

Nov. 28, 1961

D. E. STEEB
SERVO-MOTOR SYSTEM

3,011,107

Filed July 21, 1958

2 Sheets-Sheet 1

FIG. 1.

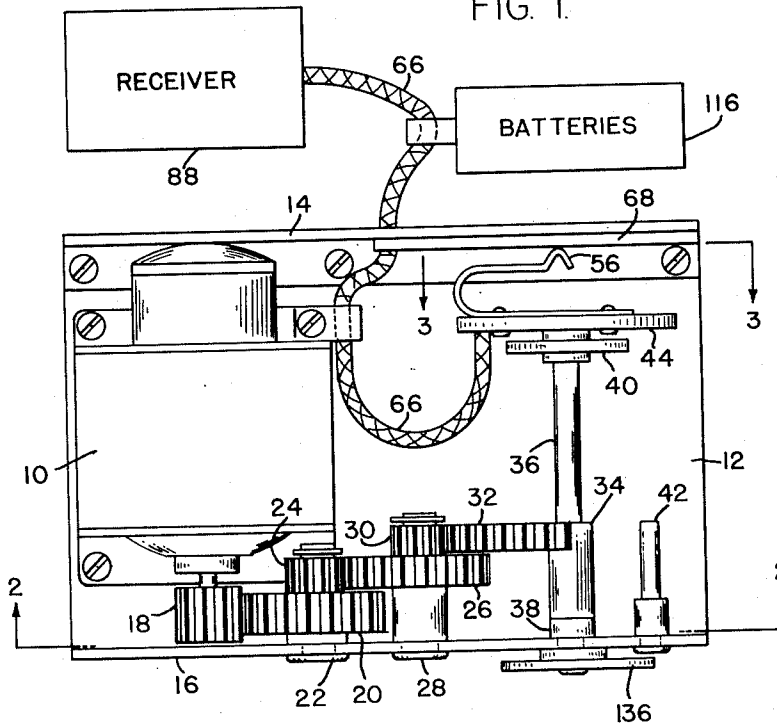


FIG. 2.

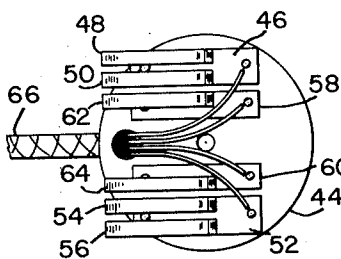
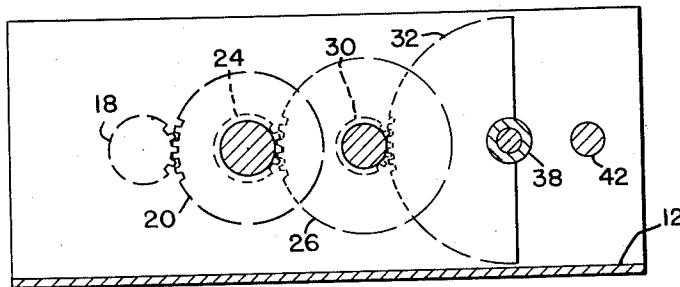


FIG. 3.

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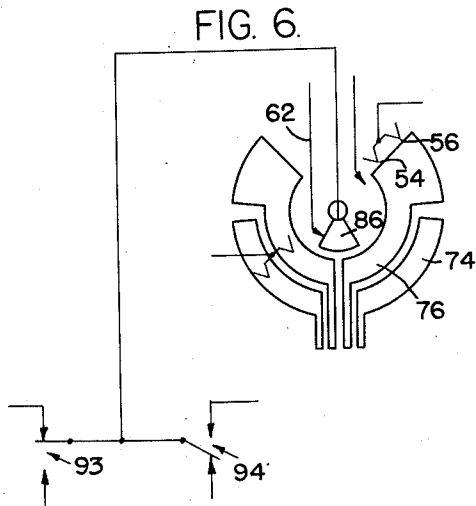
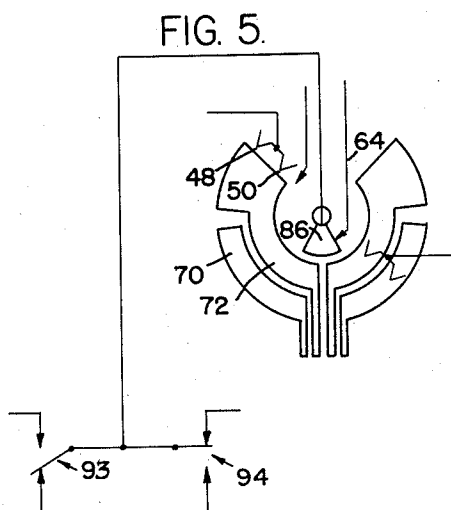
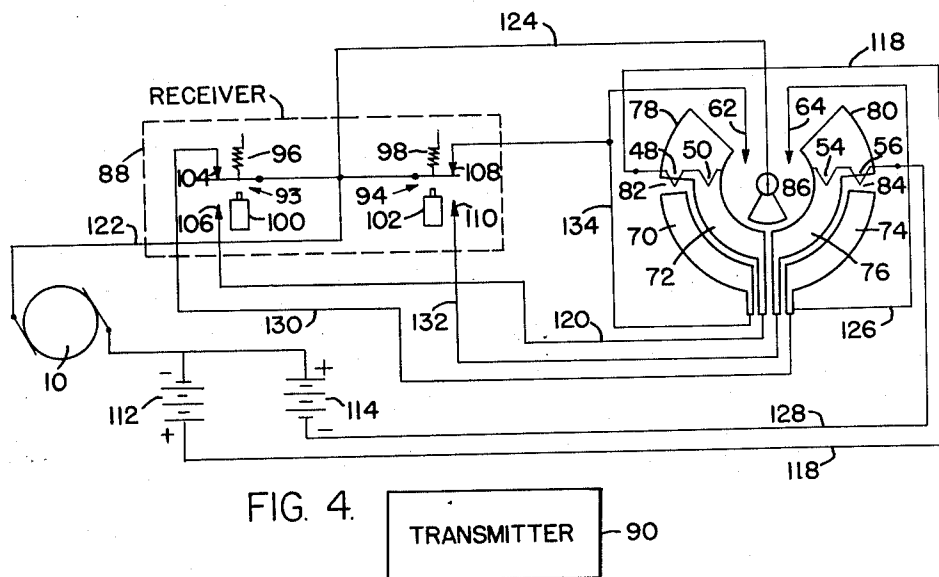
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2 Sheets-Sheet 2



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3,011,107

SERVO-MOTOR SYSTEM

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4 Claims. (Cl. 318-16)

This invention provides a servo-motor system adapted for a variety of uses such, for example, as the actuation and control of steering means for model airplanes, boats and the like, one object being to provide an improved mechanism capable of being readily adjusted in operation and affording precise control of a driven means, either from the same or a remote location.

Another object is to supply a mechanism of the above character in a simple, practical and economic construction of light weight suitable for controlling the flight of model airplanes or other vehicles.

Another object is to provide a mechanism of the character provided with electrical braking means which eliminates the need for a mechanical brake.

A further object is to provide such a mechanism having controlling electrical contact means of light weight and arranged for wiping engagement in operation so as to require no adjustment or cleaning.

Still a further object is to provide a mechanism having the above advantages and including a positive "fail-safe" stop to insure against any over travel and injury thereby of the mechanism.

To these and other ends the invention resides in certain improvements and combinations of parts, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

FIG. 1 is a top plan view of a servo-motor mechanism embodying the present invention;

FIG. 2 is a sectional elevation on the line 2-2 in FIG. 1 showing a reduction gear train;

FIG. 3 is a sectional elevation on the line 3-3 in FIG. 1 showing a rotary contact disk;

FIG. 4 is a diagram, partly schematic, of a servo-motor system embodying the present invention;

FIG. 5 shows some of the parts of FIG. 4 in a different position, and

FIG. 6 is similar to FIG. 5 but showing the parts in a different position.

In the present embodiment of the invention, herein disclosed by way of illustration, the reversible servo-motor 10 (FIG. 1) is mounted on the base 12 of an aluminum frame having upstanding side walls 14 and 16. The motor shaft has fixed thereon a pinion 18 meshing with a gear 20 rotatable on a stub shaft 22 fixed in frame wall 16 and gear 20 carries a pinion 24. A gear 26, meshing with pinion 24, is rotatably mounted on a stub shaft 28 fixed in frame wall 16 and has fixed thereto a pinion 30 meshing with a half gear 32 having a hub 34 fixed on a shaft 36 rotatably mounted in a bearing 38 mounted in frame wall 16 and in a bearing 40 on base 12. These gears form a speed reducing gearing by which the motor rotates shaft 36 and the rotation of the latter may be positively limited in opposite directions by contact of the flat sides of gear 32 with a "fail-safe" pin 42 fixed in frame wall 16, to prevent over travel of the shaft.

Shaft 36 has fixed on its upper end an electrical contact disk 44, the upper surface of which carries a set of contacts movable with relation to a set of stationary printed circuit contacts above it, as hereafter described. Fixed on disk 44 is an electrically conducting plate 46 formed with extensions to provide a pair of spaced spring contacts 48 and 50 (FIG. 3). A conductive plate 52

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on the disk carries a similar pair of spaced contacts 54 and 56. Located between plates 46 and 52 are a pair of spaced conductive plates 58 and 60 carrying, respectively, spring contact fingers 62 and 64. The upwardly extending contact fingers of the several plates are located on a diameter of the contact disk 44 through the axis of shaft 36 and the several plates are connected in circuit by leads from a multi-channel conductor cable 66 hereafter described.

The several rotary contacts described above cooperate with a set of stationary printed circuit contacts on a board 68 fixed on the inside of frame wall 14 (FIG. 1), these contacts being shown in elevation in FIGS. 4 to 6, inclusive, as comprising a pair of spaced arcuate contacts 70 and 72 and a pair of spaced contacts 74 and 76, these several contacts being spaced from each other and arranged concentrically with relation to the extended axis of shaft 36 and the movable contacts, 48, 50, 54, 56, 62 and 64. The upper ends of contacts 72 and 76 are enlarged as at 78 and 80, so as to extend outwardly over the ends of contacts 70 and 74, respectively, in spaced relation therewith, so as to leave gaps 82 and 84 therebetween. Located between contacts 72 and 76, below their center of curvature, is a contact 86 of generally truncated, triangular shape, as shown.

The above sets of rotary and stationary contacts are connected in the circuit of the system as hereafter described and the rotary contacts press in wiping contact with the stationary contacts during the rotation of disk 44 and shaft 36. The rotary contacts are shown in neutral position in FIG. 4 and in alternate operating positions in FIGS. 5 and 6. Contacts 48 and 50 move over contacts 70 and 72 and contacts 54 and 56 move over contacts 74 and 76, while contacts 62 and 64 come into engagement alternately with the opposite sides of contact 86, as shown in FIGS. 5 and 6. In the neutral position shown in FIG. 4, contacts 48 and 56 are located in the gaps 82 and 84 beyond the ends of contacts 70 and 74 and contacts 62 and 64 are spaced from contact 86. The upper ends of contacts 72 and 76 are preferably inclined at an angle of 45° to the horizontal while the opposite sides of contact 86 preferably have an inclination of 60° thereto.

As the above set of movable contacts are rotated by the motor through the speed reducing gearing described above, they cooperate with the above set of stationary contacts to stop the motor in a neutral position (FIG. 4) and in each of the opposite positions to which it is rotated as illustrated by the positions of the contacts in FIGS. 5 and 6. These sets of contacts are connected in circuit with means for starting and reversing the direction of rotation of the motor 10, comprising a receiver, indicated schematically at 88 (FIG. 4) for receiving and amplifying the radio impulses from a remote radio transmitter, indicated schematically at 90. The receiver and transmitter are of any known and suitable eight channel type such as identified as the "Bramco Regent" instruments available commercially from Bramco, Inc., of Royal Oak, Mich.

The receiver comprises known relay means (not shown) for operating a pair of single pole, double throw switches 93 and 94, the poles of which are normally moved to upper neutral positions by springs 96 and 98 and to lower operating positions by the receiver relays, as by means of their solenoids 100 and 102, respectively. The pole of switch 93 operates between upper and lower contacts 104 and 106, respectively, while the pole of switch 94 operates between upper and lower contacts 108, and 110, respectively, as shown, in response to signals from transmitter 90, for starting and reversing the rotation of motor 10, as hereafter described.

The source of electrical energy for operating motor 10 preferably comprises a pair of batteries 112 and 114, as shown in FIG. 4 and illustrated schematically at 116 in FIG. 1, these batteries being preferably mounted in or adjacent frame 12. The batteries are both connected in the motor circuit with reverse polarity as shown in FIG. 4, for operating the motor in opposite directions under control of switches 93 and 94.

Multi-channel cable 66 is of flexible construction carrying leads which are connected through an opening in disk 44 to its several rotary contacts as described above. Other leads from the conductor are connected to motor 10, to the batteries and to the receiver, as shown in FIG. 1.

In operation, with the parts in the neutral position, as shown in FIG. 4, no current flows in the circuit but when the transmitter 90 is actuated to operate receiver 88 to move the pole of switch 93 into engagement with the lower contact 106, current flows from battery 112 through line 118 to rotary contact 50, stationary contact 72, line 120, switch contact 106, line 122 to the motor and back to the battery. Such current rotates the motor and shaft 36 in one direction in which the rotary contacts are moved to the position shown in FIG. 5 in which contacts 48 and 50 are just out of engagement with printed contact 72 so as to break the circuit therethrough for stopping the motor. If the inertia of the motor and connected parts cause them to coast further, contact 64 comes into engagement with contact 86, sending a momentary reverse current from the battery 114 to line 122, line 124, contacts 86 and 64, line 126, contact 74, contact 56, line 128 and back to the battery. This momentary reverse "kick" serves to stop the motor quickly and accurately in the position shown in FIG. 5. The slight reverse rotation tends to disconnect contact 64 from contact 86 and the parts thus come to rest in the position shown in FIG. 5, with shaft 36 rotated to its extreme position in one direction in which it will be positively arrested by "fail-safe" pin 42 in case of any failure in such electrical control. When the pole of switch 93 is released for return upwardly to engage contact 104, a circuit is established from battery 114 through the motor, line 122, switch contact 104, line 130 to contacts 74 and 56, line 128 and back to the battery, thereby rotating the motor and contacts back to the neutral position of FIG. 4 in which they come to rest as contacts 48 and 56 enter the gaps 82 and 84 to break the circuit.

The transmission to the receiver of an impulse for operation of switch 94 causes its pole to engage contact 110 (FIG. 6) thereby sending current from battery 114 to the motor, line 122, contact 110 of switch 94, line 132, contacts 76 and 54, line 128 and back to the battery, with the result that the motor, shaft 36 and rotary contacts are moved to the opposite position shown in FIG. 6 where contacts 54 and 56 eventually pass out of engagement with contact 76, opening the circuit. Should the inertia of the parts carry contact 62 into engagement with contact 86, a momentary reverse current is transmitted to the motor from battery 112 through lines 122 and 124 to contacts 86 and 62, line 134, contacts 70 and 48, line 118 and back to the motor, with the result, as previously described, of quickly and accurately stopping its rotation. Such stopping of the motor by reverse currents eliminates the complication, weight and expense of mechanical braking means.

With the parts at rest in the position shown in FIG. 6, the transmission to the receiver of an impulse for deenergizing relay 102 allows spring 98 to move pole switch 94 upwardly into engagement with contact 108, establishes a circuit from battery 112 through line 118, contacts 48 and 70, line 134, switch 94, line 122 and back through the motor to the battery, so as to return the parts to neutral position ready for continued operation as described.

Gaps 82 and 84 between the printed circuit contacts may be varied in width as desired to vary the tolerance

for trimming the motor and parts to precise position. If desired, the lines leading from contacts 62 and 64 may be eliminated to make the servo-motor more fully trimmable.

The power take-off means preferably comprises a disk 136 (FIG. 1) on the lower end of shaft 36 and provided with known and suitable actuating means, such as a cam shape, gear teeth, push and pull rod connection and the like for transmitting power to the mechanism to be actuated and controlled.

Any known and suitable motor for the above purposes may be employed and I have found that the motor known and commercially available as "Aristo #12," a D.C. motor operating on a current of one and one half to six volts, is satisfactory for the purpose.

While the invention has been described as embodied in a servo-motor system comprising remote operation by radio impulse signals, it is contemplated that the transmitter and receiver may be omitted and the switches 93 and 94 operated manually or otherwise in other useful applications of the invention.

The invention thus provides a multi-channel servo-motor system and circuit adapted to be embodied in a construction of a relatively simple nature and extremely light weight, for the purposes described. The contact and other parts are so constructed and arranged to afford quick and accurate control of the driven mechanism, with provision for positive and safe stopping of the parts in the event of over travel. The provision for momentary reversal of the current eliminates the need for mechanical braking. The wiping nature of engagement between the moving and stationary contacts provides a self-cleaning action obviating any need for adjustment, thus promoting the trouble-free operation.

It will thus be seen that the invention accomplishes its objects and while it has been herein disclosed by reference to the details of a preferred embodiment, it is to be understood that such disclosure is intended in an illustrative, rather than a limiting sense, as it is contemplated that various modifications in the construction and arrangement of the parts will readily occur to those skilled in the art, within the spirit of the invention and the scope of the appended claims.

I claim:

1. A servo-motor system for controlling the steering apparatus of an aircraft or the like, said system comprising circuit means including a reversible, direct current motor having a power take-off for operating said apparatus, a pair of electrical batteries for connection with said motor in opposed polarity for actuating the same, a pair of single pole, double throw switches for connecting said batteries, respectively, with said motor for operating the same and said apparatus in opposite directions, a set of concentric stationary contacts, a set of concentric contacts movable in cooperation with said stationary contacts to control operation of said motor and apparatus in a given direction, means connecting said motor with said set of movable contacts to move the same, a receiver of radio impulses having relay means for selectively operating said switches to actuate said motor and apparatus in opposite directions, and means operating when said receiver is deenergized to reverse and return said motor and apparatus to neutral position.

2. A servo-motor system for controlling the steering apparatus of an aircraft or the like, said system comprising circuit means including a reversible, direct current motor having a power take-off for operating said apparatus, a pair of electrical batteries for connection with said motor in opposed polarity for actuating the same, a pair of single pole, double throw switches for connecting said batteries, respectively, with said motor for operating the same and said apparatus in opposite directions, a set of concentric stationary contacts, a set

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of concentric contacts movable in cooperation with said stationary contacts to control operation of said motor and apparatus in a given direction, means connecting said motor with said set of movable contacts to move the same, a receiver of radio impulses having relay means for operating said switches to actuate said motor and apparatus in opposite directions, spring means operating when said receiver is deenergized to actuate said switches to return said motor and apparatus to neutral position and relatively movable contacts for reversing the current through said motor to prevent overtravel thereof in said opposite directions.

3. A servo-motor system for controlling the steering apparatus of a model aircraft or the like, said system comprising circuit means including a reversible, direct current motor having a power take-off for operating said apparatus, a pair of electrical batteries for connection in opposed polarity with the same terminal of said motor, a pair of switches for selectively connecting said batteries with said motor for controlling operation of the same and said apparatus in opposite directions, a set of concentric stationary contacts, a set of contacts movable in cooperation with said stationary contacts, means connecting said motor with said set of movable contacts for controlling operation of said motor and apparatus in a given direction, a receiver of radio impulses having relay means for operating said switches to actuate said motor and apparatus in opposite directions, and relatively movable switch contacts for reversing the current to said motor to prevent overtravel thereof in said opposite directions.

4. A servo-motor system for controlling the steering apparatus of a model aircraft or the like, said system comprising circuit means including a reversible, direct current motor having a power take-off for operating said apparatus, a pair of electrical batteries for connection in opposed polarity with the same terminal of said motor for actuating the same in opposite directions, a pair of single pole, double throw switches for selectively connecting said batteries, respectively, with said motor, a plurality of pairs of arcuate contacts arranged concentrically at different distances from the common center thereof, a plurality of contacts for cooperation with said arcuate contacts, means connected with said motor for effecting relative movement between said arcuate contacts and said cooperating contacts for controlling operation of said motor and apparatus in a given direction, a receiver of radio impulses having relay means for selectively operating said switches, and means operating when said receiver is deenergized to reverse and return said motor and apparatus to neutral position.

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