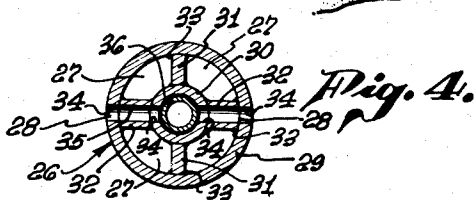
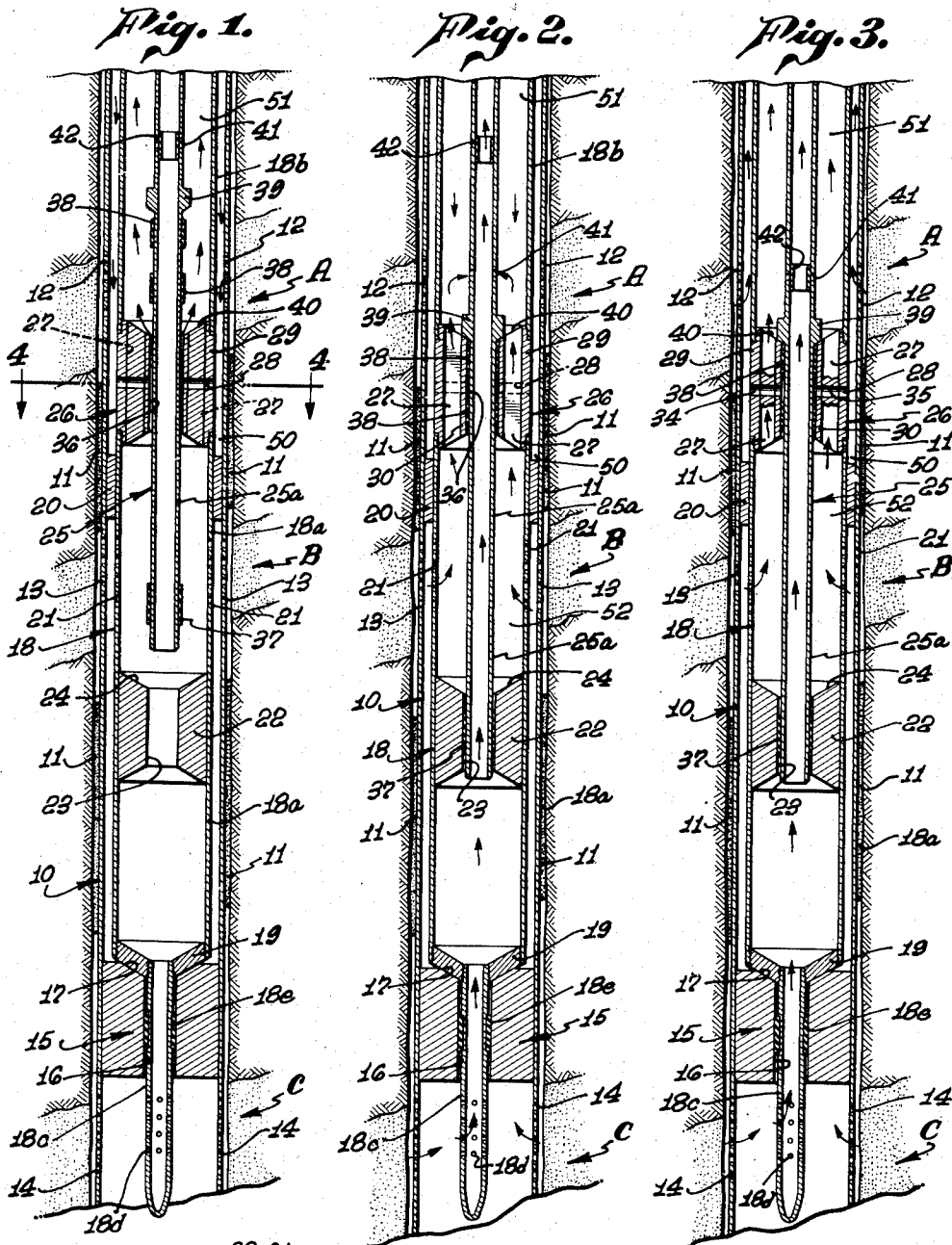


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METHOD AND APPARATUS FOR COMPLETING
MULTIPLE PRODUCTION ZONE WELL BORES
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METHOD AND APPARATUS FOR COMPLETING MULTIPLE PRODUCTION ZONE WELL BORES

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The present invention relates to the completion of well bores having a plurality of producing zones, and the conducting of the production from such producing zones to the tops of the well bores.

In view of conditions encountered in certain areas, the cost of completing and producing a well bore having a plurality of oil and/or gas producing zones has been exorbitant. A triple zone completion ordinarily involves the running and utilization of three separate tubular strings, one within the other. Heretofore, the outermost casing string was run and secured in place. This casing string contained perforated areas opposite each of the three producing horizons. The intermediate casing string, with two longitudinally spaced packers thereon, was then run in the outermost casing string. The packers were set in the outermost casing string between the three sets of perforations to isolate the respective productions from the three zones. Prior to setting of these packers, the uppermost producing zone was caused to flow, which necessitated the landing of the intermediate casing string and setting of the packers under pressure. This could only be done by the use of expensive surface control equipment. The two lower zones were then killed, as by pumping drilling mud into the intermediate casing string, and an innermost tubing string run in conjunction with a dividing packer that was set in the intermediate casing string to prevent comingling within the latter between the productions from the lower and intermediate zones.

The foregoing prior systems of completion were not only expensive, but they also entail hazards incident to completing wells under high pressure conditions.

Accordingly, an object of the present invention is to reduce substantially the cost of making multiple zone well completions.

A further object of the invention is to minimize the hazards attending the making of multiple zone well completions.

Another object of the invention is to eliminate the necessity for running a tubular string under pressure in making multiple zone, and particularly triple zone, well completions.

Still another object of the inventions is to complete a multiple zone well bore by installing all essential equipment in the well bore before any of the zones is conditioned for flowing.

Yet a further object of the invention is to provide an improved arrangement for producing three zones in a well bore independently of each other.

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This invention possesses many other advantages and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. A form of apparatus, and method of completion and production, are shown in the drawings accompanying and forming part of the present specification, which will now be described in detail, for the purpose of illustrating the general principles of the invention. It is to be understood, however, that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a somewhat diagrammatic longitudinal section through a multiple zone production apparatus located in a well bore, with the parts arranged for conditioning the upper zone;

Fig. 2 is a view similar to Fig. 1, with the parts arranged for conditioning the intermediate and lower zones;

Fig. 3 is a view similar to Fig. 1, with the parts arranged for producing each of the three zones independently of one another; and

Fig. 4 is a cross-section taken along the line 4—4 on Fig. 1.

As disclosed in the drawings, a well bore has longitudinally spaced upper, intermediate and lower producing zones A, B, C from which oil and/or gas, as the case may be, are to be conducted individually to the top of the hole. An outermost casing string 10 is run in the well bore and is cemented in place, as by depositing cement 11 around the casing string between the producing zones A and B and B and C, in a known manner. The cement sheath thus formed separates the zones and prevents comingling of their production by flowing along the exterior of the outermost casing string 10.

The casing string is provided with three sets of perforations 12, 13, 14, the upper set of perforations 12 being disposed opposite the upper zone A, the intermediate set 13 opposite the intermediate zone B, and the lower set 14 opposite the lower producing zone C. A tubular plug or production packer 15 of a known type may then be run in the outermost casing string 10 and anchored in packed-off condition within this casing between the intermediate and lower sets of perforations 13, 14. The particular tubular plug or packer employed has a central cylindrical passage 16 therethrough terminating in an upper tapered seat 17.

An intermediate casing string 18 is then run in the well bore. This intermediate casing string

includes a lower head 19 adapted to rest upon the tapered seat 17 in the tubular plug 15. When the head engages the seat, a tubular extension 13c, fixed to the head 19, extends downwardly through the plug 15. This extension has perforations 13d through which production from the lower zone C may flow. Leakage between the extension and wall of the passage 15 is prevented by a suitable side seal 13e on the extension. The intermediate string also carries a suitable packer or hanger 20, such as a hook wall packer, adapted to form an annular seal between the intermediate and outermost tubular strings 13, 10 above the intermediate perforations 13. This packer 20 is disposed above a set of perforations 21 in the intermediate string communicating with the intermediate set of perforations 13 in the outermost casing string 10 when the head 19 engages its companion seat 17.

The intermediate casing string 13 also contains a tubular plug 22 suitably secured thereto between the perforations 21 and the head 19. This plug has a central cylindrical passage 23 there-through, terminating in an upper tapered portion 24, in order to cooperate with an innermost tubular string 25, to be referred to hereinafter.

Above the location of the hook wall or set-down packer 20, the lower portion 13a of the intermediate casing string 13 is suitably attached, as by threading, onto the lower end of a production member or collar 26. The upper end of this collar is suitably secured to the upper portion 18b of the intermediate casing string, which extends to the top of the well bore.

The production member or collar 26 is designed to permit flow of fluid from the upper zone A to the interior of the intermediate casing string 13 under certain operating conditions, and also to permit flow of production from the intermediate zone B through the intermediate sets of perforations 13, 21 to a point in the intermediate string above the production collar 26. To enable these purposes to be accomplished, the production member is formed with longitudinal passages 27 extending therethrough, and also with lateral passages or ports 28 extending between its interior and exterior.

As specifically shown in the drawings, the production member includes a cylindrical outer member 29 and a cylindrical inner member 30 spaced from each other. These members are held in spaced relation by a plurality of longitudinally extending radial ribs 31, 32 that are suitably secured, as by welding material 33, to the members, as most clearly shown in Fig. 4. The members 29, 30 are provided with aligned radial ports 34, which communicate with ports 35 in the ribs 32, thus forming the lateral ports 28 between the exterior of the production member 26 and its central passage 36 contained within the inner cylindrical portion 30 of this member. The lateral ports 28 are preferably disposed intermediate the ends of the inner members 30 so as to allow uninterrupted sealing surfaces on the inner member on both sides of the ports for engagement by suitable sealing elements later to be described.

It is apparent that the construction of the production member or collar 26 provides spaced ribs 31, 32 forming arcuate longitudinal passages 27 extending completely through the member, and also lateral ports 28 extending between the interior and exterior of the collar.

The innermost tubular string 25 is composed

of sections of tubing containing a lower portion 25a of smaller external diameter than the internal diameter of the inner ported cylinder 30. The lower end of this section 25a carries one or more suitable sealing elements 37, which may be in the form of chevron packing, adapted to engage the wall of the passage 23 through the tubular plug 22 and prevent fluid from flowing through the plug 22 around the exterior of the tubing string 25a. The lower portion 25a of the tubular string also carries spaced sealing members 38, 39, which can be constituted by suitable packing rings of the chevron type, adapted to make sealing engagement with the inner wall of the inner cylindrical member 30 of the production collar 26. These spaced sealing elements 38, 39 are disposable on opposite sides of the lateral ports 28 when a locating head 39 on the tubing string 25 engages the tapered upper end or seat 40 of the production collar. When such engagement takes place, the lower sealing member 37 is disposed within the central passage 23 through the tubular plug 22.

Above the locating head 39, the tubing string 25 is provided with a side door choke device, of known design, which has a plurality of radial ports 41 that can be closed by a shiftable sleeve valve element 42. This sleeve valve member 42 is either disposed across the ports 41, to close them, or it may be moved upwardly above the ports 41, to open them.

As stated above, the outermost casing string 10 is run in the well bore and is cemented in place with its upper, intermediate and lower sets of perforations 12, 13, 14 disposed opposite the corresponding production zones A, B, C. The packer 15 is then set in this casing string between the lower and intermediate perforations 14, 13, and the intermediate casing string 13 run in the well bore, with its hook wall packer 20 in retracted position. This packer 20 is suitably manipulated, in a known manner, to bridge the annulus 50 between the outermost and intermediate casing strings 10, 13, to engage the lower head 19 with the tapered seat 17 of the tubular plug 15. With the parts in this position, the depending perforated pipe or tubing 13c, secured to the head 19 extends below the tubular packer 15, with its sealing member 13e closing the clearance space between the tubing 13c and packer 15.

When the intermediate casing 13 is located in this manner, the perforations 21 through the intermediate casing string are located opposite, or in communication with, the intermediate set of perforations 13 in the outermost casing string 10. The hook wall packer 20 has been set above the last-mentioned set of perforations and below the upper set of perforations 12. The tubing string 25 is then run in the well bore, usually with the sleeve valve 42 of the side door choke in closed position over the tubing ports 41.

During the running of all of the foregoing equipment in the well bore, the latter is ordinarily filled with drilling mud, or the like, which prevents the production from all of the zones A, B, C from flowing through the perforations 12, 13, 14 into the various casing strings. The tubing string 25 is then located in a position in which the spaced packing members 38 are disposed above the production collar 26, as shown in Fig. 1. With the parts in this position, the upper zone A can be brought in. This is usually

performed by unloading the well above this zone. One method of performing this action is to pump high pressure gas down the annulus 50 between the intermediate and outermost casing strings, the fluid being forced ahead of the gas down this annulus and through the lateral ports 28 in the collar 26 into the clearance space between the tubing string 25a and production collar cylinder 30. From this clearance space, the fluid flows to the top of the well bore through the annulus 51 between the intermediate casing string 18 and the tubing string 25.

When the annulus 50 between the outermost casing string 10 and intermediate casing string 18 has been thus unloaded, the upper zone A has been conditioned for flowing, since the hydrostatic head of the drilling mud in the annulus 50 has been removed. If desired, the annulus 51 between the intermediate casing string 18 and tubing string 25 may also be unloaded during this operation, assuming that sufficient gas pressure is available for this purpose. Ordinarily, however, this does not occur, since the gas pressure is employed for the purpose of unloading only the annulus 50 between the intermediate and outermost casing strings.

As soon as the outer annulus 50 has been unloaded, the tubing string 25 is lowered until its head 39 engages the seat 40 at the upper end of the production collar 26. In this manner, the spaced sealing members 38 are located on opposite sides of the lateral ports 28, closing these ports against the lateral flow of fluid, and preventing any production from the upper zone A from passing through the ports 28 to the interior of the intermediate casing string 18. At this time, the lower seal member 37 is disposed within the tubular plug 22, so as to prevent intercommunication between the intermediate zone B and lower zone C.

The sleeve valve element 42 of the side door choke is now elevated, in a known manner, to open the ports 41 (see Fig. 2), and the two lower zones B, C are brought into production, as by unloading the tubing string 25 and the intermediate casing string 18. This unloading action can take place as a result of swabbing the tubing 25, which will remove the drilling mud from the tubing string 25, and also from the intermediate string 18 as well. After the swabbing operation has been completed, the sleeve valve member 42 is again shifted to a position over the side ports 41 to prevent comingling between the fluid from the intermediate zone B and lower zone C (see Fig. 3).

The apparatus is now in condition for flowing the three zones independently of each other, as shown in Fig. 3. Thus, the production from the lower zone C can flow through the lower perforations 14, and through the perforated tubing 18c into the intermediate casing string 18, passing upwardly through the tubing string 25 to the top of the well bore.

The production from the intermediate zone B passes through the aligned sets of perforations 13, 21 in the outermost and intermediate casing strings 10, 18, into the annulus 52 between the tubing string 25 and intermediate casing string 18, flowing upwardly through this annulus and through the arcuate longitudinal passages 27 in the production collar 26 to a position above the latter, from where the intermediate zone production can continue flowing upwardly through the annulus 51 around the tubing string 25 to the top of the well bore.

The production from the upper zone A passes through the upper set of perforations 12 into the annulus 50 between the outermost and intermediate casing strings 10, 18, flowing upwardly therethrough to the top of the well bore.

Thus, it is apparent from an inspection of Fig. 3, that the production from each of the three zones pursues a separate path to the top of the well bore. The various plugs and packing members prevent their comingling in any particular.

By virtue of the apparatus and production method described above, it is apparent that all elements of the equipment, with the exception of the tubing string 25, are set in the well bore in cooperative relation before any of the producing zones is to be conditioned for flowing. After having been set in place, neither the outermost casing string 10 nor intermediate casing string 18, and the apparatus attached thereto, need be shifted. The unloading of the various annuli 50, 51 and tubing string 25 can occur through the simple expedient of shifting the tubing string 25 to either the position shown in Fig. 1, or the position shown in Figs. 2 and 3, and by appropriately manipulating the sleeve valve element 42 of the side door choke. Thus, the unloading of the annulus 50 of the heavy fluid acting upon the upper zone A can take place, and this zone then easily shut in merely by lowering the tubing string 25 and closing the connections for this annulus at the top of the well bore. Manipulation of the intermediate casing string 18 is not required thereafter, since this casing string has previously been set in packed-off condition within the outermost casing string 10. Opening of the side door choke 41, 42 enables the intermediate and lower zones B, C to be conditioned for flowing simply by running the usual tools, which are well known, on a wire line (not shown) to elevate the sleeve valve 42. After the swabbing operation has occurred, the sleeve valve 42 may be relocated across the ports 41.

As a result of the operations described above, special control heads at the top of the well bore are not needed to enable the well to be completed, as under pressure, since the only parts requiring manipulation are the tubing string 25 and the sleeve valve member 42 of the side door choke. The equipment at the well surface necessary for operation of these parts is comparatively inexpensive, and is usually found on multiple zone wells. Accordingly, the cost of the installation for completing the multiple zone well bore is substantially reduced, which is also true of the hazards attending the operation of equipment under high pressure conditions.

The inventor claims:

1. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, of said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and lower openings of said intermediate string for bridging the annular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular space between said outer and intermediate casing strings above said upper opening of said inter-

mediate string; said intermediate casing string having a port above said second plug means; a third plug means in said intermediate casing string between the upper and lower openings of said intermediate string, said third plug means having a passage therethrough; and a longitudinally movable tubular string within said intermediate string adapted to close said port and to engage said third plug means in leakproof relation when said port is closed to prevent flow of fluid through the passage of the third plug means and around the exterior of the tubular string, said tubular string having a lower opening communicating with the lower opening of said intermediate casing string.

2. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, of said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and lower openings of said intermediate string for bridging the annular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular space between said outer and intermediate casing strings above said upper opening of said intermediate string; said intermediate casing string having a port above said second plug means; and means including a longitudinally movable tubular string within said intermediate string adapted to close said port and having a lower opening for the entry of fluid flowing through the lower openings in said outer and intermediate casing strings.

3. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, of said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and lower openings of said intermediate string for bridging the annular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular space between said outer and intermediate casing strings above said upper opening of said intermediate string; said intermediate casing string having a port above said second plug means; and means including a tubular string within said intermediate string adapted to close said port and having a lower opening for the entry of fluid flowing through said lower openings in said outer and intermediate casing strings.

4. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, of said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and lower openings

of said intermediate string for bridging the annular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular space between said outer and intermediate casing strings above said upper opening of said intermediate string; a third plug means in said intermediate string above said upper opening in said intermediate string and having a central passage therethrough, said third plug means having a port above said second plug means establishing communication between the interior and exterior of said intermediate casing string, and said third plug means having a longitudinal passage disposed to one side of said central passage and extending throughout the length of said third plug means; and means including a tubular string within said intermediate string and extending through said central passage for selectively closing or opening said port and for conducting fluid flowing through said lower openings of said outer and intermediate casing strings, said tubular string having a lower opening communicating with the lower opening of said intermediate casing string.

5. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, of said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and lower openings of said intermediate string for bridging the annular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular space between said outer and intermediate casing strings above said upper opening of said intermediate string; a third plug means in said intermediate string above said upper opening in said intermediate string and having a central passage therethrough, said third plug means having a port above said second plug means opening into said central passage and the exterior of said intermediate casing string, and said third plug means having a longitudinal passage disposed to one side of said central passage and extending throughout the length of said third plug means; and means including a longitudinally movable tubular string within said intermediate string and extending through said central passage for selectively opening or closing said port and for conducting fluid flowing through said lower openings of said outer and intermediate casing strings, said tubular string having a lower opening communicating with the lower opening of said intermediate casing string.

6. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, of said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and lower openings of said intermediate string for bridging the an-

nular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular space between said outer and intermediate casing strings above said upper opening of said intermediate string; said intermediate casing string having a port above said second plug means establishing communication between the interior and exterior of said intermediate casing string; a third plug means in said intermediate casing string between the upper and lower openings of said intermediate string, said third plug means having a passage therethrough; a longitudinally movable tubular string within said intermediate string adapted to close said port and to engage said third plug means in leakproof relation when said port is closed to prevent flow of fluid through the passage of the third plug means and around the exterior of the tubular string, said tubular string having a lower opening communicating with the lower opening of said intermediate casing string, said tubular string having a port above said intermediate string port; and sleeve valve means within said tubular string adapted to be disposed over said tubular string port to close the same.

7. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, of said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and lower openings of said intermediate string for bridging the annular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular space between said outer and intermediate casing strings above said upper opening of said intermediate string; said intermediate casing string having a port above said second plug means establishing communication between the interior and exterior of said intermediate casing string; means including a tubular string within said intermediate string adapted to close said port and having a lower opening for the entry of fluid flowing through said lower openings in said intermediate and outer casing strings, said tubular string having a port above said intermediate string port; and sleeve valve means within said tubular string adapted to be disposed over said tubular string port to close the same.

8. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, of said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and lower openings of said intermediate string for bridging the annular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular

space between said outer and intermediate casing strings above said upper opening of said intermediate string; a third plug means in said intermediate string above said upper opening in said intermediate string and having a central passage therethrough, said third plug means having a port above said second plug means establishing communication between the interior and exterior of said intermediate casing string, and said third plug means having a longitudinal passage disposed to one side of said central passage and extending throughout the length of said third plug means; means including a tubular string within said intermediate string and extending through said central passage for selectively closing or opening said port and for conducting fluid flowing through said lower openings of said outer and intermediate casing strings, said tubular string having a lower opening communicating with the lower opening of said intermediate casing string, said tubular string having a port above said intermediate string port; and sleeve valve means within said tubular string adapted to be disposed over said tubular string port to close the same.

9. In the method of completing a well bore having upper, intermediate and lower producing zones: locating an outer casing string in said well bore with upper, intermediate and lower openings communicating with the upper, intermediate and lower producing zones, respectively; placing a plug with a longitudinal passage therethrough in said outer casing string between said intermediate and lower openings; locating an intermediate casing string in said outer casing string in leakproof relation to said plug, said intermediate casing string having an opening communicating with said intermediate opening in said outer string; providing a leakproof annular bridge between said casing strings which is disposed between said upper and intermediate outer casing string openings; providing a lateral opening between the interior of said intermediate string and the annulus around said intermediate string above said annular bridge; unloading fluid from said annulus above said bridge by forcing fluid through said lateral opening; closing said lateral opening; and then unloading fluid from said intermediate casing string.

10. In the method of completing a well bore having upper, intermediate and lower producing zones: locating an outer casing string in said well bore with upper, intermediate and lower openings communicating with the upper, intermediate and lower producing zones, respectively; placing a plug with a longitudinal passage therethrough in said outer casing string between said intermediate and lower openings; locating an intermediate casing string in said outer casing string in leakproof relation to said plug, said intermediate casing string having an opening communicating with said intermediate opening in said outer string; providing a leakproof annular bridge between said casing strings which is disposed between said upper and intermediate outer casing string openings; providing a lateral opening between the interior of said intermediate string and the annulus around said intermediate string above said annular bridge; locating a tubular string within said intermediate string; shifting said tubular string to open said lateral opening and enable fluid in the annulus above said annular bridge to be unloaded through said lateral opening; shifting said tubular string to close said lateral opening; unloading the fluid in said inter-

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mediate string and tubular string; and causing well fluid to pass from said lower zone through said tubular string, from said intermediate zone through the annulus between said tubular and intermediate strings, and from said upper zone through the annulus between said intermediate and outer strings.

11. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, on said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and the lower openings of said intermediate string for bridging the annular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular space between said outer and intermediate casing strings above said upper opening of said intermediate string; a third plug means in said intermediate string above said upper opening in said intermediate string and having a central passage therethrough, said third plug means having a port above said second plug means establishing communication between the interior and exterior of said intermediate casing string, and said third plug means having a longitudinal passage disposed to one side of said central passage and extending throughout the length of said third plug means; means including a tubular string within said intermediate string and extending through said central passage for selectively opening or closing said port and for conducting fluid flowing through said lower openings of said outer and intermediate casing strings, said tubular string having a lower opening communicating with the lower opening of said intermediate casing string, said tubular string being imperforate along a portion extending through said central passage and being movable to port opening position to allow fluid flow from the exterior of said intermediate casing string, through said port, into the annular space above said third plug means between said tubular string and intermediate string.

12. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, of said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and lower openings of said intermediate string for bridging the annular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular space between said outer and intermediate casing strings above said upper opening of said intermediate string; a third plug means in said intermediate string above said upper opening in said intermediate string and having a central passage therethrough, said third plug means having a port above said second plug means opening into said central passage and the

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exterior of said intermediate casing string, and said third plug means having a longitudinal passage disposed to one side of said central passage and extending throughout the length of said third plug means; and means including a longitudinally movable tubular string within said intermediate string and extending through said central passage for selectively opening or closing said port and for conducting fluid flowing through said lower openings of said outer and intermediate casing strings, said tubular string having a lower opening communicating with the lower opening of said intermediate casing string, said tubular string being imperforate along a portion extending through said central passage and being movable longitudinally to port opening position to allow fluid flow from the exterior of said intermediate casing string, through said port, into said central passage and the annular space above said third plug means between said tubular string and intermediate casing string.

13. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, of said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and lower openings of said intermediate string for bridging the annular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular space between said outer and intermediate casing strings above said upper opening of said intermediate string; a third plug means in said intermediate string above said upper opening in said intermediate string and having a central passage therethrough, said third plug means having a port above said second plug means establishing communication between the interior and exterior of said intermediate casing string, and said third plug means having a longitudinal passage disposed to one side of said central passage and extending throughout the length of said third plug means; a fourth plug means in said intermediate casing string between the upper and lower openings of said intermediate string, said fourth plug means having a passage therethrough; and a longitudinally movable tubular string within said intermediate string and extending through said central passage for selectively closing or opening said port, said tubular string being engageable with said fourth plug means in leakproof relation when said port is closed to prevent flow of fluid through the passage of the fourth plug means and around the exterior of the tubular string, said tubular string having a lower opening communicating with the lower opening of said intermediate casing string.

14. In apparatus of the character described: an outer casing string having upper, intermediate and lower longitudinally spaced openings; an intermediate casing string within said outer string having upper and lower longitudinally spaced openings communicating with said intermediate and lower openings, respectively, of said outer string; a first plug means between the intermediate and lower openings of said outer string and between the upper and lower openings of said intermediate string for bridg-

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ing the annular space between said outer and intermediate casing strings; a second plug means between said upper and intermediate openings of said outer string and located above the upper opening of said intermediate string for bridging the annular space between said outer and intermediate casing strings above said upper opening of said intermediate string; a third plug means in said intermediate string above said upper opening in said intermediate string and having a central passage therethrough, said third plug means having a port above said second plug means establishing communication between the interior and exterior of said intermediate casing string, and said third plug means having a longitudinal passage disposed to one side of said central passage and extending throughout the length of said third plug means; a fourth plug means in said intermediate casing string between the upper and lower openings of said intermediate string, said fourth plug means having a passage therethrough; and a longitudinally movable tubular string within said intermediate string and extending through said central passage for selectively closing or opening said port, said tubular string being engageable with said fourth plug means in leakproof relation when said port is closed to prevent flow of fluid through the passage of the fourth plug

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means and around the exterior of the tubular string, said tubular string having a lower opening communicating with the lower opening of said intermediate casing string; said tubular string having a port above said intermediate string port; and sleeve valve means within said tubular string adapted to be disposed over said tubular string port to close the same.

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