

- [54] **ENCAPSULATED CONTROL LINE**
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Related U.S. Application Data

- [63] Continuation of Ser. No. 181,391, Sept. 17, 1971,
 abandoned.
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 [51] Int. Cl. **E21b 43/12**
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166/242, 243; 138/106, 107, 110, 111, 112,
113, 115; 174/47, 138; 251/1; 175/320, 44,
45, 50

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- [57] **ABSTRACT**
 An encapsulated fluid control line includes a plurality
 of control tubes which are encapsulated in the pre-
 ferred embodiment, in an elastomeric material.

10 Claims, 4 Drawing Figures

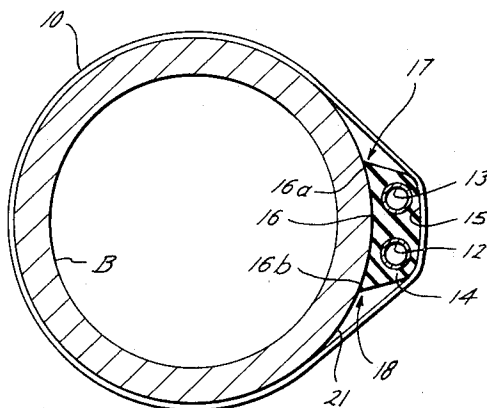


Fig. 1

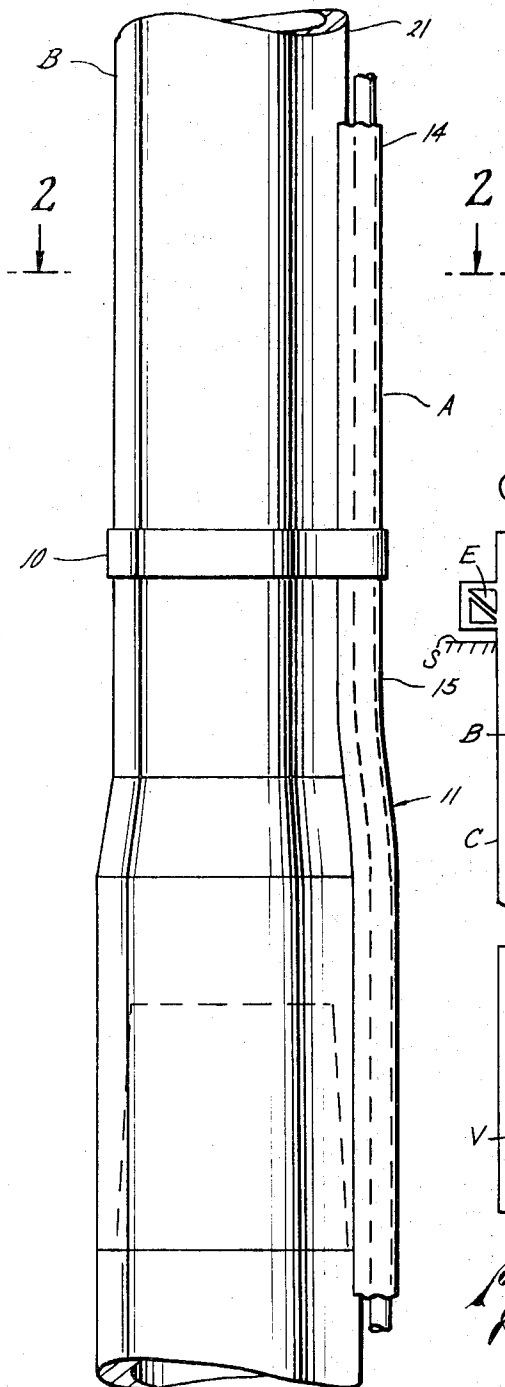


Fig. 2

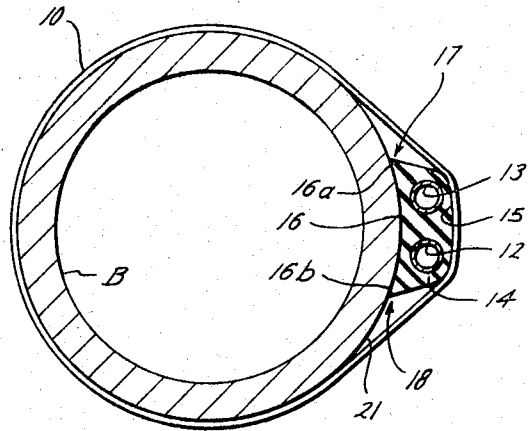


Fig. 3

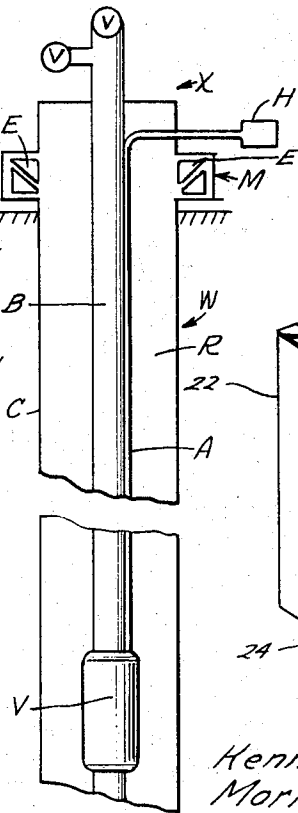
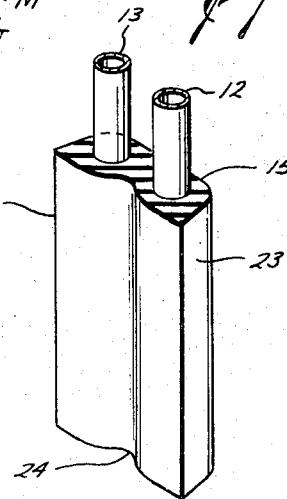


Fig. 4

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ENCAPSULATED CONTROL LINE

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of application Ser. No. 181,391, filed Sept. 17, 1971, now abandoned.

BACKGROUND OF THE INVENTION

The field of the invention relates to control lines. One use for such lines is in the operation of subsurface valves used in oil or gas producing well bores. Subsurface control valves are mounted in the production tubing and are operable from the surface in order to control flow of fluids through the production tubing. One of the most reliable types of subsurface control valves is hydraulically actuated by means of hydraulic control lines which are connected to a source of pressurized hydraulic fluid at the wellhead and extend downhole in the annular region between the production tubing and the casing to the subsurface valve mounted in the production line.

In the prior art, hydraulic control lines generally consisted of separate tubes sometimes joined by metal or other types of bands, which extended from the well head to the subsurface control valve mounted in the production tubing. Such individual control tubing offered and presented a number of disadvantages. For example, such separate tubes were difficult to install and remove since each tube had to be wound and unwound on separate spools which, of course, required more effort and machinery than if the control tubes could be unwound from one spool. Such separate tubes were virtually unprotected, and, as such, were likely to be damaged during the installation, which rendered the subsurface valve inoperable. For example, such separate tubes had to be clamped to the production tubing every 20' or 30' in order to prevent damage by chafing against the inner wall of the casing as the production tubing was run into the well with the tubes mounted thereon. Tubes made of metal had the additional disadvantage of being susceptible to corrosion and other cathodic and chemical reactions in the well.

In the event of an emergency surge in well pressure from a kick or a blowout, it was necessary to shut off flow in the annular region between the casing and the production tubing by means such as an annular blowout preventer. Since the control lines are round and in the annulus it was extremely difficult for the rubber packers of the annular blowout preventer to form an effective seal between the outside surface of the control tubes, which were forced against the production tubing by the rubber packers, and the rubber packers without damaging the tubes. One solution for eliminating leaks between the individual hydraulic control tubes and the blowout preventer was to crush the control lines with the rubber packers. Of course, this tactic was extremely expensive since the production tubing later had to be pulled so that the hydraulic control lines could be repaired.

Further, in some instances, because the rubber packers could not seal around the control lines, it was necessary to cut the lines at the surface and drop them in the annulus. This required replacement of the lines and fishing of the cut lines out of the well bore.

Also, in many instances it was necessary to bend and wrap the control lines around the tubing. When this

was done, the lines became twisted or even pinched which was undesirable because of problems in operating the subsurface control valve with twisted or pinched lines.

SUMMARY OF THE INVENTION

The present invention overcomes these problems by encapsulating the fluid control tubes in a sheath of elastomeric material so that the encapsulated control lines may be easily handled and fit against the production tubing. Another feature of this invention is that the rubber packers of a blowout preventer can form an effective seal with the sheath without damaging the hydraulic control tubes encapsulated therein.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred embodiment of this invention will be described hereinafter together with other features thereof and additional objects will become evident from such description.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof wherein an example of the invention is shown and wherein:

FIG. 1 is a view in elevation of the encapsulated fluid control line of this invention mounted on production tubing;

FIG. 2 is a sectional view taken through lines 2—2 of FIG. 1;

FIG. 3 is a perspective view of an alternate embodiment of the encapsulated control line, and

FIG. 4 is a schematic view of the fluid control line of the present invention located in a well.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The field of the invention relates to control lines. As illustrated in FIG. 4, one use for such lines is in the operation of subsurface valves V used in oil or gas producing well bores W. Subsurface control valves are mounted in the production tubing B and are operable from the surface S in order to control flow of fluids through the production tubing. One of the most reliable types of subsurface control valves is hydraulically actuated by means of hydraulic control lines which are connected to a source of pressurized hydraulic fluid H at the wellhead X and extend downhole in the annular region R between the production tubing B and the casing C to the subsurface valve V mounted in the production line.

In the event of an emergency surge in well pressure from a kick or a blowout, it was necessary to shut off flow in the annular region R between the casing C and the production tubing B by means such as an annular blowout preventer M. Since the control lines are round and in the annulus R it was extremely difficult for the rubber packers E of the annular blowout preventer M to form an effective seal between the outside surface of the control tubes, which were forced against the production tubing by the rubber packers E, and the rubber packers without damaging the tubes. One solution for eliminating leaks between the individual hydraulic control tubes and the blowout preventer was to crush the control lines with the rubber packers. Of course, this tactic was extremely expensive since the production

tubing later had to be pulled so that the hydraulic control lines could be repaired.

In the drawings the letter A designates generally the encapsulated fluid control line according to the preferred embodiment of this invention mounted on the production tubing B, the environment being downhole in an oil well with the oil well casing C being disposed concentrically outwardly of the production tubing B. The encapsulated fluid control line A is adapted to extend from the surfaces of an oil well down the production tubing B to subsurface control equipment such as a control valve V mounted in the production tubing B. In FIG. 1, the encapsulated control line A is mounted on the production tubing B by means of a simple strap or clamp 10; and, as shown in the drawings, the encapsulated fluid control line A is sufficiently flexible to bend at 11 where the outside diameter of the production tubing increases due to the pin and box joint in the tubing string. Also, with the present invention the control line A can be wrapped on the tubing B or wound and unwound from a spool without twisting, tangling or pinching the control tubes 12 and 13.

The encapsulated fluid control line A includes in the form illustrated two control tubes 12 and 13 which are connected to a source of fluid pressure at the surface of the well and to the subsurface fluid actuated control valve mounted in the production tubing in order to provide pressurized liquid or gas to the control valve, and a crescent or arcuate-shaped sheath 14 of elastomeric material. It should be understood that there may be several control tubes encapsulated in an elastomeric material.

In the embodiment illustrated by FIGS. 1 and 2, the crescent-shaped sheath 14 has a generally convex outer surface 15 and a generally concave inner surface 16. The generally concave inner surface 16 of the sheath is adapted to be mounted against the adjacent or outer surface 21 of the production tubing B. The concave configuration of the inner surface 16 tends to keep the fluid control line A adjacent the production tubing in that portion 16a of the concave surface prevents movement of the encapsulated control line in the direction of the arrow 17 and portion 16b of the concave surface prevents movement in the direction of arrow 18 — thereby maintaining the control line centered adjacent the tubing to prevent movement of the tubing control tubes into the annulus R.

The outside generally convex surface 15 of the sheath provides a gradually curved or rounded surface as compared with the round metal tubes 12 and 13 so that the closure members, which may be a rubber packer, of a blowout preventer M will form an effective seal with the outside surface 15 when the blowout preventer is actuated. Therefore, with the encapsulated hydraulic control line A shown in the position of FIG. 2, the rubber packer E of the blowout preventer M can be pressed into engagement with the outside surface 21 of production tubing and with the outside generally convex surface 15 of the sheath to form an effective seal both with the production tubing and the sheath thereby preventing the escape of any well fluids which would otherwise occur during a kick or blowout. The inner concave surface 16 is pressed against the outside surface 21 of the production tubing by the rubber packers of the blowout preventer such that no well fluid can escape therethrough. The sheath is strong enough to

prevent damage to the tubes 12 and 13 under the force of the rubber ram of the annular blowout preventer.

One of the advantages of providing a sheath configuration that will form such a seal is that fluid may pass through the tubes 12 and 13 after the kick or blowout has come under control so that the subsurface device V can be opened and production may begin again. Of course, without the sheath 14, it would have been necessary to crush the tubes 12 and 13 making it necessary to pull the control tubes and install new hydraulic lines before the subsurface valve can be opened by fluid means again.

The generally concave inner surface 22 of the sheath 23 in the alternate embodiment shown in FIG. 3 includes a notch 20 disposed therein at the center of the concave surface. One of the purposes of the notch is to allow the sheath to bend at the notch slightly in order to better conform to the outside surface 21 of the production tubing B. It should be noted in FIG. 3 that like numerals taken from the embodiment of FIGS. 1 and 2 depict and illustrate like parts set forth in FIG. 3.

The elastomeric material which comprises the sheath in both the embodiments of this invention must be capable of withstanding the pressures and temperatures present in the annular region downhole between the production tubing and the casing. It is also desirable that the elastomeric material be able to withstand relatively high downhole temperatures. It is also desirable that the material have sufficient hardness to prevent the sheath or the tubes from being damaged as the production tubing with the encapsulated control line mounted thereon is run downhole. Of course, it is understood that any other material which would provide sufficient flexibility to allow the encapsulated control line to be wound and unwound on a spool, and also withstand downhole well conditions, may be used.

In one embodiment of the invention shown herein, a 304 annealed stainless steel of 0.020 w.t. (Passivated Trent Tube Spec. 116-3c) has been found satisfactory for the tubes. Of course, it is to be understood that the metal tubes may be completely eliminated if a sheath material can be found that will be sufficiently flexible while having the strength to maintain the inside and outside working pressures with sufficient safety factors.

One advantage of these encapsulated control lines as set forth hereinabove, is that they move as a unit thereby eliminating the disadvantage of two separate metal lines which may tend to bend and chafe against each other. Further, the encapsulated hydraulic control line can be wound on a single spool so that it is only necessary to provide one set of guide straighteners as the spool is unwound. The crescent-shape of the sheath allows the encapsulated control line to be wound very tightly onto a spool since the inner concave surface of the encapsulated control line tends to fit against the outside surface of the encapsulated line wound onto the pool in the preceding layer.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials as well as in the details of the illustrated construction may be made without departing from the spirit of the invention. For instance, it is within the scope of this invention to use the control line of this invention for providing any type of fluid, such as air, water or hydraulic fluid, to any type of machine or device.

We claim:

1. A control line apparatus for operating a valve mounted with a well tubing at a subsurface location in a well from a location exteriorly of the well bore, including:

a. a control tube for carrying control fluid under pressure to the valve from the location exteriorly of the well bore; and

b. a sheath of elastomeric material substantially encapsulating said control tube in the well bore and having an arcuate shape forming an inner surface mounted against the well tubing and a generally convex outer surface for providing a sealing element about the control tube when an annular seal is substantially effected with the well tubing by a blowout preventer to prevent escape of well fluids adjacent the control tube.

2. The apparatus as set forth in claim 1, wherein: said sheath having an inner surface shaped to center the control line on the adjacent well tubing.

3. The apparatus as set forth in claim 1, wherein: said sheath having an inner surface shaped to prevent movement of the control line from adjacent the well tubing.

4. The apparatus as set forth in claim 1, including: a second control tube encapsulated by said sheath for carrying control fluid to the valve from the location exteriorly of the well valve.

5. The apparatus as set forth in claim 3, wherein: said inner surface having a notch to maintain the control line adjacent the well tubing.

6. Apparatus for controlling flow through a well tubing at a subsurface location in a well, including:

a. a controllable valve located at the subsurface location in the well for controlling flow through the well tubing;

b. a control line extending from the surface to the valve for controlling the valve, comprising:

c. a plurality of control passages for controlling the valve; and

d. a crescent sheath of elastomeric material substantially encapsulating said plurality of control passages in the well and having a shape forming a sealing inner surface mounted against the well tubing

and an outer surface for sealing engagement with a blowout preventer to prevent escape of well fluids adjacent the control line when an annular seal is effected by the blowout preventer.

7. The apparatus as set forth in claim 6, wherein: said plurality of control passages include two control passages for controlling the valve.

8. The apparatus as set forth in claim 7, wherein: said sheath having an inner surface shaped for maintaining said control line adjacent the well tubing.

9. Apparatus for controlling flow through a well tubing at a subsurface location in a well, including:

a. a controllable valve located at the subsurface location in the well for controlling flow through the well tubing;

b. a control line, comprising:

c. a control passage for controlling the valve extending from the surface to the valve for controlling the valve; and

d. a crescent sheath substantially encapsulating said control passage for forming an inner surface for sealing with the well tubing and an outer surface for sealing with a blowout preventer for providing a sealing element about the control passage when an annular seal is effected with the well tubing by the blowout preventer to prevent escape of well fluids adjacent the control line.

10. A control line apparatus for operating a valve mounted with a well tubing at a subsurface location in a well from a location exteriorly of the well bore including:

a. a control tube for carrying control fluid under pressure to the valve from the location exteriorly of the well bore; and

b. a sheath of elastomeric material substantially encapsulating said control tube in the well bore and having a crescent shape forming an inner concave surface positioned adjacent the well tubing and a generally convex outer surface for providing a sealing element about the control tube when an annular seal is effected with the well tubing by a blowout preventer to prevent escape of well fluids adjacent the control tube.

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