July 18, 1933. G. W. PICKARD 1,918,825

EXTREME LOADING CONDENSER

Original Filed Dec. 9, 1922 3 Sheets-Sheet 1

Fig. 1.

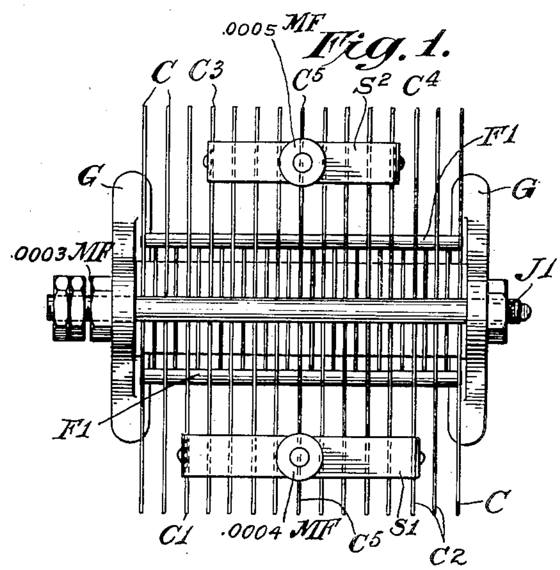

Fig. 2.

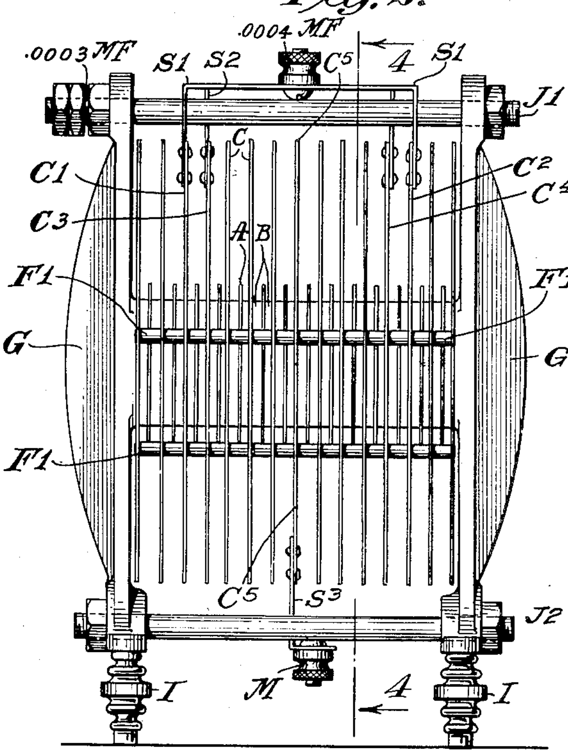

Fig. 3.

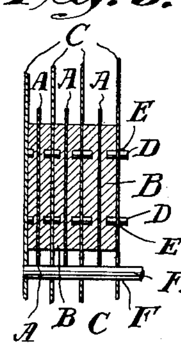

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Fig. 4.

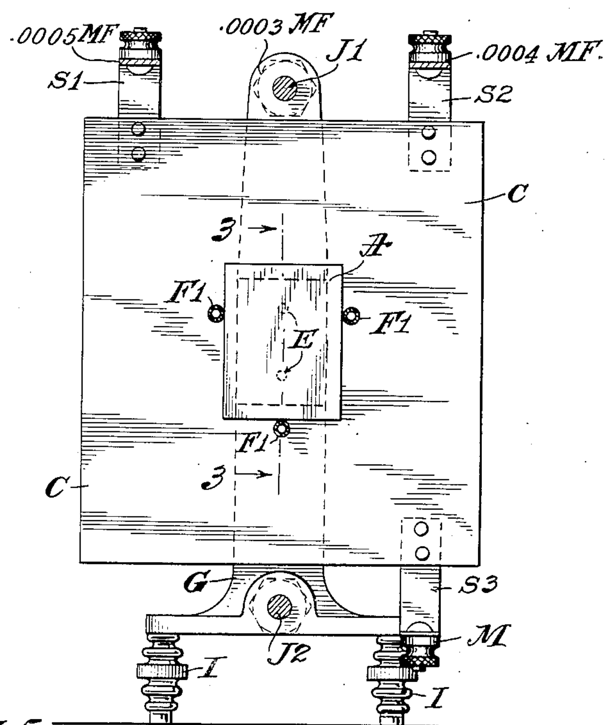

Fig. 5.

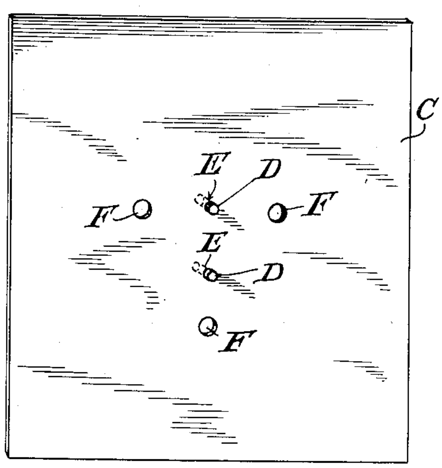

Fig. 6.

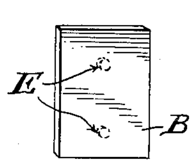

Fig. 7.

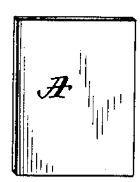

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Fig. 8.

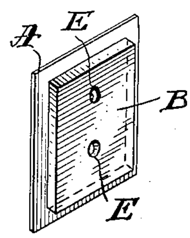


Fig. 10.

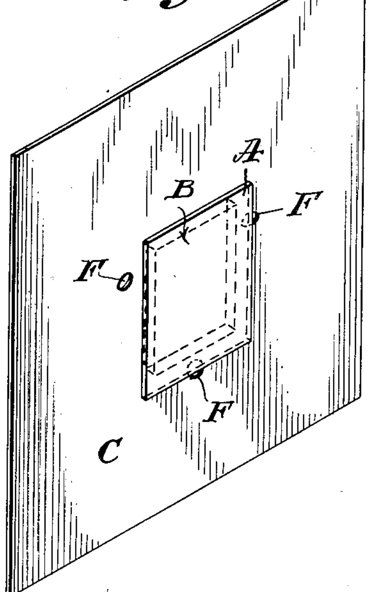


Fig. 9.

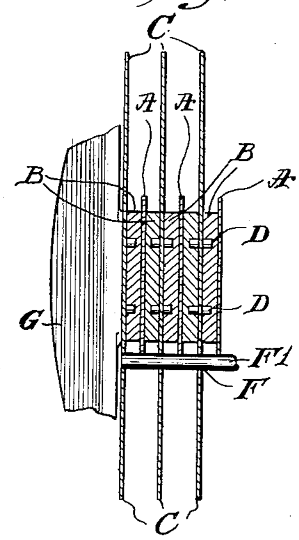


Fig. 11.

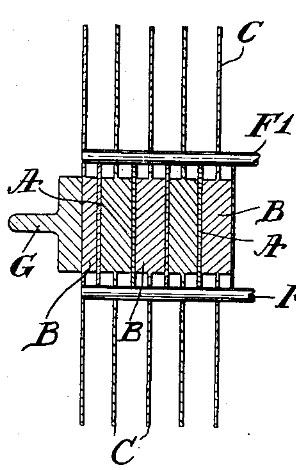
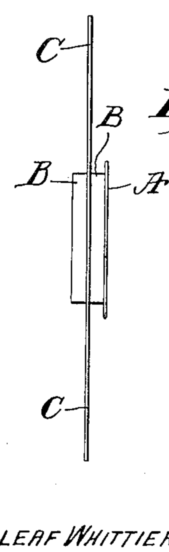


Fig. 12.



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UNITED STATES PATENT OFFICE

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EXTREME LOADING CONDENSER

Application filed December 9, 1922, Serial No. 605,794. Renewed November 8, 1924.

This invention relates to improvements in electrical condensers.

The object of the invention is to provide a condenser wherein the structure may be subjected to extreme current loading without undue heating, and whereby also economy is effected in the quantity of dielectric material employed in the construction.

The invention consists of the features hereinafter described in connection with the drawings, of which Figs. 1—7 show one form, Figs. 8 and 9 a modification, and Figs. 10—12 another modification.

As to the form shown in Figs. 1—7,

Figure 1 is a top plan;

Fig. 2 a front elevation;

Fig. 3 a fragmentary section on the line 3—3 of Fig. 4;

Fig. 4 is a vertical transverse section on line 4—4 of Fig. 2; and

Figs. 5—7 are separate perspective views of three elements of this condenser, Fig. 5 showing one of the radiator plates C, Fig. 6 a metal plate B of one of the sections, and Fig. 7 showing a dielectric plate A, as mica, of one of the sections.

As shown in Figs. 2 and 3, each section preferably comprises a single mica sheet A (Fig. 7) having a metallic plate B (Fig. 6) on each of its two faces. Also in the assembly there is a metallic heat-dissipator vane or plate C between each two successive sections. These members C preferably and in the form shown extend in the assembly from the outer faces of plates B a substantial distance outwardly beyond the edges of mica sheets A, the latter extending somewhat beyond the edges of metal sheets B.

As shown in Fig. 2, where the complete condenser stack consists of fourteen sections as shown, there are shown fifteen heat-dissipators C, the extra one being located at the end of the stack of sections so that if desired there may be members C at both ends of the stack.

As shown in Fig. 2, a sufficient number of sections comprising the single mica sheets A are placed in the form of a stack to withstand the breakdown potentials which will be applied to the complete condenser. In the form shown, a terminal M is taken from a midpoint of the condenser to constitute a high potential terminal, and there are seven condenser sections on opposite sides of the radiator vane C5 (to which vane said terminal M is connected by conducting strip S3), making fourteen sections in all. The metal plates C constitute thermal radiators, via metal stack sheets B, the latter being directly in heat-absorbing relation with each side of each sheet of mica A in the condenser. The condenser shown is designed to carry ten amperes at 1,500,000 cycles, representing an oscillating load of 30 kva. The surge potentials on this unit will be approximately 9,000 volts maximum. Test of this unit showed its losses to be approximately fifteen watts, indicating an efficiency of 99.95 per cent. In the preferred form of the invention, and in the particular design shown, there are fourteen sheets of mica in the entire condenser, as contrasted with designs heretofore for the same service which would require 350 sheets of mica.

The operation of this condenser is as follows. The losses in a dielectric (as mica sheets A) increase with extreme rapidity upon temperature increases, and in operation, of course, considerable heat is developed in the mica sheets. The losses in a condenser are, therefore, a direct function of the mean temperature of the active mica sheets under working conditions; and if the temperature of the dielectric sheets can be kept low, the condenser losses will be low. In this condenser, the thermal path consists (1) of mica of the area of the active dielectric and having a thickness of approximately one mil, (2) a metal stack plate B, and (3) the metal heat-radiating vanes C. By thus providing adequate thermal absorbers and radiators for both sides of each sheet of mica A, the best possible thermal conditions are realized, and the working temperature of the dielectric can be maintained at a low value, and therefore the losses in the condenser are kept very low. This is of great practical importance because it avoids injury to and possible destruction of the dielectric by high heating thereof due to the accumulation of the heat developed by high current. This principle of construction is contrasted with the usual form of high potential condenser, wherein the thermal path consists chiefly of a stack of mica dielectrics, and metal foil or armature elements of an area equal to the active area of the dielectric but with a thickness of both dielectrics and armatures equal to the length of the stack; and although the thermal conductivity is increased by the looped path of the foils (including the connections between series sections as in a high potential condenser), yet the thermal conductivity is very low and the high thermal gradient existing in the stack will limit the mean temperature at which the stack can be operated to approximately forty degree centigrade under conditions when the stack is surrounded in wax and the wax is to be maintained solid throughout. In other words, such usual condenser can be loaded only until the central mica sheet midway of the stack reaches a temperature of approximately fifty-six degree centigrade, representing a temperature rise of the metallic enclosing casing of wax-embedded condenser stack, of the order of ten degrees centigrade. Such condenser must be provided with sufficient mica to ensure this condition, (according to prior belief and practice), and the mica necessary is about 350 sheets to parallel the operation of a condenser like that shown in Figs. 1—7, thereby distributing the electrical load and resultant heating over a large number of dielectric sheets.

In this improved condenser all the mica sheets throughout are kept at the same temperature, and this temperature can be placed at any desired value merely by altering the size of the cooling vanes, or the method of cooling the vanes, as, for example, by providing for oil-immersion, air-blasting, etc. For example, in the higher-powered condensers employing the invention, the size of cooling vanes C may be reduced, as compared with that shown in Figs. 1–7, if the condenser is immersed in a cooling tank. But irrespective of the size of the vanes C or the method of cooling, the invention hereof results in a saving of approximately one-half to three-quarters of the mica normally used in condensers of the same performance.

As shown, and regardless of the number of dielectric sheets in each section, the exterior heat-dissipating surfaces of metal members C not only (1) possess an aggregate area which is enormous as compared with the aggregate area of the dielectrics which is exposed from the condenser, but also (2) such very large-aread metal dissipating members are connected metallically and therefore thermally, and via the active armatures B themselves, with both surfaces of every dielectric sheet (in the best form of the invention) said metallic connections being direct (altho via the armatures) in the sense that each heat path starts from the surface of an active dielectric inside the condenser (which dielectric is clamped, as hereinafter described, so as to be in good thermal surface contact with the active armatures) and extends directly via an active armature itself to the very large exposed exterior surfaces of the metal members, without first extending to other armatures in thermal contact with the surfaces of other dielectrics before reaching the ultimate exterior surfaces. The new and useful result, in connection with the very large exposed exterior surfaces, is that the active armatures themselves are employed as part of the heat dissipating means, and preferably all of the armatures in the entire condenser, thereby permitting, without undue heating, the application to the condenser terminals of really very large currents, i. e., a considerable number of amperes. Hence it is practicable to employ as many dielectrics and armatures in each section or unit as may be suitable for a given desired capacity (i. e., to have each section very thick if desired), because each active armature in the section as a part of the heat-dissipating means, is located directly against and in good thermal surface contact with the dielectric heated by the high current; and the effect of the direct connection of the armatures to the large-areaed exterior metal members is to place on the electrostatically active portion of each armature the duty of conducting heat away only from the dielectric material with the surface of which it is in direct thermal contact. The direct metallic connection of the large-areaed metal members with the active armature of opposite polarity causes such members for each section of the condenser to serve as the terminals of the sections or units and also, when the invention is embodied in a high potential series sectional condenser, as shown, such metal members constitute the means connecting the successive sections in series with one another. The metal heat-dissipating members here serving as condenser terminals of opposite polarity, are spaced from one another in some such way, as illustrated by way of example, that they are electrically isolated from one another by an insulator such as air or oil which is the agency which acts as a cooling convection fluid to carry off the heat from the large exposed surfaces exterior of the condenser.

The assembly of elements A, C, B of Figs. 5–7 is shown in detail in Figs. 1–4. Fig. 3 shows the simple assembly of the three elements of Figs. 7, 6 and 5 respectively, each mica sheet A having a metal condenser plate B on each of its two surfaces, and the opposite surface of each metal plate B facing against a single heat-conducting vane C to which each member B is pinned by the two pins D of Fig. 5 in holes E (Fig. 6); and the mica sheets A being supported in place by bakelite rods F1 (one of which is shown in Fig. 3) extending through holes F in vanes C. (See also Figs. 4 and 5.)

The entire condenser preferably is supported on four insulating legs I connected to the low potential clamping means G, with the view of separating the high potential parts of the structure, (including terminal M) from the bench on which the condenser is placed. (Figs. 2 and 4.) The entire stack, consisting of the three elements of Figs. 5, 6 and 7 is clamped at its ends (Figs. 1–2) by a clamp G, which is shaped to bear against the ends of the stack (Fig. 2), and extends beyond vanes C (Fig. 4) where it is connected at top and bottom by clamping rods J1, J2.

The arrangements for taking off circuit connections are shown in Figs. 1, 2 and 4, the clamp G and clamping rods J1, J2 being of metal and the opposite ends of the stack being of the same potential; the high potential condenser terminal being at binding post M (bottom Figs. 2 and 4) mounted on a conducting strip S3 supported by and in electrical connection with a vane C5 at a midpoint of the stack; the other end of the circuit, including the capacity of the entire condenser, being at any portion of the clamping plates G or clamping rods J1, J2, and the entire capacity being .0003 mf. as indicated at the upper left of Fig. 2 and the top of Fig. 4. For other values of capacity than that of the complete condenser, the vanes C lend themselves as a convenient means for taking off circuit connections. For example, in Fig. 1, a conducting strip S2 is mounted on and in electrical connection with vanes C3, C4, and the binding post mounted on this strip, when connected in circuit with binding post M at the bottom of the structure, will give a capacity of .0005 mf. as noted on the drawings. This connection includes the central eight sections of the condenser, the four on one side of central vane C5 being in parallel with the four on the other side of vane C5. Again, conducting strip S1 in Fig. 1 is mounted on and in electrical connection with vanes C1, C2, and when one lead of the condenser is connected to the midpoint (Fig. 2) connection from central vane C5 to the binding post M, then connection to the binding post on strip S1 will give .0004 mf. as marked. When a condenser connection is taken off the clamping means to give the .0003 mf. capacity, the central ten sections of the condenser are in circuit, the five at the left of central vane C5 being in parallel with the five on the other side of vane C5.

In Fig. 1 (plan), two top bakelite rods F1 appear, which extend (Fig. 5) through the holes F in vane C to support mica sheets A of Fig. 7. In Fig. 2 appears one of the two upper bakelite rods F1 extending through holes F (Fig. 5) in vanes C; and in Fig. 2 also appears the third or lower rod F1 fitting in the lower hole F of plate C. In Fig. 3 (section), only the lower rod F1 appears. In Figs. 1 and 2, the pins D which hold the condenser plates B to vane C do not appear, being hidden inside the stack.

The clamping means of Figs. 1, 2 and 4 maintains parts A, B and C in good heat-conducting relation with one another. In manufacture, before the clamp is tightened, the entire structure may be impregnated in paraffin wax under a vacuum. It is then placed under an arbor press by which high pressure is applied, and the clamping bolts J1, J2 are tightened, with the particular object and result of placing condenser plates B in intimate heat-conducting relation with mica sheets A from which the heat is to be conducted via plates B to extended vanes C. As above indicated, in lieu of wax impregnation, the structure may be immersed in oil for cooling, or the space between vanes C may be left open and subjected to air blast. The clamping means constitutes the low potential connection for the entire stack of fourteen sections shown.

In Figs. 8 and 9 is illustrated a form of combining elements B and A of Figs. 6 and 7 which apparently is similar to that above but is additional thereto as to the object of securing intimate heat-conducting relation between B and A in that the metal plates B are cast to the surfaces of mica sheets A. Metal plates B may be of type metal, as lead and antimony. The effect of this casting, as indicated by a subsequent separation of plate B from mica A, is that the mica adheres to the metal, so that when the surface of the metal is scraped with a knife, a thin film of mica is removed. When, in addition to this casting process, the conducting surfaces of plates B are very substantially increased by extension of vanes C, the most useful results are attained; and, although the casting process is not necessary to the successful operation of the condenser of Figs. 1—7, it may be used therein.

In Figs. 10—12, is shown a modification where the intimate contact plates B of Figs. 1—7 are formed integral with vanes C, dispensing with pins D (Fig. 5) for holding plates B and vanes C together. Fig. 10 is a perspective of this, Fig. 11 is a fragmentary horizontal section of the condenser stack, showing a succession of the combinations of Fig. 10, and Fig. 12 is a side view of a combination with a mica sheet A of the composite B, C structure of Fig. 10. Fig. 11 shows this best, where two successive plates B of Fig. 3 are formed integral with one another and with a vane C extending radially therefrom, instead of the two plates B being pinned to opposite sides of vane C as in Fig. 3; all so that here structurally, as in any case electrically, the portions of the vanes or heat-dissipating members within the stack, act as electrostatically active armatures and project out from the stack directly to the large heat-dissipating surfaces; or rather from a different point of view that the active armatures are parts of the metal heat paths which extend from the surfaces of the dielectrics inside the condenser to the large exposed surfaces outside the condenser.

In any instance, the most effective form of the invention is wherein there is only a single mica sheet A in each section of the condenser, i. e., where a thermal radiator B, C is provided on each side of each individual mica sheet. However, the invention may be embodied in less advantageous forms where each condenser section may comprise more than one dielectric sheet.

In this invention, there are no electrical losses in the condenser, because the field is entirely through the active dielectric of the condenser or through air, i. e., the field is through materials introducing no appreciable loss when stressed by the electrical field.

The metal plates B are of the order of thickness of about one-eighth inch, thereby serving not merely as the electrically conducting plates of the condenser and as heat conductors, but as separators between successive cooling vanes C; so that said vanes are maintained a sufficient distance apart to prevent breakdown of the air or other cooling fluid between them. Such separation is desirable because the cooling means between the vanes has in general considerably lower dielectric strength than that of the dielectric sheets of the condenser. The extent of separation of vanes C from one another (and therefore the thickness of armatures B and the separation between thin dielectric sheets A) will be dependent upon the voltage applied and the cooling means used; and in any event such separation will be greater than the thickness of the then dielectric sheets themselves.

The prevention of accumulation of heat in this invention is productive of various useful results involving the prevention of breakdowns and increased permissive electrical loading, among which are the important ones of (1) increasing the efficiency of operation, and (2) economy by requiring less mica. Also the saving of cost of mica is so great that it is practicable to employ the highest grade of mica, and to so rigidly inspect the individual mica sheets as to greatly reduce the possibility of failure of the sheets in operation due to physical defects. Of course, such selection of dielectric sheets reacts again to produce better electrical operation, involving lower losses, higher breakdown points, and increased permissive electric loading.

I claim:—

1. An extreme loading electrical condenser which comprises a plurality of sections each of which consists of a single dielectric sheet having metallic sheets adjacent its two faces, and metallic vanes extending from the metallic sheets a substantial distance beyond the edges of the dielectric sheets, the successive vanes being electrically isolated from one another, and having a sufficiently rigid construction to support themselves in spaced-apart relation to one another.

2. An extreme loading electrical condenser which comprises a plurality of condenser sections and metallic vanes in heat-conducting relation with the metallic elements of said sections and extending substantial distances beyond the dielectric sheets of said sections to convey heat from the dielectric sheets, said vanes having a sufficiently rigid construction to support themselves in spaced-apart relation to one another.

3. An extreme loading electrical condenser which comprises a plurality of sections each comprising a single dielectric sheet and thermal conductors in direct contact with the opposite sides of each dielectric sheet and extending a substantial distance beyond the edges of the dielectric sheet, said thermal conductors constituting the conducting elements of the condenser sections, and their extending portions having a sufficiently rigid construction to support themselves in spaced-apart relation to one another.

4. An extreme loading electrical condenser which comprises a stack of conducting and dielectric sheets, thermally conducting vanes extending from the conducting sheets a substantial distance beyond the edges of the dielectric sheets and having a sufficiently rigid construction to support themselves in spaced-apart relation to one another, and insulating rods extending through the several extending vanes along the edges of the dielectric condenser sheets, and supporting the latter in the form of a stack.

5. An extreme loading electrical condenser which comprises a plurality of dielectric sheets, and thermal conductors on the opposite faces of each sheet and consisting of the metal condenser plates and thermally-conducting vanes extending from said plates in all radial directions to substantial distances beyond the edges of the dielectric sheets.

6. An extreme loading electrical condenser which comprises a stack of conducting and dielectric sheets, and thermally conducting vanes extending from the conducting sheets substantial distances in spaced-apart relation to one another beyond the edges of the dielectric sheets, said vanes and conducting sheets being held together in the stack and the dielectric sheets being held in the stack

by insulating rods extending through the successive vanes.

7. An extreme loading electrical condenser which comprises a plurality of condenser sections consisting of dielectric and conducting sheets, and metal vanes extending from the conducting sheets substantial distances, said elements being arranged in the form of a stack; clamping plates constructed and arranged to bear against the ends of the stack and extending beyond the heat-conducting vanes; and clamping rods located beyond said vanes and connecting the clamping plates.

8. An extreme loading electrical condenser which comprises a plurality of condenser sections of dielectric and conducting sheets arranged in a stack, and metal vanes extending from the conducting sheets substantial distances, a conducting strip constituting a condenser terminal and connected to one of the extended vanes midway of the stack; and a second conducting strip constituting a second condenser terminal and connected to two of the extended vanes located on opposite sides of said midway vane.

9. An extreme loading electrical condenser which comprises a plurality of condenser sections consisting of dielectric and conducting sheets arranged in a stack, and metal vanes extending from the conducting sheets substantial distances; metallic clamping plates constructed and arranged to bear against the ends of the stack and extending beyond the heat-conducting vanes; metallic clamping rods located beyond said vanes and connecting the clamping plates electrically and mechanically; and a conducting strip constituting a condenser terminal and connected to one of the extended vanes midway of the stack.

10. An extreme loading electrical condenser which comprises a stack of dielectric sheets of mica and the like and having condenser plates cast to the dielectric sheets to be in intimate heat-conducting relation therewith; said metallic plates having thermally conducting extensions projecting substantial distances beyond the stack; and means for clamping said plates and sheets together to maintain said intimate relation.

11. A condenser of the stack-plate type comprising a plurality of sections of dielectric and conducting elements arranged in a stack, each section including a single dielectric unit between the successive conducting elements of the stack, the conducting elements lying in the stack in intimate contact with the opposite surfaces of said dielectric unit; the dielectric units projecting in all radial directions beyond said metal plates to constitute margins of the dielectric elements beyond the conducting elements; clamping means for maintaining such intimate contact between the dielectric units and conducting elements in the stack; and a plurality of metal heat-dissipating vanes in heat-conducting relation with said respective conducting elements and extending laterally from the stack beyond the dielectric units, said metal vanes extending in spaced-apart relation to one another to substantial distances beyond the stack to effect dissipation of heat therefrom.

12. A condenser of the stack sheet type comprising a stack consisting of a plurality of dielectric units; conducting condenser elements contacting intimately with the two opposite surfaces of each dielectric unit, the dielectric units projecting in all radial directions beyond the conducting elements; and metal heat-dissipating vanes extending outwardly from the stack substantial distances beyond the dielectric units from points of the conducting elements intermediate the dielectric units; said vanes extending in spaced-apart relation from and between successive dielectric units, and in spaced-apart relation from one another beyond the dielectric units.

13. A condenser of the stack sheet type comprising a stack of dielectric and conducting elements, the dielectric units having larger area than the conducting units and arranged relatively to the latter in the stack to form a margin of dielectric material; and means for dissipating heat from said stack consisting of a plurality of metal vanes extending outwardly from the stack, in heat-conducting relation to the conducting stack elements, projecting in spaced-apart relation to said dielectric margins and in spaced-apart relation to one another beyond the dielectric stack elements, and projecting substantial distances from the conducting stack elements.

14. A condenser of the stack sheet type comprising a stack of dielectric and conducting elements, in combination with a plurality of metal vanes extending outwardly from the stack, in heat-conducting and in electrically conducting relation with the conducting stack elements, said vanes extending substantial distances beyond the conducting stack elements and in spaced-apart and electrically isolated relation to one another; a condenser terminal connected to an intermediate vane; and two other condenser terminals connected respectively to two vanes lying beyond and on opposite sides of said intermediate vane.

15. A condenser of the stack sheet type comprising a stack of dielectric and conducting elements, in combination with a plurality of metal vanes extending outwardly from the stack, in heat-conducting and in electrically conducting relation with the conducting stack elements, said vanes extending substantial distances beyond the conducting stack elements and in spaced-apart and electrically isolated relation to one another; the two terminals of the condenser being connected

to a corresponding number of said spaced-apart and electrically isolated vanes.

16. A condenser of the stack sheet type comprising a stack of sheets of mica and metal, and means for dissipating heat from said stack consisting of a plurality of metal vanes extending outwardly from the stack, each vane extending from between two successive mica condenser units and in heat-conducting relation with the metal between said pair of mica units; said metal vanes being in spaced-apart relation to one another beyond the stack to dissipate the heat conducted by them form the stack.

17. A condenser of the stack sheet type comprising a stack of dielectric and conducting elements, and means for dissipating heat from the stack consisting of a plurality of metal vanes extending outwardly from the stack, in heat-conducting relation to the conducting stack elements, said vanes extending substantial distances beyond the conducting stack elements and in spaced-apart relation to one another to dissipate the heat conducted by them away from the stack from the conducting elements thereof.

18. A condenser of the sheet stack type including a stack consisting of a dielectric element and conducting elements of which one contacts with a face of the dielectric element; and means for dissipating heat from the stack consisting of a metal vane extending outwardly from the stack, in heat-conducting relation with one of said conducting stack elements and electrically insulated from the other conducting stack element; said vane projecting a substantial distance into a space occupied by a heat-dissipating medium.

19. A high potential electrical condenser comprising at least two sections electrically connected in series, at least one metal member extending between such two sections; and at least two metal members lying outside of such two sections and against the outer end faces thereof; said intermediate and end metal members having surfaces exposed from such sections which exposed surfaces have very much larger area than the exposed area of the active dielectrics of such two sections; and means compressing such sections between said end metal members bringing the active armatures into good thermal surface contact with the active dielectrics; said metal members being in good metallic thermal and electrical connection with the active armatures of opposite polarity in such two sections, whereby the metal members serve as terminals of the sections and as the means connecting the sections in series, and whereby there are provided a multiplicity of heat-paths from the surfaces of the active dielectrics of both sections to the large exposed area of said metal members.

20. A unit section of a high potential high current condenser which section comprises active armatures of opposite polarity on opposite faces of active dielectric material, and two metal members extending over the end faces of the section and having surfaces exposed from the interior of the section which surfaces have an area very much larger than the exposed surfaces of the active dielectric material; said large-areaed metal members respectively being in good metallic thermal and electrical connection with the armatures of opposite polarity in the unit, thereby constituting the metal members as the electrical terminals of the unit; and means forcing said metal members toward one another bringing the active armatures in good thermal surface contact with the active dielectric; all thereby providing heat paths from the surfaces of the active dielectric material inside the sections to the exterior large exposed area of the metal terminals.

21. A solid dielectric electrical condenser including stiff metal vanes connected to the armatures and projecting outside the condenser beyond the dielectric, said vanes being separated from one another by a distance greater than the thickness of the solid dielectric.

22. In a high current electrostatic condenser, the combination with the armatures and dielectrics suitable for the desired capacity at the high current applied, of metallic means for removing from the condenser dielectrics the heat developed therein by the high current, said means consisting of metallic extensions of the armatures to positions outside the electrostatically active area of the condenser elements and substantially beyond the dielectrics thereof, said extensions projecting from a substantial proportion of the armatures, having a substantial total cross-sectional dimension for high heat conductivity, and having substantial heat-dissipating areas exposed beyond the condenser dielectrics.

23. An electrostatic stack condenser having a plurality of serially connected sections for high potential service and provided with metallic dissipating means for heat developed by applied high current, said dissipating means having for those purposes the following novel characteristics: the series connection consisting of a metal armature extension projecting out of the stack to a substantial distance beyond the stack, for the purpose of providing surfaces exposed from the stack to a desired cooling medium, which surfaces are substantial relative to the high current applied; and a skeleton clamping device extending metallically from end to end of the stack and arranged to exert compression on the two stack ends; said clamping device contituting one circuit terminal of the condenser; and said projecting armature-extension and series connection constituting the oppositely poled circuit terminal of the condenser.

24. An electrostatic condenser provided with metallic dissipating means for heat developed in the interior dielectric by high currents, such means consisting of metallic extensions from armatures of the condenser which are in intimate thermal contact with surfaces of the dielectric inside the condenser, said extensions having a total heat-dissipating surface exposed from the interior of the condenser which is enormous as compared with the surface area of the portion of the condenser dielectric which is exposed from the interior of the condenser; and said extensions having a substantial total cross-sectional area of heat conductivity between the armatures and their own exposed surfaces.

25. An extreme loading electrical condenser stack comprising dielectric sheets and contiguous metal members on opposite sides of each dielectric sheet the metal members being provided with heat conducting metal vanes each extending beyond the edges of the adjacent dielectric sheets, said vanes being spaced and arranged to be of differing electric potential.

26. An extreme loading electrical condenser stack comprising dielectric sheets and contiguous metal members on opposite sides of each dielectric sheet the metal members being provided with heat conducting metal vanes each extending beyond the edges of the adjacent dielectric sheets and spaced from the edges of said dielectric sheets by an insulating material different from the material of which the dielectric sheets are constituted, said last mentioned insulating material being adapted to withdraw heat from said vanes.

27. An electrical condenser which includes a plurality of sections each including at least one flat dielectric and at least two cooperating flat armatures, said sections being arranged end to end in a stack, and the greater number of the armature elements of the sections being electrically isolated from but electrostatically connected to the terminals of the condenser, in combination with metallic heat-conducting plates also included in the stack in locations between adjacent ends of said sections and spaced apart by said sections and in intimate heat-conducting relations therewith and conducting heat away from the elements of the sections.

28. An electrical condenser which includes a plurality of sections each including at least one flat dielectric and at least two cooperating flat armatures, said sections being arranged end to end in a stack, and the greater number of the armature elements of the sections being electrically isolated from but electrostatically connected to the terminals of the condenser, in combination with metallic heat-conducting plates also included in the stack in locations between adjacent ends of said sections and spaced apart by said sections and in intimate heat-conducting relations therewith and conducting heat away from the elements of the sections; said heat-conducting plates being provided with heat-conducting parts extending outside the stack and conducting heat away from said sections thereof.

29. An electrical condenser which includes a plurality of sections each including at least one flat dielectric and at least two cooperating flat armatures, said sections being arranged end to end in a stack, and the greater number of the armature elements of the sections being electrically isolated from but electrostatically connected to the terminals of the condenser, in combination with metallic heat-conducting plates also included in the stack in locations between adjacent ends of said sections and spaced apart by said sections and in intimate heat-conducting relations therewith and conducting heat away from the elements of the sections; terminals for the condenser; and electrically conducting connections between said terminals and a plurality of said heat-conducting plates, said connections conducting heat away from said heat-conducting plates.

30. An electrical condenser which includes a plurality of sections each including at least one flat dielectric and at least two cooperating flat armatures, said sections being arranged end to end in a stack, and the greater number of the armature elements of the sections being electrically isolated from but electrostatically connected to the terminals of the condenser, in combination with metallic heat-conducting plates also included in the stack in locations between adjacent ends of said sections and spaced apart by said sections and in intimate heat-conducting relations therewith and conducting heat away from the elements of the sections; said heat-conducting plates being provided with heat-conducting parts extending outside the stack and conducting heat away from said sections thereof, and said heat-conducting plates being connected conductively with the flat end armatures of said sections.

31. An electrical condenser which includes a plurality of sections each including at least one flat dielectric and at least two cooperating flat armatures, said sections being arranged end to end in a stack, and the greater number of the armature elements of the sections being electrically isolated from but electrostatically connected to the terminals of the condenser, in combination with metallic heat-conducting plates also included in the stack in locations between adjacent ends of said sections and spaced apart by said sections and in intimate heat-conducting relations therewith and conducting heat away from the elements of the sections; and a terminal-lead extending from a mid-point of said stack intermediate its ends; and metallic elements of a clamping system applied to the ends of the stack and

constituting terminal means of potential opposite that of said mid-point lead; said clamping system compressing said sections and heat-conducting plates together face to face under high pressure in intimate heat-conducting relation.

32. An electrical condenser which includes a plurality of sections each including at least one flat dielectric and at least two cooperating flat armatures, said sections being arranged end to end in a stack, and the greater number of the armature elements of the sections being isolated from the terminals of the condenser, in combination with metallic heat-conducting plates also included in the stack in locations between adjacent ends of said sections and in intimate heat-conducting relations therewith and conducting heat away from the elements of the sections; terminals for the condenser; and electrically conducting connections between said terminals and a plurality of said heat-conducting plates, said connections conducting heat away from said heat-conducting plates; and metallic elements of a clamping system applied to the ends of said stack and compressing said sections and heat-conducting plates together, face to face under high pressure in intimate heat-conducting relation.

33. An electrical condenser which includes a plurality of sections each including at least one flat dielectric and at least two cooperating flat armatures, said sections being arranged end to end in a stack, and the greater number of the armature elements of the sections being electrically isolated from but electrostatically connected to the terminals of the condenser, in combination with metallic heat-conducting plates also included in the stack in locations between adjacent ends of said sections and spaced apart by said sections and in intimate heat-conducting relations therewith and conducting heat away from the elements of the sections, and metallic elements of a clamping system applied to the ends of said stack and compressing said sections and heat-conducting plates together face to face under high pressure in intimate heat-conducting relations.

34. An electrical condenser which includes a plurality of sections each including at least one flat dielectric and at least two cooperating flat armatures, said sections being arranged end to end in a stack, and the greater number of the armature elements of the sections being electrically isolated from but electrostatically connected to the terminals of the condenser, in combination with metallic heat-conducting plates also included in the stack in locations between adjacent ends of said sections and spaced apart by said sections and in intimate heat-conducting relations therewith and conducting heat away from the elements of the sections; some of said heat-conducting plates in the stack being electrically isolated from the terminals of the condenser and others of them having electrical connections to the terminals which connections also conduct heat away from said plates and therefore to the outside of said stack.

35. An electrical condenser which includes a plurality of sections each including at least one flat dielectric and at least two cooperating flat armatures, said sections being arranged end to end in a stack, and the greater number of the armature elements of the sections being electrically isolated from but electrostatically connected to the terminals of the condenser, in combination with metallic heat-conducting plates also included in the stack in locations between adjacent ends of said sections and spaced apart by said sections and in intimate heat-conducting relations therewith and conducting heat away from the elements of the sections; some of said heat-conducting plates in the stack also being electrically isolated from the terminals of the condenser and others of them having substantial rigidity extending outside the stack and electrically connected to the terminals and also conducting heat away from the sections.

36. An electrical condenser which includes a plurality of sections each including at least one flat dielectric and at least two cooperating flat armatures, said sections being arranged end to end in a stack, and the greater number of the armature elements of the sections being electrically isolated from but electrostatically connected to the terminals of condenser, in combination with metallic heat-conducting plates also included in the stack in locations between adjacent ends of said sections and spaced apart by said sections and in intimate heat-conducting relations therewith and conducting heat away from the elements of the sections; a plurality of said heat-conducting plates also being electrically isolated from the condenser terminals.

37. An electrical condenser which includes a plurality of sections each including at least one flat dielectric and at least two cooperating flat armatures, said sections being arranged end to end in a stack, in combination with metallic heat-conducting plates also included in the stack in locations between adjacent ends of said sections and spaced apart by said sections and in intimate heat-conducting relations therewith and conducting heat away from the elements of the sections, and a plurality of said metallic plates being electrically isolated from the terminals of the condenser.

38. An electrical condenser which includes a stack of a plurality of flat condenser elements of which the greater number of the armatures are electrically isolated from but electrostatically connected to the condenser terminals, in combination with a plurality of metallic plates also included in said stack in locations dividing the stack into a plurality

of sections of which each includes at least one flat dielectric and two flat cooperating armatures, said plates being located face to face in intimate heat-conducting relation with the isolated armatures at the ends of the sections and spaced apart by said sections and conducting heat away from the dielectric and armature elements of the sections; and most of said heat-conducting plates also being electrically isolated from the condenser terminals.

39. An electrical condenser which includes a stack of a plurality of flat condenser elements of which a plurality of armatures including between them at least one dielectric element, each includes metallic material of substantial thickness and rigidity included in the stack in intimate heat-conducting relation therewith and extending outside the stack and there spaced apart from one another and conducting heat from interior to exterior of the stack; and the greater number of the armatures in the stack being electrically isolated from but electrostatically connected to the terminals of the condenser.

40. An electrical condenser which includes a plurality of flat condenser elements of which the greater number of the armatures are electrically isolated from but electrostatically connected to the terminals of the condenser, in combination with a plurality of metallic plates also included in said stack in locations dividing the stack into a plurality of sections each of which includes at least one dielectric and at least two cooperating armatures, said metallic plates being in intimate heat-conducting relations with the end armatures of the sections and spaced apart by the sections and conducting heat away from the elements of the sections; and clamping means applied to the ends of said stack and maintaining intimate surface contact between the elements of the sections and between said heat-conducting plates and said end armatures of the sections.

41. An electrical condenser which includes a stack of a plurality of flat condenser elements of which the greater number of the armatures are electrically isolated from but electrostatically connected to the terminals of the condenser; a plurality of metallic plates also included in said stack in positions dividing the stack into a plurality of sections and spaced apart thereby each including at least one dielectric and at least two cooperating armatures; clamping means having substantial exteriorly exposed metallic heat-dissipating members applied to the ends of the stack subjecting the same to high mechanical pressure maintaining intimate face to face heat-conducting relation between the elements of the sections and between said metallic plates and the sections; and metallic heat-conducting connections between a plurality of said heat-conducting plates and said metallic clamping means, said heat-conducting connections extending outside the stack in spaced apart relations with one another and thereby exposed to heat dissipation.

42. An electrical condenser which includes a stack of a plurality of flat condenser elements of which the greater number of the armatures are electrically isolated from but electrostatically connected to the terminals of the condenser; a plurality of metallic plates also included in said stack and spaced from one another by stack-sections including at least one dielectric element and at least two cooperating armatures, said plates being in intimate heat-conducting relations with said stack-sections; a plurality of terminals for the condenser and outside the stack and spaced from one another; and metallic heat-conducting connections extending in spaced apart relations with one another from said spaced apart plates and outside the stack and connected to said spaced apart terminals, said connections conducting heat away from said plates to the exterior of the stack; said spacing apart of said connections being sufficient to prevent break-down between them by potential differences across the sections.

43. An electrical condenser which includes a stack of a plurality of flat condenser elements of which the greater number of the armatures are isolated from the terminals of the condenser; and a plurality of metallic heat-conducting plates included in said stack in intimate heat-conducting relations with the interior of the stack and dividing the stack into a plurality of sections each including at least one dielectric and two cooperating armatures; the lengths of individual sections between successive individuals of said heat-conducting plates being greater than the thickness of the dielectric material in the section whereby the break-down spacing between said plates is greater than said dielectric thickness.

44. An electrical condenser which includes a stack of a plurality of flat condenser elements wherein the armatures are of smaller area than the dielectrics and the greater number of the armatures are isolated from the terminals of the condenser; and a plurality of metallic heat-conducting plates also included in said stack in positions dividing it into a plurality of sections each including at least one dielectric and two cooperating armatures; at least some of said heat-conducting plates having heat-dissipating parts projecting outside the stack and the total area of said plates and projecting parts being greater than the area of the individual dielectrics; and said projecting parts being spaced from one another along the length of the stack and outside the same by substantial distances reducing liability of break-down by the potentials across them.

45. An electrical condenser which includes

a stack of a plurality of flat condenser elements of which the greater number of armatures are isolated from the terminals of the condenser; and a plurality of metallic heat-conducting plates also included in said stack in positions dividing it into a plurality of sections each including at least one dielectric and two cooperating armatures; at least some of said heat-conducting plates having heat-dissipating parts projecting outside the stack, said projecting parts being spaced from one another along the length of the stack and outside the same by substantial distances reducing liability of break-down by the potentials across them.

46. An electrical condenser which includes a stack of a plurality of condenser elements of which the greater number of armatures are isolated from the terminals of the condenser; a plurality of metallic heat-conducting plates also included in said stack in positions dividing it into a plurality of sections each including at least one dielectric and two cooperating armatures; and metallic heat-dissipating extensions outside the stack from at least some of said heat-conducting plates in positions spaced apart from one another outside the stack for increase of break-down strength against potentials across them.

47. An electrical condenser which includes a stack of a plurality of condenser elements of which the greater number of armatures are isolated from the terminals of the condenser; a plurality of metallic heat-conducting plates also included in said stack in positions dividing it into a plurality of sections each including at least one dielectric and two cooperating armatures; and metallic heat-dissipating extensions outside the stack from at least some of said heat-conducting plates; said sections having lengths causing spacing apart of said extensions outside the stack for increase of break-down strength against potentials across them.

48. An electrical condenser which includes a stack of a plurality of condenser elements of which the greater number of armatures are isolated from the terminals of the condenser; a plurality of metallic heat-conducting plates also included in said stack in positions dividing it into a plurality of sections each including at least one dielectric and two cooperating armatures; and metallic heat-dissipating extensions outside the stack from at least some of said heat-conducting plates; the armatures in said sections having a thickness greater than the dielectric elements thereby spacing said extensions apart outside the stack for increase of break-down strength against potentials across them.

49. An electrical condenser which includes a stack of a plurality of dielectric sheets, at least some of the successive dielectric sheets in the stack being separated from one another by comparatively thick metallic means also included in the stack as armatures but isolated from the terminals of the condenser and in intimate heat-conducting relations with the rest of the stack and absorbing heat therefrom; and metallic extensions outside the stack from at least some of said metallic means in the stack but of less thickness than said metallic means and dissipating to the exterior of the stack the heat absorbed therefrom by the metallic means inside the stack; and metallic connections to the terminals of the condenser from at least some of said metallic extensions.

50. An electrical condenser which includes a stack of a plurality of dielectric sheets, at least some of the successive dielectric sheets in the stack being separated from one another by flat comparatively thick metallic means also included in the stack, at least some of said metallic means including relatively thick and thin metallic portions of which the thinner metallic portions extend outside the stack; some of said metallic means being isolated from the terminals of the condenser but at least some of said thinner extensions being connected to said terminals; and means clamping the elements in the stack into intimate heat-conducting relation with one another whereby said metallic means absorbs heat from the dielectric elements inside the stack and conducts it outside the stack by way of said thinner metallic elements.

51. The improvement on the high-current mica-sheet-stack condenser of the type wherein numerous additional mica-sheets are employed in the stack for the purpose of preventing over-heating at high-current duty, said improvement including the provision of a stack having the much smaller number of micas sufficient for the desired capacity but heretofore impracticable, on account of overheating during high-current duty, and including also the provision of a plurality of metallic heat-dissipators in lieu of the much more costly additional micas of said prior condenser; said metallic dissipators, for the purpose of removing from the stack the additional heat of high-current duty, being distributed respectively in successive locations along the stack in heat-receiving relations with the heated elements thereof, and having large heat-dissipating area exposed to a heat-receiving medium outside the stack; said metallic dissipators respectively consisting of larger masses than the micas, which larger masses, being also of metal, constitute much better conducting paths than mica sheets leading to said external receiving medium, whereby the desired quantity of heat at high-current duty can be removed from the interior of the stack and conducted to said external medium, within the practicable limits of a much smaller number of the metallic

heat-dissipators hereof than of the additional micas of the prior condenser provided for the same purpose.

52. The improvement on the high-current mica-sheet stack-condenser of the type wherein numerous additional mica sheets are employed in the stack for the purpose of preventing overheating at high-current duty, said improvement including the provision of a stack having the much smaller number of micas sufficient for the desired capacity but heretofore impracticable on account of overheating during high-current duty; and including also the provision of armatures interleaved with such smaller number of micas; and including also the provision of a plurality of metallic heat-dissipators in lieu of the much more costly additional micas of said prior condenser; said metallic dissipators for the purpose of removing from the stack the additional heat of high-current duty, being distributed respectively in successive locations inside the stack in heat-receiving face-contact with armatures thereof, and having large heat-dissipating area exposed to a heat-receiving medium outside the stack; said metallic dissipators respectively consisting of larger masses than the micas, which larger masses, being also of metal, constitute much better conducting paths than mica sheets, between the armatures and said external receiving medium, whereby the desired quantity of heat at high-current duty can be removed from the interior of the stack and conducted to said external medium within the practicable limits of a much smaller number of the metallic dissipators hereof than of the additional micas of the prior condenser provided for the same purpose.

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