United States Patent

[11] 3,530,935

[72] Inventor **Henry U. Garrett**
Houston, Texas

[21] Appl. No. **733,881**
[22] Filed **June 3, 1968**
[45] Patented **Sept. 29, 1970**
By mesne assignments, to

[73] Assignee **Brown Oil Tools, Inc.,**
Houston, Tex., a corporation
of Texas

---

[54] **MOTOR FOR RUNNING AND RETRIEVING WELL TOOLS**
7 Claims, 8 Drawing Figs.

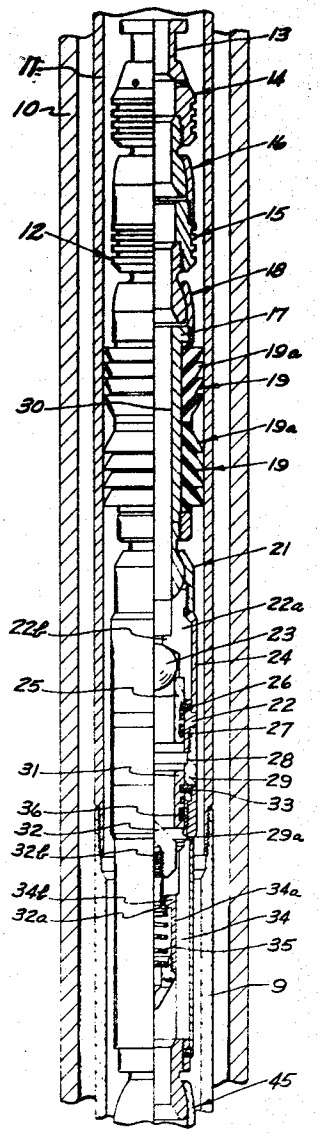
[52] **U.S. Cl.** **166/153,** 166/224
[51] **Int. Cl.** **E21b 23/02,** E21b 33/00
[50] **Field of Search** 166/153, 155, 156, 118, 224, 225, 315

[56] **References Cited**
UNITED STATES PATENTS

3,062,296	11/1962	Brown	166/225
3,150,717	9/1964	Ottemar et al	166/155
3,308,880	3/1967	Yetman	166/153X
3,312,283	4/1967	Yetman	166/156X
3,378,080	4/1968	Fredd	166/156
3,385,370	5/1968	Knox et al	166/225
3,419,074	12/1968	Brown	166/153X

Primary Examiner—David H. Brown
Attorneys—J. Vincent Martin, Joe E. Edwards and M. H. Gay

ABSTRACT: This patent discloses a motor for running and retrieving a string of well tools. Valves are opened and closed hydraulically to substantially prevent flow through the motor while it is being run or retrieved, and to permit flow through the motor while the well is being produced. The motor is moved by a differential in pressure across packing between the motor and the tubing in which it is run. The motor is combined with a gas lift valve and both are landed in a single mandrel. Landing dogs are provided for selecting one of several mandrels in a well tubing and for landing the assembly in the tubing.



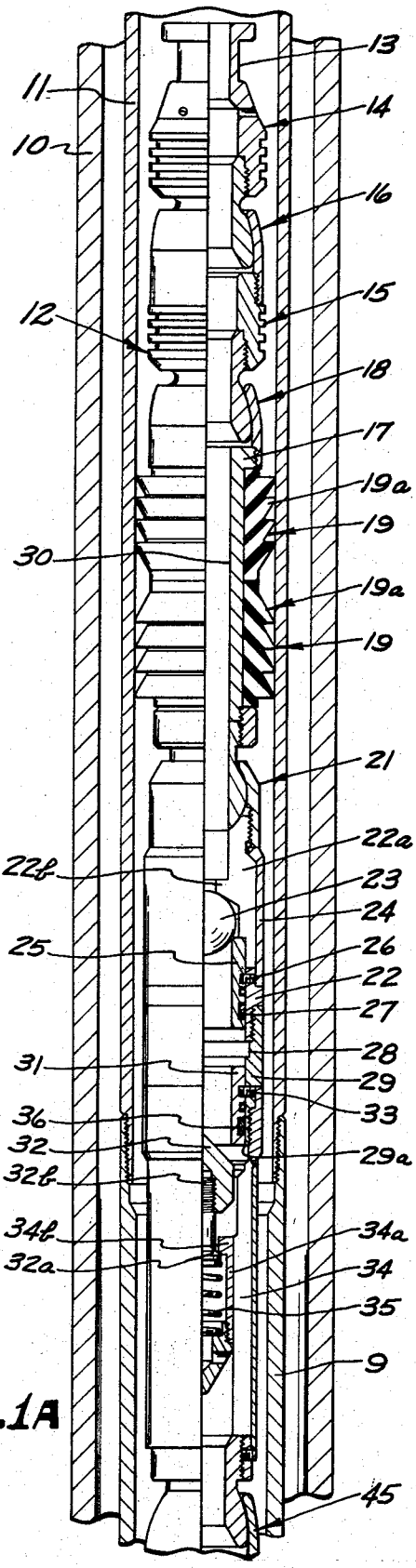


Fig. 1A

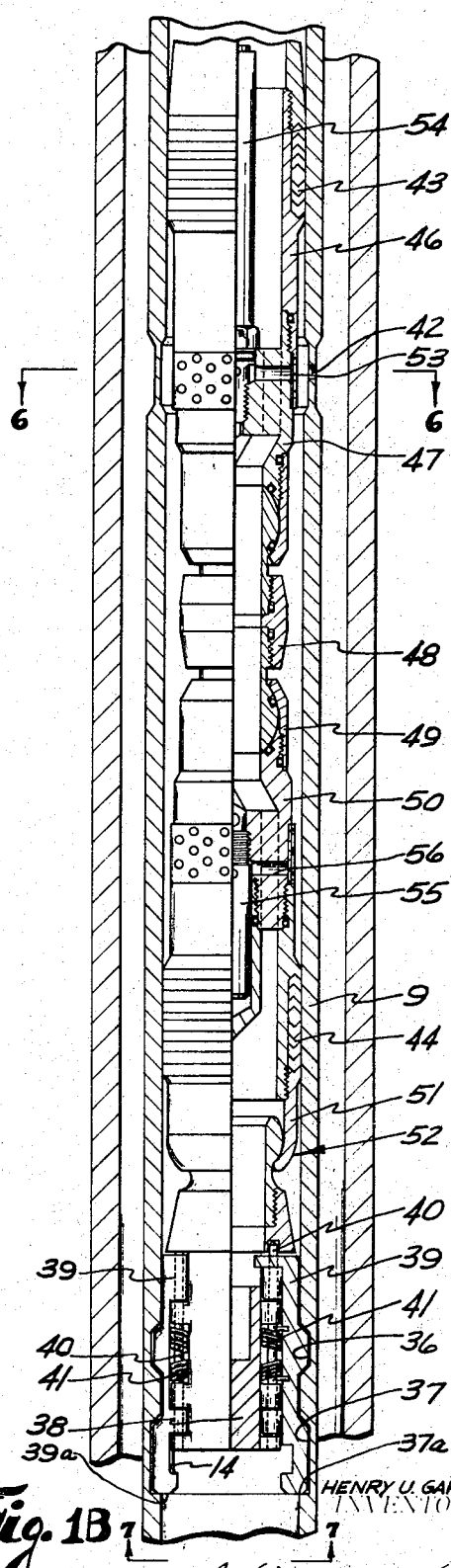


Fig. 1B

HENRY U. GARRETT
INVENTOR

BY J. Vincent Martin
Jr E. Edwards
M. N. Gay
ATTORNEYS

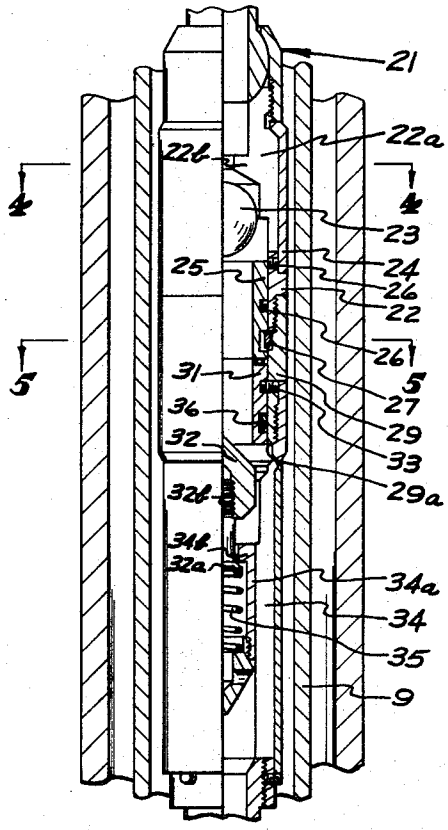


Fig. 2

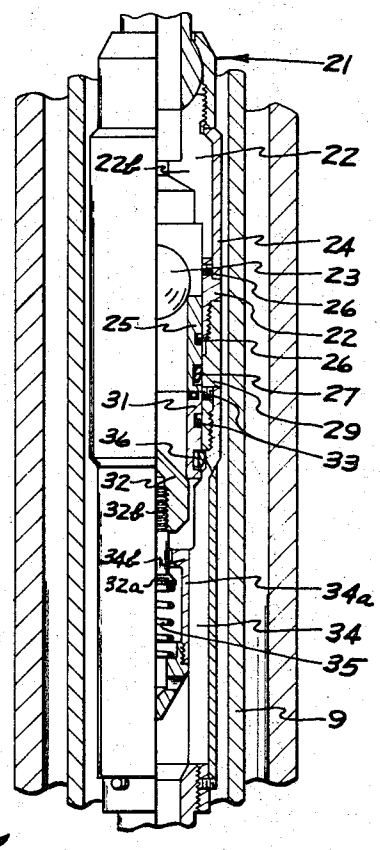


Fig. 3

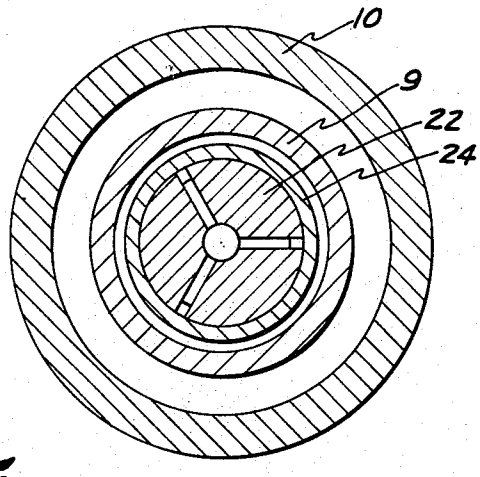


Fig. 4

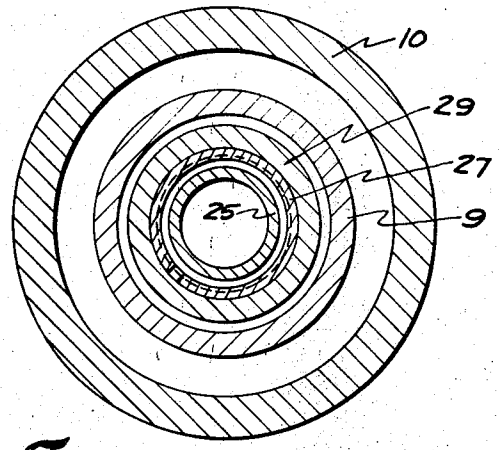


Fig. 5

HENRY U. GARRETT
INVENTOR
BY J. Vincent Martin
Joe E. Edwards
M. N. Gay
ATTORNEYS

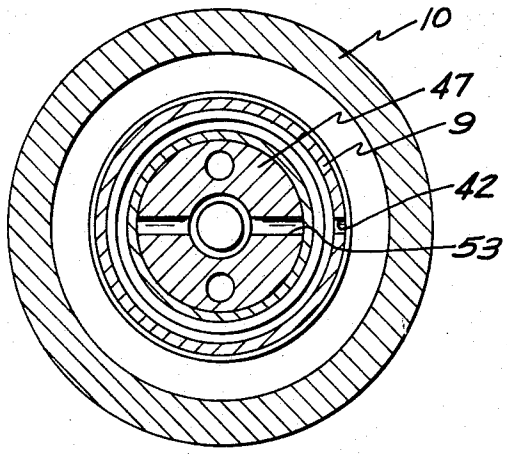


Fig. 6

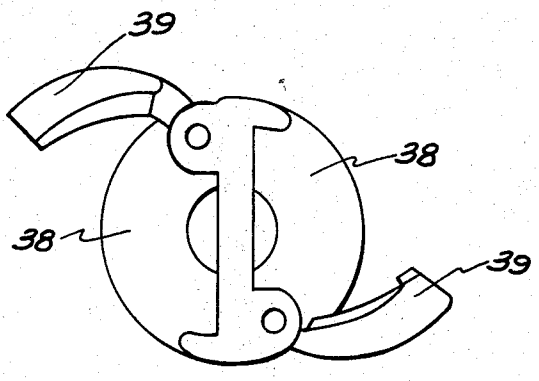


Fig. 7

HENRY U. GARRETT
INVENTOR.
BY J Vincent Martin
Jos E Edwards
Mm Gay
ATTORNEYS

MOTOR FOR RUNNING AND RETRIEVING WELL TOOLS

This invention relates to motors for pumping a plurality of well tools into and out of a well, as is disclosed in U.S. Pat. No. 3,334,690. This motor is an improvement over the motor shown in said patent, and may be used to pump the several different types of structures shown in this patent into and retrieve them from a well. In accordance with one aspect of this invention, the motor has associated therewith a gas-lift valve, both of which are landed in the lowermost mandrel.

While the motor shown in U.S. Pat. No. 3,334,690 has been successfully used, efforts have continued to improve the motor and in particular to reduce its length or change its construction such that it may be made in several parts joined together by articulating joints.

In the past, motors have been landed in mandrels which are separate from the mandrels in which other tools are landed.

By this invention a simple motor made up of several articulating sections is provided. The motor is combined with one or more gas-lift valves, all of which are serviced by a single mandrel, thus reducing the number of mandrels necessary in the system.

It is an object of this invention to provide a simple motor for pumping a train of gas-lift valves into a tubing.

Another object of this invention is to provide a simple motor for pumping a train of gas-lift valves into a tubing in which the motor is made up of several articulating sections which will permit the motor to negotiate a sharp bend in a pipe.

Another object is to provide a combination motor and gas-lift valve arranged so that a single mandrel may be used to land the motor and provide gas for the gas-lift valve.

Another object is to provide a motor for pumping a train of tools into a tubing in which valves are operated in response to pressure conditions to prevent flow through the motor during pumping in and out of the well, and to permit flow through the motor while the well is being produced.

Other objects, features and advantages of this invention will be apparent from the drawings, the specification and the claims.

In the drawings, wherein like numerals indicate like parts;

FIGS. 1A and 1B are views partially in cross section and partially in quarter section illustrating an apparatus constructed in accordance with this invention immediately after being pumped into landed position in a mandrel in a well; FIG. 1B is a continuation of FIG. 1A;

FIG. 2 is a fragmentary view similar to FIG. 1A showing the standing valve to have been rendered operative;

FIG. 3. is a view similar to FIG. 2, showing the blocking valve to have been rendered operative to permit the apparatus to be pumped out of the well;

FIG. 4 is a view along the line 4–4 of FIG. 2;

FIG. 5 is a view along the line 5–5 of FIG. 2;

FIG. 6 is a view along the line 6–6 of FIG. 1B; and,

FIG. 7 is a worm's-eye view of the latch structure carried by the assembly with the latch dogs shown in extended position.

The apparatus of this invention is shown within a well which includes the casing **10** having a tubing **11** therein. The apparatus is landed in mandrel **9** which forms a continuation of the tubing. While single string completion is illustrated, it will be appreciated that the invention is equally useful in multiple string completions. The apparatus may also be used in multiple completions wherein one string is a service string and the other string is the production string. In such case, instead of flow being from the casing-tubing annulus into the tubing as shown, it would be from the service string into the production string, and flow through the gas-lift valves would be in the opposite direction to that illustrated.

Referring to the drawings, the apparatus includes a body indicated generally at **12** which is preferably made up of a plurality of articulating sections by providing ball joints between sections as shown.

At the upper end of the body a fishing-latching neck **13** is provided. This neck is received within a cooperating groove in the latch next thereabove during running of the string. As the last valve above the motor is dropped off, the latch opens and releases this neck. Note the receiving groove **14** at the lower end of FIG. 1B. An identical latch mechanism employing this groove will be present in association with the valve next above the motor, and the fishing neck **13** will be in this groove during running of the tool.

The fishing neck is carried by a seal member for sealing between the tool and the wall of the tubing so that the apparatus may be pumped into and out of the well. In the illustrated embodiment three separate seals are used. A labyrinth-type seal which is spaced from the tubing is shown generally at **9**. This seal functions in the event of failure of the primary seal to be discussed below. A second labyrinth-type seal indicated generally at **15** is connected below the upper labyrinth seal member **9** by a suitable articulating connection provided by the ball joint indicated generally at **16**. It might be noted that throughout the length of the body articulating joints are provided by ball joints so that the entire tool may readily turn about a very short radius bend. This is of extreme value in offshore work where the tools may be pumped into the well through pipe which bends at a substantial angle at the wellhead.

The main seal body **17** is connected to the lower labyrinth seal member **15** by another articulating ball joint indicated generally at **18**. The main seal body carries a pair of substantially identical seal members indicated generally at **19**. Each of these seal members has a plurality of lips **19*a*** which engage the tubing as the tool is run into the well to provide a fluid seal between the tubing and the apparatus. It will be noted that the seals are arranged in opposite relations so that the lips of one seal extend upwardly and the lips of the other seal extend downwardly. Thus the two seal members act as opposing cups and are the primary seal during pumping of the apparatus into or out of the well.

Attached to the body **17** by a suitable articulating joint **21** is the body **22** for the valve controlling flow through the apparatus as it is run into the hole. This valve functions as a standing valve during production of the well. The standing valve body **22** is split longitudinally into multiple segments **22*a*** at its upper end (see FIG. 4) to provide a flowway past the standing valve member **23** when the member is unseated. To prevent flow through the body of the tool at this point, a suitable sleeve **24** surrounds the split segments **22*a***. The split segments **22*a*** have inwardly facing flanges **22*b*** to provide a spider for limiting upward movement of the ball valve member **23**.

The standing valve includes the ball **23** and its cooperating seat **25**. In order to permit reversal of the apparatus out of the hole before it is landed in the event difficulty is experienced in running the apparatus, means are provided which maintain this valve in closed position during running of the valve.

In the illustrative embodiment the seat **25** of the standing valve is pinned in its up position by a shear pin **26**. In this position the ball **23** is held against the cage **22*b*** to close the standing valve. Obviously the relationship could be such that the valve would be completely closed, or it could be substantially closed as limited leakage past the standing valve would not be particularly objectionable in the event it became necessary to pump the apparatus out of the hole. This is particularly true in view of the fact that it is very seldom that problems will be encountered in running the apparatus which would require reverse circulation to pump the apparatus out of the hole. Of course, on going in the hole the fluid utilized to drive the apparatus down in the hole would seat the ball **23** firmly on its seat **25**.

Once the motor is run into the hole and stopped by landing in the appropriate mandrel, the pressure of the pumped fluid will sharply increase to indicate to the operator that the motor has landed. Thereupon the pressure will be increased from the surface to cooperate with the hydrostatic head of fluid above the standing valve to exert sufficient force on the ball **23** to shear pin **26**. At this time the seat **25** will be driven

downwardly by the pumped fluid to the position shown in FIG. 2.

In order to latch the seat in down position so that fluid flowing up from the formation cannot move the seat up into engagement with the ball, the valve seat **25** carries an annular snap ring **27** which moves out into the groove **28** at the junction of the standing valve body and the pumpout valve body **29** which depends therefrom. It will be noted that the snap ring has a downwardly and inwardly inclined outer periphery for purposes which appear hereinbelow. With the valve seat held in down position, it will be apparent that the ball **23** and its associate seat **25** may function as a standing valve in the usual manner.

From the above it is apparent that the shear pin **26** acts as a holding means which holds the standing valve in closed position to permit the motor to be pumped in either direction and, after the tool is landed, the holding means is rendered ineffective by differential pressure across the standing valve to permit the valve to thereafter function as a standing valve.

Second valve means are provided to prevent flow through the passageway **30** which extends through the body in the direction permitted by the standing valve, that is, in an upwardly direction.

This pumpout valve is provided by a valve seat **31** and a valve member **32**. The valve seat **31** is slidably mounted in body **29** and a second holding means is provided to hold the pumpout valve in open position during pumping of the apparatus into the well and during production of the well. In the illustrated form this second holding means is provided by the shear pin **33**. It will be noted that the shear pin **33** is of larger diameter and thus is stronger than the shear pin **26**, and in the illustrated form of the invention a greater differential of pressure will be required to shear this pin.

The valve member **32** is supported in valve carrier body member **34**. The member **34** is slotted vertically as shown, and has a central cylinder portion **34***a* in which the valve member **32** is mounted. A suitable spring **35** urges the valve member upwardly into engagement with the inturned flange **34***b* at the top of the cylinder **34***a*. An outturned flange **32***a* carried on the valve stem **32***b* engages the shoulder **34***b* and limits further upward movement of the valve member **32**. It will be noted that in this position the valve member **32** and the valve seat **31** are spaced from each other to permit flow upwardly past the pumpout valve.

When it is desired to retrieve the motor and the train of devices which have been landed in the well therewith, the holding means for the pumpout valve is rendered inoperative in response to a selected differential across the apparatus. It will be noted from FIG. **2** that the standing valve seat rests upon the top of the pumpout valve seat, and therefore an increase in pressure in the tubing above the apparatus to a selected differential over the pressure below the apparatus will exert a shearing force on the shear pin **33**, and shear this pin to permit the seat **31** to move downwardly under the influence of the differential. The seat **31** is provided with a snap ring **36** which moves out and engages the downwardly facing shoulder **29***a* on the pumpout valve sub to lock the seat in down position. At this time the seat engages the valve member **32** as illustrated in FIG. **3**, and the spring **35** is placed under compression to thus hold the valve and seat in closed position. As the standing valve and the pumpout valve provide check valves opening in opposite directions, flow through the passageway **30** is effectively prevented, and the apparatus may be pumped out of the well by a differential of pressure in which the pressure below the seal **19** is greater than the pressure above the seal.

Referring to the bottom of the apparatus shown in FIG. **1B**, there is shown a latching system which may be used with this invention. Of course, any desired means of locating the proper mandrel and landing the apparatus in this mandrel may be utilized. The mandrel **12** is provided with a pair of grooves **36** and **37** for the latching apparatus. These grooves preferably have their shoulders which face downwardly at a substantial angle and at least one of the shoulders which face upwardly, such as shoulder **37***a*, at an angle normal to the center line of the pipe. The latch body **38** carries a plurality of latch dogs **39** which rotate about hinge pins **40** and are urged outwardly by springs **41**. See FIG. **7** in which the dogs are shown out of the pipe and in fully extended position under the influence of the springs. The outer periphery of the dogs are profiled to register with the grooves **36** and **37** in the mandrel and, as soon as the latch mechanism moves in to register with these grooves, the dogs move outwardly into the grooves. As the lower surfaces **39***a* of the dogs extend normal to the center line of the pipe and engage the shoulders **37***a* in the pipe, the apparatus cannot move downwardly any further. It will be appreciated that the profile of the several grooves in the several mandrels located up the tubing string will differ so that proper dogs may be selected for each device to be landed in each mandrel. These profiles are selected such that a latching section will not land until it reaches the mandrel having a matching profile. Thus the system selects the proper mandrel and lands the apparatus in this mandrel.

From the description as it has thus far proceeded it will be apparent that the latching system could be provided directly on the lower end of body member **34** when the motor is to be used without other immediately associated equipment. In this case the motor would be made up in a train of valves and would drop these valves off one by one as it passed mandrels and then would proceed to the lowermost mandrel and be latched in position.

In accordance with one aspect of this invention the motor is associated with a gas-lift valve so that when the motor is landed a gas-lift valve is also landed which eliminates the necessity for an additional mandrel for this gas-lift valve.

The mandrel **9** has a perforation **42** therein establishing fluid communication between the casing annulus and the tubing. The apparatus has seal means which straddle this perforation. While the seal **19** could be used as the upper packing, it is preferred to use a separate upper packing **43** in conjunction with a lower straddle packer **44** on opposite sides of the perforation. These seals **43** and **44** are designed to provide higher pressure seals than the normal design of the packer **19**, and therefore they are preferred. In the illustrative embodiment, a swivel joint indicated generally at **45** connects the lower end of body member **34** to upper packer body member **46**. These two members have opposed shoulders which confine the packer **43**. Attached to the body member **46** is the gas-lift valve carrier **47**. The carrier is connected through collar **48** and ball joint **49** to a lower gas-lift carrier **50**. This carrier cooperates with the upper end of the ball joint member **51** to confine the lower straddle packer **44**. The lower ball joint **52** which includes the part **51** is connected to the latching mechanism.

One or more gas-lift valves may be carried in the body just described. A passageway **53** is provided in the gas-lift body **47** to provide communication between the exterior of the apparatus between the straddle packers **43** and **44** and a gas-lift valve **54**. The outlet of this gas-lift valve communicates with the passageway below the pumpout valve so that, when it is desired to remove the motor from the well, fluid entering through the perforation **42** and passageway **53** may be exerted against the pumpout valve and the packer **19** to pump the apparatus from the well. It will be noted that the tubing is slightly larger in diameter than the internal diameter of the mandrel **9**, and thus there is a differential area provided against which pressure through the perforation **42** may be exerted to pump the apparatus out of the hole once the pumpout valve has been actuated.

If desired, an additional gas-lift valve **55** may be provided with gas through the port **56**. These two gas-lift valves operate in the manner explained in my application U.S. Ser. No. 540,707, now U.S. Pat. No. 3,372,650 that is, one of the valves is a differential valve which is loaded by a valve responsive to casing pressure.

In operation the assembly is made up in the form and manner shown in FIGS. 1A and 1B. A chain of mandrels carrying gas-lift valves, as shown in my U.S. Pat. No. 3,334,690, may be attached above the apparatus and the entire assembly is run into the tubing through the customary lubricator at the wellhead. Pressure is introduced into the tubing above the train and the train is pumped downwardly through the tubing, landing the valves successively in the mandrels as the train moves downwardly. The last valve-carrying mandrel is dropped off in each of the tubing mandrels as the train moves downwardly. When the last gas-lift valve above the apparatus illustrated has been dropped off, the motor proceeds downwardly until it reaches the position shown in FIGS. 1A and 1B, where it is landed in mandrel 9. The operator senses the landing of the device by a sudden increase in pressure. Pressure is permitted to build up in the tubing to the extent necessary to shear the holding pin 26 and permit the seat 25 to move downwardly, as illustrated in FIG. 2. At this time, the train is finally positioned in the well and the well is gas-lifted in the usual manner with the gas-lift valves 54 and 55 providing the lowermost gas-lift valves in the string.

If at any time it is desired to remove the train of gas-lift valves or other apparatus which have been pumped into the well with the apparatus shown, pressure in the tubing above the apparatus shown is increased to provide a differential across the standing valve which exerts a force in a downward direction of sufficient magnitude to shear the shear pin 33. At this time the pumpout valve becomes operative, as shown in FIG. 5.

The pressure is removed from the tubing and applied to the casing. As the pumpout valve is now closed, there is no way for this fluid to readily pass through the apparatus, and a pressure will be exerted on the packing 19. As this packing is larger in diameter than the straddle packing 44, an upward force will result which will collapse the landing dogs due to the upwardly inclined surfaces on the upward-facing shoulders thereof, and the motor will move upwardly in the well. As it moves up the well, it will pick up the devices landed thereabove successively and convey the entire train to the surface.

From the above it will be seen that all of the objects of this invention have been attained. The motor is very simple and trouble-free. While shear pins of different strength have been illustrated, it will be appreciated that by providing for indexing of the seat 25 in response to pressure before it can exert a downward force on the seat 31, that these pins could of course be of the same strength, or the pin 33 could actually be of a lesser strength.

It will be appreciated that by providing the apparatus with a gas-lift valve whose outlet is below the pumpout valve, that a single mandrel may be utilized to land the pumpout device and the lowermost gas-lift valve, thus reducing the number of mandrels necessary in the string.

It will be apparent that any desired latch means can be used to control the two valves so long as the means is responsive to pressure in the tubing.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. Apparatus adapted to be pumped through and landed in a tubing having at least one mandrel therein comprising:
- a body having a passageway therethrough;
- seal means on said body for sealing engagement with a well tubing to permit the apparatus to be pumped downwardly through a tubing;
- first check valve means controlling flow through said passageway;
- first holding means initially holding said first check valve means closed to permit pumping said apparatus in either direction so that it can be reversed out of the tubing if desired;
- said first holding means rendered ineffective in response to a selected differential across said first check valve means to permit it to function as a standing valve after the apparatus has been pumped into the hole;
- second valve means for preventing flow through the passageway in the direction permitted by said standing valve;
- second holding means holding said second valve means in open position to permit flow therethrough during production through said tubing; and
- said second holding means rendered ineffective in response to a selected differential across said first check valve means after said first holding means has been rendered ineffective to permit pumping said apparatus upwardly through a tubing.

2. The apparatus of claim 1 in combination with latch means for locating a particular mandrel in a tubing and landing the apparatus in said mandrel, said body being constructed of several pieces joined together by articulating joints.

3. The apparatus of claim 1 in combination with latch means for locating a particular mandrel in a tubing and landing the apparatus in said mandrel:
- spaced seal means on said body below said first mentioned seal means adapted to straddle a perforation in said mandrel and seal between the body and mandrel;
- a gas-lift valve carried by the body; and
- a second passageway through the body establishing communication between the exterior of the body between said straddle seals and said gas-lift valve.

4. Apparatus adapted to be pumped through and landed in a tubing having at least one perforated mandrel therein comprising:
- a body having a passageway therethrough;
- first check valve means controlling flow through said passageway;
- first holding means initially holding said first check valve means closed to permit pumping said apparatus in either direction so that it can be reversed out of the tubing if desired;
- said first holding means rendered ineffective in response to a selected differential across said first check valve means to permit it to function as a standing valve after the apparatus has been pumped into the hole;
- second valve means for preventing flow through the passageway in the direction permitted by said standing valve;
- second holding means holding said second valve means in open position to permit flow therethrough during production through said tubing;
- said second holding means rendered ineffective in response to a selected differential across said first check valve means after said first holding means has been rendered ineffective to permit pumping said apparatus upwardly through a tubing;
- latch means for locating a particular mandrel in a tubing and landing the apparatus in said mandrel;
- seal means on said body for sealing engagement with a well tubing to permit the apparatus to be pumped downwardly through a tubing and for straddling and sealing above and below a perforation in said mandrel;
- a gas-lift valve carried by the body;
- the outlet of said gas-lift valve communicating with said flowway below said second valve means;
- a second passageway through the body establishing communication between the exterior of the body between said straddling seal means and said gas-lift valve.

5. The apparatus of claim 4 wherein a seal means above the perforation in said mandrel is adapted to seal with a tubing having a larger diameter than said mandrel.

6. Apparatus comprising:
- a body having a passageway therethrough;

seal means on said body for sealing engagement with a well tubing;

a cooperating first valve member and first valve seat controlling flow through said passageway;

means including first shear means holding said first valve member on its seat during running of the apparatus and releasing said first valve seat for movement to a position freeing said first valve member for movement as a standing valve in response to a selected first differential pressure across the apparatus;

a second valve member and second valve seat cooperative therewith to provide a check valve operative in the opposite direction from said standing valve;

said second valve seat supporting said first valve seat upon release by said first shear means;

second shear means holding said second valve seat in spaced relationship to said second valve member;

said second shear means releasing said second valve seat in response to a second selected differential pressure across the apparatus greater than said first differential pressure and permitting said second valve seat to move to an operative position where it can cooperate with said second valve member; and

means latching said second valve seat in said operative position.

7. The apparatus of claim 6 including means latching said first valve seat against movement toward said first valve member upon shearing of said first shear means.