Nov. 28, 1933. W. DUBILIER ET AL 1,937,010

HIGH FREQUENCY SMALL CAPACITY CONDENSER

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Fig. 1.

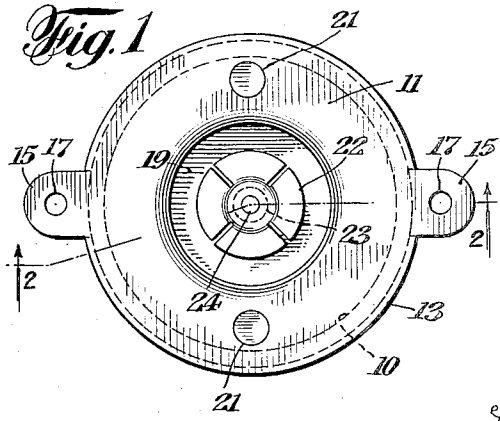


Fig. 3.

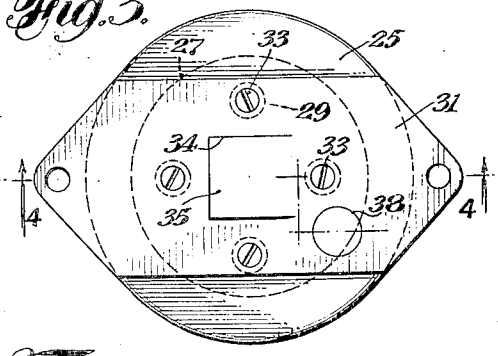


Fig. 4.

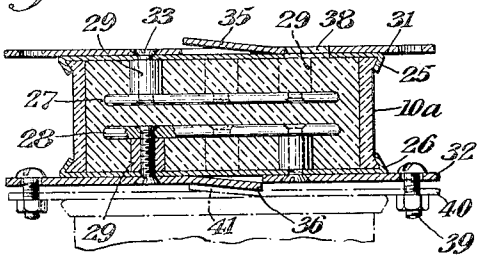


Fig. 2.

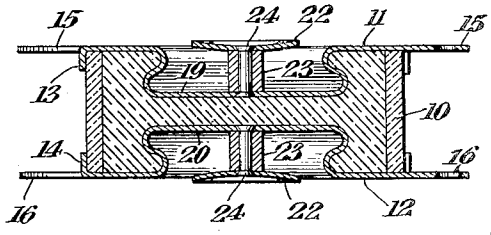


Fig. 7.

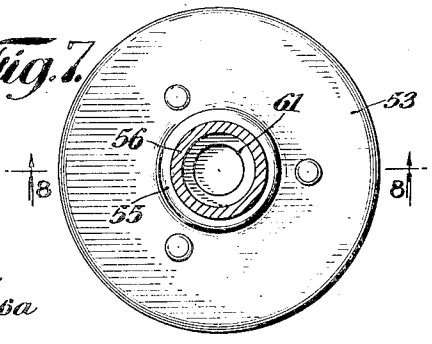


Fig. 5.

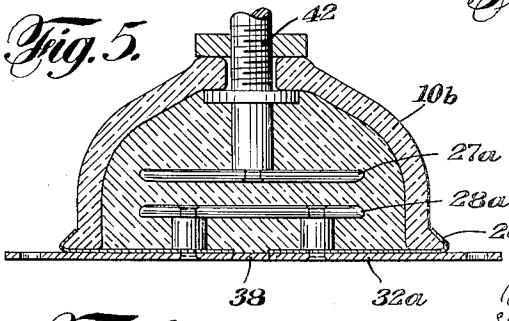


Fig. 8.

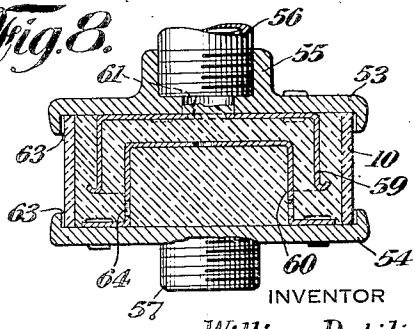
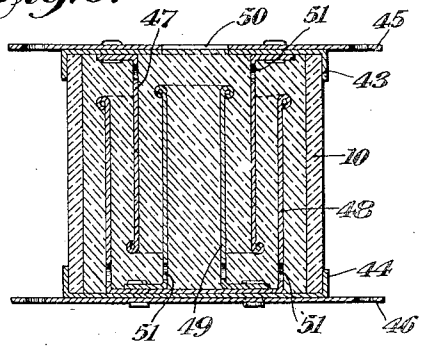


Fig. 6.



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Fig. 9.

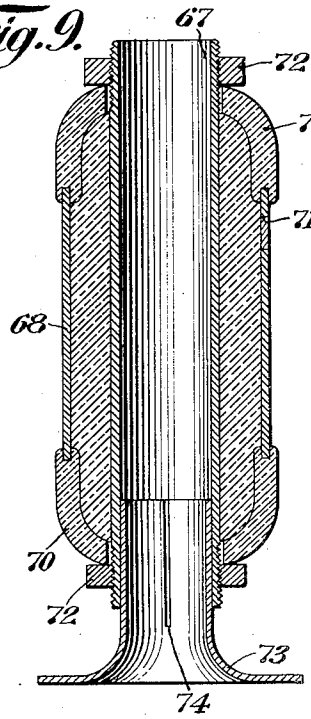


Fig. 10.

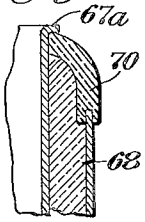


Fig. 11

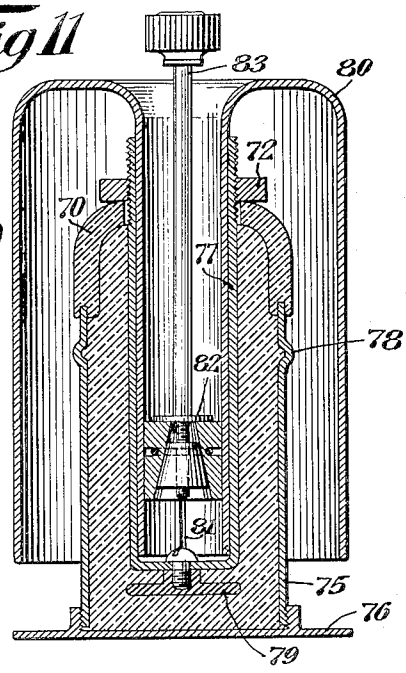


Fig. 12.

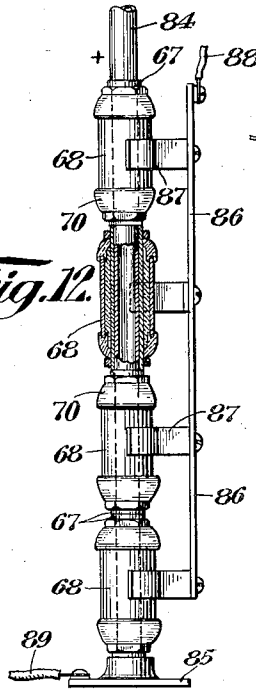


Fig. 13.

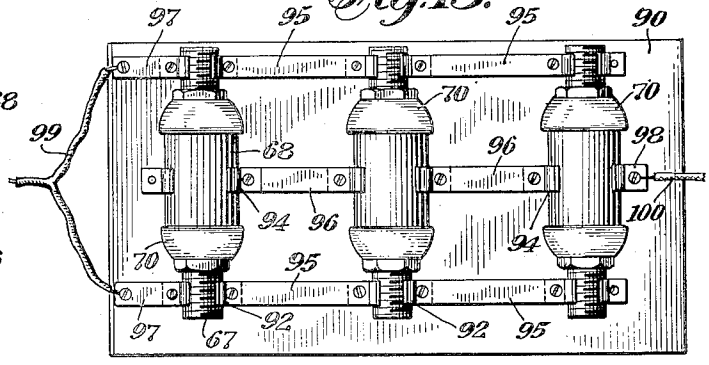
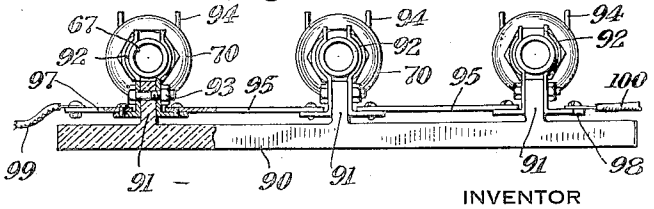


Fig. 14.



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Patented Nov. 28, 1933 1,937,010

UNITED STATES PATENT OFFICE

1,937,010

HIGH FREQUENCY SMALL CAPACITY CONDENSER

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Application February 3, 1932. Serial No. 590,560

4 Claims. (Cl. 175—41)

This invention relates to electrical condensers of small capacity for use in high frequency circuits and more particularly to condensers for ultra-short-wave radio transmitters.

An object of the invention is to use a solid dielectric in a condenser so that the dielectric imparts to the condenser great mechanical strength and rigidity.

Another object is to use a solid dielectric as the principal means for holding the parts of a condenser together.

Another object is to make a high frequency condenser of small dimensions, of simple and rugged construction wherein the losses are extremely low and which is capable of passing currents of several amperes at frequencies of the order of 60 megacycles.

Another object is to enable such condensers to be readily arranged in a group (either series, parallel, or series-parallel) with a short current path of low resistance through the group.

Still another object of the invention is to firmly hold those parts of a condenser which, by their movement or vibration, would change the capacity of the condenser.

One or more of the aforementioned objects are accomplished by arranging condenser armatures or elements and an insulating member or members to provide an enclosed space between the armatures and filling the space with a liquefied insulating material which thereafter becomes solid. Such a condenser may comprise two metallic members separated by an insulating tube, the metallic members covering the ends of the tube and forming therewith an enclosed space in which are disposed the armatures or poles of the condenser. The armatures may be portions of the metallic members or other metallic members carried thereby. Means may be provided for bolting or otherwise securing a metallic member or flange of one condenser to a corresponding flange of another condenser. Such condensers may also comprise tubular armatures, preferably disposed in coaxial relation, and an insulating member or members to complete the enclosure of the space between the armatures.

The invention also contemplates the grouping of such condensers in series, parallel or series-parallel combinations and the provision of means whereby such grouping may be easily accomplished to provide a path of low resistance through the group and to provide parallel paths of equal length through each of a plurality of parallel connected condensers. In some cases a resilient contact member is provided, preferably located in the center of an armature or flange. In a series-connected group of condensers this contact member presses against an armature of an adjacent condenser or its contact member and provides a straight current path of low resistance through the group.

The aforementioned enclosed space is preferably filled with a dielectric which is solid at ordinary temperatures and engages portions of the flanges or armatures. The dielectric material may be melted and poured into the enclosed space and subsequently solidified so that the several parts of the condenser are held together and rigidly supported thereby. Any dielectric which may be liquefied at least once may be used but sulphur is especially desirable because it is readily melted, it is a very good insulator with extremely low dielectric losses at high frequencies, and it has sufficient mechanical strength to make the condenser, so filled, extremely rigid. Sulphur has the property of tenaciously adhering to many materials and it expands on cooling, thereby reducing the formation of voids. Since sulphur causes corrosion with some metals, it is preferable to use aluminum for the metallic parts which may be exposed to the action of the sulphur.

Other objects and advantages of the invention will appear as the description proceeds.

In the accompanying drawings, which form a part of this specification,

Figs. 1 and 2 are top and sectional views respectively of a condenser in accordance with this invention.

Figs. 3 and 4 are top and sectional views respectively of a preferred construction of a condenser in accordance with this invention.

Figs. 5 and 6 are sectional views respectively of two other modifications.

Figs. 7 and 8 are top and sectional views respectively of another modification.

Fig. 9 is a sectional view of a modification having tubular armatures.

Fig. 10 is a fragmentary view of a further modification of a condenser shown in Fig. 9.

Fig. 11 is a sectional view of a modification in which one of the armatures is adjustable.

Fig. 12 illustrates how a group of condensers such as shown in Figs. 9 and 10 may be supported and connected in parallel,

Figs. 13 and 14 are plan and elevational views respectively of a support and illustrate how a group of condensers such as shown in Fig. 9 may be supported and connected.

Throughout the several figures of the drawings

like parts are indicated by like reference characters.

Referring to Figures 1 and 2 in detail, reference character 10 indicates an insulator, preferably of tubular form which may be made of isolantite, porcelain, glass, hard rubber or similar material. Over the ends of this tube are fitted cover plates or flanges 11 and 12 thereby forming an enclosed space within the tube. The edges of plates 11 and 12 may be turned as indicated at 13 and 14 respectively to engage tube 10, a portion, however, being left flat to form ears 15 and 16 respectively which may be provided with holes 17 so that the condenser may be secured to another similar condenser by short bolts or rivets or other suitable means for holding the ears of one condenser to those of another. Plates 11 and 12 have protruding portions 19 and 20 respectively which are preferably flat and circular with well rounded recurving portions connecting the flat portions with the main body of the plates. The portions 19 and 20 form the armatures or poles of the condenser and are spaced apart according to the working voltage of the condenser. In accordance with the invention, a liquefied insulating material such as sulphur, rubber composition, paraffine, rosin or other insulating material or composition which may be liquefied at least once is poured through one of the holes 21 provided for that purpose in the top cover plate 11, the other hole acting as a vent to permit the escape of air. When the space within the tube 10 and between the plates 11 and 12 is completely filled the insulating material is allowed to harden. It will be observed from the drawings that, due to the shape of the plates 11 and 12, the insulating material engages these plates and holds them securely, together with the insulating tube 10, to form a rigid and compact condenser unit. Resilient contact members, such as cupped washers 22 with spacers 23 may be secured to plates 11 and 12 as by rivets 24. The heads of rivets 24 should not project above the surface of armatures 19 or 20.

Figs. 3 and 4 illustrate another form of condenser, embodying the features of the invention, which is well adapted to be manufactured and used commercially. The condenser illustrated comprises an insulating tube 10*a* which is similar to insulating tube 10 of Figs. 1 and 2 except that its wall is thickened or enlarged at the ends as shown in Fig. 4. This tube is provided with cover plates 25 and 26 which may be spun or otherwise shaped to engage the ends of tube 10*a*. The armatures for the condenser are separate plates 27 and 28, preferably flat and circular with rounded edges, disposed within tube 10*a* at the proper distance apart by a plurality of spacers 29. Additional plates or flanges 31 and 32 are secured to the outside of cover plates 25 and 26 respectively. A single set of screws such as 33 may be used to hold plates 25, 27 and 31 securely in their proper relative positions and a similar set of screws may be used to hold plates 26, 28 and 32. The ends of screws 33 are preferably riveted over plates 27 and 28 and smoothed off flush with their surfaces.

A portion of flange 31 is partially separated from the body thereof, such as by a three-sided slit 34, and bent up as shown in Fig. 4 to form a resilient contact member 35. A similar contact member 36 may be provided for bottom flange 32. A separate resilient member may, of course, be attached to the flange instead of using a portion of the flange itself. The condenser may be filled with insulating compound as described in connection with Figs. 1 and 2 through aligned openings 38 in plates 25 and 31. In this case the hole is so large that a separate vent is not needed. The hole may be plugged by the piece of metal removed from the plate, as indicated.

Fig. 4 illustrates how the condenser may be mounted on top of a similar condenser thereby connecting the two condensers in series. Bolts or other suitable fastening means 39 may be employed to draw and hold flanges 32 and 40 together. The resilient member 36 of flange 32 will then be pressed against the corresponding flange 40, or its resilient member 41, and form a good electrical contact at the approximate center of the flanges.

To connect two or more condensers in parallel they may be placed side by side with the ears of the flanges over-lapping and secured by bolts in a similar manner. Additional condenser units may be connected in series to each of the units which are connected in parallel thereby forming a series-parallel combination in accordance with the voltage and capacity requirements of the circuit in which the group of condensers is to be used.

Figure 5 illustrates a further modification of the invention in which condenser armatures 27*a* and 28*a* are arranged substantially as shown in Figure 4, except that the insulating housing 10*b* is made in the shape of a bell with a large opening at one end and a comparatively small opening at the other through which one of the electrodes 27*a* is secured as by post 42, which at the same time forms a terminal connection for the condenser. The condenser shown in Figure 5 may be assembled and then the insulating compound poured through a filling hole 38 in the bottom plates 26*a* and 32*a*, then sealed up by metal plug in a manner similar to that previously described.

It will be noted that, by this modification, the capacity through the insulating housing 10*b* is greatly reduced, for the surface of the upper electrode exposed to the surface adjacent to the small opening of the insulating housing is very small in area compared with the surface at the other end of the housing which is adjacent the cover plate 26*a*; therefore the actual capacity effect through the insulating housing itself will be much smaller than that shown in Figures 2 and 4.

Fig. 6 illustrates a modification of a condenser in which the armatures have larger surfaces and therefore provide a condenser of larger capacity. Cover plates 43 and 44 are placed over the ends of insulating tube 10 and have attached thereto suitable flanges 45 and 46. To the top cover plate 43 is secured a tubular armature or pole 47. To the bottom cover plate 44 other tubular armatures are attached such as 48 and 49, armature 48 surrounding armature 47 and armature 49 being disposed within armature 47. It will be observed that a considerably larger effective area between armatures is obtained by this construction than by the use of the flat armatures shown in Figs. 2 and 4. The ends of tubular armatures 47, 48 and 49 are turned or spun over so as to provide well rounded edges to prevent concentration of flux. A filling hole 50 is provided through plates 43 and 45. Holes such as 51 near the flanged ends of tubular armatures 47, 48 and 49 permit circulation of the liquid insulation and escape of air.

Figs. 7 and 8 illustrate a modification which is adapted to be connected to conductors having the form of pipes or tubing. The flanges 53 and 54 in this modification are of relatively thick

metal. One flange is provided with a hub 55 threaded to receive a correspondingly threaded pipe 56, the other flange having a hub 57 which is threaded on the outside and adapted to be screwed into a pipe fitting or similarly threaded receptacle. Armatures 59 and 60 are attached to flanges 53 and 54 respectively. These armatures may be of the shapes shown or may be similar to the armatures shown in the other figures or may be given any other suitable shape which will provide the proper insulation between them and prevent concentration of electro-static flux. Flanges 53 and 54 are spaced by insulating tube 10. The interior of the condenser may be filled with liquid insulation through hole 61 and the air permitted to escape around the edges of tube 10. The small amount of insulating material which may leak out serves to more securely hold the flanges and the tube together and seal the spaces, indicated by reference character 63, between the flanges and the tube. Holes 64 are provided in armature 60 to permit circulation of the insulating material when liquid and to engage the insulation when solid.

Figure 9 illustrates another embodiment of the invention wherein the armatures 67 and 68, respectively, of the condenser are tubular. Armature 68 surrounds armature 67 and is preferably made shorter and disposed in concentric relation to armature 67. Insulating members 70 engage these armatures and provide with the armatures an enclosed space which may be filled with liquefied insulation through aperture 71 as previously described. The ends of armature 67 may be threaded and provided with nuts 72 to hold the armatures and insulating members in proper relation before filling the annular space therebetween with insulating material and to reinforce the structure after said filling. It is obvious that the filling of insulation may be omitted and the condenser used with air as a dielectric. The condenser may be mounted upon a support, as indicated at 73, which fits inside the armature 67 and may be provided with a slot 74 to secure a firm contact having low electrical resistance. Supports such as 73 are convenient when it is desired to make quick changes or replacements of the condenser units.

Figure 10 illustrates a modification of the condenser shown in Fig. 9 wherein the threads on the armature have been omitted and instead the armature 67*a* is turned or spun over the insulator 70.

Figure 11 shows a condenser having an adjustable capacity. One of the tubular armatures 75 is provided with a metallic base 76 which may serve as one terminal of the condenser and also as a means of support. Another armature 77 is disposed within the armature 75 and held in proper relation thereto by insulating member 70 and nut 72 which is threaded over the end of armature 77. The annular space formed by parts 75, 77 and 70 may be filled with insulation when the parts are in an inverted position and then the base 76 affixed. The wall of armature 75 is upset as indicated at 78, preferably around its entire periphery, so that the armature interlocks with the solidified insulating material. An interlock may also be provided for armature 77 by the flange member 79 secured to the end of this armature. An additional armature 80 has an inner, tubular portion which fits within armature 77 and preferably has its end slit as indicated at 81 to provide frictional contact therewith, and an outer tubular portion which surrounds the other armatures. Armature 80 may be raised or lowered relative to armatures 77 and 78 and thereby provide an adjustable capacity with the armature 78. It will be noted, therefore, that armatures 77 and 78 provide a fixed capacity and armatures 78 and 80 provide an adjustable capacity, the two capacities being in parallel and therefore additive. Armature 80 may be locked in the desired position by clamping means 82 which is provided with rod and thumb screw arrangement 83 making it readily accessible at all times.

Figure 12 shows one method of supporting and connecting a group of condensers such as illustrated in Figs. 9 and 10. A metal rod 84 extends from a base 85, the rod being adapted to fit within the hollow armatures 67 or 67*a*. Any desired number of condensers may be stacked one above the other on the rod 84. A terminal strip 86 is provided with a plurality of clips 87 which engage the outer armatures 68 of the respective condensers. It will be noted that in the arrangements shown the condensers are connected in parallel. If a conductive lead 88 is connected to the upper end of terminal strip 86 and another lead 89 is connected to the base 85, it will be noted that the current path from lead 88 to lead 89 will have the same length through each of the parallel connected condensers. In ultra-short wave circuits it is important that the lengths of parallel connected paths be equal.

Figures 13 and 14 illustrate a support and means for connecting a group of condensers, such as shown in Fig. 9. The support may comprise a base 90 with integral projections 91 extending above its surface and provided with pairs of clips such as 92 adapted to engage the protruding ends of armatures 67. Suitable fastening means such as bolts 93 are provided to secure the clips to projections 91. Additional clips such as 94 are adapted to engage the armatures 68. The clips 92 are connected by removable links such as 95 and clips 94 are connected by similar removable links such as 96. Suitable terminals may be provided for the group of condensers as illustrated at 97 and 98 respectively.

As illustrated in Figs. 13 and 14, three condensers are connected in parallel and connections may be made to terminals 97 and 98 by leads 99 and 100, respectively. It will be noted that lead 99 is divided and is electrically connected with both ends of each of the armatures 67 through links 95, thereby providing a double path through the condensers in a symmetrical arrangement about the center line of the group. The group of three condensers shown may be connected in series by removing the two links 95 at the left and the link 96 at the right. The current paths in such a series arrangement are also symmetrically disposed about the center line of the group. It will be obvious to those skilled in the art that, with a greater number of condensers in the group, various series or parallel combinations may be obtained by means of links such as 95 and 96.

When the armatures of a high frequency condenser vibrate, resultant changes in capacity may cause undesirable modulation of the high frequency current carried by the condenser. It will be noted in all the modifications illustrated that the dielectric which fills the space between the armatures is in direct contact therewith, thus preventing the armatures from vibrating and preventing such modulation. It is desirable that the insulating material adhere to the armatures. It will also be noted that, in the condensers of

Figs. 1, 2 and 6 to 8 inclusive, the solid dielectric is the only means for holding the several parts of the condensers together and, in the condensers shown in the remaining figures the solid dielectric is the principal holding means. In all cases the solid dielectric imparts to the condenser a solidity and rigidity not obtainable with former condenser constructions.

The embodiments of the invention illustrated and described herein have been selected for the purpose of clearly setting forth the principles involved. It will be apparent, however, that further modifications may be made to meet different conditions and it is intended that the appended claims cover all modifications within the true spirit and scope of the invention.

We claim:—

1. An electrical condenser comprising a tube of insulating material, a pair of flanged armatures partially within said tube and covering the ends thereof, and a spring member projecting from the central portion of one of said armatures.

2. An electrical condenser adapted to be connected in series with similar condensers by stacking one upon another, comprising a pair of metal flanges separated by a tubular insulator, means for securing a flange of one condenser to a flange of a similar condenser and a member projecting from said flange and adapted to make resilient contact with the adjacent flange.

3. An electrical condenser adapted to be connected in series with similar condensers by stacking one upon another, comprising an insulating tube, a metallic cover plate on each end of said tube, a metallic member projecting within said tube from each of said cover plates thereby forming oppositely disposed poles of the condenser, and a spring member secured to each cover plate at the approximate center thereof, said spring members being adapted to make resilient contact with corresponding spring members of other condensers when the said condensers are stacked.

4. An electrical condenser comprising a tube of insulating material the wall of which has a thickened portion at each end, metallic cover plates engaging said thickened portions and substantially closing the ends of said tube, a flat plate secured to each of said cover plates but spaced therefrom said flat plates having their surfaces oppositely disposed within said tube, and a solid insulating material substantially filling said tube and surrounding said flat plates.

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