

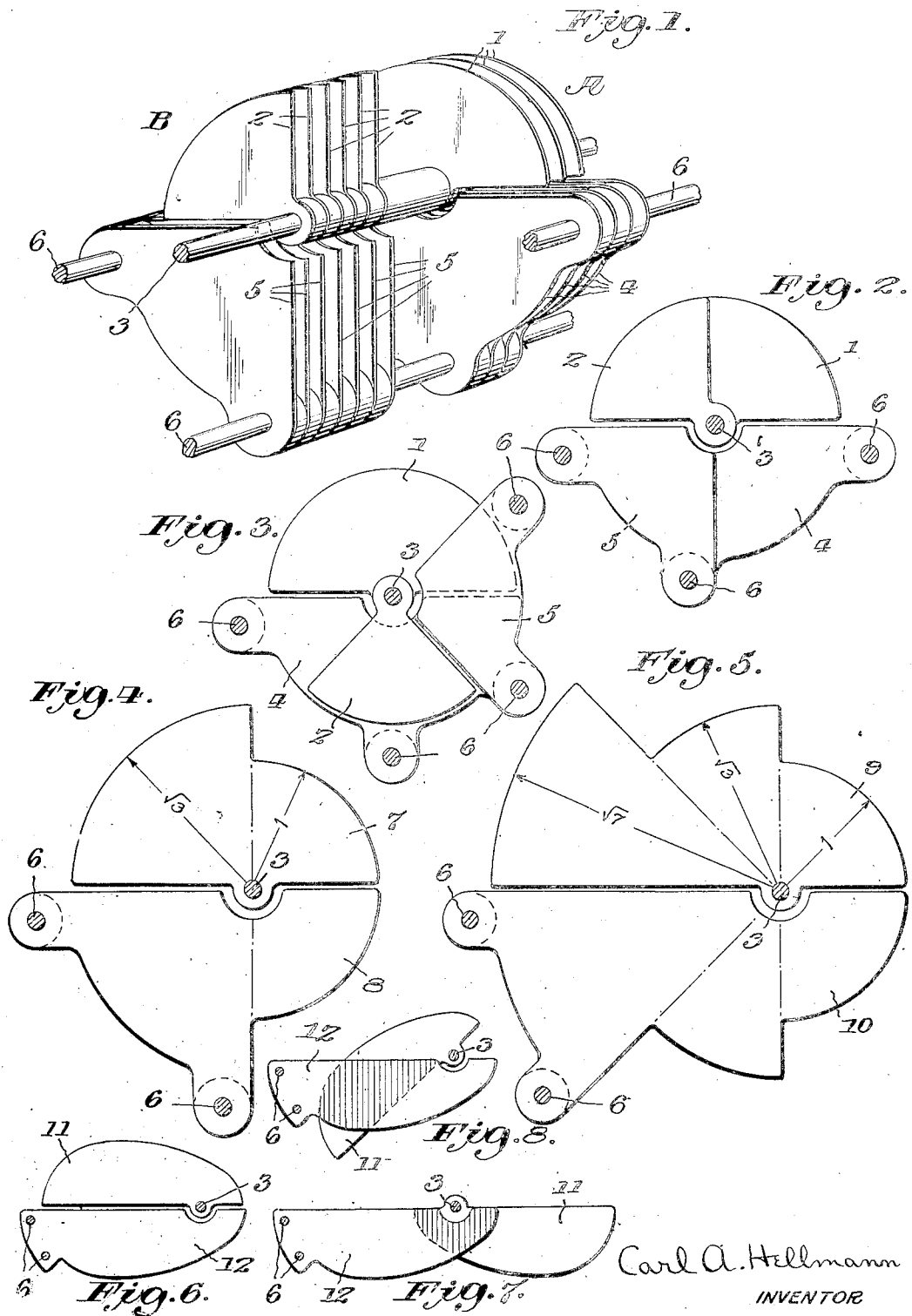
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ROTARY VARIABLE CONDENSER

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ROTARY VARIABLE CONDENSER

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My invention relates to rotary variable condensers. An object of my invention is to provide rotary variable condensers wherein a useful range of capacity variation exceeding 180° is obtained. A further object is to provide condensers of the rotary variable type wherein a useful range of capacity variation exceeding the angular extent of any of the condenser members is obtained.

In a prior application, Serial No. 553,754, filed April 17, 1922, which has matured into Patent Number 1,525,778, dated February 10, 1925, of which this case is a continuation in part, I have disclosed and claimed an invention in condensers which accomplishes this same object, but the condensers of said patent are differentiated from those herein disclosed and claimed in that in the former case, the condensers comprised some elements exceeding 180° in angular extent whereas in the present case, none of the plates needs exceed 180° . A further point of difference between the two cases is that while in the prior case, in general, one of the condenser members, i. e. rotor or stator, comprises no element of an approximate 180° extent, in the present case a preferred form has some such 180° elements on both rotor and stator. In the prior case, elements which are "mirror images" are disclosed and discussed but not illustrated. The present case is concerned with a continuation and further development of said types of condensers. Further objects and advantages of the present invention will be apparent from the following description and accompanying drawings wherein I disclose several embodiments of the invention. In said drawings:—

Fig. 1 is a diagram in perspective, illustrating one form of condenser embodying the invention;

Fig. 2 is a front elevation of said condenser;

Fig. 3 is a front elevation of a slightly modified condenser;

Figs. 4 and 5 are front elevations of other condensers embodying the invention; and

Figs. 6, 7 and 8 illustrate a further modification, showing the same in three different positions.

Referring specifically to Figs. 1 and 2, the condenser comprises a pair of individual variable condensers of well known types, one, A of 180° angle the other B of 90° angle. The rotors of these two condensers comprise the elements 1 and 2 respectively, which are all mounted on a single shaft 3. It will be noted that there are three 180° elements and six 90° elements, and that these groups are separated by a relatively large distance. The reason for said spacing is that thereby the stray capacity between either rotor and the stator of the other condenser is minimized. Each rotor has a corresponding stator, namely, the four plates 4 of 180° extent and the seven plates 5 of 90° extent. These stator plates are all supported by the three rods 6 as shown. The rotor shaft 3 is supported in any preferred way known in the art, said support being no part of the present invention. While I have shown, by way of illustration, three and six movable plates respectively in the two condensers A and B, it is obvious that these are arbitrary numbers, and the actual number and size of plates may be varied at will. It is important only that the capacities of condensers A and B be substantially equal, and that they be preferably of 180° and 90° extent respectively, and arranged as shown relatively to one another.

In operation, assume that the shaft 3 is rotated in a clockwise direction. For the first 180° of such movement, only condenser A is active, and its capacity varies from minimum to maximum in the usual way. Further rotation of this condenser causes the leading edge of the rotor to emerge from between the stator plates, but at the same time condenser B has become active, and increases its capacity just twice as fast as the capacity of A is decreasing, the net result being that the capacity of the two condensers in parallel is still increasing uniformly with the angle of rotation and will continue to increase until the rotor and stator of B are completely interleaved. This requires a movement of 270° from the position illustrated in Fig. 1, thus providing a condenser having a 270° range, that is, an effective useful range of capacity variation in one direction, of 270° . The ex-

pression "useful range of capacity variation in one direction" as used in the present specification and claims, means a range of variation extending from a minimum of capacity to a maximum thereof, or vice versa. The conventional type of condenser wherein stator and rotor are each of 180° extent has a range of 180° because the capacity will change in one direction or the other, from minimum to maximum in 180° whereas my condenser above described has a range of 270° in one direction and 90° in the other, that is, if the shaft 3 is rotated clockwise from the position of Fig. 1, it has a range of 270°, whereas if rotated counterclockwise the range is only 90°. If a rate of variation other than a uniform increase of capacity with the angle is desired, it may be readily obtained by using non-circular plates in the condensers A and B, appropriately shaped by calculation or by experiment. The term "mirror images" is used in this case to include a type of symmetry wherein the two elements, i. e. rotor and stator, while their electrically active portions are substantially duplicates of one another, are so placed that it is impossible to simultaneously cause all the rotor plates to interleave fully with the corresponding stator plates. For example, in Fig. 1, the plates 1 and 2 are symmetrically disposed as mirror images of plates 4 and 5 respectively, about the plane passing between rotor and stator, in such fashion that when the rotor and stator of condenser A are fully coincident, those of condenser B are not, and vice versa.

The condenser of Figs. 1 and 2 lends itself readily to balancing, that is, gravitational balancing, because of the fact that there are available virtually two rotors, those of A and B, of approximately the same weight. If these be disposed with their centers of gravity on diametrically opposite sides of the shaft 3, the balancing results. It is of course necessary to shift the relative positions of the stators correspondingly, as shown in Fig. 3. Thus balanced, the condenser is still of the mirror image type above defined.

Fig. 4 illustrates a different shape of plates that may be employed. The rotor plates 7 and stator plates 8 mounted on shaft 3 and rods 6 respectively, here take the places of the double sets of plates of Figs. 1, 2 and 3, by virtue of the fact that each plate 7 or 8 comprises two sectors of different radius. For instance plate 7 is shown as having a quadrant of radius unity, and another quadrant or radius $\sqrt{3}$, and plate 8 is the exact mirror image of plate 7 (neglecting the lugs and centre which of course do not enter into active service as capacity elements). Inasmuch as the areas of sectors of equal angle vary as the squares of their respective radii, it follows that each large quadrant is 3 times the area of the smaller quadrant integral there-

with. Upon clockwise rotation of rotor 7, it will be seen that for the first 180°, the capacity will increase in the ordinary way of the conventional straight line capacity type of condenser. Thereupon the leading edge of rotor 7 will emerge from the trailing edge of stator 8 and simultaneously the leading edges of the larger sectors of the rotor and stator will begin to overlap. With the relative dimensions given, the net result is that during the range 180° to 270° the capacity continues to increase uniformly at the same rate as in the first 180°, thus providing a condenser of 270° range.

The same action may be carried further by providing plates shaped as shown in Fig. 5, wherein each plate 9 or 10 comprises a quadrant of radius unity, and two 45° sectors of radius $\sqrt{3}$ and $\sqrt{7}$ respectively. By this construction, a useful angle of 315° may be obtained. It will be observed, however, that the plates become somewhat elongated and therefore less rigid, and it is questionable whether it is desirable to provide a still closer approximation to 360°, although such range is theoretically feasible by a continued increase in the number of sectors, each new sector being of half the angle of its predecessor, but of correspondingly increased radius.

Another type of mirror image plates is shown in Figs. 6, 7 and 8, these figures illustrating the rotor in three different positions. Here the rotor 11 is mounted on shaft 3, and the stator 12 on the rods 6, as in all the other types. The active parts of rotor 11 and stator 12 are of the same shape, but reversed thus constituting mirror images of one another as shown and instead of the circular outlines and sudden variations of radius of the other figures, these plates are bounded by curves which are eccentric with respect to the center of the shaft 3, and which are presumably not circular arcs. In the position shown in Fig. 6, the capacity is a minimum. Upon clockwise rotation through 180° to the position shown in Fig. 7, the capacity has increased to a value corresponding to the overlapped portion (shown cross-hatched.) Upon continued rotation, the maximum capacity is finally reached as shown by the cross-hatched portion of Figure 8.

In all the various types, the shapes of the plates may be varied to correspond to the particular relation desired between angle and capacity. While the mirror-image type of symmetry is probably the most desirable form, it is by no means essential, and some of the advantages of this invention may be obtained without strict adherence to the preferred form of plates. In the description of Figs. 4 and 5, the square roots of 3 and 7 are mentioned. These values are of course approximate only, due to the effect of the inactive central portions of the plates, and this matter is fully discussed in my prior case

hereinbefore referred to, hence need not be repeated here. It will be understood of course that the invention is not limited to condensers of any specific law of variation, and while the "straight line capacity" type has been mentioned, this is done merely for relative ease of mathematical discussion and clearness, and any desired relation of capacity and angle may be obtained by calculation—or trial—methods, for instance "straight line wave length", "straight line frequency" or "uniform percentage change with angle", or in fact any of the functions which may be deemed desirable, such relations forming no part of the present invention.

A peculiar feature of condensers made in accordance with this invention is that, whereas in the usual well known 180° condensers of the prior art, it is immaterial in which direction the rotor is turned, that is, clockwise or counter-clockwise, inasmuch as a 180° range from minimum to maximum is obtained in either case, this is not true with condensers constructed in accordance with the present invention. If the rotor of any of the condensers shown on the drawing be turned clockwise, starting from the minimum capacity positions illustrated, the capacity will increase progressively, for a range exceeding 180°, to a maximum. If the rotation be continued further in the same direction, the capacity will again decrease, but it will reach its minimum in this case with a rotation less than 180°, for instance 90° in the form shown in Figs. 1 to 4, or 45° in the Fig. 5 form. This may be referred to as the "abnormal" operation of the condenser, as distinguished from the "normal" operation, which comprises the gradual change of capacity having the range exceeding 180°. Although the normal operation is the most useful in general, the abnormal operation is also valuable, either for making a rapid transition from the maximum to the minimum capacities or vice versa, or for rapidly passing through all the possible capacity values to assist in rapidly exploring a wave length range; which is subsequently traversed more slowly and delicately in the normal operation.

Having disclosed my invention and described some of the forms in which it may be embodied, I claim:—

1. A rotary variable condenser having elements on its rotor and stator which comprise cooperating effective capacity producing areas disposed symmetrically about a straight line intersecting the axis of rotation but which are not symmetrically disposed with respect to the axis of rotation of the rotor.

2. A rotary variable condenser having all its elements not materially exceeding 180° in angular extent, and shaped to provide an effective useful range of capacity variation

substantially exceeding 180° from minimum to maximum.

3. A rotary variable condenser having rotor and stator elements of approximately 180° angular extent and having said elements shaped to provide an effective useful range of capacity variation of at least 270° from minimum to maximum.

4. A rotary variable condenser having rotor and stator elements of approximately 180° angular extent and having said elements shaped to provide an effective useful range of capacity variation exceeding 270° from minimum to maximum.

5. A rotary variable condenser having rotor and stator elements each of substantially 180° angular extent, the active area of each element being distributed unequally in successive quadrants, the area in the one quadrant being to that of the other at least in the ratio of 3 to 1, and the said elements being so disposed that the lesser quadrants thereof are adjacent each other in the minimum capacity position of the condenser.

6. A rotary variable condenser having elements of substantially 180° angular extent, the active area of each element being distributed unequally in successive quadrants, the area in the one quadrant being to that of the other at least in the ratio of 3 to 1, said elements being so disposed that the quadrants of smaller area are the first to become interleaved in normal operation of the condenser.

7. A rotary variable condenser having a cooperating pair of elements, each of substantially 180° angular extent and a cooperating pair of elements each of substantially 90° angular extent.

8. A rotary variable condenser having elements on its rotor and stator comprising effective capacity producing areas which are duplicates each of the corresponding area of the other element, but disposed in inverted relation to one another so as to constitute mirror images of one another, the axis of rotation of the rotor elements being disposed eccentrically with respect to the said effective capacity producing area of the condenser elements.

9. A rotary variable condenser having a continuous range of capacity variation from minimum to maximum exceeding the angular extent of any of the capacity producing elements of said condenser.

10. A rotary variable condenser having a shaft, a plurality of separate but electrically connected rotors rigidly mounted on said shaft, said rotors being spaced apart a distance greater than the spacings of the individual rotor plates, a like number of electrically connected stators and means supporting said stators in properly spaced relation to cooperate with the rotors, whereby

two condenser units are formed, said units being of different maximum capacity and having their respective maxima of capacity attained at different angular positions in the rotation of the shaft.

5 11. A rotary variable condenser having two elements relatively movable about an axis and each comprising a similar effective capacity producing area, said areas being arranged non-uniformly in angle with respect
10 to the axis and the two elements being so disposed that they interleave in the same order as their corresponding magnitudes of area.

12. A rotary variable condenser having
15 two elements relatively movable about an axis, each element comprising an effective capacity producing area of variable magnitude angularly with respect to said axis, said elements being so disposed that in the course of
20 varying the capacity of the condenser from minimum to maximum the portions of least effective area are the first to become interleaved and thereafter other portions of successively greater areas become interleaved.

25 In testimony whereof I affix my signature.
CARL A. HELLMANN.

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