

Dec. 20, 1949

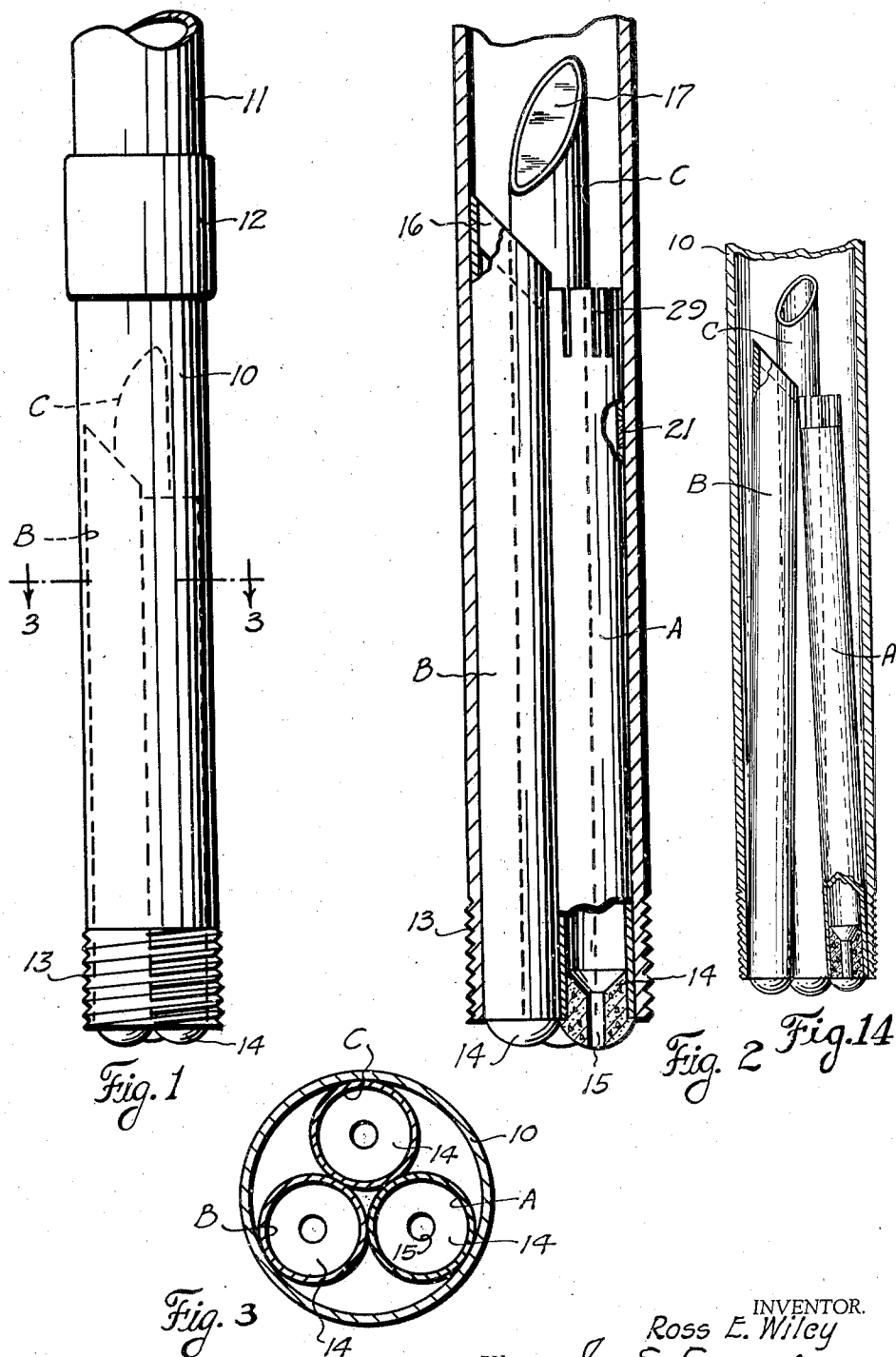
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2,492,079

APPARATUS FOR COMPLETING WELLS

Filed Dec. 9, 1943

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

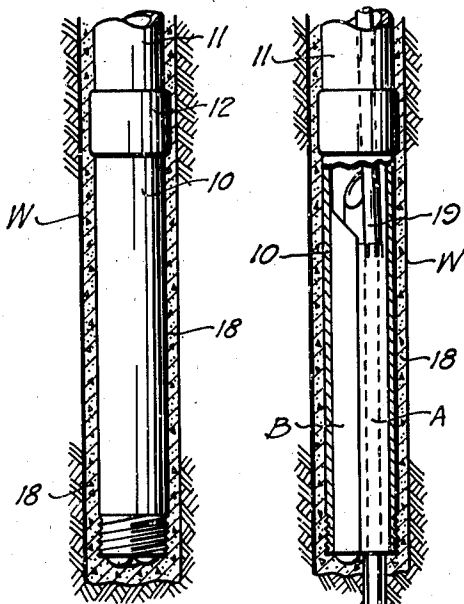


Fig. 4

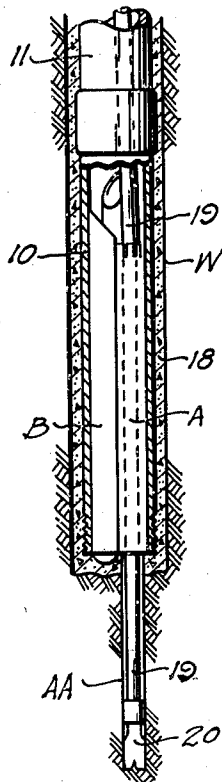


Fig. 5

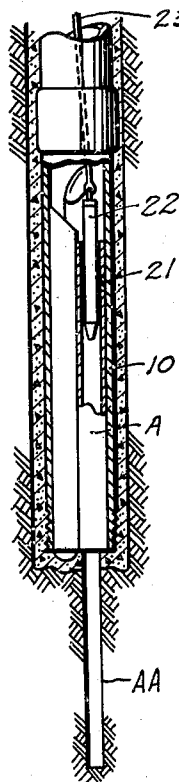


Fig. 6

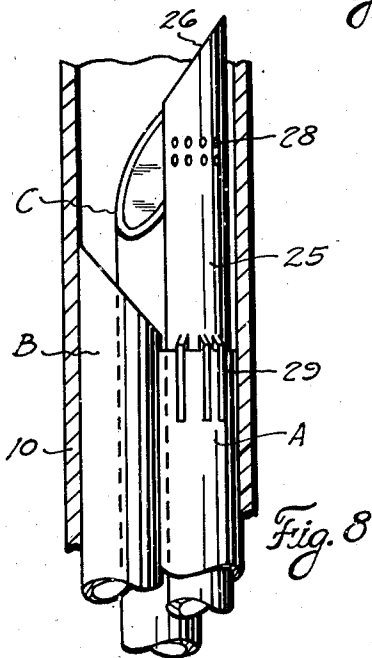


Fig. 8

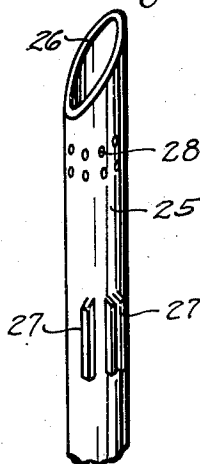


Fig. 9

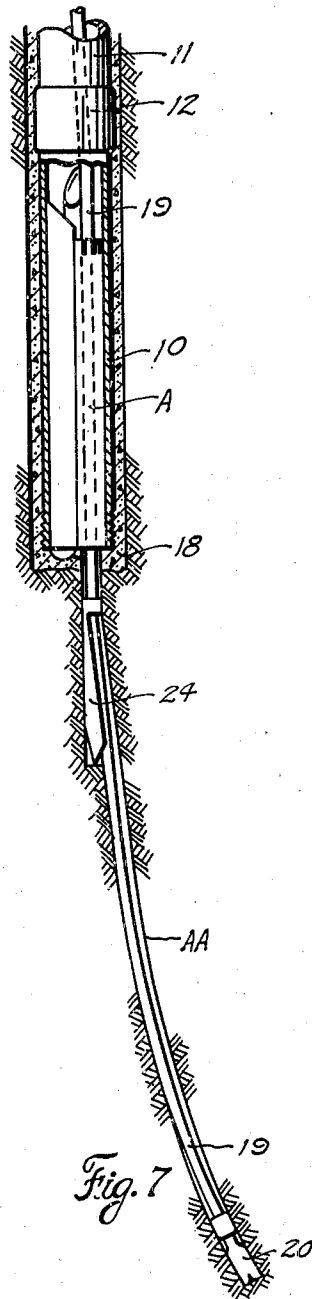


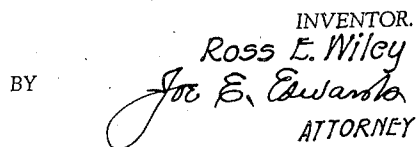
Fig. 7

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UNITED STATES PATENT OFFICE

2,492,079

APPARATUS FOR COMPLETING WELLS

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Application December 9, 1943, Serial No. 513,533

9 Claims. (Cl. 255—1.6)

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This invention relates to new and useful improvements in apparatus for completing wells.

In many instances, because of the particular disposition or the nature of the producing strata it is impossible to obtain maximum production from such strata without drilling a plurality of wells into said strata or formation. It is apparent that because of the expense involved it may not be practical from a financial standpoint to drill numerous wells to increase the production, particularly when the maximum production obtainable may be insufficient to warrant the cost of the additional wells.

It is therefore one object of this invention to provide an improved apparatus which permits completing a well by means of a plurality of laterals or radiating well bores which may be drilled outwardly from a single main well bore so that the oil producing strata may be tapped at a plurality of points or locations, while requiring only a single main well bore at the surface.

An important object of the invention is to provide an improved apparatus for well completion which makes possible the directional drilling of lateral well bores which radiate from the main well bore, that is, said lateral bores may be drilled at the desired angle and in a desired direction, whereby maximum production from the producing strata or formation is assured.

Another object of the invention is to provide an improved apparatus of the character described, which makes possible the drilling of a lateral, reduced well bore from the lower portion of a main well bore and directing it in a desired direction, and then drilling a plurality of additional reduced bores also extending from the lower portion of the main well bore and directed in desired directions, whereby the effect of drilling a plurality of separate wells into the formation is obtained and maximum production is had through a single main well bore.

A further object of the invention is to provide an improved apparatus for completing wells comprising a casing shoe joint having a plurality of guide sleeves or liners mounted therein, with means for successively guiding a drill bit and drill pipe through said liners whereby a plurality of reduced well bores may be drilled outwardly from the main well bore in which the joint is disposed.

Still another object of the invention is to provide an improved apparatus, of the character described, wherein the upper ends of said guide sleeves or liners are disposed in offset planes, with the lowermost liner being open and the re-

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maining liners having their upper ends closed with a drillable material and constructed so as to direct a drill bit lowered through the apparatus into the lowermost liner; the liners being arranged to receive tubular guide members, whereby as each auxiliary bore is completed through a liner, such liner receives a guide member to subsequently direct the drill bit to one of the other liners.

A particular object of the invention is to provide an improved apparatus, of the character described, wherein the guide sleeves or liners may be disposed parallel to the vertical axis of the casing joint or may be inclined with respect thereto, whereby drilling in a predetermined direction with relation to the main well bore may be carried out.

A construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specifications and by reference to the accompanying drawings, wherein;

Figure 1 is an elevation of a casing joint, constructed in accordance with the invention and used in practicing the improved method,

Figure 2 is a vertical, sectional view of the same,

Figure 3 is an enlarged horizontal, cross-sectional view, taken on the line 3—3 of Figure 1,

Figure 4 is an elevation of the casing joint mounted within a well bore,

Figure 5 is a view, partly in section and partly in elevation and illustrating a drill stem extending downwardly through the first guide liner which is the first step of the method,

Figure 6 is a similar view, showing a survey instrument lowered into the guide liner to determine the direction of said liner with respect to the axis of the main well bore,

Figure 7 is a view similar to Figures 5 and 6, showing the completion of the first auxiliary well bore,

Figure 8 is an enlarged partial elevation of the central portion of the joint and illustrating a guide member or extension mounted in the first guide liner,

Figure 9 is an isometric view of the guide member,

Figure 10 is a view, similar to Figure 7, showing the completion of the second auxiliary bore through the second guide liner.

Figure 11 is a view, similar to Figure 8, and illustrating the mounting of a guide member or extension in the second guide liner.

Figure 12 is an isometric view of the upper portion of the guide member shown in Figure 11.

Figure 13 is a view, similar to Figures 7 and 10 showing completion of the third auxiliary well bore, and

Figure 14 is a reduced view, similar to Figure 1 and illustrating a modified form of the invention.

In the drawings numeral 10 designates a casing shoe joint which is constructed of an elongate cylindrical housing or pipe section. The upper end of the joint is adapted to be coupled to the usual well casing 11 by means of a coupling collar 12. The lower end of the joint is provided with external screw threads 13 whereby a regular casing shoe (not shown) may be mounted thereon.

A plurality of guide liners or tubes A, B and C are mounted and suitably fastened within the bore of the joint 10. Although three of these liners or tubes are illustrated in the drawings, it is pointed out that the number of tubes within the joint may be varied as desired. The lower ends of the three liners preferably terminate in the same plane as the lower end of the joint and each tube has a restricting plug 14 disposed within its lower end. Each plug is formed with an axial reduced bore 15 and the entire plug is constructed of a material which is readily drilled out so as to completely open the bore of the tube.

As pointed out the lower end of each liner extends to the lower end of the joint but the overall length of the liners vary, each liner being of a different length. As is clearly shown in Figure 3 the liner A which has an open upper end is of the shortest length and has its upper edge terminating below the upper edge of the liner B. The upper projecting end of the liner B is formed with an inclined or sloping edge and a plug 16 closes the normally open upper end of said liner B. This plug has its upper surface inclined in accordance with the inclination of the upper edge of said liner, whereby said plug provides an inclined surface which is directed toward the upper end of the first liner A.

The liner C extends upwardly above the liners A and B and has its upper edge inclined with such inclination being directed toward the second or intermediate liner B. A plug 17 similar to the plug 16, closes the open upper end of the liner C and provides an inclined surface which directs any objects striking the same toward the liner B. It is pointed out that both of the plugs 16 and 17 are constructed of a material which is readily drilled out by the usual drill bit.

From the foregoing it will be seen that a casing joint having a plurality of guide liners or tubes therein is provided. The joint is connected to the lower portion of the well casing 11 and is lowered to the bottom of the well bore by means of said casing. The various tubes A, B and C may be utilized to guide a drill bit downwardly into the formation below the well bore in which the joint is mounted. The liners have been illustrated as spaced equi-distant from each other within the joint and obviously a trio of well bores at three different points from the main well bore may be drilled by directing the drill bit through the various guide liners. The liners have been shown as extending vertically within the joint so that the axis of each liner is substantially parallel to the axis of the joint. However, if desired, the guide liners A, B and C may be disposed at desired inclinations from the true vertical axis of the joint (Figure 14) and with such an arrangement, the auxiliary well bores which would be subsequently

drilled through the liners would be disposed at a predetermined or desired angle with respect to the axis of the main well bore. The guide liners or tubes may be welded or fastened in any suitable manner in position within the bore of the joint.

In the operation of the apparatus, the joint 10 is lowered into the well bore W by means of the well casing 11 to which said joint is attached. The casing and shoe are then cemented within the lower portion of the well bore in the usual manner, the cement being indicated at 18 in Figures 4 to 7. If desired, a usual casing shoe (not shown) may be connected to the lower end of the joint prior to lowering of the same into the bore. As explained, the upper liner C and the intermediate liner B have their upper ends closed by the inclined plugs 16 and 17 while the upper end of the lowermost liner A is open. A drill stem or pipe 19 having a drill bit 20 secured to its lower end is then lowered axially from the surface through the well casing 11. The bit and pipe is of a diameter which is smaller than the bore of the liner A whereby said bit and pipe may be guided downwardly through said liner.

As the drill bit 20 and pipe 19 are lowered through the casing the bit will strike the inclined upper end of the uppermost liner or tube C and the inclined plug 17 which closes the upper end of this liner will urge the bit downwardly toward the upper inclined end of the intermediate liner B. Upon striking the inclined plug 16 of the intermediate liner, the bit 20 will be directed into the open upper end of the lowermost liner or tube A and will be guided downwardly through this latter liner. The bit is utilized to drill out the restricting collar or plug 14 at the lower end of the liner A whereby said bit may then enter the formation below the main well bore W. By imparting rotation to the drill pipe 19, the drill bit 20 will form a reduced auxiliary bore AA which extends from the lower end of the main well bore. Drilling of this auxiliary or reduced bore is continued for a short distance below the main well bore as is clearly shown in Figures 5 and 6, and after this portion of the bore is complete the drill pipe 19 and the drill bit 20 are withdrawn from said bore and from the casing.

It is apparent that when the joint is lowered into the main well bore the particular disposition of the various liners, that is their direction with respect to the magnetic north is not known. In order to direct the auxiliary or reduced well bore AA into a desired direction it is obvious that it is first necessary to determine the location of the guide liner or tube A. For this purpose a strong magnet 21 (Figures 2 and 6) is mounted in the wall of the liner A nearer the upper portion thereof. This magnet is located within the liner or tube at the point that said liner engages the wall of the housing 10 of the joint and said magnet is arranged to cooperate with a suitable survey instrument 22 which may be lowered adjacent the magnet on a wire line 23. The particular construction of the instrument 22 is not important to the present invention and any of the well known instruments now in general use for orienting purposes may be employed. As an example, a photographic well survey instrument such as is illustrated in the patent to Hyer 2,120,670 or one such as is shown in the patent to Miller 2,327,658 may be employed. So long as the instrument is capable of making a record whereby the position of the magnet, that is, its direction with respect to "north" may be ascer-

tained, the purpose of the present invention will be carried out.

After removal of the drill stem 19 the well survey instrument 22 is run into the casing and is guided downwardly by the inclined plugs 17 and 16 of the liners C and B respectively into the open upper end of the lowermost liner A and opposite the magnet. The instrument 22 is then actuated through its usual timing mechanism and is then withdrawn so that its record may be interpreted to provide the operator with information as to the location of the liner A with respect to "north." After this information is obtained the position of the bore AA is known. It is noted that if desired the position of the liner A may be determined prior to the drilling of bore AA so as to locate it in a desired direction.

After the position of the bore AA is ascertained, the drill stem 19 is again run into the casing and whipstock 24 is connected to the lower end of the drill stem adjacent the bit 20. It is preferable to employ the type of whipstock shown in the McVicar Patent 1,970,761, in which the whipstock is attached to the drill stem by means of a shear pin which secures the collar of the whipstock to said stem.

Manifestly, the whipstock 24 is lowered into the reduced or auxiliary well bore AA and is set in a proper position therein so that upon subsequent drilling the bit 20 will be deflected into a desired direction. The whipstock may be set in position in any desired manner and as above mentioned, the particular whipstock which is illustrated is similar to that disclosed in the McVicar patent. The whipstock is provided with a collar at its upper end and the drill pipe extends through said collar with the drill bit of a larger diameter and disposed below the collar. A shear pin normally connects the whipstock collar and drill pipe whereby the pipe may be utilized to lower the whipstock and also to rotate said whipstock into proper oriented position. After the whipstock is located in a desired position, the weight of the drill pipe is imposed upon the connecting pin to shear the same and disconnect the drill pipe and bit from the whipstock, whereby said pipe and bit may be moved downwardly and rotated with respect to the whipstock to perform a drilling operation. The inclined face of the whipstock will of course guide and direct the drill bit outwardly into the formation in the usual manner. After proper setting of the whipstock the reduced or auxiliary well bore AA may be completed in a desired direction and to a desired depth. When the drill stem 19 is withdrawn, the collar in the top of the drill bit will co-act with the whipstock to remove said whipstock from the well bore along with the drill stem and bit. Thus, the auxiliary well bore AA is completed, the drill stem having been guided through the lowermost guide liner or tube A.

After completion of the first auxiliary well bore, a tubular guide member or extension 25 is lowered through the well casing by means of a suitable lowering tool (not shown). The outside diameter of the extension 25 is slightly less than the diameter of the bore of the liner A whereby the extension has a sliding fit within said liner. The upper end of the extension has an inclined edge 26 and a plurality of radially extending keys or ribs 27 are secured to the exterior surface of the extension at a point spaced from the upper end thereof. The extension also has a plurality of perforations or open-

ings 28 for permitting a flow from the interior to the exterior of said extension.

When the extension is lowered through the casing said extension is guided into the lowermost liner A and its keys 27 are arranged to co-act with narrowed slots or recesses 29 which are formed in the upper end of the liner and which extend downwardly from the upper edge thereof. The keys are aligned with the slots by lowering the extension until the lower ends of said keys strike the upper edge of the liner and then rotating the extension until said keys align with and drop into said slots. When the keys 27 are seated within the recesses 29 the extension is supported within the liner A and the upper end of said extension extends upwardly above the uppermost liner C, as is clearly shown in Figure 8.

After the extension 25 is in position, a drilling operation may be carried out through the second or intermediate liner B. The drill stem 19 having the drill bit 20 secured to its lower end is lowered through the casing 11 and obviously the bit will strike the inclined upper edge of the extension 25, which will guide said bit into contact with the inclined plug 17 at the upper end of the uppermost liner C. The reduced size of the bore of the extension prevents the bit from entering said extension. From the plug 17, the bit will be directed into contact with the plug 16 which closes the upper end of the intermediate liner B. The rotation of the drill stem will cause the bit 20 to drill out the plug 16 whereby said bit and drill stem may pass downwardly through the intermediate liner B. As the drill stem and bit are lowered into contact with the formation below the main well bore, a second auxiliary or reduced well bore BB may be drilled beneath the liner B. This auxiliary bore is first drilled for a short distance as was the case with the first bore AA after which the drill stem 19 and the bit 20 are withdrawn. The whipstock 24 is then connected to the drill stem and is lowered and set in position within the reduced bore, as is clearly shown in Figure 10. Subsequent disconnection of the whipstock from the drill stem and continued drilling will result in completion of the bore BB to a proper depth and in a desired direction. It is obvious that the well survey instrument 22 need not be run into the intermediate liner B because the direction or location of this liner can be ascertained after the first liner A has been located. Upon completion of the bore BB the drill stem 19 and bit 20 together with the whipstock 24 are withdrawn.

In order to properly guide the drill stem into the third or uppermost liner C after completion of the auxiliary bores AA and BB, a second guide member or extension 30 is adapted to be lowered through the well casing and into position within the intermediate liner B. The extension 30 is constructed of a tubular section which has a sliding fit within the liner B. The upper edge of the extension 30 is inclined as indicated at 31 and a plurality of flow openings or ports 32 extend through the wall of the extension. A supporting collar 33 surrounds and is secured to the extension 30 and the lower edge of this collar is inclined at 34, such inclination being complementary to the inclination of the upper edge of the intermediate liner B (Figure 11).

The guide extension 30 is lowered through the casing and upon entering the joint strikes the upper end 26 of the extension 25 and is guided into contact with the inclined plug 17 of the liner C; from this point said extension is directed into

the intermediate liner B. The extension telescopes the liner B and is supported by the edge 34 of the collar 33 seating upon the upper inclined edge of the said liner. When the extension 30 is supported in position, the inclined upper edge 31 of said extension is disposed between the upper edge 26 of the extension 25 and the inclined plug 17 of the third or uppermost liner C. The inclined edge 31 of the extension 30 is disposed so as to direct any tools striking said edge into contact with the plug 17, as is clearly shown in Figure 11.

After the extension 30 has been properly placed, the drill stem 19 with the bit 20 on its lower end is run into the well casing and the bit will first strike the upper inclined end of the extension 25 which will urge the bit into contact with the inclined upper end 31 of the extension 30. Since the bore of the extension will not permit entry of the bit, said bit will be guided into engagement with the plug 17 of the liner C and subsequent rotation of the drill stem will drill out the plug 17 which closes the upper end of the liner C. The bit then moves downwardly through the guide liner C and the plug 14 restricting the lower end thereof is removed so that the bit may enter the formation below said liner to drill the third auxiliary bore CC.

The bore CC is drilled in the same manner as the first two bores, that is, a portion of said bore is formed after which the drill stem 19 and bit 20 is removed from the well casing. A whipstock is then attached to the drill stem and is run back into the bore and set in the proper position whereby subsequent drilling will complete the bore CC to a desired depth and in a desired direction. After completion the drill stem and bit are removed.

From the foregoing, it will be seen that three separate and distinct auxiliary well bores which diverge outwardly from the lower end of the main well bore are drilled. Each auxiliary bore is curved or directed in a desired direction and such direction may vary to any extent. Although only a single whipstock setting has been shown and described it is apparent that more than one whipstock could be set within each auxiliary bore so that any desired angle and direction can be attained. The provision of the three auxiliary or reduced bores AA, BB and CC provide three separate and distinct channels through which production may be obtained. Manifestly, production from a formation may be had from several spaced points within the formation and such production will be through a single main bore. In this way the expense of drilling a plurality of wells into a single formation to obtain maximum production is eliminated.

As has been previously stated, three guide liners or tubes are shown in the joint 10 and these are disposed with their axis substantially parallel to the axis of said joint. However, any desired number of guide liners within the limits of the area of the joint may be employed and also each liner may be disposed at any predetermined inclination with respect to the axis of the joint. It is obvious that if the liners are disposed at an angle the drilling of the auxiliary bore will follow the same general angle and in this manner the necessity of setting a whipstock may be obviated.

The provision of the guide members or extensions 25 and 30 makes it possible to direct the drill bit into the desired liner after the original auxiliary well bore is formed. The perforations pro-

vided in the extensions provide ports through which a flow upwardly from the auxiliary bores AA and BB may enter the interior of the main well casing 11.

What I claim and desire to secure by Letters Patent:

1. An apparatus for completing wells including, an elongate tubular body adapted to be connected to a well casing, a trio of tubular guide liners mounted within the body and extending longitudinally thereof, the liners being of different lengths and having their lower ends terminating in the same plane whereby their upper ends terminate in different planes, the upper ends of the two longer liners being inclined and closed by drillable plugs, whereby a drill bit lowered through the body is directed into the open upper end of the shortest liner, and an extension member insertable within the shortest liner and of such length as to extend above the longest liner, said extension member having an inclined upper end whereby when in position, a drill bit lowered through the body is directed from said extension member to the longest liner and from said liner to the intermediate liner to permit drilling out of the plug closing said intermediate liner.

2. An apparatus as set forth in claim 1, together with co-acting means on said extension member and on the liner for supporting said member in position within said liner.

3. An apparatus as set forth in claim 1, with a second extension member insertable within the intermediate liner after its plug is removed, said second extension member having an inclined upper end and co-acting with the first extension member to guide a drill bit into contact with the third or longest liner.

4. An apparatus for completing wells including, an elongate tubular body adapted to be connected to a well casing, a trio of tubular guide liners mounted within the body and extending longitudinally thereof, the liners being of different lengths and having their lower ends terminating in the same plane whereby their upper ends terminate in different planes, the upper ends of the two longer liners being inclined and closed by drillable plugs, whereby a drill bit lowered through the body is directed into the open upper end of the shortest liner, an extension member insertable within the shortest liner and of such length as to extend above the longest liner, said member having an inclined upper end whereby when in position, a drill bit lowered through the body is directed from said member to the longest liner and from said liner to the intermediate liner to permit drilling out of the plug closing said intermediate liner, a second extension member insertable within the intermediate liner after its plug is removed, said second member having an inclined upper end and co-acting with the first extension member to guide a drill bit into contact with the third or longest liner, and co-acting means on each extension member and its respective liner for supporting said members in proper position.

5. An apparatus as set forth in claim 4, wherein each of the extension members is formed with a plurality of flow ports in that portion which projects upwardly from the liner.

6. An apparatus for completing wells including an elongate tubular body, a plurality of tubular guide liners mounted longitudinally within the body, said liners being of different lengths with their lower ends disposed in the same plane whereby their upper ends are in different planes

and at least one of said liners having its upper edge inclined to deflect objects striking said edge downwardly and away from said edge to direct such object into the bore of an adjacent liner.

7. An apparatus as set forth in claim 6, together with an extension member arranged to be inserted within one of the liners for extending the effective length of said liner.

8. An apparatus for completing wells including, an elongate tubular body adapted to be connected to a well casing, at least a pair of tubular guide liners mounted within the body and extending longitudinally thereof, said liners being of different lengths with their lower ends terminating in the same plane whereby their upper ends terminate in different planes, and an extension member adapted to be connected with the liner having the least length for extending the effective upper end of said liner beyond the other or other liners within said body.

9. An apparatus as set forth in claim 8, wherein the upper edge of the extension member is

inclined to deflect a drill bit striking said edge downwardly and away from said extension.

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