

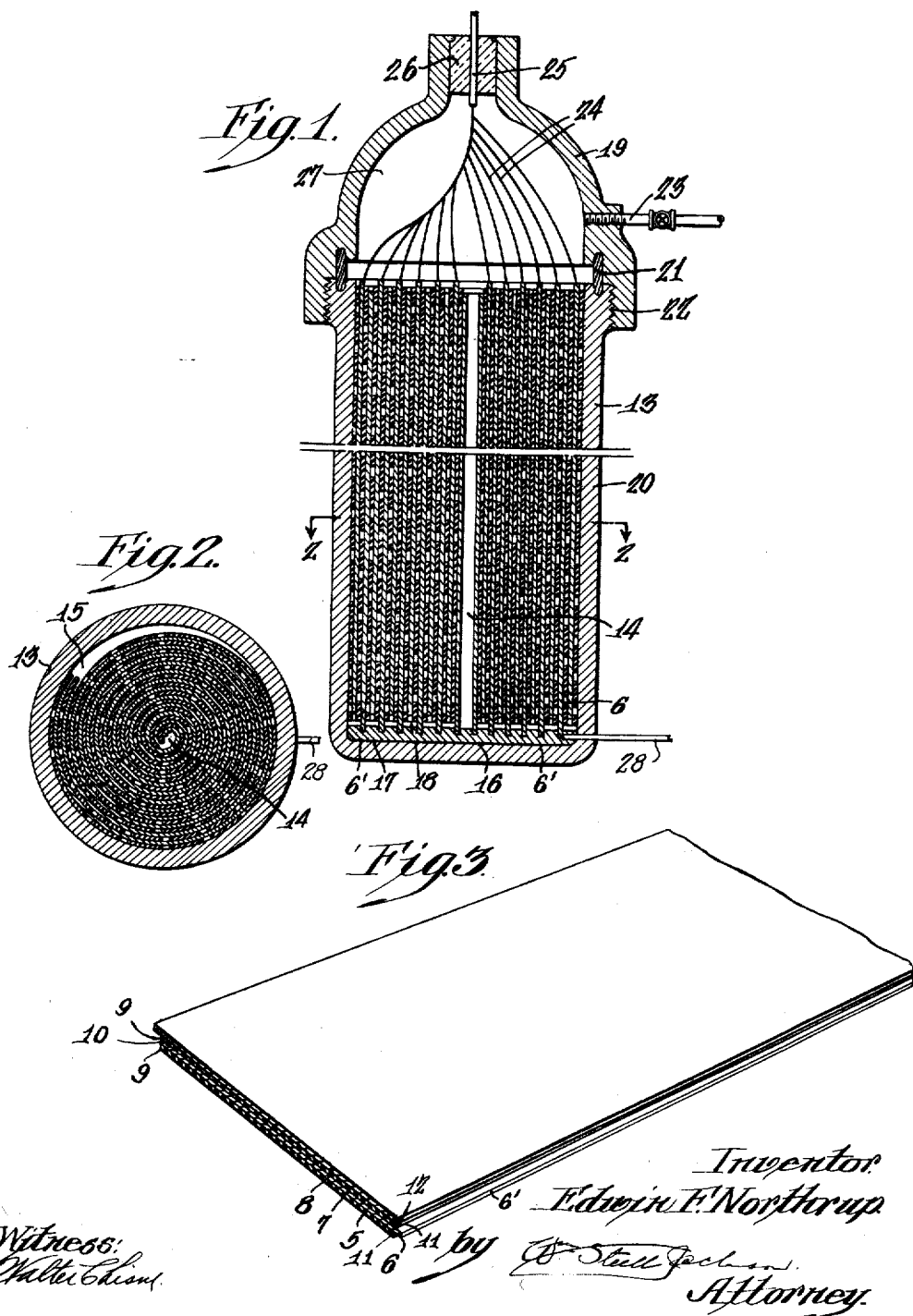
Sept. 20, 1932.

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1,878,173

ELECTRIC CONDENSER

Filed April 7, 1927



UNITED STATES PATENT OFFICE

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ELECTRIC CONDENSER

Application filed April 7, 1927. Serial No. 181,712.

My invention relates to an electric condenser.

A purpose of my invention is to adapt a condenser to operate at higher volt-ampere loads and therefore at higher frequencies by increasing the rate at which heat may be removed from its dielectric, or/and by decreasing the dielectric losses for a given volt-ampere load to a minimum, either or both.

I provide means for more effective heat absorption from the dielectric which adapts the condenser to operate at its given full voltage on higher frequencies and therefore higher amperage and higher full load output, as in practice it is temperature rise within the dielectric which limits the full load current of the condenser unit.

I also preferably make the dielectric loss for a given volt-ampere load at given voltage a minimum by the use of skeleton separators between the opposing plates, thus obtaining a condenser having substantially the same low dielectric losses that are characteristic of a gas condenser, and preferably also reduce the break-down voltage of the unit by suitably increasing the pressure of the gas filling the skeleton between the plates.

A further purpose is to increase the capacity of a condenser by bringing its opposing plates closer together while preventing corresponding reduction in the break-down voltage by increasing the pressure of gas filling a major portion of the space between the plates.

I place the condenser inside an air tight container and fill the container with atmospheric air or other gas which provided higher specific inductive capacity, at a pressure approximately that giving a maximum break-down voltage whatever the distance determined between the plates.

A further purpose is to provide a perfect thermal and electric connection between one side of one of the opposing sheets of a condenser unit along the full length of the sheet, and a conducting cooler element over the whole bottom of a container of the unit, cooling the container externally by oil or in any other suitable way.

I roll the opposing sheets of a condenser unit with intervening skeleton separators comprising pervious sheets of dielectric material such as natural or artificial silk gauze, preferably using the open woven silk, like silk mosquito netting, offsetting the opposing sheets so that they project respectively beyond the dielectric at opposite ends of the roll, and fasten the roll upright inside a tight vertical container to the bottom of the container, preferably by flooding the lower portion of the lower projecting end with a low-fusing metal or any low-fusing conducting material that melts below the melting temperature of the condenser sheets to be used but above the highest temperature for safe operation of the condenser.

A further purpose is to fit a tightly rolled condenser unit comprising opposing sheets of metal and intervening dielectric sheets into a cylindrical container, uniting one element along its full length to the bottom of the container for effective heat removal from the dielectric, leaving the upper element open for greater perviousness, providing space along the inside and outside of the roll for easy permeation of a dielectric air or other gas in the container, sealing the container with a cover preferably domed for additional volume, and preferably charging the container with gas to high pressure, approximately that giving highest break-down voltage per unit distance between the plates.

Further purposes will appear in the specification and in the claims.

I show one only of the forms of my invention, but have selected a form that is practical and efficient in operation and which well illustrates the principles involved.

Figure 1 is a vertical section through a condenser embodying my invention.

Figure 2 is a horizontal section taken upon the line 2—2 of Figure 1.

Figure 3 is a perspective view showing a fragment of two sheets of metal and two sheets of spacing material in position for rolling.

Like numerals refer to like parts in all figures.

Describing in illustration and not in limitation and referring to the drawing:—

The energy which can be stored in a condenser depends on the total volume of effective dielectric, its physical inductive capacity and the square of the voltage stress per centimeter which it can endure without rupture, and may be expressed by a relation

$$W = \frac{KV^2}{8\pi} = \frac{1CV^2}{2}$$

in which W is the stored energy, K is the specific inductive capacity, V the voltage between the opposing plates, and C the capacity of the unit. It will be seen that

$$C = \frac{K}{4\pi}$$

The limit of instantaneous energy storage in a condenser is fully determined by the volume and physical properties of the dielectric material between the opposing plates and this limit can therefore not be raised by changing the configuration or form of the opposing plates, assuming an unchanging volume of effective dielectric of a particular kind.

The maximum volt-ampere load that a given condenser can handle is determined by the product between the limit of energy storage and the frequency of alteration and therefore depends very largely upon design features in that both the volt-ampere load and internal losses in the condenser increase directly with the frequency.

If the condenser did not heat from internal losses, principally within the dielectric, the volt-ampere rating could be increased without limit by increasing the frequency of the applied voltage. However there is an internal heating that is for a given voltage proportional to the frequency of alteration and that limits the rise in frequency and the corresponding rise in volt-amperes to that which will let the temperature inside the condenser remain satisfactorily low. It thus ensues that the volt-ampere rating of a condenser is limited by its adaptation for easy removal of heat generated inside the condenser, chiefly in the dielectric, and thereby to prevent an injurious rise of temperature in the condenser.

A ten fold increase in the adaptation to remove heat from the interior of the condenser will permit a ten fold increase in the volt-ampere rating of the unit, the increase in volt amperes being accompanied by higher voltage or higher frequency, either or both, the permissible voltage from the standpoint of possible rupture of the dielectric remaining however unchanged.

From a commercial standpoint the value of a condenser unit will very largely be determined by the volt-ampere load that it is

adapted to carry per unit volume of the condenser.

The volt-ampere load per unit volume that a condenser can carry will increase as the distance between the opposing plates diminishes. The distance between the opposing plates for a given voltage is limited by the break-down voltage per spacing unit distance of the dielectric. With air or other gas this break-down voltage per spacing unit distance, or strength against rupture, increases almost linearly with the pressure of the gaseous dielectric to a point which is usually about 16 atmospheres pressure, after which the dielectric strength again falls.

There is a considerable range of pressure near 16 atmospheres at which the dielectric strength of the gas is at, or very near, its maximum strength, and I purpose to charge my unit with a gaseous dielectric at this pressure, and to bring the plates sufficiently near together that the break-down voltage is merely safely above the voltages that are to be applied to the condenser terminal.

As an illustration, a condenser having plates 1.6 millimeters distance apart and a gas at atmospheric pressure between the plates, will have about the same break-down voltage as plates of the same opposing surfaces only .10 millimeters apart if the pressure of the intervening dielectric gas is 16 atmospheres, but the capacity of the latter unit will be sixteen times as great and the volume occupied by the dielectric gas one-sixteenth as great. I thus greatly raise the capacity and greatly reduce the volume of the condenser unit for a given plate surface.

My invention is directed toward an arrangement permitting a material increase in the rate of heat removal from the condenser interior, and a material decrease in the condenser size for given volt-ampere ratings.

Referring to Figure 3 the dielectric spacing sheet 5 is placed upon the bottom and then successively a sheet 6 of metal, another spacing sheet 7 of dielectric material and then the second sheet 8 of metal. The spacing sheets are desirably somewhat narrower than the sheets of metal and occupy an intermediate position between the ends of the roll. They are preferably in relative registry, one directly over the other, one edge 9 registering with one edge 10 of one of the strips of metal and the other edge 11 registering with the edge 12 of the other strip of metal.

The sheets of metal have thus one edge even with one edge of the spacing sheets on one side and on the other side overhang or project beyond the other edge of the spacing sheets, the respective sheets of metal projecting upon opposite sides of the spacer sheets. The pile is then tightly rolled, the roll comprising the opposing sheets separated by

skeleton spacers filled with gas, and forms the condenser unit proper. The gas pressure is preferably about 16 atmospheres to obtain very high dielectric strength and to permit reducing the distance between the plates to a minimum.

Both the spacer and the metal elements are formed in strips that may have considerable length; undue length is, however, disadvantageous in that it would increase unduly the amount of heat to be removed from the end or ends of the unit per unit volume of the unit. I preferably make the dimensions of the respective sheets such that the height of the unit, as determined by the width of the sheets of skeleton spacers is about equal to the outside diameter of the finished roll.

The roll is preferably left with an interior hollow portion 14 of some size, as perhaps $\frac{3}{4}$ " in diameter, and also may desirably have some looseness of fit with the interior of a container 13 in which it fits, some slight clearance remaining in any event at 15 at the ends of the sheets. These spaces permit a more easy diffusion circulation throughout the dielectric spaces between the opposing strips of metal.

I provide heat conducting connection between the lower portion 6' of the metal strip 6 and the bottom portion of the container making connection along the whole length of the strip into a bed 16 of heat conducting material fitting the bottom of the container.

Preferably the bed 16 comprises metal having a fusing point safely below the melting point of the metal strips but above the maximum temperature at which it is safe to operate the condenser and is fused to make perfect connection with the strip 6 and perfect fit with the bottom of the container.

The bed of metal 16 thus makes direct and perfect connection with the bottom of the container and direct and perfect connection with one side of the strip 6 throughout the whole length of the strip. It extends upwardly at 17 a short distance from the edge of the strip but leaves a clearance region 18 below the lower edge of the other strip.

The container is normally made of steel or other conducting and strong material. It should be of material adapted to both heat and electrical conduction.

Heat generated flows by conduction down the strip 6 into the bed of metal 16 which conducts it into the wall of the container, whence it is carried away by external cooling of the container, normally by oil cooling.

The container preferably comprises upper and lower portions 19 and 20 adapted to be hermetically sealed and to withstand internal high pressure. A gasket 21, desirably of rubber, fits into upwardly and downwardly directed grooves in the respective portions of the casing which screw together at 22

clamping the gasket into the grooves. Suitable high pressure atmosphere or other gas is admitted through any suitable valved pipe 23 and if desired may be circulated through the condenser and externally cooled in any suitable way not shown, being continuously charged at one portion of the condenser and withdrawn at another for circulation through a cooler. Normally, however, any such circulation of the atmosphere for additional cooling is unnecessary, the gas inside the case remaining almost inert and still.

The upwardly extending metal element 8 of the condenser is connected by wires 24 to an external terminal 25 which is led through an insulation plug 26 in the top of the cover. The other terminal 28 has been shown as communicating through the casing with the bed 16 of metal.

It is desirable to provide many wires 24, from points spaced along the length of the metal element 8. They form conductors of heat from the condenser as well as electric conductors and raise the permissible load for the condenser. Pipe connection having valve control at 23 adapts the sealed container to be exhausted from air and subsequently placed under high pressure.

It is usually desirable to initially exhaust the container to eliminate any traces of moisture that may be present, after which it is charged to high pressure with a dry atmosphere that may be air or other gas having suitable dielectric properties.

The heat generated in the dielectric as well as in the metal strips flows out the projecting ends of the opposing strips 6 and 8, down the strip 6 into the metal cooler 16 and thence to the wall of the container which is externally cooled in any suitable way; and normally to much lesser extent up through strip 8 into the wires 24 in the high pressure air space 27 above the unit.

The internal hollow portion 14 of the coil and the external clearance at 15 down along the outside of the condenser element adjacent the inside wall of the container make gas connection between the upper portion of the casing and the dielectric spaces occupied by the pervious sheets 5 and 7. This connection is at both ends of the strips throughout their lengths respectively in the hollow portion 14 and in the clearance space 15, and in the form of Figure 1 there is additional direct connection into these spaces at the top of the roll. These connections permit the gas to permeate throughout the skeleton spacing material and permit a diffusion circulation of the high pressure dielectric gas from between the opposing strips which under some conditions is desirable to prevent deterioration in the dielectric properties of the gas, and also in that it gives a slight convection cooling of the condenser unit.

It will be seen that my form of condenser

is particularly advantageous in permitting more easy and more rapid removal of heat from the interior of the condenser unit, in reducing the heat developed inside the dielectric to be removed by cooling to near that of a condenser using only gas between the plates, and in reducing the requisite distance between the opposing plates, and that these are factors which severally and collectively greatly raise the permissible volt-ampere output for a given size of condenser and also for given area of plates.

It will be noted that in a condenser of given capacity an increase in volt-ampere output will involve an increase in frequency if the voltage is already at the upper limit of safety from the standpoint of possible rupture of the dielectric.

If the condenser is to be operated at a voltage lower than this upper limit of safety, an increase in volt ampere load involves an increase in frequency or in applied voltage or in the capacity. If the frequency and capacity are fixed I may run up the voltage to such a point that it gives the desired volt-ampere output provided that the voltage does not exceed a voltage at which there may be a danger of dielectric rupture.

Another feature of the invention lies in the combination between the tightly wound condenser unit and the container of a gas dielectric under pressure to give substantially maximum break-down strength. The dielectric spaces of the unit contain a pervious spacing material, a dielectric skeleton in a thin sheet to insure exact parallelism and any desired predetermined spacing of the plates, with a gas of substantially maximum dielectric strength filling the greater portion of the space between the plates. All of this is conducive to long and efficient operation of the unit upon materially higher volt-ampere loads than have hitherto been possible for a given size of unit.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structure shown, and I, therefore, claim all such in so far as they fall within the reasonable spirit and scope of my invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A heat conductive cylindrical high pressure casing, a coil condenser unit therein having two coil plate elements projecting respectively from opposite ends of the unit and spaced from one another by dielectric sheeting freely pervious to gaseous diffusion, said coil being open in the middle and externally loosely fitting the interior of the

casing, a metal cooler in the bottom of the casing filling the lower end of the coil for perfect connection with the downwardly projecting plate at the end thereof and making intimate contact with the bottom of the casing and high pressure atmosphere inside the casing.

2. A condenser in the form of a spiral roll having two elements and a spacing dielectric, one of which elements projects at one end of the roll throughout a considerable part of the length of the element, a heat conducting casing surrounding the roll and a heat conducting filling in heat conductive engagement with the projecting element and with the casing, the filling providing electrical connection with the projecting element.

3. A condenser comprising a metallic heat conductive outer casing having a bottom and side walls, a pair of spirally wound condenser elements therein one of which projects toward the bottom wall below the other, a spacing dielectric between the elements and a heat conductive filling for the bottom of the casing enveloping the projecting part of the element.

4. A condenser in the form of a spiral roll comprising two sheets of metal and two sheets of open woven fabric used in condition to be pervious to air, the sheets of metal and the sheets of fabric alternating.

5. A condenser in the form of a spiral roll comprising two sheets of metal and two skeleton sheets of dielectric material used in condition to be pervious to air, the sheets of metal and dielectric material alternating and the thickness of the skeleton spacer sheets being gauged to give a dielectric break-down rated voltage near but safely above the voltage of the condenser terminals.

6. A tight casing and a condenser unit therein comprising two sheets of metal and two skeleton spacer sheets of dielectric material used in condition to be pervious to air, the sheets of metal and the spacer sheets alternating and the thickness of the spacer sheets being gauged to give a break down dielectric voltage near but safely above the voltage to be applied to the condenser terminals and dielectric gas filling the interstitial spaces of the skeleton sheets and of pressure approximately that to give maximum dielectric strength to the gas.

7. A cylindrical heat conductive metal casing adapted to withstand high pressure, a spiral condenser coil inside the casing having two paralleled spiralled sheets projecting from the upper and lower ends, a metal cooler into which the lower side of the sheet projecting at the bottom is integrally united and connections for applying high pressure to the interior of the casing.

8. A cylindrical heat conductive condenser

- casing, a spiral condenser coil therein having a part of the coil projecting at the bottom and a combined cooling distributor and electrode terminal fused to the projecting portion of the coil and in heat conductive contact with the casing.
9. A heat conductive cylindrical condenser casing, a condenser coil therein, a terminal connected with the top of the condenser coil, a fused cooling terminal connection at the bottom of the coil and against the casing and connections for introducing gas under pressure to the casing.
10. A condenser comprising a pressure-tight casing, two sheets of metal within the casing, terminals for the two sheets, mechanical dielectric spacers on both sides of the sheets consisting of fibrous material having frequent openings therein and used in condition to be pervious to gas and gas dielectric under pressure many times atmospheric pressure permeating between the sheets and filling the openings.
11. A condenser comprising a multiplicity of plates connected alternately into two sets of plates, a skeleton spacer separating the plates and used in condition to be pervious to gas, terminals for the two sets of plates, a casing about the condenser and a gas under high pressure permeating the spaces between the plates not occupied by the material of the skeleton spacer.
12. A condenser comprising metallic plates and two adjacent skeleton spacing dielectrics providing very close approach of the plates to each other, and used in condition to be pervious to gas, in combination with terminals for the plates, a pressure-tight casing about the plates and gas under pressure within the casing permeating between the plates and increasing the dielectric strength to compensate for the close spacing.
13. A condenser comprising a pair of sheets of metal and two sheets of skeleton separator used in condition to be pervious to gas in contact with the metal sheets, respectively, having an open work character so that much less than one-half the surface of the metal sheets is covered by the material of the dielectric spacer, the sheets and spacer being rolled, terminals for the respective sheets, a pressure-tight casing about the rolled sheets and dielectric spacers and a gas under pressure within the casing whereby the permeation of the gas under pressure between the sheets reduces the necessary spacing of the sheets and increases the electrostatic capacity of the sheets and the electrical resistance between the sheets is increased by the reduction of the spacing material.
14. The process of increasing the capacity of a condenser for any given voltage which consists in spacing and condenser plates so as to allow dielectric permeation between them, pressing the plates against the spacing material and placing the condenser elements under high gaseous pressure to increase the dielectric strength.
- EDWIN FITCH NORTHRUP.

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CERTIFICATE OF CORRECTION.

Patent No. 1,878,173.

September 20, 1932.

EDWIN FITCH NORTHROP.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, line 42, before "between" insert the word "upon"; page 4, line 105, claim 5, strike out the word "rated" and insert the same before the syllable "volt-" in same line; page 5, line 4, claim 8, strike out the word "electrode"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 7th day of February, A. D. 1933.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.