Dec. 12, 1950 R. H. CHAMBERLIN ET AL 2,533,713

VACUUM CONDENSER

Filed May 27, 1947 2 Sheets-Sheet 1

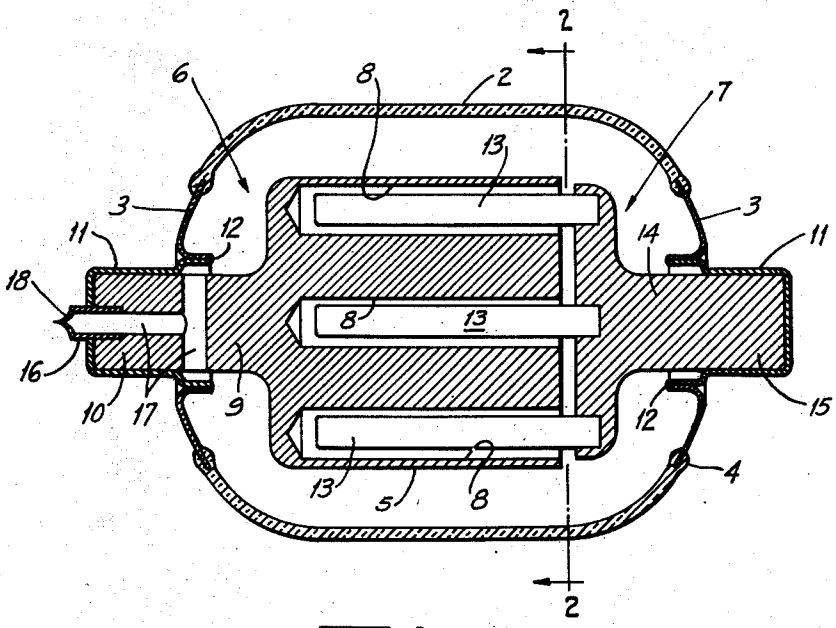


Fig. 1

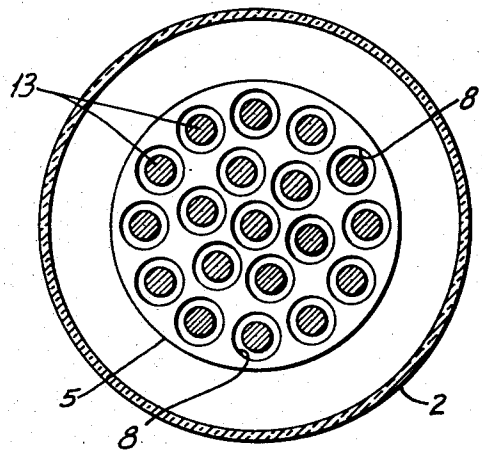


Fig. 2

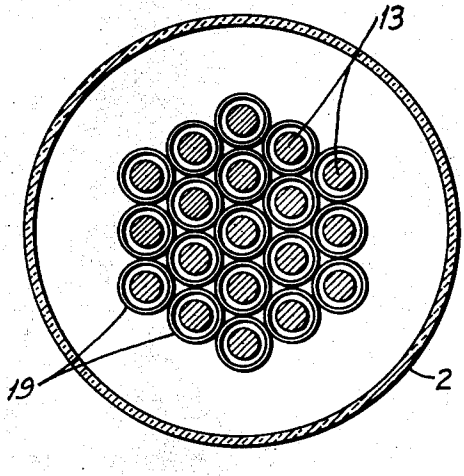


Fig. 3

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VACUUM CONDENSER

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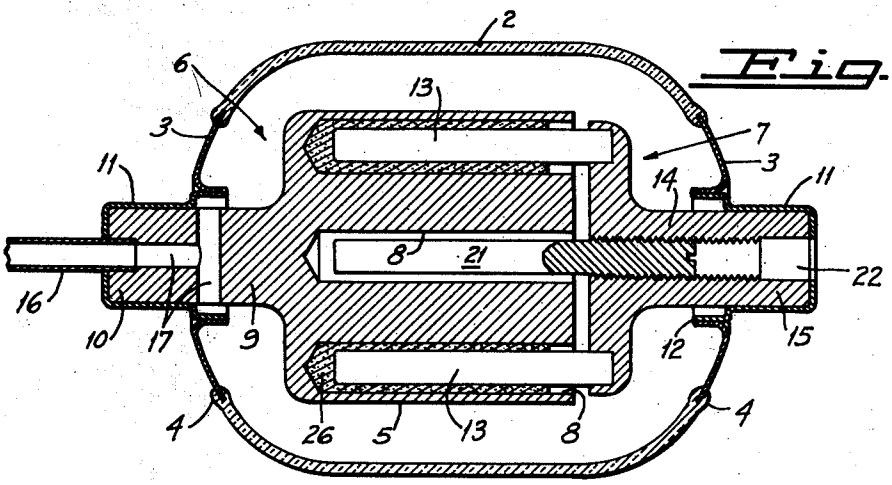


Fig. 6

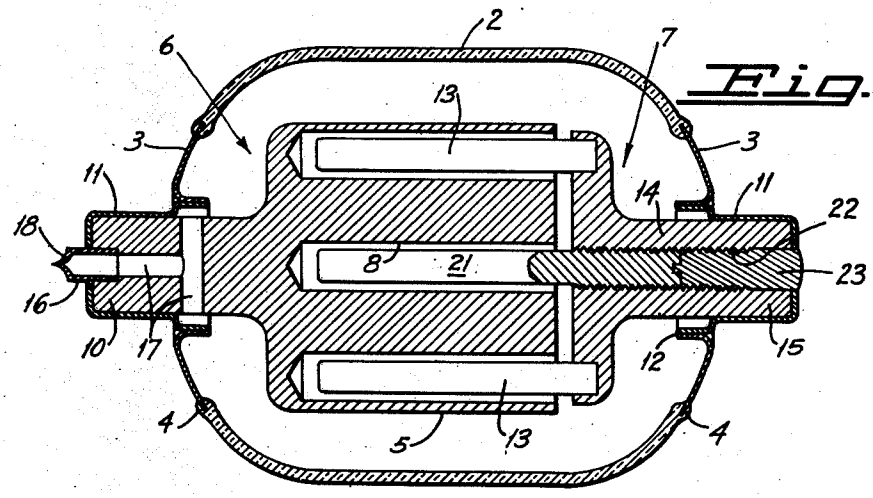


Fig. 5

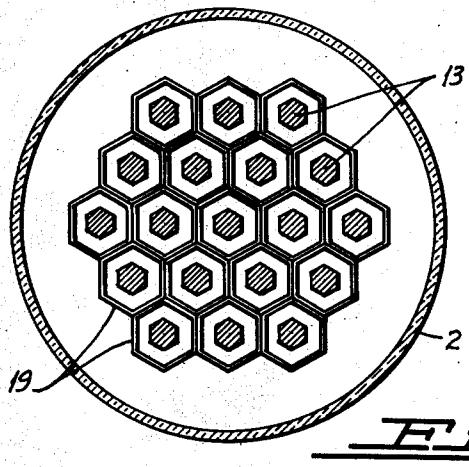


Fig. 4

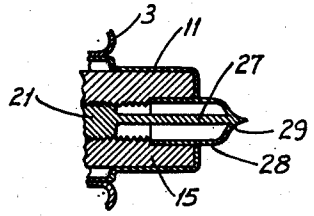


Fig. 7

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VACUUM CONDENSER

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Application May 27, 1947, Serial No. 750,828

1 Claim. (Cl. 175—41)

1

Our invention relates to condensers for use in electrical circuits, and more particularly to a condenser in which the electrodes are enclosed in an evacuated envelope.

Vacuum condensers as made in the past present a number of problems both from the standpoint of the manufacture and of electrical design. Since the capacitance is determined by spacing between the electrodes, which spacing is necessarily quite close, there is a real problem of getting the electrodes sealed into an envelope while maintaining the proper spacing between the electrodes. Consequently, precision vacuum condensers have seldom been available except at large cost. The usual practice has been to employ electrodes in the shape of parallel plates or concentric cylinders, the latter being commonly used. These electrode structures are difficult to fabricate and assemble, and require envelopes of relatively large size for condensers in the higher capacitance ranges. Vacuum condensers heretofore made are also quite limited in their current ratings because of heat problems involved, and leave much to be desired mechanically.

The broad object of our invention is to provide an improved vacuum condenser structure and fabrication method which largely overcomes the disadvantages above noted.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of our invention. It is to be understood that we do not limit ourselves to this disclosure of species of our invention as we may adopt variant embodiments thereof within the scope of the claim.

Referring to the drawings:

Figure 1 is a longitudinal sectional view of a vacuum condenser embodying the improvements of our invention.

Figure 2 is a transverse sectional view taken in a plane indicated by line 2—2 of Figure 1; and

Figures 3 and 4 are like views illustrating modified electrodes.

Figure 5 is a view similar to Figure 1 showing a condenser embodying means for establishing the final capacitance; and

Figure 6 is another similar view illustrating the method of assembly.

Figure 7 is a detail view showing an alternate closure structure.

In terms of broad inclusion, our preferred condenser structure comprises an evacuated envelope containing sets of electrodes, one electrode set having a plurality of parallel bores and the

2

other set having pins projecting into the bores. The electrode sets are preferably supported at opposite ends of the envelope and the set having the bores is preferably formed by a group of tubes arranged side-by-side. The above structure is simple to fabricate and assemble, and permits building up a large capacitance in a compact space. An important feature of our invention is the provision of adjusting means accessible externally of the envelope for varying the spacing between electrodes to establish the final capacitance after the electrodes have been sealed in the envelope, means being also provided for sealing the adjusting means to provide a vacuum tight closure after the adjustment has been made. While this feature may be incorporated in vacuum condensers having other types of electrodes, our preferred electrode structure is particularly well suited because one of the electrode pins may easily be made adjustable to function as a trimmer electrode. Our method of making the condenser comprises positioning the electrode sets to approximate the final capacitance, sealing the sets so positioned in the envelope, varying the spacing by adjusting the trimmer electrode, fixing the spacing, and then evacuating the envelope. The method also preferably includes the step of placing a dissolvable material between the electrodes to temporarily hold the electrode sets as a unit while being sealed into the envelope, which material is subsequently dissolved out prior to final adjustment and evacuation.

In greater detail, and referring first to Figures 1 and 2 of the drawing, one version of our vacuum condenser structure comprises a tubular or cylindrical envelope having a side wall 2 of a vitreous insulating material such as glass or ceramic. End walls 3 of the envelope are preferably of metal selected for making suitable joints to the vitreous wall 2. For example, if the side wall is of glass, the end walls are in the nature of sealing flanges and are made of a metal having an expansion characteristic matching that of the glass so that the parts may be sealed together at seals 4.

Internally our condenser comprises a pair of cooperating sets of electrodes positioned axially of the envelope and generally indicated by the reference numerals 6 and 7. Electrode set 6 simply comprises a solid body 5 of metal such as copper having parallel bores 8 disposed about the envelope axis and opening out on the inner end of body 5. These bores provide a plurality of individual hollow electrodes and are preferably arranged in concentric circles about the

envelope axis. An integral shank portion 9 extends through the end of the envelope to provide a terminal 10 for the condenser. The outer terminal portion of the shank is preferably held in a cap 11 which is in turn secured to the end wall flange 3 at braze 12.

The other electrode set 7 comprises a plurality of pins 13 projecting into bores 8. These free ended pin-shaped electrodes are secured at their base ends to a shank 14 which extends through the other end of the envelope to provide a second terminal 15 for the condenser. The shank at this end of the condenser has a cap 11 secured to wall flange 3 in a manner similar to the construction at the opposite end. Pins 13 and mounting shank 14 of electrode set 7 are of a suitable metal such as copper. A metal exhaust tubulation 16 is preferably brazed to terminal 10 and ported into the envelope through channel 17, the tubulation being pinched off at tip 18 after evacuation of the envelope.

The capacitance of our condenser is determined by the number and dimensions of bores 8 and engaged pins 13. Because the multiplicity of interengaged electrodes present a large total area in a compact structure, it is possible to build condensers of large capacitance in envelopes of small physical size. Another feature of our construction is that the relatively large mass of metal connecting the effective electrode areas with the terminals provides excellent heat conduction so that the improved condenser, even though of small size, is capable of handling large currents without undue heating.

Other advantages of our condenser structure above described include the following: There are but few parts and those that are present are readily fabricated and assembled; the electrodes are easily jigged for alignment when sealing into the envelope and have ample rigidity to maintain accurate alignment even though small interelectrode spacings are involved; the rigidity above mentioned holds the capacitance constant under electrical stresses; the condenser is ideally adapted for large scale production on an economical basis; and the simple structure does not introduce problems in outgassing of parts and evacuation of the envelope during exhaust of the condenser.

Instead of making the electrode set 6 of a solid block of metal, it can be of cellular structure made up of a group of metal tubes 19 arranged side-by-side as shown in Figure 3, which tubes are preferably of copper brazed together and to a mounting shank. The tubes may be circular as in Figure 3 or flat sided as in Figure 4. Hexagonal tubes nested together build up a very large capacitance in a small space, particularly if the pins 13 are also hexagonal. Since the cellular structure has advantages from the fabrication standpoint as well as providing further compactness, we prefer to use it.

Another feature of our invention illustrated in Figure 5 is the provision of adjusting means accessible externally of the envelope for varying the spacing between electrodes to establish the final capacitance after the electrodes have been sealed in the envelope. As embodied in our pin type electrode structure this adjusting feature utilizing the center pin 21 of electrode set 7 as a trimmer electrode. All of the other electrodes, which are fixed at the time of sealing them into the envelope, will be referred to herein as the main electrodes to distinguish them from the trimmer electrode. Trimmer electrode 21 has an outer screw portion threaded into a passage 22 extending through shank 14 and exposed at the end of the condenser, so that the outer screw portion provides means for adjusting the electrode. A screwdriver inserted in the passage is the only tool required to make the final adjustment. After adjustment and prior to evacuation the outer end of passage 22 is sealed with a fused metallic plug 23 of solder or the like. This plug provides a vacuum tight closure and also simultaneously locks the trimmer electrode to fix the spacing.

While we have shown the above feature in connection with our preferred pin type electrode structure, it is understood that it may be incorporated in any type of vacuum condenser where it is desired to make an adjustment for trimming the capacitance to a precise value prior to evacuating the envelope.

Summarizing the method of making the condenser, and referring to Figure 6, we first fabricate the electrode sets 6 and 7 and then engage the main electrodes and trimmer electrode to approximate the final capacitance. This positioning may be done with suitable jigs or fixtures. The electrode sets so positioned are then sealed in the envelope by fusing the vitreous side wall 2 to metal end walls 3 at seals 4. This sealing operation serves to fix the main electrodes in permanent position as will be readily understood. Since the final capacitance is not set during the sealing-in operation enough tolerances are allowable to permit the glass work to be done without undue restrictions. Seals 4 are made in an ordinary glass lathe.

The next step is to trim the capacitance by moving electrode 21 in or out. This is preferably done with the condenser in a capacitance measuring circuit. After adjustment a quantity of solder is poured into passage 22 to form the plug 23 (Figure 5), thereby locking the trimmer electrode and providing a vacuum tight closure for the adjusting means. The condenser is then ready for evacuation which is done in the conventional manner by connecting tubulation 16 to a suitable vacuum pump.

If desired an additional step may be employed to simplify holding the electrode sets 6 and 7 as a unit during the sealing-in operation. This comprises filling several of the bores with a dissolvable material 26 such as salt or chalk to embed the engaged pins 13. After the envelope has been completed the material 26 is dissolved out by introducing a suitable liquid solvent through the open tubulation 16. The steps of trimming adjustment and evacuation may then be followed as previously described. Using a dissolvable material to hold the electrodes has a special advantage in making the simpler form of structure shown in Figure 1, although the combination of this step with a subsequent trimming adjustment is an ideal method of making precision condensers. Our pin type electrode structure is particularly well adapted for use of the dissolvable spacing material 26 because the only cavities are the bores 8 which all face in one direction, thereby making it easy to wash out the spacing material.

A modified structure for locking the trimmer electrode and simultaneously providing a vacuum tight closure is shown in Figure 7, wherein an extension rod 27 on electrode 21 projects through a metal tubulation 28, both of which are pinched off at tip 29. By this arrangement the extension 27, which is originally made long enough to pro-

ject out the open end of tubulation, provides a handle for adjusting the trimmer electrode. The subsequent step of pinching through the parts serves to lock them together as well as to seal off this end of the condenser. This tubulated structure on an envelope, with a rod extending through the tubulation for adjusting the position of an element within the envelope, is useful in any kind of evacuated device where it is desirable to make a final adjustment prior to sealing the envelope.

We claim:

A vacuum condenser comprising an envelope having an end structure with a passage therein, an electrode set supported at the opposite end of the envelope and having parallel bores, another electrode set supported at the first mentioned end of the envelope and having pins projecting into said bores, adjusting means threaded into said passage for varying the degree of engagement of one of said pins, and a vacuum tight closure for the outer end of the passage.

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HAROLD E. SORG.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,333,401	Fisk	Mar. 9, 1920
1,641,687	Nolte	Sept. 6, 1927
2,036,532	Knoll	Apr. 7, 1936
2,154,542	Swanson	Apr. 18, 1939
2,192,062	Hansell	Feb. 27, 1940
2,291,445	Beyer	July 28, 1942
2,324,178	Sprague	July 13, 1943
2,339,663	Teare	Jan. 18, 1944
2,415,412	Bushwald	Feb. 11, 1947

FOREIGN PATENTS

Number	Country	Date
416,457	Great Britain	Sept. 14, 1934
523,869	Great Britain	July 24, 1940