July 6, 1937. H. E. HODGSON ET AL 2,086,030

DRIVING MECHANISM FOR VALVES

Filed Feb. 29, 1936 3 Sheets-Sheet 1

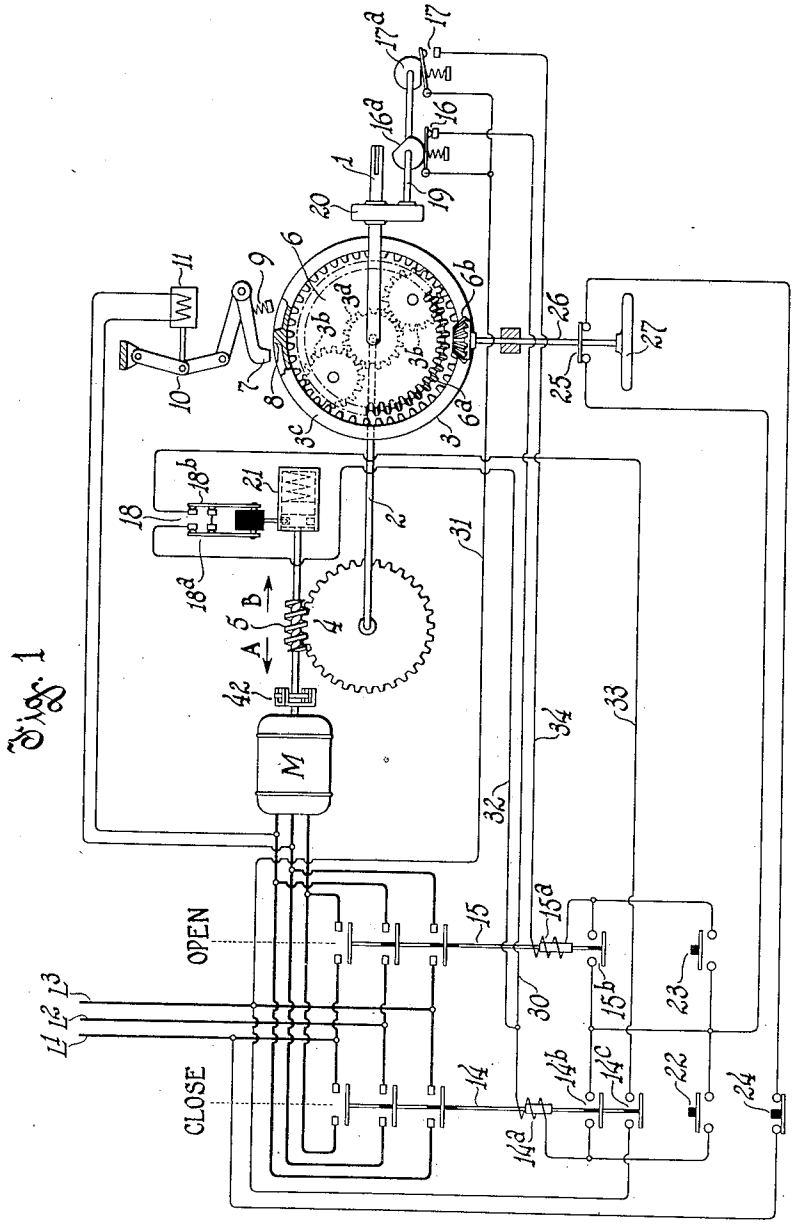


Fig. 1

Inventors
Howard E. Hodgson
John L. Defandorf
By Frank H. Hubbard
Attorney

July 6, 1937. H. E. HODGSON ET AL 2,086,030

DRIVING MECHANISM FOR VALVES

Filed Feb. 29, 1936 3 Sheets-Sheet 2

Fig. 2

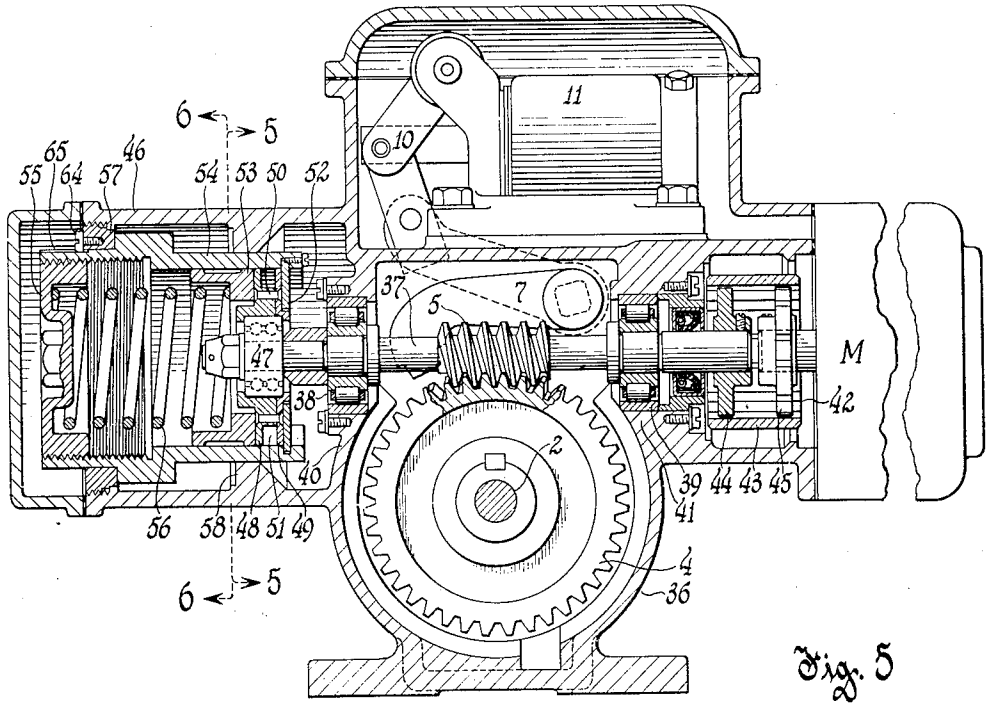


Fig. 5

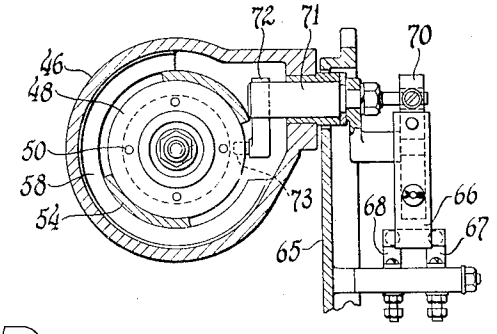
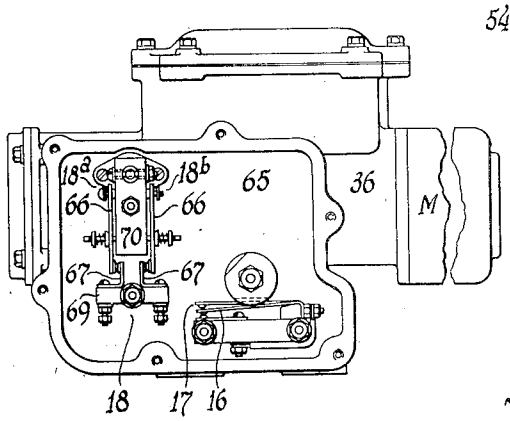


Fig. 3



Inventors.
Howard E. Hodgson
John L. Defandorf
By Frank H. Hubbard
Attorney

July 6, 1937. H. E. HODGSON ET AL 2,086,030

DRIVING MECHANISM FOR VALVES

Filed Feb. 29, 1936 3 Sheets-Sheet 3

Fig. 4

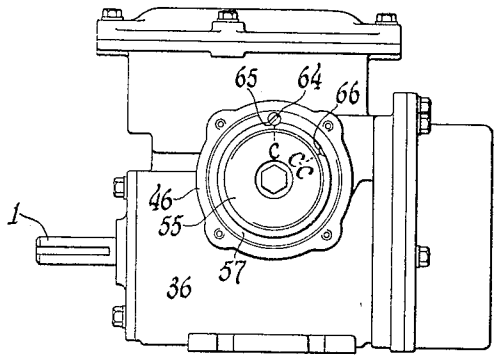


Fig. 6

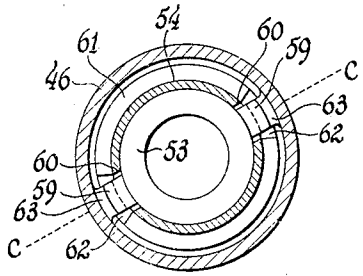


Fig. 8

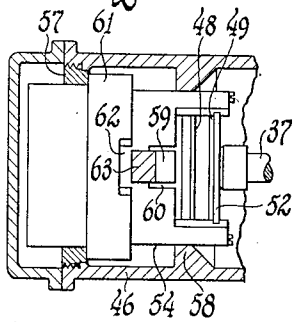


Fig. 7

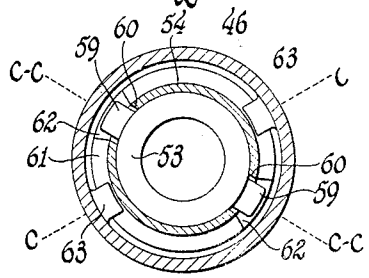
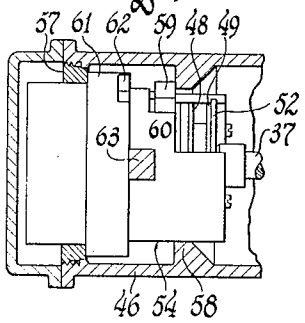


Fig. 9



Inventors.
Howard E. Hodgson
John L. Defandorf
By Frank H. Hubbard
Attorney

Patented July 6, 1937 2,086,030

UNITED STATES PATENT OFFICE

2,086,030

DRIVING MECHANISM FOR VALVES

Howard E. Hodgson, Wauwatosa, and John L. Defandorf, Shorewood, Wis., assignors to Cutler-Hammer, Inc., Milwaukee, Wis., a corporation of Delaware

Application February 29, 1936, Serial No. 66,502

5 Claims. (Cl. 172—239)

This invention relates to driving mechanisms for valves and other devices and is particularly applicable to motor driven valve operating mechanisms of the unit type.

Motor driven valve operating mechanisms have heretofore been provided with torque limit switching means for controlling valve closing operation of the motor and position limit switching means for controlling valve opening operation thereof. Such mechanisms are commonly provided with reduction gearing including a driving worm which is displaceable axially against the action of a spring to operate the torque limit switching means when the torque applied to the valve operating spindle exceeds a given value and the position limit switching means is usually operated from the valve operating shaft through the medium of an interposed reduction gearing.

The present invention relates to motor driven valve operating mechanisms of the aforesaid character and has among its objects to provide an improved torque limit switching mechanism for such mechanisms.

Another object is to provide improved electrical control means for valve operating units of the aforesaid character.

Another object is to provide a valve operating unit of the aforesaid character having improved means associated therewith for effecting manual operation thereof.

Various other objects and advantages of the invention will hereinafter appear.

The accompanying drawings illustrate an embodiment of the invention which will now be described, it being understood that the embodiment illustrated is susceptible of modification without departing from the spirit and scope of the appended claims.

In the drawings,

Figure 1 is a schematic and diagrammatic view of a valve operating mechanism and control means therefor, embodying the invention;

Fig. 2 is a sectional view of a valve operating unit embodying the operating mechanism shown in Fig. 1;

Figs. 3 and 4 are side elevational views of the valve operating unit shown in Fig. 2;

Fig. 5 is a sectional view taken substantially on lines 5—5 of Fig. 2;

Figs. 6 and 7 are sectional views taken substantially on lines 6—6 of Fig. 2 illustrating certain adjustable parts of the valve operating unit in different positions, and

Figs. 8 and 9 are side views partly in section corresponding to Figs. 6 and 7, respectively.

Referring to Fig. 1, the invention is shown in connection with a valve operating mechanism including speed reduction gearing of the character disclosed in the patent to P. P. Dean, No. 1,708,941, issued April 16, 1929. Such mechanism includes a valve operating shaft 1, a driving shaft 2, a planetary speed reducing gear 3 for establishing a driving connection between said shafts and a motor M operatively connected to shaft 2 through the medium of a worm wheel 4 and a worm 5. The planetary gear 3 includes a pinion 3^a fixed to the driving shaft 2, a plurality of pinions 3^b carried by a member 6 fixed to the valve operating shaft 1 and an internally toothed ring gear 3^c, the pinions 3^b being arranged between and in mesh with the pinion 3^a and ring ring gear 3^c. The ring gear 3^c is revolubly mounted, and as is apparent restraint of said ring gear renders the planetary gear effective as a driving connection between the driving shaft 2 and valve operating shaft 1, whereas release of said ring gear permits rotation thereof for release of said driving shaft from said driven shaft.

The means employed for restraining the ring gear 3^c includes a pivoted latch 7 adapted to cooperate with the stop 8 fixed to said ring gear. Latch 7 is biased to move out of engagement with stop 8 by a spring 9 and is movable into engagement with said stop by a toggle 10 having an operating magnet 11 associated therewith. Magnet 11 is connected to the supply circuit of motor M to provide for engagement of latch 7 with stop 8 upon energization of the motor and for disengagement of said latch with said stop upon deenergization of the motor.

Motor M may be of any desired type, the motor shown being of a three phase alternating current type to be supplied with current from a supply circuit indicated by lines L^1, L^2, L^3. The line connections for motor M are controlled by a pair of three pole electromagnetically operated direction switches 14 and 15, the former switch being provided with normally open auxiliary contacts 14^b and 14^c and the latter with normally open auxiliary contacts 15^b. As hereinafter set forth, switch 14 provides for operation of motor M in a direction to effect closure of the valve while switch 15 provides for operation of motor M in a direction to effect opening of the valve. The control means for the direction switches 14 and 15 includes a pair of position limit switches 16 and 17 and a torque limit switch 18.

The position limit switches 16 and 17 are biased to open position and are provided with operating cams 16^a and 17^a which are mounted upon a shaft 19 driven from the valve operating shaft 1 through the medium of reduction gearing 20. The reduction gearing 20 may be of the epicyclic type such as is employed to operate the limit switches shown in the aforementioned patent to P. P. Dean, and cam 16^a is arranged to permit opening of switch 16 when shaft 1 is driven in one direction into a given limit while cam 17^a is arranged to permit opening of switch 17 when said shaft is driven in an opposite direction into a given limit.

The torque limit switch 18 is provided with two series connected switches 18a and 18b and is operatively connected to the worm 5 through the medium of a torque responsive device 21. As hereinafter set forth, the torque responsive device 21 has a spring associated therewith for yieldingly holding worm 5 against axial movement in either direction out of a given normal position and the same is adjustable to positively lock said worm against movement out of normal position in either direction selectively and to permit axial movement of said worm in an opposite direction upon transmission of a predetermined torque. Movement of worm 5 in one direction out of normal position effects opening of switch 18a, and movement thereof in an opposite direction out of normal position effects opening of switch 18b.

The control means for the direction switches 14 and 15 also includes a pair of normally open start push buttons 22 and 23, a normally closed stop push button 24 and a normally closed switch 25 which is associated with a mechanism for effecting manual operation of the valve.

To provide for manual operation of the valve the member 6 which carries the pinions 3b is provided with bevel gear teeth 6a to be engaged by a pinion 6b fixed to a shaft 26 having an operating hand wheel 27 associated therewith. Pinion 6b is normally held out of engagement with the bevel gear 6a and the shaft 26 is movable axially by hand wheel 27 to move said pinion into mesh with said bevel gear for establishment of a driving connection between said hand wheel and the valve operating shaft 1. The switch 25 is associated with the shaft 26 and is adapted to be opened prior to engagement of pinion 6b into mesh with bevel gear 6a.

The function and operation of the aforedescribed system will now be more fully set forth. As is apparent, the switches 14 and 15 are connected to selectively establish connections between lines L^1, L^2 and L^3 and the motor M which provide for operation of the motor in opposite directions. However, such connections are always arranged so that switch 14 provides for operation of motor M in the direction required to effect closure of the valve, and switch 15 provides for operation of said motor in the direction required to effect opening of the valve. Also the torque responsive device 21 is adjusted to suit the direction of operation required to effect closure of the valve. If worm 5 tends to move in the direction of arrow A during closure of the valve, the torque responsive device 21 is adjusted to positively lock the same against movement out of normal position in the direction of arrow B, whereas if worm 5 tends to move in the direction of arrow B during closure of the valve said torque responsive device is adjusted to positively lock the same against movement out of normal position in the direction of arrow A. In the system illustrated it is assumed that limit switch 16 opens prior to seating of the valve, and that limit switch 17 opens at the instant the valve moves into full open position.

Assuming that the valve is in open position, closure of push button 22 establishes an energizing circuit for switch 14 extending from line L^1 through stop push button 24, through switch 25 and push button 22, to and through the operating winding 14a, by conductor 30 through limit switch 16 and by conductor 31 to line L^3. Upon closure of switch 14, motor M is energized to operate in a direction to effect closure of the valve, and immediately upon energization of the motor magnet 11 is energized to move pawl 7 into engagement with the stop 8 on ring gear 3c to establish a driving connection between shaft 2 and the valve operating shaft 1. Upon response of switch 14 the auxiliary contacts 14b thereof close and establish a shunt circuit around the start push button 22 whereby the operating winding 14a is maintained energized upon release of push button 22. Also upon response of switch 14 a second maintaining circuit therefor is established extending from line L^1 through stop push button 24, switch 25 and auxiliary contacts 14b to and through the operating winding 14a, by conductor 32 through the torque limit switch 18 and by conductor 33 through auxiliary contacts 14c to line L^3. As hereinbefore stated, limit switch 16 opens prior to seating of the valve and upon opening thereof switch 14 is maintained energized by the aforedescribed maintaining circuit extending through the torque limit switch 18. Upon seating of the valve the torque transmitted to the valve operating shaft 1 increases and upon transmission of a given torque, worm 5 moves against the action of the torque responsive device 21 in the direction of arrow A or arrow B, as the case may be, to open one of the sets of contacts of the torque switch 18. The aforedescribed maintaining circuit for switch 14 extending through torque switch 18 is thus opened and switch 14 then drops out to stop motor M and to also deenergize magnet 11 for substantially instantaneous interruption of the driving connection between shafts 2 and 1.

After seating of the valve, the torque responsive device 21 returns worm 5 and torque limit switch 18 to normal position. The contacts of the torque limit switch 18 are thus reclosed, but it should be noted that the aforedescribed maintaining circuit for switch 14 extending through said switch is not reclosed due to opening of the auxiliary contacts 14b and 14c. Also since the position limit switch 16 is in open position the energizing circuit for switch 14 cannot be reestablished by push button 22. Thus upon seating of the valve, motor M cannot be restarted in its closing direction.

Assuming that the valve is in closed position, depression of push button 23 establishes an energizing circuit for switch 15 extending from line L^1, through stop push button 24, through switch 25, through push button 23 to and through the operating winding 15a, by conductor 34, through limit switch 17 which is now in closed position, and by conductor 31 to line L^3. Upon closure of switch 15 motor M is energized to operate in a direction to effect opening of the valve and magnet 11 is energized to move pawl 7 into engagement with stop 8 to establish the driving connection between driven shaft 2 and the valve operating shaft 1. As hereinbefore stated, the torque responsive device 21 is adjusted to positively lock worm 5 against movement out of normal position during opening of the valve, and a positive drive is therefore provided between motor M and the valve operating shaft 1 to insure unseating of the valve under the action of the hammer blow which is imparted to the valve operating shaft upon engagement of latch 7 with stop 8 on ring gear 3c. Upon closure of switch 15 the auxiliary contacts 15b thereof shunt the push button 23 to maintain the aforedescribed energizing circuit for the winding 15a upon release of said push button. Upon movement of the valve into open position limit switch 17 opens to interrupt the aforedescribed energizing circuit for winding 15a. Switch

15 then drops out to deenergize motor M and to also deenergize the magnet 11 for substantially instantaneous interruption of the driving connection between shafts 2 and 1.

In the system illustrated it is assumed that limit switch 16 opens prior to seating of the valve, and limit switch 17 opens at the instant the valve moves into full open position. However, the installation may be such that limit switch 17 is adapted to open upon closure of the valve and limit switch 16 is adapted to open upon opening of the valve. In such installations limit switch 17 is adjusted to open prior to seating of the valve and limit switch 16 is adjusted to open when the valve moves into full open position. Also conductor 30 is connected to limit switch 17 and conductor 34 is connected to limit switch 16 to provide for control of switch 14 by limit switch 17 and for control of switch 15 by limit switch 16.

In connection with the foregoing it should be noted that opening of push button 24 or switch 25 disconnects the operating windings of both of the direction switches 14 and 15 from line L^1. Thus push button 24 provides for stopping of the driving motor at any time during valve opening or closing operations and the switch 25 prevents operation of the driving motor upon movement of pinion 6^b into mesh with bevel gear 6^a for establishment of the driving connection between hand wheel 27 and the valve operating shaft 1. It should also be noted that since latch 7 is released from ring gear 3^c when motor M is deenergized, the driving connection between shaft 2 and the valve operating shaft 1 will be interrupted during manual operations.

Referring now to Fig. 2, the same illustrates a mechanical embodiment of the driving mechanism shown in Fig. 1. The several parts of the driving mechanism are mounted within enclosing casing 36 and in the embodiment illustrated it is assumed that the planetary speed reducing gear 3 and its associated restraining device and also the worm gear 4 and speed reduction gearing 20 are arranged within said casing in the manner disclosed in the aforementioned patent to P. P. Dean.

As shown in Fig. 2, the worm 5 is formed intermediate the ends of a shaft 37 and said shaft is supported adjacent opposite ends of said worm by roller bearings 38 and 39 mounted within openings in walls 40 and 41 within casing 36. The roller bearings 38 and 39 are of a type permitting axial movement of the shaft 37 in opposite directions out of the normal position shown in Fig. 1 and the right hand end of said shaft is connected to the shaft of motor M by a slidable coupling 42. Coupling 42 includes an internally splined sleeve 43 and a pair of toothed members 44 and 45 engaging the splines within said sleeve, the former member being fixed to shaft 37 and the latter being fixed to the shaft of motor M.

The torque responsive device 21 is associated with the left hand end of shaft 37 and is mounted within a hollow cylindrical projection 46 on casing 36. The left hand end of shaft 37 has a ball bearing 47 mounted thereon, the inner race of said bearing being fixed to said shaft and the outer race thereof having thrust collars 48 and 49 fixed thereto. Said thrust collars are held in assembled relation on the outer race of ball bearing 47 by rivets 50 and the same are formed to provide a groove 51 between the same for receiving a switch operating part which will be hereinafter described. The thrust collars 48 and 49 are located between two stop members 52 and 53, the former stop member being fixed to the right hand end of a cylindrical sleeve 54 and the latter being slidable within said sleeve. The left hand end of sleeve 54 is internally threaded to receive a screw adjusting cap 55 and said sleeve contains a helical spring 56 which is held under compression between said cap and the stop member 53. The outer end of casing projection 46 is internally threaded to receive a threaded ring member 57 and the left hand end of sleeve 54 is slidably mounted within the opening in said ring member while the right hand end thereof is slidably mounted within a bored opening in an inwardly extending flange 58 on the interior of casing projection 46.

As shown in Figs. 6 and 7, stop member 53 is provided with oppositely disposed stop projections 59—59 which extend outwardly through oppositely disposed slots 60—60 in sleeve 54 and normally engage the left hand face of flange 58. The sleeve 54 is provided with an outwardly projecting flange 61 and the left hand face of said flange normally engages ring member 57 while the right hand face thereof is provided with oppositely disposed recesses 62—62 which are in alignment with the stop projections 59. The stop projections 59 and flange 61 also cooperate with a pair of oppositely disposed inwardly extending stop projections 63—63 on the interior of casing projection 46.

Sleeve 54 is rotatable within casing projection 46 and is adapted to be locked in different angular positions within said casing projection by a removable round headed screw 64 threaded into ring member 57. As shown in Fig. 4, the outer surface of sleeve 54 is provided with grooves 65 and 66 and the head of screw 64 is adapted to engage within either of said grooves to lock said sleeve in different angular positions corresponding to lines C and C—C.

With sleeve 54 locked in the angular position corresponding to line C, (Fig. 4) the recesses 62 in flange 61 and the stop projections 59 on stop member 53 are angularly aligned with the stops 63 on casing projection 46 as shown in Figs. 6 and 8. The stop projections 59 on stop member 53 are then located between the right hand face of flange 58 and the left hand faces on stop projections 63. Stop member 53 is thus locked against axial movement in either direction out of normal position and since recesses 62 are aligned with stop projections 63 the sleeve 54 is movable out of normal position towards the right with respect to stop member 53 against the action of spring 56. The worm 5 is thus positively locked against axial movement towards the left out of normal position by engagement of thrust collar 48 with stop member 53. However. when worm 5 tends to move towards the right, thrust collar 49 engages stop member 52 and tends to move sleeve 54 towards the right against the action of spring 56. Spring 56 normally holds sleeve 54 in the position shown in Fig. 2, but upon transmission of a given torque said sleeve and worm move out of normal position against the action of said spring.

With the sleeve 54 locked in the angular position corresponding to line C—C, Fig. 4, the stop projections 59 on member 53 and the recesses 62 in flange 61 are out of alignment with the stop projections 63 on casing projection 46 as shown in Fig. 7. As is apparent from Fig. 9, sleeve 54 is then locked against axial movement out of normal position towards the left by ring member

55 and towards the right by the stops 63. However, the stop member 53 is movable towards the left against the action of spring 56. The worm 5 is thus positively locked against movement towards the right out of normal position by engagement of thrust collar 49 with the stop 52. However, when worm 5 tends to move towards the left, thrust collar 48 engages thrust member 53 and tends to move said stop member towards the left against the action of spring 56. The spring 56 normally holds stop member 53 in the position shown in Fig. 2 but upon transmission of a given torque worm 5 and stop member 53 move towards the left out of normal position against the action of said spring.

As shown in Fig. 3, the torque limit switch 18 and the position limit switches 16 and 17 are mounted upon a wall 65 associated with casing 36. Each of the switches 18^a and 18^b shown in Fig. 1 includes a movable contact 66 and a pair of cooperating stationary contacts 67 and 68. The two pairs of stationary contacts 67 and 68 are mounted upon opposite sides of an insulating base 69 fixed to the wall 65 and the movable contacts 66 are yieldingly mounted upon opposite sides of an insulating base 70 having its upper end fixed to a shaft 71. Shaft 71 is rotatably mounted within an opening in wall 65 and the inner end of said shaft extends into the opening in casing projection 46. As shown in Fig. 5 the inner end of shaft 71 has a lever 72 fixed thereto and the free end of said lever has a pin 73 mounted thereon which projects into the groove 51 between thrust collars 48 and 49.

As shown in Fig. 3, the movable contacts 66 of the torque limit switch are normally in engagement with their cooperating stationary contacts 67 and 68. However, upon movement of worm 5 out of normal position towards the right under the action of a predetermined torque the thrust collar 48 engages pin 73 on lever 72 and shaft 71 and the insulating base 70 are then rotated in a counter-clockwise direction to disengage the right hand movable contact 66 from its cooperating stationary contacts. On the other hand, upon movement of worm 5 towards the left out of normal position the collar 49 engages pin 73 on lever 72, and shaft 71 and insulating base 70 are then rotated in a clockwise direction to disengage the left hand movable contact 66 from its cooperating stationary contacts.

What we claim as new and desire to secure by Letters Patent is:

1. In a valve operating system, in combination, a valve drive shaft, a driving motor therefor, driving connections between said motor and said shaft including a part yieldingly held in a given normal position and movable out of such position in response to a predetermined torque during operation of said motor in a direction to effect closure of the valve, means for starting said motor in opposite directions selectively, a torque limit switch acting upon movement of said part out of normal position to effect stopping of said motor, and a pair of position limit switches controlled by said valve drive shaft, one of said limit switches providing for stopping of said motor upon operation of said valve drive shaft into a given limit in its valve opening direction and the other of said limit switches being operable to render said torque limit switch ineffective except upon operation of said valve drive shaft into a given limit in its valve closing direction and to also prevent restarting of said motor in valve closing direction.

2. In a power transmission mechanism, in combination, a reversible motor, a member to be driven thereby, a driving connection between said motor and said member including an element tending to move in one direction out of a given normal position upon operation of said motor in one direction, and in an opposite direction out of said normal position upon operation of said motor in an opposite direction, a spring associated with said element, a mechanism adjustable to selectively lock said element against movement in either direction out of normal position and to render said spring operative to oppose movement of said element in an opposite direction out of normal position, and control means for said motor including a limit switch operable upon movement of said element out of normal position to effect stopping of said motor.

3. In a power transmission mechanism, in combination, a reversible motor, a member to be driven thereby, gearing interposed between said motor and said member including a worm driven by said motor, and torque responsive means associated with said worm for effecting stopping of said motor, said means including an adjustable mechanism for locking said worm against movement out of a given normal position in opposite directions selectively, and a single spring associated with said mechanism for yieldingly holding said worm against axial movement in either direction out of normal position upon locking thereof against movement in an opposite direction out of normal position.

4. In a valve operating device, in combination, a reversible motor, a valve operating shaft, gearing interposed between said motor and said shaft including a worm driven by said motor, a pair of stop members associated with said worm, said stop members being adjustable to selectively lock said worm against axial movement in opposite directions out of a given normal position, spring means for biasing said stop members to yieldingly hold said worm in normal position, and control means for said motor including means for stopping the same upon movement of said worm out of normal position against the action of said spring means.

5. In a valve operating device, in combination, a reversible motor, a valve operating shaft, gearing interposed between said motor and said shaft including a worm driven by said motor, an enclosing casing for said gearing, an adjustable torque responsive device interlocked with said casing, said device being adjustable with respect to said casing to lock said worm against axial movement out of a given normal position in opposite directions selectively, and having a spring associated therewith which acts upon locking of said worm against axial movement in either direction out of normal position to oppose movement of said worm in an opposite direction out of normal position, and a switch associated with said torque responsive device for stopping said motor upon axial movement of said worm out of normal position in either direction against the action of said spring.

HOWARD E. HODGSON.
JOHN L. DEFANDORF.