May 5, 1936. M. H. BENNETT 2,039,622

CONDENSER

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Fig. 1.

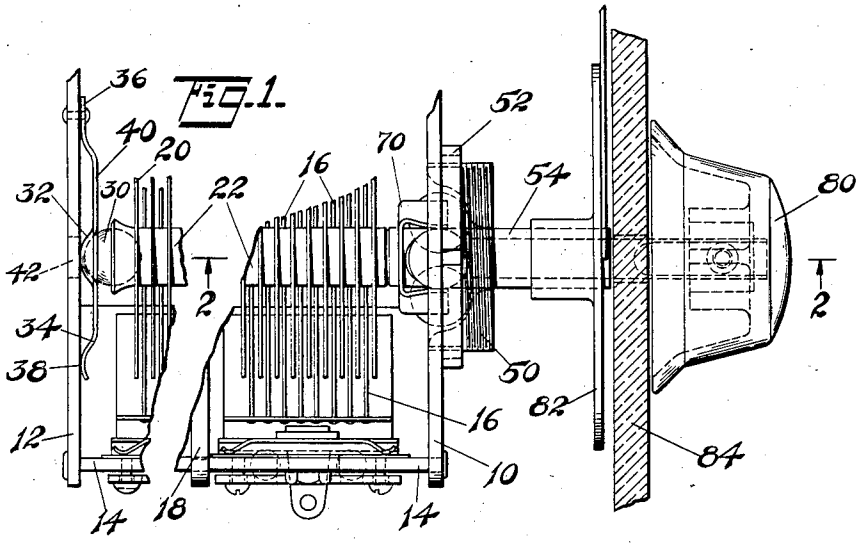


Fig. 2.

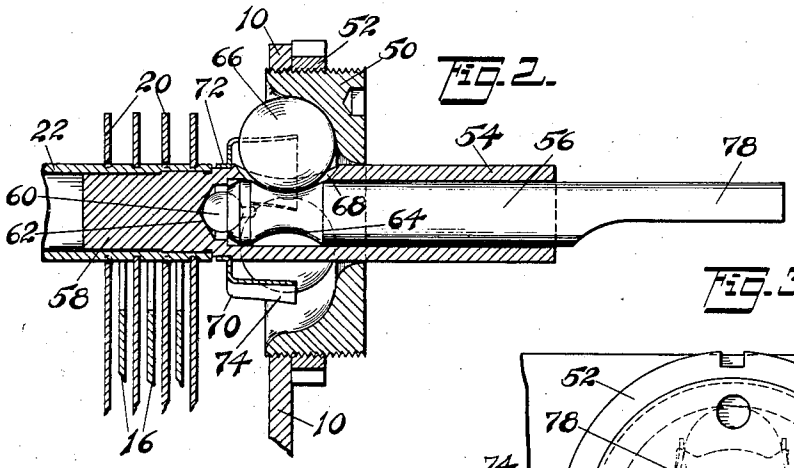


Fig. 3.

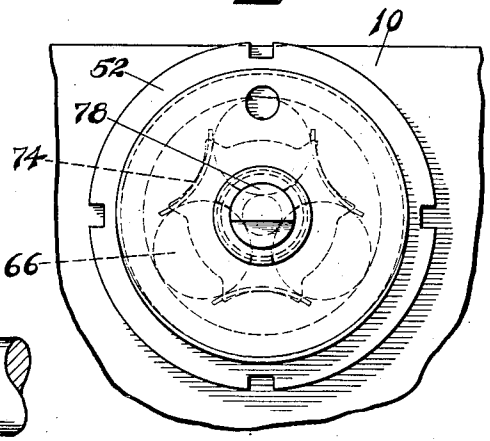
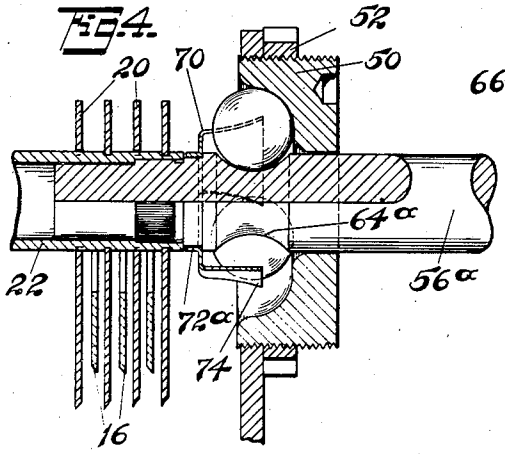


Fig. 4.



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Fig. 5.

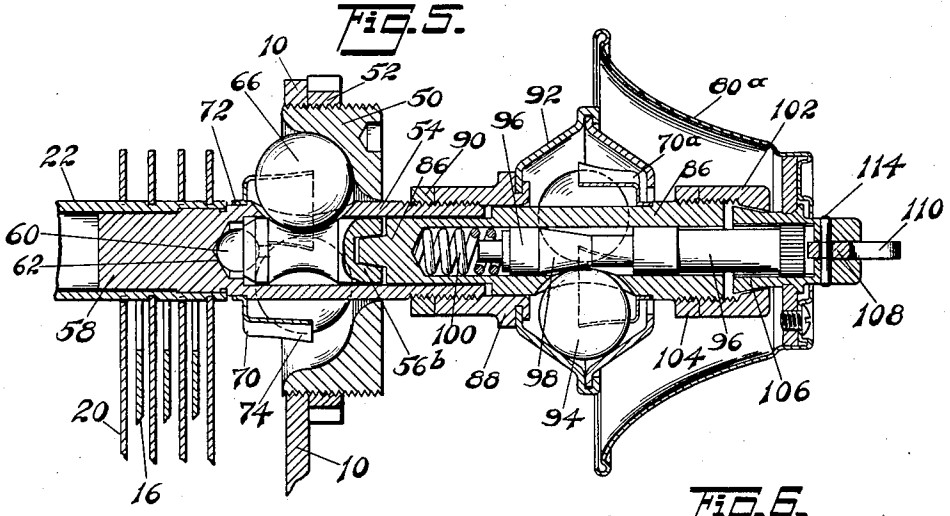


Fig. 6.

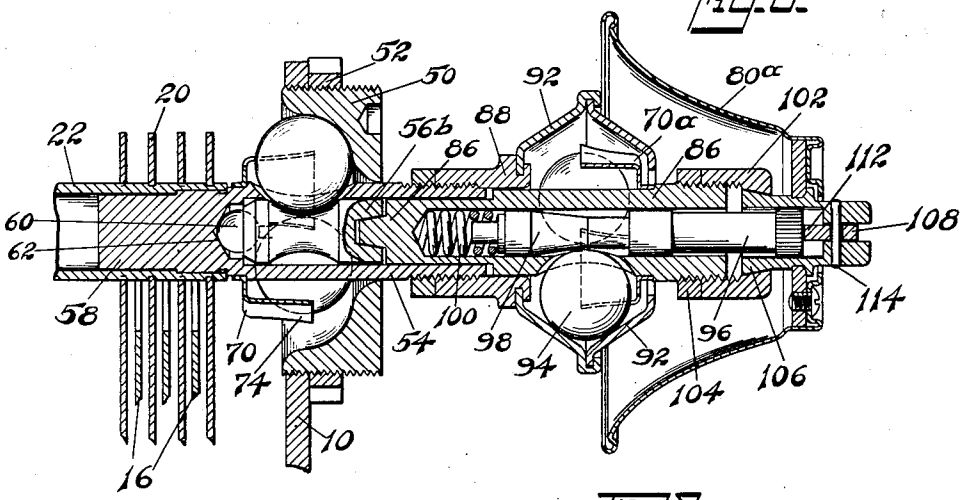
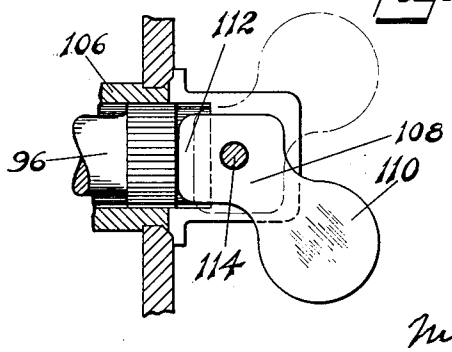


Fig. 7.



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2,039,622

CONDENSER

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Application June 17, 1932, Serial No. 617,778

15 Claims. (Cl. 74—10)

The present invention relates to condensers and especially to multiple plate condensers of the air dielectric type. More particularly, the invention relates to means for varying the relation between a group or groups of rotor plates with respect to a corresponding group or groups of stator plates interleaved therewith.

An object of the invention is to provide means for causing angular movement of the rotor plates with respect to the stator plates, said means being so arranged that for a relatively large angular movement of an actuator there will be a relatively small angular movement of the rotor plates, thus providing for a particularly accurate variation in capacity.

Another object of the invention is to provide a control, and especially a control carried by the actuator, by means of which said ratio may be selectively varied.

A further object of the invention is to provide, in connection with the foregoing and preferably as a part thereof, means for effecting rectilinear adjustment of the rotor plates with respect to the stator plates interleaved with them in order that the rotor plates may be accurately spaced between their cooperating stator plates.

The invention also provides a manually operable actuator provided with control means, such that where the angular movement of the rotor plates is to be relatively large, the first part of such movement may take place relatively rapidly for a given angular movement of the actuator, whereupon the control means may be actuated so that thereafter and as the plates approach their desired position, their angular movement may be relatively small for a given angular movement of the actuator.

Other advantages and objects of the invention will appear from the following description, taken in connection with the accompanying drawings which illustrate, by way of example, certain embodiments of the invention but which are not to be taken as a definition of the limits thereof, reference for that purpose being had to the appended claims.

In the drawings,—

Figure 1 is a fragmentary top plan view partly in section of a condenser embodying certain features of the invention;

Figure 2 is a central vertical sectional view on a somewhat enlarged scale and taken on the line 2—2 of Figure 1;

Figure 3 is an end elevation, as viewed from the right hand end of Figure 2;

Figure 4 is a view similar to Figure 2 showing a modified form of the invention;

Figure 5 is a view similar to Figure 2 and showing a further modified form of the invention, in which the driving ratio may be selectively determined by the operator;

Figure 6 is a similar view of Figure 5 but showing certain parts in a different position, and

Figure 7 is a fragmentary top plan view on an enlarged scale, partly in section, showing the selective control means of Figures 5 and 6.

Referring in detail to the drawings and particularly to Figures 1, 2 and 3, a condenser frame is provided with a front end plate 10, rear end plate 12, and opposite side plates 14. Carried in the frame is a group of stator plates 16, which are fixed in position by any desired means. There may be several distinct groups of these stator plates, if desired, with partitions 18 between adjacent groups. It is evident that the number of groups may be varied as desired.

Cooperating in interleaved relation with each group of stator plates 16 is a group of rotor plates 20, herein shown as being fixed to and carried by a rotor plate carrier or sleeve 22. At its rear end, the rotor plate carrier sleeve 22 may be flared, as indicated in Figure 1, for the reception of a thrust bearing ball 30, which bears in a depression 32, of a resilient fixed bearing member 34, which may have one end 36 secured in fixed relation to the rear end plate 12 of the condenser frame, and its other end 38 slidably engaging the inner face of said end plate, the intermediate portion 40 being arched, as shown in Figure 1, to permit a certain amount of movement of the depression 32 with respect to the condenser frame. The rear end plate 12 of the frame may be provided with an opening 42 with respect to which or within which the ball seat depression 32 may move. It will be understood that the amount of movement of this rear bearing is relatively small and that it occurs only during the hereafter described adjustment of the rotor plates rectilinearly with respect to the stator plates.

Threaded in the front end plate 10 of the condenser frame is a ball cup or outer raceway 50 which may be provided with a lock washer 52 adapted, by engagement with the face of the plate 10, to lock the outer raceway 50 in adjusted position. The rotor plate sleeve 22 is provided with an extension sleeve 54 which provides a bearing for the main drive shaft 56, the latter being rotatable in said sleeve. The inner end 58 of the sleeve 54 may, if desired, be solid and be received within the rotor plate sleeve 22 in fixed relation

therewith. The sleeves 54 may also have a bearing socket 60 for the reception of a thrust ball 62 adapted for thrusting contact with the inner end of the main drive shaft 56.

Near its inner end, the drive shaft 56 is provided with a neck portion 64 which forms an inner or driving raceway for a series of frictionally driven balls 66 which bear against the neck portion 64 of the shaft and also in the ball cup or normally stationary but axially adjustable raceway 50. The sleeve 54 is provided with ball receiving openings 68 in which the balls 66 may be located. A ball spacer 70 may have its inner end 72 fast on sleeve 54, so that it is in fixed relation to the rotor plate carrier sleeve 22. The ball spacer is preferably provided with resilient spacing arms 74 which bear against adjacent balls 66 and urge them inwardly towards the main drive shaft 56, the spacer being preferably so shaped as to hold the balls in position on the shaft 56, even without the aid of the stationary outer raceway 50.

It will be understood that by loosening the lock washer 52 the outer raceway 50 may be adjusted in either direction axially of the main drive shaft. As shown, when moved to the left, it thrusts against balls 66, neck portion 64 of shaft 56, thrust bearng 62, inner end 58 of sleeve 54, rotor plate carrier sleeve 22, and rear thrust bearing 30, which may move to the rear a slight distance due to the resilience of the plate 34. Such movement causes movement of the rotor plates rectilinearly to the left, thereby varying their spacing with respect to the fixed stator plates. Adjustment of the outer raceway 50 in the opposite direction permits the resilient plate 34 to urge rotor plate carrier sleeve 22 toward the right, thus moving the rotor plates toward the right, as viewed in the drawings, with respect to their stator plates.

Also, rotation of main drive shaft 56 causes rotation and planetary movement of the friction driving balls 66, and consequently rotation of the spacer 70, which, being in fixed relation to the rotor plate carrier sleeve, causes angular movement of the rotor plates with respect to the stator plates and consequent variation in the capacity of the condenser.

It will be evident that the angular movement of the rotor plates will, with the construction described, be relatively small with respect to a given angular movement of the main drive shaft 56 which rotates in sleeve 54. It will also be evident that the main drive shaft 56 is supported by the friction driving balls and itself supports the sleeve 54, and consequently supports the forward end of the rotor plate assembly.

The forward end 78 of the main drive shaft may be cut away to provide a flat surface for assembly thereto, by a set screw or otherwise, of an actuator 80, herein shown as being in the form of a knob. The sleeve 54 may carry any suitable indicator device 82 which may be viewed through any suitable opening provided in the casing or cabinet wall 84.

Instead of the drive being through the ball spacer 70, as above described, the drive may be directly to sleeve 54 by contact therewith of the driving balls 66 as they are rotated by the main drive shaft.

Referring to the modification of Figure 4, the drive shaft 56a may have its inner end fixed within rotor plate carrier sleeve 22 so that the drive is direct. The balls 66 bearing on neck portion 64a are held apart by a spacer 70, which may be the same as the spacer already described except that its inner end 72a is loose so that it may rotate with respect to the main drive shaft and consequently with respect to the rotor plate carrier sleeve 22. The rectilinear adjustment or relative spacing of the rotor plates with respect to the stator plates may take place as already described, the resilient ball thrust bearing 30 being provided at the left hand end of the rotor plate carrier sleeve.

Referring now particularly to Figures 5, 6 and 7, the rear or left hand resilient thrust bearing may be the same as that shown in Figure 1, and the front or friction drive bearing is the same as that shown in Figure 2, with certain additions thereto and with the exception that the main drive shaft 56b is preferably considerably shorter than the main drive shaft of Figure 2, and has a main drive shaft extension 86 in direct driving relation with the main drive shaft 56b. The main drive shaft and its extension may be integral or may be separate, as shown in the drawings, in which case their ends interlock so that they both rotate together at the same angular velocity.

The sleeve 54, in the present modification, is provided with a carrier 88 threaded on the sleeve 54 and maintained in fixed relation therewith by a suitable lock washer 90. Fixed to carrier 88 is an outer raceway 92 which rotates with the sleeve 54 at the same angular velocity as the rotor plates.

Rotatable and planetarily revoluble within the rotatable outer raceway 92, are friction driving balls 94. An auxiliary drive shaft 96 has a conical surface 98 which is urged by a spring 100 into frictional driving contact with the balls 94. The spring 100 is herein shown as being a coil spring under compression, which has one end thrusting against the bottom of the socket of the main drive shaft extension sleeve 86 and has its other end thrust axially against the auxiliary drive shaft 96. The auxiliary drive shaft 96 is rotatably mounted in the main drive shaft extension 86, which is provided with ball receiving openings and to which is fixed a ball spacer 70, similar to the ball spacer 70 already described.

When the auxiliary drive shaft is in driving engagement with the balls 94 and is rotated, the balls will cause rotational movement of the ball spacer, and, consequently, of the main drive shaft extension 86, and therefore of the main drive shaft 56b. Instead of the drive occurring through the spacer, the balls 94 may drive the main drive shaft extension 86 by contacting directly with the edges of the ball receiving opening of the exsion.

Carried by and fixed to the forward end of the main drive shaft extension 86 is a clutch member 102 having an inner conical friction clutch face and being maintained in fixed relation to the main drive shaft extension by a lock washer 104.

An actuator knob 80a may carry fixed thereto a cone clutch member 106 having an outer conical friction clutch surface within and adapted for engagement with the clutch member 102. The clutch member 106 is feathered, or otherwise nonrotatably but slidably connected with the forward end of the auxiliary drive shaft 96, and may be so connected by interlocking toothed surfaces.

Carried by the actuator 80a, and as here shown by the closed end of clutch member 106, is a control device herein shown as comprising a cam

lever 108 having a projecting manually engageable handle 110 and a thrusting cam portion 112. The lever may occupy either the full line or dotted line position of Figure 7, being angularly moved from one to the other about the pivot pin 114 carried by the actuator, and as here shown, by the clutch member 106 thereof.

In one position (Figure 6) of the lever, the main drive shaft 56b is rotated by and with the same angular velocity as the actuator knob 80a. In this position of the parts, the thrust cam 112 bears against the right hand end of the auxiliary drive shaft, causing said shaft to press coil spring 100, which spring, thrusting the shaft against the control lever, communicates its thrust to the pivot pin 114 and consequently to the clutch member 106, causing said clutch member to move axially to the right with respect to the main drive shaft extension 86 far enough to come into frictional driving engagement with the clutch member 102. In this position of the parts, by reason of the auxiliary drive shaft having been shifted to the left within main drive shaft extension 86, the conical driving portion 98 of said shaft is moved to the left out of driving engagement with the balls 94. Consequently, on rotation of the actuator 80a, clutch member 106 rotates clutch member 102 and the main drive shaft extension 86, and consequently main drive shaft 56b, at the same angular velocity as that of the actuator knob. The rotor plates, however, will have a proportionately less angular velocity, due to the reduction friction drive already described, and include the friction driving balls 66 and ball spacer or separator 70. During operation, with the parts in this position, the outer raceway 92 will rotate with the sleeve 54. Although the auxiliary drive shaft 96 will rotate, it has no driving effect, for, due to its shift to the left, the balls 94 can no longer contact with both the shaft and their outer raceway 92. Where the spacer 70 holds the balls at all times against the shaft, it will, in this position of the parts, move the balls inwardly away from their outer raceway. Where the spacer allows the balls to remain in contact with the outer raceway, they will not, in this position of the parts, contact with the auxiliary drive shaft 96, due to its shift to the left within the main drive shaft extension 86 by the thrust cam 112 of the selective control lever 108.

In another position of the parts (Figure 5), the main drive shaft extension, and consequently the main drive shaft, will be rotated by but at a less angular velocity than that of the actuator knob 80a. In such case, there is a double reduction as between the rate of movement of the actuator and the rate of movement of the rotor plates. To secure this double reduction, the control lever 108 is moved from the full line to the dotted line position of Figure 7. This allows the auxiliary drive shaft to move to the right under the influence of coil spring 100 until the conical driving surface 98 of said shaft comes into driving engagement with the balls 94 or establishes contact of the balls 94 with both the shaft and the outer raceway. The conical surface 98 of the auxiliary drive shaft 96, by its ball engagement, prevents further movement of the shaft to the right. The coil spring 100, therefore, can no longer affect the control lever 108 and consequently no longer urges clutch member 106 into frictional clutching engagement with clutch member 102, so that engagement is released.

With the parts in this position (Figure 5), rotation of the actuator 80a causes rotation of clutch member 106 which slips within clutch member 102, and which causes rotation of the auxiliary drive shaft at the same angular velocity as that of the actuator. The auxiliary drive shaft, as will be evident from the foregoing description, will, through balls 94, drive the main drive shaft extension 86 and consequently the main drive shaft 56b, either through ball spacer 70 or directly, at a less angular velocity than that of the actuator.

A second reduction in driving ratio in this position of the parts takes place through the reduction drive including friction driving balls 66 as already described.

In either position of the parts, the sleeve 54 rotates with the same angular velocity as that of the rotor plates and consequently the indicator device, such as that shown in Figure 1, is attached to the sleeve 54 so that whether the single reduction or double reduction is used, the indicator will always indicate accurately the relative angular displacement of the rotor plates with respect to the stator plates. In the construction of Figure 4, the indicator should be attached to or operated from the drive shaft 56a. It will also be evident that in the construction of Figures 5 and 6, the normally stationary but axially adjustable raceway 50 may be moved, as already described, to effect fine adjustment or final assembly adjustment of the spacing between the interleaved rotor and stator plates by causing their movement either to the right or left, as viewed in the drawings, due to the slight but sufficient resilience of the rear or left hand thrust bearing shown in Figure 1.

It will be evident that the selective control for the single or double reduction may be actuated by one finger during operation of the actuator knob 80a, and that the shift may be made simply and instantaneously in any position of the parts, permitting relatively rapid angular movement of the rotor plates until the desired capacity is approached, whereupon a simple movement of the selective control brings into action the second reduction drive so that the same actuator knob now acts as a micrometer adjuster which is particularly desirable in nice tuning for radio reception.

What is claimed is:

1. In a condenser, a set of stator plates, a set of rotor plates interleaved therewith, and driving means for said rotor plates including a sleeve having ball openings therein and having a bearing for a rotatable drive shaft, a drive shaft rotatable within said sleeve, a normally stationary sleeve-adjusting ball raceway, a thrust bearing for said shaft, sleeve-driving balls in the ball openings of said sleeve and bearing on said drive shaft and said stationary ball raceway, and a ball separator having yielding portions contacting with said balls and spacing them apart.

2. In a condenser, a set of stator plates, a set of rotor plates interleaved therewith, and driving means for said rotor plates including a sleeve having ball openings therein and having a bearing for a rotatable drive shaft, a drive shaft rotatable within said sleeve, a normally stationary sleeve-adjusting ball raceway, a thrust bearing for said shaft, sleeve-driving balls in the ball openings of said sleeve and bearing on said drive shaft and said stationary ball raceway, and a ball separator fixed to said sleeve, contacting with said balls, spacing them apart, and urging them radially inwardly against said drive shaft.

3. In a condenser, a set of stator plates, a set of rotor plates interleaved therewith, and driving means for said rotor plates including a sleeve having ball openings therein, a drive shaft rotatable within said sleeve and having a neck portion of reduced diameter and curved both circumferentially and axially of said shaft, a thrust bearing between said shaft and said sleeve, a stationary ball raceway, and sleeve-driving balls in the ball openings of said sleeve and bearing on the curved neck portion of said shaft and on said stationary raceway.

4. In a condenser, a set of stator plates, a set of rotor plates interleaved therewith, and driving means for said rotor plates including a sleeve having ball openings therein, a drive shaft rotatable within said sleeve and having a neck portion of reduced diameter and curved both circumferentially and axially of said shaft, a thrust bearing between said shaft and said sleeve, a stationary ball raceway, sleeve-driving balls in the ball openings of said sleeve and bearing on the curved neck portion of said shaft and on said stationary ball raceway, and means for urging said shaft axially of itself and said balls against said stationary raceway.

5. In a condenser, a set of stator plates, a set of rotor plates interleaved therewith, driving means for said rotor plates including a sleeve member having ball openings therein, a drive shaft rotatable within said sleeve member and having a neck portion curved circumferentially and axially of said shaft, a thrust bearing between said shaft and said sleeve member, a stationary ball raceway, and sleeve-driving balls in the ball openings of said sleeve member and bearing on said drive shaft and said stationary ball raceway.

6. In a condenser, a set of stator plates, a set of rotor plates interleaved therewith, a thrust bearing for said set of rotor plates, a main drive shaft for said rotor plates, a normally stationary raceway adjustable axially of said main drive shaft, balls in said receway supporting said main drive shaft, and main drive shaft rotating mechanism including a rotatable outer raceway, an auxiliary drive shaft, driving balls between said auxiliary drive shaft and said outer raceway, a main drive shaft extension, an actuator in driving relation to said auxiliary drive shaft, and means for causing driving of said extension, and thereby said main drive shaft, by said actuator including clutch means operable in one position to connect said extension directly to said actuator and hold said auxiliary drive shaft out of driving engagement with said balls, and in another position to hold said auxiliary drive shaft in driving relation with said balls and release the direct driving engagement between said extensions and said actuator, said balls, in said latter position of said auxiliary drive shaft, driving said extension, and thereby said main drive shaft, at an angular velocity less than that of said actuator.

7. In a condenser, a set of stator plates, a set of rotor plates interleaved therewith, a main drive shaft for said rotor plates, and main drive shaft rotating mechanism including a rotatable outer raceway, an auxiliary drive shaft, rotatable friction driving elements between said auxiliary drive shaft and said outer raceway, a main drive shaft extension adapted to be driven by said friction driving elements on rotation of the latter by said auxiliary drive shaft, an actuator for said rotating mechanism, and means for causing driving of said main drive shaft extension, and thereby adjustment of said rotor plates, by said actuator including clutch elements operable in one position to connect said drive shaft extension to said actuator for direct drive thereby and hold said auxiliary drive shaft out of driving engagement with said friction driving elements, and operable in another position to hold said auxiliary drive shaft in driving relation with said friction driving elements and release the direct driving connection between said extension and said actuator, and means for bringing said elements into and holding them in either of said two positions.

8. A condenser including a set of stator plates, a set of rotor plates interleaved therewith, and mechanism for varying the capacity of said condenser by effecting adjustment of said rotor plates angularly with respect to said stator plates at two different rates, said mechanism including a drive shaft extension in driving connection with said rotor plates, rotatable and planetarily revoluble friction driving elements, an actuator, clutch devices associated therewith and operable in one position to connect said extension to said actuator for direct drive thereby and in another position to connect said extension to said actuator by way of said friction driving elements for driving said extension at less than the angular velocity of said actuator, and a clutch control pivotally carried by said actuator for bringing said clutch devices into and maintaining them in either of their said positions.

9. A condenser including a set of stator plates, a set of rotor plates interleaved therewith, a rotor plate carrier, and mechanism including an actuator for varying the capacity of said condenser by effecting adjustment of said rotor plates angularly with respect to said stator plates at either of two different reduced rates with respect to the rate of movement of said actuator, said mechanism including a main drive shaft, a stationary outer raceway, relatively rotatable friction driving means between said shaft and raceway, said means, on rotation of said main drive shaft, causing rotation of said rotor plate carrier at an angular velocity less than that of said main drive shaft, a main drive shaft extension, rotatable and planetarily revoluble friction driving elements, and clutch devices associated therewith and operable in one position to connect said main drive shaft through its extension to said actuator for rotation of said shaft thereby at the same angular velocity as that of said actuator, and in another position to connect said main drive shaft through its extension to said actuator by way of said rotatable and planetarily revoluble friction driving elements for rotating said main drive shaft through its extension at less than the angular velocity of said actuator.

10. A condenser including a set of stator plates, a set of rotor plates interleaved therewith, and mechanism for varying the capacity of said condenser by effecting adjustment of said rotor plates angularly with respect to said stator plates at two different rates, said mechanism including a drive shaft extension in driving connection with said rotor plates, rotatable and planetarily revoluble friction driving elements, an actuator, clutch devices associated therewith and operable in one position to connect said extension to said actuator for direct drive thereby and in another position to connect said extension to said actuator by way of said friction driving elements for driving said extension at less than the angular

velocity of said actuator, and clutch control means carried by said actuator for placing and maintaining said clutch devices in either of said positions.

11. A condenser including a set of stator plates, a set of rotor plates interleaved therewith, a rotor plate carrier, and mechanism including an actuator for varying the capacity of said condenser by effecting adjustment of said rotor plates angularly with respect to said stator plates at either of two different reduced rates with respect to the rate of movement of said actuator, said mechanism including a main drive shaft, a stationary outer raceway, a first series of friction driving balls bearing on said main drive shaft and said stationary outer raceway, a ball driven separator in fixed relation to said rotor plate carrier, a rotor plate carrier extension sleeve having ball receiving openings and providing a bearing for said main drive shaft, a main drive shaft extension in fixed relation to said main drive shaft and having ball receiving openings, an outer raceway carried by and rotatable with said rotor plate carrier extension sleeve, an auxiliary drive shaft rotatable within said main drive shaft extension, a second series of friction driving balls, located between said rotatable outer raceway and said auxiliary drive shaft and in said last-named ball receiving openings, a ball separator for said second series of driving balls fixed to said main drive shaft extension, said main drive shaft extension and said actuator having inter-engageable clutch surfaces, said auxiliary drive shaft being movable into and out of driving engagement with said second series of driving balls, spring means urging said auxiliary drive shaft into engagement with said second series of driving balls, and a clutch control carried by said actuator and movable to two positions, said clutch control in one position holding said clutch surfaces in driving engagement and said auxiliary drive shaft out of driving engagement with said second series of driving balls, and said clutch control in another position releasing the driving engagement between said clutch surfaces and said spring means thereupon causing driving engagement between said auxiliary drive shaft and said second series of driving balls.

12. In combination, a frame, a rotatable member, an outer ball race secured to said frame, a sleeve portion fixed to said rotatable member and providing therewith a drive shaft bearing, a drive shaft carried by and rotatable within said sleeve portion, said drive shaft having a ball raceway and said sleeve portion having ball receiving openings therein, a plurality of driving balls between said ball race and said ball raceway and located in said openings and locking said drive shaft in said sleeve portion, and a ball spacer fixed to said rotatable member and having resilient arms cooperating with said balls for rotating said rotatable member on rotation of said drive shaft at an angular velocity less than that of said shaft.

13. In combination, a frame, a rotatable member, a ball race secured to said frame, a drive shaft carried by and rotatable with respect to said member, said drive shaft having a ball raceway, a plurality of balls between said ball race and said ball raceway, and a resilient ball retainer carried by and rotatable with said rotatable member verging together into driving relation with said balls and said drive shaft.

14. In combination, a drive shaft, a sleeve rotatably embracing said drive shaft and having a solid end portion beyond the end of the drive shaft, a driven shaft having a tubular portion secured to said solid end of said sleeve, a fixed member having an outer raceway formed therein, the inner end of the drive shaft being dished to form an inner raceway, a plurality of balls riding in said raceways, the sleeve having apertures for said balls, a spacer member secured to said sleeve and having a plurality of resilient spacer arms, and a ball thrust bearing between the inner end of the drive shaft and the solid portion of the sleeve.

15. In combination with a frame, a rotor shaft, a sleeve having a solid end portion to which said rotor shaft is secured, a drive shaft rotatably mounted in said sleeve and having an inner raceway formed adjacent its inner end, a stationary element having an outer raceway formed therein and adjustably mounted in said frame, a plurality of balls riding in said raceways, the sleeve having apertures for said balls, a spacer member secured to said sleeve and having a plurality of spacer arms, a ball thrust bearing between the inner end of said drive shaft and the solid portion of said sleeve, and a thrust bearing for the end of said rotor shaft comprising a ball and a resilient receiver therefor secured to the frame.

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