

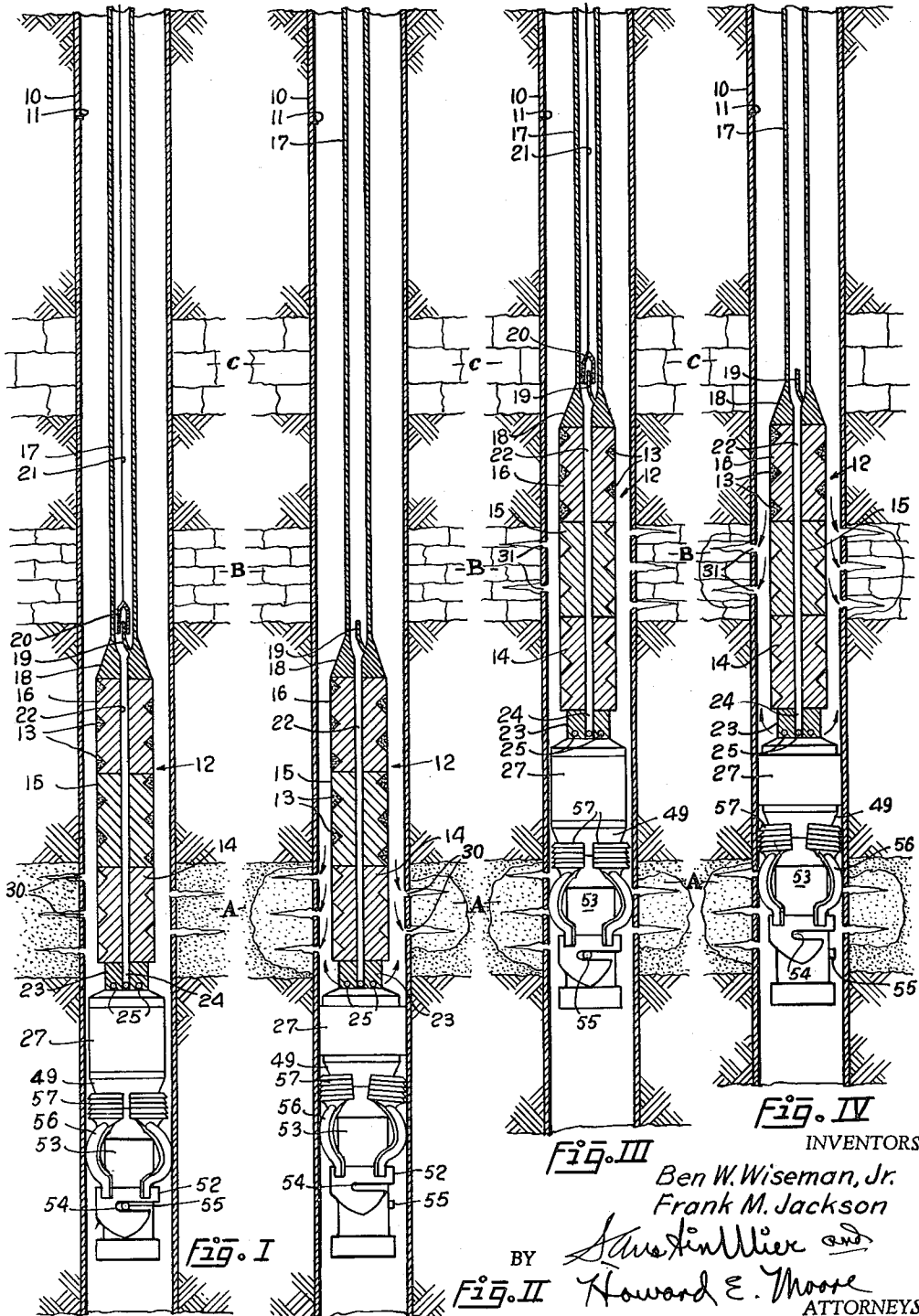
May 30, 1961

B. W. WISEMAN, JR., ET AL
APPARATUS FOR PERFORATING AND TREATING
ZONES OF PRODUCTION IN A WELL

2,986,214

Filed Dec. 26, 1956

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

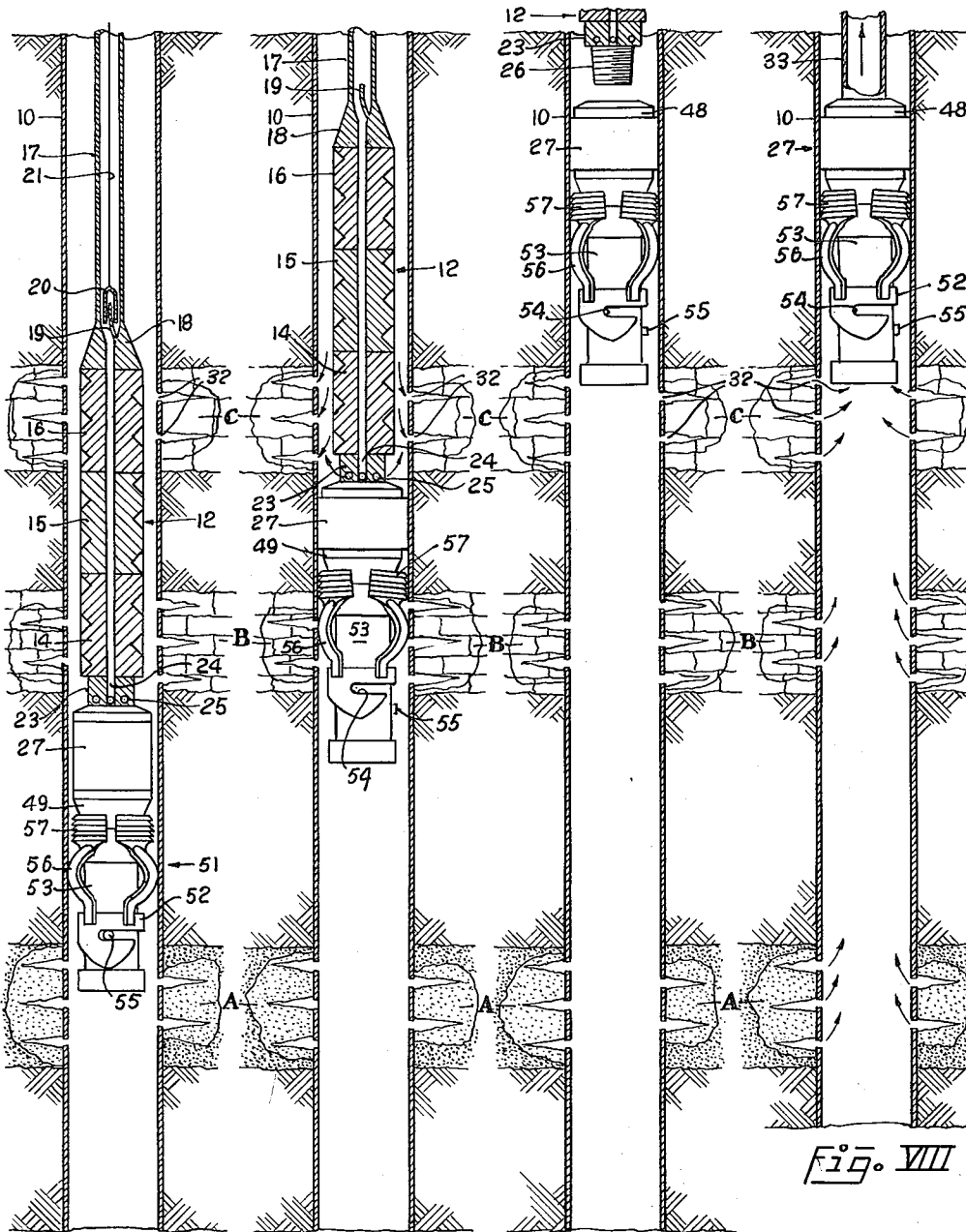


Fig. V

Fig. VI

Fig. VII

Fig. VIII

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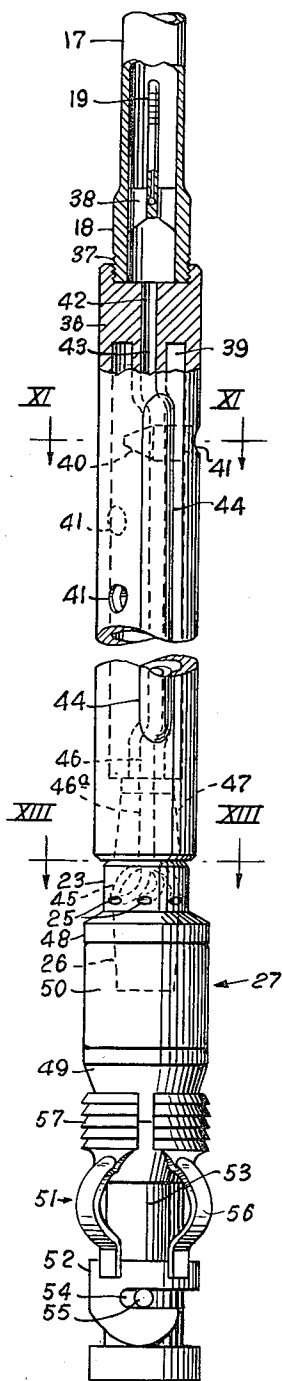


Fig. IX

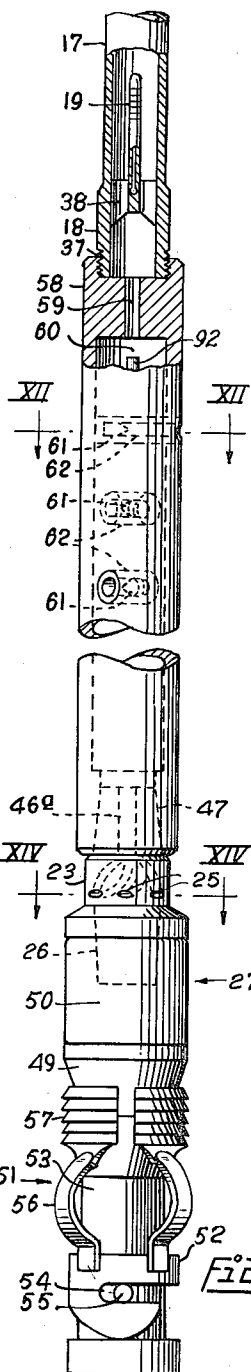


Fig. X

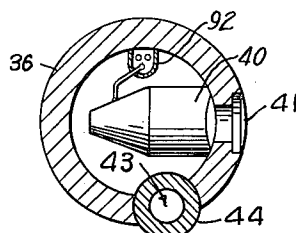


Fig. XI

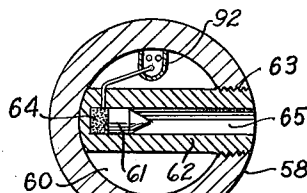


Fig. XII

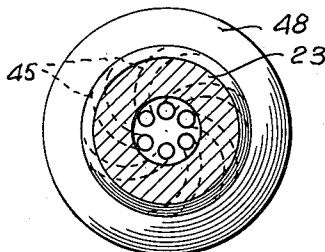


Fig. XIII

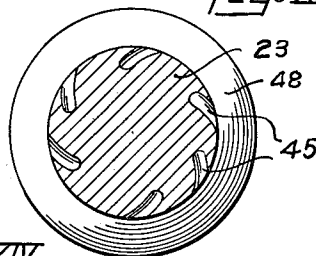


Fig. XIV

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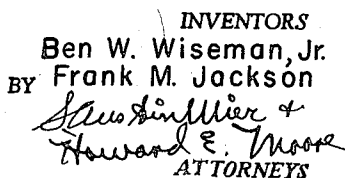
Fig. X

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2,986,214

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2,986,214

APPARATUS FOR PERFORATING AND TREATING ZONES OF PRODUCTION IN A WELL

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3 Claims. (Cl. 166—55)

This invention is concerned with perforating and treating production zones in an oil or gas well and is particularly concerned with a method of perforating and treating plural production zones and a novel combination perforating gun and packer employed in carrying out such method.

It has been the practice in the past in dual completions to set a packer below the production zone to be perforated by running it into the well on a string of pipe or a wire line. The pipe or wire line is then disengaged from the packer and withdrawn from the well and a perforating gun is then run into the well on a wire line to perforate the casing and formation. The gun is then withdrawn from the well and detached from the wire line. The pipe is then run back into the well, either open ended or with a suitable control device, and the hydrofracturing fluid or acid is injected into the formation through the perforations in the casing.

If the packer is to be removed or reset, a run into the well is required.

It will be seen that this system requires at least three separate runs into the casing to fracture and treat each separate formation. Many times there are separate productive formations in the well at different levels which must be perforated and treated so that it is necessary to carry out at least three separate runs into the well for each formation so perforated and treated. It is obvious that such procedure involves an expenditure of a great deal of time and money in perforating and treating the zones of production in a well.

This invention is primarily concerned with a new means for perforating and treating one or more zones of production in a well by a single run of the pipe into the well and in a continuous operation, thus eliminating the necessity of separately running the perforating gun, packer and well treating equipment in connection with the treating of each zone. Obviously this method results in a great saving in time and expense.

The combination packer and perforating gun disclosed herein permits fluid to be circulated around the upper end of the packer while the treating of the formation thereabove is carried out, thus preventing undesirable foreign material from settling above the packer, and permitting the packer to be easily unseated and moved in the casing, thereby eliminating objectionable fishing or drill-out operations.

It is, therefore, a primary object of this invention to provide a means of perforating and treating one or more zones of production in a well in a single and continuous operation.

It is another object of this invention to provide a means of perforating and treating one or more zones of production in a well in a continuous sequence of operations without removing the tubing from the well.

Another object of this invention is to provide a combination perforating gun and packer which prevents the settling of sand and other foreign material in the well on the packer during a treating operation, thus permitting the

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packer to be unseated and moved without the necessity of fishing or drilling operations.

A still further object of this invention is to provide a combination perforating gun and packer wherein fluid may be circulated through the gun and outwardly through ports above the packer to thereby prevent undesirable foreign material, such as sand and other sediment, from settling on top of the packer while well treating operations are being carried out.

10 An important object of this invention is to furnish a tool which permits the operator to selectively perforate and treat different formations on the same run of the tool. This is not possible employing present practice.

15 A still further object of this invention is to provide a combination perforating gun and packer which are joined together and wherein the packer may be set, relaxed and moved in the well casing as many times as may be desired while the well casing is being perforated, and zones of production adjacent thereto are treated, at different levels, without the necessity of removing the pipe from the well.

20 A still further object of this invention is to provide a combination perforating gun and packer which may be employed for perforating and treating plural zones of production in a well without the necessity of removing the gun or packer from the well during such operation.

25 Other and further objects of this invention will become apparent upon reading the detailed specification herein-
30 hereto.

The novel combination perforating gun and packer employed in the practice of the method herein disclosed includes a perforating gun having charges or bullets spaced longitudinally thereof wherein the charges or bullets at different longitudinal positions may be fired separately so that the gun may be moved adjacent formations disposed at different levels in the well and fired adjacent the separate formations to perforate the casing.

35 Such a gun is known in the art, one form of which is illustrated in United States Patent No. 2,655,619 issued to W. E. Neal on October 13, 1953, which discloses a selective charge firing perforating gun wherein the perforating charges therein may be fired separately and in sequence by electrical impulse controlled from the earth's surface.

40 Another illustration of such a perforating gun is shown in United States Patent No. 2,766,690, issued to M. P. Lebourg on October 16, 1956, which shows a perforating gun with a plurality of explosive charges therein which may be set off in succession. It is therefore believed unnecessary to illustrate in detail the electrical wiring and controls for separately and selectively firing the charges or bullets in such a gun as such is not specifically claimed as novel herein.

45 In this invention, such a perforating gun is provided with a flow passage therethrough or thereabout and it is joined to a conventional hook wall casing packer of the plugging type. Lateral flow ports are provided between the perforating gun and the packer, and preferably immediately above the packer, which flow ports are in communication with the flow passage through or about the perforating gun so that fluid may be circulated through the gun and outwardly through the lateral flow ports, after the packer has been set, and while the zone of production is being treated above the packer, to thereby prevent undesirable foreign material in the well from settling above the packer.

50 Various modifications in structure may be devised to carry out the method herein disclosed and for performing the function of the combination perforating gun and packer, preferred forms of which are shown in the attached drawings wherein,

Figure I is a partially sectionalized, elevational, semi-

schematic view of the combination perforating gun and packer, showing the perforating gun in position to perforate the casing adjacent the lowermost productive formation in a well.

Figure II is a view similar to Figure I wherein the packer has been set below the lowermost formation and treating fluid is being injected into the formation through the perforations in the casing, and fluid is being circulated through the perforating gun and outwardly through the lateral flow ports between the gun and the packer to wash away sediment which might have a tendency to settle above the packer.

Figure III is a view similar to Figure I wherein the packer has been released and the perforating gun and the packer has been moved upwardly, and the perforating gun is adjacent another formation and has been fired to form perforations in the wall of the casing.

Figure IV is a view similar to Figure I wherein the packer has again been set and treating fluid is being injected into the formation and fluid is being circulated through the perforating gun and outwardly through the lateral flow ports above the packer to wash away undesirable sediment.

Figure V is a view similar to Figure I wherein the packer has been unseated and the gun and packer have been moved upwardly to a position where the perforating gun is adjacent the uppermost formation and the gun has been fired to form perforations in the wall of the casing adjacent said formation.

Figure VI is a view similar to Figure I wherein the packer has again been set against the wall of the casing and treating fluid is being injected into the formation through the perforations in the wall of the casing and fluid is being circulated through the gun and outwardly through the lateral flow ports above the packer to wash away undesirable sediment.

Figure VII shows the packer after the perforating gun has been detached therefrom preparatory to withdrawing the perforating gun from the well.

Figure VIII shows a production tubing attached to the upper end of the packer and the packer has been opened to permit the production from the separate formations to flow upwardly through the packer and the production tubing.

Figure IX is a partially sectionalized, elevational view of the combination perforating gun and packer, such gun being of the type commonly known as a jet gun.

Figure X is a partially sectionalized, elevational view of a combination perforating gun and packer, the gun being of the bullet type.

Figure XI is a cross-sectional view taken on the line XI—XI of Figure IX.

Figure XII is a cross-sectional view taken on the line XII—XII of Figure X.

Figure XIII is a cross-sectional view taken on the line XIII—XIII of Figure IX.

Figure XIV is a cross-sectional view taken on the line XIV—XIV of Figure X.

Figures XV and XV-A show a fragmentary, vertical, cross-sectional view of a perforating gun showing electrical connections and structure arranged for selectively firing perforating bullets spaced longitudinally of the body of the gun.

Figure XVI shows a schematic view of a suitable electrical circuit and selective switch for selectively firing a plurality of perforating bullets in a perforating gun.

Figure XVII is an enlarged vertical cross-sectional view of the female socket and male plug showing the electrical connections therebetween for selectively firing the charges in the gun.

Numeral references have been employed to designate the various parts shown in the drawings and like numerals designate like parts throughout the various figures of the drawings.

Figures I—VIII illustrate in a semi-schematic manner

the method of perforating and treating plural zones of production in a well by a single run into the well in a continuous unbroken sequence, without withdrawing the pipe, perforating gun or packer from the well before all zones have been perforated and treated.

These figures also illustrate the novel means of preventing sediment from settling on top of the packer while the operation is being carried out. This is an important feature of this invention in that it permits the packer to be relaxed and moved in the casing and reset without the danger of becoming stuck and lodged in the casing.

The numeral 10 indicates a string of casing which has been run into the well bore 11 from the earth's surface, and has been cemented in place as is customary practice.

The perforating gun 12 is indicated in Figures I—VI as having three separate firing sections 14, 15 and 16, each of which has perforating charges or bullets 13 disposed in the wall thereof.

The sectioned gun is merely a schematic representation to more clearly illustrate the method herein described. In actual construction the perforating gun would have charges or bullets spaced longitudinally thereof, the charges or bullets at different longitudinal positions being arranged to be fired separately as hereinbefore indicated.

The perforating gun 12 is attached by means of a sub 18 to the lower end of a string of a tubing 17, which extends from the earth's surface. The sub 18 has mounted therein a male firing plug 19 through which electrical impulses may be supplied to the charges or bullets in the gun 12.

A female plug 20 is suspended to the lower end of an electrical lead 21 extending from the earth's surface, the said female plug being arranged to come into mating contact with the male firing plug 19 in order to make an electrical connection between the electric lead and the plug 19, and in turn, the charges or bullets within the gun. The female plug 20 is arranged to be disconnected from the male plug 19 by pulling upwardly on the electrical lead 21.

An axial flow passage 22 is provided through the gun 12. A connector sub 23 is attached to the lower end of the gun 12, such connector sub having an axial flow passage 24 therethrough which communicates with lateral flow ports 25 provided through the wall of the sub 23.

It will be seen that when the packer 27 is set, fluid may be circulated downwardly through the tubing 17, the gun 12 and outwardly through the lateral ports 25.

The sub 23 has a threaded pin end 26 thereon which is threadedly connected to the head 48 of the packer 27, preferably by left-hand threads, so that the perforating gun may be disconnected from the packer 27, as shown in Figure VII, by right-hand rotation of the pipe 17.

The packer 27, which is disengageably attached to the lower end of the gun 12 by means of the sub 23, as explained, is a hook wall packer of conventional type which is set by pushing downwardly upon the tubing 17. The construction and operation of such packer will be described hereinafter.

In carrying out the method of perforating and treating one or more production zones in a well as disclosed herein, the combination perforating gun and packer is attached to the tubing string 17 and lowered into the well as the tubing string is progressively made up at the surface. When the lowermost firing section 14 is adjacent the lower formation A, the female firing plug 20 is lowered into the tubing 17 on the electrical lead 21 and is engaged with the male firing plug 19. By electrical impulse actuated at the surface, and transmitted through the electrical lead 21, and firing plugs 19 and 20, the charges or bullets 13 in the lower section 14 are fired and penetrate the wall of the casing 10 and the formation A, forming perforations 30 in the wall of the casing.

The packer 27 is then set to seal against the wall of the casing, the packer 27 being closed at this stage of the operation. This is shown in Figure II of the drawings.

Fracturing or acidizing fluid is then forced from the

casing annulus through the perforations 30 into the formation A in the usual manner. While the fracturing or acidizing fluid is thus being injected, washing fluid, such as crude oil, is forced downwardly through the tubing 17, through the perforating gun 12 and outwardly through the lateral ports 25.

This is brought about by equalizing the pressure in the casing 10 and tubing 17, which may be accomplished by the use of two positive pumps at the surface, one of which is connected in communication with the casing and the other is connected in communication with the tubing.

After the formation A has thus been treated, the packer 27 may be released by pulling upwardly on the tubing 17, and the middle firing section 15 of the perforating gun is moved upwardly in the casing adjacent the formation B.

Electrical contact is again made between the male firing plug 19 and female firing plug 20 and the bullets or charges 13 in the firing section 15 are discharged through the wall of the casing 10 to form perforations 31 therein adjacent the formation B. The packer 27 is again set to seal against the wall of the casing and treating fluid is injected from the casing annulus through the perforations 31 into the formation B, while at the same time washing fluid is circulated downwardly through the tubing 17, gun 12 and outwardly through the lateral ports 25 in the manner hereinbefore indicated.

The packer 27 is again relaxed by pulling upwardly on the tubing 17, the upper firing section 16 is moved upwardly adjacent the upper formation C and the charges or bullets therein are fired in the same manner as before described to form perforations 32 in the wall of the casing adjacent the formation C. The packer 27 is again set by pulling upwardly on the tubing 17 and treating fluid is injected through the perforations 32 into the formation C, while at the same time washing fluid is circulated downwardly through the tubing 17, gun 12 and outwardly through the lateral ports 25 in the manner hereinbefore indicated.

Of course, additional formations could be perforated and treated by merely providing a longer gun with more spaced charges or bullets which can be selectively fired.

After all of the zones of production have thus been perforated and treated in a continuous operation, as described, the well is ready to be put on production. The packer 27 may be moved upwardly above the uppermost zone C and set as shown in Figure VII. The perforating gun 12 may be detached from the packer 27, by right-hand rotation of the tubing 17, leaving the packer set in the casing.

After the gun 12 has been withdrawn from the well a production tubing 33 may be run into the casing and threadedly engaged with the head 48 of the packer 27. The packer may then be opened to provide a flow passage therethrough, in the usual manner, such packer being preferably of conventional type which is provided with a valve therein which may be operated to open position by a wire line extending from the surface. Then fluid produced from the formations A, B and C may flow upwardly through the packer and through the production tubing 33 to the surface.

This invention does not depend upon the particular type of packer employed, except that it should be one which can be set and released and moved in the casing without withdrawing it from the well. A suitable form is disclosed herein.

Figure IX illustrates a suitable form of combination packer and perforating gun wherein the perforating gun is of the jet type having charges therein which, when fired, jets metallic molten material at high velocity through restricted orifices in the wall thereof to penetrate the casing and formation. This is a conventional type of gun, as shown in the patent to Sweetman, No. 2,708,408, issued May 17, 1955, and it is not thought necessary to illustrate same in detail.

The perforating gun has a cylindrical body 36 which

is threadedly connected, as indicated at 37, to the sub 18, said sub 18 being attached to the tubing 17.

The male firing pin 19 is mounted in the sub 18 by means of laterally extending, spaced legs 38 which are secured to the inner side of the sub 18. The legs 38 are spaced apart so that fluid may flow therebetween. The body 36 has a hollow interior 39 in which is mounted a plurality of jet charges 40. When the jet charges 40 are fired the liquid penetrating material therein is released and jetted through the restricted ports 41 in the wall of the body 36 and penetrate the casing 10 and the formation which surrounds the charges.

As explained hereinabove there are a number of such charges 40 spaced longitudinally of the body 36, the charges at different longitudinal points being arranged to be fired separately.

An axial flow passage 42 is provided through the upper end of the body 36 and communicates with the tubing 17. The axial flow passage 42 is connected to a tubular flow conduit 43 which passes downwardly through the hollow portion 39 of the body 36 and is connected to an external tubular bypass conduit 44 secured to the wall of the body 36. The flow conduit 44 extends inwardly of the body 36 at the lower end of the body and is connected to a flow passage 46 similar in construction to the flow passage 43 which opens into, and communicates with a concentric passage 46a, extending through the threaded extension 47, formed on the sub 23. The sub 23 is disengageably secured to the body 36 by a threaded extension 47. Fluid dispersal passages 45 are formed in the sub 23, which communicate with the passage 46a.

The fluid dispersal passages 45 are preferably spiral in form as shown in Figures XIII and XIV, and terminate in lateral flow ports 25 provided in the wall of the sub 23.

It will be seen that fluid may be forced downwardly through the tubing 17, through sub 18, flow passages 42 and 43, flow conduit 44, flow passages 46 and 46a, fluid dispersal passages 45 and outwardly through the ports 25. Since the flow dispersal passages 45 and flow ports 25 are restricted, the fluid is jetted therethrough in a swirling motion thus washing away sediment from above the packer 27 when the packer is set.

The packer 27 is of conventional construction and has a metallic head 48 to which the sub 23 is threadedly engaged by the threaded extension 26, previously described. A packer sleeve 50, of resilient material, such as natural or synthetic rubber is loosely disposed on a mandrel 53. A conical base or slip expander 49 is slidably arranged about the mandrel. The rubber sleeve 50 is arranged to be expanded between the heads 48 and 49 as the heads are brought together.

A slip assembly 51 has a base ring 52 which is arranged to slide on the mandrel 53, but is disengageably locked to the mandrel by means of a J slot 54 in the ring, and pin 55 on the mandrel.

A plurality of slip springs 56 are attached to ring 52 and are arranged to slidably engage the casing as the packer is lowered into the casing. Attached to the upper ends of the slip springs 56 are slip tooth segments 57 which loosely engage the expander head 49.

When it is desired to set the packer, the pipe 17 may be rotated a quarter turn to the left to disengage the pin 55 from slot 54 and the pipe 17 may then be pushed downwardly with relation to the slip assembly 51. The springs 56 are pressed against the casing 10 and hold the slip segments 57 as the tubing 17 is pushed downwardly, thus causing the slip segments 57 to be expanded along the conical head 49 and into anchoring engagement with the casing. Continued movement downwardly of the tubing 17 brings the heads 48 and 49 closer together and expands the rubber sleeve 50 into sealing engagement with the casing.

The packer 27 may be released and allowed to relax by pulling upwardly on the pipe 17 thus releasing the slip segments 57 from engagement with the casing and

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allowing the packer sleeve 50 to relax. The packer may be moved upwardly in the casing and again set by pushing downwardly on the pipe in the manner hereinbefore described.

In Figure X a form of combination perforating gun and packer is shown wherein is employed a gun of the bullet type. Such gun has a cylindrical body 58 which is hollow, as indicated at 60. The upper end of the body 58 has an axial flow passage 59 therethrough which communicates with the hollow bore 60. A plurality of bullets 61 are disposed within the hollow portion 60 of the body 58, each bullet being carried in a barrel 62 which is threadedly engaged through passages in the wall of the barrel by means of threads 63. Each bullet is propelled by a powder charge 64 disposed therebehind. When the bullet 61 is fired by electrical impulse, it passes outwardly through the bore 65 of the barrel 62 and penetrates the wall of the casing to form perforations therein.

As previously explained in connection with the jet type perforating gun, there are a plurality of bullets 61 spaced longitudinally of the body 58, the bullets at different longitudinal points being arranged to be fired separately.

It will be seen that fluid may be forced downwardly through the tubing 17, adaptor 18, flow passage 59, hollow portion 60 and flow dispersal conduits 45 and ports 25 above the packer 27. The packer 27 is the same in construction as previously described in connection with Figure IX and the operation is the same. Likewise the construction of the sub 18 and the sub 23 are the same as described in connection with Figure IX. The only difference is the construction of the gun itself, as described.

In Figures XV, XV-A and XVII is shown a suitable construction, and electrical connections, for selectively firing a plurality of bullets or charges in a perforating gun of the type described, and in Figure XVI is shown schematically a suitable electric circuit with switching means for selectively firing a plurality of bullets spaced longitudinally of the gun. The gun illustrated is of the bullet type, as shown in Figure X, but it will be apparent that the same electrical circuit and connections could be employed to selectively fire a plurality of jet charges in a gun like that shown in Figure IX.

As shown the electrical lead 21, shown schematically in Figure I, takes the form of an insulated cable 70, having a plurality of electrical leads 71, 72 and 73 extending therethrough. The female socket 20 includes an inner insulator liner 74 having conductor elements 75, 76 and 77 arranged on the inside thereof spaced apart by insulator rings 78, 79 and 79a. Each of the leads 71, 72 and 73 is connected to one of the conductors 75, 76 and 77 extending through the liner 74.

The male plug 19 has a passage 80 therein which is lined with an insulating sleeve 81. Spaced along the plug 19 is a plurality of conductor elements 82, 83 and 84 which are separated by insulator rings 85, 86 and 86a. It will be seen that the conductors 75-82, 76-83 and 77-84 are in electrical contact. Electrical leads 87, 88 and 89 are connected to the conductors 82, 83 and 84 respectively.

Electrical leads 87, 88 and 89 extend through passage 80, passage 90, provided in the sub 18, through a passage 91 in the body 58, and through a conduit 92, provided on the inner wall of the passage 60.

The leads 87, 88 and 89 are connected to the primer 93 in the perforating devices 94, 95 and 96, respectively. Each perforating device includes a housing 97, a bullet 98 and a powder charge 99 which is set off by the primer 93, when electrically energized.

The electrical circuit shown in Figure XVI for selectively firing the spaced charges in the gun includes a power source 100 which is connected to a rotary selector arm 101 through a switch 102. The power source, switch and selector arm would be located at the sur-

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face. The power source 100 may be selectively connected to the leads 71, 72 and 73 through the contacts 103, 104 and 105 by movement of the rotary arm 101. The leads 71, 72 and 73 are connected to leads 87, 88 and 89 which are in turn connected to the primer 93 in the perforating devices 94, 95 and 96, in the manner hereinbefore described.

It will be apparent that the power source 100 can be selectively placed in contact with spaced charges in the gun to fire same selectively, and at spaced intervals of time, to carry out the method claimed.

Although only one perforating element is illustrated as being fired at one time, such was done as a matter of simplicity and clarity, and it will be understood that a plurality of charges could be fired at a single position of arm 101 by simply connecting a plurality of charges to each of the leads 87, 88 and 89 within the gun.

It is believed apparent that we have provided apparatus employed in perforating and treating one or more zones of production in a well which permits the perforating and treating of such zones in a single, continuous operation, thus eliminating the necessity of a plurality of runs into the well in connection therewith. We have also provided a combination packer and perforating gun, which may be employed to perforate and treat a plurality of zones in a well in a single continuous operation and provides improvements which permits the packer to be relaxed and moved without the danger of becoming stuck or lodged in the well.

It will be apparent that other and further forms and structure for carrying out our invention can be devised without departing from the spirit and scope of the appended claims.

We claim:

1. In a device of the class described, a casing extending into a well bore; a string of tubing extending into the casing, providing an annular space between the tubing and casing; a perforating tool attached to the lower end of the tubing having a longitudinal flow passage therethrough communicating with the bore of the tubing; means to actuate the perforating tool to form perforations in the casing wall; a packer attached below the perforating tool arranged to close off the annular space below the perforating tool; a plurality of lateral flow ports between the perforating tool and the packer, providing flow communication through the longitudinal flow passage between the bore of the tubing and the annular space above the packer; the said annular space above the packer being open to the top of the well bore and in direct communication with the perforations in the casing when the packer is set in the well.

2. The combination called for in claim 1 wherein the perforating tool is a perforating gun.

3. The combination called for in claim 1 wherein the perforating tool is a jet-type perforating gun.

References Cited in the file of this patent

UNITED STATES PATENTS

2,029,491	Lane	Feb. 4, 1936
2,120,615	King	June 14, 1938
2,143,251	Savitz	Jan. 10, 1939
2,169,559	Halliburton	Aug. 15, 1939
2,171,416	Lee	Aug. 29, 1939
2,302,567	O'Neill	Nov. 17, 1942
2,330,509	McCullough	Sept. 28, 1943
2,530,966	Huber	Nov. 21, 1950
2,549,728	Villines	Apr. 17, 1951
2,655,619	Neal	Oct. 13, 1953
2,672,934	Miner	Mar. 23, 1954
2,690,123	Kanady	Sept. 28, 1954
2,745,495	Taylor	May 15, 1956
2,766,690	Lebourg	Oct. 16, 1956
2,866,508	Church	Dec. 30, 1958