June 19, 1934. J. A. PROCTOR 1,963,559

ELECTRICAL CONDENSER

Filed Nov. 12, 1927 3 Sheets-Sheet 1

Fig. 1.

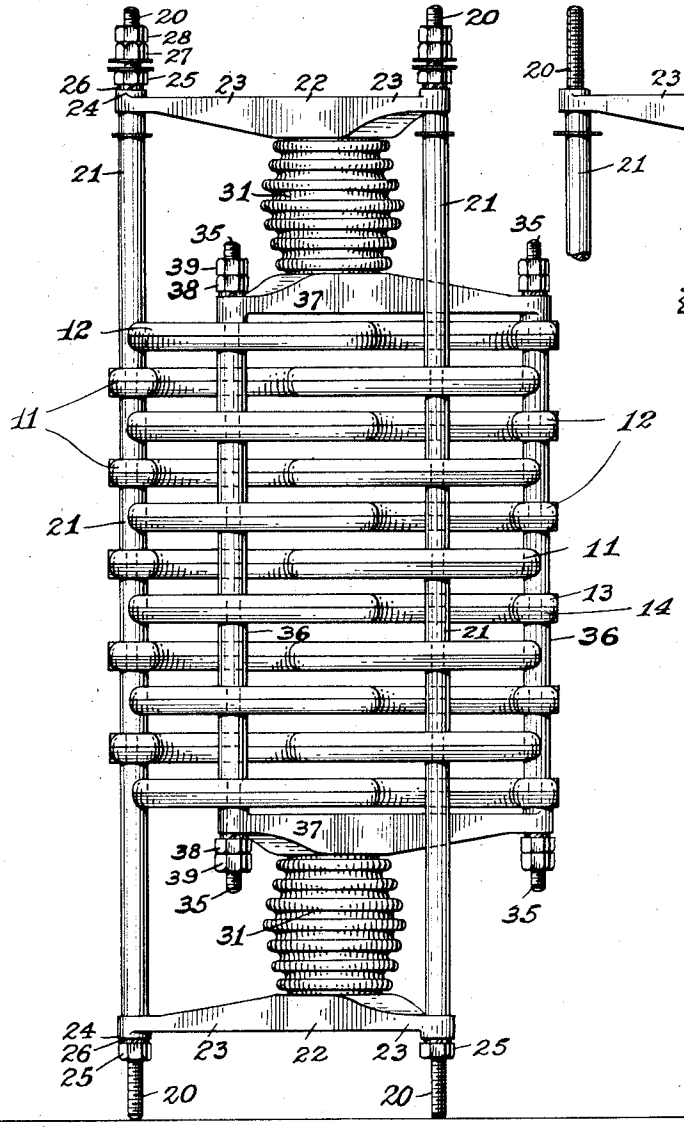
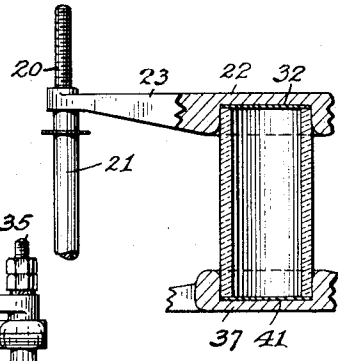


Fig. 4.



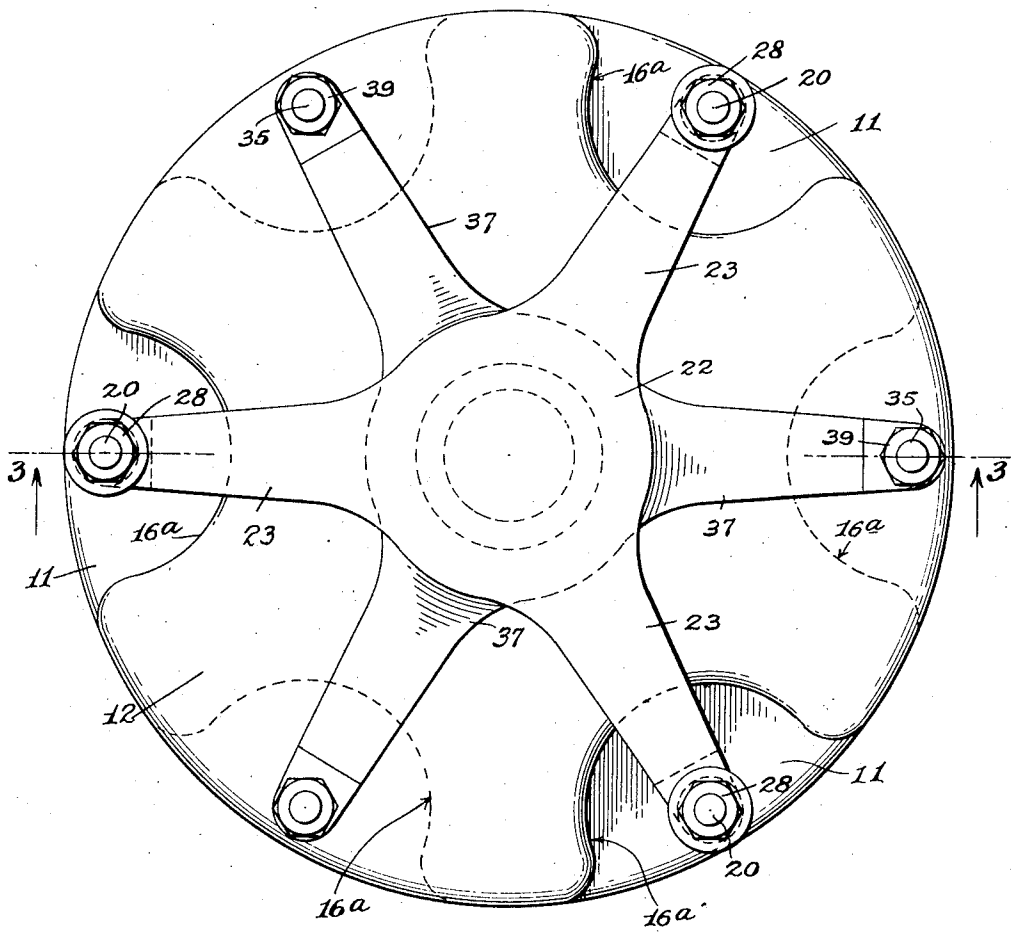
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Fig. 2.



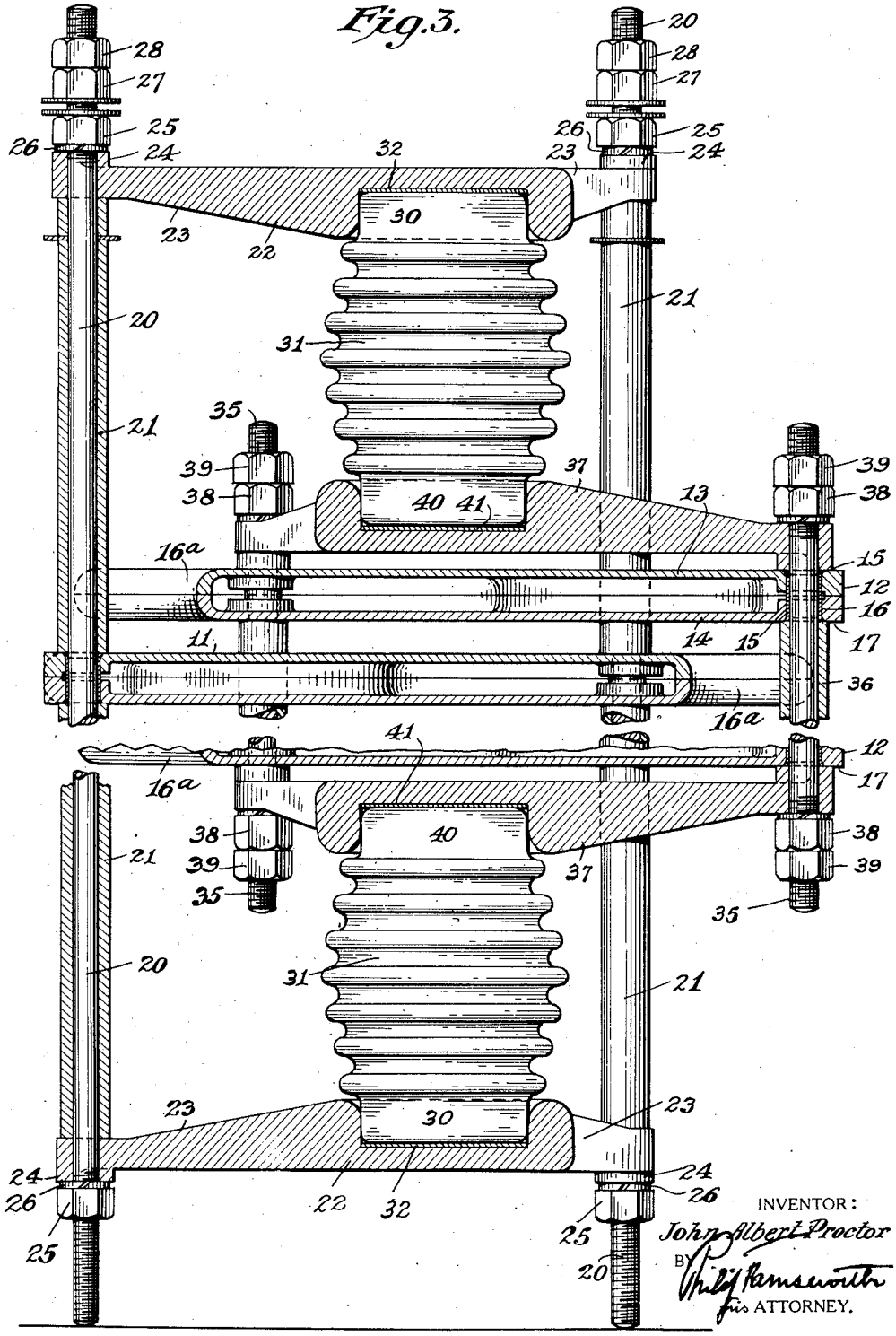
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ELECTRICAL CONDENSER

Filed Nov. 12, 1927 3 Sheets-Sheet 3

Fig. 3.



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UNITED STATES PATENT OFFICE

1,963,559

ELECTRICAL CONDENSER

John Albert Proctor, Lexington, Mass., assignor, by mesne assignments, to General Electric Company, a corporation of New York

Application November 12, 1927, Serial No. 232,742

16 Claims. (Cl. 175—41)

This invention relates to electrical condensers and, more particularly, to high power air condensers suitable for use in high frequency circuits such as those involved in radio transmission apparatus.

High frequency electrical currents travel only over the surface of a conductor without passing any appreciable distance into the interior thereof. Furthermore, field concentrations occur at all sharp corners or sudden changes in current direction which may become sufficiently strong to produce a corona discharge. It is desirable therefore in high frequency electrical apparatus to provide a large surface area and to avoid, as far as possible, sharp corners and projections.

In an air condenser for use with high power transmitters it is necessary to provide a substantial amount of space between adjacent plates in order to prevent a breakdown of the dielectric. This, of course, reduces the capacity and necessitates the use of plates having a large area in order to build up the desired amount of capacity. Furthermore, the plates of the two polarities must be carefully insulated and the entire design carried out with a view to preventing excessive losses as, for example, those due to resistance and field concentrations.

This invention provides a high power air condenser for use in radio transmission circuits or other high frequency systems in which a substantial area of plates is provided and in which the space between plates is maintained sufficiently great to prevent dielectric failure. The plates are formed of a substantial thickness and are provided with rounded edges. Furthermore, since only surface currents are involved, the plates are formed hollow in the interest of economy and lightness. A simplified mounting is employed for spacing the plates and suitably insulating the plates of different polarities.

The invention also consists in certain new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which

Fig. 1 is a side elevation of a condenser constructed in accordance with this invention;

Fig. 2 is a plan view thereof;

Fig. 3 is a vertical section broken away intermediate the ends of the condenser, to avoid repetition, taken on the line 3—3 of Fig. 2; and

Fig. 4 is a detail view of a modified form of insulator which may be used with this condenser.

Like reference characters denote like parts in the several figures of the drawings.

In the following description and in the claims parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to the figures more in detail, the invention is shown by way of illustration as applied to a condenser comprising a plurality of plates 11 which are mechanically and electrically connected together to form one condenser electrode, and a plurality of plates 12 forming a second electrode similarly joined together but insulated from the first mentioned group. Each of said plates 11 and 12 is cast or otherwise formed in two sections 13 and 14 (Fig. 3) and may be cup-shaped with rounded edges whereby, when joined together, a continuous outer surface is produced. The plates may be formed of aluminum although the invention is not limited to the use of that particular material. The co-operating edges of the various plates are suitably finished to fit tightly together and thereby reduce the resistance losses of the condenser as well as the liability of corona discharge. Without further extended description, those skilled in the arts will understand how to make this construction, so as (1) to reduce the weight sustained by lower insulator 31, (2) provide a strong mechanical construction of the parts notwithstanding their reduced weight, for the plates of large facing areas, (3) and provide the above electrically useful structure by bringing together tightly the rims of the cup-sections so as to produce such external rounded edges for the thick hollow condenser plates. Said rounded external edges being formed by bringing together the rims of the cups so that the two short sides of the facing cups constitute the rounded edges of the two-cup plates.

Sections 13 and 14 may be provided with aligned openings 15 through which supporting members may be passed and with suitable recesses 16*a* for spacing and separating the plates from parts of opposite polarity. The sections may be joined together as by tubular rivet 16 which serves to rigidly secure the sections together in good contact and receive a supporting member as tubes 21 or 36 as hereinafter set forth. Any other suit-

able means may however be employed for joining said plate sections and securing electrical contact therebetween. Although the edges of the plates are rounded wherever useful yet a flat surface 17 is provided adjacent rivets 16 for co-operating with the adjacent spacing tube 21 or 36 and assuring a tight fit therewith. Surface 17 is essentially a boss formed on the surface of the plate and is utilized only for the purpose of securing proper mechanical co-operation between the various parts.

One set of plates 11 may be supported upon rods 20 passing through aligned rivets 16 therein. Spacing members, as metallic tubes 21, are supported by posts 20 and serve to properly space the various plates and to electrically connect the same. Spiders 22 may be utilized for joining the various rods 20, being provided as shown in Figs. 2 and 3 at top and bottom and, with three legs 23 extending at equal angles therefrom. Legs 23 are provided with bosses 24 which are drilled to pass over said posts 20. The ends of posts 20 may be threaded and the assembly secured by nuts 25 and lock washers 26. One end of rods 20 may be utilized as a terminal to which a conductor may be secured as by nuts 27 and lock nuts 28.

Spiders 22 are provided with a circular recess adapted to receive the end 30 of insulator 31. A gasket 32 of yielding material may be located in said recess and adapted to bear against the insulator 31 for preventing injury thereto. Said insulator may be of a size dependent upon the voltage which is to be employed and may be formed of any suitable insulating material such, as porcelain or pyrex glass.

If formed of porcelain the surface of the insulator is corrugated as shown in Figs. 1 and 3 for increasing the surface distance between the two ends thereof. If formed of glass, however, as shown in Fig. 4 the insulator may be tubular with a flat cylindrical surface. In this case, a slightly greater length is required in order to prevent surface breakdown.

Condenser plates 12 are formed in the same manner as plates 11, above referred to, and are similarly mounted upon rods 35 and separated by spacing tubes 36 around the rods. Spiders 37 are similar to spiders 22 above described and may be utilized for joining the various rods 35 for electrically and mechanically connecting the set of plates 12. The entire assembly may be secured by nuts 38 and lock nuts 39 threaded upon the ends of rods 35 and co-operating with three-legged spiders 37.

Spiders 37 are suitably recessed for receiving the end 40 of insulators 31 between which the entire set of plates 12 is supported. Gasket 41 of yieldable material such as lead may be inserted between the ends 40 of insulators 31 and the respective spiders.

As shown in Figs. 1 and 3, each set of metallic condenser plates 11, 12 is spider-shaped, with three wide legs, in cooperation with the two three-legged end-supporting spiders 22, 23; the wide spider-legs of condenser plates 11 being staggered or offset circumferentially relative to the legs of condenser plates 12. As shown, the pair of top and bottom three-legged metallic end supporting spiders 22 for the set of condenser plates 11 have their legs staggered or offset circumferentially, relative to the legs of a pair of metallic end supporting spiders 37, and relative to the spider-legs of condenser plates 12; and the pair of metallic end supporting spiders 37 for the set of condenser plates 12 have their legs staggered or offset circumferentially relative to the spider-legs of condenser plates 11. Thus, on the basis of the two pairs of end spiders 22 and 37 having their desirable mechanically symmetrical three-legged construction for balanced securing of the condenser plates 11 and 12 in proper electrical relations, each of all said condenser plates is formed with three recesses 16*a* Fig. 2, between their legs, said recesses being spaced from one another circumferentially and the metal tubes 21 and 36 respectively are spaced amply from condenser plates of high potential difference; while the spider legs of the condenser plates, extending between the recesses 16*a* of the plates, provide maximum cooperating condenser surfaces within the over-all limits of the supporting rods 20 and 36 under the desirable condition of end-supporting spiders having at least three legs constituting the above mechanically symmetrical and balanced construction; said maximum facing surface areas of the cooperating condenser plates being provided by the fact that the legs of the condenser plate spiders are substantially twice as wide circumferentially as the plate-recesses 16*a* between them, while said recesses, individually of sufficient circumferential width to provide ample electrical clearance between supporting rods 20 and 36, yet the recesses occupy no more than one-third of the total perifery, so that two-thirds is filled by useful cooperating condenser surfaces in combination with the useful three-legged construction of the end supporting spiders.

The entire assembly may be supported upon the floor or may be insulated therefrom as by placing insulators (not shown) under the lower ends of posts 20. It may be noted that the entire assembly is directly supported by these posts since one set of plates 11 is clamped directly thereto and a second set of plates 12 is supported from insulators 31 which are secured by spiders 22 joining said rods 20.

In the condenser above described a suitable amount of spacing may be provided for preventing dielectric breaking down while a sufficient area of plates is obtained to produce the required capacity. A simplified supporting means whereby one set of plates is directly supported from a pair of insulators reduces the number of points in mechanical contact between the two sets of elements. The plates may be comparatively light since they are hollow and may be readily and cheaply cast in two sections as disclosed in Fig. 3. It is essential, however, to insure a tight mechanical fit between the two sections, which may be effected by machining the parts if necessary. Furthermore, the various surfaces have rounded contours whereby sharp corners are largely eliminated.

As a specific example of a condenser which may be employed in high frequency circuits, a spacing of one half inch between plates has been found satisfactory in a condenser operated on 20,000 volts and capable of passing 60 amperes at a frequency of 1,000,000 cycles corresponding to a 300 meter wave length. These figures are however, given as a matter of illustration only. The high KVA rating is due principally to the low loss resulting from the above described construction.

While certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the forms and details of the device illustrated

and in its operation may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. A two piece condenser plate provided with edge indentations, all edges of the plate including said indentations being rounded and said plate being split substantially mid-way in the plane thereof and provided with perforations to receive supporting rods extending through said plate and means between the outer surfaces of said plate for securing the two portions of the plate together.

2. A two piece condenser plate provided with edge indentations, all edges of the plate including said indentations being rounded and said plate being split substantially mid-way in the plane thereof and provided with perforations to receive supporting rods extending through said plate and means between the outer surfaces of said plate for securing the two portions of the plate together, said securing means comprising tubular rivets within said perforations and thru which said supporting rods may pass.

3. A high voltage air condenser which includes two sets of interleaved hollow spider-shaped condenser plates having at least three relatively staggered hollow legs; two parallel metallic spider-shaped end-supporting spiders one above the other for said respective sets of condenser plates and sustaining the weight thereof, both said end-supporting spiders having their legs staggered relative to one another, the legs of each supporting spider being staggered relative to one of the respective sets of condenser plates; said hollow condenser plates having rounded edges at the sides and periferies of their legs by virtue of their construction including two facing cup-shaped members joined at the cup-rims of which cups the short sides meeting at the cup-rims constitute a continuous rounded external perifery of the hollow condenser-plate, the bottoms of said facing cups being formed with registering bosses; two sets of metallic plate-supporting posts of which each set extends thru the bosses of one set of condenser plates and between the wide legs of the other set of condenser plates and is supported by one of said metallic end-supporting spiders; said condenser plates being connected at their bosses to said supporting posts at portions of the plates radially inward of the rounded periferies of the plates; and a support of compression resisting insulating material between the upper and lower metallic end-supporting spiders taking the weight of the upper spider and the set of condenser plates and supporting posts carried thereby and transferring said weight to the lower end supporting spider.

4. A high voltage air condenser which includes two sets of interleaved metallic plates widely spaced apart to prevent electrical break-down but of large facing areas for high capacity; a pair of parallel metallic supporting members one above the other and both below said plate-sets, parallel thereto and yet more widely spaced apart than said interleaved plates; a set of metallic supporting posts carried by said upper metallic supporting member and themselves carrying one of the sets of interleaved condenser plates; a support of compression-resisting insulating material carried by the lower of said two metallic supporting members and extending across said wide space between the two and sustaining the weight of said upper end-supporting member, of the posts and condenser plates supported thereby; means providing the necessary mechanical strength and light weight of said parts sustained by said insulating support, and providing for reduction of resistance losses and corona discharge, said means including a hollow construction of the condenser plates including two cup-shaped sections of which the rims adjoin one another, and are closely fitted together, the short cup-sides meeting at their rims and constituting a continuous rounded external perifery of the hollow condenser plate; and a second set of metallic supporting posts on which are mounted the second set of interleaved condenser plates and the lower of the two metallic supporting members which carries said insulating support and the parts carried thereby, said second set of supporting posts at their junction with said lower metallic supporting member sustaining the entire weight of the complete condenser including both sets of plates and the insulating support and the parts sustained thereby; the bottoms of the cups of the condenser plates being formed with registering apertures thru which extend the respective sets of supporting posts at portions of the plates radially inward of their rounded periferies.

5. A high voltage air condenser which includes two sets of interleaved condenser plates widely spaced apart to prevent electrical break-down but of large facing areas for high capacity, two pairs of metallic supporting members of which one member of each pair is located above the condenser plates and the other member of each pair is located below the condenser plates; two parallel sets of supporting posts to which respectively the respective sets of condenser plates and pairs of said supporting members are mechanically connected; the two metallic supporting members above the condenser plates being substantially spaced apart and connected respectively to the two sets of supporting posts; means between said two upper metallic supports insulating them from one another; the two metallic supporting members below the condenser plates being electrically spaced apart and connected respectively to the two sets of supporting posts; a support of compression-resisting insulating material between said two lower metallic supporting members, carried by the lower of the two supporting members and itself sustaining the upper one of the two supporting members and sustaining also the weight of the supporting posts and condenser plates carried by the said upper supporting member; and means providing the necessary mechanical strength and desirable light weight for the large-aread condenser plates and metallic supporting members and posts and providing also for reduction of resistance losses and corona discharge, said means including a hollow construction of the plates including two cup-shaped sections of which the rims adjoin one another and are closely fitted together, the sides of the facing cups which adjoin at the rims forming a continuous external rounded perifery of the hollow condenser plate reducing resistance losses and liability to corona discharge; the bottoms of the facing plate-cups being formed with registering apertures thru which extend the respective sets of supporting posts at portions of the plates radially inward of their said rounded periferies.

6. A high voltage air condenser which includes two sets of interleaved condenser plates of large facing areas widely spaced apart to prevent elec-

trical break-down and having wide periferal portions circumferentially spacing apart at least three relatively narrow periferal recesses; a set of supporting posts for each of the two sets of plates; two parallel metallic supports one above the other and respectively carried by said two sets of posts, the upper support carrying the weight of one of said sets of supporting posts and the set of condenser plates thereon; an insulating support of structural compression-resisting material supported on the lower support and sustaining the upper support and sustaining the posts and condenser plates supported thereby; the upper of said two metallic supports being of spider-formation for weight reduction, the ends of the legs of said spider being connected to one of said sets of supporting posts; and means further reducing the load of said set of large-aread condenser plates on said insulating support and providing a mechanically strong structure for such large-aread plates, said means including a hollow construction of the plates including two cup-shaped sections of which the rims adjoin and are closely fitted together reducing resistance losses and liability of corona discharge, and the short sides of said cups meeting at the cup-rims forming a continuous rounded external perifery of the condenser plate constituting a mechanically strong and thick but hollow light weight plate and said rounded perifery also reducing liability to corona discharge; the bottoms of the plate-cups being formed with registering apertures thru which said supporting posts extend at portions of the plates radially inward of the rounded periferies of the plates.

7. A high voltage air condenser which includes a set of at least three metallic supporting posts taking on their lower portions the entire weight of the complete condenser, a metallic supporting spider having at least three legs supported at their outer portions by the lower portions of said posts in symmetrical balanced relation; and two sets of condenser plates respectively supported by said sets of posts and supporting spider in interleaved spaced plate-relation and both of said sets of plates being spaced a substantial distance above said metallic supporting spider; the individual plates being hollow and including two cup-shaped sections of which the rims adjoin and are closely fitted together, the short sides of the cups meeting at their rims forming a continuous rounded surface at the perifery of the hollow condenser plate reducing resistance losses and liability to corona discharge, and said cups being spider-shaped in correspondence with said supporting spider but having periferally wide legs spacing apart a corresponding number of three or more periferal recesses; the wide legs of one of said sets of condenser plates being connected to said posts, the bottoms of the legs of the spider-shaped plate-cups being formed with registering openings thru which extend said posts at portions of the plate legs radially inward of their said rounded periferies; a supporting structure of compression-resisting insulating material mounted on and carried by said supporting spider; a second supporting spider carried by said insulating support and having at least three legs; and a second set of at least three supporting posts carried by said second spider; said second set of condenser plates being carried by said posts in spaced relations all whereby the weight of said second set of condenser plates, posts and second spider is sustained by said insulating support supported on the first spider.

8. A high voltage air condenser which includes a set of at least three metallic supporting posts taking on their lower portions the entire weight of the complete condenser, a metallic support itself connected to and supported by the lower portions of said posts and supported thereby in balanced symmetrical relation; a set of hollow condenser plates electrically connected together by said posts extending parallel to said metallic support and consisting of cup-shaped sections formed at their bottoms with registering apertured bosses receiving said posts the rims of said cups adjoining one another and closely fitted together, the short sides of said cups meeting at the rims forming a continuous rounded perifery of the condenser plate reducing resistance losses and liability to corona discharge; said hollow condenser plates being electrically connected together by said posts at said plate-bosses radially inward from their rounded periferies, the plates being also supported by said posts and so supported in balanced symmetrical relation; a second set of condenser plates similar to said first set and interleaved therewith in high potential spaced relation; a second set of at least three metallic supporting posts extending thru the apertured registering bosses of said second set of condenser plates and electrically connecting them together and supporting them in balanced symmetrical relation; a second metallic support itself connected to said second set of posts in a position parallel to said first metallic support and taking the weight of said second set of posts and condenser plates; and a supporting connection of structural compression-resisting insulating material between said two metallic supports and causing the first support to take the weight of the second support and its set of posts and condenser plates by way of compression stresses on said supporting insulating connection, the connection of said first metallic support with said first set of posts causing the lower ends of the latter to take the weight of all the posts and condenser plates and of both said metallic supports, said lower post-ends projecting below said first metallic support.

9. A high voltage air condenser which includes two sets each of at least three metallic supporting posts, two interleaved sets of hollow condenser plates respectively electrically connected together by connection to said respective sets of posts in balanced symmetrical relations; said hollow condenser plates consisting of two cup-shaped sections formed at the cup-bottoms with registering apertured bosses for the reception of said supporting and connecting posts, the rims of said cups adjoining and closely fitted together, and the short sides of the cups forming a rounded perifery of the hollow condenser plate extending across the adjoining rims of the cups, reducing resistance losses and liability to corona discharge; and means on the respective sets of posts for clamping together the several sectional condenser plates carried by said posts, said clamping means including metallic spacing tubes around the posts and between the successive sectional plate units, and including also threaded pressure-adjusting means on the ends of the posts, said spacing tubes abutting against the apertured bosses of the respective cup-shaped sections of the condenser plate, and said threaded means forcing said tubes and bosses into compressing relations; said bosses at the bottoms of the plate-cups and said clamping spacing tubes bearing against the bosses being located at the hollow portions of the cups at portions thereof radially in-

ward of the rounded periferies of the condenser plates formed by the adjoining rims and short sides of the facing cups.

10. A high voltage air condenser which includes a set of at least three metallic supporting posts taking on their lower portions the entire weight of the complete condenser, a metallic support itself connected to and supported by said posts at their lower portions and supported thereby in balanced symmetrical relation; a set of condenser plates also connected by said supporting posts in spaced high potential relations parallel to said metallic support and to one another, said plates being electrically connected together by said posts and also supported thereby in balanced symmetrical relations; a second set of condenser plates interleaved with said first set; a second set of at least three metallic supporting posts connected to said second set of condenser plates in balanced symmetrical relation and electrically connecting said plates together; a second metallic support itself connected to said second set of posts in a position parallel to said first metallic support, and taking the weight of said second set of posts and condenser plates; and a supporting connection of structural insulating material between said two metallic supports and causing the first support to take the weight of the second support and its set of posts and condenser plates by way of compression stresses on said supporting insulating connection, the connection of said first metallic support with said first set of posts causing the lower portions of the latter to take the weight of all the posts and condenser plates and of both said metallic supports, said weight-taking lower post-portions projecting below said first metallic support.

11. An atmospheric air condenser including two interleaved sets of spider-shaped armature plates arranged one above the other, two pairs of spider-shaped supports for said armatures one of said pairs of supporting spiders being located above and the other below the interleaved armatures; the legs of the spiders of each pair being arranged in staggered relation to one another; the legs of the alternate interleaved spider-armatures being arranged in staggered relation to one another; and the legs of the two supporting spiders which lie nearer the top and bottom of the interleaved armatures being arranged in registering relation with the legs of the armatures respectively nearest to them; and the bottom pair of supporting spiders being separated by a member of compression resisting insulating material sustaining the weight of the upper spider of said bottom pair and of the alternating armatures of which the legs are in registery with said upper spider.

12. A hollow condenser armature which includes a pair of spider-shaped metallic members having wide legs formed as shallow thin-bottomed cups, the tin bottoms of each of the cupped legs of each spider being formed with a plurality of perforations, and with a corresponding plurality of integral annular strengthening bosses on the inside walls of the bottoms constituting continuations of said cup-bottom-perforations; said cupped spiders being arranged together edge to edge, their short cup-sides meeting at the edges and cooperatively constituting a blunt armature perifery, and their respective bottom perforations and bosses being formed in an arrangement for registry with one another when the cups are arranged in said edge-to-edge relation.

13. A hollow condenser armature which includes a pair of wide and shallow metallic cups, the bottom of each cup being formed with a plurality of perforations and one cup at least being formed on the interior wall of its bottom with integral annular bosses constituting continuations of the perforations thru its bottom; said cups being arranged together edge to edge, their short sides meeting at their edges cooperatively constituting a blunt armature perifery, and their respective bottom perforations being formed in an arrangement for registry with one another and with said annular bosses when the cups are arranged in said edge-meeting relation.

14. A hollow condenser armature which includes a pair of spider-shaped metallic members having wide legs of shallow cup formation, the bottom of each cup being formed with a plurality of perforations, and the spider-members being arranged edge to edge and their short sides meeting at their edges constituting a blunt armature perifery; said bottom perforations thru the spider-cups being formed in an arrangement for registry with one another when the cups are arranged in said edge-meeting relation.

15. A hollow condenser armature which includes a pair of wide and shallow metallic cups each formed with a plurality of perforations and said cups being arranged edge to edge, their short sides meeting at their edges cooperatively constituting a blunt armature perifery, and their perforations being formed in an arrangement for registry with one another when the cups are arranged in said edge-meeting relation.

16. An element of a hollow condenser armature which consists of a wide-legged metallic spider, the wide legs being formed as shallow thin-bottom cups, and the bottom of each cupped leg being formed with a perforation and with a strengthening boss for the thin metal bottom.

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