

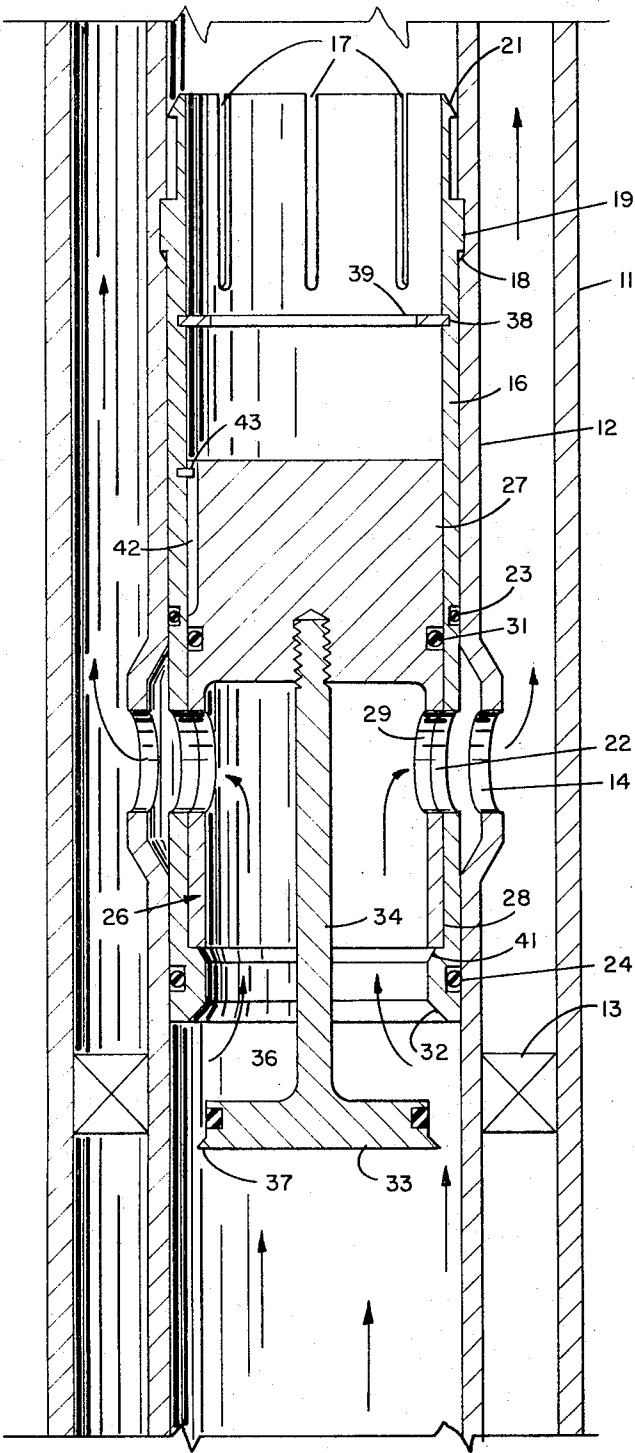
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FLUID OPERATED VALVE DEVICE

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FLUID OPERATED VALVE DEVICE

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This invention relates to valves for use in wells, and more particularly it relates to a subsurface safety valve which is fluid operated from a remote location.

Various safety valves have been employed to control the flow of fluids produced from a well and particularly to stop the flow of fluids from producing oil and gas wells when for some reason the flow of produced fluids cannot otherwise be controlled. Such safety valves are utilized to prevent blowouts which may result from damage to the wellhead or other equipment at the surface. Generally, these safety valves are installed in the well some distance below the surface and are maintained in the open position by a pressured fluid supplied from the surface during normal operations. When damage to the fluid supply occurs, the pressure of the well fluids closes the valve and stops the flow of fluid from the well.

Some devices presently available employ a sleeve type valve held open by fluid from the surface and when the fluid pressure drops below a given level the valve is closed by the pressure of the produced fluids, with spring loading to assist in closing. Other devices employ a poppet type safety valve held open by fluid pressure from the surface, and still other such valves employ a flapper valve arrangement or a ball valve operated in a similar manner. Many of the commercially available valves are relatively complex apparatus and require the maintenance of close tolerances between moving parts and freedom from particles of hard solids in order for the valves to operate satisfactorily. Also, certain of these valves are subject to wire drawing which can result in hazardous leaks through the valve.

The general object of the present invention is a subsurface safety valve actuated by fluid pressure from a remote location, which valve is of a simplified and economical design, while being relatively free from operational and maintenance difficulties.

In accordance with the present invention, there is provided a valve device employing a sliding sleeve for controlling the flow of fluid through the outlet ports of the valve and a valve disc affixed to the sliding sleeve to move therewith and sealingly contact a valve seat adjacent the valve inlet to close the valve inlet when the sleeve slides in the valve to close the outlet ports. Preferably, the sliding sleeve closes the outlet ports first, followed by the valve disc sealing against the valve seat at the valve inlet.

The present invention will be better understood by reference to the following description given in connection with the accompanying drawing of a preferred embodiment of the invention.

The valve device shown in the drawing is of the type referred to as a tubing safety valve, in that the valve is adapted to be installed in a string of well tubing through which the well fluids are produced. Typically, a well casing 11 is installed in a bore hole penetrating a producing formation. A string of production tubing is positioned inside the casing and extends to a downhole location adjacent the producing formation so that the produced fluids flow into the tubing through perforations and upwardly through the tubing. Cylindrical tubing mandrel 12 is installed in the tubing string at a suitable distance beneath the surface to form a portion of the tubing. Mechanical packer 13 is located below the valve. Alternatively, or in addition thereto, casing slips of a com-

mercially available type may be employed to prevent the downward movement of the tubing in the casing, and hydraulic hold-down slips may be employed to prevent upward motion of the tubing and the valve in the casing. Mandrel 12 is provided with mandrel ports 14 spaced around the wall of the mandrel and above packer 13 to place the inside of the mandrel in flow communication with the casing-mandrel annulus. Tubular valve housing 16 is installed in mandrel 12. Preferably, housing 16 is removably positioned in the mandrel. As shown, the upper end of cylindrical housing 16 is provided with a series of longitudinal slots 17 peripherally spaced around the upper end of the housing so that the outside diameter thereof may be reduced by a force applied exteriorly of the housing. Circumferential groove 18 is provided on the inner surface of mandrel 12 and circular ring 19 on the outer surface of housing 16 so that when housing 16 is passed through mandrel 12 and the upper end compressed, ring 19 springs outwardly and latches into groove 18 to hold the housing in place. Fishing neck 21 is provided at the upper end of housing 16 so that a fishing tool (not shown) may be passed down through the tubing and mandrel to squeeze the upper end of the housing inwardly and disengage ring 19 to groove 18 when removing the housing from the mandrel.

Housing 16 is provided with outlet ports 22 registering with mandrel ports 14 when the housing is latched in the mandrel so as to place the interior of the housing in flow communication with the annular space between casing 11 and mandrel 12 above packer 13. Typically, a plurality of outlet ports are spaced around the wall of mandrel 12. Advantageously, upper sealing means 23 and lower sealing means 24, both of which may be O-rings or other suitable sealing rings, are positioned on the upper and lower sides, respectively, of ports 22 to provide a fluid-tight seal between the mandrel and the valve housing. The lower end of housing 16 is open to place the interior thereof in flow communication with the interior of mandrel 12 below the housing, and to permit the produced fluids to flow into the valve housing and upwardly through ports 22 and 14 when the valve is open.

Inserted inside housing 16 is a cylindrical sliding sleeve element 26 which slides longitudinally in housing 16 to control the flow of produced fluids from the housing through ports 22 and 14. Sleeve element 26 is comprised of a cap member 27 at the upper end thereof and a skirt member 28 depending from cap member 27. Skirt 28 may be fabricated of Teflon or other similar plastic or it may be formed of steel or the like coated on the outside of a material such as Teflon. As shown, cap 27 is positioned above ports 22 and a skirt 28 extends downwardly toward the open end of housing 16. A plurality of sleeve ports 29 are provided in the wall of skirt 28 to register with housing ports 22 when the valve is in the fully opened position, so as to permit the flow of fluid from the interior of the sleeve to the casing-mandrel annulus. When sleeve element 26 moves upwardly in the housing, the lower portion of skirt 28 rises to cover ports 22 and prevent the flow of fluid therethrough. Advantageously, sealing rings 31 are provided between sleeve element 26 and the inside of housing 16 to prevent the flow of fluid upwardly between these members above the outlet ports.

Positioned in circumferential groove 18 on the inner surface of housing 16 at a suitable distance above sleeve 26 is ring 39 which serves to limit the upward travel of the sleeve in the housing when the valve closes. Shoulder 41 is provided on the inner surface of the housing just above valve seat 32 to limit the downward travel of sleeve 26. A longitudinal keyway 42 is formed in cap 27 and pin 43 fitted into the wall of housing 16 prevents the rotation of the sleeve in the housing.

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At the lower end of housing 16 there is provided a seat ring 32 which, as shown, may be a chamfered edge around the inside of the open end. Affixed to sleeve element 26 is a valve disc 33 which moves upwardly with sleeve member 26 in the housing. As shown, disc 33 is secured to sleeve 26 by a valve stem 34 threaded into the underneath side of cap 27 so that disc 33 depends from cap 27 and is positioned on the underneath side of the lower open end of housing 16. Thus, when sleeve 26 moves upwardly in the housing, disc 33 sealingly engages with valve seat 32 to prevent the flow of fluid from the tubing into the valve housing. Advantageously, sealing ring 36 may be provided on disc 33 to engage with the inside wall of the lower end of housing 16, while lip 37 contacts seat ring 32 to provide a metal-to-metal seal when in the closed position.

Preferably, when the valve is in the fully open position, the distance between the sealing surfaces of disc 33 and seat 32 is slightly greater than the diameter of housing ports 22. With such an arrangement, when sleeve 26 moves upwardly in the housing, the lower end of skirt 28 covers port 22 to block the flow of fluid into the casing-mandrel annulus just before disc 33 contacts seat 32 to shut off the flow of fluid from the tubing into the valve housing. As the skirt 28 moves over ports 22, the rate of flow through the valve is continuously reduced and final positive closure results from the sealing contact between the valve disc and the valve seat at the lower end of the valve. Washing on the valve seat is minimized since the major portion of the flow is cut off by the valve sleeve. Also, the pressure drop across valve seat 32, as valve disc 33 closes on it, is minimized for the same reason.

After the tubing mandrel is lowered in the casing, as described above, and the valve device inserted in the mandrel, fluid is supplied to the top side of cap 27 at a pressure sufficiently greater than the producing fluid pressure to maintain sleeve 26 and disc 33 in the open position so that produced fluid may flow upwardly from that portion of the tubing below the valve into the casing annulus above the valve. However, if desired, a separate suitable pressure fluid conduit may be provided for this purpose and the produced fluid brought to the surface through the tubing. This may be accomplished by supplying suitable perforations in the tubing above the valve with a suitable packer or other sealing arrangement between the casing and the tubing above these perforations. Advantageously, the pressure fluid may comprise a relatively small volume of liquid, such as an oil, in the tubing above the valve with pressured gas supplied to the tubing above the liquid. Such an arrangement makes the closing action very positive, since loss of tubing pressure results in a high differential pressure between the tubing on the lower side of the valve and on the upper side of the valve and the closing action of the valve is more effective.

While the valve of the present invention has been described in connection with producing fluid through the tubing, it may also be employed when producing fluid through the tubing-casing annulus by blocking off the annular space between the tubing and casing below the valve and providing entry points below this so that the fluid may be flowed into the tubing just below the valve, through the valve and out through the mandrel ports as described above.

From the foregoing description of a preferred embodiment of the present invention, various modifications in the construction thereof will become apparent to the skilled artisan, and it is to be understood that such modifications fall within the spirit and scope of the appended claims.

I claim:

1. A subsurface safety valve comprising:
an elongated tubular mandrel adapted to be connected

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into a string of well conduit to form a portion thereof;

mandrel port means in the wall of said mandrel;
a tubular valve housing insertable in said mandrel and provided with housing port means in the wall thereof communicating with said mandrel port means;

upper and lower sealing means between the inner wall of said mandrel and the outer wall of said housing on either side port means;

the lower end of said housing being open to communicate the interior of said housing with the interior of said mandrel below said lower sealing means;

a sleeve element slidably positioned in said housing, said sleeve element comprising a skirt member provided with sleeve port means communicating with said housing port means when said valve is in the open position and covering said housing port means when said valve is in the closed position, and a cap member above said sleeve port means enclosing the upper end of said skirt member;

sealing means between said sleeve element and the inner wall of said housing above said housing port means;
valve seat means adjacent the lower end of said housing;

a valve disc affixed to said sleeve element and movable therewith, said disc member being disengaged from said valve seat means when said valve device is in the open position and being sealingly engaged with said seat means when said valve device is in the closed position; and

stop means in said housing for limiting the sliding travel of said sleeve element therein.

2. The valve of claim 1 further including means for maintaining pressure in said mandrel above said cap means to resiliently maintain said valve in the open position during normal operation.

3. A valve device for use in a well comprising:
an elongated tubular valve housing, said housing being open at one end and having port means in the wall thereof;

packing means positioned on the exterior of said housing below said port means for forming a seal in the annular space in said well exterior of said housing;
a valve seat adjacent the open end of said housing;

an elongated element positioned in said housing to move longitudinally therein, a portion of said elongated element having a continuous outer circumferential surface such that said portion forms a sealing fit with the interior of said housing so that when said elongated element is in a first position there is free communication from below said packing means through said port means to above said packing means and when said elongated element is in a second position said communication is restricted by said circumferential surface;

a valve means carried by said elongated element below said portion of continuous circumferential surface for sealing against said valve seat and completely closing the open end of said housing when said elongated element is in said second position.

4. A valve device for controlling the flow of a fluid through a conduit, said device comprising:

a tubular valve housing open at one end to place the interior thereof in flow communication with said fluid;

housing port means in the wall of said housing communicating the interior with the exterior thereof;

a sleeve element slidably positioned in said housing adjacent said housing port means, said sleeve element having one end open to said fluid and being enclosed at the opposite end;

sleeve port means in the wall of said sleeve element, said sleeve port means being in flow communication with said housing port means when said device is

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open and said sleeve element covering said housing port means when said device is closed;
 sealing means between said housing and said sleeve element positioned between said sleeve port means and enclosed end of said sleeve element;
 valve seat means adjacent the open end of said housing;
 a valve disc member affixed to said sleeve element and movable therewith to sealingly contact said valve seat means upon said housing port means being covered by said sleeve element and being spaced from said valve seat means when said sleeve port means are in flow communication with said housing port means to permit fluid flow through said device;
 a tubular mandrel adapted to be installed in said conduit to form a portion thereof, mandrel port means in the wall of said mandrel, said housing being inserted in said mandrel so that said housing port means are in flow communication with said mandrel port means.

5. The device of claim 4 further including means for applying pressure against the closed end of sleeve element to resiliently maintain said device in the open position during normal operation.

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