

July 5, 1960

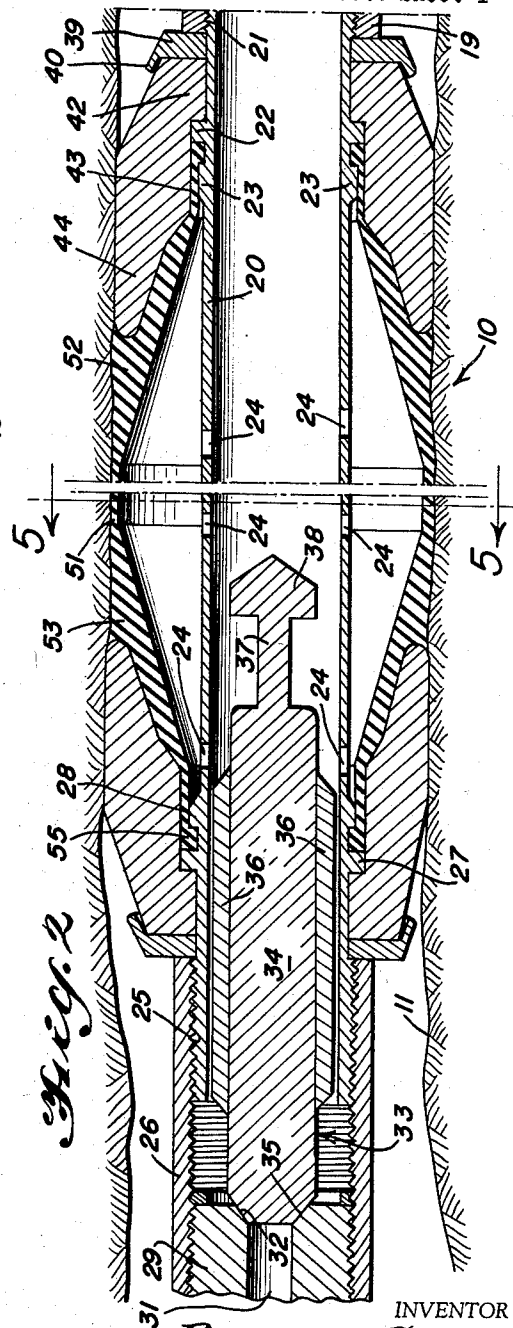
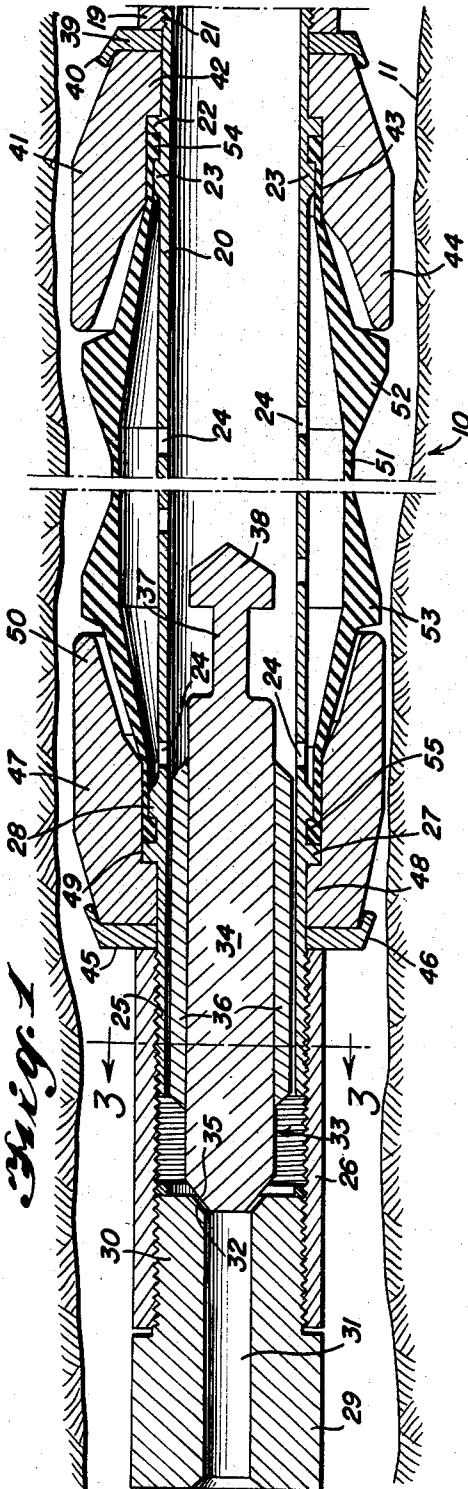
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2,943,684

SELECTIVE HYDROFRACTURING APPARATUS

Filed Feb. 13, 1958

3 Sheets-Sheet 1



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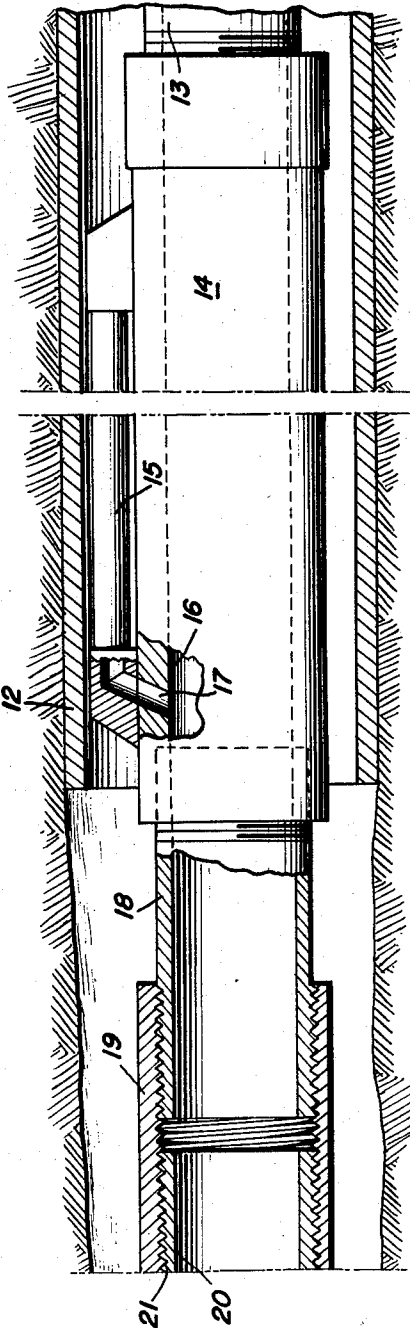


Fig. 1a

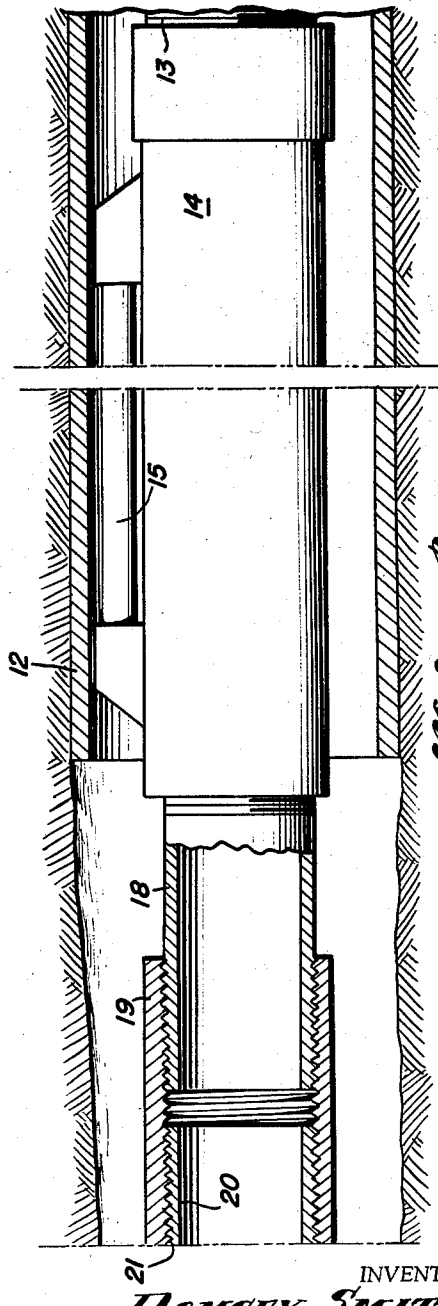


Fig. 2a

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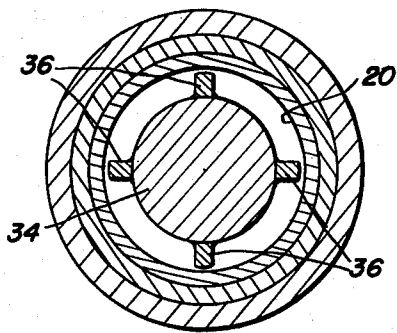


Fig. 3

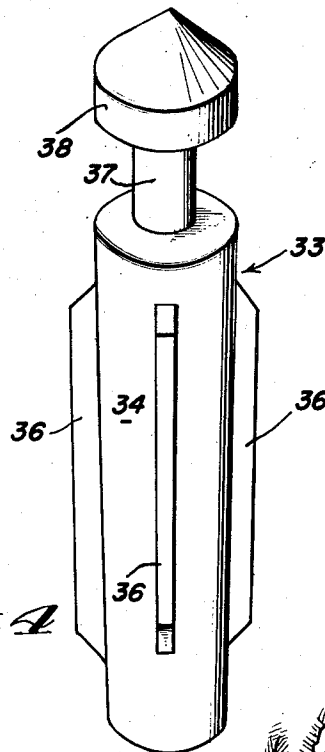


Fig. 4

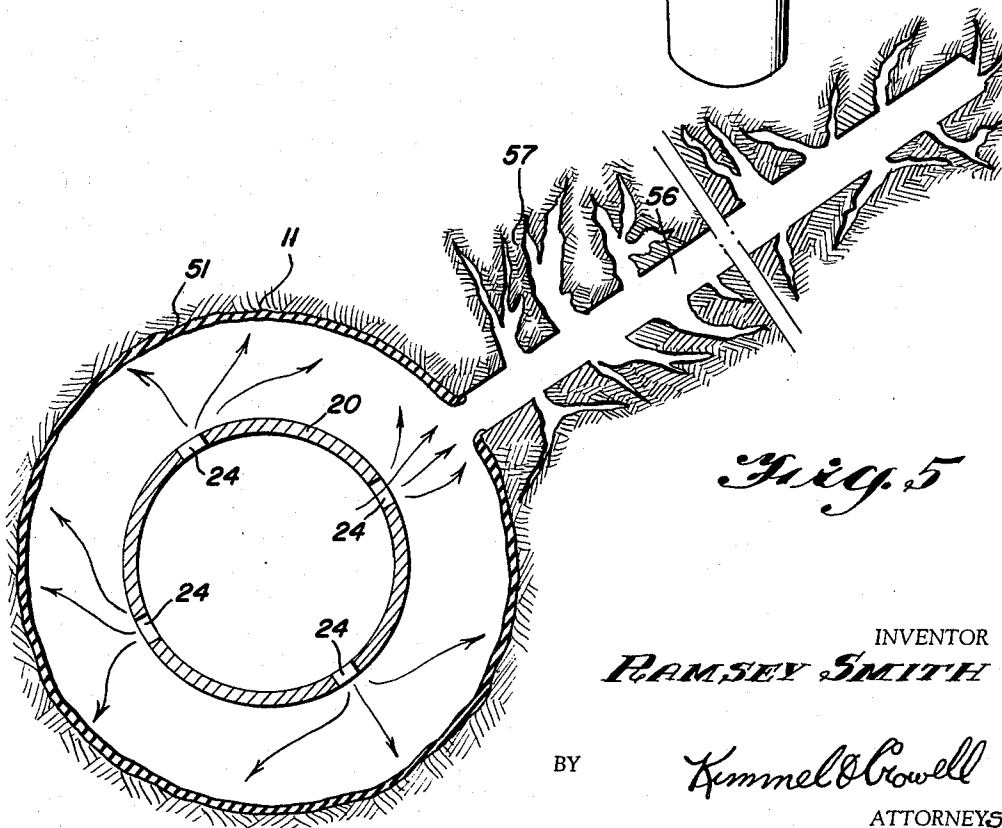


Fig. 5

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SELECTIVE HYDROFRACTURING APPARATUS

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2 Claims. (Cl. 166—187)

The present invention relates to selective hydrofracturing apparatus, and particularly to such apparatus used in an oil well below the casing thereof.

The primary object of the invention is to provide a structure for selectively applying hydrofracturing pressures to precut slots in the oil formation.

Another object of the invention is to provide a structure of the class described above in which the hydrofracturing pressures are suddenly released and applied to the oil bearing formations extremely quickly.

A still further object of the invention is to provide a hydrofracturing apparatus of the class described above in which the means for selectively applying the pressures to the oil bearing formations simultaneously seals the non-selected areas.

Other objects and advantages will become apparent in the following specification when considered in the light of the attached drawings, in which:

Figures 1 and 1a comprise a vertical sectional view illustrating the device with the hydraulic pressures not applied.

Figures 2 and 2a are a view similar to Figure 1 illustrating the device with the hydraulic pressures applied.

Figure 3 is a horizontal cross-section taken along the line 3—3 of Figure 1, looking in the direction of the arrows.

Figure 4 is a perspective view of the valve.

Figure 5, is a horizontal section taken along the line 5—5 of Figure 2, looking in the direction of the arrows.

Referring now to the drawings in detail wherein like reference characters indicate like parts throughout the several figures, the reference numeral 10 indicates generally a selective hydrofracturing device constructed in accordance with the invention.

The selective hydrofracturing device 10 is used in a well bore 11 at a point below the conventional casing 12. The selective hydrofracturing device 10 is connected to the lower end of a conventional string of well tubing 13 which is lowered into the well and raised out of the well in a conventional manner.

A conventional circulating mandrel 14 is threaded onto the well tubing 13 and provided with a conventional valve structure 15 communicating with the vertical bore 16 in the mandrel 14 through a port 17. A threaded nipple 18 depends from the lower end of the mandrel 14 and has an internally threaded jam sleeve 19 threaded thereon.

An elongated tube 20 is externally threaded at 21 and has the lower end of the jam sleeve 19 threaded thereon. The tube 20 has an annular radially outwardly extending flange 22 integrally formed thereon adjacent the threaded end 21. A second annular flange 23 extends radially outwardly from the tube 20 and is integrally formed therewith.

The flange 23 is arranged in closely spaced relation to the flange 22 and has a diameter somewhat less than the diameter of the flange 22. The tube 20 is provided with a plurality of apertures 24 extending therethrough at a point below the flanges 22, 23.

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The lower end of the tube 20 is externally threaded at 25, and a second jam sleeve 26 is threaded thereon, as best shown in Figures 1 and 2.

The tube 20 is provided with an annular flange 27 extending radially outwardly therefrom and positioned adjacent the threaded end 25 thereof. An annular flange 28 having a diameter somewhat less than the flange 27 is positioned adjacent thereto and arranged parallel thereto.

The flanges 27, 28 are formed integrally with the tube 20 and correspond to the flanges 22, 23.

A plug 29 is provided with an externally threaded reduced extension 30 threaded into the lower end of the jam sleeve 26 and has an axial bore 31 formed therein. The upper end of the plug 29 is provided with a valve seat 32.

A valve, indicated generally at 33, includes a cylindrical body 34 having a tapered valve face 35 formed on the lower end thereof to cooperate with the valve seat 32. The cylindrical body 34 has a plurality of integral fins 36 formed thereon to center the valve 33 in the tubing 13 and tube 20.

The cylindrical body 34 has a reduced extension 37 formed axially on the upper end thereof terminating in a conical head 38 to permit a conventional fishing tool (not shown) to retrieve the valve 33 when desired.

A packer cup seat box 39 is positioned on the tube 20 between the flange 22 and the jam sleeve 19. The seat box 39 is of generally circular configuration and is provided with a conical flange 40 integrally formed on the outer edge thereof.

A flexible packing cup 41 has an annular portion 42 engaged between the seat box 39 and the flange 22, as best seen in Figure 1. The packing cup 41 has an enlarged bore 43 extending over the flanges 22, 23. The packing cup 41 is further provided with an inwardly and downwardly extending conical portion 44 for use as described below.

A second packer cup seat box 45 encompasses the tube 20 between the jam sleeve 26 and the flange 27 and is of generally circular configuration. A conical flange 46 is formed integrally on the outer edge of the seat box 45 and extends toward the seat box 39.

A flexible packing cup 47, identical with the packing cup 41, is provided with a portion 48 engaging between the seat box 45 and the flange 27. The packing cup 47 has an enlarged bore 49 engaging over the flanges 27, 28, as can be seen in Figure 1. The packing cup 47 has a conical end portion 50 extending toward the packing cup 41 for use as described below.

A relative thin tubular flexible packing member 51 is positioned between the packing cups 41, 47 encompassing the tube 20. The member 51 is provided with annular thickened portions 52, 53, respectively, adjacent the packing cups 41, 47.

The member 51 is provided with a radially inwardly extending annular bead 54 at one end thereof engaging the tube 20 between the flanges 22, 23. The opposite end of the member 51 is provided with a radially inwardly projecting annular bead 55 engaging the tube 20 between the flanges 27, 28.

The bore 43 of the packing cup 41 engages over the upper end of the member 51 binding the bead 54 against the tube 20 between the flanges 22, 23. The bore 49 of the packing cup 47 engages over the opposite end of the member 51 securing the bead 55 against the tube 20 between the flanges 27, 28.

The selective hydrofracturing device 10 is used in a well bore 11 in which a slot 56 has been mechanically cut into the oil formation 57 by means (not shown) used in a previous operation.

In the use and operation of the invention, the well bore 11 is first filled with water, if not already full, and the

circulating mandrel 14 is attached to the end of the tubing 13. The tube 20 is then attached to the circulating mandrel 14 with the valve 33 removed. The well tubing 13 is then lowered into the well bore 11 until the member 51 is opposite a slot 56 mechanically cut into the oil bearing formation 57.

As the well tubing 13 is lowered into the well bore 11, the water in the well bore 11 passes upwardly through the bore 31 in the plug 29 filling the tube 20, the well tubing 13, and passing outwardly through the port 17 and the valve 15 of the mandrel 14 to equalize the pressures within the well tubing 13 and the outside thereof.

After the member 51 is positioned opposite the slot 56, the valve 33 is dropped through the tubing 13 so that the valve face 35 engages in sealing relation the valve seat 32. The valve 15 in the circulating mandrel 14 is then closed and the well tubing 13 is connected in a conventional manner to a high pressure hydraulic pump (not shown) on the surface.

The pressure of the fluid within the well tubing 13 is then increased, expanding the member 51 into engagement with the well bore 11 completely sealing the adjacent surfaces of the formation 57. As the pressure within the device continues to increase, the member 51 will begin to bulge or creep into the slot 56 until the pressure reaches the point where the member 51 will rupture directly into the slot 56 releasing the pressure from the pump directly into the slot. This released pressure onto the walls of the slot 56 under continual pressure buildup from the pump will shatter or fracture the producing formation 57 thereby opening up vastly greater productive areas of the well for oil, gas or water.

To retrieve the device from the well, the pressure from the pump is first released and by using a conventional fishing tool the valve 33 is retrieved, opening the bore 31 in the plug 29. The valve 15 in the circulating mandrel 14 is then opened to again equalize the pressures in the well bore 11 with those in the well tubing 13 and the well tubing 13 is lifted out of the well bore 11 in the usual manner with the fluid flowing therefrom freely.

Having thus described the preferred embodiment of the invention, it should be understood that numerous structural modifications and adaptations may be resorted to without departing from the scope of the appended claims.

What is claimed is:

1. A selective hydrofracturing structure comprising a tube, two pairs of annular flanges integrally formed adjacent each end of said tube and extending radially outwardly therefrom, the members of each pair being spaced axially of the tube to form an annular recess, said tube being perforated between said pairs of flanges, an elongated flexible tubular member encompassing said tube, inwardly projecting annular beads formed on opposite ends of said member engaging respectively between the flanges at each end of said tube, said annular recess being adopted for the reception of a bead, a flexible resilient internally conical packer cup slidably mounted on said tube at each end thereon, each of said cups having a bore, a pair of generally circular packer cup seat boxes engaged over opposite ends of said tube in contact with the opposite ends of said packer cups, and a jam sleeve threaded on each end of said tube engaging said seat boxes securing said seat boxes thereon in engagement with said packer cups to clamp said packer cups in member securing position, the outermost diameter of the outermost flange of each pair and the outer diameter of the elongated tubular member when in engagement with the innermost flange of each pair forming a close fit with the bore of each cup when the cup is positioned thereover.

2. A device as claimed in claim 1 wherein a plug is detachably connected to the lower end of said tube and provided with a conical valve seat, an elongated valve body positioned in said tube for reciprocation therein to engage said valve seat closing the lower end of said tube, and a plurality of elongated radially extending vanes formed on said valve body and having the circumference of said vanes slightly smaller than the internal diameter of said tube whereby said valve body is maintained in centered relation in said tube with respect to said valve seat.

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