

June 24, 1958

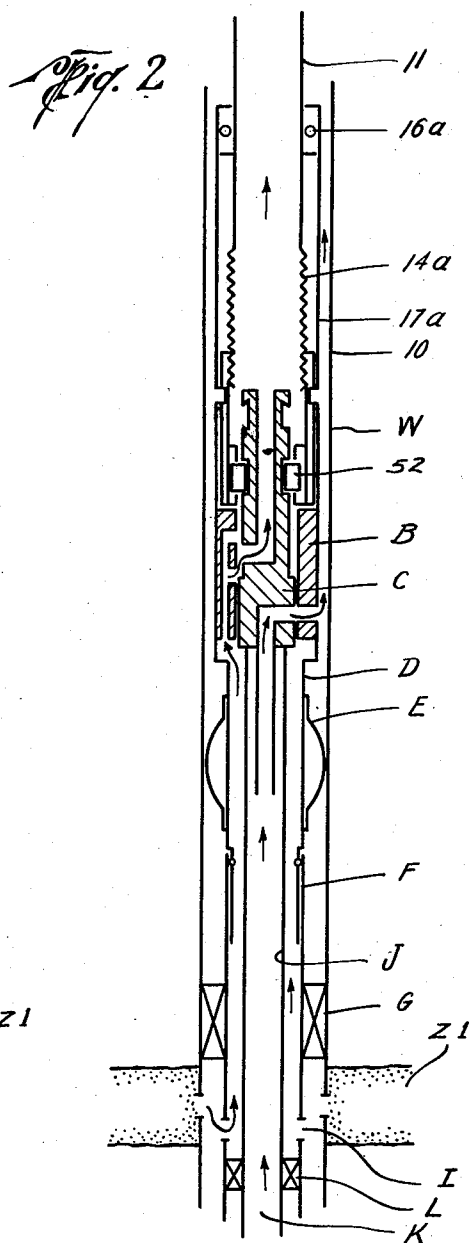
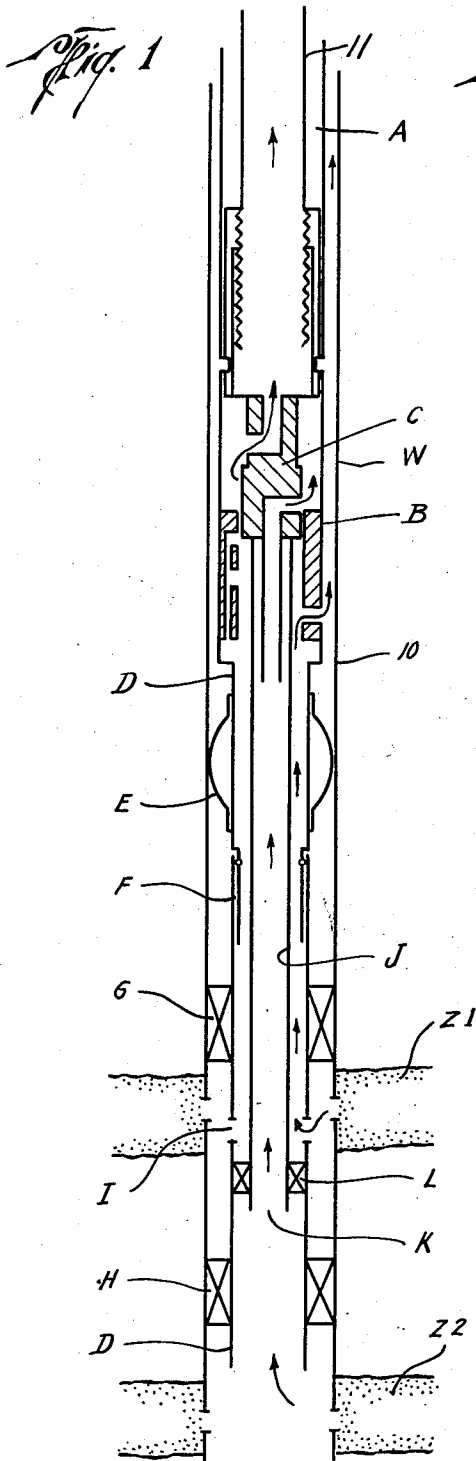
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2,840,167

CROSS-OVER WELL APPARATUS

Filed Aug. 10, 1953

9 Sheets-Sheet 1



Cicero C. Brown
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June 24, 1958

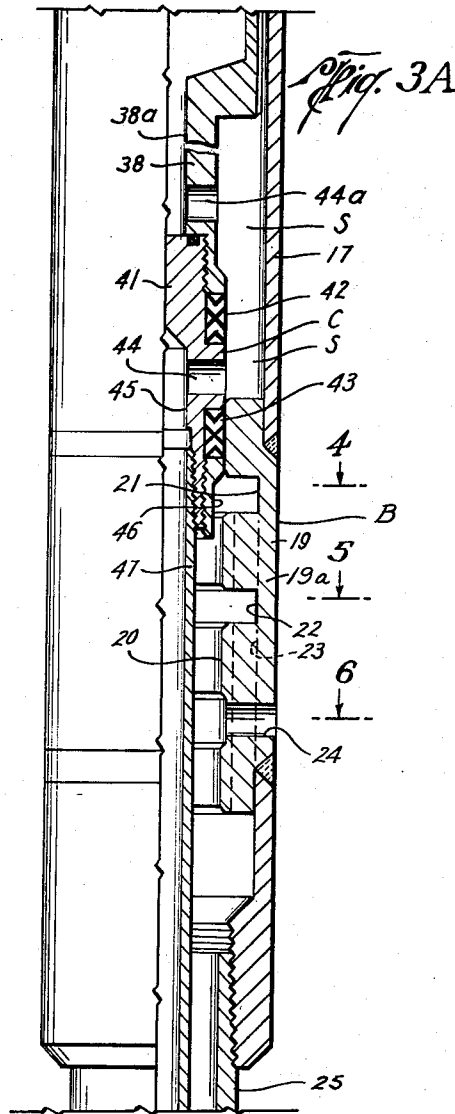
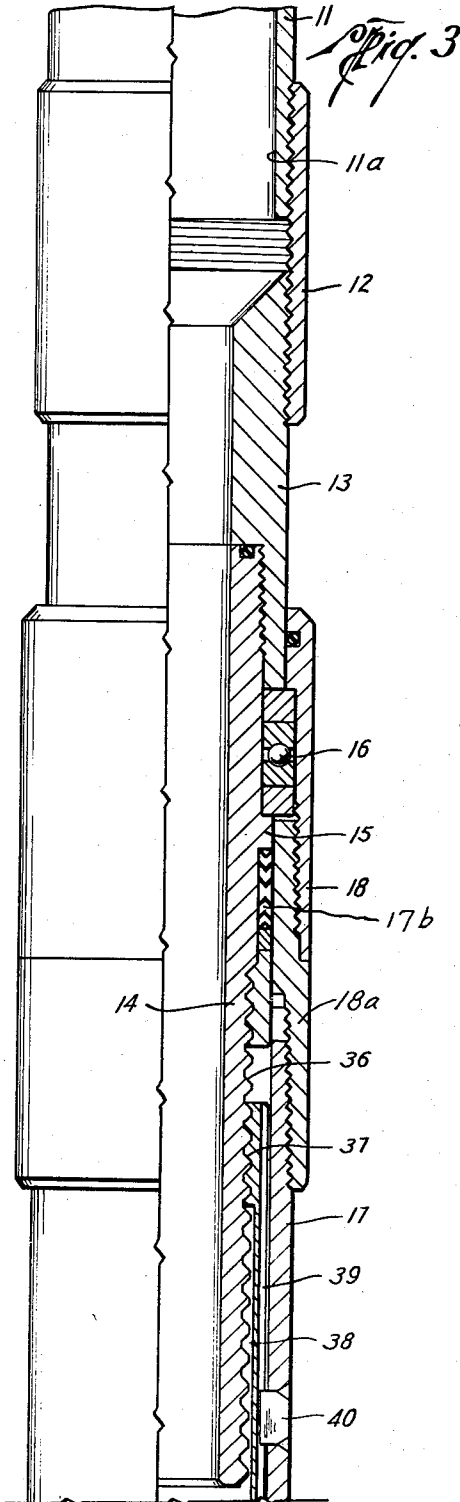
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9 Sheets-Sheet 2



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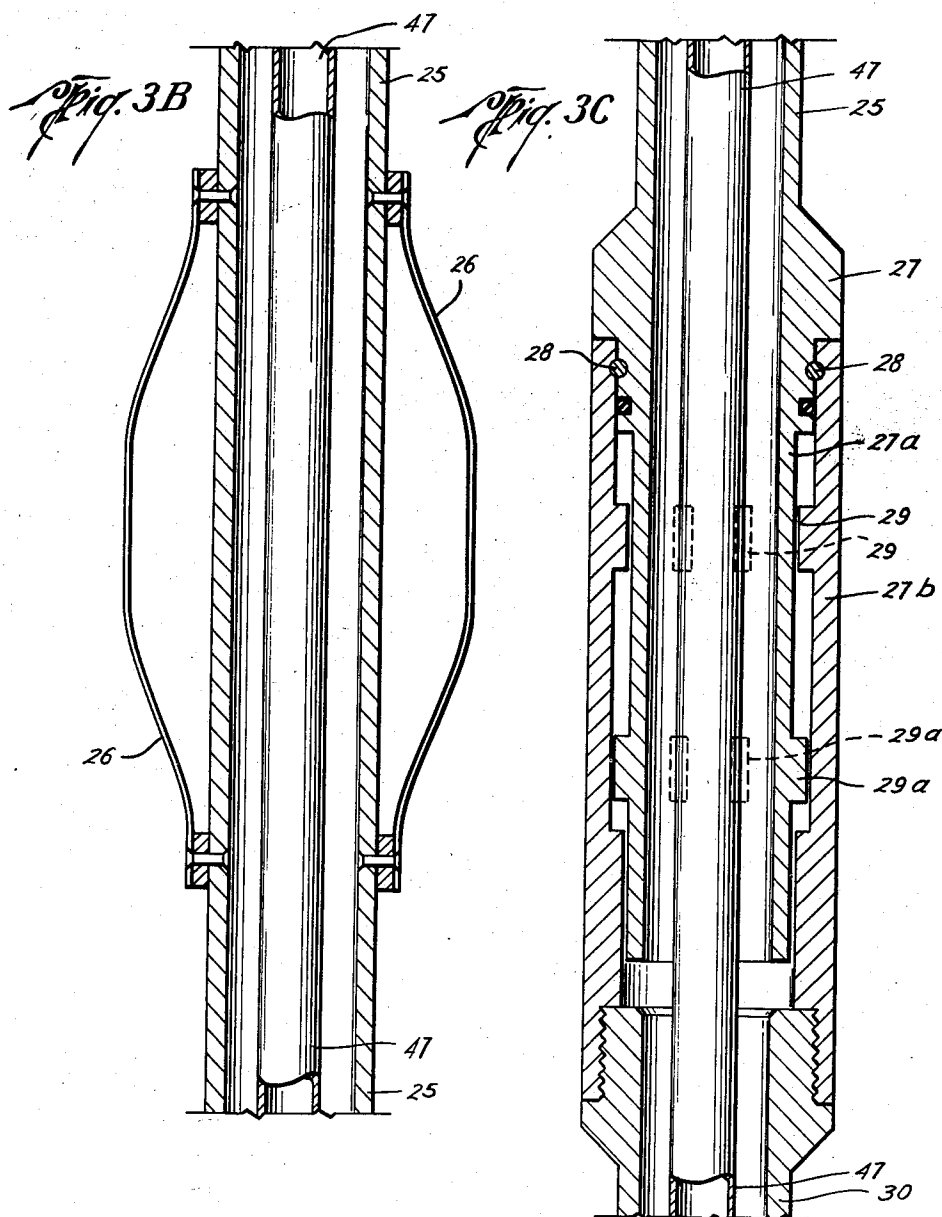
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CROSS-OVER WELL APPARATUS

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9 Sheets-Sheet 3



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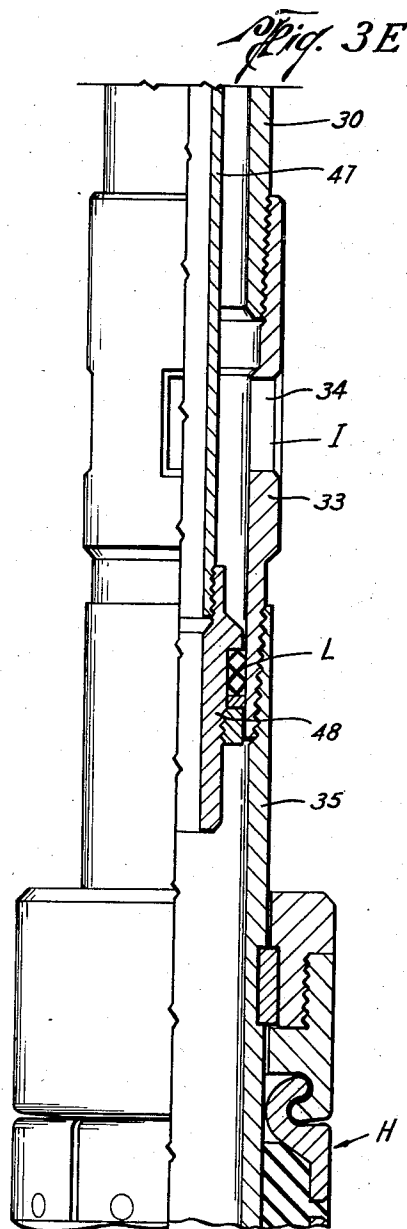
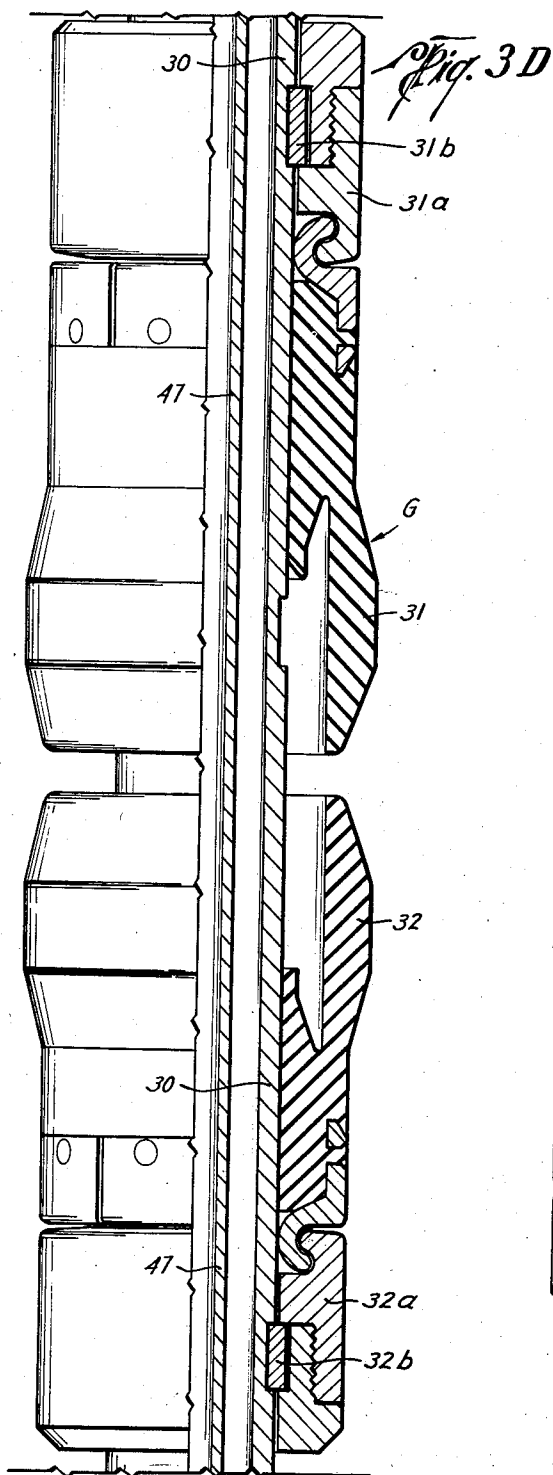
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CROSS-OVER WELL APPARATUS

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9 Sheets-Sheet 4



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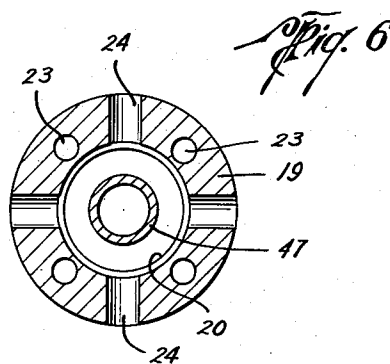
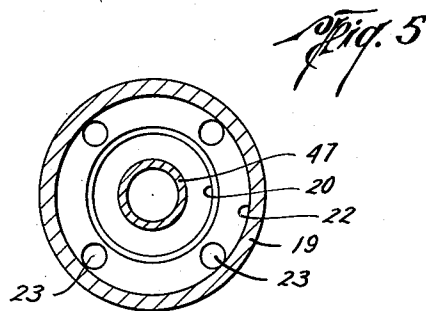
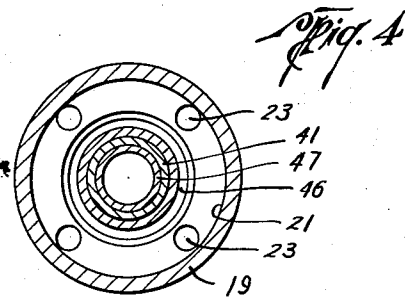
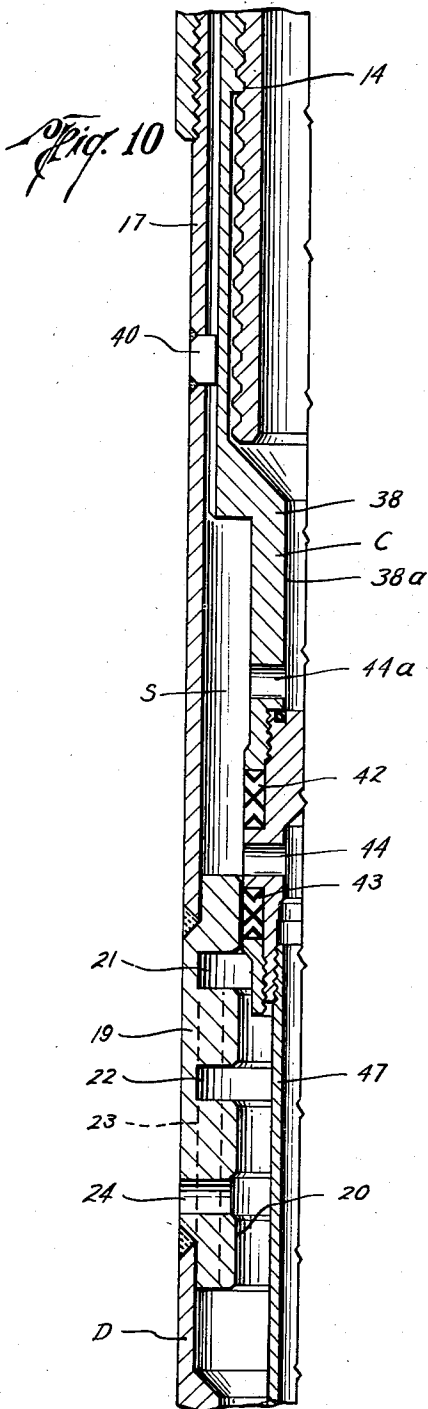
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9 Sheets-Sheet 5



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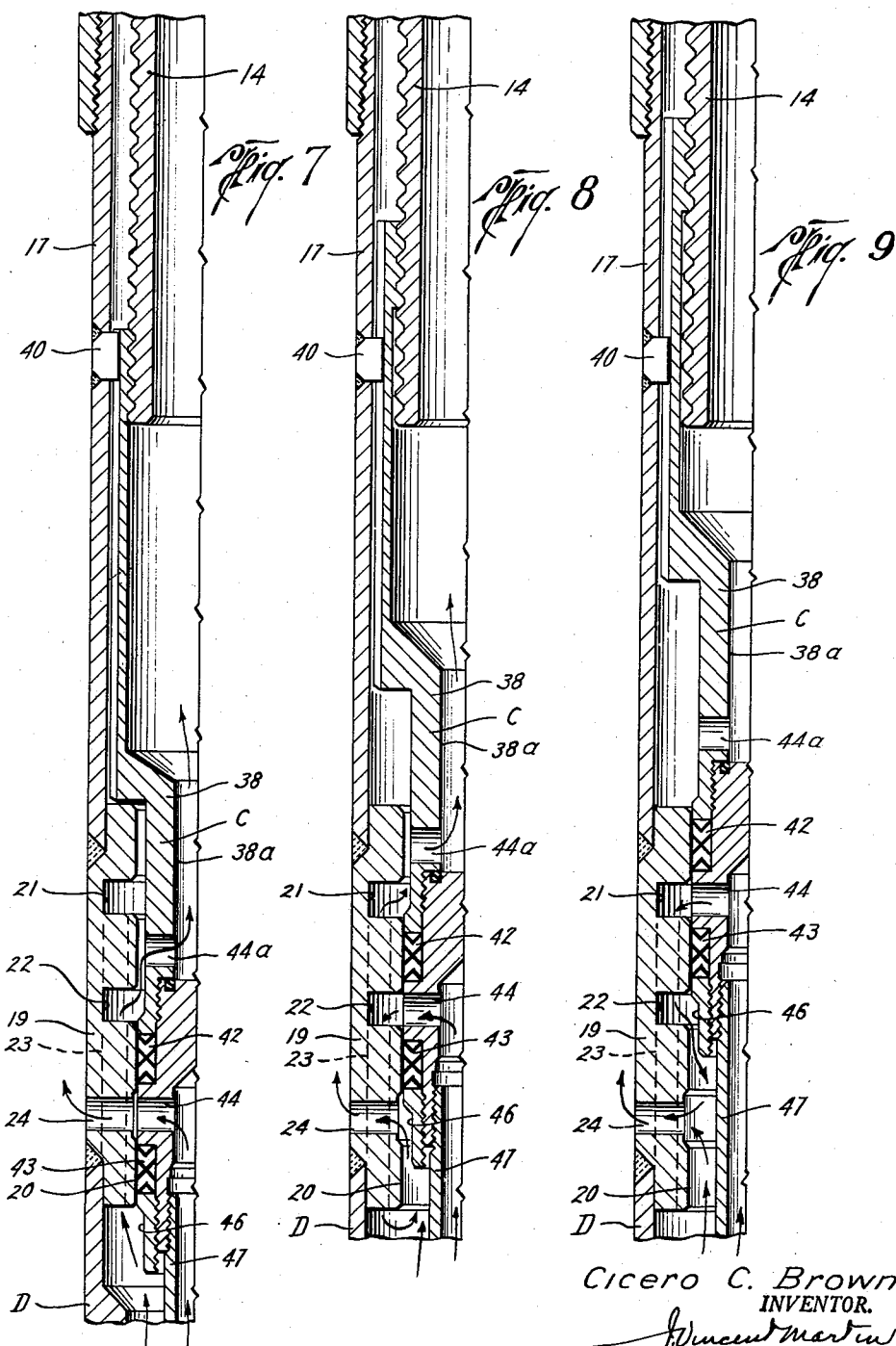
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9 Sheets-Sheet 6



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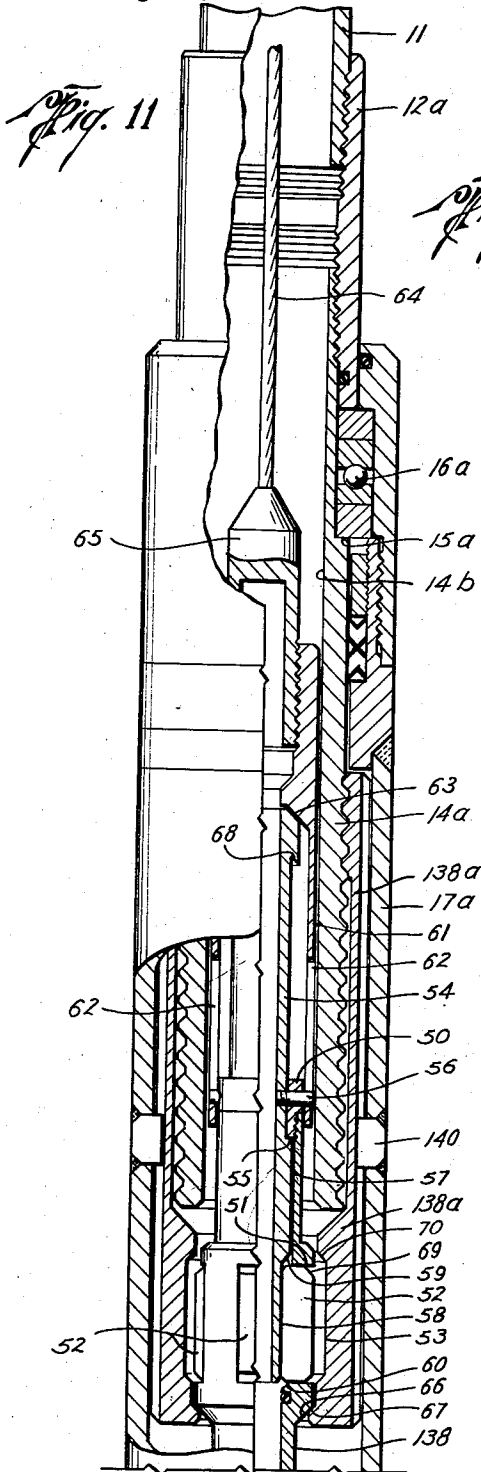
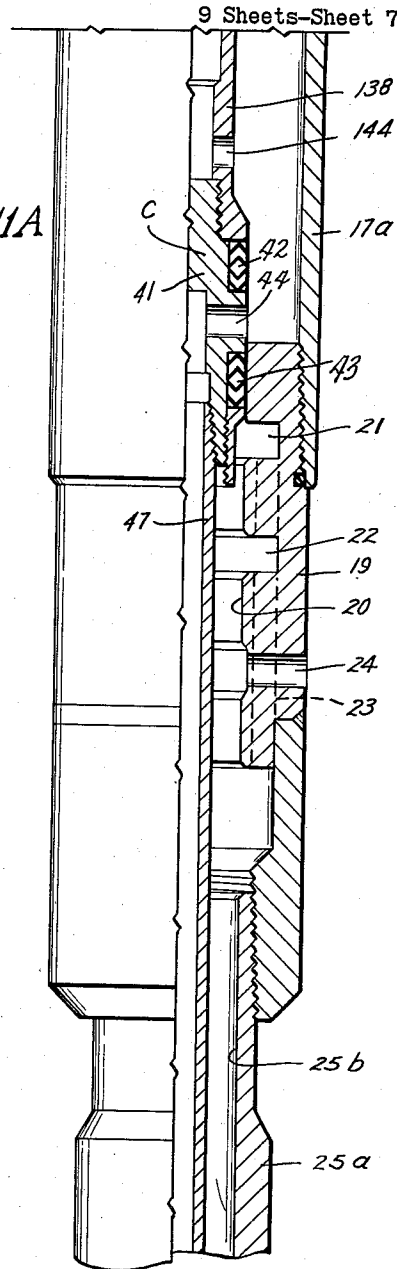


Fig. 11A



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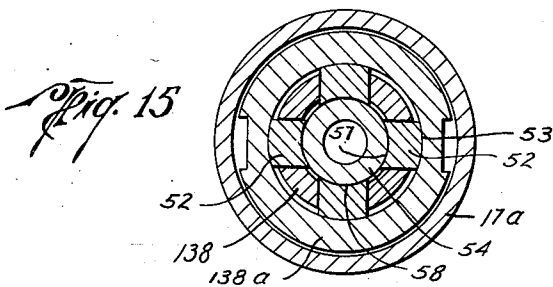
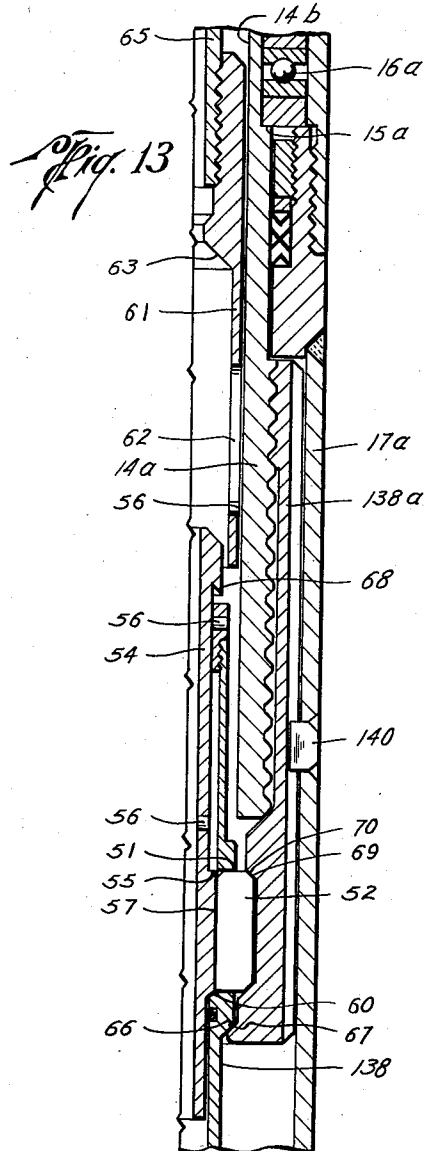
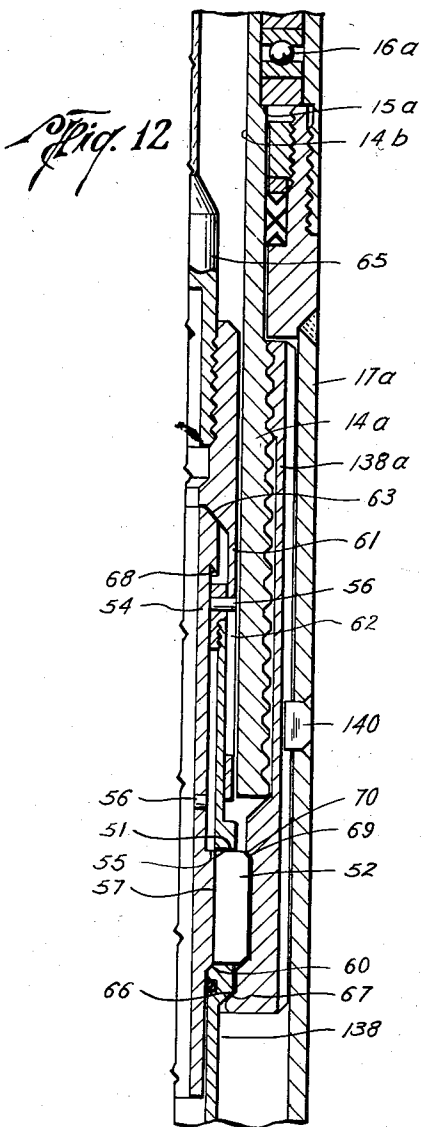
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9 Sheets-Sheet 8



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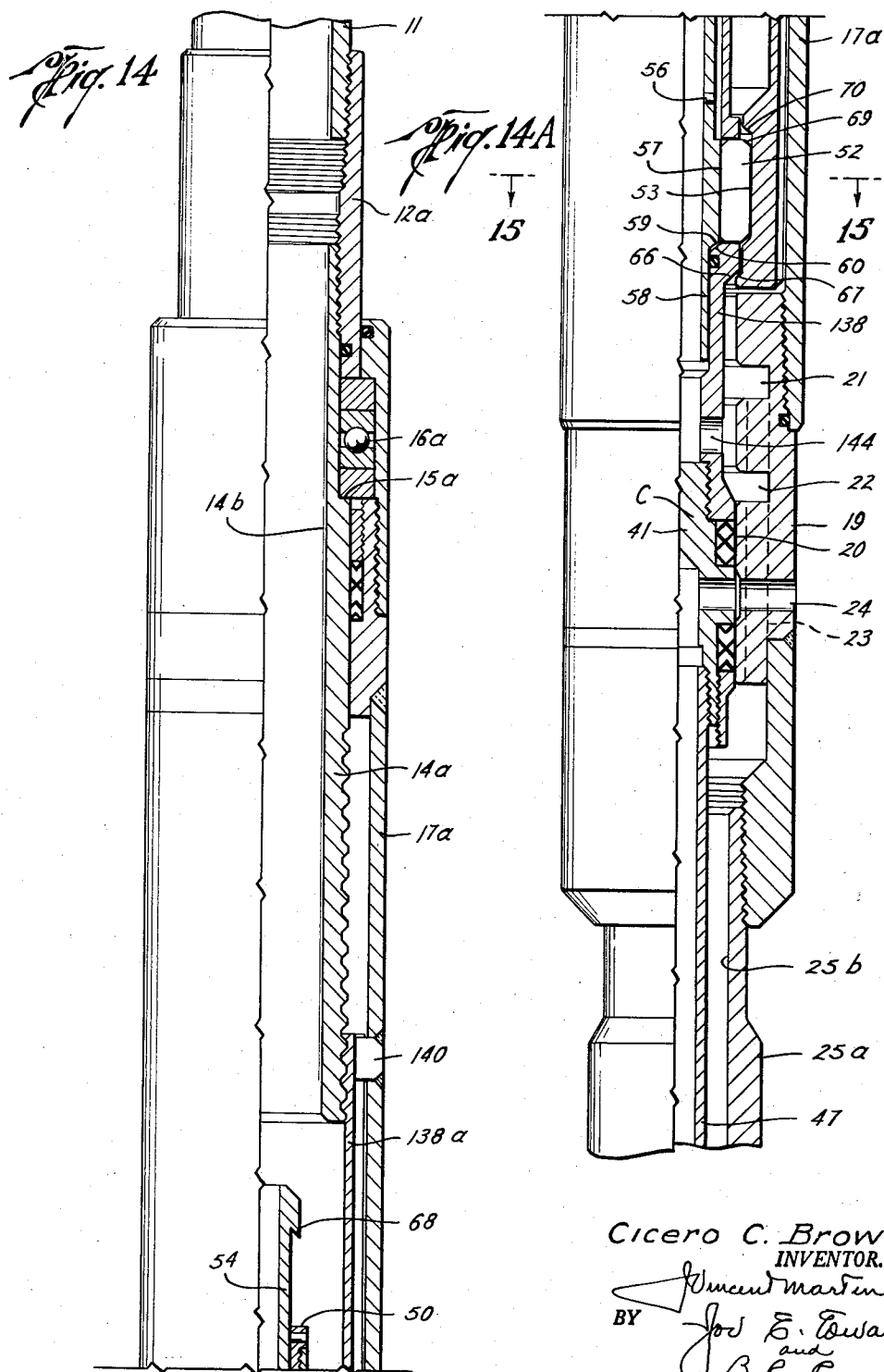
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9 Sheets-Sheet 9



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CROSS-OVER WELL APPARATUS

Cicero C. Brown, Houston, Tex.

Application August 10, 1953, Serial No. 373,231

4 Claims. (Cl. 166—152)

This invention relates to new and useful improvements in well apparatus and relates particularly to well packer apparatus of the crossover type.

As is well known, a crossover type of well packer is one adapted for use in producing from multiple zones and is provided for the purpose of directing the flow from one zone through one conductor and from another zone through a second conductor.

It is one object of this invention to provide an improved crossover type of well packer which is of improved construction and which has means for selectively directing flow from multiple zones through multiple conductors.

An important object of the invention is to provide an improved cross-over well packer apparatus in which the flow therethrough may be changed at will with operation of the device being effected by a rotation of the well pipe or tubing string.

Another object of the invention is to provide an improved well packer of the character described which is so constructed that flow from the lower producing zone may be directed through the inner conductor, with flow from the upper zone being directed through the outer conductor, or where flows may be reversed to produce the upper zone through the inner conductor and the lower zone through the outer conductor; the device also being operable to direct flow from both zones through both conductors simultaneously or to direct both flows through the outer conductor or annulus, the apparatus thus providing for a selective control in accordance with conditions in the producing zones.

A further object is to provide a crossover packer of the character described, wherein the crossover unit includes certain ports and passages which cooperate with a movable control member having coacting ports and passages, the control element being operable by a rotation of the inner conductor or well tubing which extends to the surface of the well, whereby selective control of flow through the various ports and passages of the crossover unit and control element may be had.

A particular object of the invention is to provide an apparatus of the character described which incorporates a safety joint therein whereby complete removal of the crossover unit and its associated parts may be effected in the event that such removal is deemed desirable.

Still another object is to provide an apparatus of the character described, wherein the control element of the crossover assembly may be run into and removed from the well pipe on a wire line; the arrangement being such that when the control element is removed the well pipe is substantially fully opened to permit any desired operations requiring a substantially fully opened bore to be carried on through the well pipe.

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

The invention will be more readily understood from a reading of the following specification and by reference to

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the accompanying drawings forming a part thereof, wherein in an example of the invention is shown, and wherein:

Figure 1 is a schematic view of a crossover well packer apparatus constructed in accordance with the invention, wherein the control element of the crossover unit is not independently removable from the well pipe;

Figure 2 is a schematic diagram of a modified form of the invention wherein the control element of the crossover unit may be positioned and removed by means of a wire line;

Figures 3, 3A, 3B, 3C, 3D and 3E are views partly in section and partly in elevation and illustrating the structural details of the form of the invention shown in Figure 1, Figure 3 illustrating the upper end of the apparatus and the other figures being successive continuations thereof, with Figure 3E illustrating the lower portion of said apparatus;

Figures 4, 5 and 6 are horizontal cross-sectional views taken on the lines 4—4, 5—5 and 6—6, respectively, of Figure 3A;

Figure 7 is a partial longitudinal sectional view of the crossover unit illustrating the control element of said unit in one position;

Figures 8, 9 and 10 are views similar to Figure 7 illustrating the other positions of the control element;

Figures 11 and 11A are views partly in section and partly in elevation illustrating the retrievable type control element of the modified form shown in Figure 2, the parts being shown in position during lowering of the control element into position;

Figure 12 is a view similar to Figure 11 and illustrating the initial locking of the control element in position;

Figure 13 is a similar view showing the lowering tool being disconnected from the control element;

Figures 14 and 14A are views similar to Figures 11 and 11A but showing the control element in its locked position; and

Figure 15 is a horizontal cross-sectional view taken on line 15—15 of Figure 14A.

In the drawings the letter W designates a well bore which traverses an upper producing zone Z1 and a lower producing zone Z2. The usual well casing 10 extends through the well bore in the usual manner and the improved crossover well packer apparatus, to be hereinafter described, is adapted to be set within the casing 10. The apparatus is arranged to be lowered on the inner well pipe or tubing string 11 which extends to the surface of the well.

As schematically illustrated in Figure 1, the apparatus includes an actuating assembly A which is connected between the lowering pipe 11 and the apparatus. Below the assembly A is a crossover unit B within which a control element C is disposed. The element C is movable to different positions by operation of the actuating assembly so that flow through the crossover unit may be selectively controlled. Extending downwardly from the crossover unit is an outer conductor D which has a friction spring assembly E mounted thereon and which also has a safety joint F connected therein. An upper well packer G is also mounted on the outer conductor D as is a lower well packer H, and between the well packers the outer conductor has an upper zone inlet I. Extending axially within the outer conductor and projecting downwardly from the crossover unit is an inner conductor J which has its lower end K open and in communication with the lower zone Z2 to form a lower zone inlet. A suitable packing L seals off between the lower end of the inner conductor J and the outer conductor D at a point below the upper zone inlet I.

The apparatus is set within the well as schematically illustrated in Figure 1, with the upper packer G set above the upper zone Z1 and the lower packer H set between

the producing zones and in this manner the two zones are separated, with the upper zone Z1 in communication with the inlet I and the lower zone in communication with the inlet K. As will be hereinafter described in detail, the control element C is adapted to be moved to various positions with respect to the crossover unit B, such movement being effected by operation of the actuating assembly A. The assembly A is operated by a rotation of the well tubing or pipe string 11, and the different positions of the control element C with respect to the unit B will direct the flow from the two producing zones in a desired manner. For example, the flow from the upper zone Z1 may be directed upwardly through the annular space between the tubing 11 and casing 10 in the manner indicated in Figure 1, while production from the lower zone Z2 may be directed through the tubing 11. By changing the position of the control element C through a rotation of the assembly A, flow from the upper zone may be reversed to direct flow from the upper zone through the tubing while flow from the lower zone is directed through the annulus. A further adjustment of the control element C may direct the flow from both zones simultaneously through the annulus or simultaneously through both the annulus and the tubing.

The apparatus thus provides a selective control of the flow from multiple producing zones with the control being effected through the rotation of the well pipe or tubing string.

The details of the construction of the apparatus which is illustrated schematically in Figure 1 is shown in Figures 3-3E, and referring to Figure 3 it will be seen that the upper end of the apparatus is coupled to the well tubing 11 through a coupling 12, which coupling is in turn connected through a sleeve 13 with a rotatable sleeve 14. The sleeve 14 has an external shoulder 15 upon which is supported a bearing 16 and a tubular casing 17 is suspended by means of a suitable collar 18 from the bearing, said collar being connected to the casing 17 through a coupling 18a. The space between the sleeve 14 and the casing 17 is sealed by suitable packing 17b. It will be evident that when the casing 17 is held against rotation, the inner sleeve 14, which will be hereinafter referred to as an actuating sleeve, may undergo rotation with respect thereto; rotation is imparted to the sleeve by means of the tubing 11. The tubular casing 17 has its lower end secured, as by welding or otherwise, to a cross over unit body 19a forming a crossover unit housing 19. The housing 19 is clearly shown in Figures 3A and 4-6 and includes an annular body 19a having a bore 20 extending therethrough. An upper annular recess 21 (Figure 4) extends inwardly from the bore 20 and spaced downwardly from this recess is a second annular recess 22 (Figures 3A and 5) which also extends inwardly from the bore. A plurality of vertical passages 23 are formed in the wall of the housing, and said passages extend from the lower end of the housing to the upper annular recess 21, said passages intersecting and communicating with the annular recess 22. The housing is also formed with radial ports 24 which are offset radially from the passages 23, as is clearly shown in Figure 6.

The lower end of the crossover unit housing 19 is connected to a pipe section 25 and a plurality of friction springs 26 (Figure 3B) are mounted on this section. A safety joint generally indicated at 27 in Figure 3C is secured to the lower end of the pipe section 25, this safety joint including an inner tubular member 27a and an outer tubular member 27b which are normally connected together by shear pins 28. Coacting keys 29 and 29a are provided on the inner and outer members of the safety joint and function in the usual manner to permit a jarring action. It might be noted that the safety joint merely functions as a connection in the apparatus, but in the event it becomes desirable to remove that portion of the ap-

paratus above the safety joint, the pins 28 may be sheared to permit such removal.

An elongate tubular mandrel 30 (Figures 3C and 3D) has its upper end connected to the lower end of the safety joint 27 and extends downwardly therefrom. This mandrel carries the upper well packer G which has been illustrated as a cup type packer including an upper packer cup 31 and a lower packer cup 32. The upper cup is secured to a supporting collar 31a and is suspended from the mandrel 30 by a supporting ring 31b. The lower cup 32 is mounted in a similar manner by means of a supporting collar 32a and a supporting ring 32b. The cups are oppositely directed with the upper cup having its sealing lip directed downwardly and the lower cup having its sealing lip directed upwardly.

The double cup packer illustrated in Figure 3D has been found satisfactory, but it is pointed out that any type of a well packer may be employed because the function of the well packer G is to seal off the annulus between the mandrel 30 and the well casing 10.

The mandrel 30 has connection with a tubular nipple 33 which is provided with radial inlet ports 34 which form the upper zone inlet I. A second mandrel 35 is connected to the lower end of the nipple and carries the lower packer assembly H. This packer assembly is identical to the packer G and includes the upper and lower cups. Only the upper portion of this packer is shown in Figure 3E and since its construction is identical to the packer G a complete showing thereof was deemed unnecessary. As is the case of the packer G, the lower packer H may be of any desired construction. From the foregoing it will be seen that the crossover unit housing 19 as well as the friction springs 26 and packers G and H are all suspended from the tubular casing 17, which is rotatably supported upon the well tubing 11. When the packers are in set position with the friction springs engaging the well casing, the crossover unit and all parts comprising the outer conductor D, as well as the tubular casing 17, are held against rotation, whereby the tubing string and the actuating sleeve 14 connected therewith may undergo a rotation.

Referring again to Figure 3, the actuating sleeve is formed with a plurality of actuating threads 36 on its exterior surface, and these threads are adapted to be engaged by and coact with internal threads 37 which are formed on a tubular member 38. The tubular member 38 is formed with an external groove 39 which is engaged by a key 40, the latter being welded or otherwise secured in the tubular casing 17 which is secured to the upper end of the crossover unit. The key 40 functions to lock the tubular member 38 against rotation within the casing 17, and thus when the casing is held against rotation by the friction springs 26 and the well packers G and H, the tubular member 38 is also held against rotation. Therefore, when the actuating sleeve 14 is rotated by means of the well tubing 11, the member 38 is caused to travel longitudinally within the casing 17 by reason of the coaction between the threads 36 and 37 of said sleeve, and said member, respectively.

The lower end of the tubular member 38 (Figure 3A) is secured to the control element body 41 which coacts with the crossover unit B. The control element comprises the tubular member 38 and a body 41 having external packing 42 nearer its upper end and external packing 43 at its lower end. A radial port 44 extends through the wall of the body and communicates with lower axial bore 45 in the body 41 and is positionable to establish communication between axial bore 45 and the annular space S between the member 38 and the suspension casing 17. A port 44a through the lower portion of the member 38 communicates with bore 38a and is positionable to establish communication between the annular space S and the bore 38a of member 38. Of course, bore 38a is in communication through the sleeve 14 with the bore 11a of the well tubing. The axial bore

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45 terminates short of the upper end of the body 41 providing a closure between bores 38a and 45. Below the lower packing 43 the external surface of the body 41 is reduced as indicated at 46 and an elongate tubular conductor 47 extends downwardly from the body 41. This conductor 47 may be termed an inner conductor and projects downwardly through the pipe section 25, safety joint 27, upper packer assembly G and to a point below the upper zone inlet ports 34. A packing nipple 48 (Figure 3E) is threaded onto the lower end of the inner conductor 47 and carries the packing L which seals off between the inner conductor 47, indicated at J in the schematic drawing, and the outer conductor indicated at D in Figure 1. Since the inner conductor 47 is sealed off from the outer conductor, it will be evident that flow from the lower zone Z2 may pass upwardly through the inner conductor 47 while flow from the upper zone Z1 enters the ports 34 to flow upwardly through the mandrel 30 and into the pipe section 25 and the lower end of the crossover unit B.

When the actuating sleeve 14 is operated to raise and lower the tubular member 38 and thus raise and lower the control element C, the position of the control element C within the bore 20 of the crossover unit will be varied. The particular position of the element C with respect to the crossover unit B will determine the manner of flow from the producing zones to the well tubing and to the annulus between said tubing and the well casing 10. It will be evident that longitudinal movement of the control element C can be accomplished when the packers are in set position since at that time the outer conductor D, the crossover unit B and the supporting casing 17 will be held against rotation. Because the supporting casing 17 is keyed to the tubular member 38 (Figure 3) the tubular member is held against rotation, and a rotation of the well pipe and the actuating sleeve 14 will cause the control element to move axially within the bore 20 of the crossover unit B.

The various positions of the control element C with respect to the crossover unit B are illustrated in Figures 7-10. Referring to Figure 7 the control element C is in its lowermost position with respect to the control unit housing 19, and in such position the port 44 of the control element is in communication with the port or opening 24 in the housing. The lower packing 43 of the element is sealing with the bore 20 of the housing below the opening 24, while the packing 42 is sealing with the bore above said opening. The intermediate annular channel or groove 22 in the housing is in communication through the port 44a with the bore 38a of the element 38.

In this position of the control element the flow from the lower zone Z2 which is upwardly through the inner conductor 47 (J in Figure 1) is then through the registering ports 44 and 24 into the annular space between the tubing and the casing. Flow from the upper zone Z1 is upwardly through the annular space between the conductor 47 and those parts forming the outer conductor D, then upwardly through the vertical passages 23 to the annular groove 22; from this groove the flow is through port 44a and into the bore of the element 38 and finally upwardly through the tubing. Thus, in Figure 7 flow from the lower zone is upwardly through the annulus between the tubing and casing, and flow from the upper zone is through the tubing.

When the control element is shifted to the position shown in Figure 8, which is accomplished by a rotation of the actuating sleeve 14, port 44 of the control element registers with the intermediate groove 22 and the packing 42 seals off above this groove while packing 43 seals off therebelow. In this position, flow from the lower zone passes upwardly through conductor 47, then through port 44 into channel 22 and downwardly through passage 23 into the annular space between the conductor 47 and the outer conductor D. At this point the flow from the lower zone admixes with the fluid flowing upwardly from

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the upper zone and the two flows admix and pass outwardly through opening 24 into the annulus between the tubing and the casing. At the same time, flow from both the upper and lower zones can pass through the upper portion of passages 23 and into the upper channel or recess 21 from where the fluid passes through port 44a and thence upwardly in the tubing. Thus, with the control element in the position of Figure 8 the flow from both zones is directed upwardly through both the well tubing and the annulus between the tubing and the casing.

When the control element is moved upwardly a further distance, as shown in Figure 9, the port 44 is registered with the uppermost channel or groove 21 and the upper packing 42 of the control element seals off above the groove. In this position of the element, flow from the lower zone which is upwardly through conductor 47 passes through port 44, then downwardly through the upper portion of the passages 23 into the groove 22. At this point the reduced lower end 46 of the control element is opposite the intermediate groove or recess 22 and flow is then downwardly and outwardly through the opening 24. The flow from the upper zone is upwardly between the inner conductor 47 and the outer conductor D and then outwardly through the opening 24. Thus, in Figure 9 the production from both zones is directed upwardly through the annulus between the well casing and the well tubing and there is no flow through the tubing.

In Figure 10 the control element is moved to its uppermost position which locates the port 44 above the control unit housing 19. In this position of the element the flow from the lower zone which is upwardly through conductor 47 passes through port 44 and into the space S between member 38 and the supporting casing 17, and from this point passes through opening 44a into member 38 and then upwardly into the well tubing. Flow from the upper zone Z1 is from the area outside the conductor and then outwardly through port 24. In this position of the element the lower packing 43 seals off with the bore 20 of the control unit housing and separates the two flows. It might be noted that with the element in the position shown in Figure 10 the flow is exactly reversed as compared to the flow in Figure 7, that is, the lower zone is produced through the tubing while the upper zone is produced through the annulus. In Figure 10 and also in the schematic view, Figure 1, the lower zone is produced through the tubing while the upper zone is produced through the annulus.

From the foregoing, it will be seen that a relatively simple effective control of the flow is had. The production from each zone may be selectively directed in any desired manner in accordance with well conditions and operation of the control element is accomplished merely by a rotation of the well tubing string. It might be pointed out that any suitable swivel mounting which will permit rotation of the tubing may be utilized at the well head. It might also be noted that although the friction springs 26 are shown these springs could in many instances be eliminated, since the frictional engagement of the packers G and H with the wall of the well casing will be sufficient to hold the outer conductor, control unit and suspending casing 17 stationary to permit rotation of the actuating sleeve to effect operation of the control element.

In Figures 11-15 the details of construction of the modification shown schematically in Figure 2 are illustrated. As has been noted, this modification involves lowering and retrieving the control element by means of a flexible wire line or cable. By making the control element C removable it is obvious that the control element may be removed whenever desired and the arrangement is such that the bore of the entire pipe string after such removal is substantially fully opened. This will permit various well operations to be carried out through the pipe bore.

Referring to Figure 11, the structure of the modified form includes a coupling 12a which is threaded onto the well tubing string 11. An actuating sleeve 14a which is similar to the sleeve 14 of the first form is threaded onto the coupling 12a and a supporting or suspension casing 17a is suspended from a bearing 16a supported upon a shoulder 15a, the latter being formed on the actuating sleeve. The crossover unit housing 19 is connected to the lower end of the casing 17a and is identical in construction to the housing shown in Figure 3A of the first form. A pipe section 25a extends downwardly from the crossover unit housing 19, and therebelow the packers G and H are mounted in the same manner as has been heretofore described. It is noted that the bore 25b of the pipe section is of substantially the same diameter as the bore 20 of the crossover unit housing and that the bore 14b of the actuating sleeve is at least as large as said bore 20. Thus, any tool which will pass downwardly through the well tubing 11 may also pass downwardly through the sleeve, housing 19 and pipe section 25a, whereby a substantially full open bore is provided for the purpose of permitting well operations to be carried out therethrough.

Instead of the control element C being permanently mounted within the well pipe, as is the case in the first form, said control element is adapted to be removable. As shown in Figures 11 and 11A the control element C which includes the body 41 has its upper end connected to a tubular extension member 138 instead of being connected to member 38. The extension or member 138 is provided with a port 144 which is positioned in the lower portion of the member. The upper end of the member 138 has a flanged collar 50 threaded into its upper end and spaced below the collar are a plurality of radially extending slots 51. Each slot is adapted to receive a radially movable locking block 52 (Figure 15). The locking blocks are adapted to be moved to an extended position into the annular recess 53 provided in the lower end of a tubular actuator 138a. The upper portion of the tubular actuator 138a is slidably keyed by means of a key 140 to the suspension casing 17a and the bore of said actuator member has threaded connection with the operating threads of the actuating sleeve 14a. When the dogs 52 are moved to an outer engaged position within the annular recess 53, as illustrated in Figures 14 and 14a, it will be evident that the extension 138 which carries the control element is locked to the tubular actuating member 138a. When so locked an operation of the actuating sleeve 14a by a rotation of the tubing 11 will result in a longitudinal movement of the member 138a and of the extension 138, whereby the control element C is moved to various positions with respect to the control unit housing 19. Obviously, the control element may assume any one of the positions illustrated in Figures 7-10 heretofore described to selectively control the flow from the producing zones.

For lowering the control element C into proper position and for locking said element to the tubular actuating member 138, the structure illustrated in Figures 11-13 is employed. This structure includes a tubular mandrel 54 which is formed with an external shoulder 55 upon which the collar 50 of the extension 138 is adapted to rest. A shear pin 56 which extends through the mandrel and through the collar initially secures the mandrel and the extension 138 to each other. Below the shoulder 55 the mandrel is formed with an annular surface 57 of enlarged diameter and below this surface the exterior of the mandrel is reduced as indicated at 58. It is noted that when the shear pin is connecting the mandrel to the extension 138 the reduced portion 58 of said mandrel is behind the locking blocks 52 and said blocks are in a retracted position. When the pin 56 is sheared to disconnect the mandrel from the extension 138, said mandrel may move downwardly to engage the enlarged surface 57 with the inner surface of each locking block and

thereby move said locking block to extended position so as to engage in the annular recess 53. It is noted that the downward movement of the mandrel is restricted by the engagement of the annular shoulder 59 formed between the surfaces 57 and 58 with an internal shoulder 60 formed within the extension 138.

The tool for lowering the mandrel and control element C into position comprises a sleeve-like housing 61 which engages over the upper portion of the mandrel and over the collar 50 on the upper end of the extension 138. This housing has a longitudinal slot 62 therein and the end of the shear pin initially extends through said slot in the manner shown in Figure 11. An internal shoulder 63 within the housing 61 engages the upper end of the mandrel 54 when the shear pin is at the lower end of the slot 62. A suitable cable or wire line 64 has connection through the ordinary socket 65 with the housing.

The setting operation is clearly illustrated in Figures 11-13 and the control element and its associate parts are connected to the housing 61 in the manner shown in Figure 11. The cable or wire line 64 may thus be utilized to lower the control element C downwardly through the well tubing. The control element assembly may be lowered until an external shoulder 66 on the extension 138 engages an internal shoulder 67 provided at the lower end of the tubular actuating member 138a, and when this occurs further lowering of the extension 138 which carries the locking blocks is halted. This locates the locking blocks adjacent or in alignment with the annular locking recess 53 in the tubular actuating member 138a. Suitable jars (not shown) of known construction may be connected in the cable 64 so that a downward jarring action may be imparted to the tubular seating housing 61. Due to the engagement of the internal shoulder 63 of the housing 61 with the upper end of the mandrel 54, the mandrel is jarred downwardly to shear that end of the pin which is connected in the mandrel, in the manner shown in Figure 12. When this occurs the mandrel 54 may move downwardly relative to the extension 138 and to the locking blocks 52 which are carried thereby, with the result that the enlarged diameter surface at 57 moves behind the locking dogs to move said dogs radially outwardly into the locking recess 53. This action couples the member 138 which has the control element C secured to its lower end to the actuating member 138a.

After the locking blocks have been engaged in their respective recesses, the housing 61 is pulled upwardly in the manner shown in Figure 13. Since the extension 138 is now locked against longitudinal movement, such upward travel of the housing will fracture that end of the shear pin which is engaged in the slot 62 of the housing, and thereafter the housing and cable may be removed from the well tubing. It will be evident that the control element C is now coupled to the actuating member 138a and is movable therewith as a unit.

After the control element is positioned, a rotation of the tubing 11 will rotate the actuating sleeve 14a and through the coaction of the threads the actuating member 138a is moved longitudinally with respect to the crossover unit housing 19. Since the control element C is now attached through the locking blocks 52 to the tubular member 138a, movement of such member will adjust the control element within the crossover unit housing to selectively control flow through the various ports and passages, as has been hereinbefore described.

When it is desired to remove the control element, it is only necessary to engage a suitable retrieving tool with an annular undercut shoulder 68 formed on the upper end of the mandrel 54. Such engagement and upward movement by means of a wire line will lift the mandrel from the position shown in Figures 14 and 14A and will again locate the reduced lower end 58 of the mandrel behind the locking blocks 52, whereby said locking blocks may return to a retracted position.

Retraction of the blocks from their respective locking recesses is assisted by the bevelled upper end **69** of each locking block coacting with a bevelled shoulder **70** formed in the end of each locking recess. Subsequent upward movement will remove the control element C completely from the well pipe.

It is obvious that the operation of the modified form, so far as control of flow from the producing formations is concerned, is identical with the first form because after the locking dogs are engaged to couple the control element to the tubular actuating member **138a**, positioning of the control element is accomplished by rotation of the well pipe or tubing. The only difference in the two forms is that in the modification the control element C may be run into and removed from its operating position by means of a wire line. This may be of particular advantage in certain instances where it may be desirable to carry out operations through the tubing string. In both forms of the invention selective control of the flow from the producing formations may be accomplished by merely rotating the well pipe or tubing string so that the control element is moved into a desired relative position with respect to the control unit housing.

It is pointed out that the provision of the safety joint F in the apparatus at a point between the friction spring assembly and the uppermost well packer G provides a safety feature. If for any reason it is desired to remove the apparatus and the well tubing from the well bore without removing the well packers, the shear pins of the safety joint may be fractured and all of the apparatus above said safety joint may be easily removed; normally the safety joint merely functions as an ordinary coupling in the string.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

Having described the invention, I claim:

1. A well apparatus adapted to be connected in a well tubing string and lowered therewith within a well casing, said apparatus including a cross over unit housing, a rotatable connection for connecting said housing to the tubing string, said housing having an axial bore with an intermediate bore portion of reduced internal diameter having a radial flow port communicating the bore of the housing with the annulus between the tubing and casing, the bore portion of said housing of reduced internal diameter having spaced upper and lower annular recesses in its bore wall spaced above said radial flow port and also having longitudinal passage means communicating the lower portion of said housing with said recesses, an outer conductor depending from the housing with its upper end communicable with said radial flow port and the passage means communicating with said recesses, the lower portion of said outer conductor having an inlet communicating with a first well fluid producing formation, an inner conductor extending axially within the outer conductor and having an inlet in its lower end communicating with a second well fluid producing formation, sealing means on said conductors sealing off between the respective inlets on said conductors and the well casing to prevent intermingling of the well fluids produced from said respective

formations, a control element secured to the upper end of the inner conductor and movable axially within the housing, said control element having a first port for establishing communication between the bore of the well tubing and the area within the housing exteriorly of the control element, said control element having an enlarged portion of enlarged exterior diameter immediately below said first port adapted to sealingly engage the bore wall of said bore portion of reduced internal diameter, a second port in said enlarged portion spaced below said first port for establishing communication between the inner conductor and the area exteriorly of the control element, a closure in said control element between said ports, the control element being movable to position said second port in alignment with the lower of said annular recesses thereby communicating said inner conductor with the passage means in said reduced diameter bore portion and the radial flow port in said housing, the first port in said control element communicating with said upper annular recess when the second port is aligned with said lower annular recess whereupon said inner conductor communicates with said first port and said tubing string, the outer conductor simultaneously communicating with said radial flow port, the passage means in the bore portion of reduced internal diameter and the first port, thereby providing for intermingling flow of well fluid from both producing formations through the well tubing and the casing tubing annulus.

2. The combination as set forth in claim 1 wherein the control element is movable to position said second port in alignment with said radial flow port and said first port is in communication with said longitudinal passage means whereupon said inner conductor communicates with said radial flow port and the outer conductor simultaneously communicating with said tubing string, through the passage means in the bore portion of reduced internal diameter and the first port, thereby providing for flow of well fluid from the first well fluid producing formation to the well tubing and from the second well fluid producing formation to the annulus.

3. The combination as set forth in claim 1, wherein the control element is movable to position said second port in alignment with said upper annular recess in communication with said longitudinal passage means and said lower annular recess and said radial flow port, said first port being shut off from said longitudinal passage means, thereby providing for flow from both said producing formations to said annulus.

4. The combination as set forth in claim 1, wherein the control element is movable to position both said first and second ports out of communication with both said radial flow port and said longitudinal passage means, thereby providing for flow from said first well fluid producing formation to said annulus and from the second well fluid producing formation to the well tubing.

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