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2,189,701

PRODUCTION PACKER AND LINER HANGER

Filed April 21, 1939

2 Sheets-Sheet 1

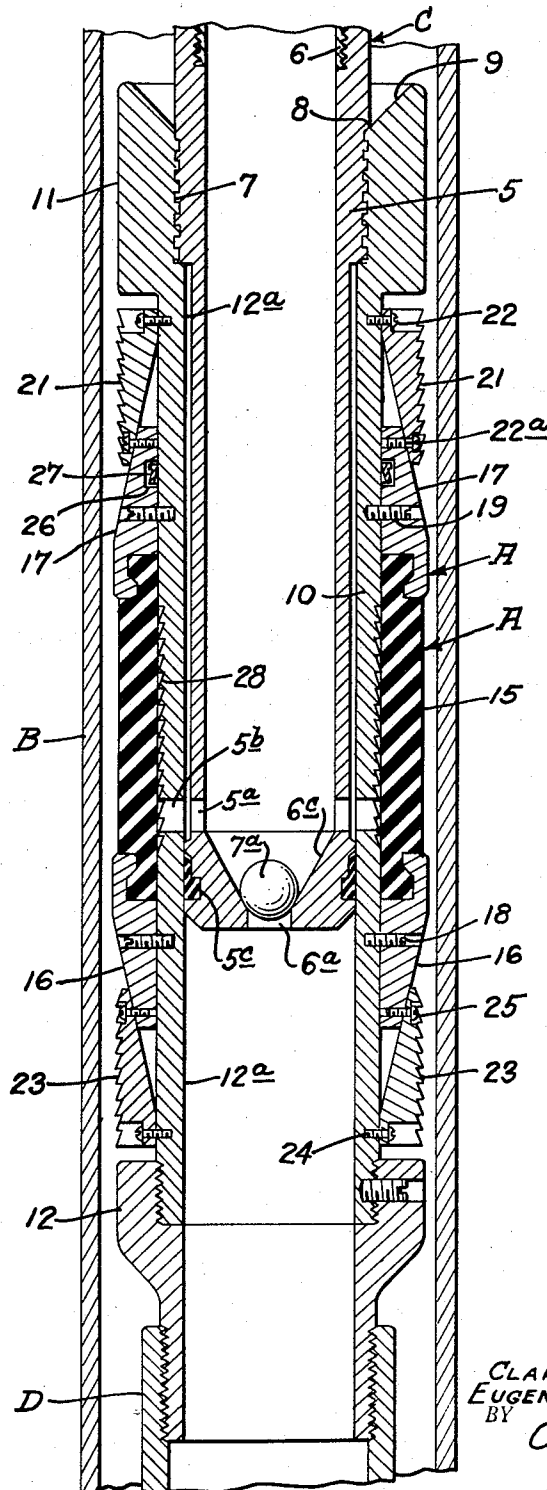


Fig. 1.

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Fig. 3.

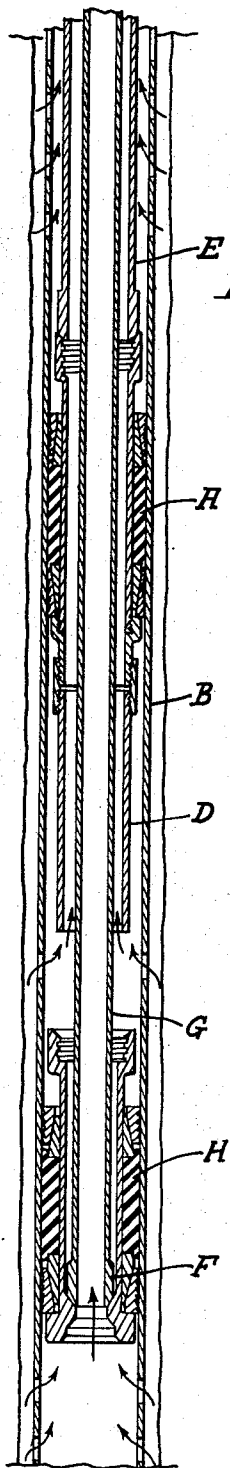
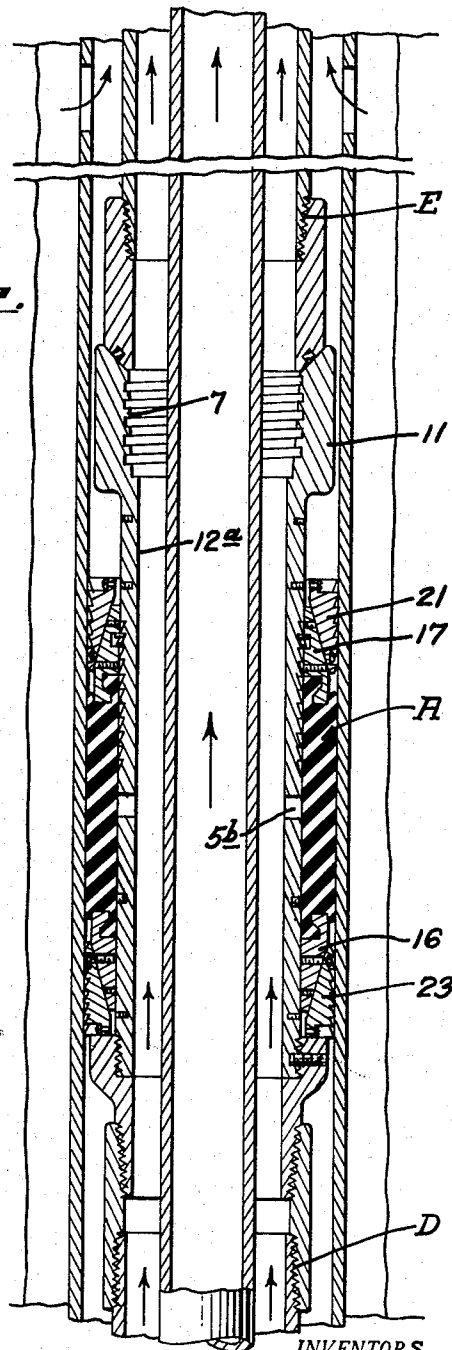


Fig. 4.



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PRODUCTION PACKER AND LINER HANGER

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16 Claims. (Cl. 166—12)

This invention relates to production equipment for oil wells and particularly pertains to a production packer and liner hanger.

It is sometimes desirable to separately produce from a plurality of zones through separate strings of tubing telescopically arranged. In so doing, it is sometimes necessary that a packer be provided to seal off the space between the production tubing or liner and the surrounding liner or casing.

It is the principal object of our present invention to provide an improved and efficient production packer and liner hanger which may be run in the bore or casing on tubing, hydraulically tripped and then set, which device has an uninterrupted bore extending longitudinally therethrough of a diameter comparatively large with relation to the inside diameter of the casing or liner in which it is to be set.

In general, the device is tubular in character and is adapted to be run in a well casing at the lower end of a string of tubing, by means of which it may be manipulated by an operator at the derrick floor, and it includes in its structure operable slips for anchoring the device firmly in the surrounding casing at a desired predetermined location. The device also includes an expansible packing means or sealing element for sealing off the annular space between the exterior of the device and the wall of the casing or liner in which it is run. The slips are tripped by fluid pressure and the device is set by manipulation of the run in string, the latter being capable of disconnection after setting. After the device has been set, the run in string of tubing may be disconnected therefrom, leaving the entire bore of the device open so that smaller tubing may be run therethrough if desired.

One form which the invention may assume is exemplified in the following description and illustrated by way of example in the accompanying drawings, in which:

Fig. 1 is a view in central vertical section through a device embodying our invention, showing the same in the condition in which it is run in a well casing.

Fig. 2 is a somewhat similar view showing the same in set condition.

Fig. 3 is a diagrammatic view showing the manner in which a device embodying our invention is utilized in producing separately from different zones.

Referring more particularly to the accompanying drawings, our improved apparatus, insofar as its general type is concerned, is of the type

disclosed in United States Letters Patent No. 2,121,051, issued June 21, 1938, to Thomas M. Ragan and Clarence E. Burt.

The production packer or liner packer A in the condition shown in Fig. 1 is run in the well casing B on a sub 5 depending from the lower end of a string of run in tubing C. The sub 5 is in effect a hollow mandrel having a female thread 6 at its upper end for connection with the lower end of the tubing string as illustrated.

The packer or liner hanger A has a hollow cylindrical or tubular body 10 with an enlarged abutment collar 11 at its upper end and a tail pipe or liner connection 12 on its lower end. The bore 12a of the interior of the body is straight and unrestricted throughout the entire length of the body 10. The upper extremity of the bore 12a is counterbored and formed with a tapered square left-hand female thread to receive similar male threads 7 on the tripping mandrel or sub 5. The portion of the mandrel 5 below the threads 7 is of a diameter so that it may slidably project into the bore 12a of the body 10 as illustrated.

Above the threads 7 on the mandrel 5, the latter is formed with an annular abutment face 8 to seat on the coinciding face 9 of the enlarged abutment collar 11 at the upper end of the body 10. In this position a radial port 5a formed in the mandrel registers with a radial port 5b formed through the wall of the packer body 10. Below the port 5a a piston type packing ring 5c is mounted on the mandrel and circumscribes the same to prevent downward leakage of fluid between the mandrel and the bore of the body 10.

A valve port 6a is formed coaxially through the lower end of the mandrel and is surrounded at the interior of the mandrel with a valve seat 6c. A ball type of valve 7a is provided which may be dropped or sent down the tubing to seat on the seat 6c, when it is desired to trip the device as will be described.

A sleeve packing 15, formed of rubber or other suitable pliable material, surrounds the medial portion of the body member 10 and is connected at its lower end to a lower cone 16 which slidably fits said body, while its upper end is connected to an upper cone 17 likewise slidably fitting said body. Normally these cones 16 and 17 are connected to the body 10 by shear pins 18 and 19, respectively, the pins 18 of the lower cone having a greater shear value than the pins 19 of the upper cone so that a lesser pressure is required to release the upper cone than that required to release the lower cone.

"Up-pressure" slips 21 are normally connected

to the body 10 by shear pins 22 and to the upper cone by shear pins 22a, and "down-pressure" slips 23 are normally connected to the body by shear pins 24 and to the lower cone 16 by shear pins 25.

It will be noted that the interior bore of the upper cone 17 has formed therein an annular groove 26 which receives a ratchet latch 27 in the form of a split contractile ring, tooth-shape in cross-section and adapted to engage annular serrations forming on the exterior of the body 10 a series of ratchet teeth 28, said teeth and latch forming a one-way ratchet means which will retain the upper cone latched to the body in operated position.

In practice, a tail pipe or liner D is fastened to the connection 12, in most cases prior to the time that the device is lowered into the well casing. However, it can be readily seen that the device has various other uses in connection with oil wells other than having a liner or tail pipe suspended from its lower end. As a matter of fact, this lower end may be provided with a back-pressure valve in the manner shown in the United States Letters Patent previously referred to in order that it may operate purely as a cement retainer.

In practice, the packing device A is conditioned as shown in Fig. 1 and is lowered into the well casing to a position of use. The trip ball valve 1a is then inserted into the run in string C to travel downwardly through said string into the mandrel and seat on the seat 5c. As soon as the trip ball 1a seats to close the flow of fluid through the lower end of the mandrel, fluid pressure will be built up in the running in string and through the ports 5a and 5b to expand and elongate the packing sleeve 15 and shear the pins 19 of the upper cone 17, moving said cone upwardly with sufficient force to shear the pins 22 and 22a of the upper slips 21. With the shearing of the slip pins, the upper slips will engage the abutment collar 11, and by reason of the co-engaging angled surfaces of the cone and slips, will be moved outwardly radially into gripping position with relation to the casing wall.

The pump pressure is then relieved and the run in string is subjected to an upward strain sufficient to move the body, the lower cone, the lower slips and the lower end of the packing sleeve relative to the now stationary upper end of the packing sleeve, so as to compress said packing sleeve 15 into sealing condition against the casing wall until it will compress no further, whereupon continued relative upward movement of the body 10 will shear the pins 18 of the lower cone 16, causing the abutment shoulder 12 to engage the lower slips 23, and then shear the pins 24 and 25 and move said lower slips upwardly and outwardly into gripping engagement with the casing wall.

The device being thus properly set in the well casing will resist dislodgement either in an upward or a downward direction.

To disconnect the running in tubing and the mandrel 5 from the body, it is only necessary to turn the running in tubing to the right, disengaging the male threads 7 on the mandrel from the female threads on the body 10 and enabling the entire tubing string and mandrel to be withdrawn from the hole. Thereafter the packing device will remain in position suspending the tail pipe or liner D within the casing and at the same time pack off between this tail pipe or liner and the casing.

Thereafter, if it is desired to produce through

the liner separately from the casing, a liner E is lowered down the casing until its lower end abuts and tightly seats on the abutment face of the enlarged abutment collar at the upper end of the body 10. Thus, as illustrated in Fig. 2, production may be had through the space between the casing and the liner E above the packer A and also upwardly through the liner D and the packer A. It is obvious that if tubing is lowered downwardly through the liner E, packer A and liner or tail pipe D, that a lower and third zone may be produced separately from the others. This situation is illustrated in Fig. 3 where the same type of packer A is employed with the exception that it has a modified lower end, in that the same is slightly restricted so that the lower end F of tubing G may abut thereon so that production will pass upwardly through the lower packer, which we have indicated at H, only through the tubing G.

From the foregoing it is obvious that we have provided a very efficient production packer and liner hanger, and while we have shown the preferred form of our invention, it is to be understood that various changes may be made in its construction by those skilled in the art without departing from the spirit of the invention as defined in the appended claims.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. An apparatus of the character described comprising a tubular hollow member with an uninterrupted bore extending longitudinally therethrough of a substantially constant diameter from end to end, means for connecting a suspended tubing to the lower end of said member, slips mounted on said member, means capable of being released connecting said slips to said member and maintaining them in an ineffective position, a packing sleeve mounted on said member and capable of being hydraulically actuated to release said means and thereby trip said slips, the upper end of said member adapted to be detachably connected to the lower end of a string of running in tubing, and a tubular setting mandrel connected with said running in string of tubing and projecting into said bore, said mandrel and said tubular hollow member having cooperating flow means enabling hydraulic pressure built up in said mandrel to actuate said packing sleeve.

2. An apparatus of the character described comprising a tubular body adapted to be connected at its upper end to the lower end of a string of running in tubing, segmental slips mounted on the body, a cone on said body, cooperating cone faces on the slips and cone whereby relative axial movement between the same will cause the slips to move radially outward, a longitudinal expansible member mounted on said body and capable of being expanded by fluid pressure exerted between it and the body to cause relative axial movement between the slips and cone, and a member adapted to be connected to the lower end of said tubing and projected into the body, said member and said body having cooperating ports to enable fluid pressure built up in said tubing to be directed between said body and said expansible member.

3. An apparatus of the character described comprising a tubular body adapted to be connected at its upper end to the lower end of a string of running in tubing, segmental slips mounted on the body, a cone on said body, cooperating cone faces on the slips and cone whereby relative axial movement between the same will cause the slips to

move radially outward, a longitudinal expansible member mounted on said body and capable of being expanded by fluid pressure exerted between it and the body to cause relative axial movement between the slips and cone, said tubing being detachably connected to the upper end of said body, a hollow mandrel connected to the lower end of said tubing and projecting downwardly into the body, said mandrel and said body having cooperating ports whereby fluid pressure built up in said tubing and mandrel will be directed between said expansible member and said body.

4. An apparatus of the character described comprising a tubular body adapted to be connected at its upper end to the lower end of a string of running in tubing, segmental slips mounted on the body, a cone on said body, cooperating cone faces on the slips and cone whereby relative axial movement between the same will cause the slips to move radially outward, a longitudinal expansible member mounted on said body and capable of being expanded by fluid pressure exerted between it and the body to cause relative axial movement between the slips and cone, said tubing being detachably connected to the upper end of said body, a hollow mandrel connected to the lower end of said tubing and projecting downwardly into the body, said mandrel having a port formed in its lower end in communication with the interior of the body, and a valve member adapted to be dropped downwardly through the tubing to seat and close said port to enable fluid pressure to be built up in said tubing and mandrel, said mandrel and said body having cooperating ports to enable fluid pressure built up in the mandrel to be exerted between said expansible member and said body.

5. An apparatus of the character described comprising a tubular body adapted to be connected at its upper end to the lower end of a string of running in tubing, segmental slips mounted on the body, a cone on said body, cooperating cone faces on the slips and cone whereby relative axial movement between the same will cause the slips to move radially outward, a longitudinal expansible member mounted on said body and capable of being expanded by fluid pressure exerted between it and the body to cause relative axial movement between the slips and cone, said tubing being detachably connected to the upper end of said body, a hollow mandrel connected to the lower end of said tubing and projecting downwardly into the body, said mandrel and said body having cooperating ports whereby fluid pressure built up in said tubing and mandrel will be directed between said expansible member and said body, and sealing means between the exterior of said mandrel and the interior of said body below said ports.

6. An apparatus of the character described comprising a tubular body adapted to be connected at its upper end to the lower end of a string of running in tubing, segmental slips mounted on the body, a cone on said body, cooperating cone faces on the slips and cone whereby relative axial movement between the same will cause the slips to move radially outward, a longitudinal expansible member mounted on said body and capable of being expanded by fluid pressure exerted between it and the body to cause relative axial movement between the slips and cone, said tubing being detachably connected to the upper end of said body, a hollow mandrel connected to the lower end of said tubing and projecting downwardly into the body, said mandrel having a port formed in its lower end in communication with the interior

of the body, a valve member adapted to be dropped downwardly through the tubing to seat and close said port to enable fluid pressure to be built up in said tubing and mandrel, said mandrel and said body having cooperating ports to enable fluid pressure built up in the mandrel to be exerted between said expansible member and said body, and sealing means between the exterior of said mandrel and the interior of said body below said ports.

7. An apparatus of the character described comprising a tubular body adapted to be detachably secured to the lower end of a string of tubing, a first set of slips mounted on said body, a second set of slips mounted on said body, a first and a second cone on said body and associated with said slips to move the same radially outward upon relative movement between the cones and said slips, shear means connecting said cones to said body, shear means connecting said slips to said body, a packing sleeve mounted on said body and connected with said cones and capable of being hydraulically actuated to shear said shear means of the first cone, means on said body operative upon endwise movement of said body subsequent to the shearing of the shear means on the first cone to engage the second set of slips and move the same longitudinally relative to the second cone, a mandrel connected to the lower end of said tubing and projecting into said body, cooperating ports in the mandrel and body to enable fluid pressure built up in the mandrel to be exerted against said packing sleeve to hydraulically actuate the same.

8. An apparatus of the character described comprising a tubular body adapted to be detachably secured to the lower end of a string of tubing, a first set of slips mounted on said body, a second set of slips mounted on said body, a first and a second cone on said body and associated with said slips to move the same radially outward upon relative movement between the cones and said slips, shear means connecting said cones to said body, shear means connecting said slips to said body, a packing sleeve mounted on said body and connected with said cones and capable of being hydraulically actuated to shear said shear means of the first cone, means on said body operative upon endwise movement of said body subsequent to the shearing of the shear means on the first cone to engage the second set of slips and move the same longitudinally relative to the second cone, a mandrel connected to the lower end of said tubing and projecting into said body, said mandrel having a normally open passageway through its lower end, means for closing said passageway after said body is positioned in a well, said mandrel and said body having cooperating ports formed therein to enable fluid pressure built up in the tubing and mandrel to be exerted against said packing sleeve to hydraulically actuate the same.

9. An apparatus of the character described comprising a tubular body adapted to be detachably secured to the lower end of a string of tubing and lowered into a well casing, means on the lower end of said body whereby tubing may be suspended therefrom, segmental slips mounted on said body and detachably connected thereto in an ineffective position, a longitudinally expansible member mounted on said body and capable of being expanded by fluid pressure built up in said body to engage said slips and move them longitudinally of the body, a tubular mandrel secured to the lower end of the tubing and

projecting into said body, said tubular mandrel and said body having cooperating ports enabling fluid pressure built up in the mandrel to be exerted against said expansible member to actuate the same.

10. An apparatus of the character described comprising a tubular body adapted to be detachably secured to the lower end of a string of tubing and lowered into a well casing, means on the lower end of said body whereby tubing may be suspended therefrom, segmental slips mounted on said body and detachably connected thereto in an ineffective position, a longitudinally expansible member mounted on said body and capable of being expanded by fluid pressure built up in said body to engage said slips and move them longitudinally of the body, a tubular mandrel secured to the lower end of the tubing and projecting into said body, the lower end of said mandrel being normally open to enable fluid to be pumped downwardly through the body and through the mandrel, means for closing the lower end of said mandrel subsequent to the positioning of said body in the well casing, said mandrel and said body having cooperating flow means through which fluid pressure built up in said mandrel will be effective to actuate said expansible member, and sealing means sealing the space between the exterior of the mandrel and the interior of the body below said ports.

11. A device of the character disclosed comprising a tubular packer body having a longitudinal flow passage extending therethrough, normally ineffective anchoring means on said body, said anchoring means capable of being rendered effective by fluid pressure, a fluid conducting tubular setting mandrel removably and slidably projecting into said body flow passage, said body and said mandrel having cooperating flow means through which fluid pressure built up in said mandrel will render said anchoring means effective, and means for valving the bore of said mandrel below said cooperating flow means to permit a build up of fluid pressure in said mandrel.

12. A device of the character disclosed comprising a tubular packer body having a longitudinal flow passage extending therethrough, normally ineffective anchoring means on said body, said anchoring means capable of being rendered effective by fluid pressure, a fluid conducting tubular setting mandrel removably and slidably projecting into said body flow passage, said body and said mandrel having cooperating flow means through which fluid pressure built up in said mandrel will render said anchoring means effective, means for valving the bore of said mandrel below said cooperating flow means to permit a build up of fluid pressure in said mandrel, and fluid excluding sealing means between said mandrel and the wall of said body flow passage below said cooperating flow means.

13. A device of the character disclosed comprising a tubular packer body adapted to be lowered into a well casing, said body having a longitudinal flow passage extending therethrough, normally ineffective packing means surrounding said body and capable of being expanded by fluid pressure, a fluid conducting tubular setting mandrel removably and slidably projecting into said body flow passage, said body and said mandrel

having cooperating flow means through which fluid pressure built up in said mandrel will be effective to expand said packing means to form a seal between said body and said well casing, and means for valving the bore of said mandrel below said cooperating flow means to permit a build up of fluid pressure in said mandrel.

14. A device of the character disclosed comprising a tubular packer body adapted to be lowered into a well casing, said body having a longitudinal flow passage extending therethrough, normally ineffective packing means surrounding said body and capable of being expanded by fluid pressure, a fluid conducting tubular setting mandrel removably and slidably projecting into said body flow passage, said body and said mandrel having cooperating flow means through which fluid pressure built up in said mandrel will be effective to expand said packing means to form a seal between said body and said well casing, means for valving the bore of said mandrel below said cooperating flow means to permit a build up of fluid pressure in said mandrel, and fluid excluding sealing means between said mandrel and the wall of said body flow passage below said cooperating flow means.

15. A device of the character disclosed comprising a tubular packer body adapted to be lowered into a well casing, said body having a longitudinal flow passage extending therethrough, normally ineffective anchoring means on said body, packing means surrounding said body and capable of being expanded by fluid pressure to actuate said anchoring means, a tubular fluid conducting setting mandrel removably and slidably projecting into said body flow passage, said body and said mandrel having cooperating flow means through which fluid pressure built up in said mandrel will be effective to expand said packing means to actuate said anchoring means to gripping engagement with said casing and to form a seal between said body and said casing, and means for valving the bore of said mandrel below said cooperating flow means to permit a build up of fluid pressure in said mandrel.

16. A device of the character disclosed comprising a tubular packer body adapted to be lowered into a well casing, said body having a longitudinal flow passage extending therethrough, normally ineffective anchoring means on said body, packing means surrounding said body and capable of being expanded by fluid pressure to actuate said anchoring means, a tubular fluid conducting setting mandrel removably and slidably projecting into said body flow passage, said body and said mandrel having cooperating flow means through which fluid pressure built up in said mandrel will be effective to expand said packing means to actuate said anchoring means to gripping engagement with said casing and to form a seal between said body and said casing, means for valving the bore of said mandrel below said cooperating flow means to permit a build up of fluid pressure in said mandrel, and fluid excluding sealing means between said mandrel and the wall of said body flow passage below said cooperating flow means.

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