

Sept. 17, 1940.

G. L. USSELMAN

2,215,200

HIGH FREQUENCY APPARATUS

Filed Nov. 9, 1937

3 Sheets-Sheet 1

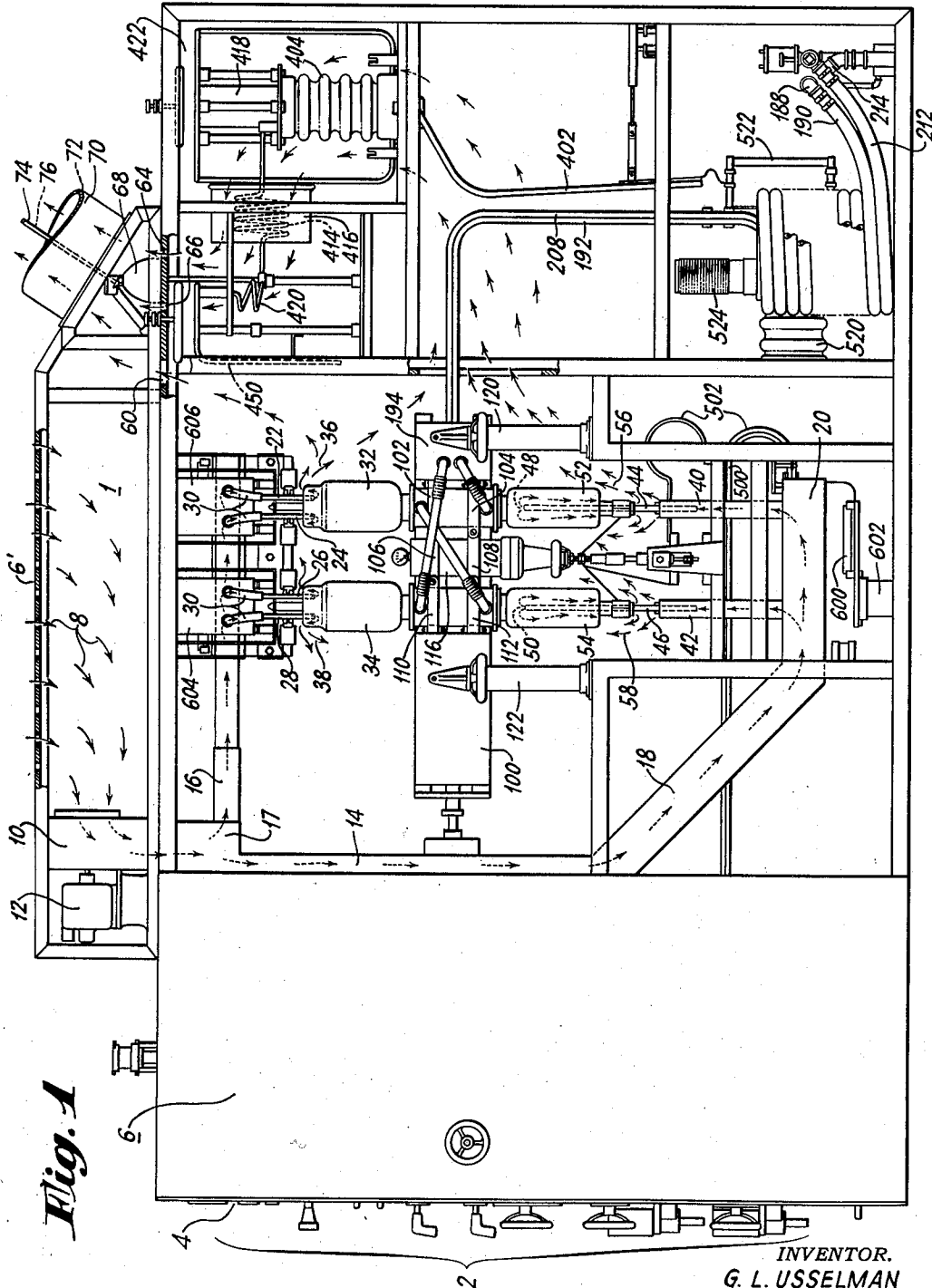


Fig. 1

2

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Fig. 1a

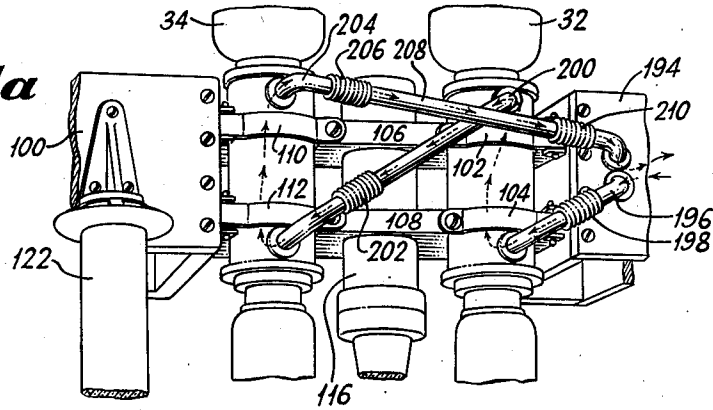


Fig. 2

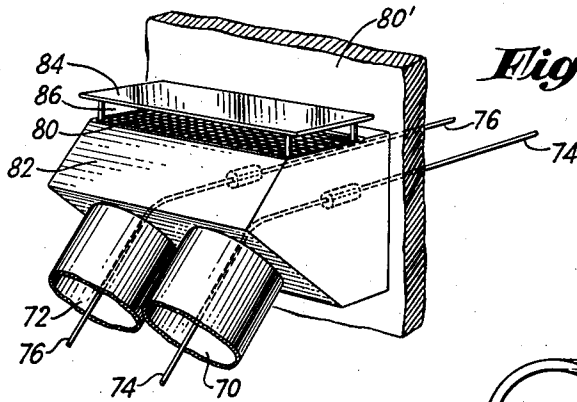
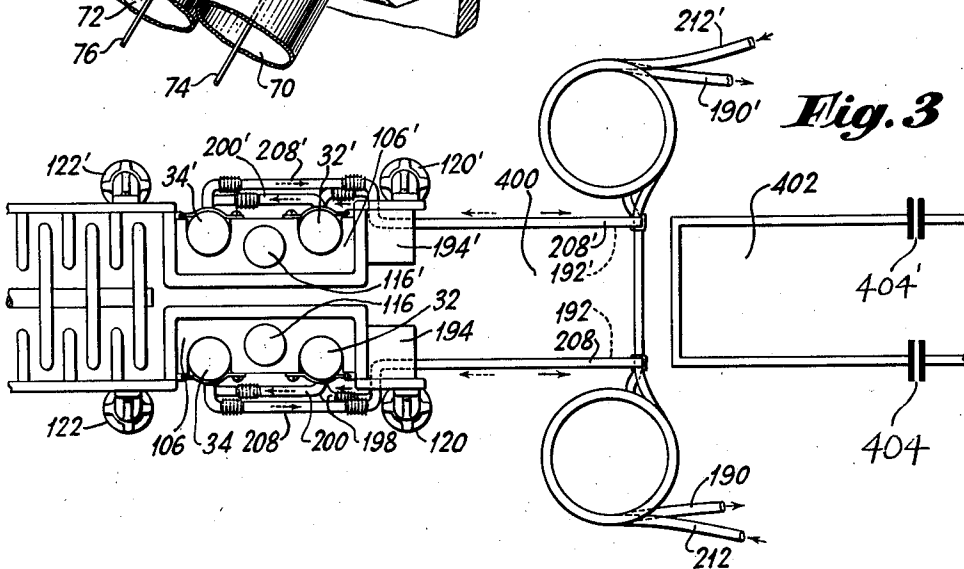


Fig. 3



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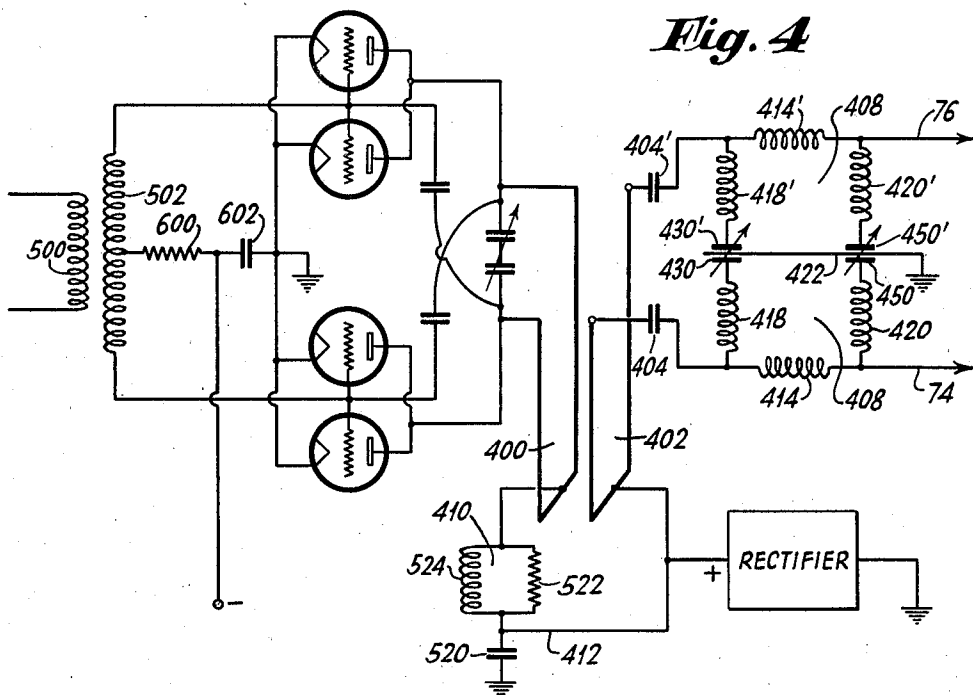
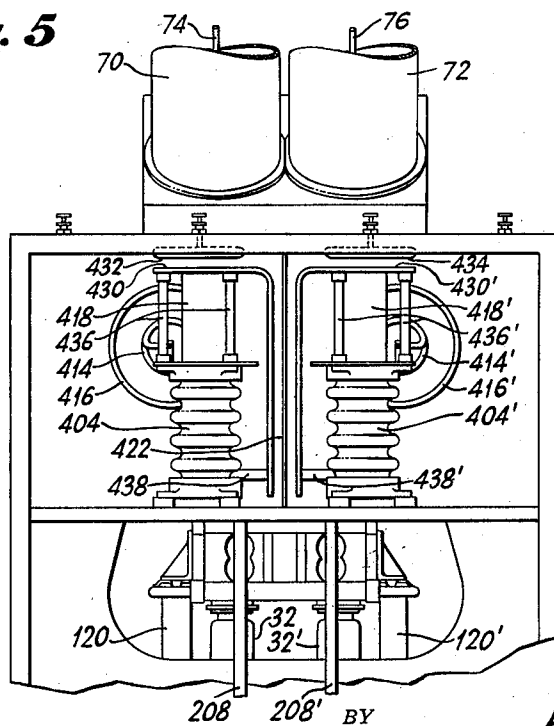


Fig. 5



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UNITED STATES PATENT OFFICE

2,215,200

HIGH FREQUENCY APPARATUS

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or to Radio Corporation of America, a corpora-
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Application November 9, 1937, Serial No. 173,592

4 Claims. (Cl. 250-17)

My present invention relates to high frequency apparatus, particularly transmitters for delivery of short waves at high power to a radio antenna.

Heretofore, radio transmitters have been enclosed within a perforated metallic cage. The perforations permitted some degree of cooling and provided a certain degree of electrical shielding. However, the perforations in the shield permitted dust to accumulate upon the parts of the transmitter, frequently giving rise to arc-overs and other undesired actions. There was, therefore, required certain periodic cleanings, increasing the maintenance cost of the transmitter.

To overcome these disadvantages is one object of my invention. In carrying out this object, substantial solid shielding is employed which is substantially airtight, thereby precluding any substantial dust formations on the parts of the apparatus. The solid shielding, obviously, has the advantage that it provides practically perfect electrical shielding. For ventilation purposes, I provide, as will be explained more fully hereinafter, a system of forced ventilation which, through the employment of air filters, does not permit of the passage of dust, insects or other undesirable material into the transmitter apparatus.

More specifically, in carrying my invention into effect, air from the building or room in which the transmitter is situated is drawn into the compartment formed by the shielding of the transmitter through an air filter. A blower then forces the air upon the parts of the transmitter which it is particularly desired to be kept cool, such as the filament seals, grid stems and the glass envelopes of the high powered tubes. The air within the transmitter being at a higher pressure than the surrounding air is then forced out through certain natural and other openings provided in the transmitter through control openings provided for the transmitter controlling elements and through other openings especially provided for ventilation.

A feature of the invention resides in making use of the antenna transmission line shields as part of the air circulating system of the transmitter. As constructed in accordance with my invention, these shields serve as chimneys for the air within the transmitter.

In the drawings:

Fig. 1 illustrates a side elevational view of my improved transmitter;

Fig. 1a shows how the vacuum tubes are mounted, and in detail the piping and metal bellows

connections for bringing cooling fluid to the tube jackets;

Fig. 2 is a perspective view of the arrangement of the transmission lines and associated venting elements employed in my transmitter;

Fig. 3 is a plan view showing, diagrammatically, the cooling system and associated push-pull vacuum tube apparatus;

Fig. 4 is an electrical wiring diagram of the transmitter of Fig. 1; and

Fig. 5 illustrates a side view of the structural elements constituting certain condensers and associated elements of Fig. 4.

Referring to Figure 1, which is, generally, a side elevational view of my improved transmitter with the side shielding removed, the various controls 2 are brought out through the front wall 4 of the transmitter. Within the section 6 are mounted the lower power push-pull radio frequency stages such as described in my copending application Serial No. 96,046, filed August 14, 1936. These stages are ventilated with the rest of the apparatus about to be described, but are not provided with specific cooling for any specific apparatus. The entire transmitter apparatus is enclosed within solid sheets of metal and, as before explained, the side nearest the reader has been removed in order to discuss the apparatus within. The top 6 of the transmitter consists of a pair of perforated metallic plates between which is mounted a layer of felt or cloth. Only one sheet of perforated metal may be employed, in which event the cloth or felt may be suitably mounted beneath the same. Air is drawn in, as indicated by the arrows 8, to the blower 10 operated by motor 12. The air so drawn in is then forced through the pipes 14, 16, 18 and 20. Glass tubes 22, 24, 26, 28 are supplied with air from the pipe 16 through rubber connections 30. The glass tubes 22 and 24, as indicated, blow air against the filament seals of vacuum tube 32 and the glass tubes 26, 28 apply air against the filament seals for vacuum tube 34.

Vacuum tubes 32, 34, as will be explained more fully later, are connected in parallel and form one side of a push-pull system. The tubes immediately behind vacuum tubes 32 and 34 are provided with glass pipes 22 to 28 inclusive connected to the air tube 16 for similar cooling purposes. After cooling the filament seals, the air is forced out into the space about the vacuum tubes 32, 34, as indicated by arrows 36, 38.

The air forced down pipe 14 and into pipes 18 and 20 passes upwardly through two insulating

fibre tubes 40, 42. Some of the air in tubes 40, 42 is forced into the glass pipes 44, 46 to points 48, 50 within the tubes 32, 34 cooling the grid stems of vacuum tubes 32, 34. The air forced up through the glass pipes 44, 46 passes inside the grid stem and by virtue of openings which may be provided within the grid stems of vacuum tubes 32, 34 over said stems. The escaping air flows back partially over the tubes 44, 46 and escapes into the transmitter, as indicated by the arrows 52, 54. This air passing down over the grid stem serves to cool the same as well as the glass seals adjacent thereto. In this way, the grids of the vacuum tubes are kept at lower temperatures since the heat generated at the grids is carried to the grid stems through the grid structure. Another portion of the air coming up through pipes 40 and 42 passes over the tubes 44, 46 and directly over the lower glass walls of vacuum tubes 32, 34, this action being indicated by the arrows 56, 58. This keeps the lower portion of the glass envelope of the tubes cool. The glass tubes 44, 46 are supported in any suitable way, such as by clips, to the fibre tubes 40, 42.

The glass tubes 44, 46 extend, as illustrated, down into the fibre pipes 40, 42 and well within the hollow grid stems of the vacuum tubes 32, 34.

The air, as it leaves the various tubes and pipes, flows into the space enclosed by the shielding, generally ventilating the remainder of the apparatus therein contained. This air being under pressure, is forced up through the slots 60, 64 and through the holes 66 around insulators 68 up into the twin shields 70, 72 for the transmission lines 74, 76.

As shown in Figure 2, the transmission lines 74, 76 pass through the wall 80', whereas the air under pressure within the transmitter passes through a screen 80 in the top of box 32. The dust cover 84 is suitably mounted over the screen 80. The air then passes beneath the dust cover 84 through the side openings 88 into the transmitter room.

As before indicated briefly, the vacuum tubes 32, 34 are connected in parallel to form one side of a push-pull circuit. An identical set of vacuum tubes forms the other side of the push-pull system, in front of which is connected a condenser 100 having V-shaped stationary plates and butterfly shaped or figure 8 shaped rotary plates, as described more fully in my copending application hereinabove referred to. The vacuum tube 32 is strapped by means of strap 102, 104 to metal blocks 106, 108 (note Fig. 1a). Similarly, tube 34 is strapped to the blocks 106, 108 by means of straps 110, 112. As indicated, the anodes of vacuum tubes 32 and 34, blocks 106, 108 and holding straps 104, 102, 110 and 112 are connected directly to one set of stator plates of the condenser 100. In addition, neutralizing condenser 116 is also supported by an electrically connected tube to blocks 106, 108. A similar tube, block, strap and neutralizing condenser arrangement is provided immediately behind the system shown and connected to the other set of stator plates of the condenser 100. The entire arrangement is supported by the insulating pedestals 120, 122.

A schematic plan view of the push-pull system is shown in Figure 3, the primed numbers indicating the corresponding elements which cannot be seen in Figure 1 since they are located immediately behind the elements of Fig. 1. It should be borne in mind that this statement applies equally well to the air piping system 16, 18, 40

and 42, pipes 16, 18 and 14 being duplicated immediately in the rear of Figure 1 and connected to the common header 17.

The water flow may be traced as follows: Through the inlet 188, rubber hose 190, hollow metal conductor 192, into a suitable conduit in block 194. Water then flows through the metal pipe 196 (note Fig. 1a) through the metal connecting bellows 198 to the lower portion of the water jacket for tube 32 out through upper portion of the jacket and into pipe 200 down through the metal bellows 202 into the lower part of the water jacket for tube 34 out through the elbow 204 in the upper part of the water jacket for tube 34. The water then flows through the metal bellows 206, pipe 208, bellows 210 through another conduit in block 194 and returns through the metal conductor 208 through the rubber hose 212 to the outlet pipe 214.

As shown diagrammatically in Figure 3, the cooling system is repeated for the rear tubes 32', 34'. An adjustable short circuiting bar 216, shown in Figure 3, serves to adjust the inductance of the loop formed by the tubular conductors 192, 208 and 192', 208'.

The electrical circuit is shown diagrammatically at Figure 4, the loop 400 being made up as shown in Figures 1 and 3 of the conductors 192, 208 and 192', 208' and the short circuiting bar 216. This, in turn, is coupled to a second loop 402 adjustable with respect to loop 400 connected through blocking condensers 404 and 404' and filter 408 to the transmission lines 74, 76. The purpose of the resistance-inductance combination 410 is to prevent push-push parasitics. It is to be noted that the loop 402 is adjustable with respect to loop 400 to control the loading of the tubes of Figure 4 and conductor 412 is provided connecting loops 400, 402 together so that no difference in direct current potential, which might cause arc-over, shall exist.

The filter 408 includes the series coils 414, 414' within cylindrical metal shields 416 and 416'. The inductances 418 and 418' of Figure 4 in practice are illustrated at 418 in Figure 1, it being noted in Figure 1 that these inductances are made up of straight sections of metallic pipe. On the other hand, the coils 420, 420' of Figure 4 are made up, as shown, of coils 420 of Figure 1. The grounded condenser plate 422 of Figure 4 is the vertical metallic plate 422 of Figure 1 and is illustrated in greater detail at 422 in Figure 5.

The condenser plates 430, 430' are so indicated in Figure 5, the variability being obtained by means of the additional plates or discs 432, 434 which are grounded, as is also the plate 422. The condenser elements 430, 430' are supported, as shown, by means of insulators 436, 436' and additional insulators 438, 438'. The condenser plates 450, 450' are identical, but immediately behind the corresponding plates in Figure 5 and, hence, will not be described in detail here.

The input coil 500 is given by the loop 500 of Figure 1 and coupling thereto illustrated by coil 502 of Figure 4 is illustrated at 502 in Figure 1. The ground by-pass condenser 520 of Figure 4 is so referred to in Figure 1. The resistor 522 and coil 524 of Figure 4 are similarly labeled in Figure 1. The resistance-condenser combination 600 and 602 of Figure 4 is so referred to in Figure 1. The filament transformers are mounted above the tubes 604, 606, the connections to the filament leads being evident to one skilled in the art.

As shown in Figure 1, the antenna loop is 75.

hinged at its top so that it may be swung closer to or further away from the inductive output loop of the parallel amplifier tubes. As shown in the schematic wiring diagram, both loops are maintained at the same direct current potential so as to prevent the possibility of short circuits, arc-overs and the like during the adjustment of the output loop with respect to the tube output loop formed of the metallic tubular water carrying conductors and the short circuiting strap.

The neutralizing condensers shown in Figure 1 and referred to diagrammatically in the other figures are of the type described in my copending application hereinabove referred to.

It is to be noted in Figure 1 that metallic bellows are used as flexible links for the metallic pipes conveying water to and from the tube water jackets. Heretofore, it has been proposed to use flexible rubber links for this purpose in order to provide flexibility in connecting the water lines to the tube jackets and supply lines. The rubber links deteriorate with use and are also objectionable since they require frequent shut-down to permit repair of leaks. In addition, I have found that when rubber connectors are used, the ends of the pipes leading to the jackets at the high frequencies involved tend to build up a standing potential wave of such value as to arc-over to the frame of the tube supports. Although this may be obviated by connecting a metal strip to the fluid conductors joined by the rubber hose, there is a possibility of loose connection which is completely eliminated, as is also the possibility of arc-over by utilization of the metal bellows, as shown. I have also found that there is a tendency for high frequency transmitters such as illustrated to set up parasitic oscillations when sections of the water cooling system are connected together by rubber pieces of pipe. These parasitics are also removed by means of the metallic bellows system.

I have also found when rubber connectors are used, it is usually necessary to employ metallic clamps to prevent leakage. I have further found that the metal conduit, the rubber hose and the clamp forms a capacity at the high frequencies involved which tends to cause a considerable capacitive current to flow through the rubber hose, causing its rapid deterioration. I have remedied this by connecting a metallic conductor from the clamp to the metal pipe, but, preferably, I employ the metal bellows system here illustrated since it reduces the number of connections involved and, necessarily, the number of possibilities of loose connection.

I have also found that my metal bellows system is of decided importance in high frequency work since with rubber connectors and metallic clamps, parasitic oscillations at unwanted frequencies are frequently set up.

The deterioration of the rubber connection explained hereinabove, follows from the use of the equipment in high frequency circuits in which the rubber connectors are subjected to high frequency voltages of relatively large value. These voltages cause currents to flow through the rubber, causing it to heat up and rapidly deteriorate.

It is to be noted that the harmonic filter connected in the antenna transmission line makes use of first inductors in the form of straight sections of pipe. These inductors rest directly upon the condenser plates of condensers forming another part of the harmonic filter. This section of the condenser, including the low inductance pipe, eliminates the higher frequency harmonics.

The later section, including the coils, eliminates the lower frequency harmonics.

A further feature of the harmonic filter resides in its condenser structure. It is to be noted that the condensers have fixed portions or fixed capacities with respect to ground and at right angles thereto another section whose capacity may be varied with respect to ground. For convenience, as illustrated, and for some economy in space, it is to be noted that the condenser plates are arranged at right angles, as illustrated in the rear elevational view of Figure 1, being the fixed capacitive part of the condenser and the horizontal adjustable disc and the horizontal bend in the condenser plate being the adjustable part of the condenser. The adjustability is obtained through variation in the division of the grounded disc with respect to the right angles condenser plate. The handle of the disc, as illustrated, is brought out through the transmitting housing so that it can be adjusted from the outside of the transmitter without necessitating entrance into the interior.

A further feature of the harmonic filter construction, as shown in the drawings, resides in the fact that the low inductance element or pipe section of the filter is mounted directly upon the blocking condensers.

It is to be noted that all coils of the filter are made of heavy self-supporting copper tubing. This construction is desirable since it prevents heating up due to high current flow and also prevents corona losses.

A further feature of the invention resides in the fact that it is divided into sections and being connected together by the shielded coil. In this way, reaction of one section of the filter upon another is substantially prevented.

Figure 1A is a sectional perspective view of the tubes 32, 34 of Figure 1 and shows in greater detail the piping and metal bellows connections for bringing cooling water to and from the tube jackets.

Having thus described my invention, what I claim is:

1. A transmitter comprising a substantially airtight housing, an air filter attached to the top of said housing, means for drawing air through said filter into said housing, means for forcing the air so drawn in against vacuum tubes mounted within the housing, transmission line shields connected to said housing, and means for permitting egress of air from said housing through said transmission line shields.

2. In combination, electron discharge device apparatus, a metallic housing for said apparatus serving both to shield said apparatus and to prevent the formation of dust thereon, a blower within said housing for forcing air under pressure into said housing, a filter for filtering the air drawn into said blower, air channels communicating with said blower and with the filament and grid seals of said electron discharge device apparatus, a shielded transmission line communicating with said housing, said shielded line having a screen for permitting the escape of air from within said housing.

3. In combination, electron discharge device apparatus, a substantially imperforate metallic housing for said apparatus serving both to shield said apparatus and to prevent the formation of dust thereon, means for filtering air and for forcing the resultant filtered air against certain electrode seals of said electron discharge device apparatus, an electrical circuit associated with

said electron discharge device apparatus and located within said housing, and a conduit for enabling the air forced against said electrode seals to thereafter flow over said electrical circuit, and means for supplying cooling liquid to other electrodes of said electron discharge device apparatus.

4. In combination, electron discharge device apparatus, a metallic housing for said apparatus 10 serving both to shield said apparatus and to prevent the formation of dust thereon, a blower within said housing for forcing air under pressure into said housing, a filter for filtering the

air drawn into said blower, air channels communicating with said blower and with the filament and grid seals of said electron discharge device apparatus, a shielded transmission line communicating with said housing, said shielded line having a screen for permitting the escape of air from within said housing, means for forcing air against certain electrode seals of said electron discharge device apparatus, and means for supplying cooling fluid to other electrodes of said 10 electron discharge device apparatus.

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