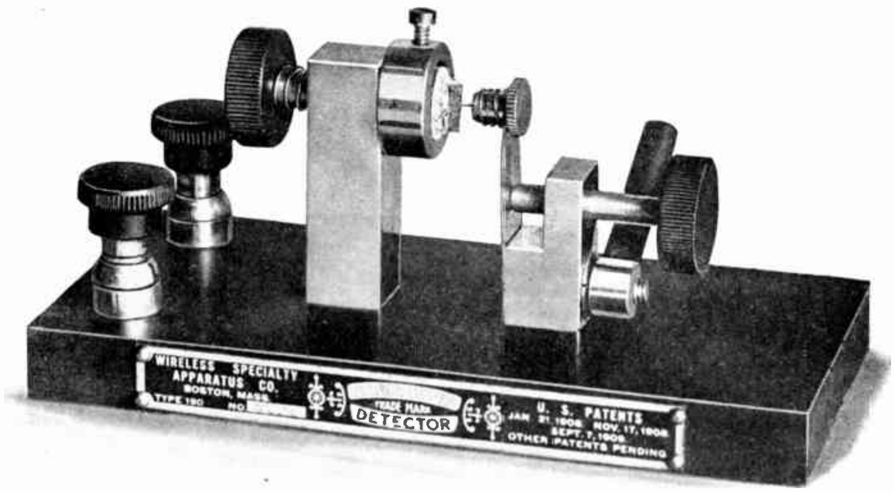
This unit is mounted on a substantial bakelite dilecto base, which is supported by four rubber feet.

Size, 5½" x 4½" x 2½" Weight, 10 ounces



SILICON DETECTOR

GALENA DETECTOR, TYPE I-P-201



THE Galena Detector is especially sensitive and requires an extremely fine regulation of pressure between a metal point and the galena crystal, together with a rigid method of locking the sensitive adjustment. When a proper contact has been secured, the Galena Detector is the most sensitive of all crystal detecting devices. This type of detector, as shown in the photograph, is provided with a compound spring adjustment that has proven highly successful in practice.

Size, 5" x 2⅜" x 2⅛" Weight, 10 ounces

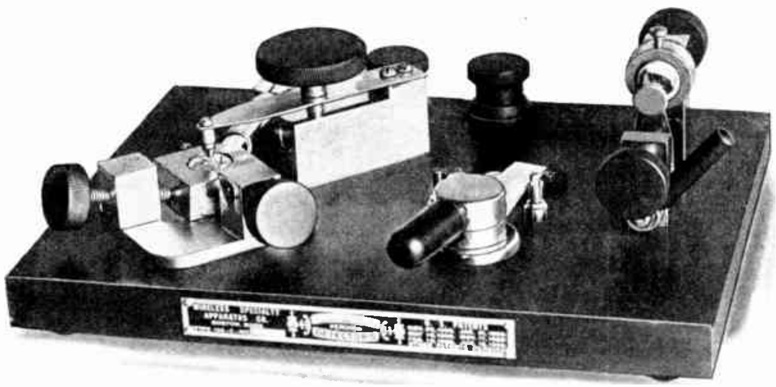
COMBINED SILICON AND GALENA DETECTOR, TYPE I-P-202

A SINGLE-STAND combination of the silicon detector and the galena detector is provided for securing reliability of operation. This combination insures successful reception of signals through heavy static, by means of the silicon, and long-range operations in cases of light atmospherics, by means of the galena.

The detectors are mounted on a single bakelite dilecto base, with a three-point switch, allowing operation of either detector at the operator's will, or the short-circuiting of both detectors, during transmission. The base is mounted on four rubber feet, to eliminate vibration.

This detector is standard with THE GREAT WHITE FLEET.

Size, 7⅜" x 5½" x 2½"
Weight, 2 pounds



COMBINED SILICON AND GALENA DETECTORS

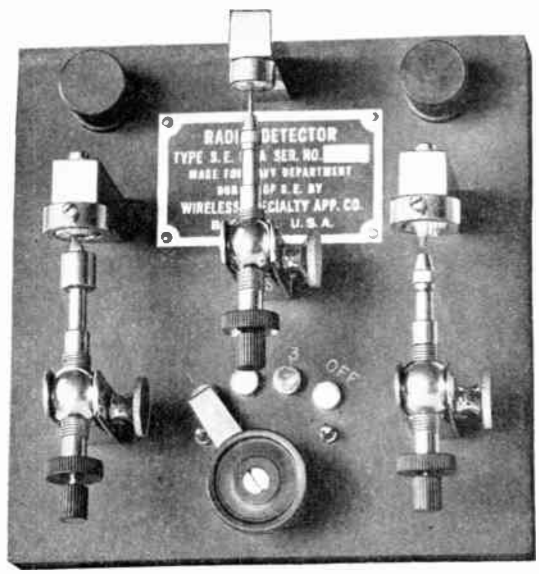
TRIPLE CRYSTAL DETECTOR, TYPE I-P-203

A TRIPLE detector combination has been designed to give the maximum possible freedom from both electrical and mechanical disturbances.

The detectors are all adjusted by our compound plunger spring contact mechanism. The degree of contact pressure and the permanency of adjustments are insured by simple clamping screws. A four-point switch permits the connection of any desired detector in the circuit on receiving, or the open circuiting of all the detectors on transmission. This arrangement protects the detector during transmission and makes readjustment after transmission unnecessary.

The United States Navy uses this type exclusively.

Size, 5¾" x 5¾" x 2⅝" Weight, 2½ pounds



TRIPLE CRYSTAL DETECTOR

V. EATON CIRCUIT DEVICES

ONE of the earliest devices used for the reception of undamped signals with a vacuum tube was the circuit invented by Lieutenant William A. Eaton of the United States Navy. This system of reception called for the use of a combination of condensers that would cause any initial impulse in a tuned circuit to be reflected back into the circuit with an amplified amplitude. The additional energy is drawn from a local battery and exactly follows the variations of the initial pulse. The invention of Lieutenant Eaton was made the subject of a special printed report, which was distributed to the radio officers of the United States fleet for test and comment. By a process of elimination the number of variables originally used in its operation was gradually reduced. The values of the circuit constants and their interrelation were reported on from a multitude of sources. This information, coupled with the operation record of the Eaton Circuit, guided its design so that it became the simplest and most reliable system for undamped reception.

Successive developments of this circuit have reduced it to a form requiring no adjustments for operation as an undamped receiver. For operation as a regenerative spark receiver, with the additional features of reception of undamped signals and simple detector reception of spark signals, but one adjustment is required. This adjustment is independent of the wave-length being received, and is furthermore independent of physical relation to the tuned receiver circuit. An Eaton unit can be connected directly between a tuned circuit and a vacuum tube, across the terminals of the condenser in the tuned circuit. It will then serve either as a source of oscillations in the tuned circuit, or, as is common practice, a source of oscillation differing by an audible frequency from an incoming oscillation impressed upon this tuned circuit, and thus permit the reception of signals by the autodyne. These Eaton Circuit devices are distinctive in their elementary simplicity. They can be directly connected across a wavemeter or any other inductance-capacity combination, and will produce oscillations without any further adjustment of the tuned circuit.

We manufacture Eaton Circuit devices at the present time in three different forms. The first form is called the Eaton Oscillator, and consists of a unit exclusive of tube apparatus, and is most useful in the reception of undamped signals.

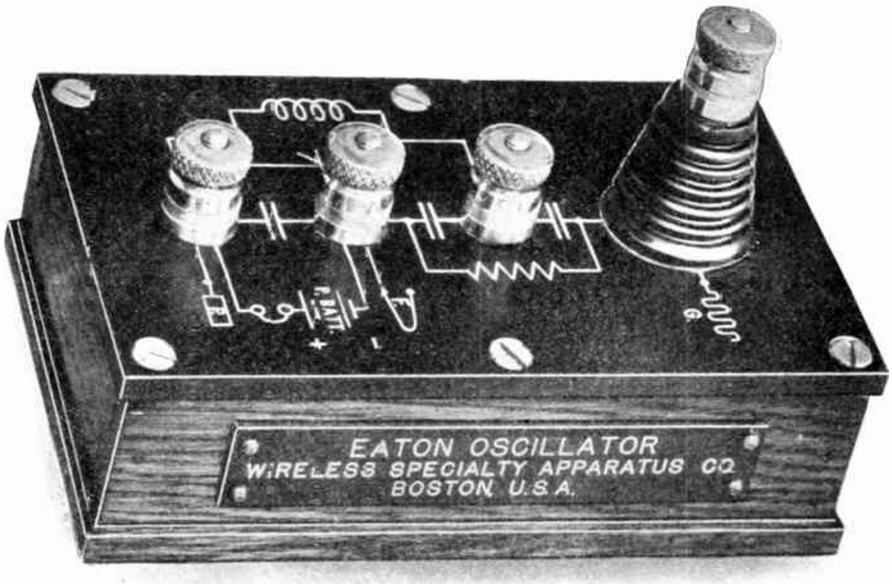
The second form is known as the Eaton Circuit Driver, and is equipped with the vacuum tube control, as well as with a buzzer and switch for driving from either buzzer or vacuum tube. In this form it serves essentially as a source of oscillations for laboratory work. Either damped or undamped oscillations may be obtained by this device used in conjunction with a wavemeter circuit. It may likewise be used as a receiver of undamped oscillations.

The third form is the Eaton Regenerator. This instrument contains the vacuum tube control and a control of the coupling between the local battery and the oscillating circuit, permitting the passage from a detector stage through the extremely sensitive regenerative stage to the oscillation stage. This control is accomplished without a detuning of the circuits connected to the Eaton Regenerator. It affords the maximum possible amplification that may be obtained with a single tube. The Eaton Regenerator is similar in general appearance to the Control Box Type Triode A, shown on page 30 and the Amplifier Type Triode B, shown on page 41.

Early in 1917 the United States Navy standardized exclusively on the Eaton Circuit for its receivers. Its most sensitive receivers at the present time employ the Eaton Circuit for producing and controlling oscillations in their associated vacuum tube detectors.

This form of Eaton Regenerator was designed by our Chief Engineer W. H. Priess in 1917 at the Washington Navy Yard, while he was an Expert Radio Aide in the Navy Department.

THE EATON OSCILLATOR, TYPE TRIODE C



THIS instrument can be used for the reception of arc, tube, high-frequency alternator and other types of undamped stations. A new departure in radio apparatus design is incorporated in this device. A glance at the photograph will clearly show the extreme simplicity of this very ingenious instrument. It consists simply of a small case with posts for connecting the external circuit.

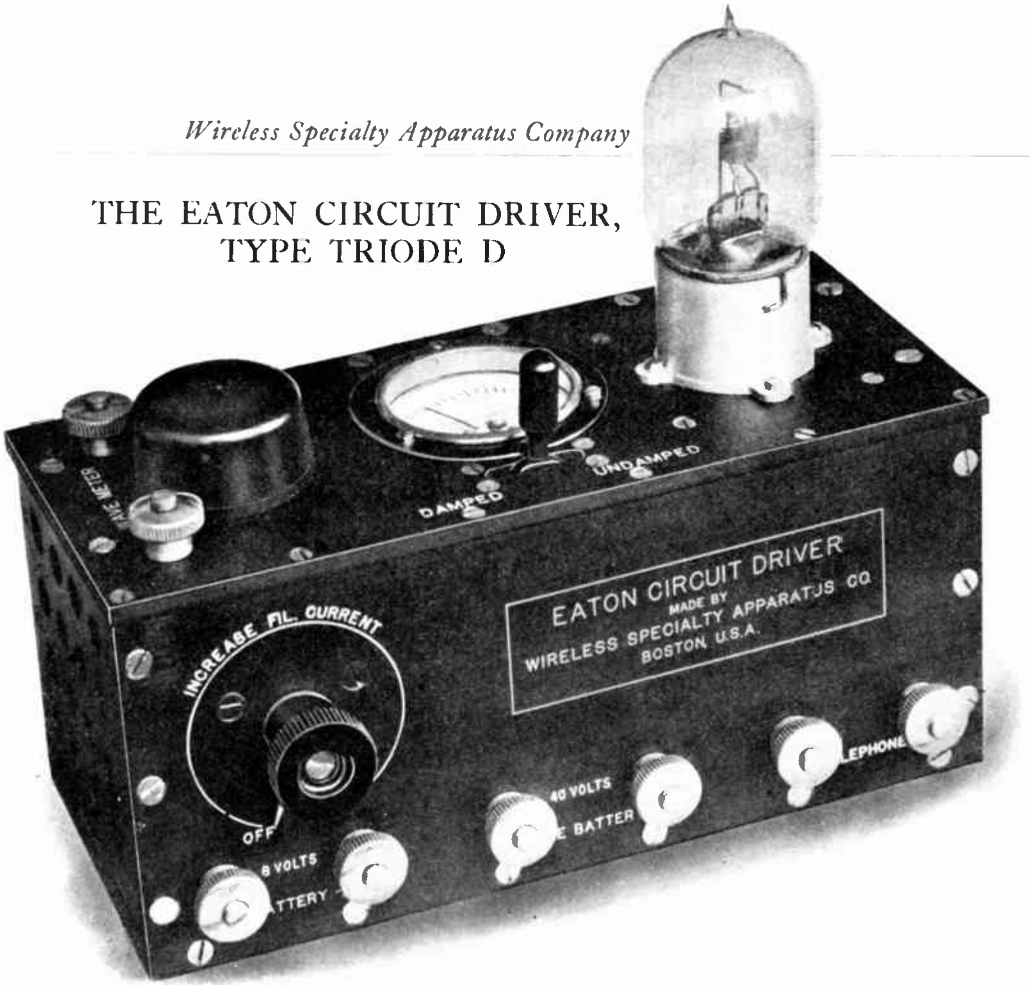
A novel departure in radio practice is incorporated in this design, in that the wiring diagram of the complete external circuit is engraved upon the cover so that no instruction is necessary for its use. The external circuit is engraved in white, the internal circuit in red. On the left-hand side is engraved the oscillating circuit, on the right-hand side the tube circuit.

A high insulation resistance between the grid and the ground is provided by a tall corrugated insulator. The complete internal apparatus is thoroughly impregnated under vacuum, and sealed in a moisture-proof low dielectric loss insulator. We recommend its use for wave-length ranges between 230 and 45,000 meters. It may be used across circuits having inductance between .05 and 100 m.h. and capacity between .0003 and .005 mfd.

The Eaton Oscillator is, in short, a device designed to receive undamped waves with a minimum of equipment. It is used in conjunction with an inductance, a variable condenser and a vacuum tube, and is without question the most efficient, most convenient and most economical way of receiving sustained waves.

Overall Size, 5" x 3" x 3"

THE EATON CIRCUIT DRIVER, TYPE TRIODE D



MODERN practice in radio laboratory work is to employ a source of undamped oscillations for the measurement of resistance, capacity, inductance, and wave-length at radio frequencies. In the photograph is shown a device for exciting a driver circuit with either damped or undamped oscillations for making these measurements. The vacuum tube control consists of an ammeter and 35-point skeleton frame rheostat and tube socket. An auto-transformer is inserted in the plate circuit for choking the high-frequency energy from the plate battery. Taps taken off this transformer are led to the telephone binding-posts to permit the functioning of the instrument as a receiver of undamped oscillations as well as a circuit driver. The oscillating system is the Eaton circuit, previously described. A key switch throws the circuit from the undamped to the damped operation.

The buzzer used for producing the damped oscillations gives a high pitched note. The current and the buzzer may be controlled by the same rheostat that controls the filament current of the tube. Two binding-posts are provided for the connection of either the wavemeter or the receiver circuit. Binding-posts are likewise provided for the filament battery, plate battery and telephones.

The instrument is built on two bakelite dilecto panels which form respectively the side and top of the protective case. An asbestos shield between the rheostat and the remaining circuit, and the ventilation provided in the rheostat compartment, effectively prevent the flow of heat into the tube circuit and Eaton Oscillator compartment. The instrument is mounted on four rubber feet. It provides the most compact form of twin driver that has yet been devised.

TWO-STEP AMPLIFIER, TYPE TRIODE B

THE two-step amplifier is a compact unit of the resonance low-frequency type. It provides a maximum of amplification due to the transformer design which is greatly superior for radio reception to the flat amplifying transformers manufactured by the telephone companies. The input impedance of each tube is automatically controlled by the filament rheostat.

The apparatus consists of two vacuum tube receptacles, two filament control rheostats, and two amplifying transformers. Shock-proof mountings protect the vacuum tubes from "noise" due to mechanical vibration.

The apparatus is mounted on the rear of a bakelite dilecto panel and enclosed by an oak box. At the bottom of the panel are terminals for connecting the 6-volt filament and the 40-volt plate batteries. At the lower left of the panel are the two input binding posts for connection to the receiver equipment. At the right of the panel are two binding posts for connecting telephones which indicate the amplified signals.

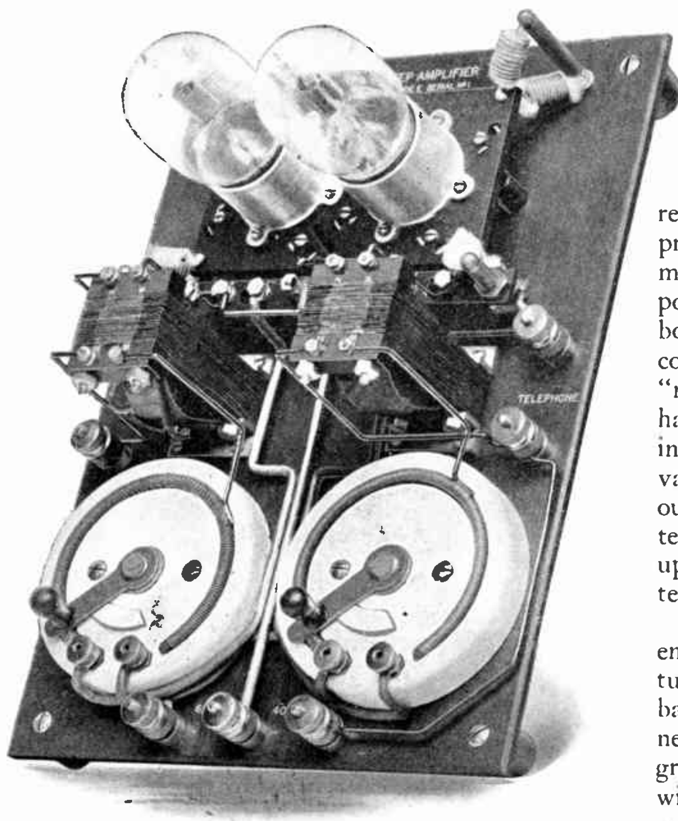
This amplifier will provide a greater degree of signal amplification than any other similar device on the market. It is compact, simple, and efficient, and represents an attractive investment.

Size, 11⅜" x 7½" x 6¼"

TWO-STEP AMPLIFIER, TYPE TRIODE E

THE Type Triode E Two-Step Amplifier was designed to provide an instrument in which all connections would be visible and easily accessible, and thus facilitate experimenting. It functions in a manner identical with the Type Triode B Amplifier described on the previous page. It is equally efficient with the Type Triode B Amplifier, and differs only in its less expensive construction.

All the necessary apparatus is mounted upon a bakelite dilecto panel supported by four rubber feet. The amplifier consists of two vacuum tube receptacles, two closed-core audio-frequency amplifying transformers, and two porcelain base circular control rheostats.



Two-Step Amplifier, Type Triode E.

The tube receptacles are designed to receive standard tubes of the four-prong type. The two receptacles are mounted on a bakelite dilecto piece supported and held away from the panel board by eight coil springs, stuffed with cotton. This arrangement eliminates all "noise" by a spring support system that has a high damping, thus quickly eliminating vibration. The leads from the vacuum tube receptacles are brought out to binding posts on a small strip terminal board which has engraved upon it an identifying letter for each terminal.

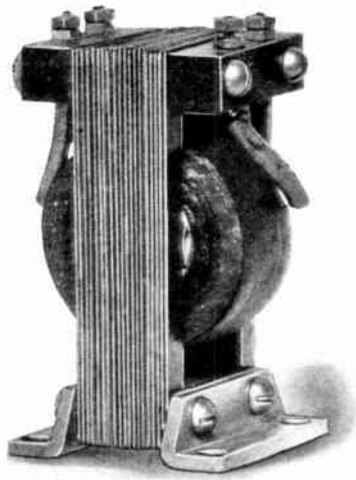
All wiring in the filament circuits is enclosed in yellow varnished cambric tubing. The wires of the grid circuit are baked with red enamel, and the connecting wires in the plate circuits with green enamel. In this way the various wires may be easily identified. Firm connection is established at each terminal by a special locking nut. Upon loosening these nuts the wires may be disconnected, making it easy to experiment with different circuits.

The closed-core audio-frequency amplifying transformers used are the Wireless Specialty Apparatus Company's transformers, Type P, described on page 43 of this catalog. At the left of the panel board are two "input" binding posts and at the right are the "telephone" binding posts. At the bottom of the panel are three binding posts for connecting the six-volt filament and forty-volt plate batteries. The middle post is common to both circuits. The input impedance of each tube is automatically controlled by its filament rheostat.

This instrument will provide the same maximum amplification accomplished with the Type Triode B Amplifier. The design of this unit is such that it will not "squeal," "fry," "roar," or "howl," as is common with the majority of other amplifying devices now on the market.

Overall size, 11" x 8" x 3¾"

CLOSED-CORE AUDIO-FREQUENCY AMPLIFYING TRANSFORMER, TYPE P



THIS amplifying transformer is the type used in all naval radio receiving equipment, and for radio telegraphy is superior in every respect to amplifying transformers designed for wire telephone work. Due to its operation on the principle of voltage amplification through resonance, this transformer provides a maximum of low-frequency amplification. The principle involved and the design were developed by Mr. William H. Priess, Chief Engineer of the WIRELESS SPECIALTY APPARATUS COMPANY, and Mr. Lester L. Israel during the time they were radio aides in the Navy Department, Washington, D. C.

The first amplifying transmitter embodying this principle was sent to the naval laboratory, Bureau of Standards, Washington, where it was tested by Dr. L. W. Austin. It was found to be superior to any other amplifying transformer which had been submitted to the naval radio laboratory up to that time; and as a result of Doctor Austin's tests it was standardized by the Navy and embodied in all of their amplifiers.

The closed core of the transformer is built up of silicon-steel laminations to eliminate the action of stray fields. The windings consist of a primary and secondary coil assembled as a single unit and impregnated in insulating varnish. Leads are brought out from the windings to a hard rubber terminal block on the top and attached to suitable nickel-plated binding posts. Two drilled and nickel-plated brass angle brackets are attached to the bottom of the transformer so that it may readily be mounted on a base or panel.

Overall Size, 2¾" x 1¾" x 1½"

INDUCTANCE LOAD COILS

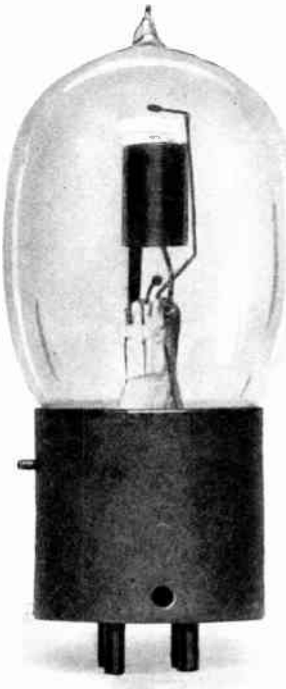
WE offer a high-grade, compact and efficient load coil in two different values, namely, 30 and 50 millihenries. These coils consist of two bakelite dilecto side pieces, between which is mounted a highly efficient wave-wound coil of high-frequency cable. The electrostatic capacity of the coil is extremely low. The side pieces and coil are firmly held together by three horn fibre screws. The side pieces are finished square, forming a base for the coil. Close coupling between two or more load coils is possible as their rear surfaces are plane and close to the central plane of the coil. Two nickel-plated binding posts are provided for making connections to the coil. The inductance of the coil is engraved upon one side.

While these coils are normally furnished in two values of inductance listed above, coils of special values can be wound by us very quickly at slightly additional cost. The coils are ideal units for loading receivers to long wave-lengths as they are efficient and permit easy and very wide variation of coupling. A pair of these coils, used in conjunction with two variable air condensers of the types shown on page 57, constitute a receiver. Their values are constant and they may be used as standards and for general experimental purposes.

30 millihenries coil, size, 1" x 5½" x 5¾"
50 millihenries coil, size, 1" x 5½" x 5¾"

VACUUM TUBES

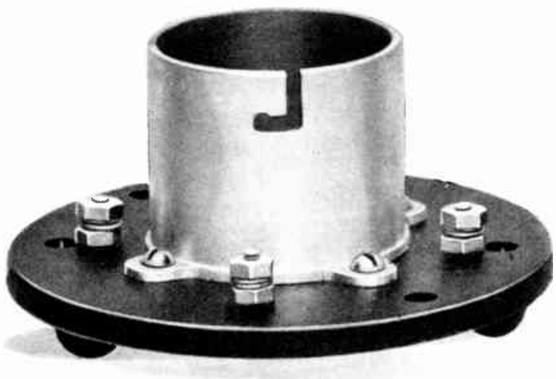
WE can make immediate delivery on standard Moorehead Vacuum Tubes, as shown in the cut. These tubes are of the four-prong type and of the same design as supplied to the U. S. Navy. They may be used either as detectors or amplifiers. They have a very low current consumption, working best under .7 ampere. They are absolutely reliable and very rugged. These tubes originated from the tube designed by the French Signal Corps and slightly modified by the British. Each tube is thoroughly tested before shipment, so that the sensitiveness of every tube is guaranteed. With ordinary care these tubes have a normal operating life of about 1500 hours.



MOOREHEAD VACUUM TUBE

VACUUM TUBE SOCKET, TYPE TRIODE F

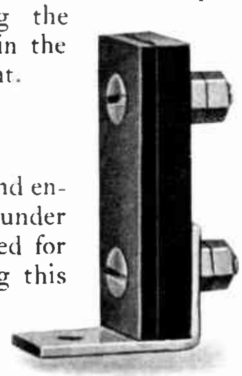
WE supply the vacuum tube socket, as shown in the cut, for the individual mounting of standard vacuum tubes. The socket is mounted on a circular piece of bakelite dilecto supported by three rubber feet. We wish to point out that the base of this socket is bakelite dilecto and not moulded composition, and will not break and crack like the latter material. The filament, plate, and grid connections are brought out to binding posts on top of this plate, thus making connections easy and simple. The contact springs are stamped with the letters G, P, F +, and F—, respectively, identifying the grid, plate, and filament. Four countersunk screw holes are drilled in the base for mounting this unit on a panel or base with other equipment.



VACUUM TUBE SOCKET, TYPE TRIODE F

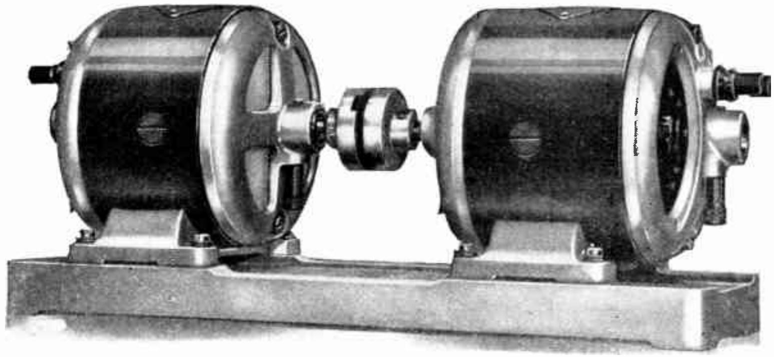
GRID LEAK, TYPE TRIODE G

THIS unit consists of a 500,000-ohm resistance securely mounted and enclosed between two pieces of bakelite dilecto, and impregnated under vacuum with insulating material. Two binding posts are provided for making connections. A small angle bracket is furnished for mounting this unit on a panel, thus effectively insulating the high potential grid side by holding it away from the panel. The resistance used in this leak is of constant unchanging value. An efficient grid leak is vitally necessary for the successful operation of vacuum tube detecting circuits. Grid leaks of other resistances are furnished on request.



GRID LEAK, TYPE TRIOLE G

HIGH-VOLTAGE D.C. GENERATORS FOR UNDAMPED TRANSMITTERS



WE are offering for sale a complete line of high voltage D.C. generators for applying energy to the plates of vacuum tubes used in undamped radio telephone transmitters. Tube transmitters have the very desirable qualities of simple apparatus, low operating potentials, and the great carrying range peculiar to undamped equipment.

These generators are shunt-wound, self-excited, with outputs of 50, 100, or 150 watts at either 375, 500, or 750 volts. Single-phase alternating current or direct current motors will be provided as specified. The alternating current motor operates on 110 or 220 volts, 1 phase, 60 cycles at 1725 r.p.m. The direct current motor is shunt wound for either 110 or 220 volts as specified, and operates at 1725 r.p.m.

For belt drive the generators are equipped with cast-iron pulleys 2½" in diameter, with a 1½" face. The pulley diameter, however, will be varied to suit individual requirements.

Where very high voltage plate supplies are required, two or more generators may be employed series connected. The 50-watt machine will supply three Moorehead tubes. Large power tubes, or banks of smaller tubes may be used for increased ranges.

Undamped sources of high-frequency energy in powers greater than supplied by the Eaton Circuit Driver (page 40) for use in measuring electrical constants and reactions of circuits, may be obtained by a tube set driven from any of these machines. It is then possible to make measurements at very loose couplings, so that the reaction between the circuit under measurement and the high power circuit driver need not enter into the calculations.

In general, the high-voltage machine replaces the high-voltage storage battery previously used for the purpose of supplying energy to plate circuits of transmitting tubes. With any simple filter the slight commutation ripples, present in all these machines, may be eliminated to such an extent that they cannot be detected in the tubes used for ordinary telephonic transmission.

Dimensions of 50-watt machine, 22" x 12" x 11" Weight, 64 pounds
Dimensions of 100- and 150-watt machines, 26" x 12" x 11" Weight, 75 pounds

VI. TELEPHONES

CENTURY

CENTURY Telephones consist of a double head set of the non-adjustable type, and are equipped with a universal canvas-covered head-band. Their resistance is 3,200 ohms. The receivers are highly sensitive, and especially suitable for crystal detector and tube use. The instrument is tuned to approximately 1,000 cycles, which makes it selective to 500-cycle quenched spark and heterodyne reception.

CENTURY TELEPHONE

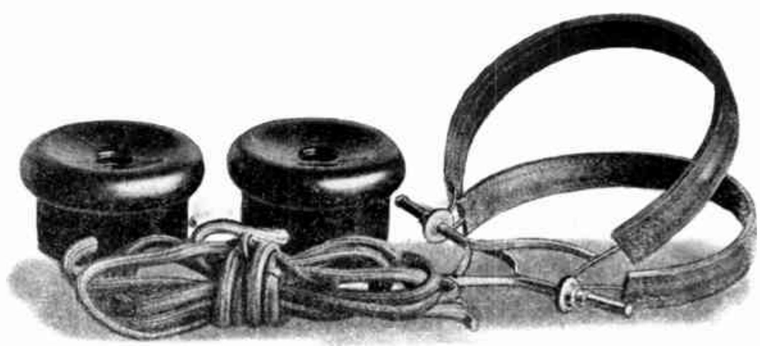
The sensitivity is obtained by an efficient design of the magnet system, and accurate machining of the pole pieces and diafram set. The diafram is of silicon steel .012" thick. This assures a telephone receiver that will be rugged and free from fatigue of the diafram.

The case is aluminum. The ear cups are designed to offer a high degree of sound-proofness and comfort. The receivers are fitted with a six-foot double silk-covered green cord. The weight of the head set is very small, being only 13½ ounces.

BALDWIN

BALDWIN Telephone Receivers are of the non-adjustable mica diafram type, and are especially suited for the reception of very weak signals. The magnet system operates a small armature which, in turn, acts upon the diafram. The resistance of the telephones is 2,000 ohms.

The cases and ear cups of the receivers are black molded composition. The ear cups are designed to exclude all external noise, and at the same time to maintain a maximum degree of comfort. The head band is leather covered, and self-adjusting. The telephones are equipped with a six-foot double silk-covered cord. The weight of the head set complete is nineteen ounces.

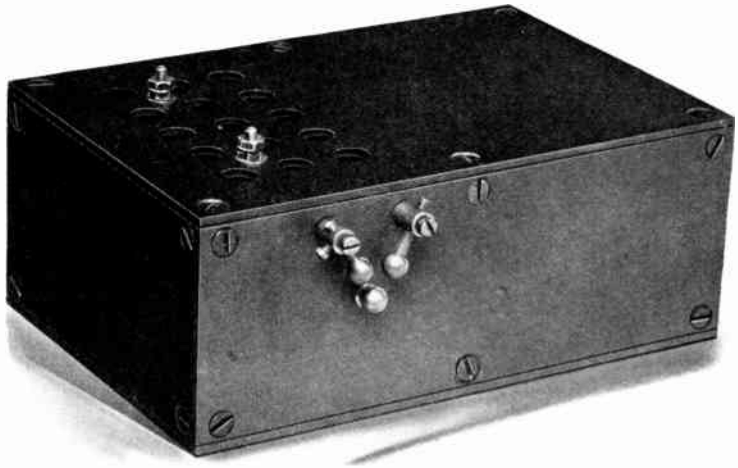


BALDWIN TELEPHONE

VII. TRANSFORMERS

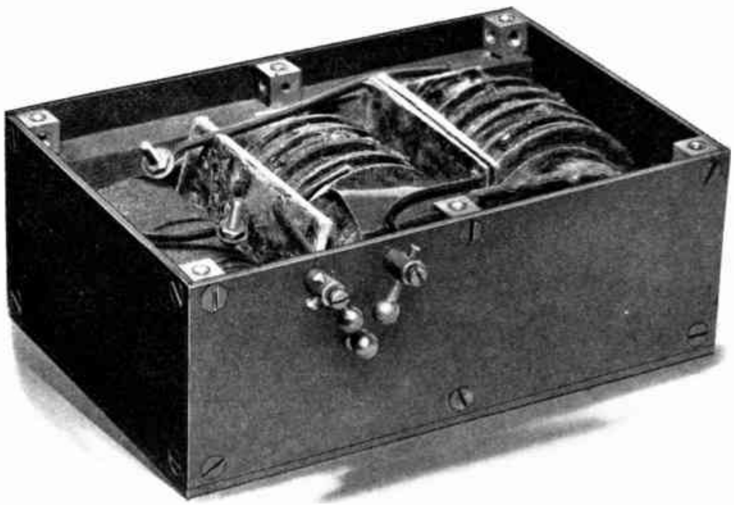
THE following transformers, designed by the WIRELESS SPECIALTY APPARATUS COMPANY, are used in the transmitting sets listed in this catalog. They are of the air-cooled type, and are all designed for operation across 500-cycle sources. In the table on the next page are given the secondary capacity and the synchronous impedance of the 500-cycle generators from which these transformers operate.

The transformers have been designed with a very high insulation safety factor. They have an unusually high efficiency at the powers for which they were designed. All the transformers, with the exception of the 1 K.W., are of the minimum leakage type, and are built with reactances inside the transformer case. The 1 K.W. transformer is of the high-leakage type, and designed with the necessary reactance as leakage reactance in the transformer proper. A high insulation is provided between the core and the windings, between the primary and the secondary windings, and between the several sections of the secondary windings. The insulation between primary winding and core is sufficient to withstand a potential of 2500 volts, while the insulation between secondary and primary and between secondary and core is built to withstand a potential of 35,000 volts. The insulation between adjacent primary sections has a safety factor of 20.

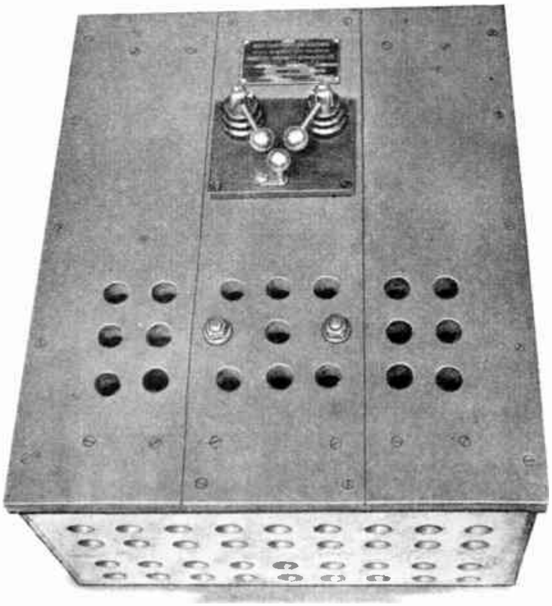


¼ K.W. TRANSFORMER WITH COVER ON

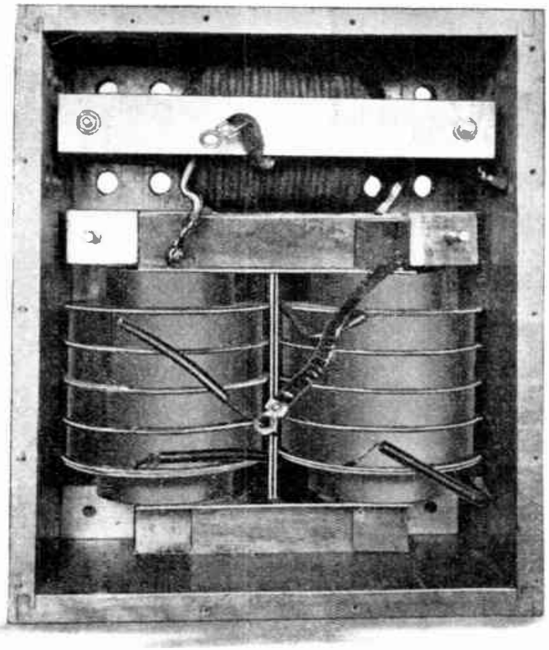
A three-ball safety gap is provided between the high-potential terminals and the ground. It is mounted upon a dilecto base, directly on top of the transformer. The sparking distance between balls is 1½ times the secondary voltage. In the ½ and ¼ K.W., 1 and 2 K.W. sizes, the reactance is fixed, while in the 5 K.W. the reactance is variable in five steps.



¼ K.W. TRANSFORMER WITH COVER OFF



2 K.W. Transformer with Cover on



2 K.W. Transformer with Cover off

The case for the ¼ K.W. unit is a bakelite dilecto box. The cases for the ½, 2 and the 5 K.W. transformers are of impregnated maple. The 1 K.W. is of the open uncased type. These transformers are built for heavy duty, and will stand an almost unlimited amount of abuse.

Transformer Input	¼ K.W.	½ K.W.	1 K.W.	2 K.W.	5 K.W.
Capacity across Transformer Secondary	.004 mfd.	.004 mfd.	.004 mfd.	.016 mfd.	.032 mfd.
Synchronous Impedance of 500-Cycle Generator	29 ohms	29 ohms	18 ohms	7 ohms	2.9 ohms
Open circuit voltage of Generator	175	150	250	250	250
Secondary voltage of Transformer	11200	16000	28000	16000	18000
Efficiency of Transformer	89.10%	92%	94.2%	94.1%	95.8%

Type Q-S-5005 5 K.W. Size, 27" x 18" x 13 5/16"; weight, 210 pounds
Type Q-S-2001 2 K.W. Size, 23⅞" x 14¼" x 9 5/16"; weight, 145 pounds
Type Q-S-1001 1 K.W. Size, 20" x 14" x 9 5/16"; weight, 104 pounds
Type Q-S-503 ½ K.W. Size, 14⅜" x 11⅛" x 7 3/16"; weight, 57 pounds
Type Q-S-201 ¼ K.W. Size, 8¾" x 6⅝" x 3⅞"; weight, 11¼ pounds

VIII. KEYS

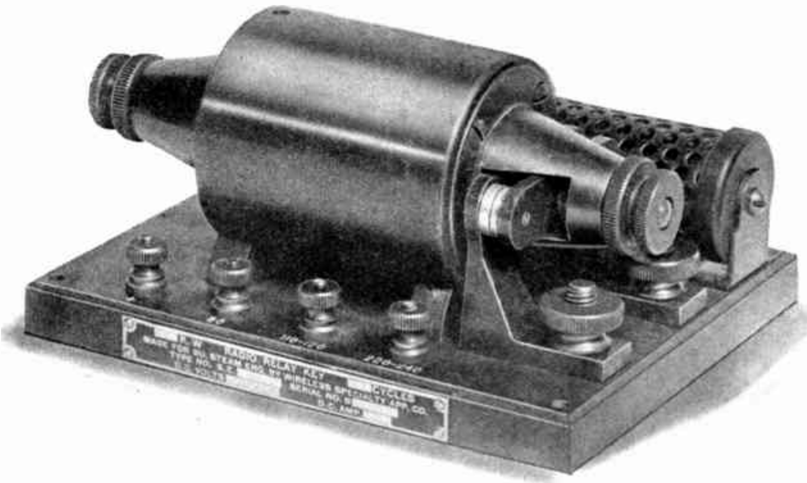
RELAY KEY, TYPE Q-S-5003

FOR remote operation of transmitters or in cases where high currents at medium high voltages are to be broken, a relay key offers the best solution. The contacts of the relay key shown are 5/8" fine silver, and will handle currents up to 60 amperes, without arcing or overheating.

The relay key is designed with a very small time constant, and will operate at a reliable breaking speed up to forty words a minute. The armature is of the double-break type, thereby causing a hammer break in the circuit, and eliminating the possibility of a lingering arc. The solenoid coil is equipped with external resistance, and has binding posts which permit operation at 80, 110, or 220 volts.

The base is of heavy bakelite dilecto, and drilled for vertical mounting. This key is used on our standard 5 K.W. set furnished to the Navy Department.

Size, 8 3/8" x 6 3/8" x 3 15/16"
Weight, 13 pounds



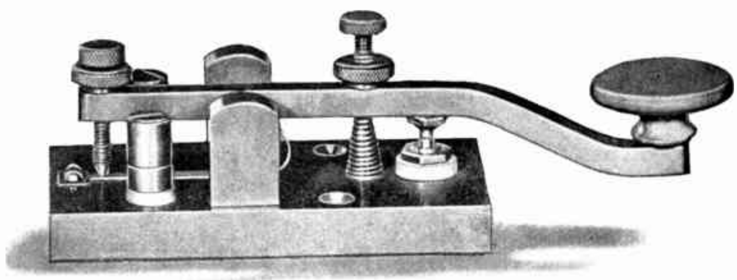
RELAY KEY, TYPE Q-S-5003

LIGHT HAND KEY, TYPE Q-S-504

THIS key is well adapted to break all currents up to six amperes, without arcing or overheating. The balance and movement is such as to permit a continual high speed of operation without fatigue. Current is conducted to the arm, not through the bearings, as in most keys, but by heavy copper braid provided especially for this purpose.

The key is mounted on a heavy bakelite dilecto base, provided with two binding posts, and countersunk screw holes for fastening to the operating table.

Size of Base, 3 1/2" x 1 3/4" x 1/2"
Overall Length, 5 9/16"



LIGHT HAND KEY, TYPE Q-S-504

FLAME-PROOF KEY, Q-S-505

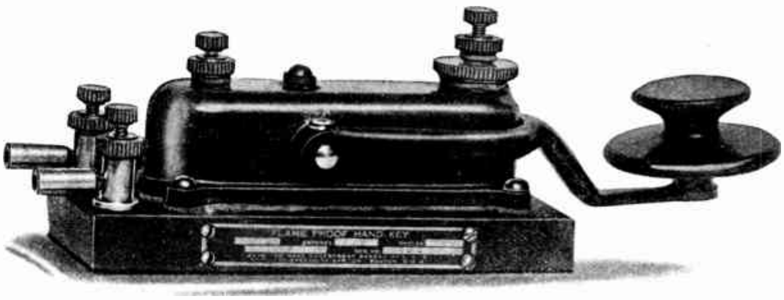
THIS key is of the enclosed type, designed to minimize the danger of sparking contacts in the vicinity of inflammable and explosive gases, and has been adopted by the United States Navy for use in submarines and air-craft.

The contacts are standard, of ¼" silver, and easily removable. They will handle currents up to ten amperes. The lever is fitted with a shield for the operator's protection. A flexible pig-tail connects the lever with one binding post, insuring a perfect contact independent of the lever adjustment.

The key is well balanced and responsive to the slightest touch, allowing a high rate of transmission with a minimum of effort. The housing and covers are finished in black japan, while all adjustment screws and binding posts are of polished nickel.

The key is mounted on a bakelite dilecto base, with four countersunk screw holes for fastening it to the operating table. This insures high insulation and safety.

Size, 8" x 2¼" x 1⅞"
Weight, 1¼ pounds



Flame-Proof Key, Type Q-S-505

THE HAND KEY, TYPE Q-S-5004

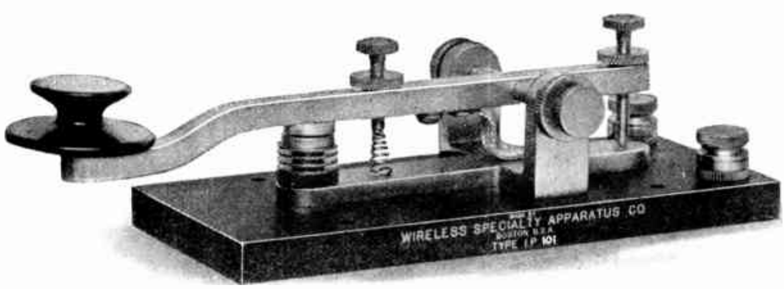
THIS key is designed for use with transmitters of all powers up to 5 K.W., and as an auxiliary in stations where a relay key is usually employed.

The construction is of heavy brass throughout, finished in polished nickel, with ⅝" diameter silver contacts, which are easily removable. The lever arm is well balanced, permitting easy and rapid operation. The key will handle currents up to 40 amperes with a continued breaking speed of thirty-five words a minute without arcing or overheating. The heat is dissipated by means of a series of radiating flanges, attached to the lower contact electrode.

The bearings are not depended upon to carry current to the arm, but a heavy copper braid is provided for this purpose. The handle of the key is fitted with a safety disc to prevent the operator's hand from accidentally touching the metal.

The key is mounted on a heavy bakelite dilecto base, provided with two binding posts and countersunk screw holes for fastening to the operating table.

Size, 9" x 2½" x 2¼"
Weight, 1½ pounds



The Hand Key, Type Q-S-5004

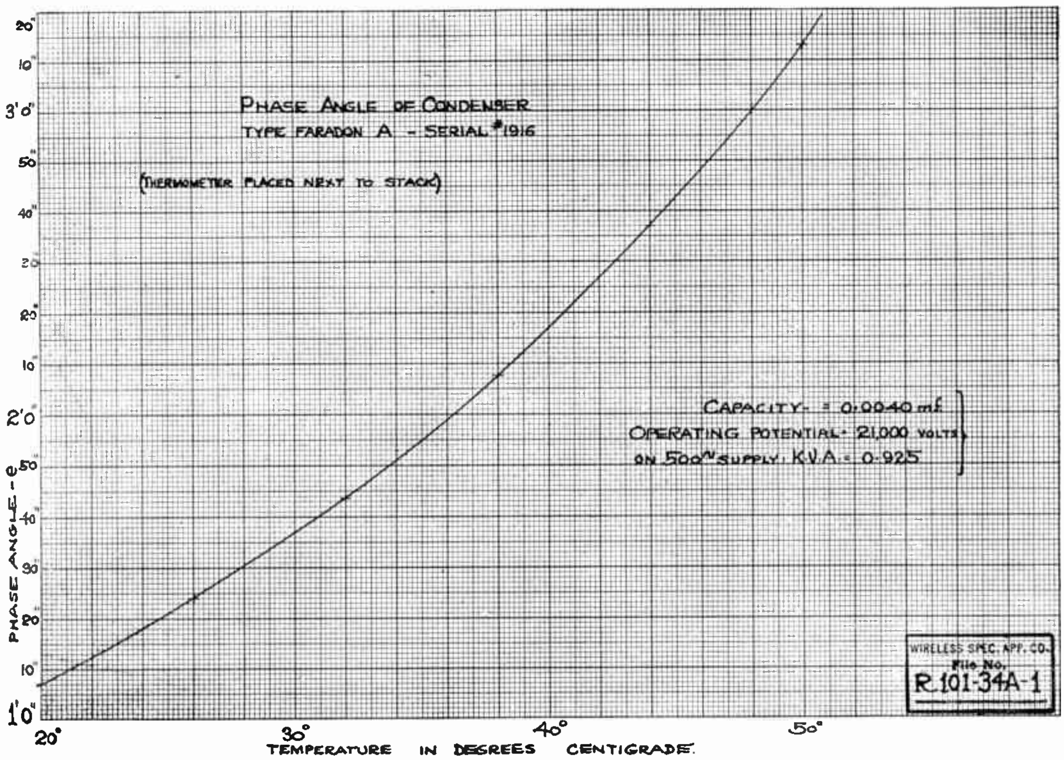
IX. FARADON MICA CONDENSERS

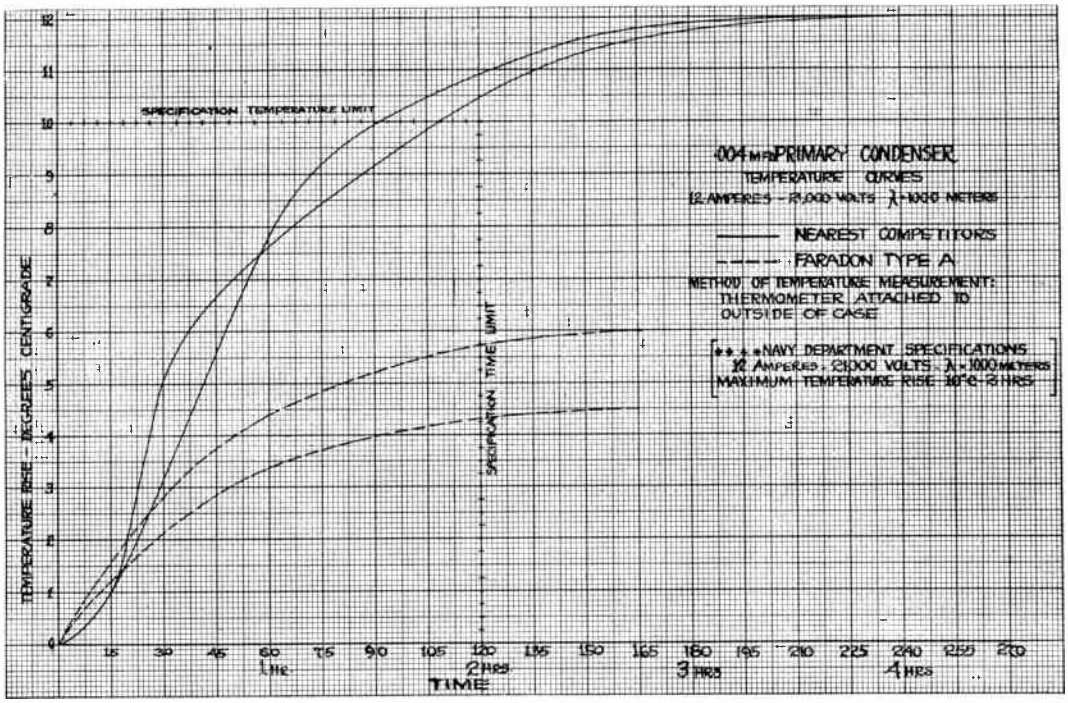
ALL damped wave radio transmitters require condensers, the function of which is to store energy from the low-frequency circuit and discharge it across the spark gap, thus producing oscillations in the radio frequency circuit. In a radio frequency circuit the condensers are subjected to a high impressed potential difference and a high effective current. In the early days glass dielectrics in the form of Leyden jars, or glass dielectrics immersed in oil, were used. The condensers constructed in this manner were very fragile, and there resulted a large loss from breakage. Their internal electrical loss was very high, and the volume occupied by them very great.

When a condenser is operated at potentials at which brush discharges occur, the losses rise to enormous values. This is clearly shown by the heating and breakdown of Leyden jars at the edges of the conductor coatings. The ohmic loss is also of a considerable magnitude since the current is carried by a single sheet of metal.

For these reasons, and because of the superiority of mica as a dielectric, mica condensers began to be substituted, about 1908, for glass condensers, i. e., about the time when quenched spark transmitters came into general use.

The dielectric hysteresis furnishes a very important factor in the total loss of a condenser at radio frequency. The magnitude of this dissipation of energy is directly proportional to the phase angles of the materials used. Condenser glass has a phase angle of between one degree and eighteen minutes. Transil oil has a phase angle of between one degree ten minutes and thirty minutes. Certain grades of selected mica, such as is used in FARADON Condensers, have a phase angle of between forty and fifty SECONDS. Also, the phase-angle temperature curve of mica is approximately a straight line, while with other





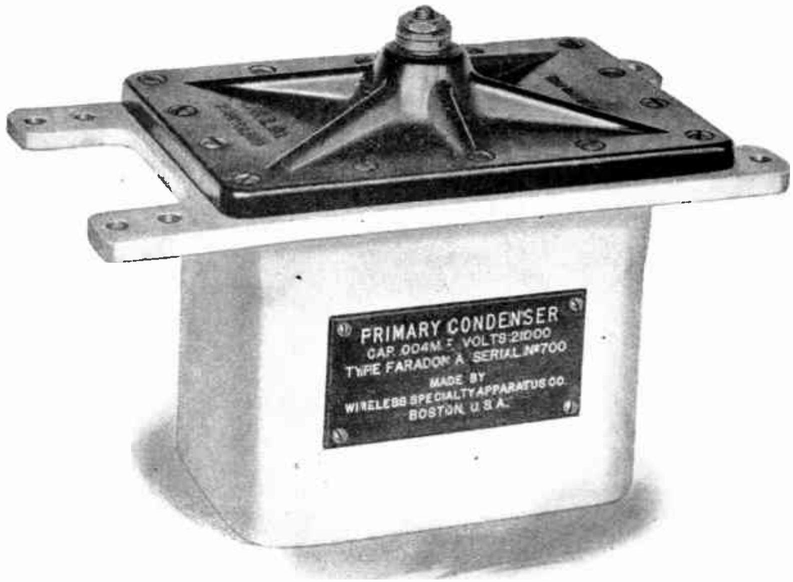
dielectric materials such as glass, oil, varnishes, and most compositions, the rate of increase of phase angle with respect to temperature becomes increasingly greater as the temperature rises. We have developed a .004 mfd. mica condenser which has a phase angle of approximately 1 minute at room temperature. In this condenser brush discharge has been entirely eliminated and it is therefore obvious that ohmic losses have been reduced to a negligible factor. The dielectric losses of this condenser are so small as to be almost negligible when compared with the losses occurring in other types of condensers employing glass, oil, varnishes, etc., as a dielectric, and for an equal K.V.A. load it occupies less than 4% of the space required for the old type of Leyden jar condenser. It is metal-clad and unbreakable. This condenser is known as the FARADON Type A, and is the result of our twelve years' experience in high tension condenser design. "FARADON" is our trade name, given in honor of Michael Faraday.

The curve on page 52 is the phase angle of the FARADON Type A Condenser at temperatures up to 50° C. It will be noted that in this particular case the phase angle is 1'7" at 20° C., and rises to 3'13" at 50° C. At 20° C. in a 1000 meter circuit this is equivalent to a series resistance of 0.15 ohm, or an efficiency of over 99% when used in the primary circuit of a quenched spark transmitter.

Our high potential condensers are fundamentally the same as have been used for the last quarter century, i.e., comprising a plurality of sections connected in series and suitably impregnated with a special insulating compound. Our methods of manufacture follow the general lines of the improvements developed by the Army and Navy between 1910-1916, and greatly improved by our own development and the production of our own novel designs and construction. A performance curve of the temperature rise of these condensers made by a large user of our FARADON Type A is shown above.

We also manufacture protective condensers, laboratory standards and many other special types of mica condensers for special commercial and experimental requirements.

FARADON PRIMARY CONDENSERS, TYPE A



THE FARADON Condenser, Type A, embodies all the latest improvements in primary condenser design. It is superior in every respect to all mica and other forms of primary condenser now on the market. For an equal K.V.A. load, it occupies only 4% of the space required for Leyden jars. It is metal-clad and unbreakable. It has an efficiency of over 99% and has a practically unlimited life. FARADON Condensers of this type which have been in continuous use eight hours a day — six days a week, over a period of two years, still show the same efficiency as when originally placed in service. This condenser also eliminates the brush discharge common to Leyden jars and the corresponding losses.

The .004 mfd. FARADON Mica Condenser has a phase angle of approximately one minute at room temperatures. Each of these condensers is tested at 18 amperes in a 1000-meter circuit, whose decrement is such that the maximum potential across the condenser is 21,000 volts. These tests are conducted at a room temperature of 20° C. and with a resultant temperature rise at the condenser case of less than 4° C. Normally, the average temperature rise is 3½° C. Under actual radio operating conditions the temperature rise is negligible and is of the order of 1° C.

Competitors have used the cover of the condenser case as a pressure member for the mica stack, but temperature changes cause expansion of the filler, which lifts the cover slightly and thus removes the stack pressure when it is most urgently needed. FARADON Condenser stacks are built in units totally independent of either the case or the cover, and a live load is applied to the stack, which brings into play a factor which serves to improve the condenser with time.

FARADON Condensers are normally furnished in three different sizes, namely, .004 mfd., .002 mfd. and .001 mfd. capacities, all tested at 21,000 volts. Condensers of other capacities and any required voltage can be made up quickly at slightly additional cost. The .004 mfd. FARADON Condenser, Type A, is standard with the U. S. Navy where it has replaced the bulky and inefficient Leyden jars.

FARADON PROTECTIVE CONDENSERS, TYPE B

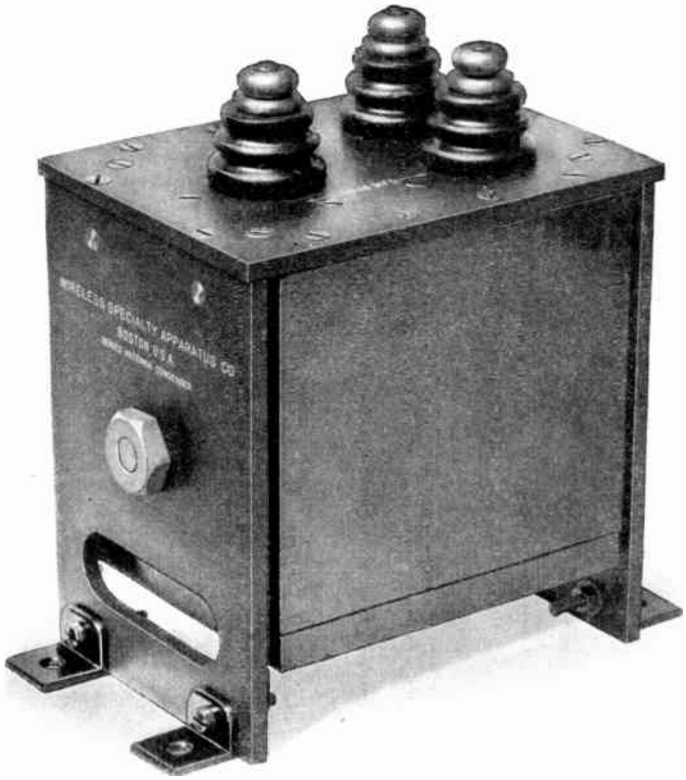
IN the development of FARADON Primary Condensers we have also carried on the development of mica protective condensers for protecting the direct current line, the motor-generator windings, and the transformer windings from high-frequency surges. Experimenters employing the local lighting or power lines as a source of energy for operating their radio transmitting apparatus should protect the service lines from radio frequency surges. A surge passing back into the line may cause the breakdown of its insulation or that of the equipment connected to the line and, in this way, destroy valuable generators, motors, or transformers, or may cause disastrous fires in nearby homes. Complete protection is assured by installing FARADON, Type B, protective units.

The FARADON Condenser, Type B, consists of two mica condensers connected in series and placed across the line with their mid point grounded. These condensers are normally built in two sizes, namely, .02 mfd. and .05 mfd. capacities, and provide effective protection from all radio frequency surges. Copper terminal-lugs are provided in these units for making secure connections to the lines. The lugs are mounted on a bakelite dilecto top and identified by suitable engraving.

After the connections have been made and soldered, the terminal board is protected by another bakelite dilecto piece which covers the terminal board and is supported by four bakelite dilecto pieces. This is removable by loosening four screws. Short-circuiting of the line by accidentally dropping a metal object on the unit is in this way prevented. On the under side of the protecting bakelite dilecto piece the circuit of the condenser and the method of connecting to the line is shown engraved in white.

While these condensers are usually made in only two sizes, as specified above, different capacities can be supplied at slightly additional cost, on request. The FARADON Protective Condenser, Type B, is a vitally necessary unit in all modern radio installations where safety is of prime importance.

FARADON SERIES ANTENNA CONDENSERS, TYPE D



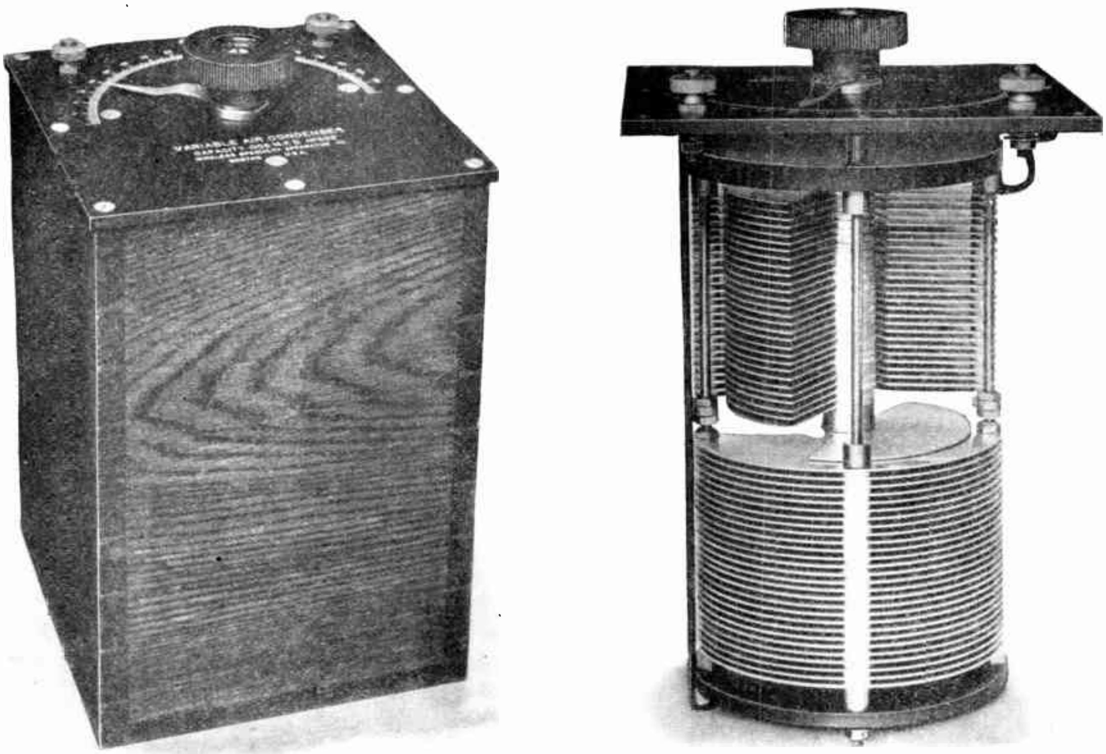
A SERIES Antenna Condenser is necessary for short wave transmission on antennae whose natural periods are equal to or greater than the wave to be transmitted. Since the U. S. Radio Law requires all commercial ship stations to be able to transmit on 300 meters, practically all ship equipments include a series antenna condenser for this purpose. Furthermore, since experimental stations must transmit on wave-lengths of 200 meters and below, the series antenna condenser is quite essential in cases where experimenters employ large, efficient antennae systems.

A series antenna condenser must withstand the enormous potential differences which are built up in the antenna system, and since the effective resistance of an antenna system is low, it follows that a condenser inserted in series with the antenna must also have a very low effective resistance, otherwise a large portion of the antenna energy is absorbed.

FARADON Type D Condensers meet all of these requirements. They are enclosed in an insulated case and can be mounted on a wall or a steel bulkhead with perfect safety. The large leakage paths at the base of the side pieces, the air space between the condenser case and the side piece, and the insulated bearing for the condenser case, are clearly shown in the photograph. All terminals are rounded to prevent brush discharge.

The FARADON Type D has three terminals giving two values of series capacity, namely, .0006 mfds. and .0008 mfds. These values are indicated by suitable engraving on the covers and adapt it for either a normal ship antenna or a large antenna. The condenser is tested to withstand 40,000 volts.

VARIABLE AIR CONDENSERS



VARIABLE AIR CONDENSER, TYPE I-P-300

THESE condensers are built in four different capacities, namely Type I-P-300 of .005 mfd., Type I-P-301 of .003 mfd., Type I-P-302 of .0015 mfd., and Type I-P-303 of .0007 mfd. They are all of the balanced type and will hold any adjustment regardless of the position in which they are placed.

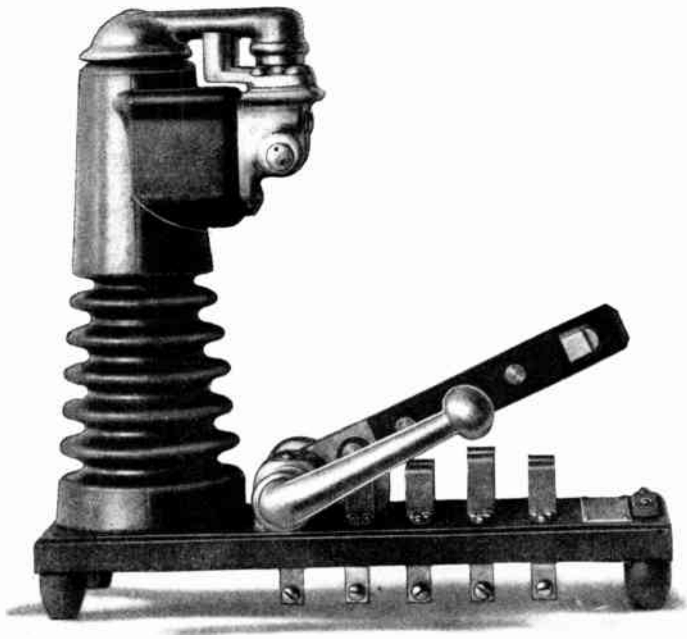
The .005 mfd. condenser shown in the illustration contains a total of 56 semi-circular fixed plates and 58 semi-circular variable plates. The smaller capacity condensers have a correspondingly smaller number of plates. The plates of the upper half of the condenser are mounted on the opposite side of the shaft from the similar lower plates, thus effectively balancing the system.

The plates are hard aluminum $\frac{1}{32}$" thick. The air-space between plates is $\frac{3}{32}$". The plates are separated by aluminum washers accurately machined. The rods supporting the stationary plates are of brass. The movable plates are mounted upon a steel shaft. The system is fastened to two circular bakelite dilecto end pieces, the upper of which is, in turn, fastened to the bakelite dilecto top of the condenser. The unit may be easily lifted from the case by the removal of eight screws. On the bakelite dilecto top is the rotary control knob and pointer which is provided with an engraved 180° scale. Two nickel-plated binding-posts are provided for making connections to the condenser.

These condensers are mounted in neat oak boxes, and are provided with calibration.

X. GENERAL EQUIPMENT

ANTENNA SWITCH, TYPE Q-S-5001



THE antenna switch shown above is designed for radio equipments up to 10 K.W. The heavy corrugated pillar of the switch is electrose. The metal parts are heavy composition castings finished and lacquered.

The rugged construction used throughout this switch, and the soft rubber bumpers, prevent any injury from resulting by hard or quick throwing of the transfer lever.

The switch is mounted on a raised heavy bakelite dilecto base, which permits wires to be attached either on the side or at the bottom.

In the sending position, the switch accomplishes the following:

1. Closes a break in field circuit of alternator.
2. Closes circuit that operates the solenoid of a clapper switch, of the double-pole type, which controls alternator field and armature.
3. Closes circuit that operates detector protective relay.
4. Closes one spare set of contacts.
5. Grounds the terminal that connects to receiver.
6. Connects antenna to loading coil of transmitter.

In the receiving position:

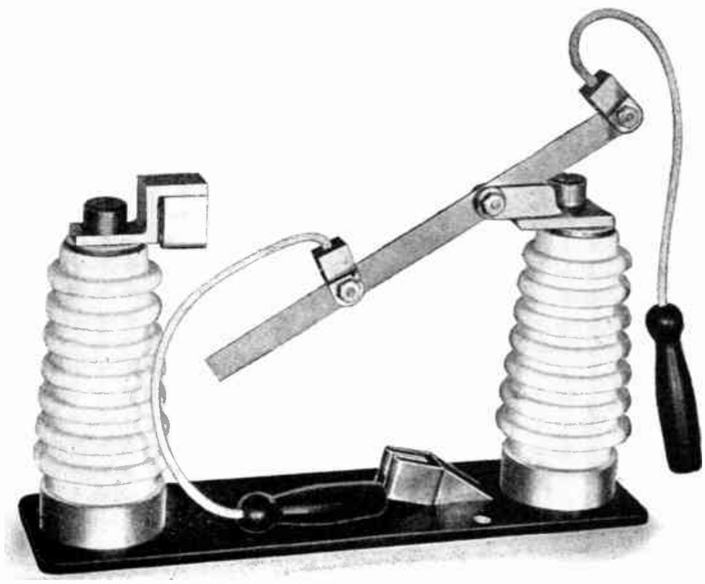
7. Opens contacts or circuits 1, 2, 3, 4, above.
8. Connects receiver lead to antenna.
9. The connection (5) above remains closed until the antenna is grounded just before the switch reaches the final receiving position.
10. Design is such that contact (2) will open before (1), so that spark at breaking field occurs at the clapper switch on the switchboard, and not at the antenna switch, unless the clapper switch fails to open.

Size, 13" x 8½" x 4½" Weight, 18 pounds

LIGHTNING SWITCH, TYPE Q-S-5007

EVERY modern radio installation is equipped with a reliable lightning switch, which grounds the antenna when not in use. A ship at sea with ungrounded antenna is subject to being struck by lightning. A grounded antenna offers the same protection as a lightning rod. The Fire Underwriters require this protection on all shore equipments.

This lightning switch is designed for ceiling mounting. It is operated by sash-cord pull lines. This system provides a simple, safe method of throwing the switch, and at the same time locates the equipment free from the operating table. Two heavy, tapered, corrugated porcelain insulators afford ample insulation. The air separation provided during transmission is 4". The switch blade is a 14" heavy copper arm. The base is ¼" brass, finished in black japan, so that the switch makes an excellent appearance in black, white, and copper. This switch is used on all our tropical installations, which are subjected to the most severe electrical storms.



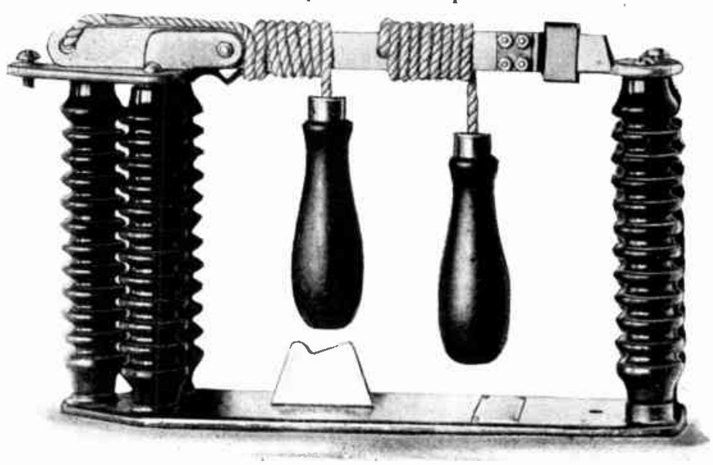
LIGHTNING SWITCH, TYPE Q-S-5007

Overall dimensions, 15" x 8⅝" x 4"
Weight, 9 pounds

LIGHTNING SWITCH, TYPE Q-S-5002

THIS lightning switch is used by the United States Navy in their shipboard installations. It is similar in general construction to the commercial type switch above. It is designed for ceiling mounting, and is operated by sash-cord pull handles. In this type adequate insulation is secured by five 8" corrugated electrose column insulators, three at the pivot end of the switchboard, and two at the contact end. The lever arm and switch-blades are of heavy drawn copper. All other metal parts are brass, heavily copper plated, buffed and lacquered.

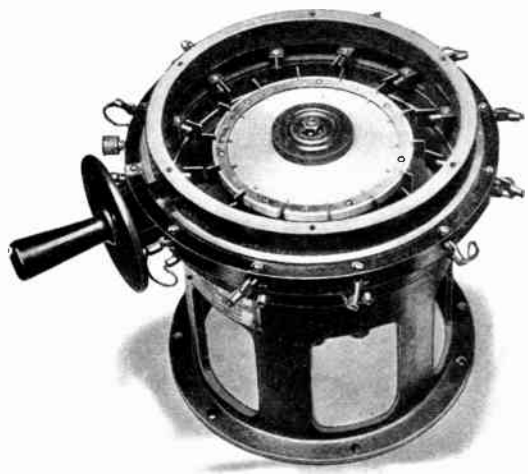
Overall dimensions, 15$\frac{1}{16}$" x 8½" x 3⅝"
Weight, 10 pounds



LIGHTNING SWITCH, TYPE Q-S-5002

ROTARY SPARK GAP, TYPE Q-S-5006

THE rotary spark gap shown in the following illustration was designed for use on spark transmitters up to five kilowatts. Its main advantage over the quenched spark gap is one of reliability of operation. Since the gap is designed with broad parallel sparking surfaces, and operates at a high breaking speed which can be adjusted to synchrony with the motor-generator, its operation is essentially the same as that of the quenched spark gap of the ordinary parallel plate type. The efficiency of the rotary gap is of the order of magnitude of the usual quenched spark gap. The gap is mounted with its rotor shaft on a vertical axis. The rotor consists of an aluminum wheel upon which are mounted fourteen hard-drawn copper electrodes, held in place between two steel clamping rings. The stator consists of twelve stationary electrodes pivoted between two insulated rings and arranged so that rotation of one of the rings varies (simultaneously for all electrodes) the sparking distance between the stator and rotor. The stationary electrodes are connected by a flexible connection to a collector ring. An insulated handle on one side of the unit permits adjustment and clamping of this adjustment while the gap is in operation.



ROTARY GAP WITH COVER REMOVED

The spark chamber is encased in an aluminum housing and cast with heat-radiation flanges. A transparent window affords a view of the spark.

The motor consists of a ¼ H.P. 120-volt direct-current motor, operating at a speed of 4,000 revolutions a minute. This produces 5,600 parallel breaks per second between two sets of electrodes 180° apart. The two terminals of the gap are the aluminum casing and the collector ring. On our 5 K.W. equipment, the gap is operated at 17,600 volts in a condenser circuit of .032 mfd. The 2 K.W. equipment is operated at a voltage of 16,000 volts in a condenser circuit of .016 mfd.

Reliability offered by this type of gap has caused the Navy to specify it as an auxiliary in all 5 K.W. and 2 K.W. radio installations.

Overall size, 17" x 14" x 12"

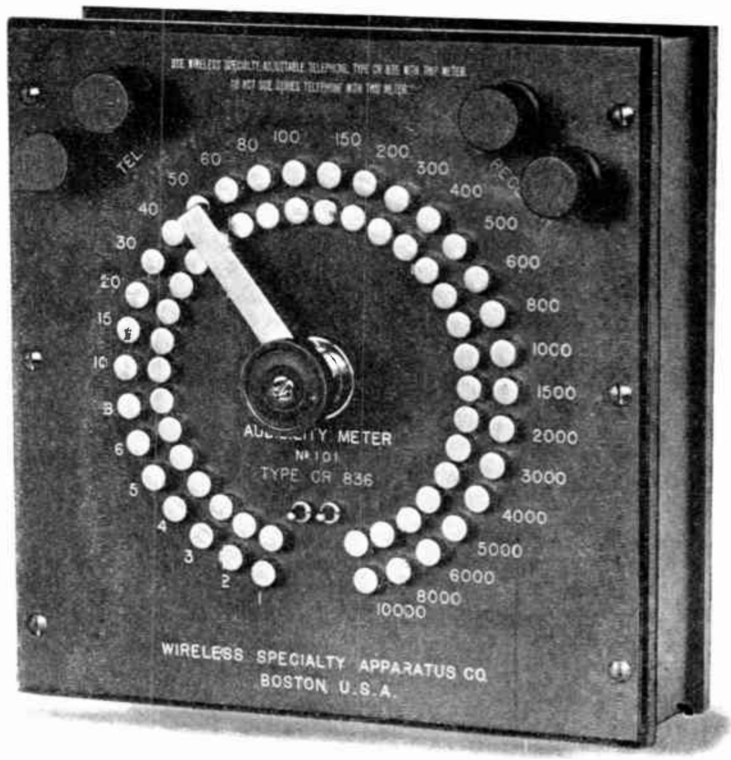
Weight, complete with motor, 40 pounds

ROTARY GAP WITH COVER

CONSTANT IMPEDANCE AUDIBILITY METER, TYPE I-P-306

AN audibility meter is an essential piece of apparatus in all comparative tests of receivers and telephones, for the reason that it reduces the strength of signals to a definite standard basis of numerical comparison; thus, unit audibility, or an audibility of one, is the strength of a signal which is just audible. By means of a variable shunt around the telephones, we can always reduce the strength of signal to unit audibility. If we knew the proportional current passing through the shunt, we could readily determine the number of times audibility of the signals, provided that at the same time we introduced an impedance in series with the detector output, so as to maintain constant the total impedance across the detector.

In the old types of audibility meters, inaccuracy was introduced in the readings because of the variation in the total impedance across the detector, which resulted in a variation in detector output. The constant impedance audibility meter maintains a constant impedance across the detector terminals, which is equal to the impedance of the telephones, and insures a constant detector output in all adjustments. The above meter is designed so that this constant impedance is automatically secured. The range of the instrument is from one to ten thousand audibility.



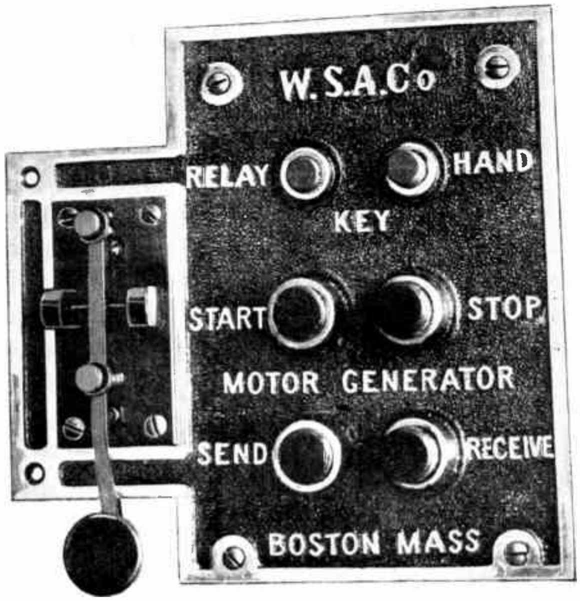
CONSTANT IMPEDANCE AUDIBILITY METER
(Patented 1919)

This meter is invaluable in measuring the strength of signals in comparing receivers, receiver circuits, telephones, the amount of amplification in oscillating circuits, and other laboratory and commercial measurements. It can be left connected in the circuit without a reduction of signal strength, when the contact switch is on contact number one. It may be used with equal success in either vacuum tube oscillating circuits or with crystal detectors, and reads directly in "times audibility."

The meter is beautifully furnished in a hard-wood box, with a bevelled bakelite dilecto top, on which the audibility is directly engraved. Connection is readily afforded by four binding posts, two for the receiver circuit, and two for the telephones. The taps and contact arm are of polished nickel, so that the instrument makes an attractive, as well as invaluable, addition to any radio station or laboratory.

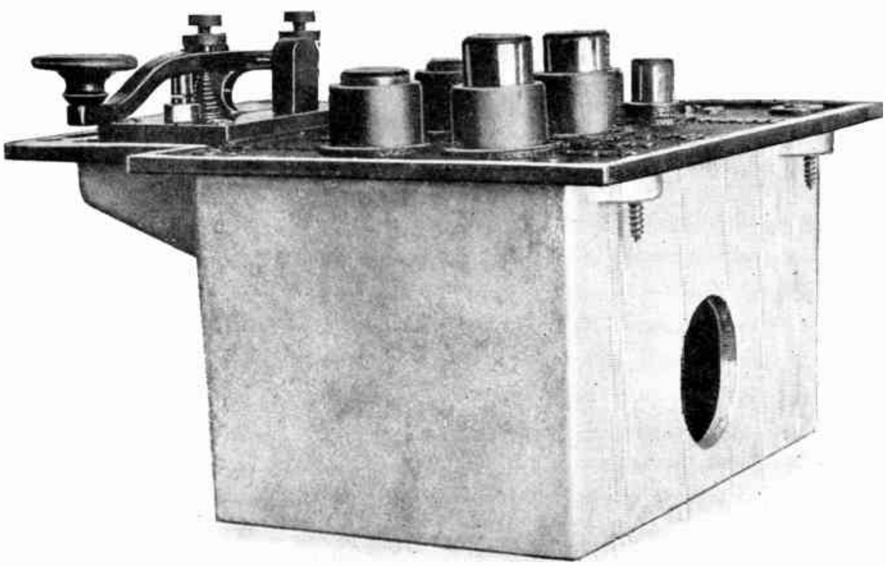
Overall size, 8" x 8" x 3½" Weight, 4 pounds

AUTOMATIC CONTROL PANEL, TYPE Q-S-1002



IN the early types of radio equipment much time was lost in alternating the antenna connection between the receiving and sending circuits. It was necessary to protect the detector, manipulate an awkward antenna switch, and laboriously start the motor generator with a hand rheostat. In these days of high pressure radio communication, every second is valuable, and avoidable delays will not be tolerated. This central control board is designed to facilitate quick transfers and reduce delays to a minimum.

The key is a standard WIRELESS SPECIALTY APPARATUS key of the light type with ¼" silver contacts, and is mounted directly on the panel, thus eliminating lost motion in reaching from the key to the switches. The panel is arranged so that it may be set into the operating table. It contains three push-button switches. The top one permits a choice of hand or relay keys. The second starts and stops the motor generator, while the third actuates an automatic send-receive switch. To reach from the key to the switches requires only the slightest movement of the hand.

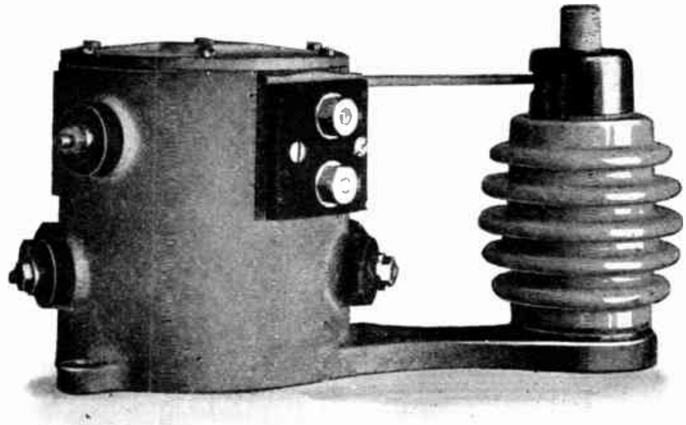


The relay key is described on page 50.

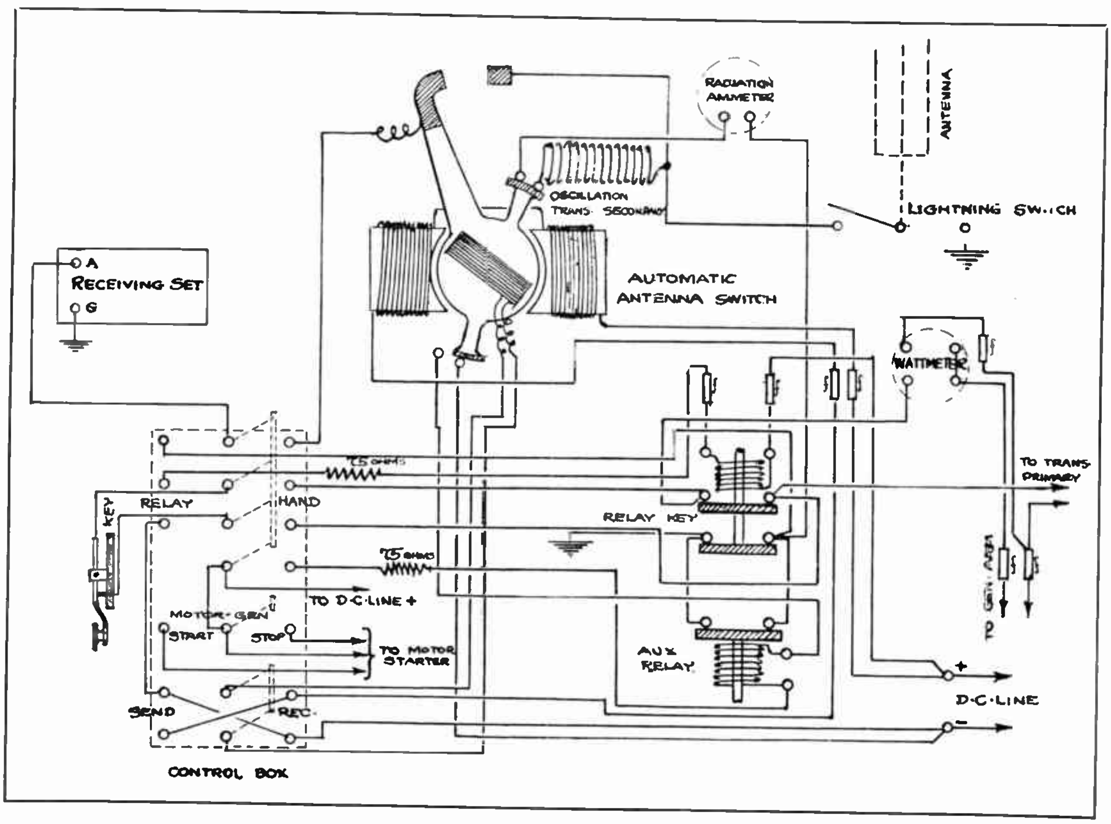
The antenna transfer switch shown in the photograph is operated by reversals of a shuttle armature bringing into play an high inertia which produces positive contacting of the switch clips. Insulation for operation on powers of 1 K.W. is provided.

The circuits are shown in the accompanying wiring diagram.

Size, 8" x 7" x 5" Weight, 15 pounds



ANTENNA TRANSFER SWITCH



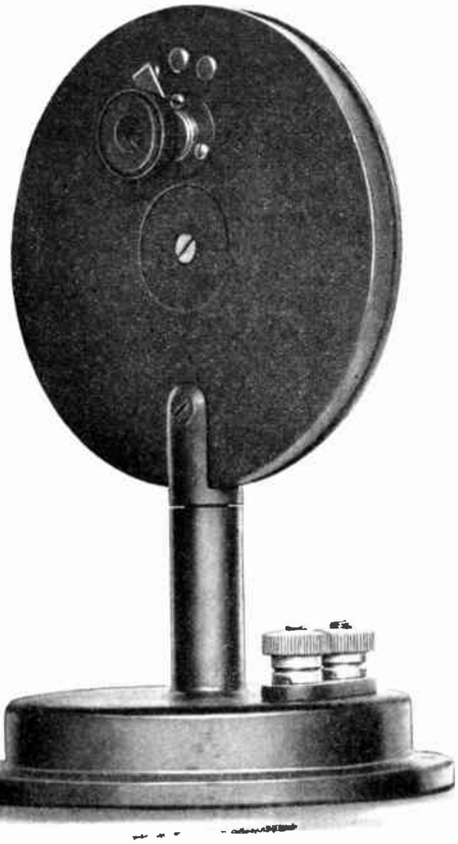
WIRING DIAGRAM, AUTOMATIC ANTENNA SWITCH AND CONTROL BOX

THE CLARK TONE-TESTER

THE transmitting range of any radio station is dependent in a large degree upon the carrying power and tone of the spark. This device was designed to enable an operator to test the tone of the spark easily and quickly, and gives the true note of the spark as heard in a distant receiving station.

This tone-tester was originally designed by Mr. Geo. A. Clark, and consists of a miniature crystal detector, inductance, and fixed condenser, all mounted upon a heavy cast base, equipped with two binding posts for telephone connections.

The fixed condenser is contained within the inductance spool, while the detector and inductance switch are mounted directly upon the alternate sides of the spool. The contact switch has three taps, permitting the test of a spark tuned on any one of the three standard wave-lengths, 300 meters, 600 meters, and 1200 meters. The tune of the tone test circuit, however, is sufficiently broad for use with sparks of lower or higher wave-length range. The inductance spool is mounted upon a swivel which thus permits setting of the coil in any desired plane, relative to the inductance plane of the transmitting apparatus. In this way, any desired degree of intensity may be obtained.



FRONT VIEW

BACK VIEW

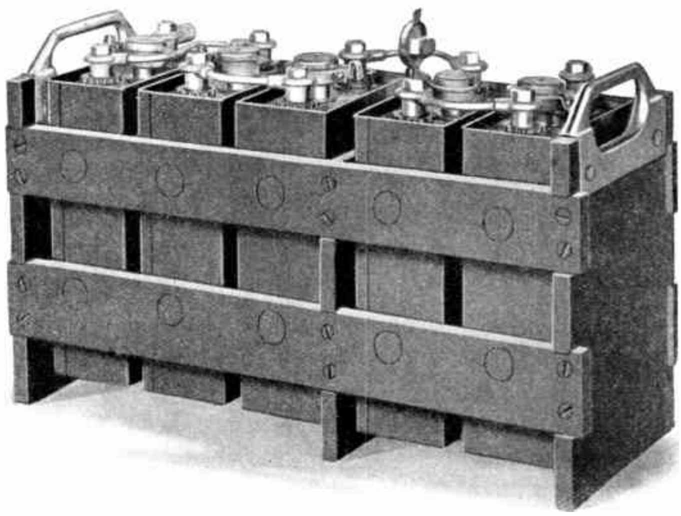
The spool is bakelite dilecto, while all metal parts are black japanned or polished nickel, making the tone-tester an attractive and useful piece of apparatus in any radio station.

Size, 8" x 4 7/8" x 3½" Weight, 3½ pounds

XI. EDISON STORAGE BATTERIES

THE United States Radio Law requires, on all vessels, radio equipment capable of emergency transmission over a minimum distance of one hundred miles, and for a minimum period of four continuous hours. This necessitates a source of power external to the engine room. The Edison nickel-iron-alkaline storage battery has met the exactions of the marine auxiliary wireless service more closely than any other source of power.

Several large and progressive steamship companies have adopted Edison Storage Batteries for their ships. On page 70 of this catalog will be found photographs of a WIRELESS SPECIALTY APPARATUS installation on the UNITED FRUIT COMPANY'S Steamship *Pastores*, equipped with an Edison Storage Battery for emergency operation of the radio apparatus and ship's lights. This battery was installed in 1913 and has not required any replacements to date. No depreciation is evident, either electrically or mechanically.

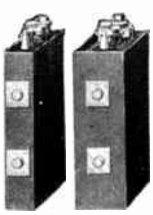


A BATTERY OF 5 B-4 CELLS MOUNTED IN MARINE TRAY

The Edison Battery can be discharged to zero, and even short-circuited, without injury. If it is connected "reversed" no harm is done, although, of course, the connections must be changed to their proper poles in order to charge the battery. It can be left on charge indefinitely and may be charged at several times its normal rate, for limited periods, without injury. We do not recommend this practice, however, on account of the excessive evaporation of the electrolyte.

The Edison Battery may be left standing idle indefinitely either charged or discharged, without attention and without injury.

Excessive vibration and concussion do not affect the Edison Battery. There is no buckling or growing of the plates, no shedding of active materials, no necessity for plate renewals and no breakage. After seven and eight years' service, Edison Batteries with the original plates are operating at full capacity and apparently yet good for many years.



B2 B4
TYPE CELLS

In addition to the units for marine and industrial purposes, Edison Batteries are now made in small compact units designed for the operation of vacuum tubes. This source of power is, of course, far superior to dry cells or other primary batteries.

Edison Batteries are shipped charged ready for immediate use. We recommend the installation of the battery in the radio room. We will be pleased to quote on steel skeleton frame battery racks for the cell units from sketches or blueprints of the radio room.

Additional information and prices on application.

XII. THE PATENTED CONTRIBUTIONS OF THE WIRELESS SPECIALTY APPARATUS COMPANY

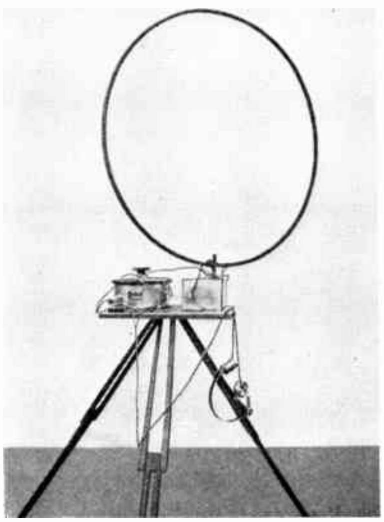
A NEW art has its birth in the fruits of inventive genius. It is, therefore, so intimately connected with the general patent situation that no discussion in its field is complete without a survey of each manufacturer's contribution to the art, measured by the importance and scope of his acquired patents.

The WIRELESS SPECIALTY APPARATUS COMPANY was formed upon the inventive talent of Mr. Pickard. His patents are the record of twenty years of extensive research work in radio communication that had its initial success when he discovered his first form of detector. Mr. Pickard's crystal detector patents thoroughly cover this universal and simple method of radio reception.

At a recent dinner of the Washington Branch of the American Institute of Radio Engineers, Commander S. C. Hooper — the administrative head of the Radio Engineering Department of the United States Navy — delivered an address in which he stated that the Direction Finder Loop (*patented by Mr. Greenleaf Whittier Pickard in 1908*) was the most important modern device employed in the radio art by the United States Navy during the World War.

The static elimination devices invented by Mr. Pickard and placed in the Bar Harbor Station carried the bulk of the Transatlantic radio reception traffic from our expeditionary forces in France. This station was entirely designed and built by the WIRELESS SPECIALTY APPARATUS COMPANY. Its most recent achievement was the reporting of the radio traffic in the Transoceanic flight of the U. S. Navy Seaplanes during their entire course.

The fifty or more patents issued since 1906 to the WIRELESS SPECIALTY APPARATUS COMPANY control a wide range of devices and circuits used in radio telegraphy and telephony. The crystal patents include the controlling and subsidiary patents on crystal detectors, constituting a complete patent situation on the various standard features, including the crystals themselves, the contact selection, the standard fusible metal holder for the crystals, all the operative forms of crystal contacts, the standard crystal detector circuits and apparatus combined with crystals, and many mechanical devices for using and operating crystals.



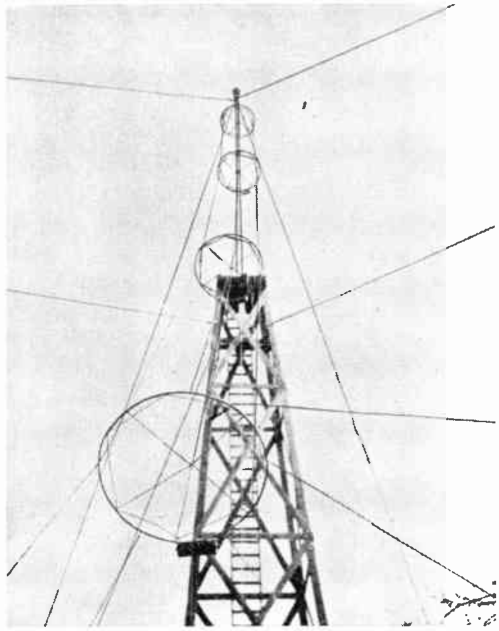
THE EARLY DIRECTION FINDER LOOP

In 1907, two other remarkable inventions were filed in the United States Patent Office. The first of these was the Loop Patent issued in 1908 (No. 876,996); the second, the Multiple Antenna Patent, issued in 1910 (No. 956,165).

The Loop Patent is controlling in the use of a loop antenna for transmission and reception, the property of direction finding of a loop, and the combination of a loop with an ordinary antenna.

The accompanying photograph is taken from an article by Mr. Pickard, published in the *Electrical Review*, June 15, 1907, and shows an early Direction Finder Loop of four series turns, one meter in diameter, arranged on a tripod with the associated tuning condensers and detector apparatus. At that early date this loop was used to determine the direction of a distant transmitter and plot the distortion of the wave front of a station when it met obstacles such as metal structures and natural geographical variations, such as trees hills and streams.

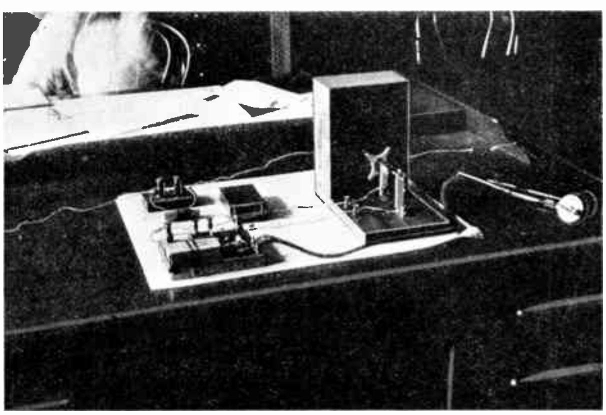
The great freedom from static of a loop compared with the straight antenna is mentioned in this patent. No high-seas navy vessel at the present time is completely equipped without a Loop Direction Finder, essentially identical with the one shown in the photograph. The service performed by it during the war in hastening the destruction of the German submarines and Zeppelins, in locating the exact position of enemy field units, of guiding our night bombers back to their airdromes, and of navigating vessels at sea in fog or thick weather, cannot be measured. The NC-4 was guided in her historic flight from the United States to England by a directive loop receiving system. The entire front line communication of the Allies was planned on a portable quenched gap loop transmitter and receiver, capable of being entirely contained in a dugout, and communicating with similar stations at distances up to eight miles in the rear. This set was developed in France by our Chief Engineer, W. H. Priess, at that time an officer in the United States Signal Corps, when enemy fire was making it impossible to maintain telephone wire lines.



First Attempt at Static Elimination

The Wireless Specialty Apparatus Company's Loop Patent also shows for the first time the circuits for unilateral direction finding, local elimination of static, and adjustment of radio-frequency phase relations.

The Multiple Antenna Patent covers broadly the use of tuned combinations of Loop Antennae, Straight Antennae, or arrangements of the two types, connected by Radio Frequency Circuits, the phase relations of which are designed according to the principle described in the patent, so as to combine the desired radio-frequency energy collected in the various antennae at the required phase in a common detector circuit. In the patent the particular case of transoceanic and transcontinental reception was disclosed, and the special form described is two tuned vertical loops in the same east-west plane, separated approximately one-half wave-length, or a distance of several thousands of meters. The complete disclosure here of radio-frequency phase-control of the energy of several circuits is remarkably far ahead of the art at this date. This patent shows the basic circuits used in our land station static eliminator.



The First Wireless Telephone Receiver

Some of the other important inventions and patents owned by the Wireless Specialty Apparatus Company are:

The standard receiving inductance with two interconnected switches for control by large and small units;

Leyden jar condensers in which the conducting surfaces are electrolytically deposited copper or other metal;

Basic patent for use of the combination consisting of a 500-cycle generator at the transmitter and rectifying detector with telephone at the receiver;

Various forms of sheet condensers for spark circuits, protective condensers and various other uses;

Constant impedance audibility meter;

Telephone receivers with protective spark gaps;

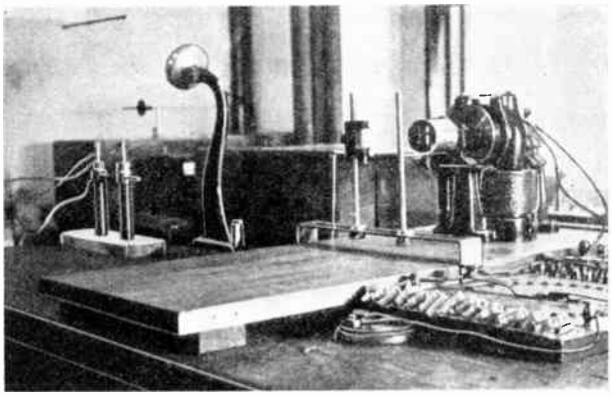
The so-called inductance "ticker" system of receiving radio signals;

Testing apparatus for detectors and receiving circuits, using oscillations from a buzzer or other source;

Rotary tone condenser reception;

Various circuits: the apparatus and methods for transmission and reception, including the standard system involving the transmission of waves in groups at high frequency, the rectification of the received currents, the charging of a condenser and discharging it through the telephones;

Various practical forms of static eliminators, including those using the Loop Antenna.



The First Wireless Telephone Transmitter

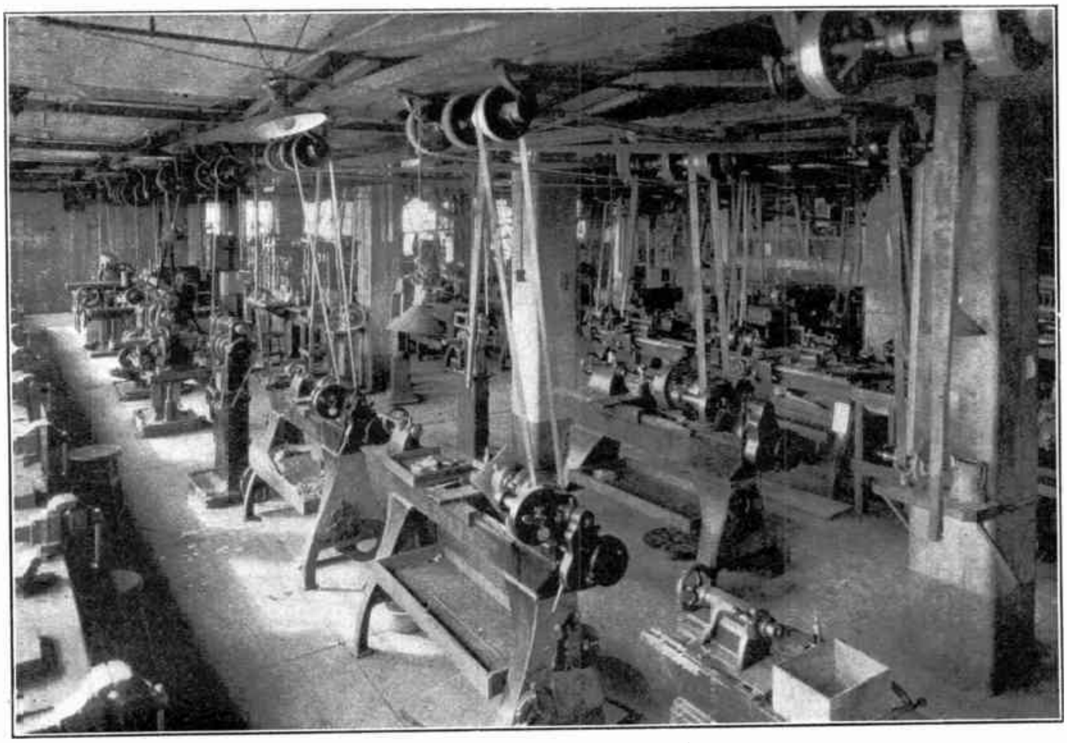
A large number of patents on important phases of radio communication are pending. This is indicative of the policy of the company to maintain its supremacy as a *specialist* in the development of the radio art.

The accompanying photographs show the earliest successful apparatus for the transmission of speech by means of wireless waves, known to us.

On September 6, 1902, in Boston, Mass., Mr. Greenleaf Whittier Pickard used this equipment in a demonstration before a group of telephone engineers, including Messrs. H. J. W. Fay and H. W. Shreeve, under the auspices of the American Telegraph and Telephone Company (Bell System). The receiver was of special interest, for it included the first Wollaston-wire "electrolytic" detector. The transmitter was of the spark type, using discharges above audible frequency.

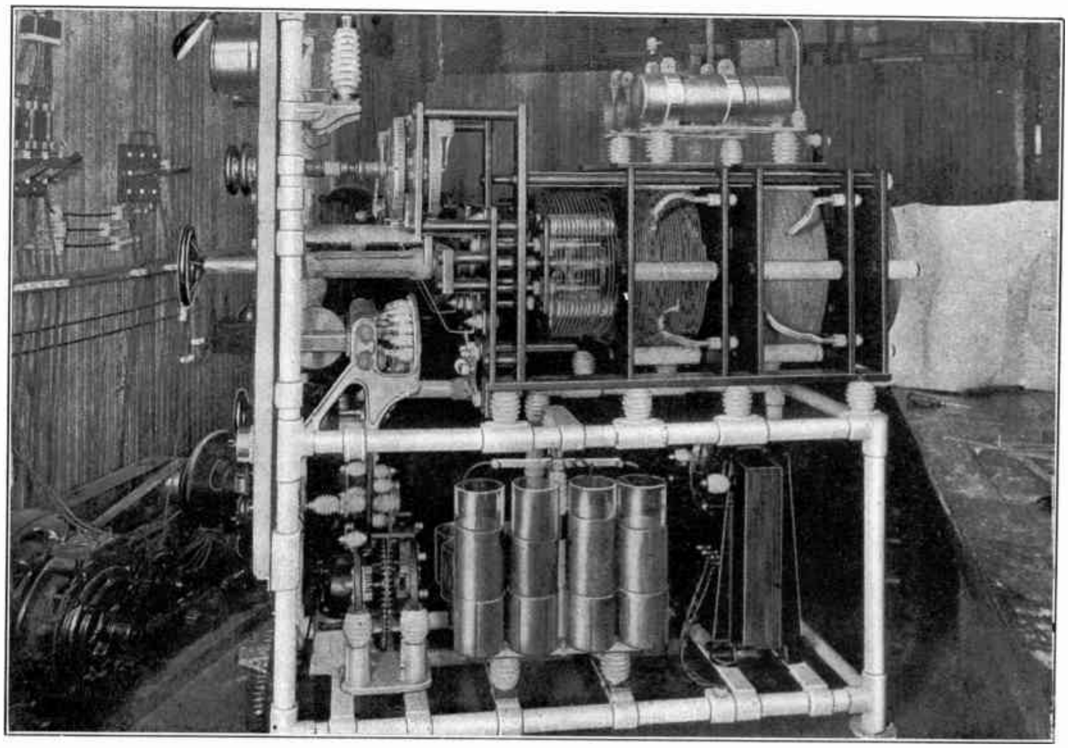
This 1902 installation was not of commercial nature, of course, but it was operative radio telephony and demonstrated the future possibilities.

Light-Assembly Room of Main Plant of WIRELESS SPECIALTY APPARATUS COMPANY

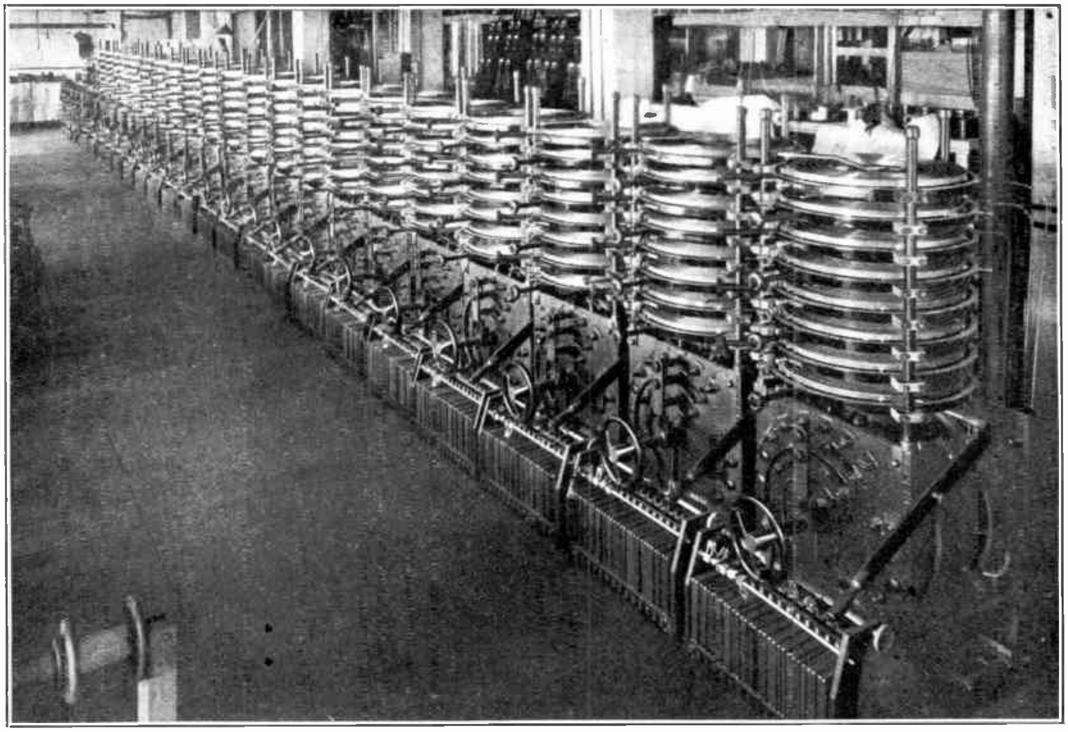


Machine Shop of Main Plant of WIRELESS SPECIALTY APPARATUS COMPANY

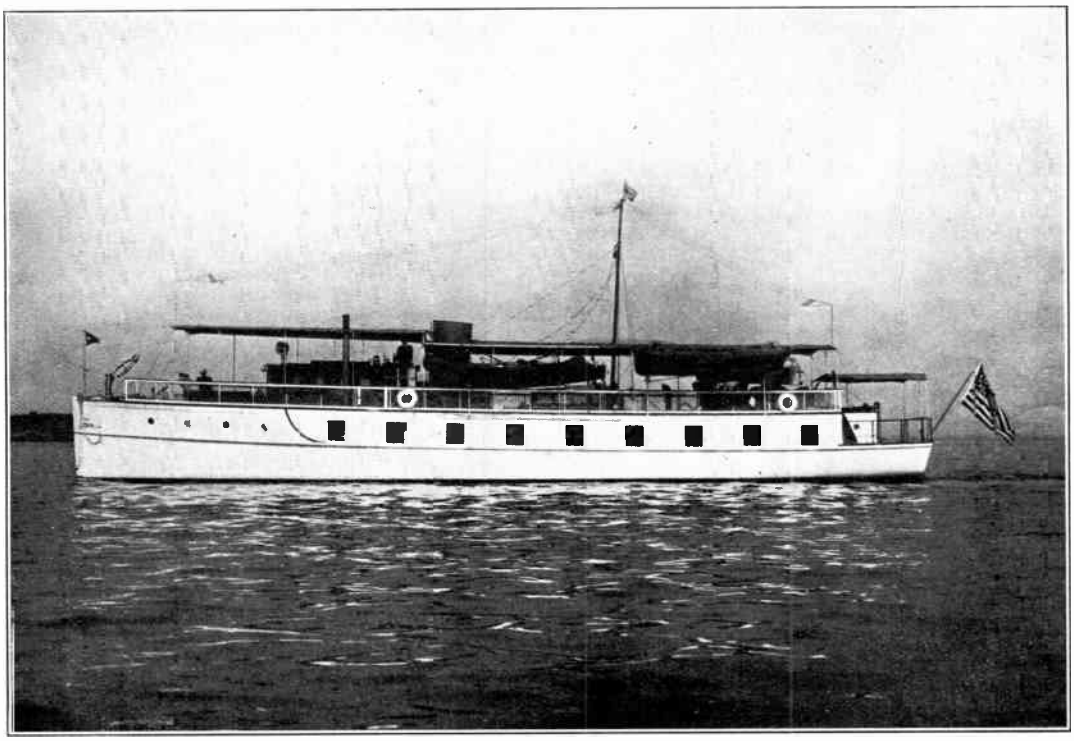
Radio Installation on United Fruit Company's Steamship *Pastores* designed and built by Wireless Specialty Apparatus Company. In continuous operation since 1913



5 K.W. Transmitter designed and built by the Wireless Specialty Apparatus Company and installed in the United Fruit Company's station at Swan Island, Caribbean Sea



A few high-tension panels of one lot of two hundred 5 K.W. Radio Transmitters manufactured for the U. S. Navy by the WIRELESS SPECIALTY APPARATUS COMPANY



Power Yacht *Santanta* equipped with WIRELESS SPECIALTY APPARATUS

THE RELATION OF NATURAL WAVE-LENGTH, FREQUENCY, AND INDUCTANCE-CAPACITY PRODUCT IN CONDENSER CIRCUITS

PREPARED BY GREENLEAF W. PICKARD

THIS table gives the relation between free wave-length in meters, frequency in cycles per second and capacity inductance product in microfarads and microhenries, for circuits above 100 meters. The relation between wave-length and capacity-inductance product may be relied upon throughout the table to within one part in two hundred. Three examples are given below, to illustrate important uses of the table.

Example 1. What is the natural wave-length of a circuit containing a capacity of 0.001 microfarad, and an inductance of 454 microhenries? The product of inductance and capacity is 454 x 0.001 = 0.454. Find 0.454 under L x C; opposite under "meters" is 1270 meters, the natural wave-length of the circuit.

Example 2. What capacity must be associated with an inductance of 880 microhenries, in order to tune the circuit to 3500 meters? Find opposite 3500 meters the L x C value 3.45; divide this by 880, and the quotient, 0.00397, is the desired capacity in microfarads.

Example 3. A condenser has a capacity of 0.004 microfarad. What inductance must be placed in series with this condenser in order that the circuit shall have a wave-length of 600 meters? From the table, the LxC value corresponding to 600 meters is 0.1013. Dividing this by 0.004, the capacity of the condenser, gives the desired inductance, 25.3 mocrohenries.

Meters	n	L x C	Meters	n	L x C	Meters	n	L x C	Meters	n	L x C
100	3,000,000	0.00282	500	600,000	0.0704	700	429,000	0.1379	900	333,000	0.228
110	2,727,000	0.00341	505	594,000	0.0718	705	426,000	0.1399	905	331,000	0.231
120	2,500,000	0.00405	510	588,000	0.0732	710	423,000	0.1419	910	330,000	0.233
130	2,308,000	0.00476	515	583,000	0.0747	715	420,000	0.1439	915	328,000	0.236
140	2,143,000	0.00552	520	577,000	0.0761	720	417,000	0.1459	920	326,000	0.238
150	2,000,000	0.00633	525	572,000	0.0776	725	414,000	0.1479	925	324,000	0.241
160	1,875,000	0.00721	530	566,000	0.0791	730	411,000	0.1500	930	323,000	0.243
170	1,764,000	0.00813	535	561,000	0.0806	735	408,000	0.1521	935	321,000	0.246
180	1,667,000	0.00912	540	556,000	0.0821	740	405,000	0.1541	940	319,000	0.249
190	1,579,000	0.01015	545	551,000	0.0836	745	403,000	0.1562	945	317,000	0.251
200	1,500,000	0.01126	550	546,000	0.0852	750	400,000	0.1583	950	316,000	0.254
210	1,429,000	0.01241	555	541,000	0.0867	755	397,000	0.1604	955	314,000	0.257
220	1,364,000	0.01362	560	536,000	0.0883	760	395,000	0.1626	960	313,000	0.259
230	1,304,000	0.01489	565	531,000	0.0899	765	392,000	0.1647	965	311,000	0.262
240	1,250,000	0.01621	570	527,000	0.0915	770	390,000	0.1669	970	309,000	0.265
250	1,200,000	0.01759	575	522,000	0.0931	775	387,000	0.1690	975	308,000	0.268
260	1,154,000	0.01903	580	517,000	0.0947	780	385,000	0.1712	980	306,000	0.270
270	1,111,000	0.0205	585	513,000	0.0963	785	382,000	0.1734	985	305,000	0.273
280	1,071,000	0.0221	590	509,000	0.0980	790	380,000	0.1756	990	303,000	0.276
290	1,034,000	0.0237	595	504,000	0.0996	795	377,000	0.1779	995	302,000	0.279
300	1,000,000	0.0253	600	500,000	0.1013	800	375,000	0.1801	1000	300,000	0.282
310	968,000	0.0270	605	496,000	0.1030	805	373,000	0.1824	1010	297,100	0.287
320	938,000	0.0288	610	492,000	0.1047	810	370,000	0.1847	1020	294,200	0.293
330	909,000	0.0306	615	488,000	0.1065	815	368,000	0.1870	1030	291,300	0.299
340	883,000	0.0325	620	484,000	0.1082	820	366,000	0.1893	1040	288,500	0.304
350	857,000	0.0345	625	480,000	0.1100	825	364,000	0.1916	1050	285,700	0.310
360	834,000	0.0365	630	476,000	0.1117	830	361,000	0.1939	1060	283,000	0.316
370	811,000	0.0385	635	472,000	0.1135	835	359,000	0.1962	1070	280,400	0.322
380	790,000	0.0406	640	469,000	0.1153	840	357,000	0.1986	1080	277,800	0.328
390	769,000	0.0428	645	465,000	0.1171	845	355,000	0.201	1090	275,200	0.334
400	750,000	0.0450	650	462,000	0.1189	850	353,000	0.203	1100	272,700	0.341
410	732,000	0.0473	655	458,000	0.1208	855	351,000	0.206	1110	270,300	0.347
420	715,000	0.0496	660	455,000	0.1226	860	349,000	0.208	1120	267,900	0.353
430	698,000	0.0520	665	451,000	0.1245	865	347,000	0.211	1130	265,500	0.359
440	682,000	0.0545	670	448,000	0.1264	870	345,000	0.213	1140	263,200	0.366
450	667,000	0.0570	675	444,000	0.1283	875	343,000	0.216	1150	260,900	0.372
460	652,000	0.0596	680	441,000	0.1302	880	341,000	0.218	1160	258,600	0.379
470	639,000	0.0622	685	438,000	0.1321	885	339,000	0.220	1170	256,400	0.385
480	625,000	0.0649	690	435,000	0.1340	890	337,000	0.223	1180	254,200	0.392
490	612,000	0.0676	695	432,000	0.1360	895	335,000	0.225	1190	252,100	0.399

XV. FORMULÆ FOR THE CALCULATION OF RADIO PHENOMENA

COLLECTED BY WILLIAM H. PRIESS
CHIEF ENGINEER WIRELESS SPECIALTY APPARATUS COMPANY

The following list of Symbols applies to the formulae listed for convenient reference:

J = Energy in joules
W = Power in watts, 10^3 watts = 1 kilowatt
I = Current in amperes
E = Potential difference in volts
R = Resistance in ohms
R_r = Radiation resistance in ohms
L = Inductance in henries, 10^9 cms. = 1 henry
C = Capacity in farads, 10^6 mfds. = 1 farad
M = Mutual inductance in henries
K = Coupling coefficient
n = Number of sparks per second
k = Dielectric constant
c = Conductivity
μ = Permeability
ϵ = Base of natural logarithms
Z = Number of turns
A = Amplitude of parameter
N = Oscillation frequency in cycles per second
T = Oscillation period in seconds
$\omega = 2\pi N$
λ = Oscillation wave-length in meters
V_L = Velocity of light $= 3 \times 10^8$ meters per second
d = Logarithmic decrement

The **energy** stored in the electrostatic field of a condenser =

$$J = \frac{1}{2} CE^2 \text{ joules} \tag{1}$$

The **energy** stored in the electromagnetic field of an inductance =

$$J = \frac{1}{2} LI^2 \text{ joules} \tag{2}$$

In an oscillating circuit, its energy is transferred from the electrostatic to the electromagnetic field and then returned to the electrostatic field, with each transfer requiring a quarter cycle for its completion. If the phase angle of the circuit is zero (i. e., neglecting losses),

$$LI^2 = CE^2 \tag{3}$$

The **power** carried by either the electrostatic field of a condenser or the electromagnetic field of an inductance is the product of the number of times these fields are built up per second and the energy stored at each charge.

$$W = \frac{1}{2} nCE^2 \text{ watts} \tag{4}$$

$$W = \frac{1}{2} nLI^2 \text{ watts} \tag{5}$$

The **frequency of oscillation** of a condenser circuit of low damping =

$$N = \frac{1}{2\pi\sqrt{LC}} \text{ cycles per second} \tag{6}$$

The **period of the oscillation** =

$$T = \frac{1}{N} \text{ seconds} \tag{7}$$

Since $N\lambda = V_L$ for an electromagnetic wave, the **wave-length** =

$$\lambda = 3 \times 10^8 \times 2\pi\sqrt{LC} \text{ meters} \tag{8}$$

A more useful form of equation (8) is

$$\lambda = 59.6 \sqrt{L \text{ cms. } C \text{ mfds.}} \text{ meters} \quad (9)$$

The **logarithmic decrement** of a condenser circuit =

$$d = \frac{R}{2\,L\,N} = \pi R \sqrt{\frac{C}{L}} \quad (10)$$

The value of the **amplitude** of either the current or the potential in an oscillating circuit whose decrement is logarithmic at any time t =

$$E = E_0\,\epsilon^{-\left(\frac{d}{T}t\right)} \quad (11)$$

$$I = I_0\,\epsilon^{-\left(\frac{d}{T}t\right)} \quad (12)$$

where E_0 and I_0 are, respectively, the maximum amplitude of the potential and the current at time $t = o$, and obtained from the envelope of the maximum peaks of these quantities.

The **current** and **potential** for the primary of a quenched spark transmitter follow the equation,

$$A = A_0\left(1 - \frac{a}{T}t\right) \quad (13)$$

The envelope of the oscillation is a straight line.

The **number of oscillations** required for the amplitude of either the current or potential difference to equal $1/x$ the initial amplitude =

$$G = \frac{\log_e x + d}{d} \text{ oscillations}$$

$$\text{For } x = 0.01 \quad G = \frac{4.60 + d}{d}$$

$$\text{For } x = 0.1 \quad G = \frac{2.30 + d}{d} \quad (14)$$

The **effective current** for an oscillation train when the envelope of an oscillation is logarithmic =

$$I^2_{eff.} = \frac{I_0^2}{4Na} \quad (15)$$

The **effective current** for a wave-train of a linear decrement a is given by

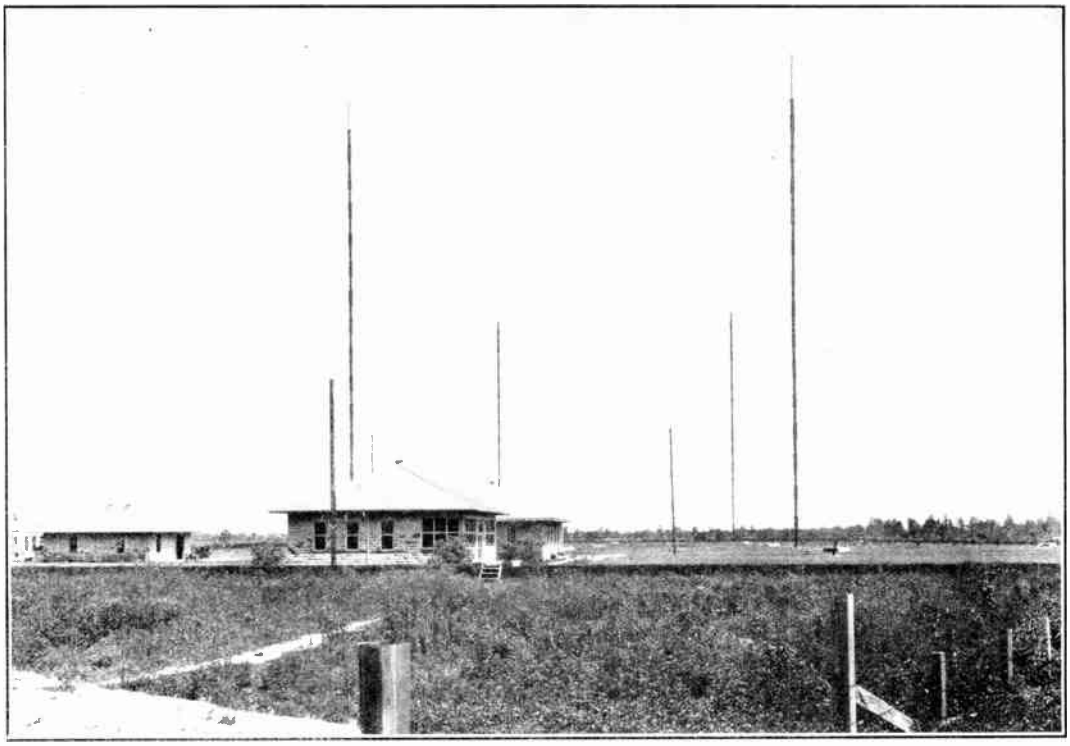
$$I^2_{eff.} = \frac{I_0^2}{6Na} \quad (16)$$

If there are n trains per second, and each train dies down completely (or practically) when

$$GT < \frac{1}{n}, \text{ where } x = 0.01 \quad \text{(See eq. 13.)}$$

the **effective current** in the circuit as measured by a thermo-ammeter =

$$I_{eff.} = \sqrt{\frac{n}{4\,Nd}}\; I_0 \quad (17)$$



New Orleans Station of the Tropical Radio Telegraph Company

Operating Room of the New Orleans Station of the Tropical Radio Telegraph Company, equipped with WIRELESS SPECIALTY APPARATUS COMPANY'S Auxiliary Transmitter and Receiver

COUPLED CIRCUITS

The **coupling coefficient** between two circuits whose electromagnetic fields are interlinked =

$$K = \frac{M}{\sqrt{L_1 \; L_2}} \tag{18}$$

where M is the mutual inductance between the circuits, and L_1 and L_2, the respective inductances of the two circuits.

When two circuits tuned to a common wave-length λ are coupled, two waves are present in the circuits. Their wave-lengths are dependent upon the decrements of the circuits and the coupling between them

$$\lambda_1 = \lambda \sqrt{1 - K_1} \tag{19}$$

$$\lambda_2 = \lambda \sqrt{1 + K_1} \tag{20}$$

$$\text{where } K_1 = \sqrt{K^2 - \left(\frac{d_1 - d_2}{2\pi}\right)^2} \tag{21}$$

in which d_1 is the decrement of one of the circuits and d_2 the decrement of the other circuit considered unlinked.

The **decrements** of the two coupling waves are, respectively,

$$d_a = \frac{d_1 + d_2}{2} \frac{\lambda}{\lambda_1} \tag{22}$$

$$d_b = \frac{d_1 + d_2}{2} \frac{\lambda}{\lambda_2} \tag{23}$$

If two circuits are coupled and the primary of frequency N_1 is excited by a potential difference E, which breaks down the gap n times per second, **a thermo-ammeter in the secondary circuit will register the current I_2 eff.** which reaches a maximum when the frequency of the secondary N_2 equals that of the primary. The current I_2 eff. equals

$$I_2\,eff. = E_1 \left[n \frac{1}{64\pi^2 N_1^3 L_2^2} \cdot \frac{d_1 + d_2}{d_1 d_2} \cdot \frac{1}{\left(1 - \frac{N_2}{N_1}\right)^2 + \left(\frac{d_1 + d_2}{2\pi}\right)^2} \right]^{\frac{1}{2}} \tag{24}$$

At **resonance** $N_1 = N_2$

$$I_2\,eff. = E_1 \left[n \frac{1}{16\, N_1^3 \; L_2^2} \cdot \frac{1}{d_1 d_2 \,(d_1 + d_2)} \right]^{\frac{1}{2}} \tag{25}$$

With **primary undamped** and $N_1 = N_2$

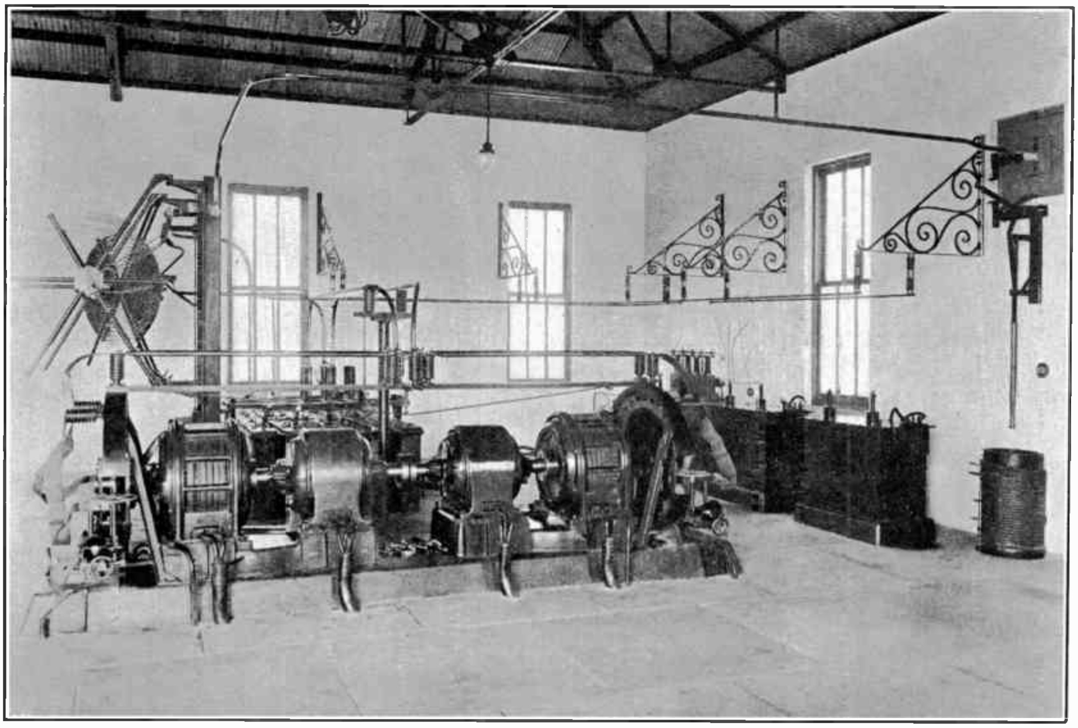
$$I_2\,eff. = E_1 \left[\frac{1}{8 N_1^2 \; L_2^2} \cdot \frac{1}{d_2^2} \right]^{\frac{1}{2}} \tag{26}$$

CALCULATION OF CAPACITY

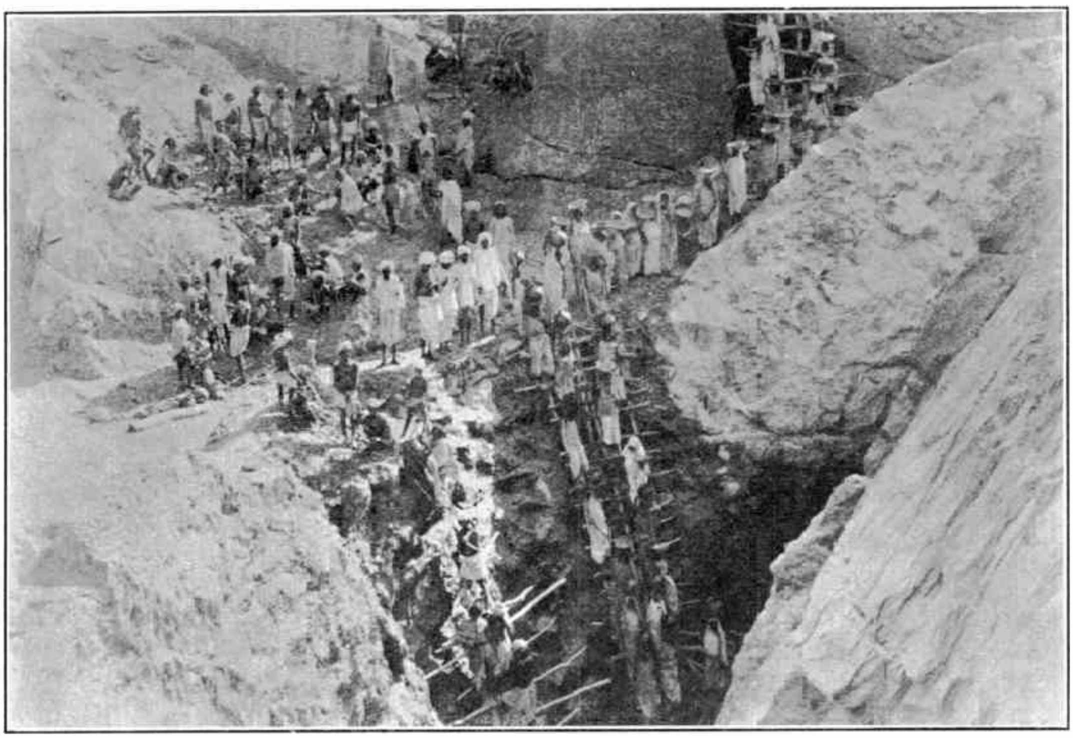
The **capacity of a condenser** consisting of parallel plates relatively close and separated by a dielectric of area (a) and thickness (t) =

$$C = \frac{ka}{36\pi \cdot 10^5 \cdot t} \text{ mfds.} \tag{27}$$

where (a) is in cms.^2 and (t) in centimeters. At radio frequencies the capacity is lower than that calculated, dependent upon the thickness and nature of the dielectric, and the frequency.



Power Plant of the New Orleans Station of the Tropical Radio Telegraph Company, showing the 50 K.W. Transmitter



Mining Mica in India for WIRELESS SPECIALTY APPARATUS COMPANY'S FARADON Mica Condensers

With (a) in square inches and (t) in thousandths of an inch

$$C = 2.25 \times 10^{-4} \frac{a}{t} \text{ mfds.} \tag{28}$$

$$k = \begin{cases} 1 \text{ for gases and vacuum} \\ 2\text{-}3 \text{ for oils and waxes} \\ 3\text{-}4 \text{ for rubber} \\ 3\text{-}6.5 \text{ for glasses and mica} \end{cases}$$

The **capacity of an antenna** consisting of a single vertical wire of diameter b cms. and length l cms.,

$$C = \frac{l}{4.15 \log_{10} \frac{2l}{b}} \times 10^{-6} \text{ mfds.} \tag{29}$$

The capacity of a long horizontal antenna =

$$C = \frac{0.241 l}{\log_{10} \frac{4h}{b}} \times 10^{-6} \text{ mfds.} \tag{30}$$

where h is the height in cms. of the horizontal portion above the earth.

These capacities are in general 10–20% higher than calculated, due to the increase of capacity through neighboring objects. On the other hand, the capacity of the wire at the fundamental wave-length is approximately 20% lower than calculated, due to the non-uniform distribution of the charge on the wire.

CALCULATION OF INDUCTANCE

The **inductance of a long cylindrical coil** =

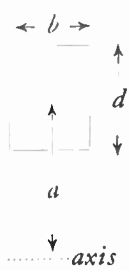
$$L = \frac{4\pi^2 a^2 Z^2}{b} P \text{ cms.} \tag{31}$$

where P is a constant depending on the ratio of $\frac{2a}{b}$ and obtained from the accompanying curve on page 79.

The **inductance of a pancake coil** =

$$L = 4\pi a Z^2 \left[\left(\log_e \frac{8a}{.2235\,(b + d)} \right) - 2 \right] \text{ cms.} \tag{32}$$

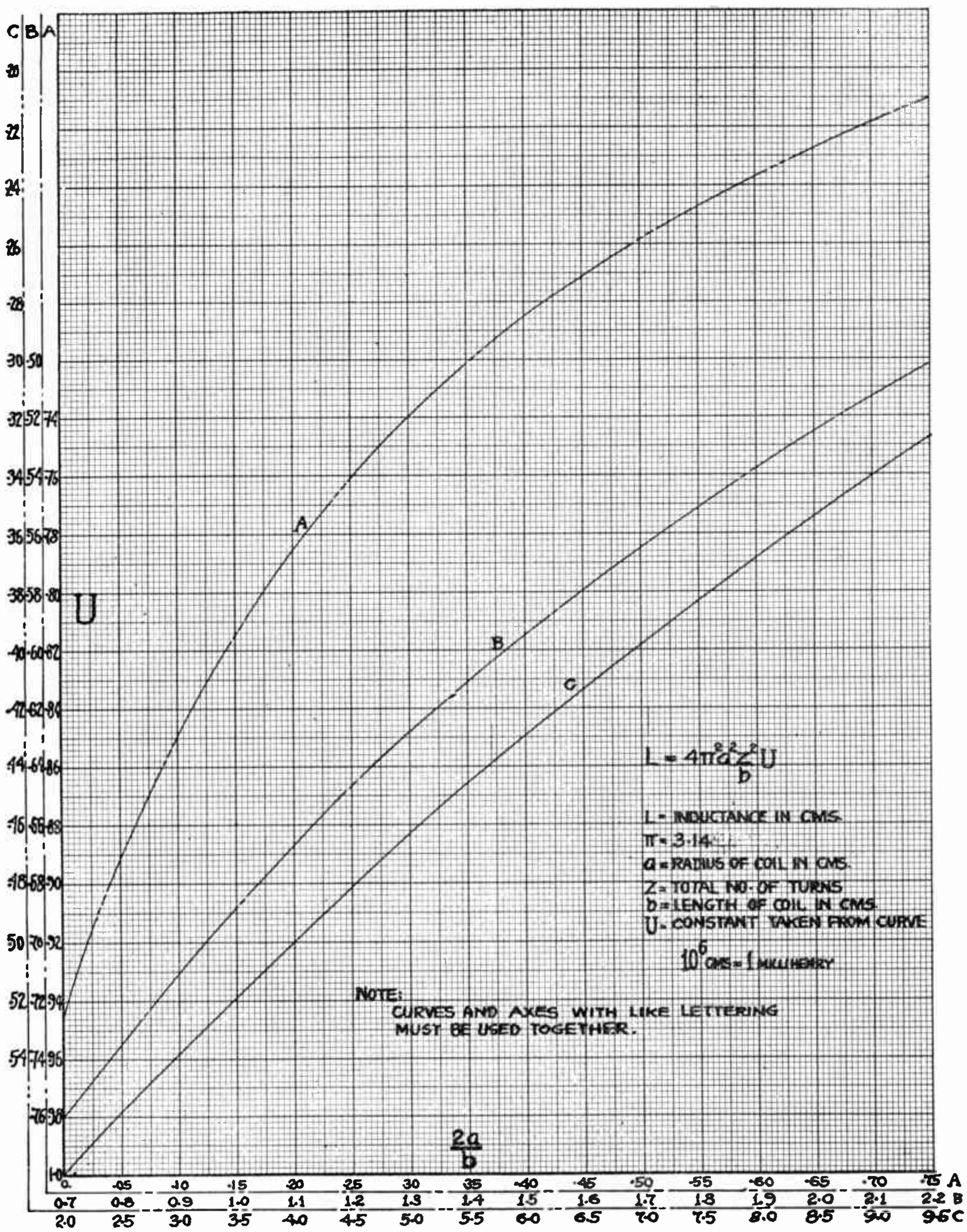
where a = mean radius in cms.
Z = total turns on the coil
b = axial length of the coil in cms.
d = depth of the coil in cms.



For **maximum inductance** for a deep winding

$$\left. \begin{aligned} b &= d \\ a &= 1.51 \times d \end{aligned} \right\}$$

$$L = 17.aZ^2 \text{ cms.} \tag{33}$$



Curves for determining constant for the calculation of the induction of a solenoid

For a spiral or pancake in which the width of the tape is b, the depth of the coil d, the **maximum inductance** for a given length of tape is obtained when the mean radius

$$a = 1.51d$$

$$L = \mathcal{Q}aZ^2 \text{ cms.} \tag{34}$$

where

b/d	$\mathcal{Q}$	b/d	$\mathcal{Q}$
0.5	20.4	0.2	23.2
0.4	21.2	0.1	24.2
0.3	22.1	0.05	24.7
		0.00	25.4

(35)

The **depth of penetration** of a radio frequency current into a conductor =

$$P = \frac{5030}{\sqrt{\mu Nc}} \text{ cms.} \tag{36}$$

for copper $\mu = 1$ $\qquad c = 5.8 \times 10^5$

The **radiation resistance** of an antenna =

$$R_r = 160\pi^2\left(\frac{\alpha h}{\lambda}\right)^2 \text{ ohms} \tag{37}$$

where α is the form factor, h = height in meters, λ the wave-length in meters. The form factor α is dependent upon the current distribution along the vertical portion of the antenna. For uniform distribution $\alpha = 1$, for a straight wire at its fundamental $\alpha = 2/\pi$, for a highly loaded antenna $\alpha = 0.5$.

The **fundamental wave-length** of an antenna is approximately five times the length of one of its symmetrical elements measured along the wire from the ground to the open tip.

The current I_r **in a receiving antenna** due to a current I_s at a distant transmitting antenna

$$I_r = 4.25\frac{I_s h_r h_s}{\lambda l}\epsilon^{\left(-0.0015\sqrt{\frac{\lambda}{l}}\right)} \tag{38}$$

where the currents are in amperes, the effective heights of the antenna h_r and h_s, the distance between the stations l, and the wave-length λ are in kilometers. This formula is strictly accurate only for the case of a receiving antenna with an effective resistance of 25 ohms. For readability on a crystal detector a minimum current of 25×10^{-6} amperes is required.

The **current in a receiving loop** from a transmitting open antenna

$$I_r = 2369\left(\frac{I_s h_s Z_r h_r L_r}{\lambda_2 lR}\right)\cos\theta \tag{39}$$

where the currents are in amperes, the lengths in meters and the resistance of the loop R in ohms, the inductance of the loop L_r in henries, and the effective height of the loop h_r in meters and given by the equation

$$h_r = \frac{2\pi \times \text{area of loop} \times Z_r}{\lambda} \text{ meters} \tag{40}$$

where the area is in square meters.

DECREMENT MEASUREMENT

The decrement of a circuit gives a figure of prime importance in deducing circuit efficiencies. Decrements are measured by coupling a variable frequency tuned circuit including a current indicating device to the circuit to be measured, and driving the instrument circuit by a constant excitation source in the circuit to be measured, and noting the instrument deflections for corresponding frequency settings of the measuring circuit. Plot the ratio of $\left(\frac{I}{I_r}\right)^2$ as ordinates and the ratio of $\frac{N}{N_r}$ as the abscissa. The resultant curve is approximately symmetrical with respect to the axis drawn through the line $\frac{N}{N_r} = 1$. For any value of $\left(\frac{I}{I_r}\right)^2$ there are two values of $\frac{N}{N_r}$. If the distance between these values $= 2x$

$$d_1 + d_2 = xS \qquad (41)$$

The values of S drawn to the argument $\left(\frac{I}{I_r}\right)^2$, i. e., y, are plotted on the appended curve sheet. A typical resonance curve is likewise included on this sheet.

The **half deflection method** is often used. If the scale of measuring instrument is divided in current squared values, and C_r, C_1 and C_2 are respectively the capacities that produce full deflection at resonance and half deflection on either side of resonance

$$d_1 + d_2 = \frac{\pi}{2}\left(\frac{C_1 - C_2}{C_r}\right) \qquad (42)$$

For **separating** d_1 **and** d_2, two general methods are used:

(1) Calibrate the measuring circuit by exciting it from an undamped source. This gives the value of d_2 directly.

(2) At resonance between the two circuits, note the current I_r. Without changing adjustments, insert a non-inductive resistance ΔR into the secondary and note the current I. Then, since

$$\Delta d_2 = \pi (\Delta R) \sqrt{\frac{C_2}{L_2}}$$

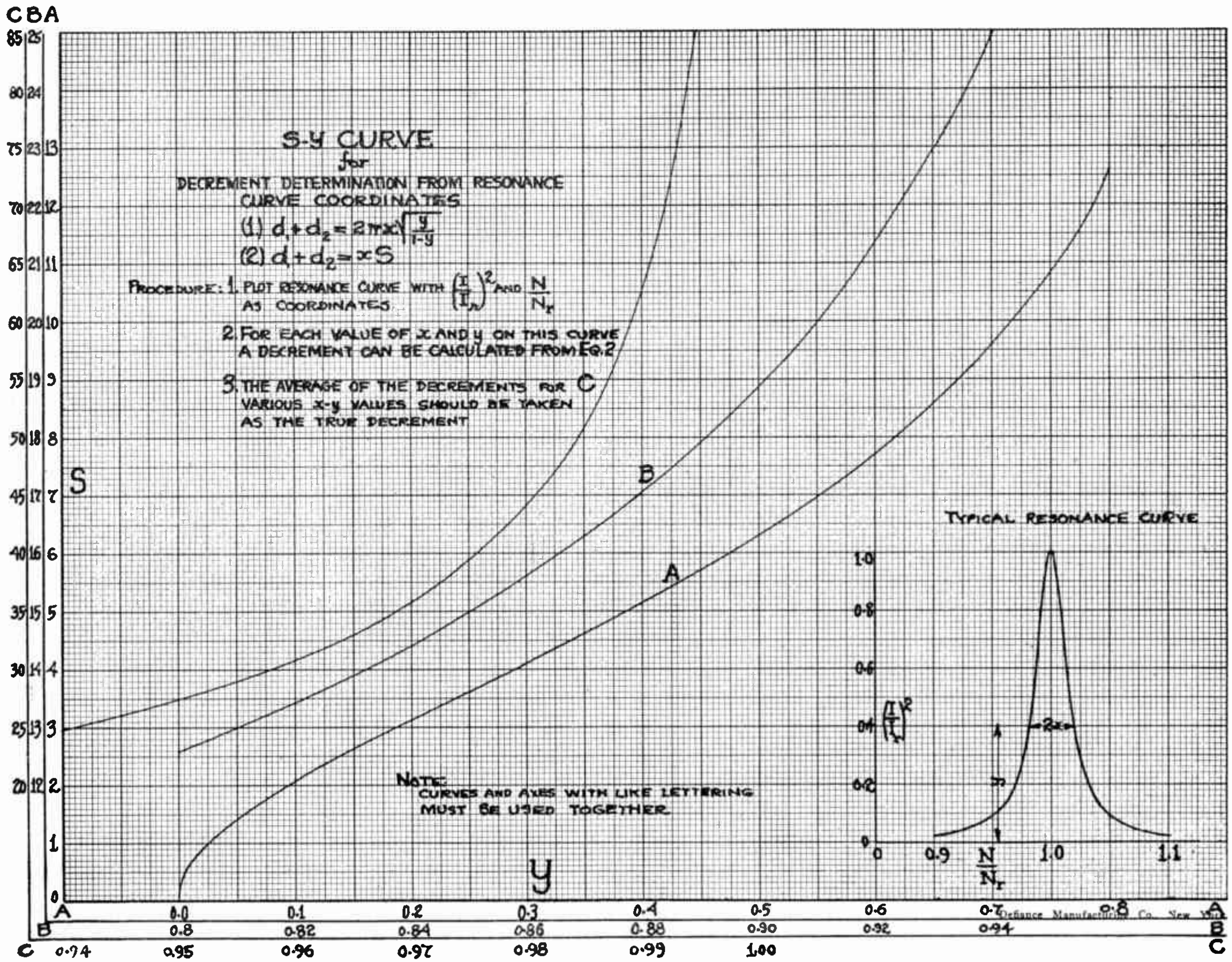
$$d_2 = \Delta d_2 \frac{1}{\left(\frac{I_r}{I}\right)^2 - 1} \qquad (43)$$

In the foregoing it is assumed that the circuit to be measured is excited by a source that does not introduce appreciable reaction between it and its exciting source, i. e., quenched spark excitation, and that the measuring circuit is very loosely coupled to the circuit being measured.

ANTENNA MEASUREMENTS

The measurement of the **decrement** of an antenna has been covered. It should be noted that transmission conditions should be duplicated to cover the decrement due to corona.

The **fundamental wave-length** of an antenna λ_f is measured by inserting a small loop between the antenna entrance lead and the ground connection, and exciting the antenna



Curves for determining constant for the calculation of logarithmic decrement from the resonance curve from a calibrated driver. A detector or current indicating instrument may be used to indicate resonance.

The **fundamental inductance and capacity** of an antenna may be measured by the following method:

(1) Measure the fundamental wave-length λ_f of the antenna.

(2) Insert an inductance L_1 in series with the antenna and measure the resulting wave-length of the antenna λ_1. If λ_f, C_f and L_f indicate the antenna constants at the fundamental

$$L_f = \left(\frac{\lambda_f^2}{\lambda_1^2 - \lambda_f^2}\right) L_1 \text{ cms.} \tag{44}$$

$$C_f = \left(\frac{\lambda_f}{59.6}\right)^2 \frac{1}{L_f} \text{ mfds.} \tag{45}$$

where L is in cms., C in mfds., and λ in meters.