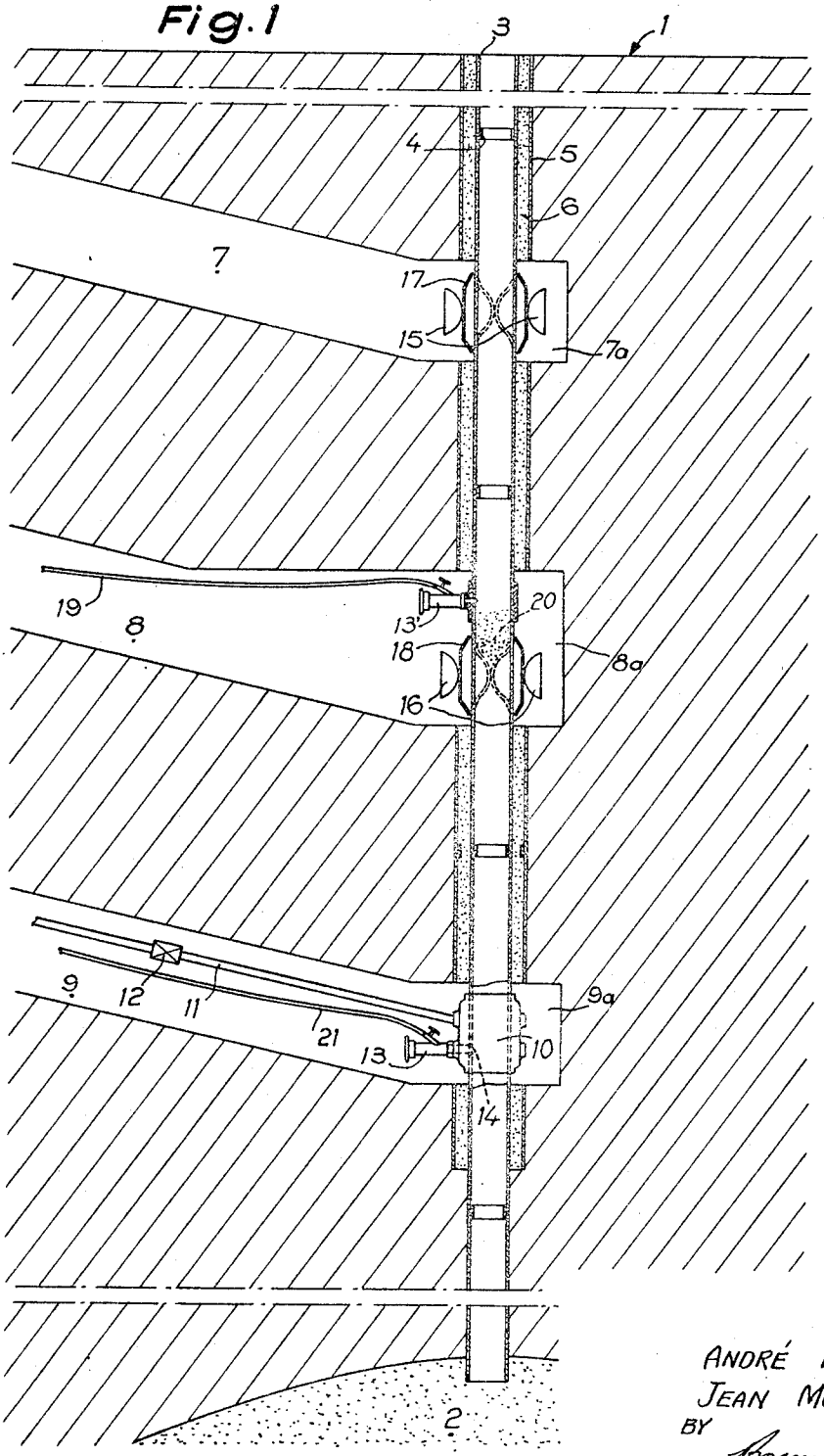
Oct. 11, 1966 A. HOUPEURT ETAL 3,277,964

METHOD FOR CONTROLLING THE DISCHARGE OF COMBUSTIBLE FLUID FROM OIL WELLS AND THE LIKE

Filed Feb. 15, 1963

3 Sheets-Sheet 1

Fig. 1



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3 Sheets-Sheet 2

Fig. 4

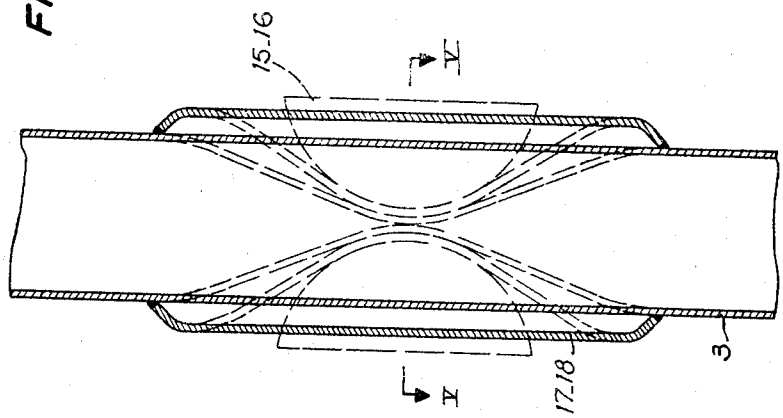


Fig. 5

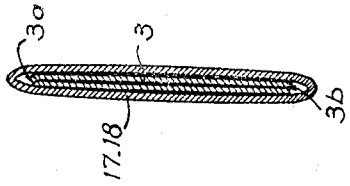
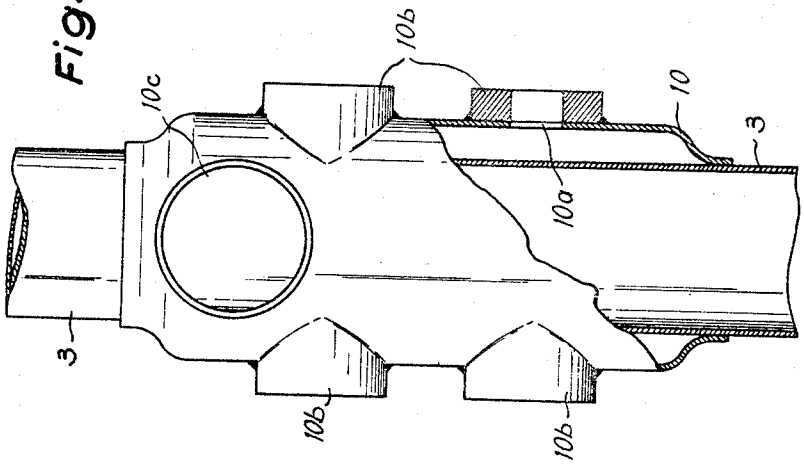


Fig. 2



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3 Sheets-Sheet 3

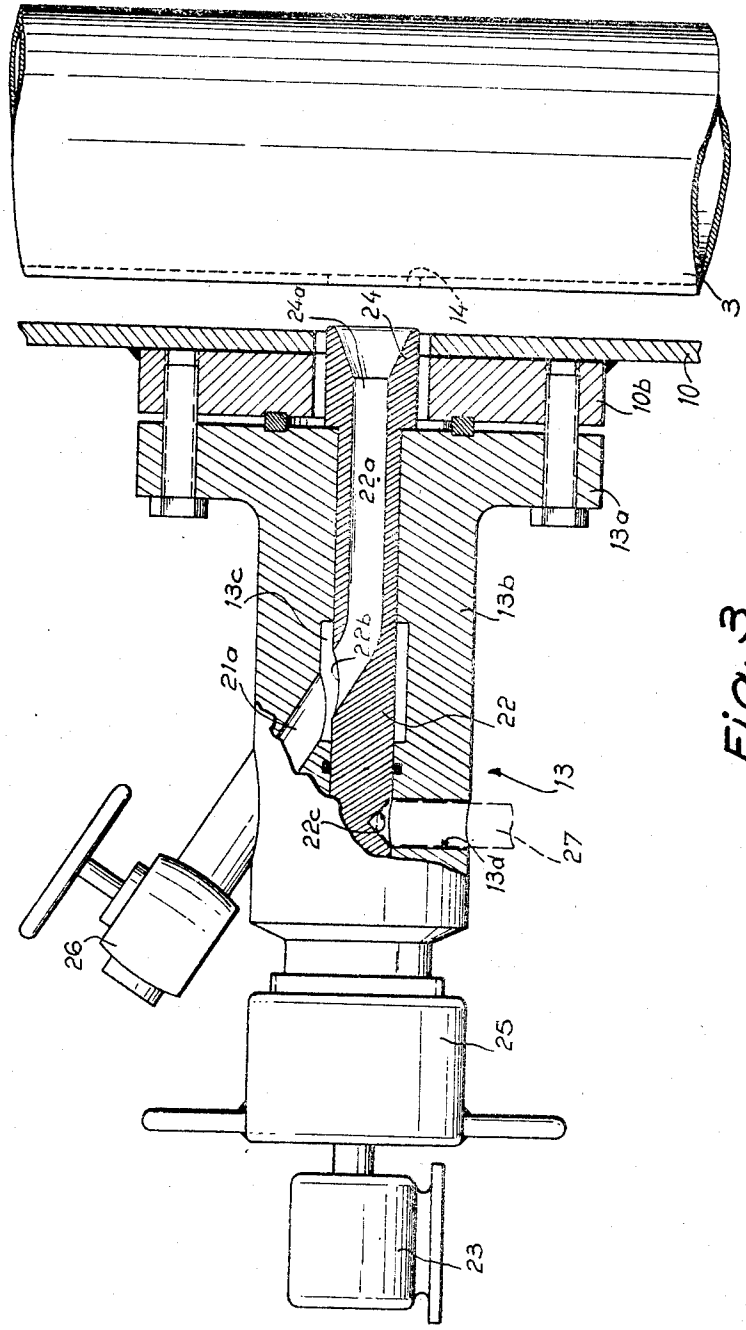


Fig. 3

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METHOD FOR CONTROLLING THE DISCHARGE OF COMBUSTIBLE FLUID FROM OIL WELLS AND THE LIKE

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4 Claims. (Cl. 166—35)

This invention relates to hydrocarbon-mining techniques, and more especially to methods and means of handling accidental blowout of combustible liquid and gas from the head of a well or borehole.

Such blowouts not only represent a considerable loss of valuable hydrocarbon product, but are a source of atmospheric pollution as well as a serious fire hazard. The high-pressure discharge of gas and oil is very difficult to control and the resulting fires are equally difficult to put out. Conventional procedures for this purpose frequently involve drilling an auxiliary hole leading to a point of the underground sheet of hydrocarbon adjacent the foot of the first hole, and dumping large amounts of mud in an attempt to stop the discharge. Such procedures are tedious, expensive and unreliable. Moreover, when successful, extraction from the initial well cannot generally be resumed, with serious economic consequences.

Objects of the invention are to provide improved techniques and equipment for controlling the accidental discharge of combustible fluids under high pressures from a well or borehole, whereby dangerous blowouts can be arrested in a comparatively short time, reliably and relatively cheaply, and in such a manner as to allow the initial well to be put back into commission in a short time after the blowout has been dealt with. A related object is to avoid contaminating the sheet of hydrocarbon with mud and water. Further objects are to provide improved combined drill-and-injector appliances operable for first drilling a hole through a well casing pipe or the like, and then injecting material into said pipe through the hole thus formed.

The invention will be described with reference to the accompanying drawings, given by way of illustration but not of limitation and wherein:

FIG. 1 is a schematic vertical section through an oil well fitted with equipment according to the invention for controlling a blowout,

FIG. 2 is a larger-scale view, with parts broken away and shown in section, of a part of the well of FIG. 1 fitted with a tapping sleeve or shell according to the invention,

FIG. 3 is a view on a further enlarged scale, with parts broken away and shown in section, illustrating a combined drilling and injection appliance,

FIG. 4 is a section through the well casing for illustrating the pinching operation, and

FIG. 5 is a cross section on line V—V of FIG. 4 after the pinching operation has been completed.

In accordance with the invention, for controlling blowout in an oil-well or the like, a branch pipe is connected with the casing of the well some distance below the ground surface, and the well casing is pinched some distance above the branch connection. Referring to FIG. 1, a well is shown as bored from the surface 1 of the ground to an underground bed 2 of oil or natural gas. The well is provided with a conventional casing pipe 3 comprising a series of sections interconnected as at 4 by threaded joints or the like. An upper portion of the well usually includes, as shown, an outer casing 5 of substantially

larger diameter than the inner casing 3 so as to be spaced coaxially around it, and cement 6 is cast in between the two casing pipes 3 and 5.

Assuming a blowout has occurred at the well orifice a gallery 9 is tunneled to connect with a point of the well at a point situated well below the danger zone where a fire hazard from the blowout is present, for connection of a branch line or tap to the well casing 3 as presently described. One or more additional tunnels, two being shown at 8 and 7, are similarly made to connect with the well at respective points spaced a relatively short distance above the gallery 9. The connecting points of the galleries 7, 8, and 9 with the well casing are preferably selected to lie intermediate the casing joints such as 4. Chambers such as 7*a*, 8*a* and 9*a* are recessed around the well casing at the point of connection of the galleries therewith.

A branch connecion is then made with the casing pipe 3 for tapping the discharge of pressure fluid, within the lowermost chamber 9*a*, using the following technique. The outer casing 5, if present, is first cut away throughout the height of the chamber 9*a*, if this can be done without excessively weakening the inner casing pipe against internal pressure. If not, additional concrete may have to be cast into the annular space between the casings above and below the cut-away portion, or the subsequent operations, described hereinafter, may have to be performed on the outer casing 5 rather than the inner casing 3. Assuming however the inner casing 3 is found to be sufficiently strong to withstand the internal pressure and the stress resulting from the operations to follow, it is laid bare by cuting away both the outer casing 5 and the cement lining 6. If the wall of the inner casing 3 is deemed to be too thin or weak to withstand the subsequent operations it may be reinforced locally as required. A two-part sleeve or shell 10 is then fitted around the casing 3. The shell 10 as shown in FIG. 2, has a cylindrical body substantially larger in diameter than the outer diameter of the casing 3, and has its ends tapered into flanges tightly surrounding said casing, and welded to the latter or otherwise secured in a pressure-tight manner. A branch line 11 fitted with a flow control valve 12 is passed through the gallery 9 and is connected in pressure-tight relation with the side wall of shell 10 so as to communicate with the annular space between the shell and the casing 3. Also connected with the sidewall of shell 10 is a drilling unit 13 which can be operated from outside the shell 10 to drill a hole through the wall of casing 3 and thereby establish communication from the interior of said casing to the branch line 11 by way of the annular space between the casing 3 and shell 10. Connecting with the drill housing 13 is a pipe 21 for the injection of water, mud or cement under pressure into the casing through the drilling unit as will later appear. The details of the structure comprising shell 10 and drill housing 13 will be described later with reference to FIGS. 2 and 3.

In each of the chambers 7*a* and 8*a* the inner well casing 3 is similarly laid bare, and a sleeve or shell 17 and 18 respectively is secured around it. The shells 17 and 18 are generally similar in shape to shell 10, having a cylindrical body portion of larger diameter than the casing 3, and inturned end portions welded around the casing surface. The shells 17 and 18 are made of a grade of steel having substantial deformability for reasons that will presently appear. Means are provided in each of the chambers 7*a* and 8*a* for applying high inwardly directed forces to diametrically opposite areas of the shell 17 or 18 so as to flatten the shell and therethrough the walls of casing 3, as indicated in dotted lines in FIG. 1, thereby to pinch the casing and seal the interior flow space there-

through. The pinching means may comprise a pair of hydraulic rams, not shown, having pusher heads 15 and 16 engaging the shell 17 or 18 at opposite points of each shell. The chamber 8*a* further contains a combined drilling and injection unit 13', which may be similar to the drill unit 13 provided in chamber 9*a*, but which is connected directly with the wall of casing 3 just above the shell 18, instead of being connected with the shell as was the case for unit 13 in chamber 9*a*. Unit 13' has a pipe 19 connecting with the body thereof for injection of mud or cement therethrough and through the hole drilled thereby in the casing wall 3 into the interior of the casing, as will be presently described.

The general procedure for stopping a blowout using the equipment summarily described above is the following. With the valve 12 in the branch line 11 being initially closed, the combination drill-and-injector unit 13 is operated to drill a hole through the casing 3 in chamber 9*a*, and provide communication between the interior of the casing and the annular space within shell 10. Valve 12 is then opened, so that a substantial portion of the gas flow rushing up through the casing 3 is tapped off through pipe 11 and can be directed therethrough to suitable storage tank means, and/or burned under controlled conditions in a flare. With the consequent reduction in pressure of the gaseous discharge through the well, the hydraulic ram device 16 can be operated to flatten the shell 18 and thereby pinch the casing pipe 3 in chamber 8*a*, as indicated in dotted lines. The combination drill-and-injector 13' in chamber 8*a* is now operated to drill a hole through the casing wall just above the pinched portion, and immediately thereafter inject a suitable amount of mud, cement or other plugging material as indicated at 20 into the casing 3, by way of pipe 19 and the body of the unit 13'. In many cases the residual leakage flow of gas through the pinched section of the well casing may be so great as to prevent a successful plugging by means of the material at 20, as by causing injected cement to set in a porous condition. If this is the case, then a single additional pinching of the casing 3 by means of ram device 15 in chamber 7*a* will in general be sufficient to correct the situation. However, under especially severe circumstances, more than one additional points of the casing 3, spaced above the main pinched section in chamber 8*a*, may have to be subjected to a similar pinching treatment. Moreover an injector-drill device similar to 13' may be used in conjunction with the additional pinch section in chamber 7*a* (and possibility at further additional points) for injecting plugging material thereat. On the other hand, there will be more practical situations where a single pinched and plugged portion of the casing 3, as in chamber 8*a*, will permit successful control of the blowout, so that even the single additional tunnel 7, chamber 7*a* and associated equipment will not be needed.

At this stage the combustible gases are being discharged entirely by way of branch pipe 11 and the blowout can be said to be under control. The valve 12 is gradually operated to seal off the branch line, and completely cut off the discharge of gas. The column of gas in the well below the pinched section is now in static equilibrium, and plugging material, such as mud, cement and/or water, can be injected through pipe 21 and the combination drill-and-injector unit 13 into the casing 3 to plug the casing somewhat below the branch-off point of pipe 11. The plugging material should of course be selected so as not to interact objectionably with the hydrocarbons present in the well. With the well plugged below the tapping 11, most of the valuable equipment present in the chambers such as 9*a*, 8*a*, 7*a* can be dismantled and retrieved by way of the galleries, the flattened and otherwise damaged portions of the pipe casing 3 cut away and replaced with new casing sections welded in place, the concrete casing 6 and outer casing pipe 5 (if any) similarly replaced where they were removed, all of which operations are greatly facilitated by the provision of the working chambers 7*a*, 8*a*, 9*a*. Thereafter the plugs of material injected into the well casing by way of the injector drills such as 13 and 13' can be bored through from the ground surface by conventional means, and the well can be rapidly put back into service to resume hydrocarbon-winning operations as before the blowout occurred. It will be noted in this respect that in contrast with certain prior blowout controlling procedures which involve the dumping of enormous amounts of material into the oil or gas bed at the foot of the well by means of an auxiliary drill hole, as earlier mentioned herein, whereby the bed is liable to be contaminated to such an extent that subsequent extraction from a wide area surrounding the well where the blowout occurred will be permanently prohibited, the method of the invention completely avoids this liability in that it involves dumping only limited amounts of plugging materials into the well casing itself.

Certain components of the equipment summarily described above will now be redescribed in greater detail with reference to FIGS. 2 to 5. First referring to FIG. 2, it will be seen that the shell 10 serving to effect the branch connection or tapping in chamber 9*a*, is formed with an upper opening 10*c* in its cylindrical side wall for connection with the branch line 11, through a suitable welded and/or flanged joint. The shell 10 has at least one further opening 10*a* formed in its side wall, four such openings being shown, and each surrounded by a welded-on flange 10*b* for the attachment of injector drill unit 13. As shown in FIG. 3 the injector drill unit comprises a cylindrical body or casing 13*b* having an end flange 13*a* adapted to be secured, e.g. bolted, over the flange 10*b* to provide a pressure-tight connection by way of an annular seal as shown. It will be understood that the flanges 10*b* of any openings 10*a* in the shell 10 that are not in use, are sealed with suitable covers not shown. The drill body 13*b* is formed with an axial through bore in which a drill shaft 22 is mounted for rotation in suitable bearings and by way of annular seals permits rotation of the shaft in a pressure-tight manner. The shaft 22 is driven in rotation from an electric motor 23 mounted beyond the outer end of drill casing 13 and drivingly connected with the outer end of shaft 22 through a connection not shown. A conventional axial feed device 25 provided with a handwheel is associated with the outer end of shaft 22. The inner end of shaft 22 projecting through the aperture 10*a* in shell 10 has formed or secured on it a drill tool or bit 24 of any suitable type, e.g. a diamond trepanning bit or the like. The drill tool 24 is formed with an axial recess 24*a* in alignment with an axial channel 22*a* formed through shaft 22 over part of the length of the shaft, the outer end of channel 22*a* being angled as at 22*b* so as to open outwardly of said shaft into a cylindrical groove 13*c* recessed in the drill housing around the shaft. The recess 13*c* corresponds in axial length with the axial displacement of drilling tool 24. Formed through a side wall of drill housing 13*b* is an inclined duct 21*a* which open into the recess 13*c* and is so positioned and angled as to register with the angled outer end portion 22*b* of channel 22*a* for a predetermined angular position of shaft 22 when said shaft is axially retracted as in FIG. 3. Duct 21*a* connects with a union projecting from the side of drill housing 13*b* and fitted with a flow-control valve 26, which union is adapted for connection with pipe 21 referred to earlier (see FIG. 1). Means are provided for blocking the drill shaft 22 in the particular angular position thereof for which the outer end of its channel 22*a* registers with the duct 21*a*, and said means include therein a tapered centering recess 22*c* formed in the outer surface of shaft 22 and a radial passage 13*d* formed through the side wall of housing 13*b*. When the center

recess 22*c* is positioned to register with passage 13*d*, a centering pin 27 can be inserted through passage 13*d* to engage into the recess 22*c*, whereupon the shaft 22 is blocked in the aforementioned position in which the ducts 22*b* and 21*a* register.

The injection pipe 21 and the associated flow passages provided in the drill unit described may serve a dual purpose. During the drilling operation, when motor 23 is energized to rotate the drill shaft 22 and bit 24 so as to form a hole through the well casing 3 as indicated at 14 in FIG. 3, a liquid coolant and lubricant may be delivered by way of pipe 21 (at such time connected to a suitable pressure source of coolant) into recess 13*c* and thence through duct 22*b*–22*a*–24*a* into the drilling zone to cool the drill bit. The main function of the injection arrangement described, however, is the subsequent injection of plugging material into the casing 3 as earlier described. After the hole 14 has been drilled in the well casing, rotation of drill shaft 22 is arrested and the drill shaft is retracted by means of the manual device 25 to the rearward position shown in FIG. 3 wherein the drill bit 24 is abutted against the end wall of drill body 13*b*, clearing the hole 14. The gas in well casing 3 now issues out through hole 14 into the annular space within shell 10, and out through hole 10*c* and branch pipe 11. After the well casing pipe has been sealed above the branch pipe connection in chambers 8*a* and 7*a* as described hereinabove, and cut-off valve 12 has been finally closed, the coolant delivery pipe is disconnected from the passage 21*a* of the drill unit 13, and pipe 21, connecting with a pressure source of plugging material, e.g. cement connected thereto instead. Drill shaft 22 is rotated to the position in which centering recess 22*c* registers with passage 13*d*, and centering pin 27 is inserted to block the shaft in that position. A continuous flow passage is now provided for the heavy plugging material through pipe 21 and passages 21*a*–22*b*–22*a*–24*a*–14 into the well casing 13 for sealing the well below the branch connection as already explained.

Referring now to FIGS. 4 and 5, each of the shells 17 and 18 used in the well-sealing operation in chambers 7*a* and 8*a* comprises as earlier indicated a shell in two parts welded to each other along their longitudinal edges and welded around the casing at their ends. On application of compression forces by means of the rams 15 and 16, the shell is deformed inwardly and the casing 3 is pinched, as indicated in dotted lines in FIG. 4 and in cross section in FIG. 5. During this operation the wall of casing pipe 3, generally made of relatively brittle carbon steel, will crack, especially at the edges 3*a*, 3*b* of the flattened section, and in the absence of the shells 17 and 18 of the invention, there would be considerable leakage, through such cracks and the pinching process would be ineffective. However, the shells 17 and 18 according to the invention are made of a tough, relatively ductile grade of steel and treated to present a high elongation characteristic. It is found that in this way the leakage from the pinched well casing section can be reduced to a negligible amount.

It will thus be seen that the steps of procedure and the appliances described provide the possibility of practically and efficiently controlling dangerous blowout situations in oil and gas wells, with much greater reliability and at less cost than the more or less empirical methods currently used. The improved process moreover avoids contaminating the bed of hydrocarbons being mined and permits of resuming the extracting operations promptly after the blowout has been dealt with, through the same well and with only a small amount of repair work. It will be evident that in view of the great variability of individual conditions that may be encountered, the practical details of embodiment of the method and means of the invention may depart in various ways from what has been illustrated and described herein while still remaining within the scope of the invention as defined in the appended claims.

What we claim is:

1. In a process for controlling high-pressure fluid discharge from metal-cased oil wells and the like, the steps of gaining access from a side of the well to a first point of the well casing below ground surface and at least one further point below ground surface spaced above the first point; connecting a branch line to the well casing at said first point to tap the fluid discharge therefrom; applying pressure to opposite sides of the well casing at said further point to deform the casing to a substantially flattened condition; and injecting plugging material into the casing from a side thereof above the flattened portion.

2. In a process for controlling high-pressure fluid discharge from metal-cased oil wells and the like, the steps of gaining access from a side of the well to a first point of the well casing below ground surface and at least one further point below ground surface spaced above the first point; connecting a branch line having valve means therein to the well casing at said first point to tap the fluid discharge therefrom; applying pressure to opposite sides of the well casing at said further point to flatten the casing thereat; injecting plugging material into the casing from a side thereof adjacent said further point above said flattened portion; operating said valve means to cut off the flow of fluid through the branch line; and injecting plugging material into the casing from a side thereof adjacent said first point below said branch line connection.

3. In a process for controlling blowout from a metal-cased well, the steps of gaining access from a side of the well to a first point of the well casing below ground level and at least one further point below ground level above the first point; connecting a branch line to the well casing at said first point to tap the blowout fluid therefrom; sealingly surrounding the well casing at said further point with a shell made from a material having tough, ductile characteristics and applying pressure to opposite sides of said shell to flatten the shell and well casing to seal the well at said further point.

4. In a process for controlling blowout from a metal-cased well, the steps of gaining access from a side of the well to a first point of the well below ground level and at least one further point below ground level spaced above the first point; sealingly surrounding the well casing at said first point with a shell having a branch line extending therefrom and dimensioned to define a sealed annular space between said well casing and shell; drilling a hole in said well casing withing said shell from the exterior thereof to connect the interior of the casing through said space with said branch line and tap blowout fluid therefrom; and pinching the well casing to a flattened condition at said further point.

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