Aug. 25, 1953 H. C. OTIS 2,649,914

FLOW GUIDING DEVICE

Filed March 6, 1948

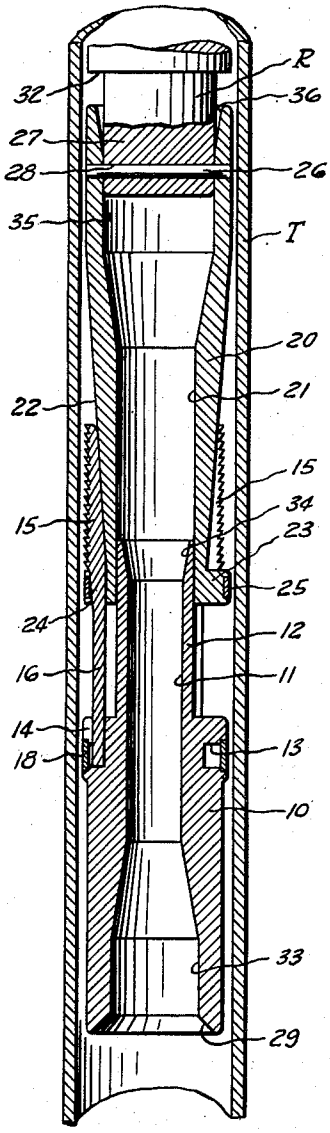


Fig. 1

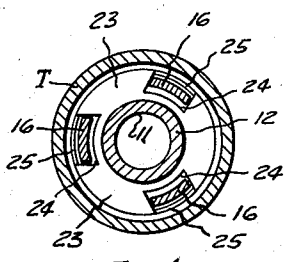


Fig. 4

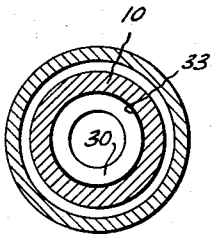


Fig. 5

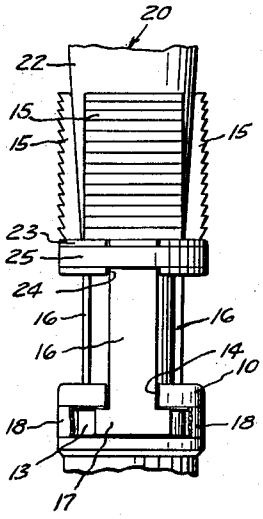


Fig. 3

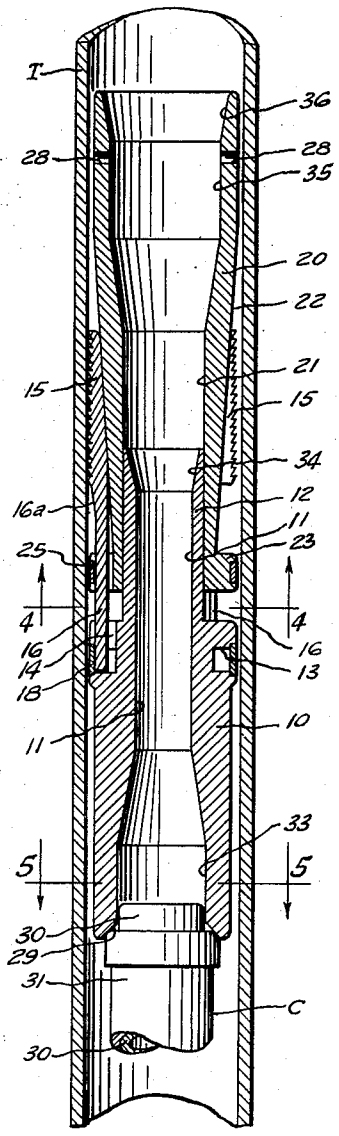


Fig. 2

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FLOW GUIDING DEVICE

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4 Claims. (Cl. 166—2)

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This invention relates to new and useful improvements in flow guiding devices for sub-surface well flow control devices.

Removable sub-surface flow control devices for oil or gas wells, such as the removable choke disclosed in the patent to H. C. Otis, 1,972,791, issued September 4, 1934, have been widely adopted for controlling the flow of fluids from the producing formations of such oil or gas wells upwardly through the well flow conductor to the surface. As higher sub-surface pressures have been encountered, greater pressure reductions are effected across the flow control device. Furthermore, the presence of sand, water, or other extraneous matter, in such high pressure well fluids has created a dangerous condition in the well flow conductor because of the turbulence and cutting action of the fluids flowing upwardly out of the tubular mandrel of the removable well flow control device and into the considerably larger bore of the tubing thereabove. The gaseous fluids leaving the upper end of the mandrel or tube of the flow control device and entering the larger bore of the conductor expand or bell out rapidly and create a condition of turbulence just above the flow control device. This turbulence causes a severe wearing and cutting action on the bore wall of the well tubing or flow conductor, and in some cases will cause erosion completely through the wall of the conductor.

It is, therefore, one object of this invention to provide an improved flow guiding device which is adapted to be positioned in a well flow conductor at the upper end of a sub-surface well flow control device for reducing or preventing the turbulence and cutting action of the fluids flowing through the flow controlling device, as such fluids leave the upper end of the bore of the control device.

An important object of the invention is to provide a flow guiding device which is adapted to be inserted into the well flow conductor and anchored therein at the upper end of the sub-surface flow controlling device for the purposes described, said flow guiding device being separately removable from the flow conductor without disturbing the conductor or the flow control device therein.

Another object of the invention is to provide a flow guiding device of the character described which is provided with a thick-walled section immediately above the upper end of the flow control device, whereby fluids flowing into the flow guiding device act upon the thick-walled section, thus providing for longer life of the guiding device.

Still another object of the invention is to provide a flow guiding device, of the character described, which is formed with a gradually increasing bore, whereby the flow passage provided

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by the bore is gradually increased from a diameter substantially equal to the diameter of the bore of the sub-surface flow control device to a diameter approximately as great as the bore of the well flow conductor in which the guiding device is mounted, whereby fluids flowing through the bore of the sub-surface flow control are directed in a gradually increasing stream to the bore of the flow conductor, and flow cutting and turbulence are thereby reduced.

A further object of the invention is to provide a device of the character described wherein all parts of the device are placed under compression and held substantially stationary when the device is anchored in flow guiding position, whereby vibration and loosening of the parts are substantially eliminated.

Another object of the invention is to provide a flow guiding device, of the character described, which is constructed and arranged to be lowered into the well flow conductor and anchored therein by means of a flexible line lowering mechanism, and which may also be removed from said flow conductor by means of a flexible line removing mechanism.

A particular object of the invention is to provide a flow guiding device of the character described which is arranged to engage the locking mechanism of the removable sub-surface flow control device to supplement the gripping action thereof.

A still further object of the invention is to provide a flow guide of the character described wherein the smallest bore through the flow guide is provided in the body portion upon which the expansible gripping elements are mounted, said gripping elements being expanded into gripping engagement with the wall of the flow conductor by a sleeve telescoping the body and having a bore diameter greater than the bore of the body, whereby fluid pressure reduction is taken across the smaller bore of the body and the sleeve is not urged upwardly by the well fluid pressure, so that the guide remains anchored in the conductor.

Additional objects and advantages of the invention will be readily apparent from a reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

Figure 1 is a transverse, vertical sectional view of a flow guiding device, constructed in accordance with the invention, and showing the same being lowered into a well flow conductor,

Figure 2 is a view, similar to Figure 1, showing the flow guide in anchored flow guiding position in the flow conductor,

Figure 3 is a fragmentary view, partly in elevation and partly in section, illustrating the gripping mechanism of the flow guide,

Figure 4 is a horizontal cross-sectional view, taken on the line 4—4 of Figure 2, and

Figure 5 is a view similar to Figure 4, taken on the line 5—5 of Figure 2.

In the drawings, the numeral 10 designates an elongate cylindrical body or mandrel having an axial flow passage 11 therethrough. The diameter of the upper portion of the body is reduced to provide an upstanding cylindrical neck section 12 at the upper end of said body. Immediately below the neck portion 12, an external annular recess or groove 13 is formed in the periphery of the body, and spaced slots 14 extend upwardly from the annular groove through the upper surface of the large portion of the body. Gripping elements or slips 15, having sharp gripping teeth or serrations on their outer surfaces, are provided with depending handles 16 which extend downwardly through the slots 14 and into the annular groove 13 in the body. An inverted T-shaped foot piece or end 17 is formed at the lower end of each slip handle and the lateral portions of said foot piece extend laterally from the handle in the annular groove to positively loosely connect the handles with the body. The T-shaped foot ends of the slips are retained in place in the annular groove by a band 18, which is mounted in a counter-bored outer portion of the annular groove and surrounds the body.

An elongate tubular expander member or sleeve 20 is provided with an axial bore or flow passage 21, the lower portion of which receives the cylindrical neck 12 of the body or mandrel 10, whereby the sleeve telescopes the neck with a loose sliding fit. The sleeve is provided with an external inwardly and downwardly tapered expander surface 22 which terminates short of the lower end of the sleeve, and the gripping slips are slidable longitudinally on the expander surface of the sleeve. An external annular flange 23 is formed on the sleeve immediately below the expander surface, and the slip handles 16 of the gripping slips extend through and are freely movable in spaced slots or openings 24 formed in said flange. The slip handles are restrained against outward displacement from the slots 24 in the flange by a band 25 which is secured in an annular groove surrounding such flange. Downward movement of the gripping slips with respect to the sleeve is limited by the engagement of the lower ends of the slips with the upper surface of the flange 23, while upward movement of the slips is limited by the engagement of the lower end of the sleeve 20 with the shoulder on the body at the lower end of the neck portion 12 thereof. Thus, the sleeve may undergo a limited longitudinal movement with respect to the body for expanding the slips or permitting retraction thereof.

The portion of the sleeve 20 above the expander section 22 is substantially cylindrical in shape and has an external diameter preferably only sufficiently smaller than the inner bore of the conductor or tubing T to permit the sleeve to move freely through the tubing.

As will readily be seen, the weight of the body 10 and the slips 15 carried thereby will normally move said slips to their lowermost position on the expander section 22 of the sleeve, where the slips engage and are supported upon the upper surface of the flange 23 of said sleeve. However, downward movement of the sleeve with respect to the slips will move the expander section downwardly between the slips to force said slips radially outwardly into gripping engagement with the wall of the tubing or conductor T. Once the slips have engaged the wall of the tubing, further application of force to the sleeve tends to increase the gripping action of the slips. Also, any upward force applied to the body 10 will be transmitted through the slip handles to the slips to prevent upward movement of said body.

In use, the flow guiding device is connected by means of a shear pin or other releasable means 26 to the lower end of a running tool R, which has a prong 27 slidable into the upper end of the bore of the sleeve. The shear pin is inserted into a radial opening 28 extending through said sleeve and prong. The running tool R is a part of a lowering mechanism (not shown) by means of which the guide may be lowered into the well flow conductor. As will readily be seen, the lowering mechanism may be of the well-known flexible line type.

The flow guide is lowered into the conductor T until the lower end of the body 10 engages over the upper end of a tubular mandrel 30 of a subsurface flow control device C such as, for example, the flow control device disclosed in Otis, 1,972,791, and engages against the upper end of a slip carrier or sleeve 31 on said control device. The lower end of the bore of the body is bevelled at 29 to provide for facilitating entry of the upper end of the mandrel 30 into the bore 11 of the body and to provide for centering the body on the slip carrying sleeve 31 of the flow control device.

When the lower end of the body has engaged the carrier 31 of the flow control device, further downward movement of the body is prevented, whereupon further downward movement of the sleeve 20 causes the expander section of the sleeve to force the slips 15 outwardly into gripping engagement with the bore wall of the flow conductor. Continued application of a downward force to the running tool R, by jarring or otherwise, causes the shear pin 26 to be fractured, whereby the running tool is disconnected from the sleeve. Fracturing of the shear pin permits the running tool to move downwardly until the downwardly facing shoulder 32 on the running tool engages the upper end of the sleeve, whereby the running tool may be used to further drive the sleeve downwardly by a jarring or hammering action. Thus, the sleeve may be firmly driven between the gripping slips to positively anchor the slips and guide in position in the conductor, said guide being positively set and anchored by means of a straight downward non-rotative force. The running tool R may then be lifted upwardly out of the bore of the well conductor.

Since the lower end of the body 10 of the flow guiding device engages the upper end of the slip carrier or sleeve 31 of the well flow control device C, it will be seen that any upward movement of the carrier 31 of the control device tending to release the gripping members of such control device from gripping position will be resisted by the gripping engagement of the slips 15 of the flow guiding device against the wall of the well flow conductor, thus providing for supplemental or additional anchoring of the flow control device C in the well flow conductor.

Furthermore, it will be noted that the body is pressed firmly downwardly against the upper end of the carrier 31 of the control device, that the slips 15 are firmly pressed downwardly toward the body 10 with the foot pieces 17 of the slip handles abutting against the lower side of the groove 13 in the body, that the slips are also

securely pressed outwardly against the bore wall of conductor, and that the expander sleeve 20 is firmly held between the slips 15. Thus, all parts are under compression, and vibration and loosening of the parts is substantially eliminated.

The lower portion 33 of the bore of the body 10 is enlarged in diameter and is preferably only slightly larger in diameter than the upper end of the mandrel 30 of the well flow control device C, whereby said mandrel may slide upwardly into said bore and fluids flowing from the tubular mandrel into the body of the guide will pass without undue turbulence. Above the lower portion 33, the bore of the body tapers inwardly to the smaller bore 11, which is substantially equal in diameter to the bore of the mandrel 30 of the control device C. The smaller bore 11 extends substantially throughout the length of the body and is again flared outwardly at its upper end 34 to substantially the diameter of the bore 21 of the sleeve 20, whereby fluids flowing through the bore of the body will pass along the flared portion into the bore of the sleeve with very little turbulence. The upper portion 35 of the bore of the sleeve is also enlarged, the bore being tapered in merging from the smaller portion 21 into the larger portion. The extreme upper end of the enlarged portion 35 of the bore of the sleeve is further belled or flared outwardly, as illustrated at 36, whereby fluids flowing through the sleeve will pass along such belled portion 36 and into the bore of the tubing T without undue turbulence.

Thus, it will be seen that the stream of fluids flowing upwardly through the well flow control device C will emerge from the upper end of the mandrel of said device into the bore of the body 10 of the flow guiding device, and will pass through said flow guiding device in a stream of gradually increasing size to the bore of the flow conductor thereabove, whereby flow cutting and turbulence above the flow control device are greatly reduced or substantially eliminated. It will also be noted that the walls of the lower portion of the body 10 are relatively thick, whereby the abrasive action of the fluids flowing from the mandrel of the flow control device to the bore of the body of the flow guiding device must erode or cut away a considerable amount of material before such fluids can act upon the walls of the well conductor adjacent the upper end of the mandrel of the flow control device. Thus, danger of eroding or cutting the conductor in two, with the hazards attendant thereupon, is substantially eliminated.

When it is desired to remove the flow guiding device from within the conductor T, a suitable fishing spear (not shown) of any well-known desirable type, having expansible gripping dogs thereon, may be lowered through the conductor into the enlarged upper portion 35 of the bore of the expander sleeve 20, where the gripping dogs of said spear may be expanded into engagement with the bore wall or the sleeve. Application of an upward force of pull by means of said spear will lift the sleeve upwardly, thus withdrawing the expander surface 22 from between the slips 15 and permitting said slips to be moved to a retracted position. Upwardly and outwardly inclined wedge surfaces 16a at the upper ends of the slip handles 16 are provided for engaging the band 25 on the lower end of the expander sleeve for causing the slips to be moved inwardly to retracted non-gripping position. The slips move downwardly until they rest upon the upper

surface of the flange 23 at the lower end of the sleeve, whereupon further upward movement of the sleeve 20 will lift the body 10. Thus, the flow guiding device may be removed from the bore of the well flow conductor, leaving the flow control device C in position therein.

The retrieving spear (not shown) may be lowered into and operated in the well conductor by means of a flexible line lowering and retrieving mechanism, or in any other suitable manner. It will be noted that the only movement or motion necessary to retrieve the guide device is a straight upward non-rotative pull on the expander sleeve.

From the foregoing, it will be seen that a flow guiding device has been provided which is adapted to be positioned in a well flow conductor at the upper end of a sub-surface well flow control device for reducing the turbulence and cutting action of fluids flowing through the flow control device, and that such flow guiding device is adapted to be inserted into the conductor and anchored therein and removed therefrom independently of the flow control device. It will also be seen that the flow guiding device is arranged to be anchored in position in the conductor engaging the locking mechanism of the removable sub-surface flow control device to provide an additional or supplemental anchor for such flow control device, and that the parts of the guiding device are held in compression whereby vibration is prevented. Furthermore, the flow guiding device is so constructed and arranged that any fluid pressure reduction or drop is taken across the body of the guide, whereby the upward force resulting from such pressure reduction is applied directly to the gripping slips of the flow guiding device to prevent displacement of the guide from position in the conductor. It is to be particularly noted that a flow guiding device has been provided which is constructed and arranged to be lowered into a well flow conductor and anchored therein by means of a straight line downward non-rotative movement of the expander sleeve, whereby the guide may be inserted and anchored in place in the conductor by means of a flexible line lowering mechanism. Furthermore, the flow guiding device is removable from the conductor upon the application of a straight line upward non-rotative pull on the expander sleeve, whereby the guide device is readily removable from the conductor by means of a flexible line mechanism. In both instances, the flow guiding device is insertable into and removable from the flow conductor independently of the flow control device C.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. A flow guiding device adapted to be positioned in a well flow conductor for reducing turbulence of fluids flowing from a sub-surface well flow control device mounted in said conductor, said flow guiding device including: a body having a bore extending axially therethrough and having a stop shoulder at its lower end adapted to engage an upwardly facing surface on the flow control device to position said body with its bore communicating with the bore of the well flow control device, expansible gripping means carried by said body and projecting up-

wardly therefrom, and an expander sleeve telescoping the body and extending upwardly above the upper end of the body, said expander sleeve being movable downwardly with relation to said gripping means for expanding the gripping means into gripping engagement with the bore wall of the well flow conductor to maintain the body in position therein, the bore of the expander sleeve forming an upward continuation of the bore of the body, and the bores of the body and sleeve gradually increasing in diameter in an upward direction from a point intermediate the ends of the body to deliver fluids flowing through the flow guiding device to the bore of the conductor in a stream of gradually increasing diameter above said point intermediate the ends of the body.

2. A flow guiding device adapted to be positioned in a well flow conductor for reducing turbulence of fluids flowing from a sub-surface well flow control device having a bored mandrel and a slip carrier sleeve slidable on said mandrel and mounted in said conductor, said flow guiding device including: a body having a bore therethrough and having its upper portion reduced in external diameter to provide a neck section, a stop shoulder at the lower end of the body adapted to telescope over the upper end of the mandrel of the flow control device and engage the slip carrier of such device to limit downward movement of the body and to position the bore of the body in communication with the bore of the flow control mandrel, an expander sleeve telescoping over and extending upwardly above the upper end of said neck section of the body, gripping means carried by the body and slidable upon the exterior of the expander sleeve whereby movement of the expander sleeve downwardly with respect to the gripping means expands said gripping means into gripping engagement with the bore wall of the flow conductor to maintain the flow guiding device in position therein, the bore of the sleeve forming an upward continuation of the bore of the body, the bores of the body and sleeve gradually increasing in diameter in an upward direction from a point intermediate the ends of the body to substantially the diameter of the bore of the conductor to guide fluids flowing from the upper end of said control device to the bore of the conductor in a stream of gradually increasing diameter above said point intermediate the ends of the body.

3. A flow guiding device adapted to be positioned in a well flow conductor for reducing turbulence of fluids flowing from a removable subsurface well flow control device mounted in said conductor, said flow guiding device including: a body having an axial flow passage therethrough, said body having its upper portion reduced in external diameter to provide a cylindrical neck section, a tubular expander sleeve telescoping over the neck section of the body and slidable longitudinally thereon, said expander sleeve having a downwardly tapering expander section formed on its exterior, gripping slips slidable upon the expander section of the sleeve and having depending handles loosely connected with the body below its neck portion, an external annular flange at the lower end of the expander sleeve having openings formed therein through which the slip handles are freely slidable, the gripping slips being expansible to gripping engagement with the bore wall of the flow conductor upon downward movement of the expander sleeve with respect to said slips whereby the guiding device is positively releasably anchored in said conductor, the lower portion of the bore of the body being engageable over the downstream end of the flow control device whereby fluids flow from said control device into the bore of the body, the bore of the body at its lower end being substantially equal in size to the bore of the control device and having its upper end flared upwardly to substantially the diameter of the lower portion of the bore of the expander sleeve, the bore of said expander sleeve forming an upward continuation of the bore of the body and being flared upwardly and outwardly above the upper end of the body neck section to substantially the diameter of the bore of the conductor, connecting means at the upper end of the expander sleeve for connecting the guide device with a flexible line lowering and removing device, the gripping slips being movable to retracted non-gripping position upon upward movement of the expander sleeve with respect to said slips, and wedge means on the slip handles engageable with the flange at the lower end of the expander sleeve for positively moving said slips to retracted position.

4. A flow guiding device adapted to be positioned in a well flow conductor for reducing turbulence of fluids flowing from a removable subsurface well flow control device mounted in said conductor, said flow guiding device including: a body having an axial flow passage therethrough, said body having its upper portion reduced in external diameter to provide a cylindrical neck section, a tubular expander sleeve telescoping over the neck section of the body and slidable longitudinally thereon, said expander sleeve having a downwardly tapering expander section formed on its exterior, gripping slips slidable upon the expander section of the sleeve and having depending handles loosely connected with the body below its neck portion, an external annular flange at the lower end of the expander sleeve having openings formed therein through which the slip handles are freely slidable, the gripping slips being expansible to gripping engagement with the bore wall of the flow conductor upon downward movement of the expander sleeve with respect to said slips whereby the guiding device is positively releasably anchored in said conductor, the lower portion of the bore of the body being engageable over the downstream end of the flow control device whereby fluids flow from said control device into the bore of the body, the bore of the body at its lower end being substantially equal in size to the bore of the control device and having its upper end flared upwardly to substantially the diameter of the lower portion of the bore of the expander sleeve, the bore of said expander sleeve forming an upward continuation of the bore of the body and being flared upwardly and outwardly above the upper end of the body neck section to substantially the diameter of the bore of the conductor.

HERBERT C. OTIS.

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