Nov. 1, 1960 W. A. BARDEN 2,958,837

TANDEM CONTROL FOR STEREOPHONIC SOUND REPRODUCING SYSTEMS

Filed Aug. 31, 1959 2 Sheets-Sheet 1

Fig. 1.

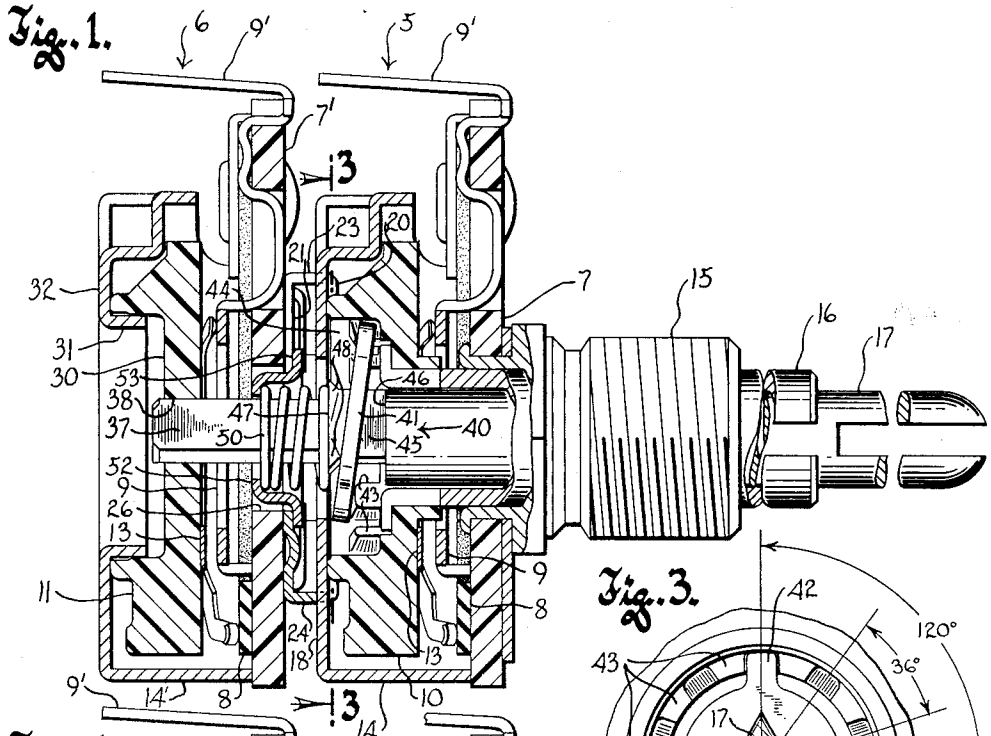


Fig. 3.

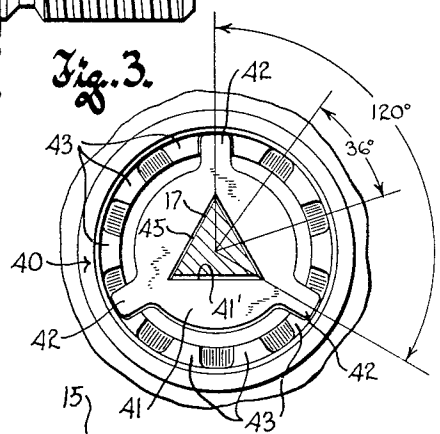


Fig. 4.

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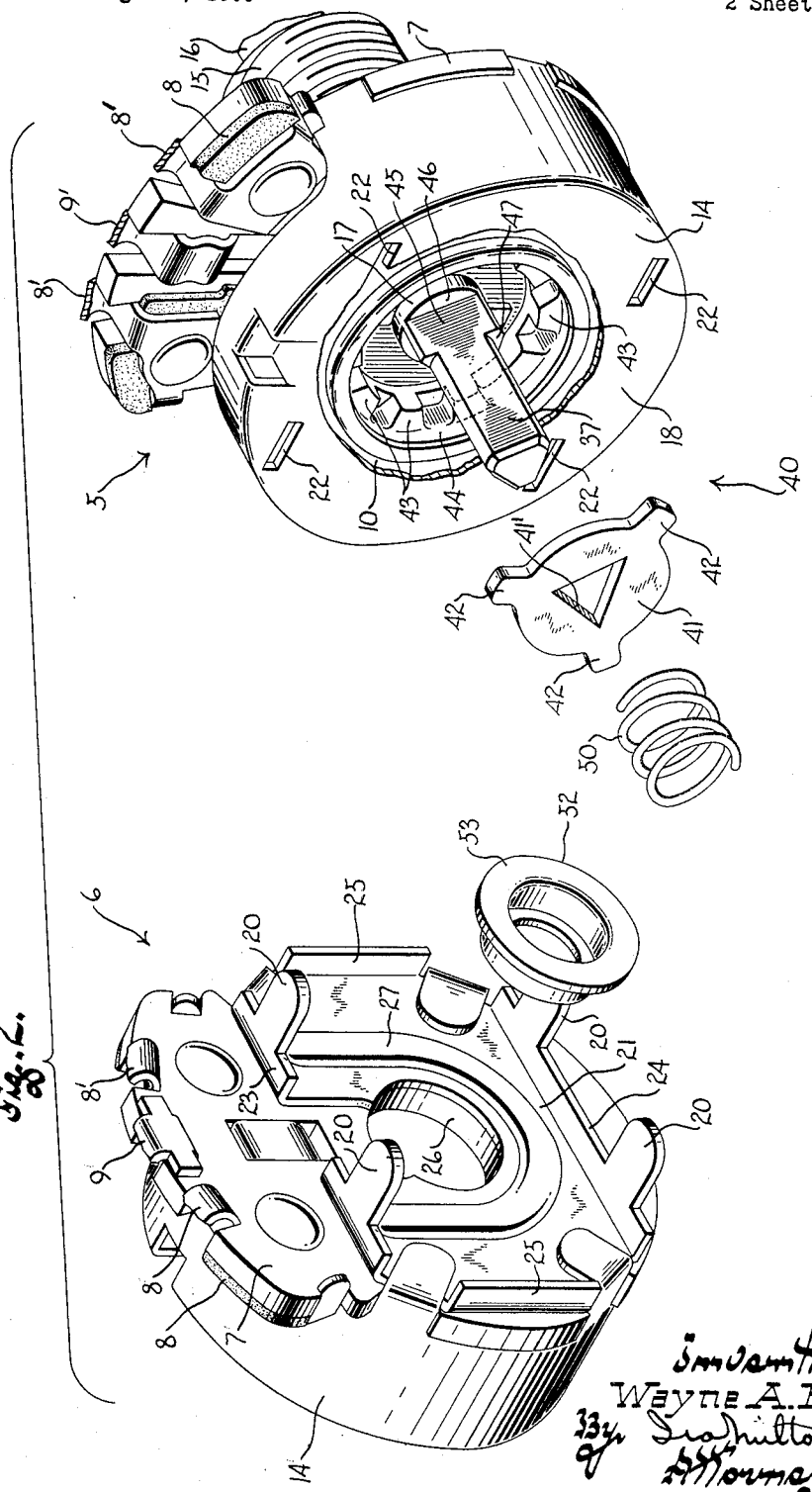


Fig. 2.

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TANDEM CONTROL FOR STEREOPHONIC SOUND REPRODUCING SYSTEMS

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14 Claims. (Cl. 338—134)

This invention relates to electric controls and refers more particularly to a control for stereophonic sound reproducing systems. Very broadly and simply stated the purpose of this invention is to provide an improved volume control for stereophonic sound reproducing systems.

Stereophonic sound reproducing systems and some radio and television receivers with audio amplifiers utilizing the stereophonic principle have two or more separate amplifier channels each of which feeds a separate speaker. It is of course desirable that each channel have its own volume control, but it is also desirable that all of the channels be capable of concomitant adjustment so that once a predetermined balance between the speakers is achieved, the total sound level may be controlled by a single adjustment.

This invention achieves this object through the provision of a tandem control in which the adjustable elements, that is the rotors, of two or more tandem connected variable resistors are releasably coupled together to be concomitantly adjustable by a single knob, but also capable of individual adjustment.

One of the objects of this invention is to provide a tandem control with a simple disengageable clutch means by which the rotors of the individual control units are normally coupled together to turn in unison in a selected position of relative rotation; but which clutch means may be readily disengaged to allow one rotor to be turned with respect to the other and thereby establish a different position of relative rotation between the rotors.

More specifically it is an object of this invention to provide a disengageable clutch means between two adjacent coaxial rotors of a tandem control, which in its engaged condition couples the rotors together for rotation in unison by a common actuating or drive shaft and which in addition may be quickly disengaged by simply shifting the shaft axially.

Bearing in mind that controls of the character to which this invention pertains must be small in size, it is another object of this invention to provide a clutch means for the purpose described, which is of such design and construction and so combined with the elements of the tandem control that its presence therein in nowise increases the overall size of the control.

Another object of this invention is to provide a disengageable clutch for the purpose set forth, which operates upon the jaw clutch principle to positively connect the rotors of the adjacent controls in definite relative positions of rotation, and in addition is so designed and constructed that the angular distance between the defined positions in which its elements are connectible is very small.

A further object of this invention is to provide disengageable clutch means between the rotors of two tandem mounted variable resistors or similar control units by which the rotors of the adjacent control units may be coupled together for concomitant adjustment by a single actuating shaft but which is so designed and constructed that each of the two units may have its own shaft so that when

the clutch is disengaged, the rotor of each unit may be individually adjusted or positively held against turning while the rotor of the other is adjusted.

With the above and other objects in view which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate two complete examples of the physical embodiments of the invention constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a longitudinal sectional view through a control embodying this invention, and which comprises two tandem connected variable resistors, each equipped with its own operating shaft;

Figure 2 is an exploded perspective view of the control shown in Figure 1 and illustrating particularly the elements of the disengageable clutch means by which the rotors of the two resistors may be coupled together for concomitant adjustment by a single shaft;

Figure 3 is a detail cross sectional view through Figure 1 on the plane of the line 3—3; and

Figure 4 is a longitudinal sectional view similar to Figure 1 but illustrating a slightly modified embodiment of the invention which differs from that shown in Figure 1 primarily by the fact that there is only one actuating shaft.

Referring now particularly to the accompanying drawings in which like reference characters designate like parts, the numerals 5 and 6 identify generally the front and rear units of a compound tandem or multiple control of the type with which this invention is concerned. In this embodiment of the invention each of these units is a variable resistor having the customary stator and rotor elements. The stator elements of the two units are mounted on bases 7—7′ of insulating material and in each instance consist of an arcuate resistance element 8, a center or collector contact 9, and terminals 8′ and 9′. The rotors of the front and rear units comprise round disc-like contact carriers or drivers 10 and 11 respectively, and bridging contactors 13 mounted thereon and provided with resilient contact fingers which ride upon and bridge the resistance elements and the collector contacts. Since the details of these stator and rotor elements form no part of this invention they have not been illustrated in detail, and description beyond that given is superfluous. Moreover, these elements may be of any conventional form.

In each of the two units the insulated base 7—7′ coacts with a stamped metal shell or cover 14—14′ to enclose the instrumentalities of the control unit; and a threaded bushing 15 is secured to the base 7 of the front unit to provide means for mounting the complete control upon a supporting panel, not shown. In that embodiment of that invention shown particularly in Figures 1 and 2 where each unit of the control has its own shaft, the bushing 15 forms a bearing for a tubular shaft 16, the inner end of which is fixed to the driver or contact carrier 10 of the front unit in any suitable way. The tubular shaft 16 projects from the front of the bushing and in practice has a control knob, not shown, mounted thereon.

Inside the tubular shaft 16 is a solid metal actuating shaft 17. This shaft is freely slidable and rotatable in the tubular shaft 16 and extends all the way through the front unit and through a hole in the rear wall 18 of its cover 14 so that its rear end portion is in the rear unit. In that embodiment of the invention illustrated in Figure 4, a shaft 17′ which is the counterpart of the shaft 17, is journaled directly in the bushing 15 and

passes freely and directly through the rotor of the front unit.

The two units are connected together in fixed coaxial tandem relationship by tangs 20 on a ground plate 21, fixed across the front face of the insulated base 7' of the rear unit, and passing through slits 22 in the rear wall 18 of the cover of the front unit, over which they are clinched or bent. The tangs 20 project forwardly from the front edges of flanges 23 and 24 on the ground plate, which along with similar flanges 25, seat squarely upon the flat rear wall 18 of the front unit to space the two units apart; and of course the tangs 20 and the slots 22 are so located that upon connection of the two units in the manner described coaxiality therebetween will be assured.

As best shown in Figure 2 the ground plate 21 is substantially a U-shaped metal stamping embracing a hole 26 in the base 7' of the rear unit and preferably provided with a reinforcing bead 27. Attention is directed to the fact that part of the ground plate is directly contiguous to the edge of the hole 26. For a reason to be hereinafter explained this relationship between the ground plate and the edge of the hole is important in that embodiment of that invention shown in Figure 2, but has no particular significance in the control shown in Figure 4.

The drivers or contact carriers 10 and 11 of the two rotors are alike in many respects but there are also certain significant differences therebetween. Both are molded of insulating material, preferably an all purpose phenolic, and both have relatively flat front faces upon which their respective bridging contactors are mounted. Also, both have rearwardly opening central cavities or sockets, but the configuration and purpose of these sockets is different in the front and rear units. The socket of the rear unit, designated 30, provides the means by which the rotor is centered in the housing of the rear unit, and to this end a cylindrical extrusion 31 in the rear wall 32 of the rear unit cover projects into the socket 30, with the side wall of the socket journaled thereon.

The rotor of the front unit, in that form of the invention shown in Figure 1, is held properly centered by virtue of its being fixed to the tubular shaft 16, and in that form of the invention shown in Figure 4 where there is only the single actuating shaft 17' it is held centered by having the molded driver or contact carrier 10 slidably journaled directly on the shaft 17'.

In each embodiment of the invention illustrated the rear end portion 37 of the actuating shaft (17—17'') is polygonal in cross section, and preferably triangular. This polygonal (triangular) rear end portion of the shaft is slidably received in a correspondingly shaped hole 38 in the driver or contact carrier 11 of the rear unit. Accordingly, in each instance the actuating shaft has a splined torque transmitting connection with the rotor of the rear unit, which connection however accommodates axial motion of the shaft.

The actuating shaft is thus at all times drivingly connected to the rotor of the rear unit, and to enable both units to be concomitantly adjusted, the rotors thereof are releasably coupled together by clutch means indicated generally by the numeral 40. The clutch means 40 comprises a driving element in the form of a toothed disc or plate 41 having a torque transmitting connection with the actuating shaft and radially projecting teeth 42 which are interengageable with teeth 43 fixed in the bottom of the rearwardly opening socket 44 in the molded driver or contact carrier 10 of the front unit. The teeth 43 thus may be considered the driven element of the clutch means.

Obviously, if one of the teeth 42 on the drive plate engages between two teeth 43 on the driver 10, the rotor of the front unit is connected to the shaft to rotate therewith and with the rotor of the rear unit. In other words when the clutch is engaged the rotors of the two units are coupled together for rotation in unison.

The torque transmitting connection between the shaft and the drive disc 41 consists of a shaft portion 45 of polygonal cross section received in a correspondingly shaped hole 41' in the drive disc. In both embodiments of the invention illustrated, the hole 41' and the shaft portion 45 received therein are triangular, but it will be readily apparent that any polygonal shape will suffice providing that the connection allows the drive disc 41, to tilt or wobble somewhat on the shaft for a purpose to be described. This, of course, requires a bit more clearance between the shaft and the edges of the hole than would be needed for only a slidable driving connection.

Wobble or tilting of the drive disc with respect to the shaft is required for the attainment of one of the objectives of this invention, and for which it is essential that only one at a time of the three teeth 42 on the drive disc can be engaged with the teeth 43 on the driver 10; and to attain this condition the disc 41 must assume a tilted position as shown in Figure 1.

The junction of the polygonal shaft portion 45 with the round portion of the shaft forwardly thereof provides a rearwardly facing shoulder 46 which is engageable with the front of the drive disc as the shaft is pushed in to disengage the clutch means; and although the flat sides of the polygonal portions 45 and 37 are flush with one another, a second rearwardly facing shoulder 47 is formed at the junction thereof by virtue of the fact that the corners of the shaft portion 37 are cut off. The resulting steps which collectively form this second shoulder 47 provide a spring seat or stop on the shaft for a coil spring 50 which encircles the triangular shaft portion 37, and bears against the rear unit to yieldingly urge the shaft forward. These portions which provide the stop 47 are swedged after assembly of the drive disc 41 with the shaft to form lugs or abutments 48 that engage the disc and thereby transmit the forward spring produced thrust on the shaft to the disc. Consequently the spring 50 yieldingly holds the drive plate in its operative or clutch engaged position with one of its teeth 42 interengaging the teeth 43.

In the embodiment of the invention illustrated in Figure 4 the rear end of the spring 50 bears directly against the front face of the molded driver or contact carrier 11, but in the preferred embodiment of the invention shown in Figure 1 the rear end of the spring bears against a hat-shaped washer 52 seated in the hole 26 of the adjacent insulated base 7' with its flange 53 bearing upon the front of the ground plate 21. This arrangement assures good electrical grounding of the metal shaft 17; and in addition provides a more stable support for the rear end of the spring.

As noted hereinbefore only one at a time of the teeth 42 on the drive plate 41 can be engaged between teeth 43. This follows from the fact that the angular distance between adjacent teeth 43, of which there are many more than there are teeth 42, is not a multiple of the much greater angular distance between adjacent teeth 42. This relationship is illustrated in Figure 3 where the angle between the adjacent teeth 43 is shown to be 36°, and between the teeth 42, 120°. Because of it the steps between the defined positions in which the two rotors may be locked together by the clutch means, are much smaller than would be the case if all of the teeth 42 of the drive disc were to interengage the teeth 43 at one time. Specifically with the relative tooth spacing described, the angular distance between the defined positions in which the rotors may be coupled together, instead of being 36° as are the teeth 43, is one-third this angle, namely, 12°.

Attention is directed to the fact that in each of the embodiments of the invention illustrated the drive plate 41 is confined in the cavity formed conjointly by the walls of the socket 44 and the rear wall 18 of the metal cover of the front unit. Rearward motion of the shaft to disengage the clutch is thus limited by the rear wall

18. When the clutch is fully disengaged, the drive disc 41 occupies a position flat against the wall 18, as shown in Figure 4, so that its teeth 42 are entirely free from the teeth 43.

Operation

When the control of this invention is employed for the purpose for which it was primarily devised namely as a volume control for stereophonic sound reproducing systems, each of its two tandem arranged variable resistors is appropriately connected into one of the two audio frequency amplifier channels of the system. So connected it provides concomitant adjustment of the two channels to regulate the total sound level with a predetermined balance between the speakers fed by the two channels. This concomitant adjustment is effected by turning the shaft 17 in the embodiment of the invention shown in Figure 1 and 17' in the Figure 4 embodiment. If it is desired to adjust the channels individually, as for the purpose of changing the balance between speaker outputs, the shaft (17—17') is pushed in. This disengages the clutch which normally couples the resistors together for concomitant adjustment, and allows either resistor to be adjusted independently of the other. In the embodiment of the invention shown in Figure 1 such independent adjustment of the two resistors is facilitated since each has its own shaft, the tubular shaft 16 being connected to the front resistor. After a desired balance between speakers is effected by such separate and independent adjustment of the two resistors the clutch is reengaged by allowing the shaft (17—17') to be projected forwardly by the spring acting thereon, and thereafter both resistors can be concomitantly adjusted by simply turning one knob.

What I claim as my invention is:

1. In a control unit for stereophonic sound reproducing systems, the combination of: a pair of variable resistors connected coaxially in tandem, each having a rotor, rotation of which effects adjustment of its respective resistor; an actuating shaft coaxial with the rotors of the two variable resistors for concomitantly adjusting both resistors; means providing a splined torque transmitting connection between the actuating shaft and the rotor of one of the variable resistors, said connection accommodating limited axial motion of the shaft with respect to the two variable resistors; disengageable clutch means positively coupling the rotors of the two variable resistors for concomitant adjustment in any one of a number of different relative positions of rotation; and means operable by axial motion of the shaft in one direction to disengage the clutch means and thereby enable the relative positions of rotation of the two rotors to be changed.

2. The control unit of claim 1, further characterized by the provision of a second actuating shaft having a fixed torque transmitting connection with the rotor of the other variable resistor, so that the rotor of one of the resistors may be positively held against rotation while the rotor of the other resistor is rotationally adjusted.

3. The control unit of claim 1 further characterized by the fact that the rotor which is not splined to the actuating shaft has the shaft passing therethrough, and has teeth concentrically arranged around the shaft to provide the driven element of the disengageable clutch means; a toothed disc slidably splined to the actuating shaft, between the two rotors and forming the driving element of the clutch means, said disc being movable along the shaft to and from an operative clutch engaged position in which a tooth thereon interengages with certain of the rotor carried teeth; and spring means yieldingly urging the toothed disc towards it operative clutch-engaged position; the means for disengaging the clutch means comprising a shoulder on the shaft engageable with the disc to move the disc axially of the shaft against the bias of said spring means.

4. In a control unit for stereophonic sound reproducing systems the combination of: a pair of variable resistors

each having a rotor including an insulated contact driver; means mounting the two variable resistors in axially fixed coaxial tandem relation; an actuating shaft for concomitantly adjusting both resistors, said shaft passing freely through the rotor of one of the variable resistors and having a splined driving connection with the insulated driver of the other resistor; the insulated driver of the first designated resistor having a central socket opening toward the other resistor; circumferentially spaced fixed teeth in said socket; a clutch disc in said socket, slidably splined to the actuating shaft; circumferentially arranged teeth on said clutch disc interengageable with the teeth on the socketed driver to thereby couple the rotors of the two variable resistors for concomitant adjustment; a spring yieldingly urging the clutch disc to its operative clutch engaged position; and abutment means on the shaft engageable with the disc upon axial motion of the shaft in one direction to move the disc against the bias of said spring means and thereby disengage the clutch and allow the rotors to be turned relative to one another.

5. The control unit of claim 4 further characterized by the fact that the teeth on the socketed rotor driver are considerably greater in number than the teeth on the clutch disc, and are circumferentially spaced a distance which is not a multiple of the larger angular spacing of the teeth on the clutch disc, so that only one of the teeth on the clutch disc can interengage with the teeth on the rotor driver to thereby decrease the angular spacing between the defined positions of relative rotation in which the two rotors may be coupled together.

6. The control unit of claim 5 further characterized by the fact that there are three equispaced teeth on the clutch disc.

7. In a control unit of the character described, the combination of: front and rear tandem disposed coaxial control units, each of which has a rotor, the front rotor having a rearwardly opening socket at its center; an actuating shaft passing through the front unit and being freely rotatable and slidable with respect to its rotor; means providing a slidably splined torque transmitting connection between the actuating shaft and the rotor of the rear unit so that the rotor of the rear unit is at all times drivingly coupled to the shaft; and disengageable clutch means to drivingly couple the rotor of the front unit to the shaft so that both rotors may be concomitantly turned by the shaft, with the two rotors in a selected position of relative rotation, said clutch means comprising circumferentially spaced teeth fixed to the rotor of the front unit inside the socket therein, a toothed drive disc in said socket and having teeth interengageable with the teeth in the socket, and a torque transmitting connection between the shaft and the drive disc, said last named connection accommodating movement of the drive disc along the shaft to and from a clutch engaged position in which the teeth of the drive disc interengage with those fixed in said socket; a spring reacting between the rear unit and said drive disc to yieldingly hold the disc in its clutch engaged position; and abutment means on the shaft engageable with the drive disc upon rearward axial motion of the shaft, to disengage the clutch and thereby enable relative rotation of the rotors.

8. The control of claim 7, further characterized by the fact that the teeth which are fixed to the rotor of the front unit are more in number than the teeth on the drive disc and are spaced apart an angular distance which is not a multiple of the greater angular spacing of the teeth on the drive disc, so that only one at a time of the drive disc teeth can engage between teeth fixed in said socket; and further characterized by the fact that said torque transmitting connection between the shaft and the drive disc accommodates the tilting of the drive disc necessary to have only one of its teeth engaged with the teeth fixed in the socket.

9. The control unit of claim 7, further characterized by

a tubular shaft surrounding the actuating shaft and fixed to the rotor of the front unit, said tubular shaft providing means whereby, upon disengagement of the clutch means, the rotor of the front unit may be turned independently of the rotor of the rear unit or held against rotation while the rotor of the rear unit is turned.

10. The control unit of claim 7, further characterized by: a metal ground plate on the rear unit and forming part of the front wall thereof, said ground plate having a hole through which the actuating shaft passes, the shaft being metal; a forwardly facing shoulder on the actuating shaft engageable with the rear of the drive disc; a rearwardly facing shoulder on the actuating shaft forwardly of said ground plate; and a metal washer encircling the actuating shaft and bearing against said ground plate; the spring being coiled about the shaft and confined between the rearwardly facing shoulder on the shaft and said washer, so that the drive disc, the shaft and the spring are at all times electrically grounded to said ground plate.

11. In combination: two separate rotors; means rotatably mounting the rotors coaxially in tandem and in fixed axially spaced relation; a common drive shaft for the two rotors; a splined driving connection between the shaft and one of the rotors, said connection accommodating limited axial movement of the shaft relative to the two rotors; disengageable clutch means to couple the two rotors together; and a clutch disengaging connection between the drive shaft and the clutch means through which axial motion of the shaft in one direction effects disengagement of the clutch means to enable the rotors to be rotated with respect with one another for adjustment of their relative positions of rotation.

12. The structural combination of claim 11, wherein the disengageable clutch means comprises a driving element having a torque transmitting connection with the shaft and axially movable with respect thereto, a driven element constituting part of the rotor which is not splined to the shaft, and teeth on said elements interengageable by axial movement of the driving element towards the driven element to couple the two rotors together in any one of a number of different relative positions of rotation; wherein said clutch disengaging connection comprises an abutment on the shaft engageable with the driving element to move the same axially away from the driven element as the shaft is shifted axially in the direction to carry the abutment thereon towards the driving element; and spring means urging the driving element towards the driven element.

13. The structural combination of claim 11 further characterized by the fact that the clutch means comprises a toothed driving element between the two rotors, a torque transmitting connection between said toothed driving element and one of the rotors at all times coupling said rotor and the toothed driving element, and a series of circumferentially spaced teeth on the other rotor with which a tooth on the toothed driving element connects in the engaged condition of the clutch means; said toothed driving element being axially movable by the drive shaft to disconnect the toothed element from said rotor carried teeth.

14. The structural combination of claim 11 further characterized by the fact that the rotor which is not splined to the drive shaft has a central socket opening toward the other rotor; and the fact that the clutch means comprises a series of circumferentially spaced teeth fixed in the bottom of the socket, a drive disc in the socket splined to the shaft to at all times turn with the shaft, circumferentially spaced teeth on the drive disc, the number of such teeth on the drive disc being in excess of two but considerably less than the number of said teeth in the bottom of the socket, and said teeth in the bottom of the socket having an angular spacing which is not a multiple of the larger angular spacing of the teeth on the drive disc so that only one drive disc tooth at a time may interengage the teeth in the bottom of the socket, and means yieldingly urging the drive disc axially toward the bottom of the socket; the clutch disengaging connection between the shaft and the clutch means being an abutment on the shaft positioned to engage the drive disc and move it away from the bottom of the socket as the shaft is moved axially to disengage the clutch means.

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