

July 15, 1952

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2,603,293

MEANS FOR SEALING OFF WELL FORMATIONS

Original Filed Sept. 20, 1944

2 SHEETS—SHEET 1

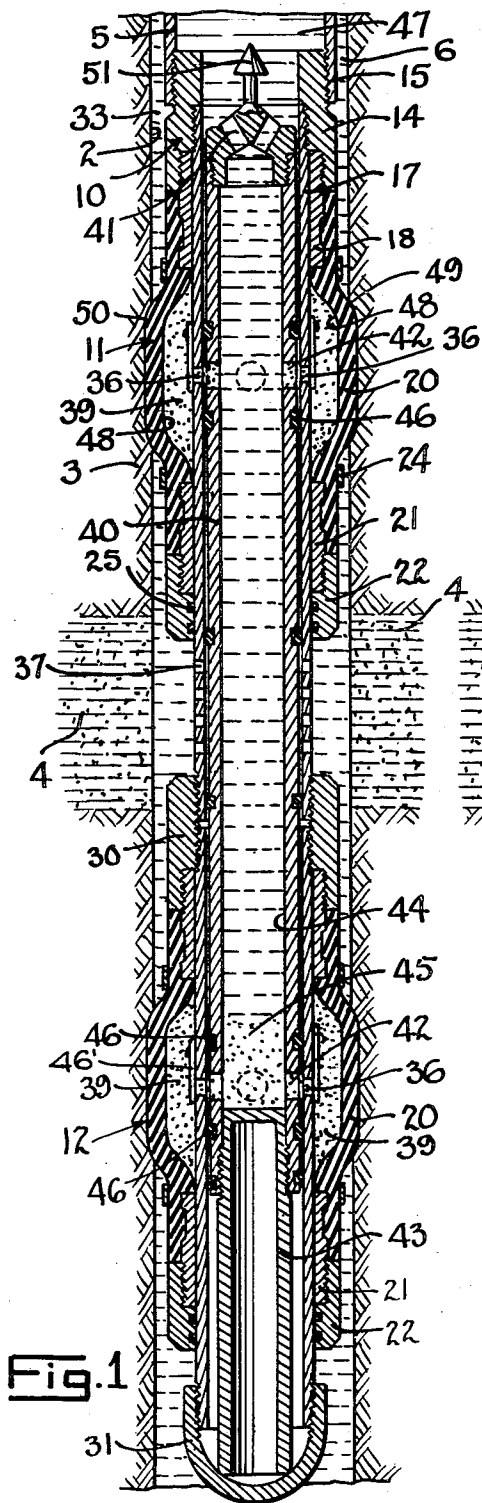
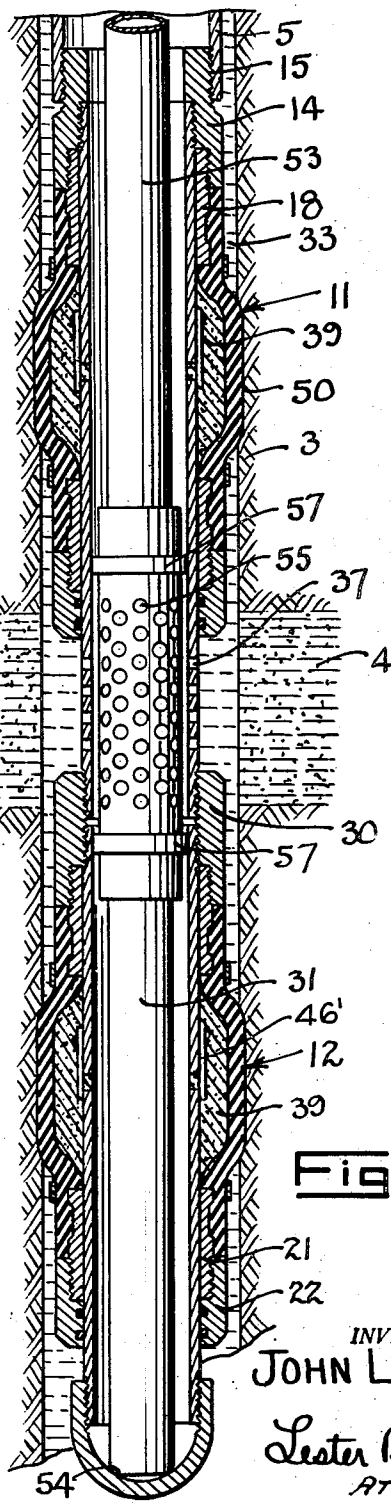


Fig. 2.

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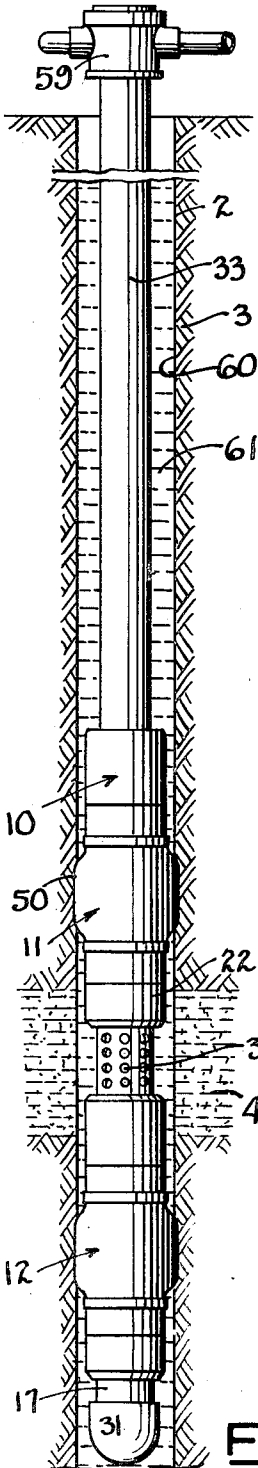


Fig. 3.

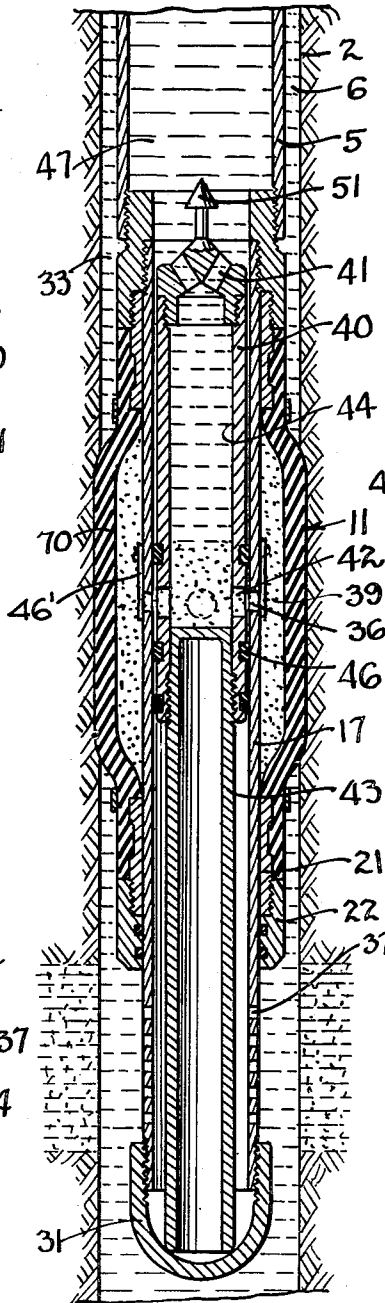


Fig. 4.

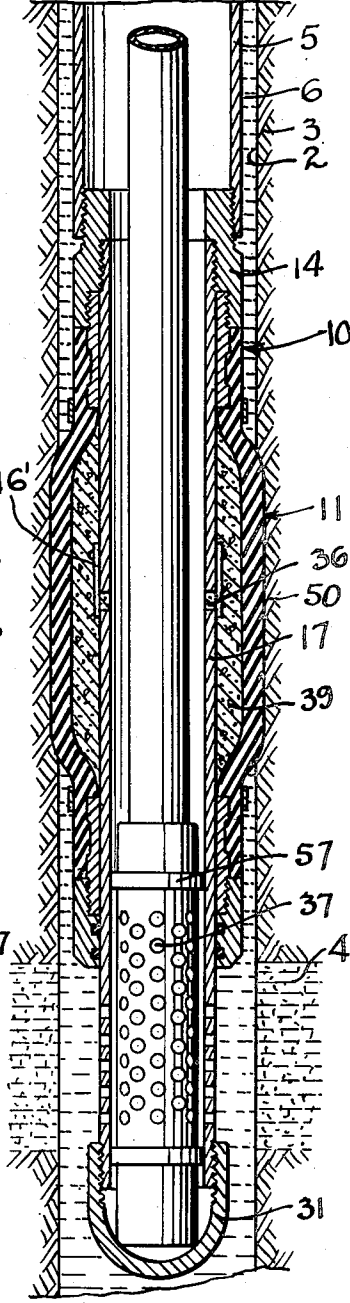


Fig. 5.

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2,603,293

MEANS FOR SEALING OFF WELL FORMATIONS

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Continuation of application Serial No. 554,943, September 20, 1944. This application May 17, 1950, Serial No. 162,469

2 Claims. (Cl. 166—11)

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The invention relates to means for sealing and isolating well formations.

This application is a continuation of my prior copending application Serial Number 554,943, filed September 20, 1944, now abandoned, and is entitled to the benefit of the filing date thereof.

In the drilling, completing and producing of wells either by flowing or pumping, it is desirable to exclude the flow from certain formations in order to obtain uncontaminated production from other formations. Great difficulty has been encountered in the cementing and sealing of the well casings and pipe, and in sealing off some formations to the exclusion of others.

In the usual practice of cementing, the cement is pumped down through the casing and upwardly around the outside thereof in the hope that a complete seal will be obtained between the outside of the casing and the face of the formation or well bore. Very often the pipe is not centered in the well bore and the cement does not penetrate entirely around the pipe for forming a complete seal. Very often the cement channels through the drilling fluid in the well. The result is that no proper seal is obtained and contamination of the production from the well results.

The term "cementing" is used generally in describing the present invention and contemplates any material which can be introduced in liquid or semi-liquid form and which will solidify after being deposited in the proper position. The term "cement" is therefore contemplated as including any suitable materials, be they the usual and well known cementing materials, plastics, chemical compositions or any combination of materials by which a seal can be formed.

It is one of the objects of the present invention to provide an apparatus which seals well formations by creating a seal by the introduction of a liquid material which will be suitably confined so as to solidify.

Another object of the invention is to provide an inflatable packer or packers which can be set to provide a seal at any desired location in the well where the material used for inflating the packers will solidify to form a permanent or semi-permanent installation.

Another object of the invention is to provide a hydraulically inflated packer of a type and construction which will constitute a permanent installation in the well bore when inflated with a material which solidifies.

Another object of the invention is to provide

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an apparatus for cementing a well by confining the cement within an inflatable sleeve or confining member.

Still another object of the invention is to provide an apparatus for inflating hydraulic packers with a cementing material by introducing the cement in a retrievable container, and discharging the cement by hydraulic pressure into the packers.

Still another object of the invention is to provide an apparatus for completing wells by sealing the tubing or production pipe in position while eliminating the use of casing.

Still another object of the invention is to isolate a productive formation by providing packing seals in position above and below the formation.

Still another object of the invention is to cement a casing in position by packers inflated with cement slurry.

Still another object of the invention is to provide an apparatus for sealing a casing in a well bore by attaching an inflatable packer to the lower end of the casing.

Still another object of the invention is to produce a well through a tubing and flow pipe extending through a cemented packer.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings, wherein:

Fig. 1 is a vertical sectional view of a productive formation which has been isolated by the setting of cement inflated packers.

Fig. 2 is a vertical sectional view of the construction of Fig. 1 where the packers have been set, the inflating liquid container retrieved, and the tubing or flow string arranged in position.

Fig. 3 shows the well completed where the casing has been omitted and the tubing cemented in position with the cemented packers.

Fig. 4 is a vertical sectional view showing the use of one cemented packer to seal the lower end of the casing.

Fig. 5 shows the construction of Fig. 4 with the inflating liquid container retrieved and the tubing or flow string arranged in position.

Having reference to Fig. 1, a well bore 2 has been drilled in the earth 3 and has penetrated a formation 4 containing a desirable fluid which is to be produced from the well. Such fluid may be oil, gas, water, sulphur, or any material which is to be removed.

Such formation is shown in Figs. 1 and 2 as being spaced above the lower end of the well

bore but it may be closely adjacent the bottom of the well bore, as seen in Figs. 4 and 5.

A string of pipe or casing 5 is shown as extending down into the well in Fig. 1. The usual practice heretofore has been to run this string of pipe or casing into the well and then discharge large quantities of cement downwardly therethrough and upwardly around the lower end and attempt to fill the annular space 6 therearound to prevent any pressure in the productive formation from escaping except through the casing and to exclude other fluids from above the productive formation. Such a cementing operation involves considerable difficulty, expense, and the present invention contemplates that the lower end of the string of pipe 5 will have attached thereto a sealing assembly 10. If a seal is to be obtained, both above and below the productive formation 4, then this assembly 10 will be made up of the upper packer 11 and a lower packer 12. If the seal is to be above the formation as seen in Figs. 4 and 5, then only one packer 11 will be used.

The assembly 10, as seen in Fig. 1, embodies a head 14 threaded at 15 into the lower end of the casing. This head has the mandrel or body 17 threaded into it and this mandrel serves as a support for both the packers 11 and 12 which are made up by a collar 13 threaded into the head 14 and supporting the resilient packing sleeve 20. The lower end of each packer includes another collar 21 and the fitting or nipple 22 threaded thereon. The packing sleeve 20 may be affixed in any desired manner to the collar 21 and may have a retainer band 24 to assist in confining the resilient material. The fitting 22 may have the packing rings 25 therein to provide a seal with the mandrel because when the packing sleeve 20 is inflated it will contract longitudinally as it increases in diameter and the fitting 22 is arranged to slide along the mandrel when such action occurs.

While the packing sleeve 20 is shown as a cylinder of resilient material in the drawings, it is to be understood that it will be as thin as possible so that it will allow a maximum inflation with cement but will have sufficient strength to retain the applied pressures and may be constructed with suitable reinforcing to insure its ability to withstand high pressures. Such a packer is disclosed in my copending application, Serial Number 473,928, filed January 29, 1943, for High Pressure Hydraulically Inflatable Packer and Assembly for Testing and Treating Wells, now abandoned, and refiled as application Serial Number 65,843, filed December 17, 1948. It is to be understood that these packers may be set and reset at will depending on conditions and may be of any desired length to provide the desired seal. The length may vary with the type of formation against which the packer is to be set, the depth of the well, or the pressures and type of packer being set. Generally such length may be from five to twenty feet.

The general description of a packer given above can be applied to the upper packer 11 and the lower packer 12 of Figs. 1 and 2 or the single packers shown in Figs. 4 and 5.

The lower end of the mandrel or body 17 is preferably closed with a shoe 31. Arranged in this mandrel 17 are the ports 36 which are disposed at a desired elevation within the inflatable sleeve 20 so that a fluid material may be forced into the packers to inflate them as seen in the drawing.

Intermediate to the two packers as seen in Fig. 1 and below the single packer as seen in Figs. 4 and 5, a series of inlet ports 37 have been shown. These ports are arranged to admit fluid from the formation 4 into the tool so that it may flow upwardly in the well.

In order to inflate the packers 11 and 12, a container 40 has been devised which is in the form of a cylindrical member adapted to be filled at the surface with the material which is to be forced into the packers through the ports 36. As previously stated, this material is preferably a liquid or semi-liquid or suitable chemical which will solidify in the form of a solid block of material 39 inside of each of the packers.

This container 40 will preferably have the openings 41 by which pressure might be applied in order to discharge the filler material from the container. A plurality of openings 42 are arranged in the wall of the container to permit such discharge and the container will be so constructed and arranged with a nipple 43 threaded into the lower end thereof first to close the container body and second to space the openings 42 in alignment or at the elevation of the ports 36 leading into the packers. This nipple 43 will cause the container to stop at the desired elevation.

The hollow body of the container forms a chamber 44 which contains the filler or cementitious material 45.

In order that the container will be suitably sealed against the inner periphery of the mandrel or body 17, a plurality of packings 46 have been disposed in the surface of the container both above and below the openings 42. In this manner the cement will be prevented from flowing along the container inside of the mandrel. Similar packings 46 may be placed above and below the flow ports 37.

In operation, the tool 10 will be attached to the lower end of the operating pipe 5 which may be the casing which is to be set in the well. The entire assembly will then be lowered into the well except that the container 40 may not be in position. It will be understood that the well bore 2 is filled with a liquid 33 which may be the drilling fluid or any fluid which has flowed into or pumped into the well. The packers will be deflated and the ports 37 will be open so that as the casing is lowered, the well fluid may flow in through the ports 37 into the tool and such liquid inside of the tool and the casing is indicated at 47. The assembly can thus be lowered to the elevation where the packers are to be set.

In some instances, however, where the operating pipe 5 or casing has a tremendous weight, it is desirable to float it into the well liquid 43 and in such an instance the casing could be lowered a suitable distance to allow the inflow of some of the well fluid and then when the string of the casing became heavier and the flotation effect was achieved as desired, a tool similar to the container 40 could be lowered into place so as to close or cover the ports 37 and prevent any further inflow of liquid. Subsequent lowering of the casing would develop additional floating effect. It is desirable to allow the liquid to flow into the casing so as to prevent collapse due to the static pressure in the well bore. When the casing is landed in the desired position, if the shoe 31 rests upon the bottom of the well, then this closure sleeve could be removed so as to allow the pressure to equalize on the inside and the outside of the casing.

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The container 40 would then be filled with cementitious material and lowered or dropped into the casing so that it would move to the position shown in Fig. 1. The application of pressure to the liquid 47 inside of the casing would thus create a predominant pressure inside the casing and the container 40 which would exceed the pressure of the static column of liquid 33 in the well bore. This predominant pressure would cause the liquid to be forced out of the container through the ports 42 and 36 to inflate the packers and form a body of material inside of the packers.

It seems clear that any desired pressure could be applied in this manner so that the packers would be definitely inflated and so that the periphery 49 of the packing sleeves 20 would be forced against the surface or face of the well bore with considerable pressure and the face of such formation could actually be deformed or compressed as shown at 50. The inside or interior 48 of the packers would preferably be completely filled with the material except for possibly a small amount of liquid which might have seeped in during the lowering operation.

When the pressure has been applied and the packers inflated, such pressure may be maintained on the casing to keep the packers inflated until the cementitious material solidifies or takes a permanent set. An alternative method would be to lower a suitable grappling tool into the well which would engage the spear head 51 on the container 40 and by a slight upward movement, the ports 42 would be moved out of alignment with the ports 36 and the packing ring which was previously just below the ports 36 would be moved thereabove and the next lower packing ring 46 would then be below the ports 36 so that such ports would be sealed off between the two packings and the material in the packers would thus be locked in position so that the discharging pressure need not be maintained on the casing. The container could be held in this position until the material became solid and then it is preferably removed or retrieved by raising the grappling tool and container. The container is thus removed from the well. If desired the spring flap or check valves 46' can be used to lock the cement in the packers.

In this manner the packers are inflated and form a permanent seal with the wall of the well bore. These seals will prevent the fluid from above moving downward into the formation 4 or for any pressure in the formation to escape upward around the outside of the casing 5. When the container 40 is removed, if there is a predominant pressure in the formation 4, there will be a voluntary flow into the well. If there is no such flow, of course the liquid 47 inside of the casing can be bailed or pumped out so as to allow an inflow of fluid from the formation.

It is the usual practice to produce the liquid from a formation through a pipe of smaller diameter than the casing and Fig. 2 shows a string of tubing or pipe 53 as having been lowered down through the casing into the mandrel so that the lower end 54 engages the shoe 31 and this pipe is shown as carrying a strainer or perforated section 55 which is disposed at the elevation of the inlet ports 37. This section may have the sealing rings 57 thereon above and below the screen portion 55 so that the inside of the mandrel is sealed and the flow will be directed through the tubing. The well may flow voluntarily or suit-

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ble pumping equipment may be run and set inside the tubing.

The well may be completed by the process shown in Fig. 3 wherein the parts are the same as described in connection with Figs. 1 and 2, except that the casing 5 has been omitted and the tubing 53 has had the sealing assembly 10 affixed thereto. The lowering operation and the inflating of the packers is the same except that the container 40 has been lowered and retrieved through the tubing 53. Suitable wellhead fittings 59 have been attached to the tubing and the well is now ready to produce by any means whatsoever.

The open bore hole 60 above the packers and sealing assembly may remain full of liquid 61 which may be the drilling fluid or any other fluid introduced into the well. An arrangement of this sort is a permanent or semi-permanent installation and even if the wall does cave in, no damage will occur. If the well is to be later abandoned, the tubing can be salvaged, leaving the sealing assembly in the well bore.

Figs. 4 and 5 show an arrangement where only a single packer 70 is to be positioned and instead of the lower packer assembly being connected to the lower end of the mandrel, the shoe 31 has been connected to the upper portion of the mandrel so that the packer forms a seal directly above the productive formation 4. The container 40 will be somewhat shorter and the nipple 43 will be somewhat longer, so as to properly proportion the parts. An assembly of this sort may be run where the productive formation 4 is closely adjacent the bottom of the well bore or where no salt water or other objectionable material is present in the bottom of the well.

Fig. 5 shows the tubing and strainer arrangement as having been run into the mandrel after the sealing material has been deposited in the packer.

With the foregoing process, it seems clear that a minimum quantity of the cementing material 45 will be used because only a sufficient quantity to inflate the packers is required. A very small quantity of cement may therefore be employed and the introduction of it into the packers assures that it is positioned in the proper location, and it assures the centering of the pipe, and insures a permanent seal.

Broadly, the invention contemplates an apparatus for sealing well formations which permits a substantial reduction in the amount of sealing material required, permits the production of a well without any casing, and permits the creation of a permanent seal without anchoring the entire casing in the well bore.

What is claimed is:

1. A cementing structure for well casing comprising a perforate casing section, an inflatable packer on the casing above the perforated section to provide a seal with the open well bore wall, and means including a liquid plastics carrying container to be positioned in said casing adjacent said packer, means in said container for admitting pressure fluid into said container to discharge plastic material therefrom under pressure to inflate said packer to seal with the well bore wall, ports in said casing and container alignable to discharge said plastic material into said packer, and sealing means to seal between said container and casing above and below the aligned ports.

2. A cement retainer for pipe in wells, comprising a pipe to be cemented in the well bore, a flexible inflatable packer carried by and dis-

posed around said pipe, a port through said pipe into the packer, a plastics material carrier to be filled at the surface and inserted into and movable through the pipe to the elevation of said packer, discharge port in said carrier, means in the pipe and on said carrier to align the carrier and pipe ports, openings in said carrier above the material therein to admit fluid pressure in the pipe to discharge the plastics material through said ports to inflate said packer, and seal means on said carrier to seal with the inside of said pipe above and below said ports to retain the material.

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