United States Patent

[11] **3,590,965**

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[54] **SEQUENCE AND DIRECTION VALVE**
9 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **192/3,** 91/410, 91/445, 91/468, 192/141, 192/144, 244/85

[51] **Int. Cl.** **F16d 71/04,** B64c 13/36

[50] **Field of Search** 91/410, 445, 452, 468; 192/3, 141, 144; 244/85

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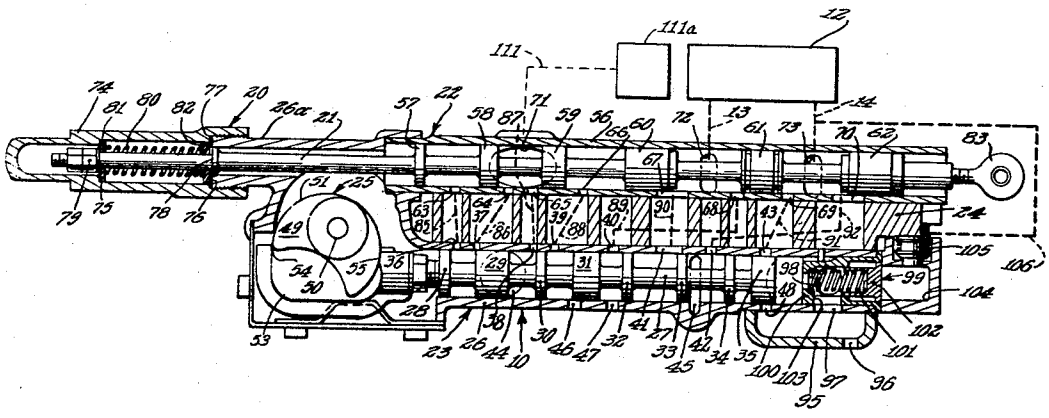
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Attorney—Hill, Sherman, Meroni, Gross and Simpson

ABSTRACT: A valve assembly adapted to control rotary actuators by providing velocity reduction and stopping function to the actuator and thereby greatly enhancing the positional accuracy of the rotary actuator to duplicate the velocity reduction and stopping characteristic of a linear actuator. The valve assembly includes a directional control spool valve and a sequence control spool valve which is to slow and stop the actuator at the end of the desired output displacement. In the preferred embodiment, the valve assembly also controls the engagement and disengagement of a braking means associated with the actuator and includes means to control the speed of travel of the actuator in one direction by applying a variable back pressure on the exhaust line from the actuator.



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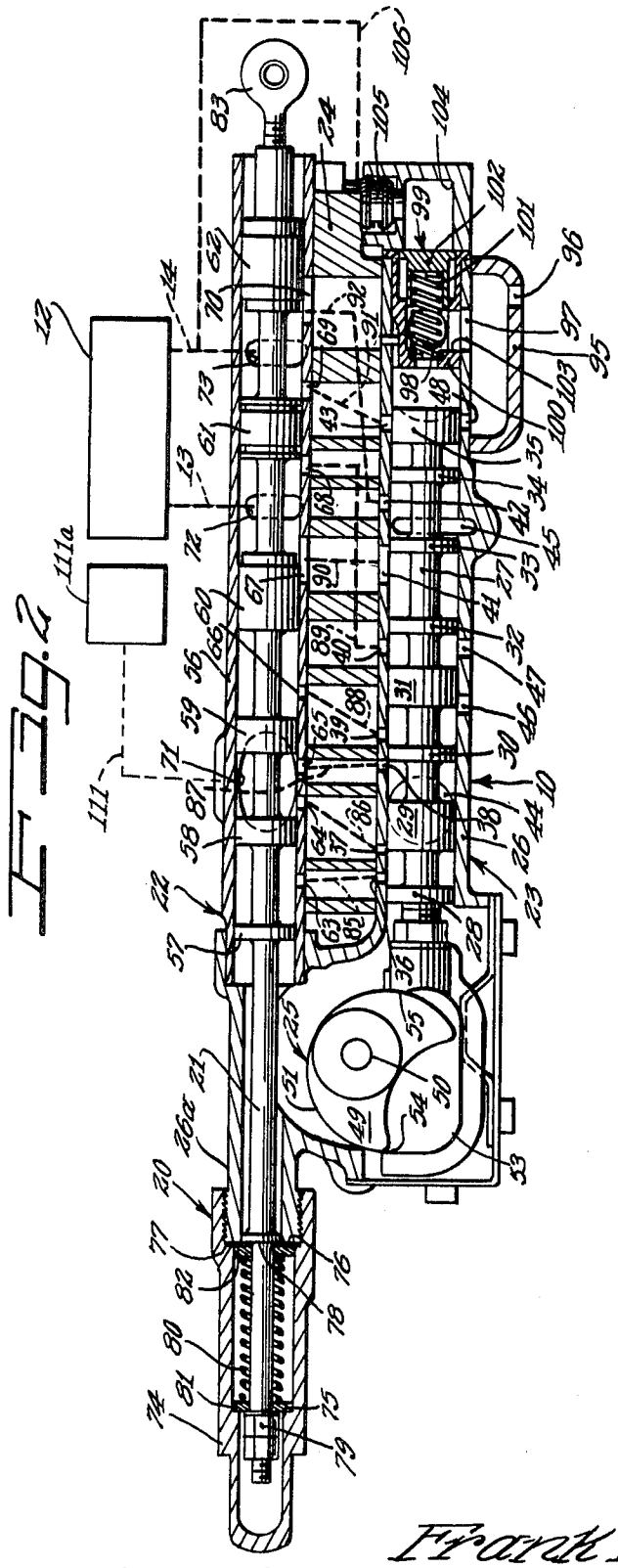


Fig. 2

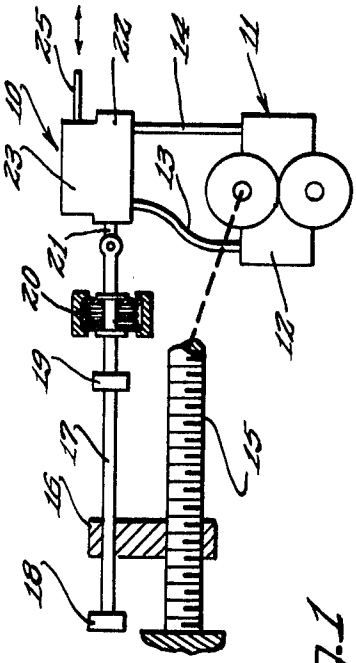


Fig. 1

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Fig. 3

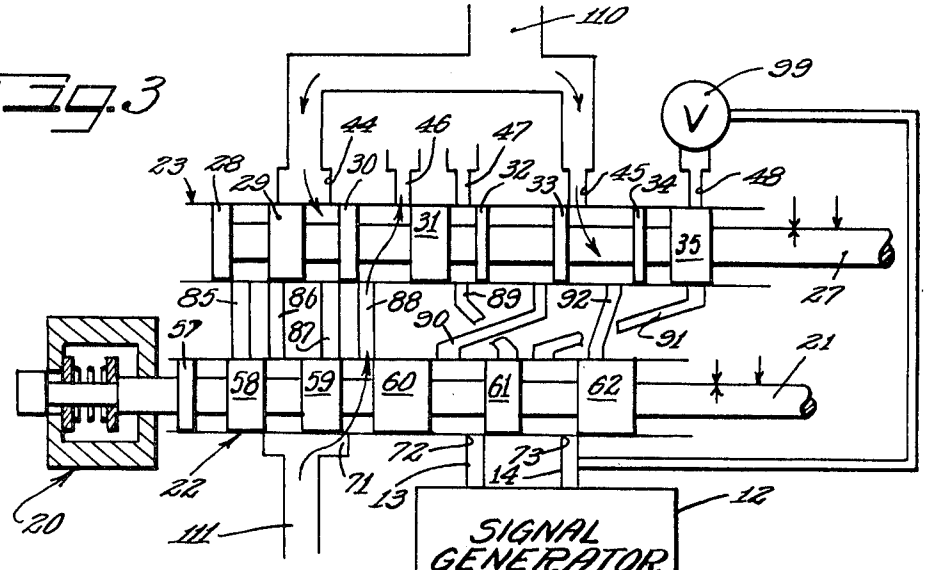


Fig. 4

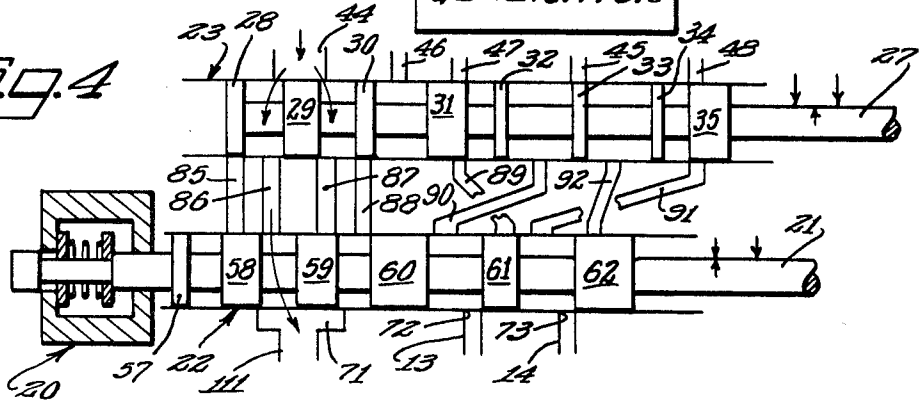
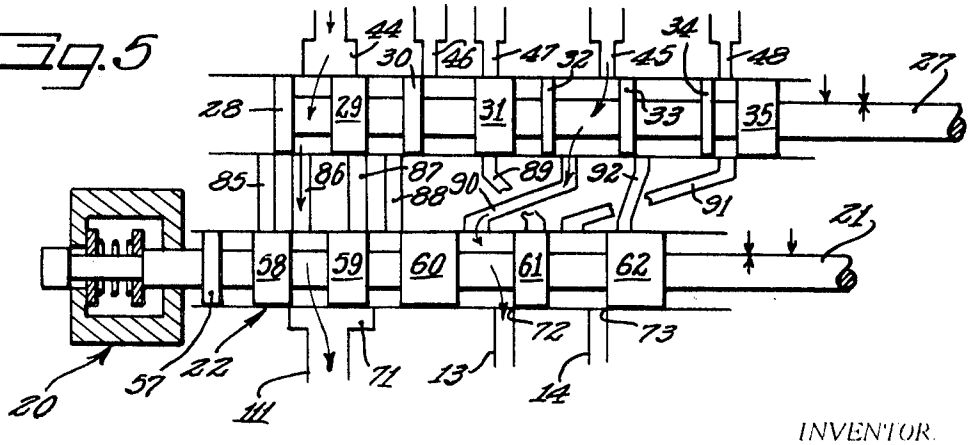


Fig. 5



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Fig. 6

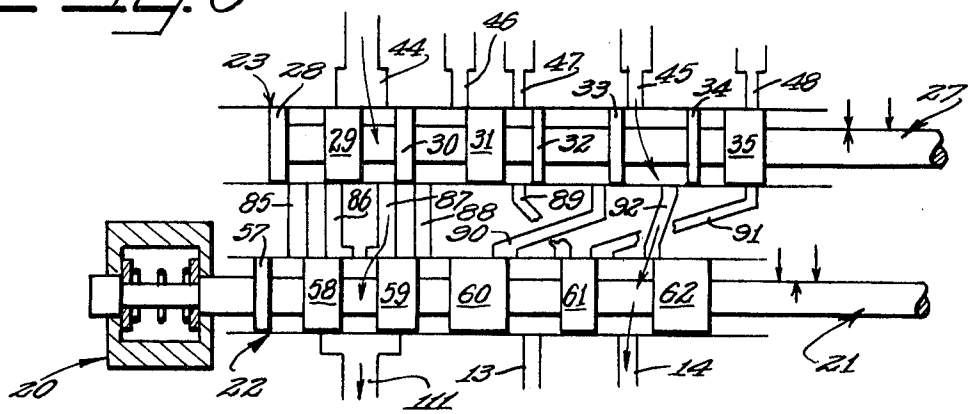


Fig. 7

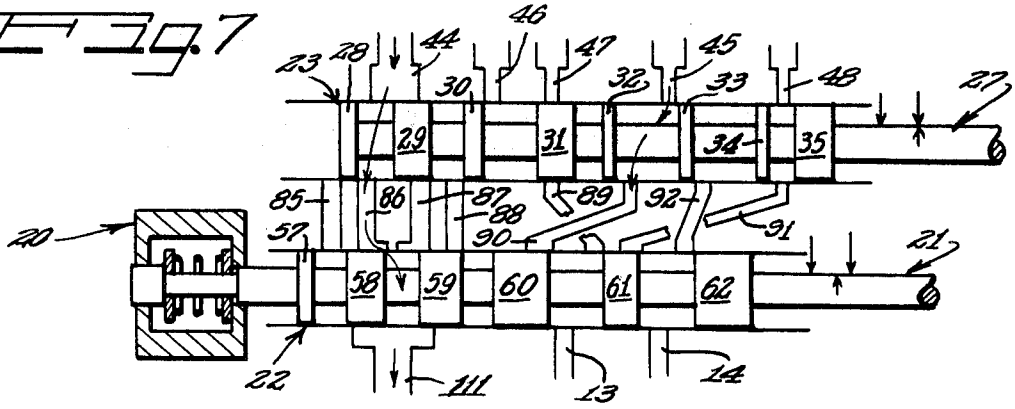
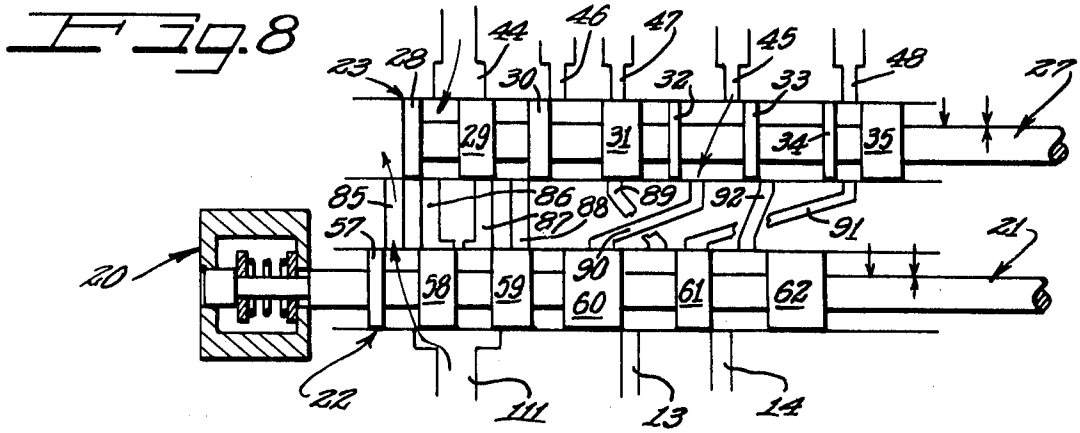


Fig. 8



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SEQUENCE AND DIRECTION VALVE

BACKGROUND OF THE INVENTION

1. Field of the Invention

A fluid control valve assembly and particularly a valve assembly responsive to a directional signal and a sequence signal.

2. Description of the Prior Art

Linear actuators with built-in snubbing devices at each end of the stroke are commonly used for displacement of loads or are used as signal input devices for positioning control systems. When extremely high positioning accuracy is required, the signal input device has to incorporate a large stroke to accomplish the required accuracy. In cases of envelope and weight restrictions, only a rotary actuator can be used to meet the high accuracy requirements and to satisfy the requirements as to space or weight of the device. A rotary actuator or a signal generator usually has to turn more than one revolution to accomplish the input function and, therefore, positive stop means cannot be directly incorporated to engage the rotor of the generator for snubbing the movement thereof.

SUMMARY OF THE INVENTION

The present invention is directed to a control valve assembly having a directional valve means and a sequence valve means which permits the use of a high gain rotary actuator to give high accuracy without the use of heavily loaded stops for positioning or snubbing the stroke or linear displacement of the actuator. The sequence valve means is responsive to the linear travel or displacement of the rotary actuator and accomplishes velocity reduction and stopping of the rotary actuator at a minimum force level as the rotary actuator approaches and completes the end of its stroke. In the preferred embodiment, the valve assembly also controls the supplying and exhausting of a fluid to a fluid actuated brake device so that it is engaged and disengaged at particular points in the operation cycle of the actuator. The preferred embodiment further includes control or governor means on one of the exhaust or vent ports which is responsive to pressure of the fluid passing through the actuator in one direction to develop a back pressure on the exhaust side of the actuator for limiting the velocity of the actuator.

Accordingly, an object of the present invention is to provide a valve assembly for controlling fluid supply and an exhaust from a device which assembly controls the direction of flow of the fluid medium and reduces and stops the flow as the device being controlled reaches the end of its linear displacement.

Another object of the present invention is to provide a valve assembly having means to control the fluid flow to a fluid actuated rotary device and means of slowing or stopping the flow to the device as a function of a reference linear output displacement thereof.

A further object of the present invention is to provide a valve assembly having directional sequence controls adapted to control the fluid flow through an actuator including means to limit the speed of travel of the actuator in one direction.

Yet another object of the present invention is to provide a valve assembly having a sequence valve and a directional valve incorporating the pneumatic logic for reducing and stopping the movement of an actuator at a minimum force level.

A still further object of the present invention is to provide a valve assembly incorporating a sequence valve and a directional valve having capabilities to reverse the direction of the actuator during the stroke of the actuator.

Yet another object of the present invention is to provide a valve assembly incorporating a sequence valve means and a directional valve means for controlling the fluid flow to a fluid actuator and also controlling the fluid flow to a different device such as a brake means associated with the actuator.

Other objects, features and advantages of the invention will be readily apparent from the following description of a preferred embodiment thereof taken in conjunction with the accompanying drawings although variations and modifications may be effected without departing from the spirit and the scope of the novel concept of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view of the valve assembly of the present invention connected with an actuator showing the relations thereof;

FIG. 2 is a cross-sectional view of the preferred embodiment of the valve assembly of the present invention; and

FIGS. 3—8 are diagrammatic illustrations showing the position of the valve members in their respective housing during a stroke of the signal generator or actuator.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The principles of the present invention are particularly useful in a valve assembly generally indicated at **10** which assembly is schematically illustrated as being used in an actuator assembly **11** illustrated in FIG. **1**.

The actuator assembly **11** includes actuator means **12** illustrated to be a rotary actuator or rotary signal generator connected by passageway means **13** and **15** to the valve assembly **10**. The rotary actuator **12** has a threaded output shaft **15** threadedly receiving a follower **16** which slides on a followup or feedback shaft **17** between a pair of adjustable stops **18** and **19**. The shaft **17**, as illustrated in FIG. **1**, supports a centering means **20** and is connected to an end of a sequence valve spool member **21** of a sequence valve means **22** of the valve assembly **10**. As illustrated when the follower **16** is moving along the shaft **15** of the signal generator **12** between the stops **18**, **19**, the centering means **20** positions the feedback shaft **17** and the spool member **21** in a center or null position. Contact by the follower **16** with either of the stops **18** or **19** will shift the feedback shaft **17** and the spool member **21** in the direction of movement of the follower.

The generator **12** by converting rotational motion into linear motion can accurately position an element through a fixed linear distance without any noticeable increase in size or weight of the generator. Thus a rotary generator or actuator is especially adapted for use in devices such as airplanes in which the weight of the device is a major consideration.

The valve assembly **10** includes the sequence valve means **22**, a directional valve means **23**, and a manifold means **24** interconnecting the sequence valve means and the directional valve means. In the preferred embodiment illustrated in FIG. **2**, the sequence valve means **22**, the directional valve means **23** and the manifold means **24** are in a unitary assembly which also includes the centering means **20** and a positioning means **25** for positioning the directional valve means in response to a directional signal. The directional valve means **23** includes a housing **26** which receives the valve member **27**. Preferably the valve member **27** is a spool valve member having axially spaced lands separated by grooves cooperating with ports in the housing **26**. In the preferred embodiment illustrated, the spool valve member **27** has eight land portions **28—35** which coact with eight ports **36—43** extending to the manifold means **24** with port means **44** and **45** which are adapted for connection to a pressurized fluid supply and with port means **46**, **47** and **48** which are adapted to be connected to vent or exhaust means.

The positioning means **25**, which includes means to convert a rotary movement or signal to a linear movement, is disposed at one end of the housing **26** and includes, a cam member **49** mounted on a shaft **50**. The cam member **49** has a cam surface **51** which is a segment of an arc whose center is offset from the center of the shaft **50**. Adjustably connected to the end of the spool valve member **27** is a cam follower **53** having cam engaging surfaces **54** and **55** for engaging substantially diametrically opposite portions of the cam surface **51**. Thus spool valve member **27** is positively shifted along its axis by rotation of the shaft **50** in either direction.

The sequence valve means 22 includes a housing 56 which as illustrated is attached to an extension 26*a* of the housing 26. Disposed in the housing 56 is the valve member 21 which is illustrated as the spool valve member. In the preferred embodiment, the spool valve member has six land portions 57—62 which are axially spaced along the valve member 21 and separated by grooves. The land portions 57—62 cooperate with eight ports 63—70, which are connected to the manifold means 24 and with three port means 71, 72 and 73. The port means 72 and 73 are adapted to be connected to the conduits or lines 13 and 14, respectively, of the signal generator or actuator (shown in dash lines). Port means 71 is adapted to be attached by a conduit line 111 (shown in a dash line to another device such as a pneumatic or fluid actuated brake means 111*a* associated with the signal generator or rotary actuator 12.

In the preferred embodiment, the centering means 20 is disposed on the end of the spool valve member 21 of the sequence valve means 22. The centering means 20 is enclosed in a cap 74 threaded on the end 26*a* of the housing 26. The cap 74 has an internal shoulder 75 and forms a second internal shoulder 76 with end 26*a*. As illustrated a shim 77 is utilized to adjust the axial distance of the shoulders 75 and 76, from the ports of the housing 56 of the sequence valve means 22. The spool valve member 21 is provided with a shoulder 78 and has an axially spaced shoulder 79 formed by nuts threaded on the opposite end. A resilient means such as a spring 80 urges a pair of movable abutment means or washers 81, 82 outwardly against the shoulders 79 and 78 respectively of the valve member 21 and the shoulders 75 and 76 formed by the housing. When the valve member 21 is in the center position as illustrated the washers 81 and 82 engage both sets of shoulders. When the valve spool 21 is shifted towards the left as viewed in FIG. 2, the washer 81 bears against the shoulder 75 and the washer 82 bears against the shoulder 78 with the spring 80 being compressed and resisting movement of the spool from the center position.

To connect the spool member 21 to the followup shaft 17, the valve member 21 at an end opposite the centering means 20 is provided with an adjustable connecting means 83.

The manifold means 24, as illustrated, is a manifold block providing passageways interconnecting the various ports of the valve housing 26 with the ports of the housing 56. Since the eight passageways in the manifold means 24 are not easily recognized, they are represented as lines 85—92 and each passageway interconnects a pair of ports as follows: passageway 85 connects port 36 with port 63, passageway 86 connects port 37 with port 64, passageway 87 connects port 38 to port 65, passageway 88 connects port 39 to port 66, passageway 89 connects port 40 to port 68, passageway 90 connects port 41 to port 67, passageway 91 connects port 43 to port 69, passageway 92 connects port 42 to port 70.

The exhaust port 48 extends into a manifold 95 having an exhaust port 96 and a port 97 which communicates with an exhaust port or a vent 98. A valve means 99 is disposed in between the ports 97 and 98. The valve means 99 has a housing 100 containing a spring means 101 and a slidable piston 102. Movement of the piston 102 against the spring 101 closes an orifice 103 which is in communication with the port 97 and closes the port 98. Adjacent to the piston 102 is a chamber 104 for receiving fluid pressure through a connector 105 and line 106 from a source such as the line 14 of the signal generator. The fluid in the chamber 104 is acting on the piston 102 and urges the piston against the spring. When the force of the fluid pressure in chamber 104 exceeds the force of the spring 101, the piston 102 moves to the left to restrict the flow through the port 97 and the port 98. If a sufficient pressure is applied to the chamber 104 the flow through a port 97 is completely stopped with only port 96 remaining open for fluid flow. Thus the amount of fluid being exhausted through the port 48 can be adjusted by the valve means 99 which creates a back pressure in the manifold 95.

The operation of the valve assembly 10 using FIGS. 3—8 is as follows. As shown in FIG. 3, the sequence spool member 21 is at its left position as indicated by the matching arrows and the directional spool member 27 is in its left position as indicated by the matching arrows. The fluid supply ports 44 and 45 which are diagrammatically interconnected to a single source 110, which may be either a hydraulic fluid or pressurized gas source, introduce fluid into the directional valve means 23. Since the spool member 27 is in the left position, the fluid in ports 44 and 45 flows into passageways 87 and 92 which are blocked by the lands 59 and 62 of the sequence valve spool member 21 and, therefore, no fluid pressure is applied to the actuator 12. The axial position of the spools 21 and 27 is such that the port 71, which is attached to a conduit line 111 that extends to the pneumatic actuated brake means 111*a* (FIG. 2), is in communication through the sequence valve 22 and the manifold passageway 88 to a vent or exhaust port 46. Thus, no pressure is applied on the brake means which is a type of brake means that is disengaged by a fluid pressure acting thereupon, and the element to be positioned by the generator or actuator 12 is held in its position by the brake means.

As shown in FIG. 4, a control signal is transmitted to a directional valve means 23 and the spool member 27 begins its movement in response to the control signal toward the right position. With the movement of the spool 27, the land 29 unblocks the passageway 86 allowing fluid pressure applied at port 44 to pass through the directional valve housing into the passageway 86 to the port 71 and into the line 111 for application on the brake means for disengaging the brake from the element that is to be moved by the rotary actuator 12. The land 30 of the spool valve member 27 blocks the port of the passageway 88 to close the exhaust connection which had been previously applied to the line 111. Thus the element such as a wing flap that is to be positioned by the actuator 12 is released by the brake means and is free to be repositioned by the actuator 12.

As illustrated in FIG. 5, the spool member 27 of the directional valve means 23 has moved to its furthest position to the right as indicated by the matching arrows. The fluid supply means attached to the port 45 is now in communication with the passageway 90 of the manifold 24 for conducting fluid pressure to the port 72 and into the line 13 to drive the rotary generator 12. The line 14 which is connected to the port 73 is in communication with the manifold passageway 91 which due to the arrangement of the spool member 27 is in communication with the vent or exhaust port 48. As mentioned above the exhaust port 48 is connected to a valve means 99 which is pressure actuated to regulate the fluid flow therethrough. If the fluid supply through the port 45 is excessive, the pressure in the exhaust line 14 of the rotary generator 12 will exceed a predetermined amount which predetermined amount acting on the piston 102 of the valve means 99 will close the orifice or opening 103 to create a back pressure in the exhaust manifold 95 which back pressure will prevent the rotary actuator from operating at an excessive velocity or speed. Another cause of an excessive speed or velocity of the rotary actuator 12 is that the element such as a wing flap when being moved in one direction will have its movement assisted and accelerated by the airflow over the flap. Thus it is possible that the wing flap or element being moved will tend to drive the rotary actuator 12 and such driving will cause the pressure in the exhaust line 14 to exceed the predetermined maximum.

As the rotary actuator moves the element, the follower 16 moves out of contact with the stop 18 on the followup shaft 17 and the centering means 20 will assume the center or null position as illustrated in FIG. 6. With the centering means 20 centering the sequence valve spool 21, the lands will not effect the flow of fluid through the passages 86, 90 and 91 of the manifold means 24. Once the centering device 20 has positioned the spool member 21 of the sequence valve means 22 in the center or null position, the directional valve means may be reversed during the stroke or travel of the rotary actuator 12.

As shown in FIG. 6, the operator has decided to reverse the travel of the rotary actuator 12 after he had initiated travel in the other direction. Once the signal is received to reverse the direction of travel of the rotary actuator 12, the spool valve member 27 of the directional valve means 23 is positively moved to the left position as indicated by the matched arrows. When in the left position, the land 35 closes the passageway 91 and the land 33 is positioned to divert the flow of the supply fluid through the port 45 into the passageway 92 and to prevent flow through the passageway 90. The pressurized fluids flow through the passageway 92 into the line or conduit 14 and the line or conduit 13 of the actuator is connected by the passageway 89 with the exhaust port 47. In such a connection, the rotary actuator is reversed in its direction of movement and will move the unit in the direction until the sequence valve assumes the position shown in FIG. 3, at which time the valve members 21 and 27 assume the position which vents the brake means and prevents flow to the rotary actuator 12.

Assuming that the operator did not change his mind and had initiated the movement of the directional spool 27 to the right position as illustrated in FIG. 5, the fluid pressure flowing through passageway 90 into conduit 13 and being exhausted through conduit 14, passageway 91 to the exhaust port 48 would continue to operate the generator 12 in one direction until the follower 16 contacted the stop 19 to shift the spool member 21 of the sequence valve 22 towards the right position. As shown in FIG. 7, the spool member 21 is beginning to be shifted towards the right position and the shifting causes the lands 60 and 61 to begin to restrict the flow in the passageways 90 and 91 respectively. Such a restriction in the flow of the passageways 90 and 91 reduces the speed or velocity of the actuator in its direction of movement. Furthermore, the land 58 of the spool member 21 begins to close off the passageway 86 which supplies the fluid pressure to the conduit or line 111 of the brake means. The stops 18 and 19 are set to be engaged by the follower 16 at a predetermined percentage of travel of the rotary actuator stroke or linear displacement. For example, the stop 18 will be engaged by the follower 16 from the beginning of the stroke in moving towards the right, as illustrated in FIG. 1, until the follower has moved approximately 5 percent of its linear distance. Then the centering means 20 centers the spool member 21 of the sequence valve means. As the follower 16 completes approximately 95 percent of its total linear distance of travel, it engages the stop 19 to start shifting the spool member 21 of the sequence valve means towards its right hand position.

Once the stops are engaged and the sequence valve is shifted from the center position, the lands 60 and 61 begin to restrict the flow of fluid through passages 90 and 91.

As previously mentioned, the lands 58, 60 and 61 of the spool member 21 of the sequence valve 22 begin to cut off the flow of the fluids in their respective passageways 86, 90 and 91 and as the actuator continues to move towards the end of its stroke or linear displacement, the amount of restriction increases.

As shown in FIG. 8, the actuator 12 has reached the end of its stroke or linear travel and the spool member 21 of the sequence valve means 22 has assumed the position in which land 60 and 61 completely block flow of the fluid in passageways 90 and 91 respectively. Thus the actuator 12 receives no fluid and is unable to discharge or exhaust any fluid contained therein. The land 58 has moved to block flow of fluid in the passageway 86 and while so moving interconnects port 71 with passageway 85 of the manifold to exhaust the conduit 111 of the brake means. In the preferred embodiment, the passageway 85 due to the position of the land 28 of the spool member 27 of the directional valve means is connected or discharges into the cavity containing the positioning means 25.

When the actuator 12 has reached the right-hand position of its linear travel and the spool members 21 and 27 are in the position illustrated in FIG. 8, the reversing of the direction of movement of the actuator 12 is accomplished in the following manner. Upon receiving the command signal the spool member 27 of the directional valve means 23 shifts towards the left position with the land 28 closing the passageway 85 which is venting the conduit or line 111. The land 29 uncovers the ports of the passageway 87 allowing fluid in the port 44 to flow into the passageway 87 and into the line 111 to disengage the brake means.

With continual movement of the spool member 27 of the directional valve means 23 to the position illustrated in FIG. 3, the lands 33 and 34 of the spool member 27 are axially positioned so that the fluid supply of port 45 enters passageway 92 and line 14 of the rotary generators and line 13 of the rotary generator is connected by a passageway 89 to the exhaust port 47. After the rotary generator has moved its follower 16 approximately 5 percent of its travel towards the left position, the spool members 21 and 27 will assume the position illustrated in FIG. 6. With further movement of the travel so that the follower engages the stop 18, the spool member 21 of the sequence valve means 22 is shifted towards the left position illustrated in FIGS. 3—5 and the lands 61 and 62 begin to restrict the flow of fluid through passageways 89 and 92 respectively to decrease the velocity of the rotary actuator. When the rotary actuator has reached the end of its linear travel in that particular direction, the lands 61 and 62 have completely closed the passageways 89 and 92 respectively and as illustrated in FIG. 3, the land 59 of valve member 21 closes the passageway 87 and opens the passageway 88 so that the fluid in the conduit 111 is exhausted to the exhaust port 46. The above described positions are best illustrated in FIG. 3.

While the preferred structural embodiment has been described utilizing two fluid supply ports 44 and 45 and has been described for controlling fluid flow to a rotary actuator and to a fluid actuated brake means, it should be realized that if the valve assembly 10 were to be used only to control the fluid flow to a rotary actuator or signal generator such as 12, the fluid supply port 44 and the exhaust port 46 could be removed along with the lands 28, 29 and 30 of the valve member 27 of the directional valve means 23 and the port 71 along with the lands 57, 58 and 59 of the valve member 21 of the sequence valve means 22 would not be necessary. Furthermore the passageways 85—88 of the manifold means would not be needed. Thus the valve assembly 10 modified to control only the fluid flow to a signal generator or actuator 12 needs only the exhaust ports 47 and 48 with the fluid supply port 45, a spool valve member for the directional valve means having lands 31—35, a spool valve member for the sequence valve means having lands 60, 61 and 62 and a manifold means having passageways 89—92.

Whether the valve assembly 10 is of the type illustrated in FIG. 2 or the modified one described hereinabove, it provides a control of the fluid through a signal generator in response to a directional signal applied to the directional valve means and controls the amount of fluid flow in response to a followup signal received by the sequence valve means. Therefore, the valve assembly 10 includes the capability of decreasing the velocity of the actuator and stopping the movement of the actuator at the desired point of the actuator's linear travel without the necessity of utilizing mechanical snubbing means which would increase the size and weight of the actuator system and its control.

I claim:

1. A valve assembly for controlling fluid input and exhaust for an actuator comprising: a directional valve means having a valve member responsive to a directional signal, a sequence valve means including a spool member axially shiftable in a housing and a centering means connected to said spool for biasing the spool to a center position in said housing, said centering means enabling axial displacement of said spool member from said center position in response to a feedback signal generated by the displacement of the output movement of the actuator, manifold means establishing communication between the directional valve means and the sequence valve means, one of the valve means having means for connecting to

said one valve means a fluid supply and a fluid exhaust, the other of said valve means having means to receive a pair of passageway means from the actuator whereby the directional valve means controls the direction of movement of the actuator and said sequence valve means throttles the flow of fluid through the actuator to reduce the speed of the actuator near the end of the desired displacement and to stop the flow of fluid at the point of the desired displacement.

2. A valve assembly according to claim 1 wherein the directional valve means is a spool valve having a spool valve member slidable in a spool housing, and positioning means for positive displacing said spool valve means in said spool housing in response to a directional signal.

3. A valve assembly according to claim 2 wherein said positioning means include means for converting rotational movement into linear movement to axially displace the spool member in response to the direction signal.

4. A valve assembly according to claim 3 wherein said positioning means includes a cam member mounted for rotation in said housing of the directional valve means and a follower mounted on said spool member, said follower shifting said spool member in response to the angular movement of the cam members.

5. A valve assembly according to claim 1, wherein said centering means includes a rod connected to said spool member of said sequence valve means, housing means disposed adjacent said rod, abutment means attached to said rod and axially movable relative to said housing means and resilient means biasing said abutment means to a predetermined position.

6. A valve assembly according to claim 1 wherein said directional valve means includes a spool member shiftable in a spool housing having a port means for connection to a pressure fluid source and at least a pair of exhaust port means for connection to the exhaust means, one of the exhaust port means including valve means responsive to fluid pressure in a passageway of the actuator to vary the back pressure at said one exhaust port to limit the velocity of the actuator in one direction.

7. A valve assembly according to claim 6 wherein said valve means of said one exhaust port means is a valve member cooperable with an orifice of the exhaust means, means biasing said valve means to a position opening said orifice and means supplying pressure of said one passage on said valve member to urge said valve member to a position closing said orifice whereby predetermined pressure increase in the fluid in the one passageway displaced said valve member to restrict the flow through said orifice creating a back pressure in the exhaust flow through said valve assembly.

8. A valve assembly for controlling fluid input and exhaust for an actuator and for controlling a fluid actuated brake means comprising directional valve means responsive to a directional signal for controlling the direction of output movement of the actuator, sequence valve means responsive to displacement of the output movement of the actuator for controlling the speed of the actuator and manifold means having a plurality of passageways for establishing communication between the directional valve means and sequence valve means, said directional valve means being a spool valve having a pair of supply port means for connection to a fluid supply means of pressurized fluid and an exhaust port for connection to a fluid exhaust means, said sequence valve means being a spool valve having a pair of port means for connection to a pair of passageways extending to the actuator and a third port means for connection to a fluid actuated brake means, each of said spool valves having axially spaced lands coacting together for interconnecting the supply port means and exhaust port means to the third port means of the sequence valve means so that the fluid actuated brake means is disengaged when the actuator is energized and engaged at the end of the output movement of the actuator, whereby a directional signal received by the directional valve means controls the direction of output movement of the actuator and said sequence valve means throttles the flow of fluid through the actuator near the end of the desired displacement to reduce the speed of the actuator and stops the flow of fluid through the actuator at the point of the desired displacement.

9. A valve assembly for controlling the flow of a pressurized fluid through an actuator and the exhaust therefrom, comprising a manifold having a plurality of fluid passages, a first spool valve having a first housing having a plurality of ports with a port in communication with each of said passages of the manifold, an exhaust port in communication with a fluid exhaust and a supply port in communication with a supply of fluid under pressure, a first spool member axially displaceable in said first housing for preventing and enabling fluid flow between said exhaust and supply ports and predetermined ports in response to the axial position of said first spool member, a second spool valve having a second housing having a plurality of ports with a port in communication with each of said passages of the manifold and a pair of port means for receiving conduits to an actuator, a second spool member axially displaceable in said second housing for preventing and enabling fluid flow between said passages and said pair or port means in response to the axial position of said second spool member, positioning means for axially shifting said first valve spool member to a predetermined axial position in response to a direction signal, and means for axially shifting the second spool member to predetermined axial positions in response to a feedback signal for the linear displacement of the actuator, said last mentioned means including centering means for biasing the second spool member to a center position in said second housing, said centering means enabling axial displacement of said second spool member from the center position in response to a feedback signal generated by the linear displacement of the actuator, whereby the first spool valve controls the direction of flow of fluid in the conduits of the actuator and said second spool valve throttles and stops the flow in response to the linear displacement of the actuator approaching and reaching a predetermined point.