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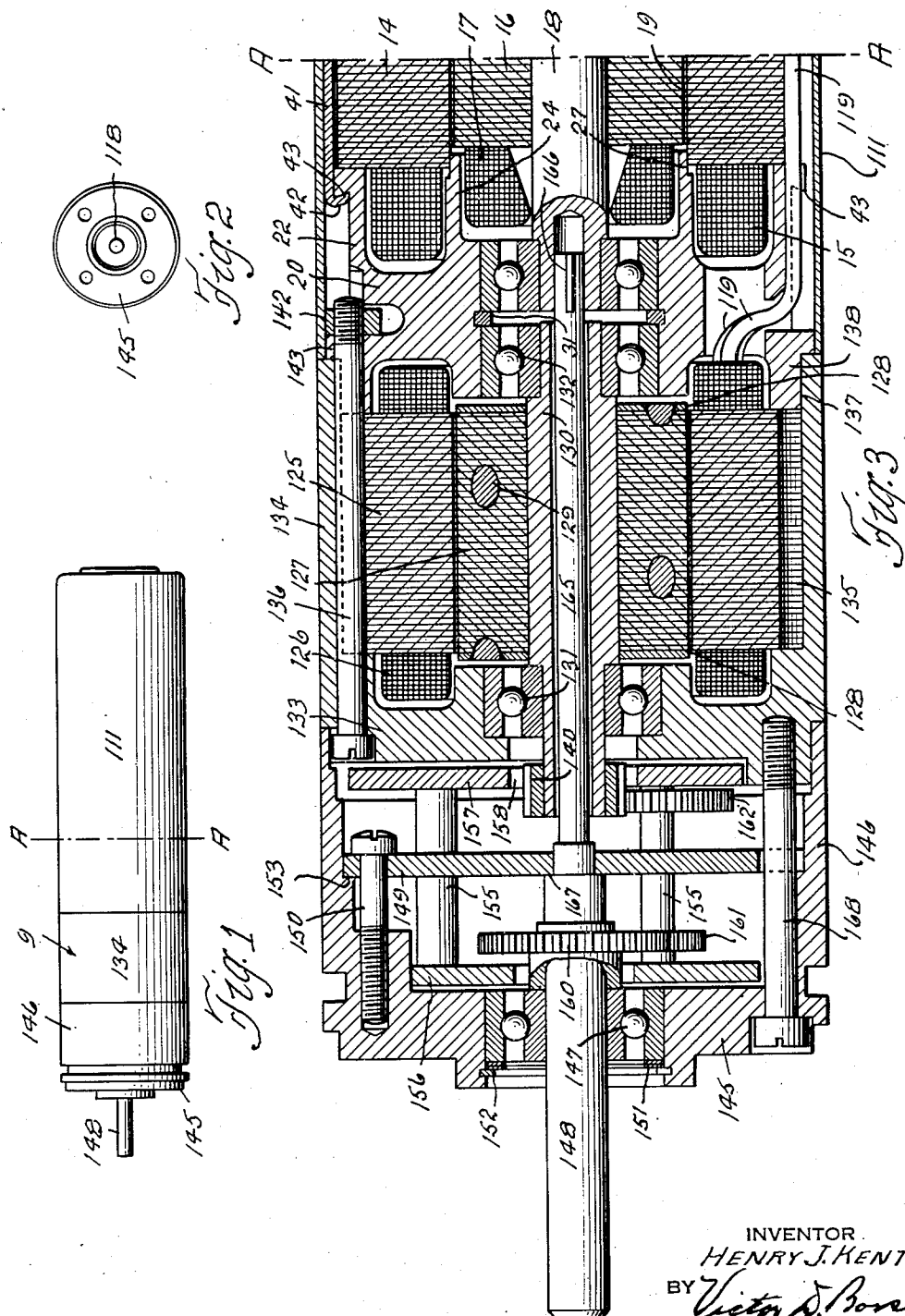
H. J. KENT

2,448,374

DUAL SPEED SYNCHRO UNIT

Filed June 7, 1947

4 Sheets-Sheet 1



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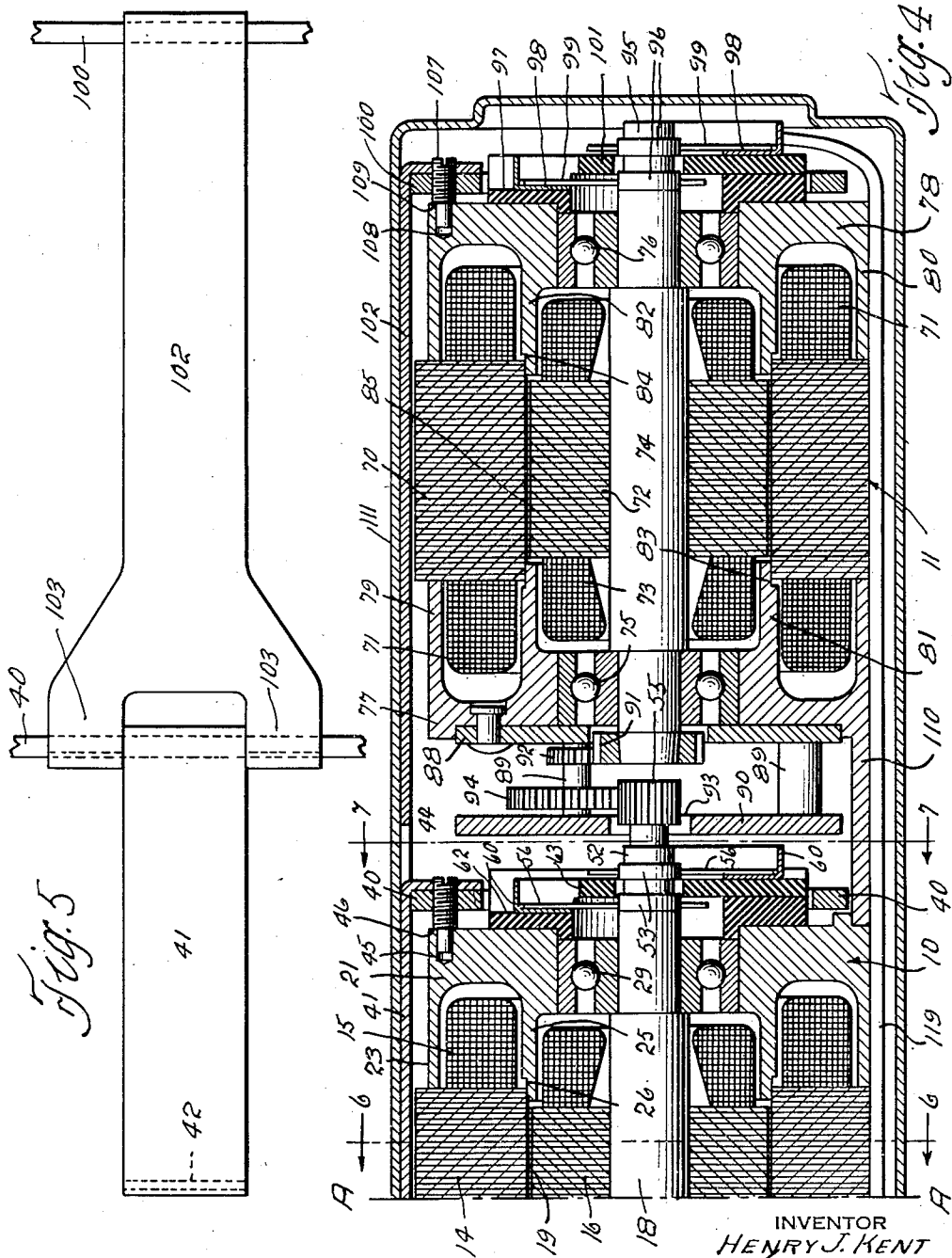
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DUAL SPEED SYNCHRO UNIT

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4 Sheets-Sheet 2



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4 Sheets-Sheet 3

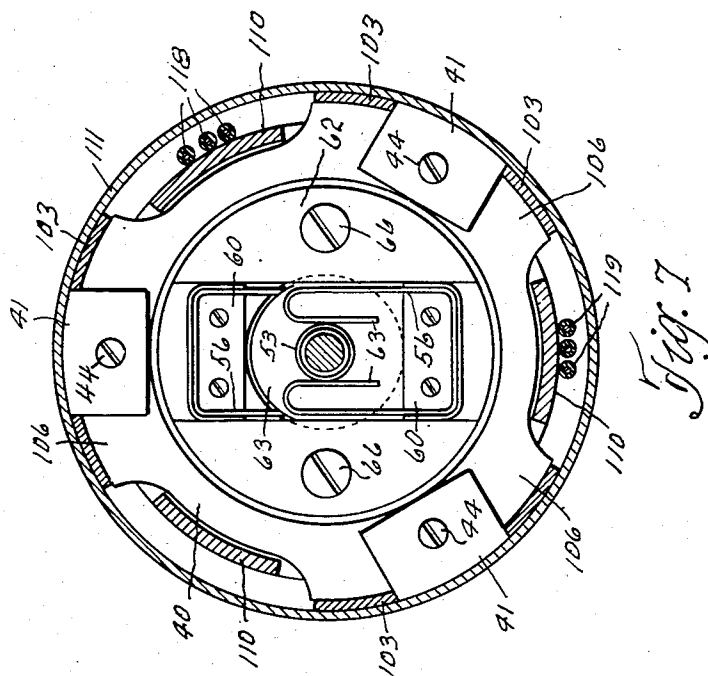


Fig. 7

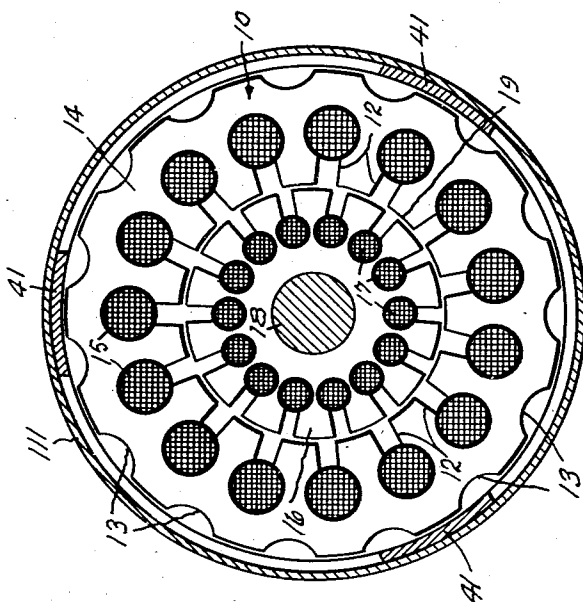


Fig. 6

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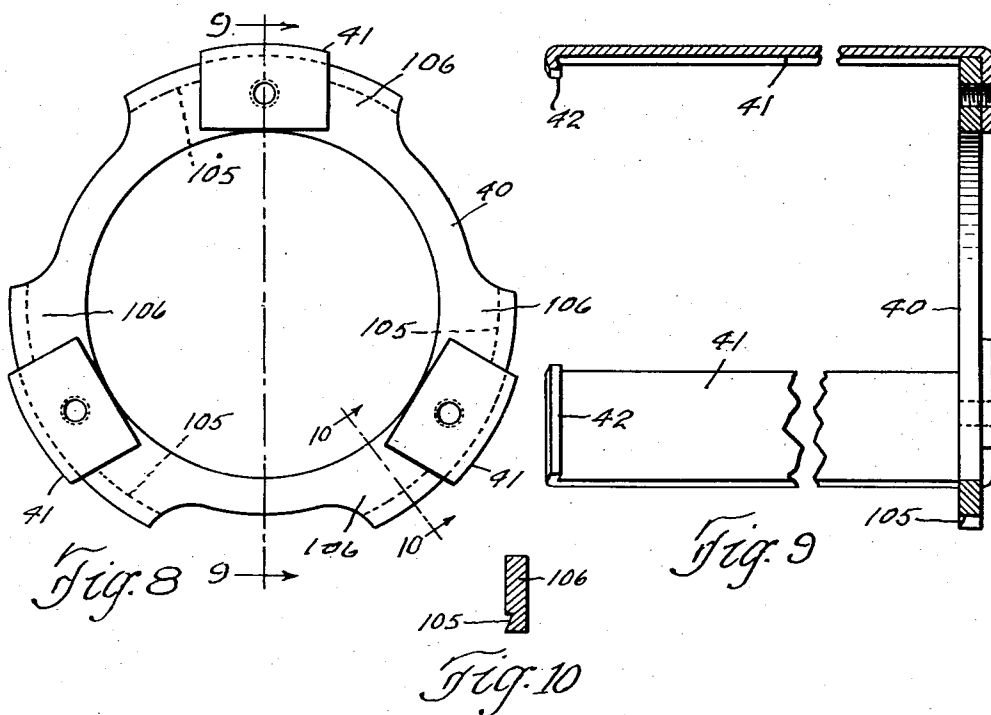
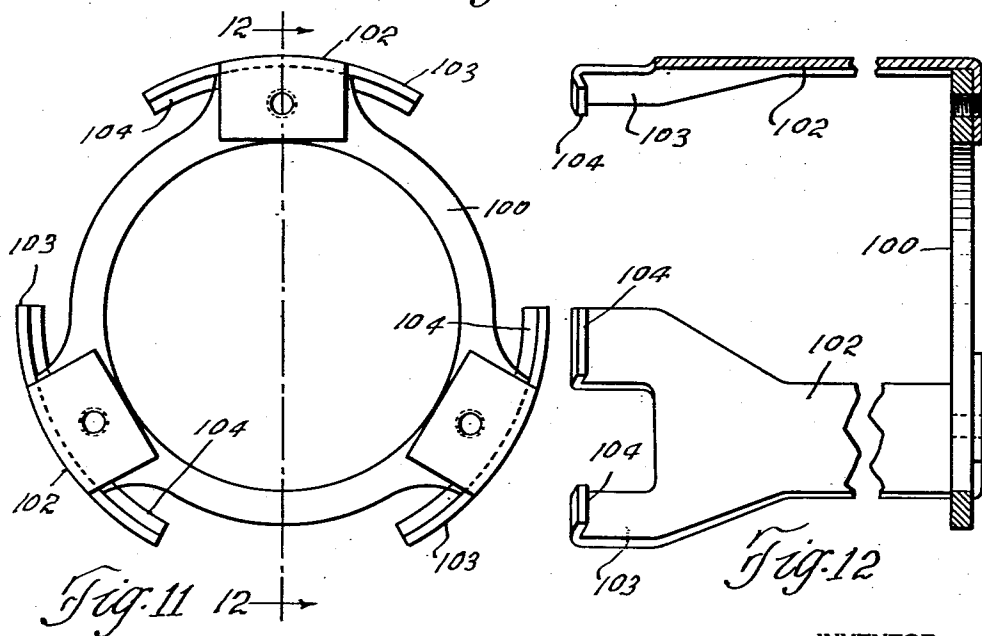
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DUAL SPEED SYNCHRO UNIT

Filed June 7, 1947

4 Sheets-Sheet 4



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2,448,374

DUAL SPEED SYNCHRO UNIT

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Application June 7, 1947, Serial No. 753,335

4 Claims. (Cl. 171-252)

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This invention relates to a synchro unit and more particularly to a unit including a servomotor and a pair of synchro elements geared together for operation at selected speed ratios.

An object is to provide, in a unit of the above type, novel and improved clamping means for securing the various elements together.

Various other objects and advantages will be apparent as the nature of the invention is more fully disclosed.

More specifically, the present invention may be embodied in a unit including a pair of synchros of the wound rotor type which are geared together so that one synchro constitutes a high speed element and the other synchro constitutes a low speed element, and a motor which is mounted in axial alignment with the synchros and is geared thereto for driving the same to their designated positions. The motors and the synchros are provided with wound stators of magnetic material having axially extending, aligned peripheral grooves to receive axially extending clamping means and electrical leads.

Although the novel features which are characteristic of this invention are pointed out more particularly in the claims, the nature of the invention will be better understood by referring to the following description, taken in connection with the accompanying drawings in which a specific embodiment thereof has been set forth for purposes of illustration.

In the drawings:

Fig. 1 is an approximately full sized side elevation of a unit embodying the present invention;

Fig. 2 is an end elevation thereof;

Fig. 3 is an axial longitudinal section through the portion of the unit of Fig. 1 to the left of the line A—A taken on an enlarged scale;

Fig. 4 is a similar longitudinal section through the portion of the unit of Fig. 1 to the right of line A—A;

Fig. 5 is a detail view of one of the clamping elements;

Figs. 6 and 7 are sections taken on the lines 6—6 and 7—7, respectively, of Fig. 4;

Fig. 8 is a front elevation of the clamping ring for the high speed synchro;

Figs. 9 and 10 are sections taken on the lines 9—9 and 10—10, respectively, of Fig. 8;

Fig. 11 is a front elevation of the clamping ring for the low speed synchro; and

Fig. 12 is a section taken on the line 12—12 of Fig. 11.

Referring to the drawings more in detail, the unit is shown as comprising a motor 9, a high-

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speed synchro 10 and a low-speed synchro 11 which are mounted in axial alignment.

The high speed synchro 10 comprises a stationary field 14 of magnetic material having slots 12 (Fig. 6) carrying a distributed winding 15, and a rotor 16 of magnetic material having slots carrying a distributed winding 17 and mounted on a shaft 18. The stator 14 is provided with an axial bore 19 in which the rotor 16 revolves.

End plates 20 and 21 are provided with peripheral flanges 22 and 23, respectively, which bear against the ends of the stator 14 and with hubs 24 and 25 having cylindrical surfaces 26 and 27 which are machined to fit tightly within the bore 19 of the stator 14 for centering the rotor 16 in the stator. The end plates 20 and 21 carry bearings 28 and 29 in which the shaft 18 is journaled. The bearing 28 is positioned by a snap ring 31.

The stator 14 is provided with a plurality of axially extending grooves 13 (Fig. 6) spaced around the periphery thereof and located peripherally between the slots 12 so that the thickness of the magnetic path is not reduced by the grooves.

The shaft 18 projects beyond the bearing 29 and carries an insulating bushing 52 on which slip rings 53 are mounted. The bushing 52 and slip rings 53 are of a size to pass through the bearing 29 for purposes of assembly. The shaft 18 also carries a gear 55 for connection to the low speed synchro 11 to be described.

A pair of U-shaped brush ribbons 56 (Fig. 7) are attached to plates 60 which are screwed to an insulating ring 62. The brush ribbons 56 are bent back at their ends to form brushes 63 which bear against the slip rings 53. An insulating baffle 64 is disposed between the brushes to prevent accidental contact therebetween. The insulating ring 62 is secured against the end plate 21 by screws 66.

A clamping ring 40 (Figs. 4 and 7-10) carries a plurality of clamping arms 41 which span the stator 14 and are provided at their ends with hooks 42 which engage an undercut annular shoulder 43 formed on the flange 22 of the end plate 20. The clamping ring 40 carries set screws 44 which are journaled in aligning recesses 45 in the end plate 21 and are provided with shoulders 46 which bear against the end plate for tightening the arm 41 so as to clamp the flanges 22 and 23 of the end plates 20 and 21 against the ends of the stator 14. The shoulder 43 extends entirely around the flanges 22 so that the end plates may be clamped in any desired relative angular posi-

tion so as to provide maximum concentricity between the stator 14 and the rotor 16.

The low speed synchro 11 comprises a stator 70 formed of magnetic material having slots carrying a distributed winding 71 and a rotor 72 formed of magnetic material, having slots carrying a distributed winding 73. The rotor 72 is mounted on a shaft 74 which is journaled in bearings 75 and 76 mounted in end plates 77 and 78, respectively. The end plates 77 and 78 are provided with outer peripheral flanges 79 and 80 which bear against the ends of the stator 11 and with inner hubs 81 and 82 having cylindrical surfaces 83 and 84 which are accurately machined to fit within an internal bore 85 of the stator 70. The stator 70 is provided with peripheral grooves similar to the grooves 13 of the stator 14.

A ring 88 is attached to the end plate 77 by suitable means, shown as studs 89, which carry a second ring 90 axially spaced from the ring 88 and having an axial opening 93 to receive the gear 55. The shaft 74 carries at its end a gear 91. Gears 92 and 94 are carried by the studs 89 and mesh respectively with the gears 55 and 91.

The shaft 74 projects through the bearing 76 and carries an insulating bushing 95 on which slip rings 96 are mounted. The bushing 95 and slip rings 96 are of a size to pass through the bearing 76 for purposes of assembly. An insulating ring 97 carries plates 98 on which brushes 99 are mounted. An insulating baffle 101 is disposed between the brushes 99. The ring 97, plates 98, baffle 101 and brushes 99 are similar to the corresponding elements of the synchro 10 above described. The insulating ring 97 is secured to the end plate 78 by screws (not shown).

A clamping ring 100 carries a plurality of clamping arms 102 which span the stator 70 and end plates 77 and 78 and are provided with bifurcated ends 103 which are spaced to pass on opposite sides of the clamping arms 41 and are formed with hooks 104 which engage undercut grooves 105 (Figs. 8 and 10) formed in ears 106 on the clamping plate 40 on opposite sides of the clamping arms 41. The ring 100 carries set screws 107 which enter aligning recesses 108 in the end plate 78 and are provided with shoulders 109 which bear against the end surface of the end plate 78 for exerting clamping pressure on the arms 102.

The end plate 77 is provided with a peripheral positioning flange 110 which is adapted to engage the end plate 21 of the synchro 10 for positioning the two elements. The flange 110 is formed with segmental slots to receive the arms 102.

A casing 111 is positioned over the assembled unit and secured over peripheral flange 22 on the end plate 20.

The motor 9 comprises a stator 125 of magnetic material having slots carrying a distributed winding 126 and a rotor 127 of the squirrel-shaped type including conducting rings 128 joined by conductors 129. The rotor 127 is mounted on a hollow shaft 130 which is journaled in a bearing 131 in an end plate 133 and in a bearing 132 in the end plate 20. The end plate 133 is provided with a peripheral flange 134 which spans the stator 125 and engages the end plate 20.

The stator 125 is provided with peripheral grooves 135 similar to the groove 13 of the stator 14. Clamping rods 136 extend through holes in the end plate 133 and are threaded into a clamping ring 142 which bears against a flange 143 on the end plate 20. The clamping rods 136 serve

to secure the end plate 133 to the end plate 20 for supporting and positioning the stator 125 and rotor 127. The flange 134 of the end plate 133 seats in a recess 137 in a flange 138 of the end plate 20 for positioning the motor element.

The hollow shaft 130 carries a gear 140 located beyond the end plate 133. A cap 145 is provided with a flange 146 seating against the end plate 133 to provide a gear chamber. The cap 145 carries a bearing 147 in which a shaft 148 is journaled. A disc 149 is located against a shoulder 153 on the cap 145 and is secured thereto by screws 150. The bearing 147 is locked by means of shims 151 and a snap ring 152 engaging a recess in the cap 145. The ring 149 carries a plurality of studs 155 on which plates 156 and 157 are mounted. The plate 157 is provided with a central opening 158 which is adapted to pass over the gear 140. A gear 160 is mounted on the shaft 148. Gears 161 and 162 are mounted on a stud 155 and mesh respectively with the gears 160 and 140 for gearing the shaft 148 to the hollow shaft 130. The shaft 148 is provided with an extension 165 of reduced diameter which extends through the bore of the hollow shaft 130 and is keyed to the shaft 18 of the synchro 10 by means of a key 166. The shaft 148 is also provided with a shoulder 167 which positions the shaft against the disc 149. The end cap 145 is secured to the end plate 133 by a plurality of bolts 168 which extend through the cap 145 and are threaded into the end plate 133.

In assembling this unit the synchro 10 is first assembled by positioning the end plates 20 and 21 against the two ends of the stator 14, positioning the clamping ring 40 against the end plate 21 with the set screws 44 inserted in the aligning holes 45 in the end plate and engaging the hooks 42 of the arms 41 in the annular shoulder 43 of the end plate 20. The set screws 44 are then tightened for clamping the elements together.

The synchro 11 is next assembled by positioning the end plates 77 and 78 against the stator 70 and locating the flange 110 of the end plate 77 against the end plate 21 of the synchro 10. The clamping ring 100 is then positioned over the end plate 78 with the set screws 107 engaged in the aligning recesses 108, and the hooks 104 of the arms 102 are engaged in the recesses 105 of the clamping ring 40. The set screws 107 are then tightened for clamping the unit 11 in position as shown in Fig. 4.

The motor 9 is then assembled by assembling the end plates 20 and 133, the stator 125 and the rotor 127 and securing the same by means of the rods 136. The end cap 145 is then positioned over the end plate 133, the shaft 165 passing through the hollow shaft 130, and sliding into the end of the shaft 18. At the same time the gear 162 is brought into mesh with the gear 140. The end cap may be secured by the bolts 168.

The electrical connections from the rotor windings to the slip rings may be positioned in suitable recesses in the shafts 18 and 74, respectively. Leads 118 from the windings of the synchro 10 may be positioned around the positioning flange 110 in the space between the ears 106 of the ring 40 (Fig. 7) and may be positioned in certain of the spaced axial grooves in the stator 70. Electrical leads 119 to the motor 9 may lie in certain spaced axial grooves of the stators 14 and 70 and may extend between adjacent ears 106 of the ring 40 so that all of the leads are contained within the peripheral confines of the unit.

In the operation of this device, the gear trains

comprising the gears 35, 91, 92 and 94 may be selected to provide any desired ratio between the low speed synchro 11 and the high speed synchro 10. A ratio of 36:1 may, for example, be used. The low speed synchro thus comprises the primary follower to follow the signal and the high speed synchro comprises a vernier for increasing the accuracy of the unit. The low speed synchro, however, prevents the high speed synchro from falling one or more complete rotations out of registration with the incoming signal.

The synchro elements have been shown as including wound rotors with distributed windings, but the structure may also be applied to rotors of the salient pole type or to brushless rotors. The stator windings may be of the two-phase or three-phase type and the rotor windings may be of the single phase, two-phase or three-phase type depending upon the use to which the unit is to be applied.

For operation as a servo, the synchros are electrically connected as control transformers to the corresponding synchros of a transmitter and the motor 9 is energized to drive the synchros 10 and 11 to the designated angular position as indicated by the received signals. The clamping arms as shown may, of course, be applied to a double synchro unit and have been shown for purposes of illustration only as applied to a unit including a servomotor.

The unit above described is compact and may be assembled in a small size as indicated by Fig. 1. The motor 9 may be designed to supply power to operate a suitable apparatus which is to be controlled by the incoming signal.

Although a specific embodiment of the invention has been shown for purposes of illustration, it is to be understood that the invention is capable of various uses and that modifications may be made therein as will be readily apparent to a person skilled in the art. The scope of the invention is only to be limited in accordance with the following claims.

What is claimed is:

1. A multiple synchro unit comprising a pair of synchro elements mounted in axial alignment, each of said elements comprising a stator of magnetic material, end plates engaging the ends of said stator, a shaft journaled in said end plates and a rotor carried by said shaft to rotate in the stator, gears interconnecting the shafts of the respective elements, a spacing flange extending between the inner end plates of said elements, and clamping means for said elements comprising a clamping ring adjacent the inner end plate of one of said elements, a plurality of clamping arms carried by said ring, spanning the stator of said one element and terminating in flanges engaging the outer end plate of said one element, members carried by said clamping ring and bearing against said inner end plate for exerting clamping pressure on said arms, a second clamping ring positioned adjacent the outer end plate of the other of said elements and carrying clamping arms spanning said other element and said spacing flange and having bifurcated ends extending on opposite sides of said first arms and provided with flanges engaging said first clamping ring, and members carried by said second clamping ring and engaging said last mentioned outer end plate for exerting clamping pressure on said last arms to secure said other element to first element.

2. A multiple synchro unit comprising a pair

of synchro elements mounted in axial alignment, each of said elements comprising a stator of magnetic material, end plates engaging the ends of said stator, a shaft journaled in said end plates and a rotor carried by said shaft to rotate in the stator, gears interconnecting the shafts of the respective elements, a spacing flange extending between the inner end plates of said elements, and clamping means for said elements comprising a clamping ring adjacent the inner end plate of one of said elements, a plurality of clamping arms carried by said ring and spanning the stator of said one element and terminating in hooks engaging the outer end plate of said one element, members carried by said clamping ring and bearing against said inner end plate for exerting clamping pressure on said arms, a second clamping ring positioned adjacent the outer end plate of the other of said elements and carrying clamping arms spanning said other element and said spacing flange and having bifurcated ends extending on opposite sides of said first arms and terminating in hooks engaging said first clamping ring, and members carried by said second clamping ring and engaging said last mentioned outer end plate for exerting clamping pressure on said last arms to secure said other element to the first element.

3. A multiple synchro unit comprising a pair of synchro elements mounted in axial alignment, each of said elements comprising a stator of magnetic material, end plates engaging the ends of said stator, a shaft journaled in said end plates and a rotor carried by said shaft to rotate in the stator, gears interconnecting the shafts of the respective elements, a spacing flange extending between the inner end plates of said elements, and clamping means for said elements comprising a clamping ring adjacent the inner end plate of one of said elements, a plurality of clamping arms carried by said ring and spanning the stator of said one element, an annular shoulder formed on the outer end plate of said one element, hooks formed on the ends of said arms and engaging said annular shoulder, set screws carried by said clamping ring and bearing against said inner end plate for exerting clamping pressure on said arms, a second clamping ring positioned adjacent the outer end plate of the other of said elements and carrying clamping arms spanning said other element and said spacing flange and having bifurcated ends extending on opposite sides of said first arms, said bifurcated ends being provided with hooks engaging said first clamping ring and set screws carried by said second clamping ring and engaging said last mentioned outer end plate for exerting clamping pressure on said last arms to secure said other element to the first element.

4. A servo unit comprising a pair of synchro elements and a servomotor element mounted in axial alignment, each of said elements comprising a stator of magnetic material, end plates engaging the ends of said stator, a shaft journaled in said end plates and a rotor carried by said shaft to rotate in the stator, gears interconnecting the shafts of the adjacent elements, a spacing flange extending between the inner end plates of said synchro elements, a common end plate between said servomotor element and the adjacent synchro element, and clamping means for said elements comprising clamping rods spanning the end plates and stator of said servomotor element, a clamping

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ring adjacent the inner end plate of said last synchro element, a plurality of clamping arms carried by said ring and spanning the stator of said last synchro element, an annular shoulder formed on said common end plate, hooks formed on the ends of said arms and engaging said annular shoulder, set screws carried by said clamping ring and bearing against said inner end plate for exerting clamping pressure on said arms, a second clamping ring positioned adjacent the outer end plate of the other of

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said synchro elements and carrying clamping arms spanning said other synchro element and having bifurcated ends extending on opposite sides of said first arms, said bifurcated ends being provided with hooks engaging said first clamping ring and set screws carried by said second clamping ring and engaging said last mentioned outer end plate for exerting clamping pressure on said last arms to secure said synchro elements.

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