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ELECTROSERVOMECHANISM

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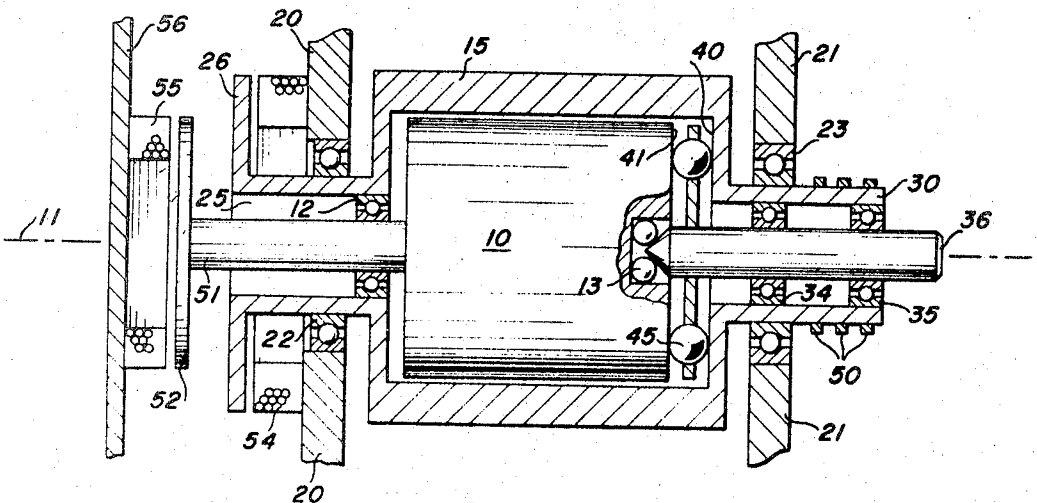
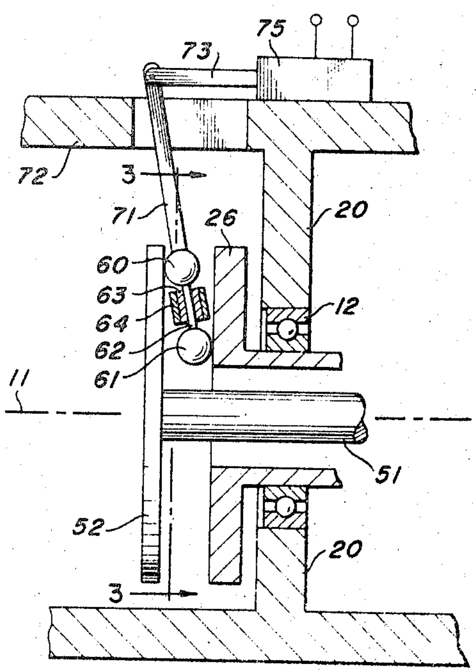



fig. 1

fig. 2



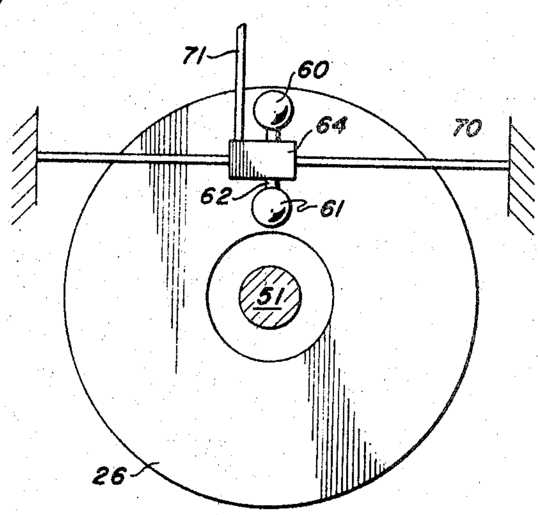




fig. 3

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## ELECTROSERVOMECHANISM

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### ABSTRACT OF THE DISCLOSURE

A wound rotor and an induction rotor are mounted one within the other and are free to rotate; a disc having spheres positioned thereby is placed so that the spheres contact opposing faces of the two rotors. Energization of the wound rotor results in rotation in opposite directions of the respective rotors with the resulting disc motion equal to zero as a result of the differential action of the spheres contacting the rotors. Motion is imparted to the discs by causing a change in velocity of either or both rotors.


The present invention pertains to electroservomechanisms, and more particularly, to the type of servomechanisms that promptly react to a signal for generating output motion and torque on an output shaft.

Servomechanisms are a generally well-developed art; the use of such devices is dictated by the need to develop torque on an output shaft in response to an electrical signal. The time lag resulting from the inertia of the system is an undesirable concomitant of the mechanical motions involved. To increase the speed of response to the signal and provide output motion and torque, several systems of the prior art use constantly rotating masses. These masses are coupled to an output shaft through a clutch arrangement when the further requirement of reversibility of the output torque is added to the stringent requirement of quick response. Prior art systems have tended to become complex with the accompanying reduction in reliability and increase in bulk.

It is therefore an object of the present invention to provide an electroservomechanism that will rapidly produce a torque on an output shaft in response to an electrical signal.

It is a further object of the present invention to provide an electroservomechanism that will rapidly produce a torque on an output shaft and which will also rapidly reverse the torque in response to the appropriate electrical signals.

It is still another object of the present invention to provide an electroservomechanism utilizing counter rotating masses coupled through a differential unit to an output shaft and which utilizes the rotational momentum of the entire system to produce torque on an output shaft.

These and other objects of the present invention will become apparent to those skilled in the art as the description thereof proceeds.

Briefly, in accordance with one of the embodiments chosen for illustration, a wound rotor and an induction rotor are mounted concentrically, one within the other. The outer rotor includes a radially, inwardly extending end wall spaced from one end of the inner rotor. A disc is positioned in this space and supports a plurality of spheres, each of which contacts the end walls of both rotors. Energization of the windings on the wound rotor results in counter rotating motion of the two rotors and zero motion of the disc. Brake means are provided for developing an arresting force which may be applied to either rotor, resulting in the development of a differential rotational velocity which imparts rotation to the disc via the spheres supported thereby. An output shaft is con-



nected to the disc to deliver the torque developed by the motion of the rotors to a utilization device. In one embodiment, the rotational momentum of one rotor is effectively transferred to the second rotor while developing a differential velocity therebetween.

The present invention may more readily be described by reference to the accompanying drawings, in which:

FIGURE 1 is a partial cross-sectional view of an electroservomechanism constructed in accordance with the teachings of the present invention.

FIGURE 2 is a sectional view of a portion of FIGURE 1 showing another embodiment.

FIGURE 3 is a sectional view of FIGURE 2 taken along line 3—3.

Referring now to FIGURE 1, an induction rotor **10** is mounted for rotation about an axis **11** and is journalled in bearings **12** and **13**. A wound rotor **15** is mounted co-axially with the rotor **10** and surrounds the latter so that both rotors **10** and **15** may rotate about the axis **11**. The wound rotor **15** is mounted for rotation in frame members **20** and **21** and is supported by bearings **22** and **23**. The frame members **20** and **21** may form part of the housing in which the electroservomechanism of the present invention is contained; since the housing shape is of no significance to the present invention, the remainder of the housing will not be shown.

The wound rotor **15** includes a cylindrical extension **25** passing through the bearing **22** and terminating in a radially extending brake disc **26**. A second cylindrical extension **30** passes through the bearing **23** and supports the outer races of bearings **34** and **35**. The inner races of the bearings **34** and **35** contact and support an output shaft **36** which is co-axially positioned relative to the rotors **10** and **15**. The wound rotor **15** includes a radially, inwardly extending end wall **40** which opposes the end **41** of the induction rotor **10**. The space between the end wall **40** and the end **41** is occupied by a disc **43** which, in the embodiment chosen for illustration, may be formed integrally with output shaft **36**. The disc **43** supports a plurality of spheres or ball bearings **45**, each of which is free to "roll" in the disc **43** and each of which contacts both the end **41** of the induction rotor **10** and the end wall **40** of the wound rotor **15**.

The windings (not shown) of the wound rotor **15** may be energized through the expediency of slip rings **50** positioned on the cylindrical extension **30**. The induction rotor **10** includes an axially extending shaft **51** terminating in a radially extending brake disc **52**. The brake discs **26** and **52** act as mechanical brakes when immersed in an electromagnetic field provided by coils **54** and **55** respectively. Coil **54** is secured to the frame member **20** while the coil **55** is secured to another frame member **56**.

The operation of the system of FIGURE 1 may now be described. Energization of the wound rotor **15** results in the rotation of the rotor **15** and the counter rotation of the induction rotor **10** equal in opposite rotation of the two rotors and causes the spheres **45** to "idle" and simply rotate in the respective sockets provided in the disc **43**. No motion is imparted to the disc **43**, and the output shaft **36** therefore remains at zero velocity. Energization of one of the coils **54** or **55** will cause an arresting force to be imparted to the corresponding rotor. For example, energization of the coil **55** causes the brake disc **52** to be immersed in an electromagnetic field, thereby developing an arresting force on the brake disc **52** which is imparted through the shaft **51** to the induction rotor **10**. The deceleration of the induction rotor **10** causes an equal but opposite reaction on the wound rotor **15** which therefore increases its velocity. The decrease in the velocity of the rotor **10** and the increase in the velocity of the rotor **15** causes the spheres **45** to travel in an annular path about the end 41 of the rotor 10 (and about the end wall 40 of the rotor 15). This translatory or orbital motion of the spheres 45 imparts a rotational force to the output shaft 36 through the disc 43. It may be noted that the torque applied to the output shaft 36 is effectively multiplied as a result of the circumferential differences around each of the spheres 45 differing from the distance traveled by the sphere in its annular path about the ends of the rotors; further, torque multiplication is also a function of the distance between the spheres 45 and the axis 11. The direction of rotation of the output shaft 36 may be reversed by energizing the coil 54 instead of the coil 55.

The rotational momentum of the rotating rotors may effectively be conserved and utilized for the production of torque on the output shaft by the embodiment illustrated in FIGURE 2. Referring to FIGURE 2, only the lefthand portion of FIGURE 1 is shown since the remainder of FIGURE 2 is identical to FIGURE 1. In FIGURE 2, the brake discs 26 and 52 are frictionally engaged by rotatable contact members 60 and 61. The rotatable contact members are joined to each other by an axle 62 journalled in a bushing 63 mounted in a pivotable bearing support member 64. The bearing support member 64 is pivotable about a shaft 70 (FIGURE 3) and is pivoted by means of a control rod 71 extending upwardly through an opening in the housing 72. The control rod 71 may be connected, for example, to the armature 73 of a solenoid 75. In the position shown in FIGURE 2, the rotatable contact member 60 (in the embodiment chosen for illustration, the rotatable contact members 60 and 61 are spheres) is in contact with the brake disc 52 and the rotatable contact member 61 is in contact with the brake disc 26. The pivotable bearing support member 64 will have three positions, the first of which is illustrated in FIGURE 2, the second of which will result in the contact of member 60 with brake disc 26 and member 61 with brake disc 52, and the third of which will be intermediate the two previous positions wherein both rotatable contact members 60 and 61 will be out of contact with the brake discs. The description of the operation of the embodiment shown in FIGURES 2 and 3 may begin with the assumption that both the wound rotor and the induction rotor are rotating at equal but opposite rotational velocities.

As explained previously, the output shaft under this condition would have zero velocity. When the pivotable bearing support member 64 is forced to the position shown in FIGURE 2, the rotors connected to the brake discs 26 and 52 will be forced to change respective rotational velocities to values such that the linear velocity at the point of contact between member 60 and disc 52 equals the linear velocity at the point of contact between member 61 and brake disc 26. Since the former point of contact is displaced further from the axis 11 than the latter point of contact, it follows that the induction rotor 10 connected to the brake disc 52 must reduce its rotational velocity while the wound rotor connected to the brake disc 26 must increase its rotational velocity. The resulting difference between rotational velocities will cause cause the output torque to be developed on the output shaft in the manner described in connection with FIGURE 1. The arresting force caused by the contact of the rotating member 60 with the brake disc 52 immediately and simultaneously causes an accelerating force by reason of the contact of the rotatable contact member 61 with the brake disc 26. The development of an accelerating force by utilization of the arresting force utilizes the rotational momentum of the entire system for the substantially instantaneous development of torque at the output shaft. In the embodiment chosen for illustration in FIGURES 2 and 3, the rotatable contact members 60 and 61 are shown as spheres; a variety of rotatable contact member designs may be used and it may be noted that the space between the brake disc 52 and brake disc 26 may be reduced so that a very small pivotal motion of the pivotable bearing support member 64 will result in a change in relative contact between the rotatable members and the brake discs. Further, only one pair of rotatable members are illustrated; under normal circumstances, it has been found appropriate to utilize more than one pair to eliminate unbalanced forces and thrusts developed through the application of the rotatable contact members.

It will also be obvious to those skilled in the art that a variety of modifications may be made in the specific embodiments chosen for illustration without departing from the spirit and scope of the invention. For example, the spheres 45 utilized in the differential motion sensing mechanism, including the disc 43, may conveniently be replaced by small discs or wheels journalled on the disc 43. It is therefore intended that the present invention be limited only by the scope of the claims appended hereto.

I claim:

1. An electroservomechanism comprising: a first rotor co-axially and rotatably mounted within a second rotor; a frame rotatably supporting said second rotor; one of said rotors having windings thereon and the other rotor being an induction rotor, said rotors rotating in opposite directions when said windings are energized; said second rotor having a radially, inwardly extending end wall spaced from one end of said first rotor; a disc mounted co-axially of said rotors and positioned in the space between the end wall of said second rotor and said one end of said first rotor; an output shaft connected to said disc; a plurality of rotatable members supported by said disc, each rotatable member contacting said one end of said first rotor and the end wall of said second rotor; and brake means for selectively applying an arresting force to one of said rotors.

2. The combination set forth in claim 1 including means for transmitting an arresting force applied to one of said rotors to the other of said rotors as an accelerating force.

3. The combination set forth in claim 1 wherein said rotatable members are spheres.

4. The combination set forth in claim 1 wherein said brake means comprises: a first and a second brake disc connected to said first and second rotors respectively; a first and a second electromagnetic field producing coil, each positioned proximate a different one of said brake discs for providing an electromagnetic field in which said brake discs may rotate to develop an arresting force.

5. The combination set forth in claim 1 wherein said brake means comprises: a first and a second brake disc connected to said first and second rotors respectively, said brake discs each having one face thereof opposing the other brake disc; a pair of rotatable contact members connected to each other by an axle in a plane extending radially of said brake discs and journalled in a pivotable bearing member; the first of said pair of contact members contacting said first brake disc and the second of said pair of contact members contacting said second disc when said pivotable bearing member is in a first operating position; the first of said pair of contact members contacting said second brake disc and the second of said contact members contacting said first brake disc when said pivotable bearing member is in a second operating position.

6. The combination set forth in claim 1 wherein said brake means comprises: a first and a second brake disc connected to said first and second rotors respectively, said brake discs each having one face thereof opposing the other brake disc; a pair of rotatable contact members; means connecting said contact members to each other for mutually transmitting the rotation of one contact member to the other; means selectively supporting said contact members in a first and a second operating position; said first operating position defined by the positioning of the first of said pair of rotatable contact members in contact with said first brake disc and the second

of said pair of rotatable contact members in contact with said second brake disc; said second operating position defined by the positioning of the first of said pair of rotatable contact members in contact with said second brake disc and the second of said pair of rotatable contact members in contact with said first brake disc.

7. The combination set forth in claim 4 wherein said rotatable members are spheres.

8. The combination set forth in claim 5 wherein said rotatable members are spheres.

9. The combination set forth in claim 5 wherein said rotatable members and said rotatable contact members are spheres.



10. The combination set forth in claim 6 wherein said rotatable members and said rotatable contact members are spheres.


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