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FLUID PRESSURE CONTROL MECHANISM

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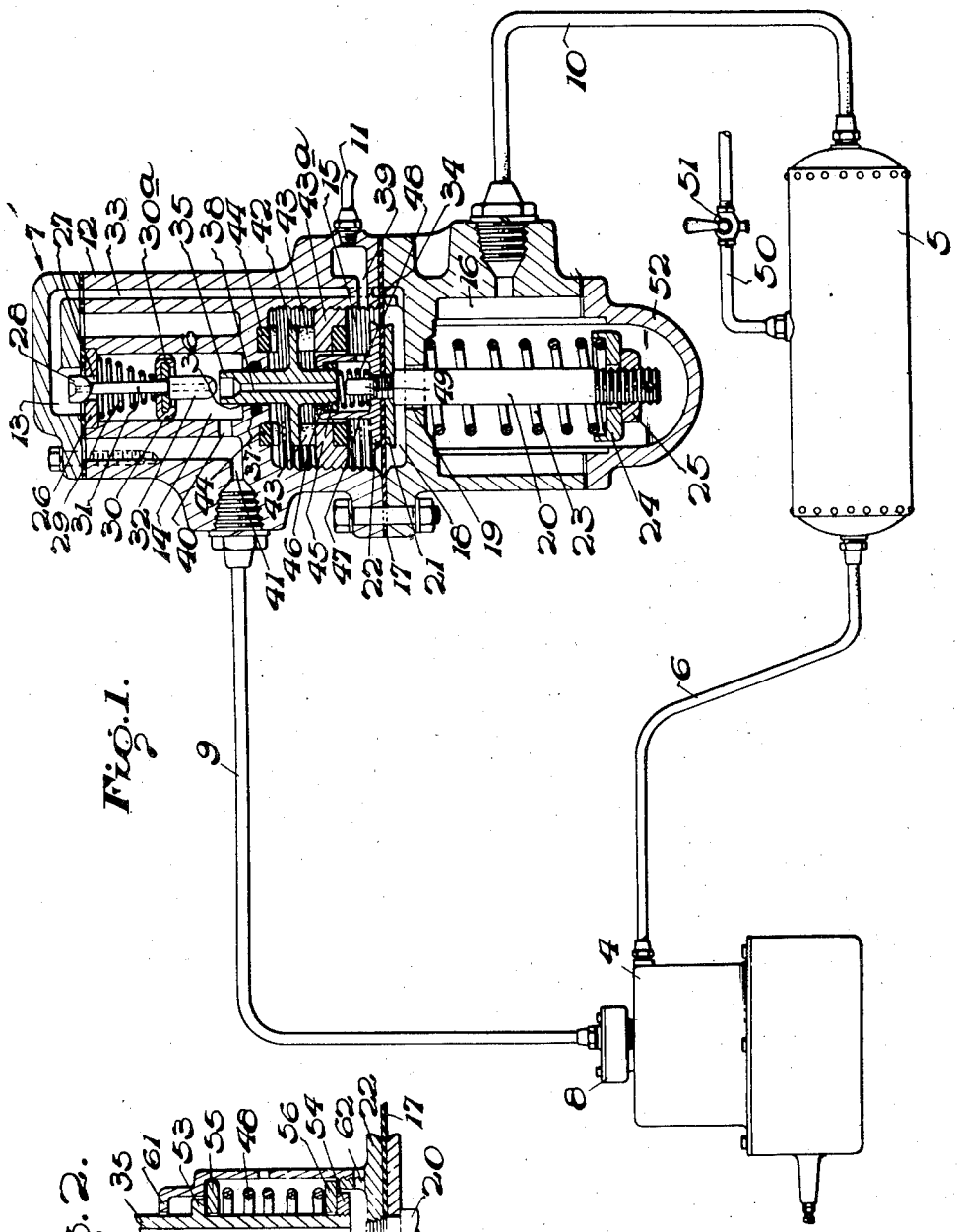


Fig. 1.

Fig. 2.

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FLUID PRESSURE CONTROL MECHANISM

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This invention relates to fluid pressure control mechanism, and more particularly to mechanism of the above type for controlling the operation of a compressor or pump in accordance with variations of pressure in the reservoir supplied by the compressor.

Numerous constructions have been previously proposed for accomplishing this type of control, but many of these constructions have involved the use of intricate and delicate parts which prevented economical manufacture of a device of this type, and it is accordingly an object of the present invention to provide mechanism of the above type so constituted as to eliminate the use of delicate operating parts and to facilitate economical manufacture.

Another object of the invention is to provide a control mechanism or compressor governor of the above type, so constituted as to insure positive operation in accordance with variations of pressure in the compressor reservoir in order to insure a uniform and reliable control of the operation of the compressor.

Yet another object of the invention is to provide a governor of the above type, so constituted as to permit ready adjustment of the device whereby the latter will become effective at a desired pressure to unload the compressor.

Still another object of the invention is to provide, in a governor of the above type, means for insuring positive loading and unloading action of the governor in accordance with variations of the pressure in the reservoir.

A further object of the invention is to provide magnetic means for insuring positive operation of the valves to load and unload the compressor.

These and other novel features and objects of the invention will appear more fully hereinafter from the following detailed description when considered in connection with the accompanying drawing wherein one embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawing is employed for purposes of illustration only, and is not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawing:

Fig. 1 is a diagrammatic view, partially in section, of a fluid pressure supply system having a compressor or pump controlled by a governor of the above type, and

Fig. 2 is an enlarged sectional view showing a modification of a portion of the mechanism shown in Fig. 1.

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Referring more particularly to Fig. 1 of the drawing, a fluid pressure supply system is shown diagrammatically, and includes in general a compressor 4, a storage reservoir 5 adapted to be supplied with fluid pressure from the compressor through a conduit 6, a governor mechanism 7, to be more fully described hereinafter, and an unloading mechanism 8 of conventional type mounted on the compressor. An outlet conduit 9 is connected from the governor to the unloader 8 on the compressor, and pressure is supplied to the governor from the reservoir through a conduit 10, the governor in turn being provided with an exhaust conduit 11.

The unloader 8 on the compressor is of the fluid pressure operated type, and it will be understood by those skilled in the art, that when fluid pressure is supplied to the unloader from the governor, the unloader will be operated to render the compressor ineffective to supply fluid pressure to the reservoir 5 through the conduit 6. With the parts of the governor 7 in the position shown, communication is permitted between outlet conduit 9 and the exhaust conduit 11, and is prevented between the supply conduit 10 and the outlet conduit 9, an increase in pressure in the reservoir 5 above a predetermined value serving to operate the governor mechanism to prevent communication between conduits 9 and 11 and to establish communication between conduits 10 and 9, whereupon the unloader 8 is operated to unload the compressor.

Referring more particularly to the sectional view of the governor mechanism 7, a casing 12, is provided with an inlet chamber 13, an outlet chamber 14, an exhaust chamber 15, and a supply chamber 16. A pressure responsive diaphragm 17 is clamped in the casing as shown, and a chamber 18 formed in the casing directly below the diaphragm is connected by a bore 19 with the supply chamber 16, the result being that the lower surface of the diaphragm is subjected at all times to the pressure in the supply chamber, and consequently to the pressure in the storage reservoir. A diaphragm stem 20 is connected to the diaphragm by means of a clamping washer 21 and a clamping nut 22 threadedly received on the upper end of the stem, and the diaphragm is normally biased in a downward direction with a predetermined force by means of a spring 23 interposed between the casing and a washer 24 adjustably positioned on the lower end of the stem by means of an adjusting nut 25 threadedly received by the lower end of the stem. A partition 26, carried by the casing, serves to separate the

inlet chamber 13 from the outlet chamber 14, the partition being provided with an inlet port 27. This port is normally closed by means of an inlet valve 28 held against the upper end of the port by means of an inlet valve spring 29 interposed between the lower surface of the partition and a washer 30 provided with slots 30a on its outer edge and carried by a valve stem 31 which serves to connect the inlet valve with an exhaust valve 32 mounted on the lower end of the stem. The inlet chamber 13 is connected with the supply chamber 16 by means of a passage 33 formed in the casing, a port 34 being provided in the right side of the diaphragm 17 in order to permit the flow of fluid pressure through the passage from the supply chamber to the inlet chamber. A valve operating element 35 is slidably mounted in a bore 36 formed in the casing, a sealing element 37, mounted in the bore in engagement with the valve operating element serving to prevent leakage from the outlet chamber to the exhaust chamber 15. The valve operating element is provided with a central bore 38, and a lower end of this bore is in communication with the exhaust chamber 15, as will be more fully pointed out hereinafter. Thus, with the valve operating element in the position shown, the outlet chamber 14 is connected with atmosphere through the bore 38, the exhaust chamber 15 and a passage 39 to which the exhaust conduit 11 is connected, while on upward movement of the valve operating element, the exhaust valve 32 is first engaged to prevent communication between the outlet chamber and atmosphere, and the inlet valve is subsequently moved to open position to permit fluid pressure to be supplied to the unloader 8 from the reservoir 5 through conduit 10, supply chamber 16, bore 19, chamber 18, diaphragm port 34, passage 33, inlet port 27, outlet chamber 14, passages 40 and 41 formed in the casing, and conduit 9.

In mechanisms of the above type, it is essential that the inlet and exhaust valves which serve to control the supply of fluid pressure to the unloader of the compressor, operate instantaneously in order to prevent partial unloading and loading of the compressor, and to this end, novel means are provided for insuring instantaneous movement of the valve operating element from one position to another in response to variations of pressure in the reservoir 5. The valve operating element is accordingly provided with an armature portion 42 formed of magnetic material such as iron, and adapted in the position shown, to engage permanent magnets 43 rigidly positioned in an adjustable member 43a threadedly received in the casing as shown. Thus the valve operating element is maintained in the position shown with a predetermined force, and since the characteristics of a permanent magnet and armature are such that the attracting force decreases with extreme rapidity as the armature moves away from the magnet, it will be understood that when a force is applied to the valve operating element sufficient to move it away from the magnets, the element will move rapidly upwardly to close the exhaust valve and open the inlet valve. In order to insure a similar rapid movement of the valve operating element in the reverse direction to close the inlet valve and open the exhaust valve, similar permanent magnets 44 are rigidly attached to the casing and are adapted to be contacted by the upper surfaces of the armature when the latter and the valve operating element are in inlet valve opening position. Consequently, the application of a predetermined force to move the valve operating element downward from the above position will again result in rapid movement of the element in that direction and instantaneous closing of the inlet valve and opening of the exhaust valve.

In order that the valve operating element may be operated in accordance with variations of pressure in the reservoir 5, an operative connection is provided between the diaphragm 17 and the lower end of the element. A flange 45 is formed on the lower end of the element, and with the parts in the position shown, the upper surface of the flange is adapted to be engaged by a pair of lips 46 formed on a pair of upwardly extending members 47 formed integrally with a diaphragm clamping nut 22, this contact being normally maintained by means of a spring 48 interposed between the upper surface of the nut and the lower end of the valve operating element. Thus the spring forms a resilient operating connection between the diaphragm and element, and by properly dimensioning the parts, the spring may be initially preloaded to exert any desired force in the position shown. The upper end of the plunger 20 is provided with an extension 49 which is adapted to directly engage the valve operating element when sufficient force has been applied to the plunger to overcome the force exerted by the spring 48. The tension of the spring 48 is preferably so chosen that on upward movement of the plunger 20, the extension 49 is permitted to engage the lower end of the valve operating element before sufficient force is being exerted on the latter by the spring 48 to cause the armature to move upward from the magnets 43. Thus when sufficient force is exerted upwardly on the valve operating element by the spring 48 and the extension 49 to cause the armature to move upward away from the magnets 43, the spring 48 will tend to rapidly move the valve operating element and the armature 42 upward into engagement with the permanent magnets 44.

When the compressor is started initially, the pressure in the reservoir 5 and in the chamber 16 of the governor, will gradually increase to a point where the pressure acting upward on the diaphragm is sufficient to overcome the tension of the spring 23, whereupon the diaphragm will move upward to collapse the spring 48, and the diaphragm will exert force directly on the valve operating element through the extension 49. When this force exceeds the force exerted by the magnets 43 on the armature 42, the valve operating element will be moved upward by the action of the diaphragm, through the projection 49 and the spring 48, and the valve operating element will immediately act to close the exhaust valve and open the inlet valve to supply fluid pressure from the reservoir to the unloader 8 through the passages heretofore described. At the same time, the armature will engage the magnets 44 and will be retained in engagement therewith until sufficient force is exerted on the valve operating element in a downward direction to move the armature away from the magnets 44. The reservoir is provided with an outlet conduit 50, which may be connected with any suitable fluid pressure actuator, not shown, together with a control valve 51 for controlling the flow of fluid pressure from the reservoir to the actuator through a conduit 50. After the compressor has been unloaded by the action of the governor as described in the preceding paragraph, no further

fluid pressure will be supplied to the reservoir, and the pressure in the latter will decrease, either due to leakage or due to the opening of the valve 51 to supply fluid pressure to the actuator. The pressure in the chamber 16 and in the diaphragm chamber 18 will decrease correspondingly, and a point will eventually be reached such that the force exerted downwardly on the plunger 20 by the spring 23 and the air pressure acting on the upper end of the valve operating element 35 will exceed the force exerted upwardly on the diaphragm by fluid pressure and the force exerted by the magnets 44 on the armature 42, whereupon the valve operating element will move downward to permit closing of the inlet valve by the action of the spring 29 and opening of the exhaust valve to permit the exhaust of fluid pressure from the unloader 8 to atmosphere through the passages already described. When this occurs, the compressor will again become operative to supply fluid pressure to the reservoir. When the above action occurs, the net downward force exerted by the spring 23 must be sufficient to overcome the attraction of the magnets 44, and since the force of this attraction substantially disappears as soon as the armature leaves the magnets, it will be understood that the parts may be so designed that this force is also sufficient to move the valve operating element and armature downward sufficiently to cause the latter to reengage the magnets 43. When this action occurs, the parts are again substantially in a position shown in the drawing, and will remain in this position until the pressure in the reservoir increases sufficiently to cause the governor to again operate to supply fluid pressure to the unloader mechanism to unload the compressor. As heretofore stated, the tension of the spring 23 may be adjustably controlled by means of the adjusting nut 25, and this adjustment may be made at will by the operator on removal of a cover 52 normally maintained in sealing engagement with a lower end of the casing by means not shown, in order to normally prevent leakage of fluid pressure from the chamber 16.

There has thus been provided in the mechanism shown in Fig. 1, means for moving the valve operating element 35 from one position to another with a positive snap action in order to operate the inlet and exhaust valves 28 and 32 to control the supply of fluid pressure to the unloading mechanism 8. This snap action is further enhanced if desired by means of a lost motion connection between the diaphragm and the valve operating element, this lost motion including the collapsible spring 48 and the lips 46 formed on the members 47 and serving to engage the flange 45 on the valve operating element. The pressure at which the mechanism becomes effective to supply fluid pressure from the reservoir to the unloader mechanism can be controlled by adjustment of the tension of the spring 23, and the pressure range of the governor can be controlled by adjustment of the magnet carrying member 43*a*. The distance between the magnets 43 and 44 determines the travel of the valve operating element as well as the travel of the diaphragm and the plunger 20, and it will be understood that the force exerted by the spring 23 to move the valve operating element downward to the position shown will increase with an increase in travel of the valve operating element, and will decrease when the travel is correspondingly decreased. Thus the change in pressure necessary in the diaphragm chamber 18 to permit the return of the diaphragm to the position shown under the action of the spring 23 will also be governed by the spacing of the magnets 43 and 44, and by adjusting the spacing of the magnets in conjunction with an adjustment of the tension of the spring 23, the pressure at which the governor operates to unload the compressor, as well as the pressure at which it operates to again load the compressor, may be adjusted to any desired value within the limits of any particular design.

It is also considered desirable in some cases in connection with the resilient lost motion connection between the diaphragm and valve operating element, to provide a construction so constituted as to render the collapsible spring effective in both directions of operation, and to this end, a modified construction of the operative connecting means between the diaphragm and valve operating element is illustrated in Fig. 2 of the drawing. In this modification, the valve operating element 35 is provided with a shoulder 53, and a nut 54 threadedly received on its lower end. A pair of washers 55 and 56 are slidably mounted on the valve operating member between the shoulder 53 and the nut 54, and are normally maintained in the positions shown by a preloaded spring 48 interposed between the washers. The extension 49 is omitted from the upper end of the plunger 20, and a sleeve 57 is threadedly received by the nut as shown. The upper end of the sleeve is provided with a bore 58 adapted to slidably receive the flange 53, and a shoulder 59 is adapted to engage the upper surface of the washer 55, the lower surface of the washer 56 being normally engaged by an annular portion 60 formed in the nut 22. The shoulder 59 and the annular portion 60 are so spaced as to engage the washers 55 and 56 without further compressing the spring 48 with the parts in normal position. On upward movement of the diaphragm and the nut 22 as the pressure below the diaphragm increases, the spring 48 is compressed in the manner described in connection with the construction shown in Fig. 1 and serves to assist in insuring engagement of the armature with the upper magnets 44. When the diaphragm and plunger are moved in the opposite direction under the action of the spring 23, and in response to a reduction in pressure in the reservoir, the sleeve 57 moves downward with the diaphragm and plunger, and the shoulder 59 picks up the washer 56, and moves it downward to compress the spring 48 while the armature is still in engagement with magnets 44. When the spring 48 has been compressed a predetermined degree, a shoulder 61 formed on the upper end of the sleeve 57 engages the upper surface of the shoulder 53 on the valve operating element and exerts a force directly on the element to move the armature away from the magnets 44. As soon as the armature leaves these magnets, the magnetic force decreases rapidly, and the spring 48 is operative to move the valve operating element downward in order to permit engagement of the armature with magnets 43. While this lost motion connection, as well as that illustrated and described in Fig. 1, may be advantageous in certain types of construction, it will be understood that the lost motion and the resilient connection may be eliminated in some cases without interfering materially with satisfactory operation of the governor mechanism. In the case of the mechanism shown in Fig. 2, a port 62 is provided in the nut 22 and in the wall of the sleeve 57 which insures communication be-

tween the passage 38 in the valve operating element and the exhaust chamber 45.

Although one embodiment of the invention and a modification of a portion of the mechanism have been described and illustrated herein, it will be expressly understood that various changes and substitutions may be made therein without departing from the spirit of the invention, as will be well understood by those skilled in the art. Reference will, therefore, be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A pressure responsive governor including a casing having an inlet chamber, an outlet chamber, an exhaust port, inlet and exhaust valves for normally preventing communication between the inlet and outlet chambers and for normally permitting communication between said outlet chamber and exhaust port, a valve operating element movable in one direction to close the exhaust valve and open the inlet valve, means responsive to the pressure in the inlet chamber for moving the element in said one direction, resilient means for moving the element in the other direction, means including magnets for opposing movement of the element in either direction, and means for varying the tension of said resilient means together with means to vary the effect of said magnets to adjust the range of the governor.

2. A pressure responsive governor including a casing having an inlet chamber, an outlet chamber, an exhaust port, inlet and exhaust valves for normally preventing communication between the inlet and outlet chambers and for normally permitting communication between said outlet chamber and exhaust port, a valve operating element operable in one position to open the exhaust valve and operable on movement to another position to close the exhaust valve and open the inlet valve, a magnet for opposing movement of the element from said one position with a predetermined force, a magnet for opposing movement of the element from said another position with a predetermined force, means responsive to the pressure in the inlet chamber for moving the element from said one position to said another position, resilient means for moving the element from said another position to said one position, and means for varying the tension of said resilient means together with means to vary the effect of said magnets to adjust the range of the governor.

3. A pressure responsive governor including a casing having an inlet chamber, an outlet chamber, an exhaust port, inlet and exhaust valves for normally preventing communication between the inlet and outlet chambers and for normally permitting communication between said outlet chamber and exhaust port, a valve operating element operable in one position to open the exhaust valve and operable on movement to another position to close the exhaust valve and open the inlet valve, a magnet for opposing movement of the element from the first position with a predetermined force, a magnet for opposing movement of the element from said another position with a predetermined force, means responsive to the pressure in the inlet chamber for moving the element from said one position to said another position, resilient means for moving the element from said another position to said one position, and means for adjusting said resilient means together with means to vary the effect of said magnets to adjust the range of the governor.

4. A pressure responsive governor including a casing having an inlet chamber, an outlet chamber, an exhaust port, inlet and exhaust valves for normally preventing communication between the inlet and outlet chambers and for normally permitting communication between said outlet chamber and exhaust port, a valve operating element movable in one direction to close said exhaust valve and open said inlet valve, means including a magnet for opposing movement of the element in said one direction with a predetermined force, means responsive to the pressure in said inlet chamber for moving the element in said one direction, and preloaded resilient means for connecting said element and pressure responsive means and permitting relative movement of said pressure responsive means and element prior to movement of the element in said one direction by the operation of said pressure responsive means.

5. A pressure responsive governor including a casing having an inlet chamber, an outlet chamber, an exhaust port, inlet and exhaust valves for normally preventing communication between the inlet and outlet chambers and for normally permitting communication between said outlet chamber and exhaust port, a valve operating element operable in one position to open the exhaust valve and operable on movement to another position to close the exhaust valve and open the inlet valve, means including a permanent magnet for opposing movement of said element from either one of said positions to the other of said positions with a predetermined force, resilient means for moving said element from said another position to said one position, a member responsive to the pressure in the inlet chamber for moving the element from said one position to said another position, and means including a preloaded spring for connecting said member and element and for normally opposing relative movement of said member and element with a predetermined force, said last named predetermined force being less than said first named predetermined force.

6. A pressure responsive governor including a casing having an inlet chamber, an outlet chamber, an exhaust port, inlet and exhaust valves for normally preventing communication between the inlet and outlet chambers and for normally permitting communication between said outlet chamber and exhaust port, a valve operating element operable in one position to open the exhaust valve and operable on movement to another position to close said exhaust valve and open said inlet valve, permanent magnet means for opposing movement of said element from either one of said positions with a predetermined force, a member responsive to the pressure in the inlet chamber for moving the element from said one position to said another position, and connecting means for said element and member for permitting limited relative movement therebetween in either direction including a preloaded spring for opposing said relative movements with a force less than said predetermined force.

7. A pressure responsive governor including a casing having an inlet chamber, an outlet chamber, an exhaust port, inlet and exhaust valves for normally preventing communication between the inlet and outlet chambers and for normally permitting communication between the inlet and

outlet chambers and for normally permitting communication between said outlet chamber and exhaust port, a valve operating element movable in one direction to close the exhaust valve and open the inlet valve, means responsive to the pressure in the inlet chamber for moving the element in said one direction, resilient means for moving the element in the other direction, means including spaced magnets for opposing and limiting the movement of said element in either of said directions, and means for adjusting the tension of said resilient means and the spacing of said magnets, whereby the valves are operable to respectively connect the inlet and outlet chambers and to connect the outlet chamber and exhaust port at different predetermined pressures in the inlet chamber.

8. A pressure responsive governor including a casing having an inlet chamber, an outlet chamber, an exhaust port, inlet and exhaust valves for normally preventing communication between the inlet and outlet chambers and for normally permitting communication between said outlet chamber and exhaust port, a valve operating element operable in one position to close the exhaust valve and open the inlet valve and operable in another position to open the exhaust valve and permit closing of the inlet valve, an armature connected with the valve operating element, a permanent magnet carried by the casing adapted to engage and maintain the armature and element in said one position with a predetermined force, a permanent magnet spaced from the first named magnet adapted to engage and maintain the armature and element in said another position with a predetermined force, means responsive to the pressure in the inlet chamber for moving the element from said another position to said one position, resilient means for moving said element from said one position to said another position when the pressure is reduced in the inlet chamber, and means for varying the spacing of said magnets and correspondingly varying the travel of said element, whereby the degree of variation in force exerted by said resilient means on the element on movement of the latter between said positions is varied and the degree of pressure reduction required in the inlet chamber to permit movement of the element to said another position is correspondingly varied.

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