Nov. 25, 1969 H. W. FERGUSON 3,479,924

PISTON TYPE OPERATOR WITH POWER CHECKING

Filed April 19, 1968 2 Sheets-Sheet 1

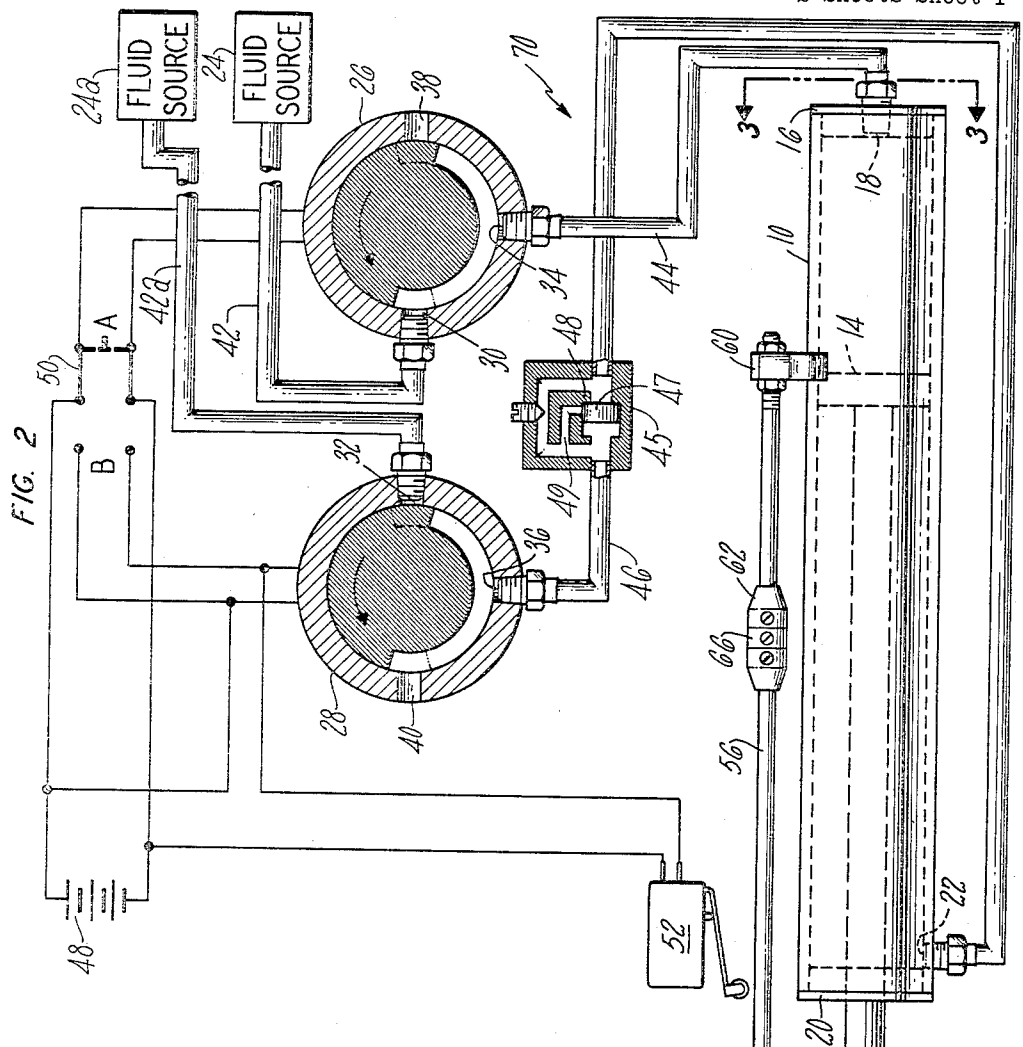


FIG. 2

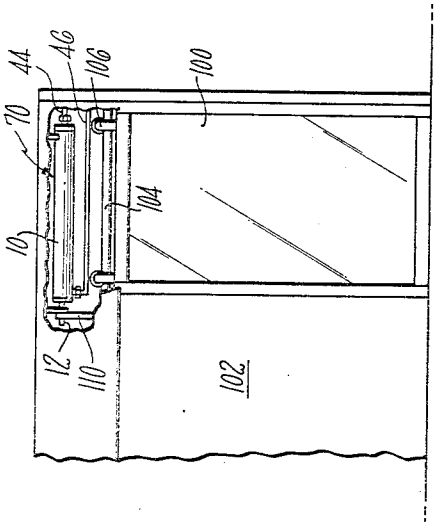


FIG. 1

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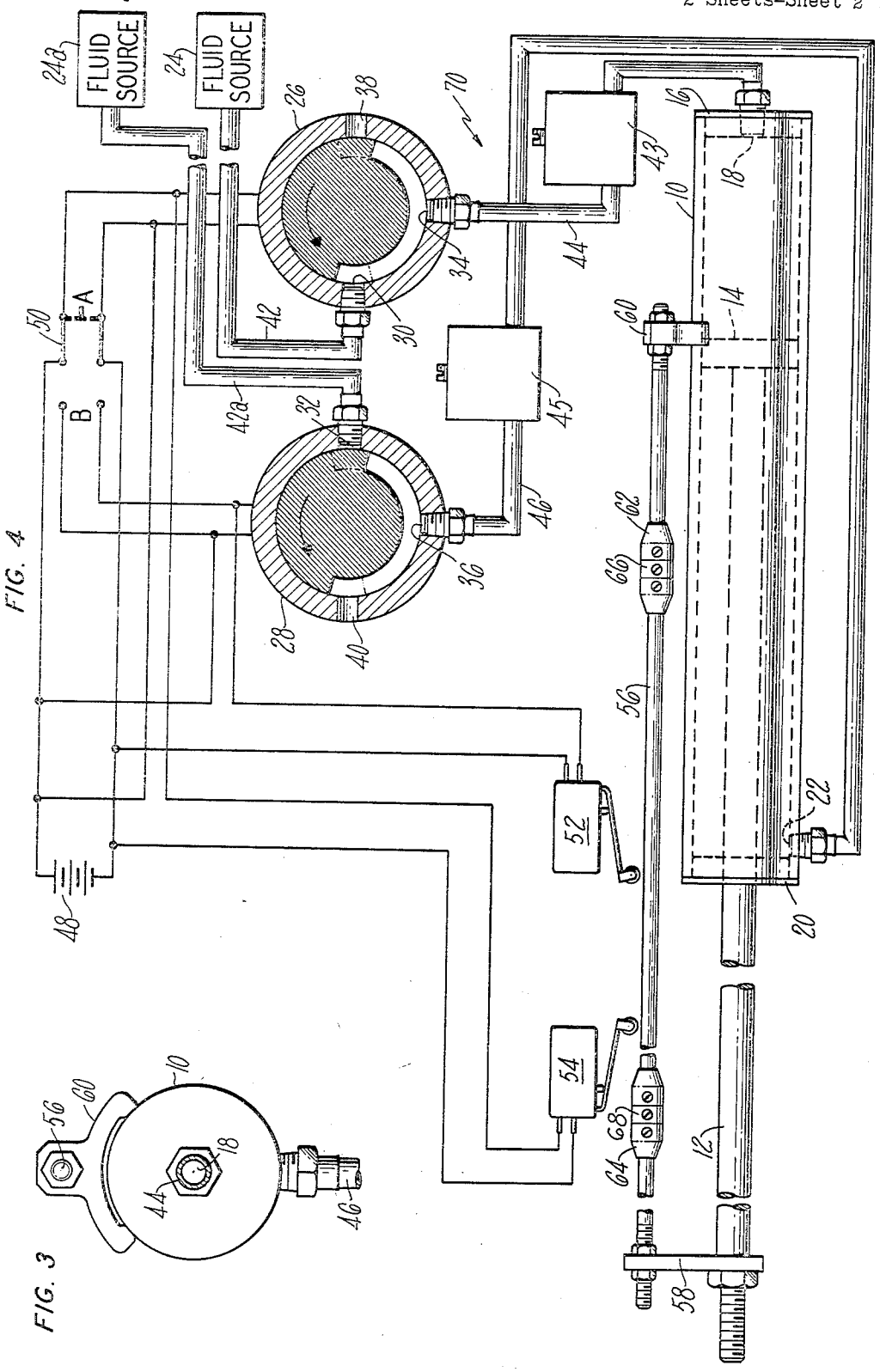


FIG. 4

FIG. 3

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PISTON TYPE OPERATOR WITH POWER CHECKING

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ABSTRACT OF THE DISCLOSURE

A fluid powered door operator having a double acting piston and cylinder assembly, sources of fluid at different pressures, one supplying each end of the cylinder, and a fluid flow control valve in each supply line for controlling fluid flow to the cylinder. An operator control switch initiates the flow to the cylinder of fluid under full pressure. Cam operated switch apparatus, also associated with the valve structure, is adapted, after a predetermined movement of the piston, to admit fluid under positive pressure to flow against the then advancing side of the piston while continuing the full pressure to the other side, to power check the piston and a door attached thereto and to stop the door at a predetermined point in a short distance. An adjustable valve can be utilized for providing throttled fluid flow in one direction and unthrottled exhaust flow, increasing the precision and versatility of the design.

This invention pertains generally to operators for panel members such as doors which are movable relatively to their supporting structures, and particularly to the double acting piston type of operator for such panel members, having apparatus for power checking the associated mechanism and doors to a stop.

The disposition of a series of cylinder exhaust ports which are progressively isolated from the fluid confine in the cylinder downstream of the drive piston exemplifies one well-known means for gradually decelerating a fluid operated piston. This and other heretofore known means for de-energizing and stopping a high velocity piston and cylinder assembly such as is utilized for a door operator of the type described are relatively expensive to make; require considerable installation space; and fail to positively stop a moving object at a predetermined point and within a relatively short distance.

The present invention overcomes the above recited drawbacks of the heretofore available checking devices, with a novel power checking apparatus featuring pressurized fluid simultaneously bearing against upstream and downstream sides of a moving piston during braking phases of operator function.

An object of this invention is to provide a new and improved piston type panel operator.

Another object of this invention is to provide a piston type panel operator that introduces driving fluid downstream of the traveling piston for power checking the panel, thereby eliminating extra checking devices and reducing both unit bulk and cost.

Another object of this invention is to provide a bidirectional piston type high velocity panel operator that maintains positive control of high velocity motion and can be quickly de-energized and braked to a stop at a predetermined point of transit.

Another object of this invention is to provide a bidirectional piston type high velocity panel operator in which fluid under adjustable positive pressure is caused to flow first against one side of the piston for driving the same and subsequently, simultaneously with that flow,

also against the other side for retarding and stopping the advancing piston.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application which will be indicated in the appended claims.

In the drawing:

FIG. 1 is a front elevation, partly schematic and partly broken away, showing a portion of the novel operator of the invention;

FIG. 2 is an enlarged front view, partly schematic, showing additional detail of the operator disclosed in FIG. 1;

FIG. 3 is an end view taken along line 3—3 of FIG. 2; and

FIG. 4 is an enlarged fragmentary front view, similar to FIG. 2, of an adaptation of the novel operator of the present invention.

One embodiment of the operator **70** of the invention is illustrated in association with a sliding door **100** that is movably disposed between open and closed positions relatively to a passageway (not shown) in wall **102**. Track **104**, fixed to the wall above the passageway supports trolleys **106** which in turn are mounted on and support the door **100**, and provide for smooth operation of the same. Drive arm **110** engages one of the trolleys **106** and is appropriately attached to the operator **70** for drivingly linking the door thereto.

The novel operator **70** is shown in FIG. 2 during an opening stroke thereof, and includes a fluid cylinder **10**, which is of uniform size along its length, having end ports **18** and **22**, a double acting piston **14** reciprocably driven within the cylinder, and a piston rod **12** attached to said piston. Cylinder **10** is equipped with an upstream end cap **16**, and the opposite end of the cylinder through which the rod **12** passes, is fitted with a downstream end cap **20** suitably apertured to guide the rod as it reciprocates within the cylinder **10**.

During an opening stroke of the operator **70**, pressurized fluid from source **24** is supplied to flow regulating three way valve **26**, which is opened by means of operator switch **50** for supplying fluid to cylinder **10** to drive the piston **14** toward downstream end cap **20** and the door **100** toward its open position. When the switch **50** is positioned at A, energy from electrical source **48** flows through the switch and opens valve input port **30** so that fluid from source **24** flows therethrough and across output port **34** into conduit **44** for delivery to the upstream end of cylinder **10** through end port **18**, whereafter it bears against the upstream side of piston **14** to drive the same as indicated above. Fluid is exhausted from the downstream end of the cylinder **10** during each opening stroke, through end port **22** in the cylinder **10**, into conduit **46** and thence through valve **45** and a flow regulating three way valve **28** also associated with electrical source **48** and discharged therefrom during an opening stroke, via output port **36** and exhaust port **40** communicating therewith.

As piston **14** and piston rod **12** move along within the cylinder **10**, camshaft **56** moves in step with the rod, carried by cross-link **58** attached to adjacent ends of the rod and shaft and externally of the cylinder. The opposite end of the shaft **56** is supported by traveler **60** riding on the cylinder to maintain uniform spacing between the said shaft and the cylinder. Cam **62** is so disposed upon the camshaft **56** that it contacts microswitch **52** at an adjustable time predetermined with respect to the position of the piston **14** in the cylinder **10**. The microswitch **52**

is closed upon contact with cam **62**, and energy source **48** is connected therethrough with valve **28**, shifting the same from its exhaust condition described above to its driving condition in which the input port **32** and the output port **36** are brought into communication and the exhaust port **40** is closed. Positive pressure from source **24***a* shown as being separate from source **24**, is now applied through conduit **42***a*, and the valve **28** so that positive pressure is applied simultaneously into both the upstream and downstream ends of the cylinder **10**. The fluid thus delivered to the downstream end of the cylinder normally has greater pressure than that delivered to the upstream end to compensate for the reduction of effective area of the piston **14** caused by the piston rod **12**. While separate fluid sources **24** and **24***a* having different pressure levels are shown, it is apparent that other arrangements for compensating for the different effective areas of the two sides of the piston could be used. The positive pressure delivered downstream of piston **14** opposes and quickly checks the motion of the piston, thus deenergizing and stopping the same and the door **100** linked thereto.

Cross-link **58** is adjustably disposed on piston rod **12**; camshaft **56** is axially adjustably disposed in the cross-link; and the cam **62** is positionable along the camshaft **56**. This arrangement of structure facilitates presetting the exact moment at which cam **62** will contact switch **52**, close the same and introduce the flow of braking fluid to cylinder **10**. That contact is normally set to occur slightly before the door is fully opened. Positive reduction of velocity of the piston and the door linked thereto is obtained, therefore, at a predetermined point of beginning the downstream injection of fluid after the optimum movement of the piston **14**. Refinement of the duration of downstream injection of fluid can be accomplished by using different sizes and numbers of replaceable cam segments **66**, thus controlling the time during which microswitch **52** is held closed by the cam **62**. The cam is thus sized to hold the switch closed long enough to completely stop the advancing piston and therefore the door. Positive control of high velocity motion in a relatively short distance of piston and door travel is thus also readily achieved by the invention, and is further refined by the valve **45** which offers adjustable resistance to fluid flow. In the power checking direction of fluid flow, plug member **47** seats against stop **48** cutting off fluid flow through passage **49** so that fluid for checking passes through the valve only along passage **51**. In the exhaust direction, flow through the valve is unthrottled as the plug **47** unseats and opens the conduit **49** so that fluid passes through both the conduits **49** and **51**.

Once opened as described above, the door **100** will be held open by the operator **70** as long as both valves **26** and **28** remain open, that is, with their input ports in communication with their output ports. In other words, after cam **62** contacts and closes microswitch **52**, fluid from the common source **24** ordinarily will impinge upon both the upstream and downstream sides of piston **14** as long as switch **50** remains in A position, and therefore the door will be immobilized in the open position.

In order for the door **100** to be closed, the fluid in the upstream end of the cylinder must have an exhaust route. Shifting the operator switch **50** out of A position opens the needed route by closing the valve **26**, whereupon it assumes its exhaust condition, and output port **34** communicates with exhaust port **38** so that fluid from the upstream end of the cylinder can vent through conduit **44**, port **34** and thence through port **38**. In this condition of the valve **26**, input port **30** is closed off from fluid flowing through conduit **42**.

Effective reversal and closing drive of the piston **14** and door **100** is achieved by placing the switch **50** in B position directly from A position, whereby valve **28** is opened, without respect to the condition of microswitch **52**. That is, as the switch **50** is positioned at B, input port **32** and output port **36** are interconnected and fluid flows from source **24**, through conduit **42** and the valve **28**, through conduit **46** and downstream aperture **22**, bearing against piston **14** and driving the same toward the upstream end of the cylinder **10** and the closed position of the door as valve **28** is closed to exhaust conduit through ports **34** and **38**. Suitable braking means, such as a check spring (not shown) contacting the door prior to completion of its return movement, could be installed to prevent the retracting piston from impacting at full velocity against the end cap **16**.

The invention is shown in FIG. 4 adapted for bidirectional power checking, that is to say, power checking of the return or closing stroke in addition to power checking of the opening stroke. As has been disclosed above, power checking of the opening stroke is effected with appropriately disposed microswitch **52** and cam means **62**. Power checking of the door **100** upon the return stroke of piston **14** is provided by means of a second microswitch **54** and cam means **64**, as shown. The traveler **60** maintains uniform camshaft-to-cylinder clearance, as in the FIG. 2 embodiment. With the switch **50** in A position, the operator **70** functions as indicated for the first embodiment: fluid passes through valve **26** to bias the upstream side of the piston **14**, driving the piston, the camshaft **56** and the door **100** downstream toward the open position of the door. At the appropriate moment cam **62** contacts and closes microswitch **52**, causing fluid to flow into the downstream end of the cylinder **10** and quickly brake the motion of the piston and door. Changing the switch **50** to B position causes valve **26** to shift to exhaust condition and also causes valve **28** to maintain fluid flowing to the downstream side of the piston **14**, thus driving the piston and the door in reverse. In addition, in this embodiment, the bidirectional adaptation includes the microswitch **54** and the cam **64** so disposed relatively to each other and to the camshaft **56** that the cam **64** is adapted to contact and close switch **54** and thereby open the valve **26**, causing fluid to flow against the upstream side of the piston **14**, via conduit **44**. This flow begins at the appropriate moment which is predetermined with respect to the position of the piston **14**, during its return stroke in the cylinder **10**. That moment occurs during the interval when driving fluid is still being injected in the downstream end of the cylinder **10**. The timing of the fluid injection for return stroke braking is based on the same principle, and except for the cam **64**, the switch **54** and the adjustable valve **43**, which is identical to valve **45**, is obtained with the same structure as is the opening stroke braking in the FIG. 2 embodiment. Normally, therefore, the injection of the braking flow upstream is timed to occur slightly before the door is fully closed. The effect of this braking flow is to quickly check the motion of the piston **14** and door **100** as the latter reaches its closed position. Control of the duration of the fluid flow which functions to check piston and door closing motion is achieved by using different sizes and numbers of replaceable cam segments **68** for the cam **64**, just as various segments **66** can be used for the cam **62**. Moreover, with proper relative positioning of cam **62** with respect to microswitch **54** as well as microswitch **52**, both microswitches may be actuated by a single cam **62**.

In addition to controlling the operator **70**, the switch **50** enhances smooth functioning of the mechanism by maintaining the valves opened as needed to first reverse and then sustain the drive, independently of the microswitch and cam operation of the valves. That is, as the cam **62** and switch **52** disengage after power checking during an opening stroke of the operator, the switch **50** maintains the fluid flow. In the same manner, as the cam **64** and switch **54** disengage after power checking during a closing stroke of the operator, the switch **50** maintains the fluid flow. The switch **50** always ensures, therefore, that the door **100** will be held open or closed depending

upon whether it—the switch—is left in A or B position.

The present invention thus provides means for quickly power braking or checking a high velocity fluid operated piston assembly at a predetermined point of the piston travel, and within a relatively short distance. The usually severe impacting forces experienced under high velocity conditions are nullified by de-energizing and stopping the piston with fluid introduced against the advancing side of the piston simultaneosuly with the flow of fluid driving the upstream side of the piston. The usual extra checking devices are thus eliminated and machining costs and the bulk of the apparatus are reduced. The operator is disclosed in a sliding door environment but is readily adaptable to other types of installation such as are used for swinging doors.

I claim:

1. A fluid powered door operator for controllably driving a door between open and closed positions comprising a cylinder having longitudinally spaced first and second ports for both receiving and exhausting driving fluid, a fluid actuated piston movable within said cylinder between said ports under the driving force of the fluid, first and second fluid flow regulating valves associated with the first and second ports, respectively, for regulating the flow of fluid through the ports into and out from the cylinder, and means associated with at least the second fluid regulating valve for braking the travel of the piston as it approaches the second port, said means including a sensor for sensing the approach of the piston toward the second port and for opening the second valve to permit flow of fluid into the cylinder through the second port without interrupting fluid flow to the first port to thereby brake the travel of the piston by the simultaneous flow of fluid against both sides of the piston.

2. An operator as claimed in claim 1 in which the sensor includes a piston actuated cam and a cam actuated switch connected with and controlling the operation of the second valve.

3. An operator as claimed in claim 2 in which the cam is adjustably disposed relatively to the switch to ensure timely switch actuating contact by the cam as the piston approaches the second port, said cam consisting essentially of a plurality of replaceable cam segments facilitating change in the duration of contact between the cam and the switch.

4. An operator as claimed in claim 1 including a throttling valve communicating both with the second valve and the second port of the cylinder for providing resistance to fluid flow in one direction and affording full flow exhaust.

5. An operator as claimed in claim 1 wherein said throttling valve is adjustable.

6. An operator as claimed in claim 1 including apparatus for supplying one end of the cylinder with fluid at a pressure different from that supplied to the other end, to compensate for the different effective areas of the piston created by the piston rod.

7. An operator as claimed in claim 1 including additional means associated with the first valve for braking the travel of the piston as it approaches the first port, said additional means including a sensor for sensing the approach of the piston toward the first port and for opening the first valve to permit flow of fluid into the cylinder through the first port without interrupting flow of fluid to the second port to thereby brake the travel of the piston by the simultaneous flow of fluid against both sides of the piston.

8. An operator as claimed in claim 7 in which the valves are movable between fluid flow and fluid exhaust positions and said sensors include cam operated switches responsive to the movement of the piston for independently controlling the movement of the valves into said positions.

9. An operator as claimed in claim 7 including valve control means for alternately controlling fluid flow through each of said valves independently of the braking means associated with the valves.

10. An operator as claimed in claim 7 including an adjustable valve communicating both with the first valve and the first port of the cylinder for throttling the fluid flow in one direction and providing unthrottled flow in the other direction.

11. An operator as recited in claim 7 wherein the sensor includes a cam mounted on a camshaft one end of which is connected to the piston rod and the other end of which is connected to a traveler slidably mounted on the cylinder for maintaining the camshaft in fixed position prallel to the piston rod.

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U.S. Cl. X.R.

91—358, 392, 415, 459, 465