July 8, 1969 H. U. GARRETT 3,454,096

CROSSOVER DEVICE FOR PARALLEL PIPE STRINGS

Filed Jan. 29, 1968 Sheet 1 of 2

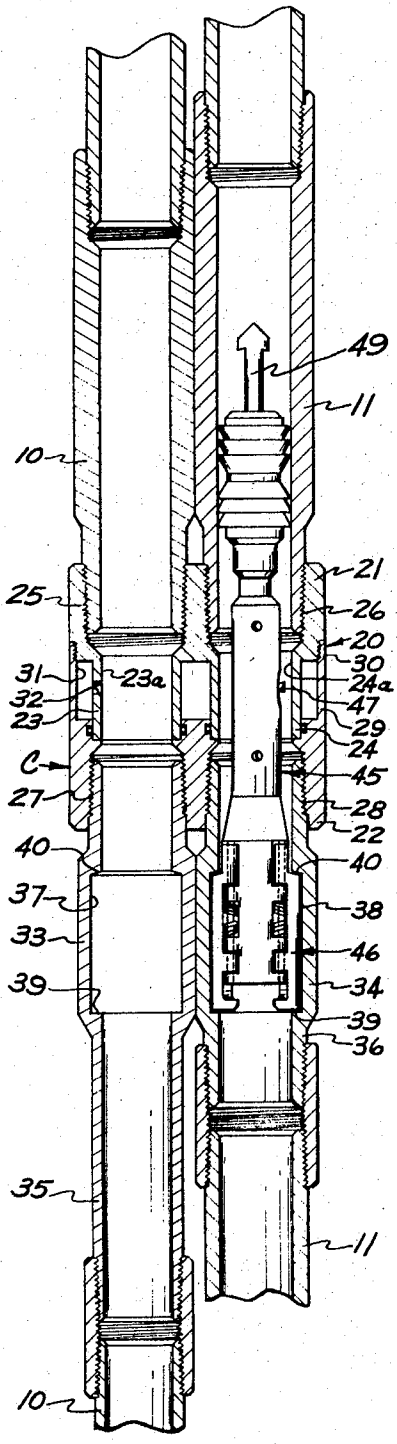


Fig. 1

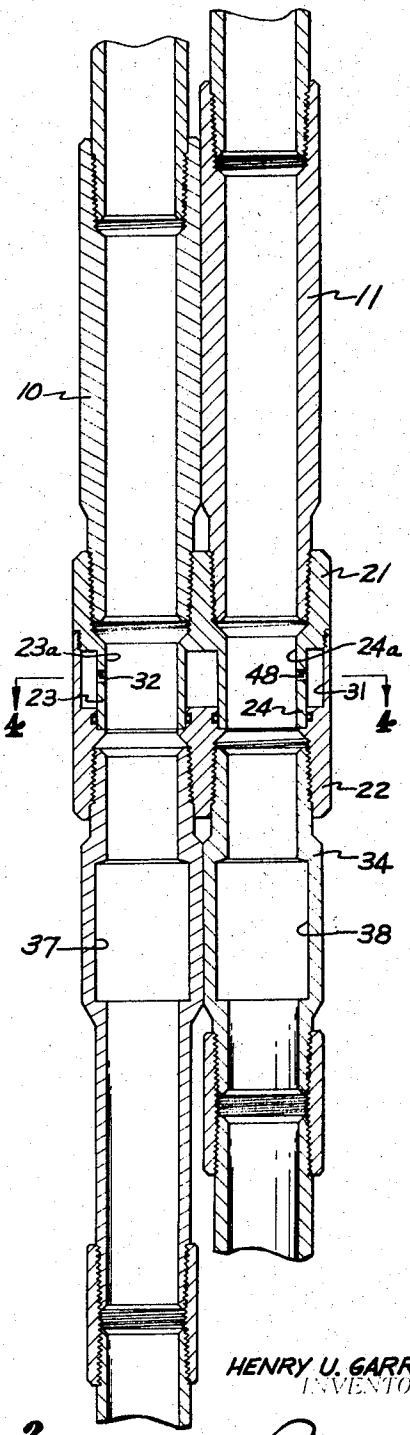


Fig. 2

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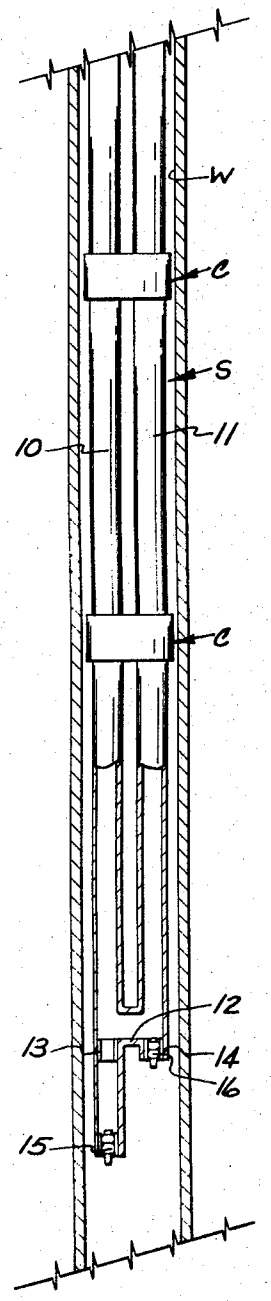


Fig. 3

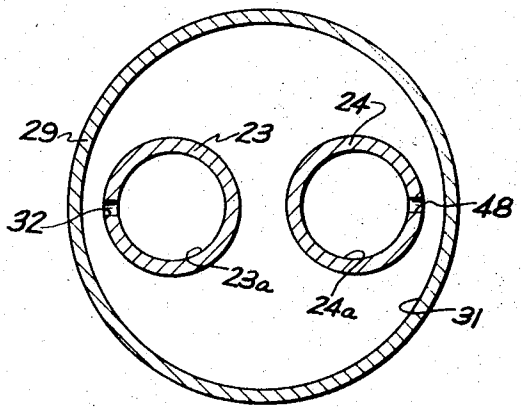


Fig. 4

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CROSSOVER DEVICE FOR PARALLEL PIPE STRINGS

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ABSTRACT OF THE DISCLOSURE

A crossover device adapted for connection into a plurality of parallel pipe strings to provide means for opening communication between the pipe strings when necessary to establish cross-flow between the pipe strings.

In the operation of oil and gas wells, it is frequently necessary, after the wells have been in operation for various periods of time, to perform various operations in the production strings to improve the functioning thereof. Such operations may include installing or activating artificial lift equipment, cleaning out paraffin deposits, removing accumulating sand and other detritus which may plug the production pipe string, and various other operations familiar to those engaged in oil well operations.

While the performance of such servicing operations in wells located on land usually involve various difficulties and complexities, the latter are greatly increased in wells in offshore locations. To meet the service and workover requirements for such wells with minimum difficulty and expense, various types of servicing systems have been devised.

In one such system installed as part of the original well equipment, parallel pipe strings are run into a well, one or more of such pipe strings being equipped to function as production strings and one or more additional pipe strings equipped to function as service strings, the pipe strings being frequently interchangeable as to function. By providing a service pipe string in communication with a production pipe string, fluids under pressure may be circulated from one string to the other to remove obstructions, to clean out sand and paraffin, and to perform other operations in which such circulating fluids may be useful.

In such multiple string systems, an open crossover connection will usually be provided between the strings adjacent their lower ends so that initially a fluid circulation path may be established between the strings as may be required.

However, it is found that in the course of operation, plugging by paraffin or sand, or some other defect or difficulty may occur at one or more points in the production string above the lower ends of the pipe strings and it becomes necessary in some manner to establish cross-flow between the pipe strings at points below or between such plugged or obstructed points, so that pressure fluid may be circulated from the service string into the production pipe string at the elevation most effective to eliminate the difficulty.

The present invention is directed to a form of crossover device adapted to meet and overcome such problems and comprises a body having a plurality of parallel bores and construction to be installed in a corresponding plurality of parallel pipe strings. The body of the device is provided with crossover passage means disposed to connect the several bores, but which initially is sealed off from communication with at least one of said bores, so that upon opening communication between the latter and the crossover passage, as by operation of a perforating device in the sealed-off bore, cross-communication may be established between the several pipe strings.

The crossover device includes a positioning or indexing seat for receiving a perforating tool or the like, in a manner to index the perforating tool at a position enabling it, when actuated, to form an opening through the wall of the sealed-off bore into the crossover passage.

In the case of a dual pipe string system, an opening will ordinarily be pre-formed between the bore of the production string and the crossover passage, and communication established with the service pipe string, when required, by perforating the latter to provide communication with the crossover passage.

Ordinarily, a plurality of such crossover devices will be initially installed at longitudinally spaced points along the parallel strings, so that a plurality of spaced crossover points will be provided at which fluid communication between the several pipe strings may be established as determined by conditions which may develop during the course of operation of the well.

Other and more specific objects and advantages of this invention will become more readily apparent from the following detailed description when read in conjunction with the accompanying drawing which illustrates one useful embodiment in accordance with this invention.

FIG. 1 is a longitudinal sectional view of a parallel dual pipe string system having installed therein a crossover device in accordance with this invention, and showing positioned in one of said pipe strings a perforating tool in position to form a perforation to establish communication with the crossover passage in the device;

FIG. 2 is a view similar to FIG. 1, showing the perforation formed by the perforating tool;

FIG. 3 is an elevational view, partly in section, showing a dual pipe string system in a well, and provided with a pluurality of longitudinally spaced crossover devices in accordance with this invention; and

FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 2.

Referring first to FIG. 3, there is shown a dual parallel pipe system, designated generally by the letter S, installed in a well bore W. System S comprises a pair of parallel pipe strings **10** and **11**. Pipe string **10** may be designated for purposes of this description as a production pipe string, and pipe string **11** as the service pipe string. Adjacent their lower ends pipe strings **10** and **11** are connected by an open crossover connection **12** having a pair of parallel passage means **13** and **14** defining downward extensions of the respective pipe strings **10** and **11**. The passage means **13** and **14** are closed by means of upwardly opening check valves **15** and **16**, respectively, commonly referred to as "standing valves" through which production fluids may enter the respective pipe strings from producing formations intersected by the well bore.

A number of crossover devices, designated generally

by the letter C and constructed generally in accordance with this invention, are positioned at vertically spaced points along the pipe system connected into both pipe strings **10** and **11**. As best shown in FIGS. 1, 2 and 4, each of these crossover devices C comprises a generally tubular body, designated generally by the numeral **20**, comprising telescopically interconnected upper and lower body sections **21** and **22**, respectively. Body **20** is provided with a pair of parallel sleeves **23** and **24** having the respective bores **23***a* and **24***a* coaxial, respectively, with pipe strings **10** and **11**. The upper ends of sleeves **23** and **24** are formed to provide internally threaded sockets **25** and **26**, respectively, which connect into the respective pipe strings **10** and **11**. The lower ends of sleeves **23** and **24** likewise communicate with internally threaded sockets **27** and **28**, respectively, provided in lower body section **22**. The upper portion of lower body section **22** is defined by an annular wall **29** which is threadedly connected to upper body section **21** at **30** and surrounds sleeves **23** and **24** to define an annular crossover passage **31** extending circumferentially about both sleeves **23** and **24**. The wall of sleeve **23** is initially provided with a pre-formed opening **32** placing bore **23***a* into communication with crossover passage **31**. The other sleeve **24** is imperforate and, therefore, initially out of communication with the crossover passage but is placed in communication therewith in a manner to be subsequently described.

Sockets **27** and **28** in lower body section **22** are adapted to receive the threaded upper ends of tubular latch mandrels **33** and **34**, respectively, the lower ends of which carry externally threaded pins **35** and **36**, respectively, for connection to lower sections of the respective pipe strings **10** and **11**. Mandrels **33** and **34** are provided with enlarged bore portions **37** and **38**, respectively, coaxial with the bores of the mandrels and the respective bores **23***a* and **24***a* and their related pipe strings **10** and **11**. The enlarged bore portions **37** and **38** are each defined by a lower end wall **39** and an upper end wall **40**, the latter being downwardly and inwardly bevelled, as shown. Enlarged bore portions **37** and **38** provide latching seats for reception of perforating tools, as will be subsequently described.

Operation of the dual pipe string system may require that fluid circulation be established between pipe strings **10** and **11** at points above crossover connection **12**, for whatever purposes needed. In such case, a perforating tool of generally conventional design, designated generally by the numeral **45**, will be run through the bore of service pipe string **11** to a position in bore **24***a* opposite passageway **31**. To accomplish this positioning of the perforating tool, the lower end of the latter will be conneced to a known form of cam latch, designated generally by the numeral **46**, which forms no part of the present invention but is illustrated in a form which enables perforating tool **45** to be latched into bore enlargement **38** in a position to dispose the perforating element, indicated at **47**, adjacent the wall of sleeve **24** and opposite passageway **31**. It will be understood that the perforating tool, the latch mechanism, and the fishing head **49** by which the tool is inserted into and withdrawn from pipe string **11**, are generally conventional and the details thereof do not form any part of the present invention.

When perforating tool **45** has been positioned as described and illustrated, it will be fired in a generally conventional manner, either by electrical or hydraulic means, so as to cause the perforating element **47** to form a perforation **48** through the wall of sleeve **24** to place bore **24***a* in communication with crossover passage **31**. When this has occurred it will be evident that fluid communication will now be established through crossover passage **31** between bores **23***a* and **24***a*, so that pressure fluid may be circulated down through pipe string **11**, thence through crossover device C into the bore of pipe string **10**, and thence back toward the surface, in order to lift or wash out any obstruction which it is desired to remove from the production pipe string **10**.

By employing a number of crossover devices C at a plurality of points along the pipe string system, circulation may thus be established at any one or more of these several points between these pipe strings.

It will be understood that the crossover devices in accordance with this invention may be made to accommodate more than two parallel pipe strings. In each instance, however, the crossover device will incorporate as many parallel sleeves as may be required to connect it to the several pipe strings. At least one of the sleeves initially will be imperforate and out of communication with the crossover passage, so that communication may be subsequently established, as required, between the several pipe strings. Initially only one of the pipe strings will have a pre-formed opening communicating with the crossover passage, although it may be useful in some cases, where more than two pipe strings are involved, to have more than one of the bores in the crossover device initially open to the crossover passage.

It will be understood that various other modifications and variations may be made in the details of the illustrative embodiment within the scope of the appended claims but without departing from the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

1. A crossover device for connecting parallel pipe strings, comprising:

(a) a body having a plurality of parallel bores therethrough for connection into a corresponding number of parallel pipe strings,

(b) a lateral passage in the body extending between said bores,

(c) an opening communicating said passage with one of said bores, and

(d) means in each of the other bores constructed and arranged to locate a perforating tool therein in a position to provide, when actuated, an opening communicating that one of said other bores with said passage.

2. A crossover device according to claim **1**, wherein the number of said parallel pipe strings is two.

3. A crossover device according to claim **1**, wherein said means comprises cylindrically enlarged portions of said bores defining seats for latching engagement by said perforating tool.

4. A crossover device according to claim **1**, wherein said passage comprises an annular passage extending circumferentially of said body exteriorly of said bores.

5. An equipment system for wells, comprising the combination of:

(a) a plurality of parallel pipe strings extending into a well bore,

(b) an open crossover connection member connecting said pipe strings adjacent their lower ends,

(c) said connection member including extensions coaxial respectively with said pipe strings and having upwardly opening check valve means therein,

(d) crossover devices connecting said pipe strings at one or more vertically spaced points above said crossover connection member, each of said crossover devices comprising:

(i) a body having a plurality of parallel bores therethrough for connection into the several said pipe strings,

(ii) a lateral passage in the body extending between said bores,

(iii) an opening communicating said passage with one of said bores, and

(iv) means in each of the other bores constructed and arranged to locate a perforating tool therein in a position to provide, when actuated, an opening communicating that one of said other bores with said passage.

6. An equipment system according to claim 5, wherein the number of said pipe strings is two.

7. In an equipment system according to claim 5, said means comprising a cylindrically enlarged portion of said bore defining a seat for latching engagement by said perforating tool.

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U.S. Cl. X.R.

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