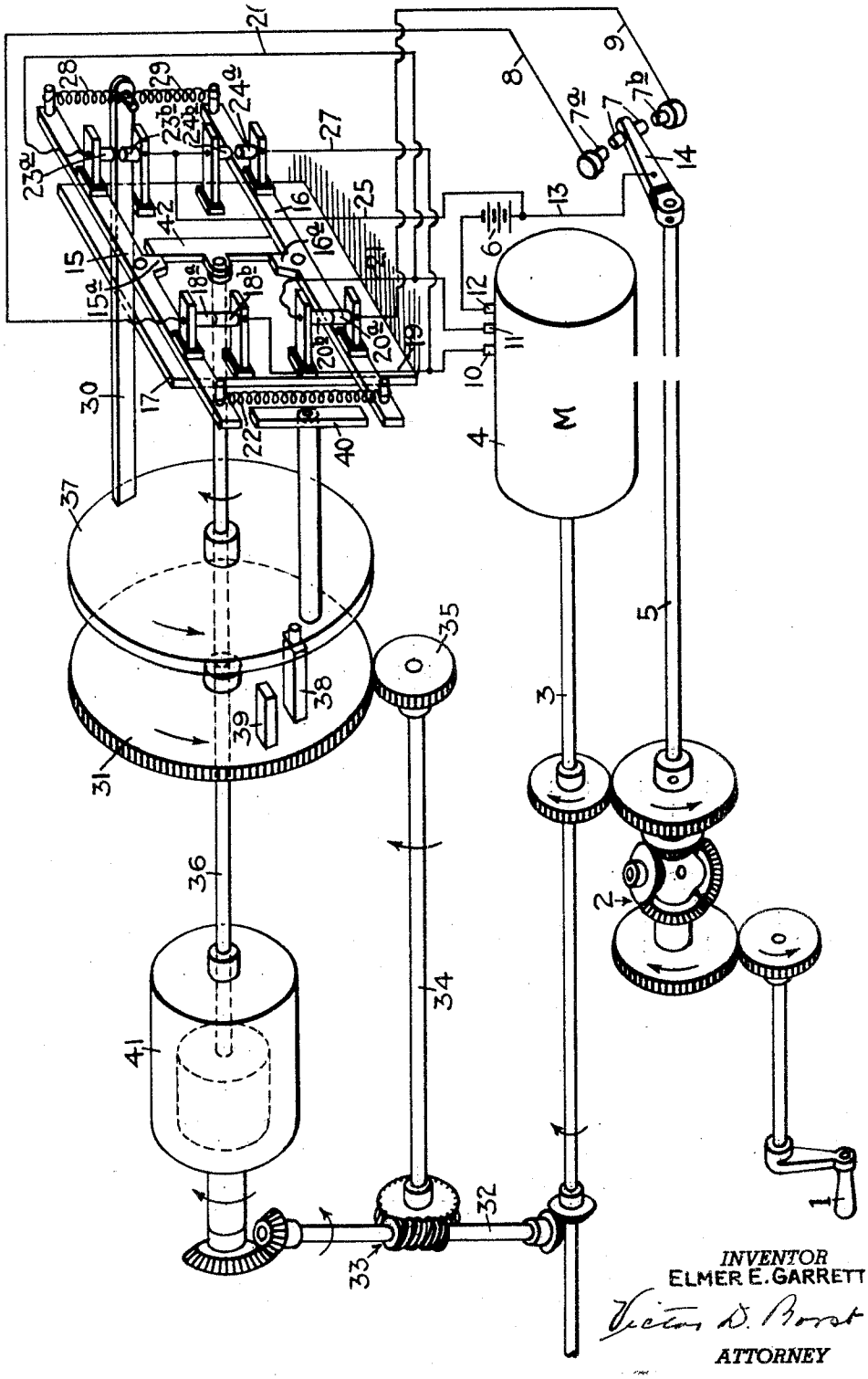
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ELECTRICAL STOP MECHANISM

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ELECTRICAL STOP MECHANISM

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This invention relates to stop devices to limit the extent of motion of a movable member and particularly to such devices which operate to interrupt the power which drives the movable member.

When the movable member has considerable mass it will move under its inertia after the propelling power is cut off a distance depending upon its speed and a characteristic of this invention is the fact that the time of cut-off is advanced with respect to the limit of movement an amount proportional to the speed.

For this purpose under the invention a drag device operated by the power motor develops an output torque proportional to the operating speed and this variable torque is used to interrupt the power according to conditions. Specifically the power device is electrically operated and a contact in the circuit is biased to closed position, but this biasing force is opposed by the torque of the drag device, and as the movable member comes within a predetermined distance of the absolute limit of its movement it sets into operation a cause that progressively weakens the biasing force until the torque of the drag device is sufficient to overcome the residual biasing force and open the contact.

For practical purposes the power means must be reversible so as to actuate the movable member in either direction and there is a circuit breaking contact in each directional circuit. These are mounted on pivoted arms the adjacent ends of which are connected by a spring that holds the contacts closed. Centering springs are attached to the opposite ends of the arms and have their inner ends attached to a movable post between the arms. These centering springs are weaker than the holding spring and normally exert little opposition torque. As the post is moved however one way or the other the torque of one of the centering springs is increased and to that extent neutralizes the torque of the holding spring.

The output of the drag device has a torque member engageable with the arms in a direction to supplement the torque of the centering springs as the post is displaced. The greater the output torque, that is, the greater the speed, the sooner is the torque of the holding spring overcome and the circuit broken.

A mechanical member that may be termed a movement measuring device is driven proportionately to the movable member and it becomes effective near the limit of movement in both directions to move the post with it and thus begin to store up energy in one of the centering springs. The mechanical member also operates a projection at the limit of its movement that engages the contact arm and breaks the contact if the opening torque produced by the drag device and the centering spring has not overcome the bias of the holding spring.

The invention also includes means to decelerate the movable member. In the preferred construction this includes means to reverse the energization of the power means and thus brake its movement. The contact arms on their opposite ends carry normally open contacts that are connected in circuit with the power means reversely to that of the normally closed contacts on the respective arms. The torque in opposition to the holding spring therefore first moves the contact arm to open the circuit that controls the power device in the direction in which it is operating, and further movement of the contact arm will energize the power device in the opposite direction so that the resulting deceleration will be such as to maintain a balance between the torque of the holding spring and the combined torques of the output of the drag device and of the centering spring.

The drawing is a schematic showing of one way in which the invention may be embodied, but it will be understood that this is only intended to illustrate the principles involved and that the mechanical embodiment of those principles will accord with individual discretion.

The drawing shows a follow-up or motion reproducing mechanism in which a servomotor supplies the power for the driven member. Other power amplifying means may of course be employed, such as a magnetic clutch of known form operated by reversely energizable coils.

The input or primary movement is shown as introduced manually by a crank 1 and fed into one side of a differential 2, the other side being geared to the output shaft 3 of servomotor 4. The output 5 of the differential therefore represents the difference between the input and the response.

The motor is energized in one direction or the other, depending upon the position of contacts, by a source 6 of electric power. The usual relay contacts are operated by the differential output 5, and consist of center movable contacts 7 and the fixed contacts 7*a* and 7*b* connected in circuit, respectively, with leads 8 and 9 and, through other contacts to be described, with motor terminals 10 and 11, respectively. The common terminal 12 is connected to one side of the power source 6 the other side of which is connected by lead 13 with arm 14 that carries the contacts 7.

The motor 4 is assumed to have a split field winding so that connection of the source 6 with the terminals 10 and 11 will energize the motor in relatively opposite directions. The leads 8 and 9 are connectible with these terminals through contacts that operate as circuit breakers and are automatically controlled in accordance

with the position and speed of the follower member.

Two contact arms 15 and 16 are pivotally mounted on a fixed support 17. Each of these arms carries two contacts, one on each side of the pivot, that coact with fixed contacts carried by the support 17, the contacts being disposed so that rotation of an arm tends to open one pair of contacts and close the other. Lead 8 connects with movable stop contact 18a on arm 15 that coacts with fixed contact 18b connected by lead 19 with terminal 10. Lead 9 connects with movable stop contact 20a on arm 16 that coacts with fixed contact 20b connected by lead 21 with terminal 11. A spring 22 connects the two ends of the arms and exerts a torque that urges both movable contacts 18a and 20a to closed position.

On the opposite side of its pivot arm 15 carries movable contact 23a that coacts with fixed contact 23b, and similarly on its opposite end arm 16 carries contact 24a that coacts with fixed contact 24b. Spring 22 biases these contacts to open position. They are for the purpose of reversing the motor energization and decelerating the follower member as it approaches its limit of movement, as will hereinafter be explained. At the present it is sufficient to note that they are in alternative energizing circuits. One side of the power source 6 is connected by lead 25 to the fixed contacts 23b and 24b, while the movable contacts are connected with the motor terminals, lead 26 connecting contact 23a with lead 21 and hence with terminal 11, and lead 27 connecting contact 24a with lead 19 and hence with terminal 10. Thus it will be seen that the circuits including these decelerating contacts are independent of the follow-up or relay contacts 7, 7a and 7b, and are made only when the follow-up circuits are open.

Turn now to the means for actuating the contact arms 15 and 16. Opposing the holding spring 22 are centralizing springs 28 and 29 that are anchored at their inner ends to a post 30 between the arms and at their outer ends to the ends of the respective arms. The post is movable and is normally held central by the springs. The springs are under little or no tension when the post is centralized and they are weaker than the holding spring 22 so that as the post is moved one way or the other and places one of the centralizing springs under tension, the counter torque thus produced is not sufficient to overcome the torque of the spring 22. A supplemental torque must be produced to combine with that of the centralizing spring in order to open the circuit breaking contacts, and in order that the breaking of the motor circuit may be advanced according to the speed, the supplemental torque producing means is made responsive to the speed of the follower member. This supplemental torque will not alone be sufficient to open the motor circuit at the maximum speed of the follower and it is necessary for the torque of the centralizing spring also to be present to overcome the torque of the spring 22. Therefore the post 30 remains central until a predetermined distance before the follower reaches the limit of its movement when a member moved with the follower contacts the post support and causes the post to move along. This will now be described.

A motion measuring member 31, shown as a geared disc, is driven at a reduced rate by output shaft 3 of motor 4 through countershaft 32, reduction gearing 33, shaft 34 and pinion 35. This member 31 is loosely mounted on shaft 36 that will later be referred to, and is adjacent and opposes a stop disc 37 also loosely mounted on shaft 36 and carrying the post 30. The stop disc 37 has an abutment 38 that is disposed in the path of an abutment 39 on the member 31. Therefore the member 31 can make a rotation of nearly 360° from one abutment contact position to the other. The disc 37 also carries a striker member 40 that is located to strike the arms 15 and 16 adjacent the spring 22 and is positioned midway between them when the disc is centralized by the springs 28 and 29. A sufficient movement of the disc 37 therefore will positively open either contact 18a or 20a, depending upon which way the disc is moved.

The speed responsive device consists of a drag member 41 that may be of any known construction suitable for the purpose, such as a magnetic drag or a viscous drag. The housing or rotor is geared to the shaft 32 so as to be driven at a speed proportional to that of the output 3, and the drag element is on the shaft 36. This shaft will therefore be biased by a torque proportional to the speed of the rotor. The shaft extends through a bearing in the fixed support 17 midway between the pivots for the arms 15 and 16 and has on its end a T-shaped lever 42 the ends of which are positioned to engage projections 15a and 16a on the respective arms. Therefore the member 42 will exert a force upon one of these projections, depending upon which way the motor is turning, proportional to the speed of the follower member.

A primary movement in the direction of the arrow will close contacts 7, 7b and energize the motor 4 in the direction indicated by the arrow on the shaft 3 through contacts 20a, 20b, and the motor will continue to run until its response equals the primary movement, when the shaft 5 and the contacts will be on center position and the motor will be deenergized. The faster the motor runs to keep up with the primary movement the more torque is being exerted by the member 42 on the projection 16a. This alone however is not enough to overcome the closing torque of the holding spring 22 and open the contact 20a. If the follower member approaches sufficiently close to its limit of movement for the abutment 39 to engage the abutment 38, the stop disc 37 will be caused to rotate in the direction indicated by the arrow and thus move the post 30 away from the arm 16 and increase the tension on the spring 29. The torque produced by the spring 29 combined with that exerted by the member 42 will overcome the torque of the spring 22 if the speed of the motor is at all considerable, and the faster the motor is running the less torque from the spring 29 and hence the less movement of the stop disc is required to open the motor circuit.

The desired characteristics of the stop are that when either stop contact is opened the friction of the follower member will oppose the inertia so that the follower member will slow down at a rate to maintain this balanced condition with the stop contacts just opened. If the follower member does not decelerate at the desired rate the excessive drag effect on member 42 will cause the appropriate contact arm to move sufficiently to close its decelerating contact. As this further movement of the arm closes the decelerating contact the motor is reversely energized and the

follower member is forcibly decelerated at the desired rate.

At very low speeds the drag has little effect and the torque of the centering spring is just sufficient to balance the torquqe of the holding spring at the limit of travel. At this point the member 40 engages the contact arm, thus assuring positive control in arresting motion of the follower member.

It will be noted that since the torque exerted by the drag is proportional to the speed of the power means, the velocity of the follower movement is proportional to the distance of the driven member from the limit of travel while the electrical stop is in control.

It is obvious that the invention may be variously otherwise embodied and that changes may be made in the construction shown in the drawing and above particularly described within the principle and scope of the invention as pointed out in the appended claims.

I claim:

1. An electrical limit stop mechanism comprising an electrically operated power device, a driven member operated thereby, an energizing circuit for the power device including a movable contact, means normally biasing the contact to closed position, mechanical means operated by the power device for opening the contact at the limit of movement of the driven member, and means responsive to the speed of the driven member for applying an opening force upon the movable contact.

2. An electrical limit stop mechanism comprising an electrically operated power device, a driven member operated thereby, an energizing circuit for the power device including a movable contact, means normally biasing the contact to closed position, mechanical means operated by the power device for opening the contact at the limit of movement of the driven member, means actuated by the mechanical means for developing a force in opposition to the biasing means before the limit of movement is reached, and means responsive to the speed of the driven member for applying an opening force upon the movable contact, whereby the opening of the contact anticipates the limit of movement.

3. An electrical limit stop mechanism comprising an electrically operated power device including an output element driven thereby, an energizing circuit for the power device including a movable contact, a biasing spring urging the contact to closed position, a drag device driven by the output element and adapted to produce an output torque proportional to the speed of the power device, and a torque element operated by the drag device and arranged to act upon the movable contact in opposition to the biasing spring.

4. An electrical limit stop mechanism comprising an electrically operated power device, an energizing circuit for the power device including a movable contact, a biasing spring urging the contact to closed position, mechanical means operated by the power device for opening the contact at the limit of movement, a speed responsive drag device operated by the power device and arranged to apply its output force in opposition to the biasing spring, and means operated by the mechanical means for supplementing the output force.

5. An electrical limit stop mechanism comprising an electrically operated power device, an energizing circuit for the power device including a movable contact, a biasing spring urging the contact to closed position, mechanical means operated by the power device for opening the contact at the limit of movement, a speed responsive drag device operated by the power device and arranged to apply its output force in opposition to the biasing spring, a second spring connected to supplement the output force of the drag device and normally exerting less force than that of the biasing spring, and means operated by the mechanical means for increasing the tension of the second spring.

6. An electrical limit stop mechanism comprising an electrically operated power device, a driven member operated thereby, an energizing circuit for the power device including a movable contact, a pivoted contact arm carrying the movable contact, a biasing spring exerting a closing torque on the arm, a second relatively weak spring connected at one end to the arm to exert an opening torque thereon, a movable attachment for the opposite end of the second spring, mechanical means operated by the power device for positively opening the contact at the limit of movement of the driven member, speed responsive means operated by the driven member for exerting an opening torque upon the contact arm, and means operated by the mechanical means for moving the movable attachment in a direction to increase the torque of the second spring.

7. An electrical limit stop mechanism comprising an electrically operated reversible power device, a driven member operated thereby, circuits for energizing the power device in respectively opposite directions, a movable contact in each circuit, two pivoted contact arms, each carrying one of the movable contacts, a holding spring connecting the two arms and biasing the contacts to closed position, a rotative disc having a spring attaching post thereon, centering springs attached at one end to the post and at their other ends to the respective contact arms in opposition to the holding spring, mechanical means operated by the movable member adapted to engage the disc in advance of the limit of movement of the driven member and thereby increase the tension of one of the centering springs, and means actuated by the driven member and responsive to the speed thereof for applying an opening torque to the contact arm to which the said one centering spring is attached.

8. An electrical limit stop mechanism comprising an electrically operated reversible power device, a driven member operated thereby, circuits for energizing the power device in respectively opposite directions, a movable contact in each circuit, two pivoted contact arms, each carrying one of the movable contacts, a holding spring connecting the two arms and biasing the contacts to closed position, a rotative disc having a spring attaching post thereon, centering springs attached at one end to the post and at their other ends to the respective contact arms in opposition to the holding spring, mechanical means operated by the movable member adapted to engage the disc in advance of the limit of movement of the driven member and thereby increase the tension of one of the centering springs, a drag device operated by the driven member and adapted to produce an output torque proportional to the speed of the driven member, and a torque member operated by the output of the drag device and engageable with the contact

arms in a direction respectively to supplement the opening torque of the centering springs.

9. An electrical limit stop mechanism comprising an electrically operated reversible power device, a driven member operated thereby, circuits for energizing the power device in respectively opposite directions, a movable contact in each circuit, two pivoted contact arms, each carrying one of the movable contacts, a holding spring connecting the two arms and biasing the contacts to closed position, a rotative disc having a spring attaching post thereon, centering springs attached at one end to the post and at their other ends to the respective contact arms in opposition to the holding spring, mechanical means operated by the movable member adapted to engage the disc in advance of the limit of movement of the driven member and thereby increase the tension of one of the centering springs, a drag device operated by the driven member and adapted to produce an output torque proportional to the speed of the driven member, a torque member operated by the output of the drag device and engageable with the contact arms in a direction respectively to supplement the opening torque of the centering springs, and means operated by the disc for positively opening the contacts at the limit of movement of the driven member in its respective opposite directions.

10. In a motion reproducing mechanism including a primary movable member the motion of which is to be reproduced and a driven follower member, an electrically operated reversible power device connected to actuate the driven member, circuits for energizing the power device in respectively opposite directions including reversing contacts operated by the primary movable member, a movable contact in each circuit in series with one of the reversing contacts, a pivoted contact arm carrying each of said movable contacts, the two arms being juxtaposed, a holding spring connecting the adjacent ends of the two arms and biasing the said series contacts to closed position, alternative energizing circuits for the power device each including a movable contact on one of the arms so arranged as to be biased toward open position by the holding spring, the normally open contact on each arm being connected to energize the power device in the same direction as the normally closed series contact on the other arm, a rotative disc having a spring attaching post thereon, centering springs attached at one end to the post and at their other ends to the respective contact arms in opposition to the holding spring, mechanical means operated by the movable member adapted to engage the disc in advance of the limit of movement of the driven member and thereby increase the tension of one of the centering springs, and means actuated by the driven member and responsive to the speed thereof for applying a torque selectively to the arm to which the said centering spring is attached supplemental to that of the centering spring and in opposition to that of the holding spring, thus tending first to open the normally closed contact and then to close the normally open contact.

11. In a motion reproducing mechanism including a primary movable member the motion of which is to be reproduced and a driven follower member, an electrically operated reversible power device connected to actuate the driven member, circuits for energizing the power device in respectively opposite directions including reversing contacts operated by the primary movable member, a movable contact in each circuit in series with one of the reversing contacts, a pivoted contact arm carrying each of said movable contacts, the two arms being juxtaposed, a holding spring connecting the adjacent ends of the two arms and biasing the said series contacts to closed position, alternative energizing circuits for the power device each including a movable contact on one of the arms so arranged as to be biased toward open position by the holding spring, the normally open contact on each arm being connected to energize the power device in the same direction as the normally closed series contact on the other arm, a rotative disc having a spring attaching post thereon, centering springs attached at one end to the post and at their other ends to the respective contact arms in opposition to the holding spring, mechanical means operated by the movable member adapted to engage the disc in advance of the limit of movement of the driven member and thereby increase the tension of one of the centering springs, a drag device operated by the driven member and adapted to produce an output torque proportional to the speed of the driven member, and a torque member operated by the output of the drag device and engageable with the contact arms in a direction respectively to supplement the torque of the centering springs.

12. In a motion reproducing mechanism including a primary movable member the motion of which is to be reproduced and a driven follower member, an electrically operated reversible power device connected to actuate the driven member, circuits for energizing the power device in respectively opposite directions including reversing contacts operated by the primary movable member, a movable contact in each circuit in series with one of the reversing contacts, a pivoted contact arm carrying each of said movable contacts, the two arms being juxtaposed, a holding spring connecting the adjacent ends of the two arms and biasing the said series contacts to closed position, alternative energizing circuits for the power device each including a movable contact on one of the arms so arranged as to be biased toward open position by the holding spring, the normally open contact on each arm being connected to energize the power device in the same direction as the normally closed series contact on the other arm, a rotative disc having a spring attaching post thereon, centering springs attached at one end to the post and at their other ends to the respective contact arms in opposition to the holding spring, mechanical means operated by the movable member adapted to engage the disc in advance of the limit of movement of the driven member and thereby increase the tension of one of the centering springs, a drag device operated by the driven member and adapted to produce an output torque proportional to the speed of the driven member, a torque member operated by the output of the drag device and engageable with the contact arms in a direction respectively to supplement the torque of the centering springs, and means carried by the disc and operative to engage the arms selectively and apply a positive torque thereto in opposition to that of the holding spring.

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