

July 23, 1946.

W. M. ROBERDS

2,404,404

HIGH FREQUENCY APPARATUS

Filed May 15, 1943

3 Sheets-Sheet 1

Fig. 1.

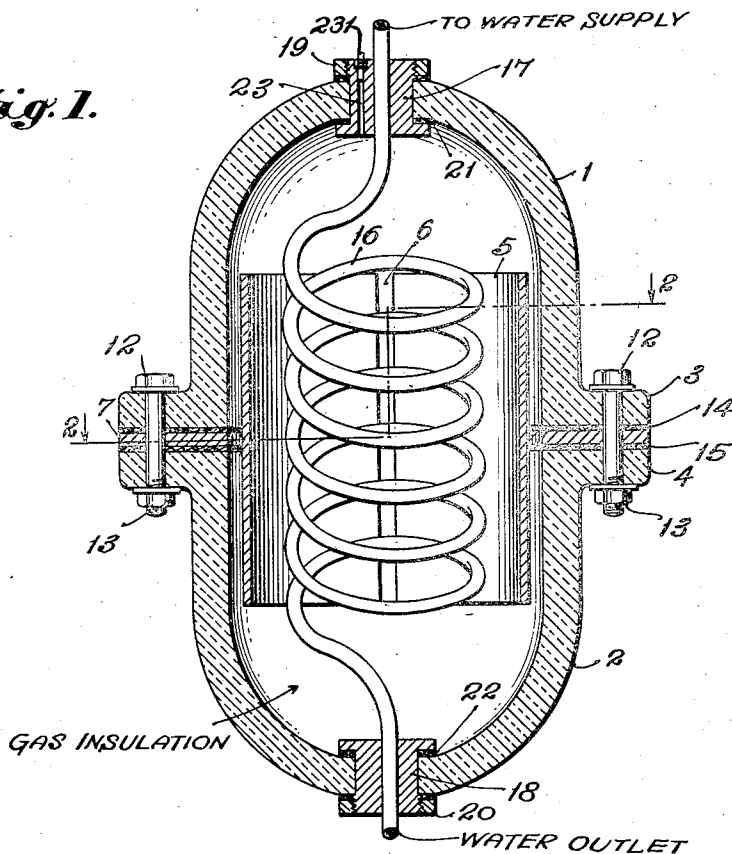
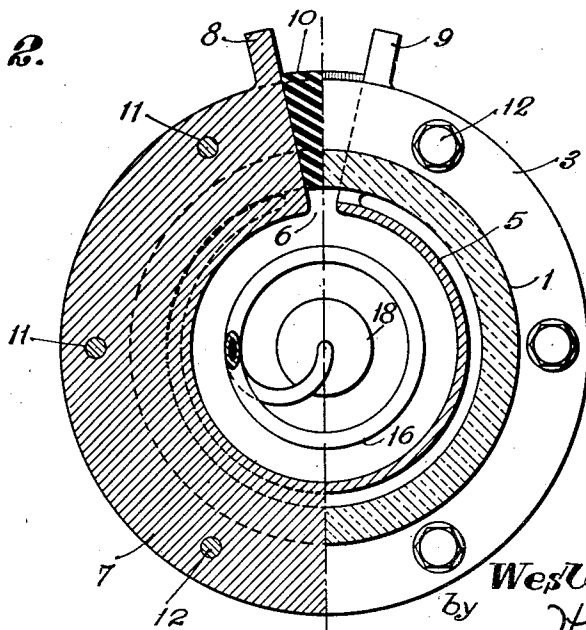


Fig. 2.



INVENTOR
Wesley M. Roberds
by *H. S. Swover*
ATTORNEY

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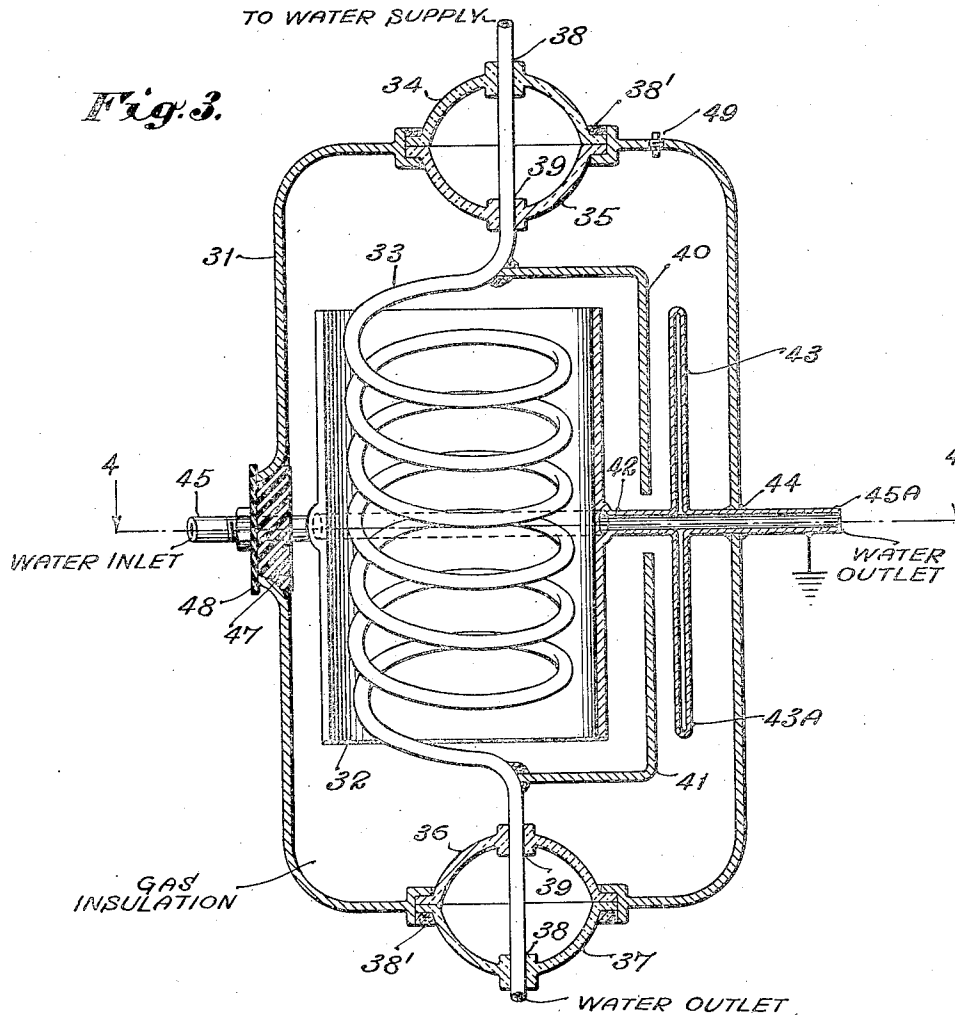
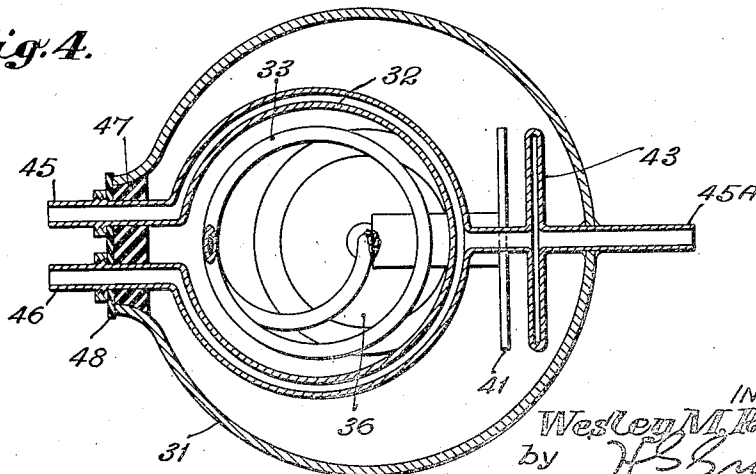


Fig. 4.



INVENTOR
Wesley M. Roberds
by H. S. Grover
ATTORNEY

July 23, 1946.

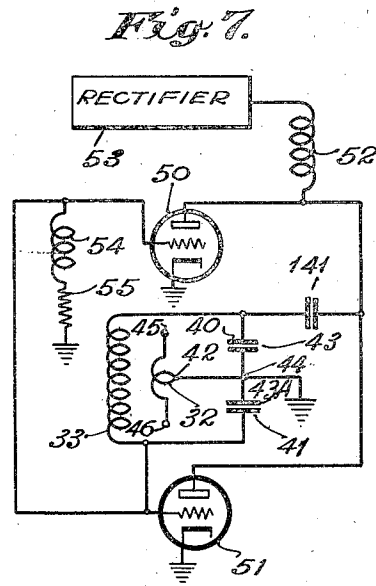
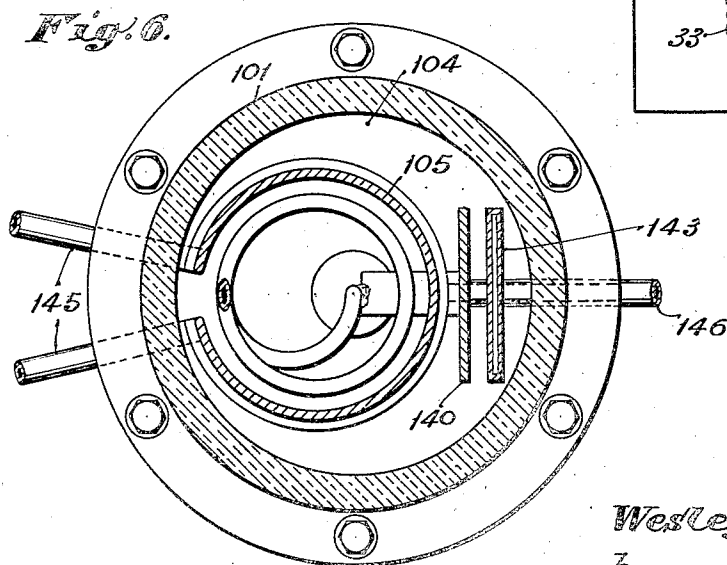
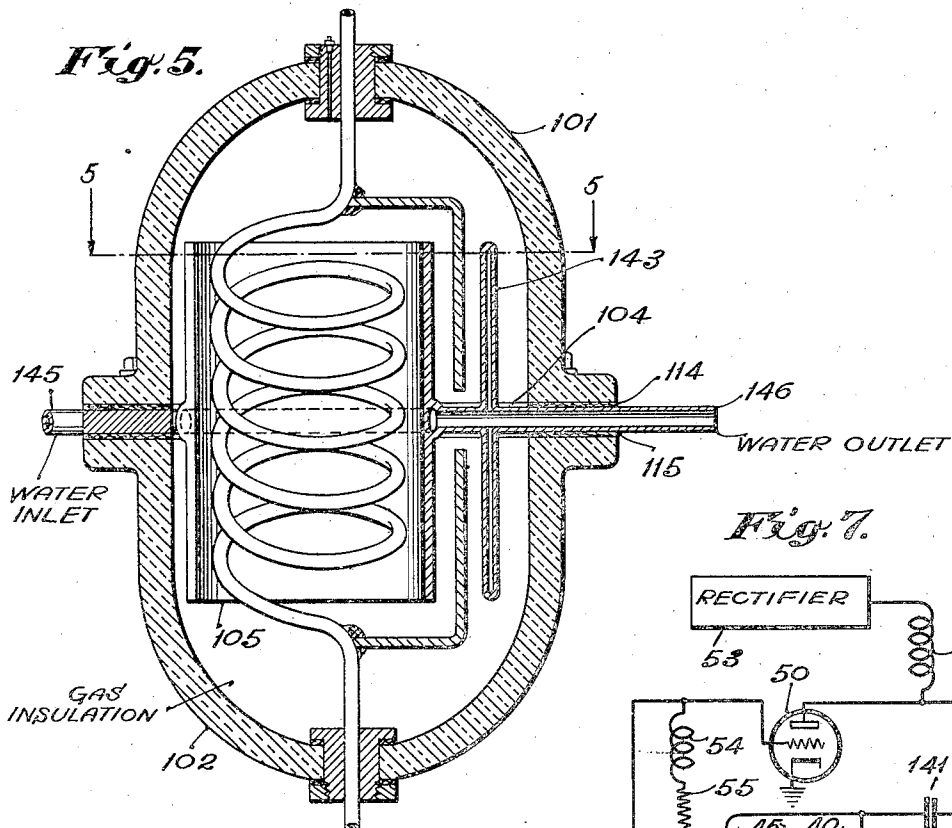
W. M. ROBERDS

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3 Sheets-Sheet 3



INVENTOR
Wesley M. Roberds
by H. S. Brown
ATTORNEY

UNITED STATES PATENT OFFICE

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HIGH-FREQUENCY APPARATUS

Wesley M. Roberds, Collingswood, N. J., assignor
to Radio Corporation of America, a corporation
of Delaware

Application May 15, 1943, Serial No. 487,133

15 Claims. (Cl. 250—16)

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This invention relates to improved high frequency apparatus and is particularly directed to devices for feeding high frequency currents from any suitable source to a load which is to be heated by the currents.

An object of this invention is to provide novel high frequency apparatus which may be employed to couple electrical energy from powerful oscillator tubes to industrial work which is to be heated by radio frequency currents generated by the oscillator tubes.

Another object of this invention is to provide a novel high frequency device which includes the combination of tank circuit and a high current transformer assembled together as a unit and enclosed in a casing under high gas pressure for electrical insulation.

Still another object of this invention is to provide an improved high frequency device which has a primary inductive member and its terminals insulatingly supported at the ends of the casing, and a secondary inductive member coupled to the primary inductive member and having its terminals supported at a position intermediate terminals of the primary inductive member.

A feature of this invention is the locating of a high frequency and high current transformer and a condenser within a sealed container, the transformer and condenser being cooled by any suitable fluid means such as for example a water supply.

In the prior art high frequency devices, when powerful oscillator tubes are employed to provide heat from radio frequency currents, the apparatus is generally very expensive to manufacture, bulky, unwieldy and dangerous to handle. This invention overcomes the prior art difficulties by enclosing and mounting the transformer and condenser elements within a casing in which a gas under pressure is employed for electrical insulation.

This invention is particularly adapted to the industrial methods of heating metal by high frequency current although not specifically limited thereto. The devices of this invention are for use in circuits having a frequency range of the order of from 100 kilocycles per second to approximately one megacycle per second.

This invention will be described in greater detail with reference to the accompanying drawings in which:

Fig. 1 is a longitudinal sectional view of a gas enclosed high current transformer,

Fig. 2 is a cross-sectional view taken on lines 2—2 of Fig. 1,

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Fig. 3 is a longitudinal sectional view of a high frequency device comprising an oscillatory tank circuit including a water-cooled condenser enclosed within a steel casing, the condenser being shown only schematically,

Fig. 4 is a cross-sectional view taken on lines 4—4 of Fig. 3,

Fig. 5 is a longitudinal sectional view of a high frequency device wherein the tank circuit is enclosed within an insulating casing similar to that shown in Fig. 1,

Fig. 6 is a cross-sectional view taken on line 5—5 of Fig. 5, and

Fig. 7 is a circuit diagram of the device shown in Figs. 3 and 4.

Referring now in detail to Figs. 1 and 2 of the drawings, two porcelain bells 1 and 2 are each provided with flange portions 3 and 4, which are arranged to clamp a split cylinder forming a secondary inductive member 5 of a high current transformer. The secondary 5 is in the shape of a cylinder and is made of copper. Secondary 5 is split at 6 and has located at the central portion thereof and integral therewith an open flange 7 or annular portion 7 which terminates in the separated lugs 8 and 9.

An insulator in the form of a wedge shaped block 10 is cemented in to fill up the gap formed between the terminal lugs 8 and 9. The block is cemented in place while the flange is colder than normal. Then, since the coefficient of thermal expansion of the insulator is greater than that of the metal, as the temperature increases, the seal will be made tighter.

The flange portions 3 and 4 of the insulating bells and also the flange portion 7 of the secondary inductive member are provided with a plurality of apertures 11 through which pass the binding bolts 12 the latter having nuts 13. Suitable gasket material 14 and 15 is interposed between the metal flange 7 and flanges 3 and 4 of the porcelain bells to maintain a gas tight seal.

The primary winding or inductive member 16 of the transformer consists of any desired number of turns of copper tubing forming a helical coil which carries cooling water derived from any suitable water supply (not shown). The ends of the tube forming primary 16 pass through small metallic bushings 17 and 18 which are bound in place by means of lock nuts 19 and 20. Gaskets 21 and 22 are provided as shown to maintain a gas tight seal. The bushing 17 has an aperture 23 and inlet valve 231 through which gas under pressure can be put in the casing to provide insulation sufficient to withstand the high voltages

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encountered in this type of high frequency apparatus.

The embodiment shown in Figs. 3 and 4 comprises a metal casing 31 enclosing a cylindrical secondary inductive member 32 which is similar in shape to that of secondary 5 shown in Figs. 1 and 2, except that the flange 7 is omitted. A secondary water cooling tube 45, which is substituted for the flange 7, supports a condenser plate having upper and lower portions 43 and 43A respectively. The primary winding 33 consists of any desired number of turns of copper tubing and is also arranged as in Fig. 1 for water cooling. The ends of the primary winding are secured to the upper and lower portions of the metal tank 31 by means of insulating bells 34, 35, 36 and 37 which are secured to tank 31 by any suitable means such as cement 38'. The ends of the copper tube are sealed in a gas tight manner at 38 and 39.

Located adjacent one portion of the secondary 32 and electrically connected to the ends of primary winding 33 are the high potential terminals of two plate condensers or sections 43 and 41. The low potential condenser plates 43 and 43A are electrically grounded at a tap point 42 which is taken off from secondary 32. The tap 42 is electrically connected to point 44 by means of a water outlet tube 45A which connects to the metallic casing 31. The condenser plates or sections 43 and 43A are located between the tap 42 and the casing at point 44. The secondary 32 is provided with terminals 45 and 46 which form part of metallic tubes 45 and have good thermal conductivity metal such as, for example, copper, brass or silver. A portion of the tube 45 is in the form of a fluid coupling member located between tap 42 and point 44 to carry the cooling fluid around the condenser sections to provide cooling of the condenser plates 43 and 43A. The terminal ends of the secondary inductive member are secured to the metal casing by means of an insulating member 47 which is sealed in any suitable gas tight manner such as is provided by a cover 48. An inlet valve 49 is provided at one end of tank 31 for supplying gas under pressure to the inside of the tank. As in Fig. 1, the cylinder 32 is split but in the arrangement shown in Figs. 3 and 4, the hollow tubes 45 and 46 replace the solid terminal lugs 8 and 9 of Figs. 1 and 2.

The embodiment shown in Figs. 5 and 6 is generally of similar construction to that mentioned above in connection with Figs. 3 and 4 except that the secondary 105 has an additional central flange portion 104 which is provided with cooling apertures which are connected to a water inlet 145 and water outlet 146. The flange portion 104 supports both the secondary inductive member 105 and condenser plate elements 143 which are cooled by being in fluid communication with water inlet 145 and outlet 146. High potential condenser plates 140 are supported and connected to the primary winding. The entire unit is encased by means of two porcelain bells 101 and 102 which are similar in shape to that mentioned above in connection with Figs. 1 and 2 except that the bells are made larger to accommodate the condenser elements 143. The two porcelain bells are clamped together after being placed upon flange 104. Suitable gasket material 114 and 115 is provided to maintain a gas tight seal and as mentioned above, the construction is such that the seal will become tighter as the temperature increases.

Fig. 7 is a circuit diagram of the device shown in Figs. 3 and 4. The same general arrangement

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will also apply to Figs. 5 and 6 except that the elements are numbered differently. The condenser element which is formed by the plate section 40 is arranged to be connected to the anodes of tubes 50 and 51 through a coupling condenser 141. The condenser plate section 41 is connected to the grids of tubes 50 and 51. The primary winding 33 also connects to condenser plate sections 40 and 41. The steel tank or casing 31 connects at a point 44 to the ground side of the condenser plates 43 and 43A, and also to the center of the transformer secondary at 42. The secondary terminals 45 and 46 are arranged to be connected to the work circuit or metallic member to be heated. A choke coil 52 is connected between the rectifier 53 and the plate circuit of tubes 50 and 51. A grid bias circuit includes a choke coil 54 and grid bias resistor 55. The grid bias circuit also includes suitable bypass condensers not shown which are connected to the heater or grounded side of tubes 50 and 51. It will be noted from the above that there is located within the casing 31 all the principal parts of the high frequency generator with the exception of the tubes 50 and 51, bypass condenser 141 and the various control circuits.

Although Figs. 3 and 4 show a complete tank circuit enclosed within a metal tank, it might be desirable in some systems to enclose only the transformer primary and secondary inductive members as is indicated in Figs. 1 and 2. The metal container described in connection with Figs. 3 and 4 should preferably be plated on the inside portion with copper or silver in order to keep down stray energy losses which are encountered in the high frequencies employed.

While I have indicated and described a system for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular mechanism shown and described, but that many modifications may be made without departing from the scope of my invention.

What I claim is:

1. High frequency apparatus comprising an insulating casing having gas under pressure contained therein, said casing being formed by two bell shaped ceramic members having flange portions arranged to be joined together, a transformer located within said casing, said transformer including a primary and a longitudinally split cylindrical secondary inductive member, said secondary inductive member having a flange portion secured thereto, the flange portion of said secondary inductive member being interposed between the flanges of said ceramic casing, and means for joining the flange portion of said secondary inductive member and the two sections of said ceramic member together whereby an increase in temperature will tend to seal the casing more tightly.

2. A high frequency device comprising a split metallic casing having a gas contained therein, a transformer inductive member insulatingly supported within and by said casing, means for fluid cooling said inductive member, a second transformer inductive member inductively coupled to said first mentioned inductive member having a longitudinal slot and a midpoint tap electrically connected to the wall of said casing.

3. A high frequency current transformer comprising a primary winding and a secondary inductive member, said secondary inductive member being in the form of cylindrical member with a longitudinal slot and having a central flange

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portion, two insulating bells having flange portions arranged to enclose said primary and secondary inductive members, means for supporting said primary inductive member at the ends of said bells and means for supporting said secondary inductive member by clamping the flange portion thereof between the flange portion of said insulating bells.

4. A high frequency current transformer comprising a primary inductive member and a secondary inductive member, said secondary inductive member having a flange portion, two insulating bells having flange portions arranged to enclose said primary and secondary inductive members, means for supporting said primary inductive member at the ends of said bells, means for supporting said secondary inductive member by clamping the flange portion thereof between the flange portion of said insulating bells, and means passing through said primary inductive member for fluid cooling said transformer.

5. A high frequency device comprising an insulating casing having a gas contained therein, flanges on said insulating casing, a transformer inductive member insulatively supported within and by said casing, means passing through said inductive member for fluid cooling thereof, a second transformer inductive member inductively coupled to said first mentioned inductive member and having a flange member which is interposed between two flange portions of said insulating casing.

6. High frequency apparatus comprising a split casing, a primary inductive member having its terminals insulatively supported at the ends of said casing, and a secondary inductive member coupled to the primary inductive member, said secondary inductive member having its terminals supported at the split portion of said casing and in a position intermediate the terminals of said primary inductive member.

7. A high frequency device comprising a casing member split in two halves, reactive elements located within said casing, said reactive elements including primary and secondary coils, said primary coil being insulatively supported at the ends of said casing, said secondary coil being insulatively supported at the central portion where the two halves of the casing are joined, and means, for cooling said reactive elements, passing through at least one of said reactive elements.

8. A high frequency device comprising a casing member split in two halves and having a gas contained therein, a primary coil insulatively supported within said casing, said primary coil having terminals located at the casing ends, a secondary coil insulatively located within said casing adjacent said primary coil and coupled therewith, and means for supporting said secondary coil at the central portion thereof where the two halves of the casing are joined.

9. High frequency apparatus comprising a casing, a primary coil mounted within and supported by said casing, leads for said primary winding hermetically sealed to and extending through said casing, a split metallic cylinder also within said casing, said split cylinder surrounding said primary coil and a pair of terminals fixed to said split cylinder adjacent the longitudinal separated edges of the split cylinder, said terminals extending through and being hermetically sealed to said casing, said terminals moreover serving to establish electrical contact with said split cylinder forming the secondary for said primary coil.

10. Apparatus as claimed in claim 9 charac-

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terized by the fact that said terminals establish contact with said split cylinder at points substantially centrally located along the surface of said metallic cylinder and being further characterized by the fact that means are provided for admitting and retaining gas within said casing.

11. Apparatus as claimed in claim 9 characterized by the fact that a third terminal is provided for said split cylindrical secondary, said third terminal extending through and being hermetically sealed to said casing and making contact with said split cylinder at a point on said secondary diametrically opposite the split in said cylinder.

12. Apparatus as claimed in claim 9 characterized by the provision of a third terminal extending through said casing and making contact with said split cylinder at a point on said cylinder diametrically opposite the split in said secondary, a condenser plate within said casing making electrical contact with said third terminal and extending in a direction which is parallel to the axis of said split cylinder and another condenser element also within said casing connected to said primary coil, said last mentioned condenser element being supported in the space between said first mentioned condenser element and said split cylinder and means for admitting and retaining a suitable insulating medium within said container.

13. High frequency apparatus comprising a metal container, a primary coil within said container, a pair of leads for said primary coils extending through the walls of said container, said leads being insulatively removed from and hermetically sealed to the walls of said container, a split metallic cylinder forming a secondary within said container and surrounding said primary coil, a pair of terminals connected to said secondary cylinder adjacent the longitudinal separated edges thereof and extending through the walls of said cylinder, said secondary terminals being insulatively separated from the metal wall of said container and hermetically sealed thereto, a third terminal for said secondary cylinder electrically fixed to said split cylinder at a point diametrically opposite the split in said cylinder and making electrical contact with the metal wall of said container, a pair of condenser plates electrically fixed to said third terminal and being supported within said container and a second pair of condenser plates connected to separated points on said primary and extending in the space between said first mentioned pair of condenser plates and said cylindrical secondary.

14. High frequency apparatus comprising a casing, a primary coil mounted within and supported by said casing, leads for said primary winding hermetically sealed to and extending through said casing, a split metallic cylinder also within said casing, said split cylinder surrounding said primary coil and a pair of terminals fixed to said split cylinder adjacent the longitudinal separated edges of the split cylinder, said terminals extending through and being hermetically sealed to said casing, said terminals moreover serving to establish electrical contact with said split cylinder forming the secondary for said primary coil, said terminals being hollow and in flow connection with a conduit around said secondary whereby cooling fluid may be circulated through said hollow terminals and conduit.

15. High frequency apparatus comprising a metal container, a primary coil within said container, a pair of leads for said primary coils ex-

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tending through the walls of said container, said leads being insulatingly removed from and hermetically sealed to the walls of said container, a split metallic cylinder forming a secondary within said container and surrounding said primary coil, a pair of terminals connected to said secondary cylinder adjacent the longitudinal separated edges thereof and extending through the walls of said cylinder, said secondary terminals being insulatingly separated from the metal wall of said container and hermetically sealed thereto, a third terminal for said secondary cylinder electrically fixed to said split cylinder at a point diametrically opposite the split in said cylinder and

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making electrical contact with the metal wall of said container, a pair of condenser plates electrically fixed to said third terminal and being supported within said container and a second pair of condenser plates connected to separated points on said primary and extending in the space between said first mentioned pair of condenser plates and said cylindrical secondary, all of said terminals having flow connected conduits whereby a cooling liquid may be circulated there-through and means for admitting and retaining an insulating medium in said container.

WESLEY M. ROBERDS.