

[54] WELL FLOW CONTROLLING SYSTEM AND APPARATUS

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[51] Int. Cl. E21b 33/00

[58] Field of Search 166/72, 73, 127, 191, 209, 166/226, 314, 315, 237, 289, 290, 297, 313

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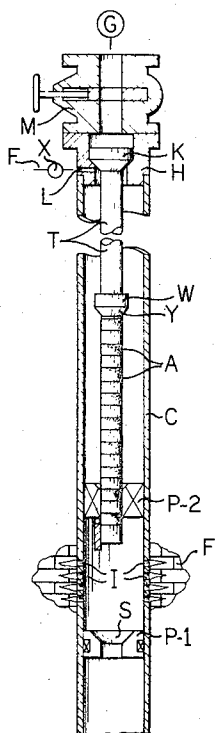
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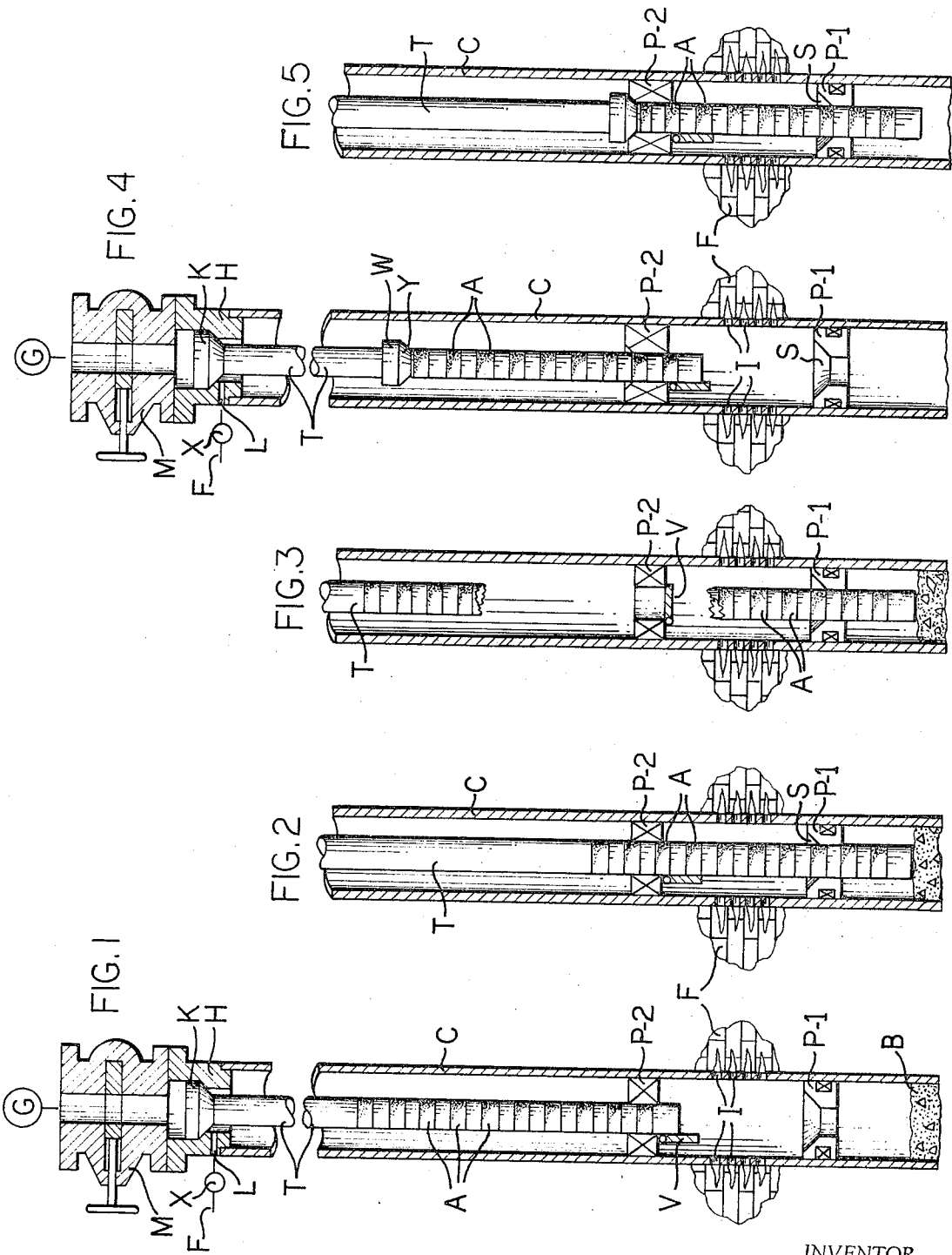
Primary Examiner—Marvin A. Champion
Assistant Examiner—Jack E. Ebel

[57] **ABSTRACT**

A method of controlling flow from the producing formation of a well upon the occurrence of a disaster, an accident or a fire which could result in turning the well loose for wild flow of the well fluids from the well out of control, as might occur in the event of a bombing, a ship striking a marine type installation, a storm or other disaster. The method contemplates movement of the producing tubing string downwardly through at least two spaced packers one above, and one below the producing formation, the tubing having sealing assemblies connected therein in sufficient length to seal with the two spaced packers to close off entrance of well fluids into the tubing string when the tubing has been moved downwardly to the lower position. The movement may result from destruction of the suspension for the tubing string accidentally or intentionally upon the occurrence of the disaster or hazard. Means is also disclosed for closing the upper packer in the event the tubing string parts and a shorter section passes completely through the upper packer.

17 Claims, 5 Drawing Figures





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WELL FLOW CONTROLLING SYSTEM AND APPARATUS

This invention relates to new and useful improvements in methods and means for controlling flow from a producing formation of a well, in the event of the occurrence of a disaster or hazardous condition.

It is one object of the invention to provide a system for controlling the flow of well fluids from the producing formation of a well by lowering the tubing string or production flow conductor through a pair of packers positioned above and below the producing formation to provide an imperforate section of the conductor exposed to fluids from the producing formation to close off admission of such well fluids into the flow conductor and close off flow from the producing formation.

A particular object of the invention is to provide a system and method in which a first lower packer having a guide head at its upper end is disposed below the producing formation in the well and locked in place in the well casing extending through such producing formation and a second upper production packer is anchored in place in the casing above the perforations to the producing formation and provided with an automatically closable valve for the bore thereof which is open when the tubing string is lowered through the packer in the usual manner, and which closes when the tubing string is not in place therein, and a string of sealing assemblies or subs connected in the lower portion of the tubing string providing an imperforate section of sufficient length to engage and seal with the two vertically spaced packers when the tubing string is moved downwardly in the well casing for any reason to close off flow from the producing formation upwardly through the well bore.

A principal object of the invention is to provide a method and apparatus for closing off the producing formation of a well in the event of the occurrence of a disaster or hazardous condition, to prevent the uncontrolled escape of well fluids from the well bore, and in which the closure is effected automatically by movement of the tubing upon destruction or release of the suspension therefor or intentionally produced as a result of a shot or explosion at the well head, to deliberately free the tubing for dropping in the well.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIG. 1 is a schematic view of a well having apparatus positioned therein for carrying out the method of the invention, and showing the well in producing condition;

FIG. 2 is a view similar to FIG. 1 showing the lower portion of the well with the tubing or flow conductor moved downwardly to close off flow from the producing formation;

FIG. 3 is a view similar to FIG. 2 showing the upper packer closed when a short section of the tubing is parted and moves downwardly or is dropped through the upper packer;

FIG. 4 is a view similar to FIG. 1 showing a slightly modified form of the apparatus for carrying out the method and showing the well in condition for producing the well fluids therefrom; and,

FIG. 5 is a view of the lower portion of the well of FIG. 4 showing the tubing moved downwardly to a position closing off flow from the formation.

In the drawings, FIG. 1 schematically illustrates a well installation having a string of well casing C extending downwardly into the earth and through a producing formation F. The lower portion of the bore of the casing is plugged as by a cement plug B in the usual manner. A production packer P-1, such as the well known Baker Model D production packer, is anchored in the casing below the perforations I leading to the producing formation F, and has a downwardly tapered guide surface S formed in the upper end of its bore for a purpose to be described. An upper packer P-2, which may also be a Baker Model D production packer, is anchored in the casing C above the perforations I and has a flapper valve V at its lower end in the usual manner.

A string of tubing T has a plurality of seal assemblies or seal subs A connected therein in sufficient number to provide an imperforate section therein with a length of seal assemblies great enough to extend from the uppermost packer P-2 through the lowermost packer P-1 when the tubing string is moved downwardly in the well casing to the position shown in FIG. 2 for any reason. The upper end of the tubing string T is supported in a well head H by a hanger K in the usual manner. The hanger seals between the well head and the upper end of the tubing string and directs fluids flowing upwardly through the tubing through the master valve M and through the Christmas tree of the well thereabove with a gauge G at the upper end thereof. A lateral flow port or circulation port L is formed in the tubing head and a lateral flow line F is connected thereto and has a casing lateral flow valve X connected therein in the usual manner.

In the event of the occurrence of a disaster, such as a storm destroying the well head connections including the gate valve or master valve M, or a fire, or a ship striking the well head connections, or any other disastrous, dangerous or hazardous condition, the tubing T may be dropped in the well casing from the surface, as by shooting off the hanger or suspension at the tubing head H with a charge of dynamite or a cannon, or the tubing may be dropped as a result of fire or any other damage to the well head which would result in the accidental dropping of such tubing string.

Upon the occurrence of any such event, the well would flow wild through the casing and tubing if the tubing string did not move downwardly from the position shown in FIG. 1 to the position shown in FIG. 2. When the tubing does move downwardly to the position shown in FIG. 2 for any of the foregoing reasons, or for any other reason, the imperforate section thereof with the plurality of seal assemblies or subs A connected therein is disposed in sealing engagement in bores of the upper packer P-2 and the lower packer P-1 as shown in FIG. 2, and the imperforate section of tubing with the seal assemblies provides a closure in the well bore between the packers preventing flow of well fluids from the formation through the perforations I into the tubing string or upwardly in the casing.

Thus, a positive, quick and sure closure is provided for preventing the well fluids from flowing in an uncontrolled manner from the producing formation through the casing or tubing to the surface. This prevents pollution of the surrounding areas, or the water if a marine installation, and eliminates the danger of fire from combustible well fluids which would otherwise exist.

The system and the method of dropping the tubing or flow conductor, whether accidentally or intentionally,

provides a positive shut off of the flow of well fluids from the producing formation through the well to the surface by moving the tubing string or flow conductor downwardly through the packers P-1 and P-2 to position the imperforate section with the seal assembly sections A therebetween in sealing engagement with the packers as shown in FIG. 2.

It is believed readily apparent that, if it should occur that the tubing string should part at a point which would permit the dropping of a short section of tubing through the upper packer a sufficient distance to dispose the upper end of the dropped section below the upper packer P-2, as shown in FIG. 3, the flapper valve V will close to prevent escape of well fluids upwardly through such upper packer.

It is also believed readily apparent that, in some well installations, it may be desirable to limit the movement of the imperforate seal assembly sections through the well packers P-1 and P-2. This condition could arise where the depth of the well below the lower packer P-1 is sufficiently great that a tail pipe (not shown) could not be attached to the lower end of the tubing string of sufficient length to support the imperforate section and sealing assemblies in position to seal with the two packers, or for any other reason. In such event a stop member or flange W having an external annular beveled lower stop or supporting shoulder Y is connected in the tubing string above the upper seal assembly or sub of the several sealing assemblies A forming the sealing assembly section of the tubing string. Should the tubing of this form of the device drop in the same manner as that of the form first described, the stop shoulder Y of the stop member W will engage the upper end of the upper packer P-2 to stop downward movement of the tubing string and the sealing assemblies A and imperforate section to position the sealing assemblies in engagement with the packers P-1 and P-2, as shown in FIG. 5.

As shown in FIG. 4 and 5, the lower end of the well is substantially below the lower packer P-1 and the tubing string and the imperforate seal assembly sections A will be supported by the stop member W with the lower end of the tubing string spaced above the bottom of the well bore in the casing C.

The hanger and the tubing head for suspension of the casing, and the master valve and other elements of the Christmas tree of the well installation are the same as those of FIG. 1, and are given the same identifying letters.

It is also possible that the sealing assemblies A immediately below the stop member W may part, and the tubing string and the sealing assemblies therebelow move downwardly through the upper packer P-2 in the same manner as the tubing string illustrated in FIG. 3, in which event the flapper valve V of the upper packer P-2 would close, if no tubing string or sealing assemblies interfere with such closing movement. In most cases it is believed likely that the sealing assemblies would part immediately below the stop member W in such an event.

From the foregoing, it will be seen that an improved simple method for positively controlling the flow of well fluids from a producing formation of a well in the event of a disaster or hazardous condition arising has been disclosed, and that suitable apparatus for carrying out the method is described. It will be seen that the flow is closed off by moving the producing string or tubing

flow conductor downwardly in the well to position an imperforate section and a long string of sealing assemblies in sealing engagement with two or more vertically spaced packers in the casing string to position such imperforate section of conductor between the packers and so positively close off the flow from the producing formation in the well and through the flow conductor in the casing.

The foregoing description of the invention is explanatory only, and changes in the details of the constructions illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A method of controlling flow of well fluids from a well in the event of a disaster or the occurrence of a hazardous condition, comprising: supporting a flow conductor having an inlet near its lower end in the well; sealing between the lower portion of the flow conductor above the inlet and the well bore above the producing formation; causing the flow conductor to move downwardly to a lower position in the well bore upon the occurrence of such hazardous or disastrous condition; sealing between the flow conductor above the inlet and the well bore at a point below the producing formation while maintaining the seal between the flow conductor and the well bore above the producing formation to seal off an imperforate section of said flow conductor between said seals to provide a closure in the well bore against flow of well fluids from the producing formation upwardly through the conductor or the well bore to the surface.

2. A method of the character set forth in claim 1, including: the additional step of supporting the flow conductor at said lower position in which the imperforate section thereof is disposed between the seals above and below the producing formation and said seals are effective to seal with the flow conductor to close off flow of well fluids thereinto.

3. A method of the character set forth in claim 1, including: the step of providing in the lower portion of said flow conductor above the inlet an imperforate section having a plurality of sealing assemblies thereon located with the lower portion of the sealing assemblies disposed engaging the upper seal above the producing formation and said flow conductor is movable to a lower position in which said sealing assemblies are disposed to engage the lower seal below the producing formation while maintaining the upper portion of said sealing assemblies in sealing contact with the seal at the upper end of the imperforate section disposed above the producing formation, and supporting said flow conductor with the sealing assemblies in such lower position in sealing engagement with the seals.

4. A method of controlling flow from a well of the character set forth in claim 2, wherein the step of supporting the flow conductor in said lower position comprises supporting said flow conductor at its lower end in said lower position by engagement of the lower end of said conductor with the bottom of the bore of the well.

5. The method of claim 3 including: the step of supporting the string of sealing assemblies on the flow conductor in said lower position by a supporting shoulder engaging the upper seal to suspend the sealing assem-

blies in sealing engagement with the upper and lower seals.

6. Apparatus for controlling flow of well fluids from a well in the event of the occurrence of a disaster or hazardous condition which includes: a string of well casing in place in the well having flow communication with the producing formation surrounding the well bore in the lower portion thereof; an upper packer disposed in the casing in sealing engagement therewith above the communication of the casing with the producing formation; a lower packer disposed in the casing in sealing engagement therewith below the communication of the casing with the producing formation and above the bottom of the well; a flow conductor having an inlet near its lower end extending from the surface downwardly to an upper position in which the inlet is below the upper packer; an imperforate sealing section connected as a part of the flow conductor above the inlet and initially sealing between said flow conductor and said upper packer and having a sufficient length to extend between the upper and lower packers when moved to a lower position in the casing to seal between said imperforate sealing section and both said packers for closing off flow of well fluids from the producing formation through the casing and flow conductor; first means for supporting said flow conductor in said upper position, said flow conductor imperforate sealing section being movable downwardly from said upper to said lower position upon said first supporting means becoming ineffective; and second means for supporting the flow conductor in said lower position in which the imperforate sealing section is disposed in sealing engagement with both of the packers in the well.

7. Apparatus of the character set forth in claim 6 wherein: said first supporting means is provided at the surface of the well for supporting the flow conductor in a position in which the lower portion of the imperforate sealing section connected in the flow conductor is as a part of sealing engagement with the upper packer; and said second supporting means becomes effective for supporting the imperforate sealing section in sealing engagement with both the upper and lower packers when the lower portion of said flow conductor is moved downwardly in the well for any reason.

8. Apparatus of the character set forth in claim 7 wherein: the second supporting means for supporting the imperforate sealing section in sealing engagement with the upper and lower packers to close off flow from the producing formation into the flow conductor and through the casing to the surface comprises the engagement of the lower end of the flow conductor with the bottom of the well.

9. Apparatus of the character set forth in claim 7 wherein a stop member is connected as a part of the flow conductor above the uppermost end of the imperforate sealing section disposed to engage the upper packer to support the sealing section in sealing engagement with the upper and lower packers when the tubing is moved downwardly for any reason, to close off flow from the producing formation through the tubing and casing to the surface.

10. Apparatus for controlling flow of well fluids from a well having a string of well casing in place in the well having flow communication with a producing formation surrounding the well bore, which includes: a well flow conductor disposed in said casing and having flow inlet means providing flow communication with said

producing formation; a well packer disposed in said well above the communication of said casing and flow conductor with said producing formation; means for sealing between said packer and said casing; means sealing between said packer and said flow conductor to close the annulus between said flow conductor and said packer against fluid flow therethrough; means for closing off flow from the producing formation through said flow conductor to the well surface upon downward movement of at least a portion of said flow conductor extending through said packer from an upper position to a lower position in the well; and support means for initially supporting said portion of said flow conductor in said upper position in which said flow inlet means is open to permit fluid flow from the producing formation through said inlet means and said flow conductor to the surface, failure of said conductor above said packer or of said support means permitting downward movement of said portion of said flow conductor therebelow in sealing engagement with respect to said packer from said upper supported position to said lower position closing off fluid flow from the producing formation.

11. Apparatus for controlling flow of well fluids from a well having a string of well casing in place therein having flow communication with the producing formation surrounding the well bore, which includes: a well flow conductor disposed in said casing and having flow inlet means providing flow communication with said producing formation; a first well packer disposed in said well above the communication of said casing and flow conductor with the producing formation, said packer being in sealing engagement with said casing and said flow conductor to close the annulus therebetween against fluid flow upwardly therethrough; a second well packer disposed in said well below the communication of the casing with said producing formation; coengageable means on said first and second packer and said flow conductor for closing off flow from said producing formation to said flow inlet means of said flow conductor upon downward movement of at least a portion of said conductor from a first upper position in engagement with said first packer to a second lower position in engagement with both said first and second packers; first retaining support means for supporting said portion of said flow conductor in said first upper position for holding said flow inlet means open to permit fluid flow from the producing formation through said inlet means and said flow conductor to the surface, said first retaining support means being operable to permit downward movement of said portion of said flow conductor to said second lower position to engage both said packers to close said flow inlet means to close off fluid flow from the producing formation; and second support means for supporting said portion of said flow conductor in said second lower position.

12. Apparatus for controlling flow of well fluid from a well having a string of well casing in place therein in flow communication with the producing formation, of the character set forth in claim 11, which includes: valve means on said first well packer movable to close off flow through said first packer from the well producing formation in the event said at least a portion of said well flow conductor moving downwardly through said packer from said first upper position moves completely through said first packer to a position below said first packer.

13. Apparatus for controlling flow of well fluids from a well in the event of the occurrence of a disaster or hazardous condition which includes: a string of well casing in place in the well having flow communication with a producing formation surrounding the well bore; an upper packer disposed in the casing in sealing engagement therewith above the communication of the casing with the producing formation; a lower packer disposed in the casing in sealing engagement therewith below the communication of the casing with the producing formation and above the bottom of the well; a well flow conductor extending from the surface downwardly to a point below the upper packer and having an inlet adjacent its lower end; an imperforate sealing section connected as a part of the flow conductor above said inlet and having a sufficient length to extend between the upper and lower packers when moved to a position in the casing in which said imperforate sealing section is disposed in sealing engagement with both the packers for closing off flow of well fluids from the producing formation through the casing and flow conductor; first support means for initially supporting the flow conductor in a first position in which the lower portion of said imperforate sealing section thereof is in sealing engagement with only the upper packer and said inlet is in communication with said producing formation, said flow conductor being movable downwardly to said position in which said imperforate sealing section is in sealing engagement with both of said packers for closing off flow of well fluids from the producing formation through said inlet into said flow conductor when said first support means is rendered ineffective to support said imperforate sealing section in said first position; and second support means for supporting the imperforate sealing section of said flow conductor in said last mentioned position in sealing engagement with both said packers and said inlet below said lower packer.

14. Apparatus of the character set forth in claim 13 wherein: the means for supporting the imperforate sealing section in sealing engagement with the upper and lower packers to close off flow from the producing for-

mation into the inlet of the flow conductor comprises the engagement of the lower end of the flow conductor with the bottom of the well.

15. Apparatus of the character set forth in claim 13 wherein a stop member is connected as a part of the flow conductor above the uppermost end of the imperforate sealing section disposed to engage the upper packer to support the sealing section in sealing engagement with the upper and lower packers when the tubing is moved downwardly for any reason, to close off flow from the producing formation into the inlet of said flow conductor.

16. A method of controlling flowing well fluids from a well in the event of a disaster or the occurrence of a hazardous condition comprising: supporting a well flow conductor having an inlet opening therein in the well; sealing between the flow conductor above the inlet opening and the well bore above the producing formation; causing at least a portion of the flow conductor having said inlet opening therein to move downwardly in the well bore upon the occurrence of such hazardous or disastrous condition; sealing between the flow conductor above the inlet and the well bore below the producing formation to close the inlet opening of said flow conductor while maintaining said seal between said flow conductor and the well bore above the producing formation after said portion of said flow conductor moves downwardly to close off flow of well fluids from the producing formation through the inlet to the conductor or exteriorly of said flow conductor in the well bore to the surface.

17. A method of controlling flow of well fluids from a well in the event of a disaster or the occurrence of a hazardous condition, of the character set forth in claim 16, including: closing the bore of the seal in the base of the well above the producing formation and above the upper end of said portion of said flow conductor which moved downwardly to close off flow of well fluids from the producing formation upwardly through the conductor or the well bore to the surface.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,792,732 Dated February 19, 1974

Inventor(s) Norvin G. Stewart

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 4, following "means" insert --for--
line 5, following "packer" insert --and said
casing; means sealing between said packer--

Signed and sealed this 17th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents