Dec. 1, 1953 D. G. KNOX 2,661,024

PLUNGER CONSTRUCTION

Filed Aug. 8, 1947

Fig 1

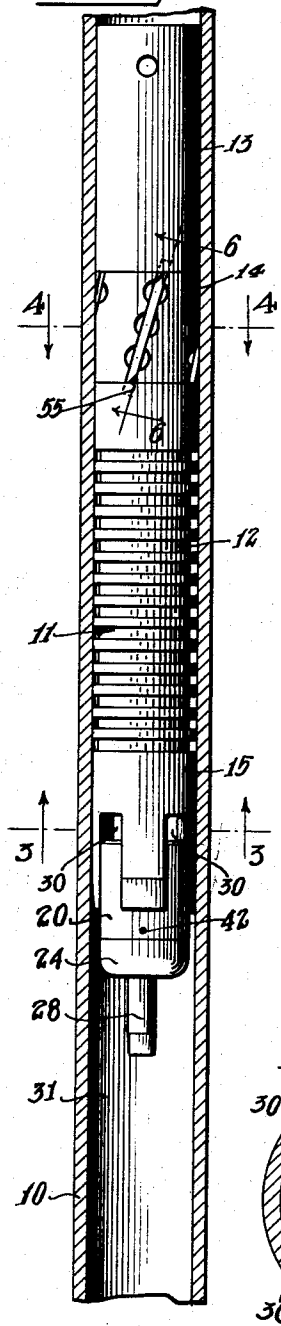


Fig 2

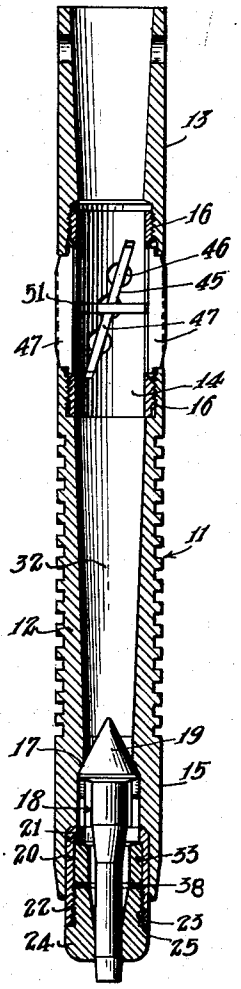


Fig 4

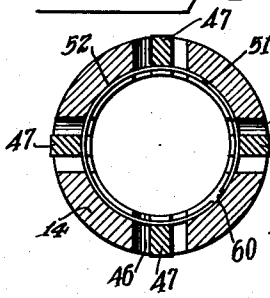


Fig 5

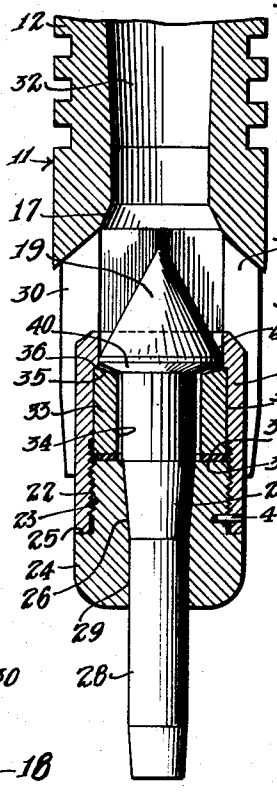


Fig 6

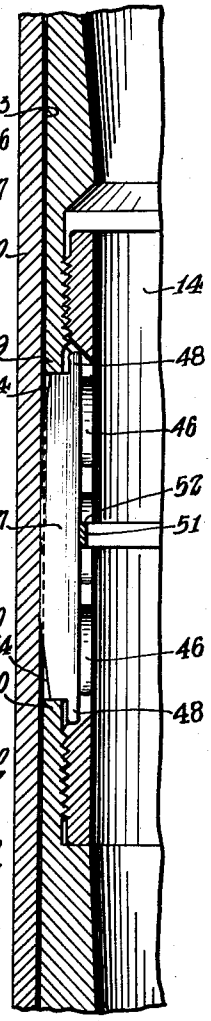
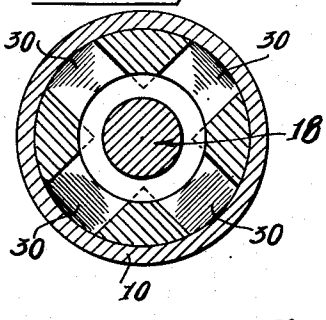


Fig 3



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UNITED STATES PATENT OFFICE

2,661,024

PLUNGER CONSTRUCTION

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6 Claims. (Cl. 137—692)

1

This invention relates to plunger lift apparatus of the type used in lifting well fluid by means of a pneumatically driven plunger which travels substantially the full length of an eduction tube. Apparatus of this general type is disclosed in the Fletcher patent, 1,846,000, dated February 16, 1932. Certain improvements in control apparatus for such devices are shown in the co-pending application of Knox et al., Serial No. 626,052, filed November 1, 1945, now Patent No. 2,508,174 issued May 16, 1950.

One of the problems which is encountered in operating plunger lift apparatus is that the valve which travels with the plunger sometimes does not remain in its open position for the entire length of the descent of the plunger within the eduction tube. Premature closing of the valve results in "short-stroking" and consequent loss of production. Various proposals have been made to provide means for holding the valve in fully open position against accidental closure so that the valve will remain fully open while the plunger drops from the surface to the bottom of the well. A coil spring for accomplishing this purpose is shown in the Ricker patent, 1,905,058. One difficulty with the Ricker construction is that the characteristics of a spring are such that a comparatively large force is present tending to open the valve when it is in its closed position. This is an undesirable feature since it is important that the valve remain fully closed during the upward travel of the plunger within the eduction tube.

Another problem which has been recognized in the operation of pluger lift apparatus is that wax or paraffin or lime, or other foreign matter, sometimes is deposited in the inner wall of the eduction tube and the accumulation of such material may interfere with the normal action of the plunger. Various forms of scraper devices have been proposed, one of which is shown in the Bettis patent, 1,993,258.

It is the primary object of this invention to provide improvements in the construction of the traveling plunger as utilized in plunger lift apparatus.

A more particular object is to provide an improved device for automatically maintaining the plunger valve in its fully open position during descent of the plunger, yet which exerts a minimum force tending to move the valve from closed position.

A more particular object is to provide an annular permanent magnet through which the valve stem operates, which magnet is effective to hold the valve in fully open position.

2

Another object is to provide a novel form of mounting for such permanent magnet.

Another object is to provide a scraper assembly for the plunger which will operate effectively irrespective of minor variations in the dimensions of the bore of the eduction tube which will pass across joints in the eduction tube without difficulty.

Another object is to provide a scraper assembly having angularly positioned straight scraper blades curved on their outer edges to fit the interior surface of the eduction tube.

Another object is to provide scraper blades of this type which are movable in slots under the action of a band type spring.

Another object is to provide a scraper device of this type in which the band type spring exerts unequal force on a plurality of scraper blades, so that in traveling within the eduction tube rotary motion is imparted to the scraper assembly.

A further object is to provide a scraper assembly of this type having a full opening through the interior thereof corresponding with the opening within the tubular body of the plunger.

Another object is to provide one or more recesses along the scraper blade slots to receive foreign material scraped from the inner surface of the eduction tube.

Other objects and advantages will appear hereinafter.

In the drawings:

Figure 1 is an elevation partly in section illustrating a preferred embodiment of my invention.

Figure 2 is a sectional elevation of the plunger shown in Figure 1, the plunger valve being in closed position.

Figure 3 is a transverse sectional view taken substantially on the lines 3—3 as shown in Figure 1.

Figure 4 is a transverse sectional elevation taken substantially on the lines 4—4 as shown in Figure 1.

Figure 5 is a partial sectional view on an enlarged scale showing details of the mounting of the permanent magnet.

Figure 6 is a sectional view on an enlarged scale partly broken away taken substantially on the lines 6—6 as shown in Figure 1.

Referring to the drawings, the eduction tube 10 may comprise a plurality of jointed sections which depend into a well bore. A plunger generally designated 11 is adapted to travel the full length of the eduction tube from a position near the bottom of the well to the surface. The oper-

ation of such a plunger is described in detail in the Fletcher and Ricker patents referred to above and therefore need not be repeated here. In general the principal of operation is that gas under pressure below the plunger 11 raises the plunger together with a load of well fluid above the plunger within the eduction tube 10. The well fluid is discharged through suitable conduits at the surface and the plunger 11 falls by gravity down toward the bottom of the well hole in order to bring up another load.

The plunger 11 comprises a tubular body generally designated 12. This body includes an upper portion 13, a sleeve 14 and a lower portion 15 connected by the threaded elements 16. A conical seat 17 is provided on the lower portion 15 of the body member 12 and a poppet valve 18 provided with a head 19 is adapted to engage the seat 17 to form a seal. An insert bushing 20 is mounted within a counterbore 21 provided in the lower end of the member 15 and secured thereto by any convenient means such as, for example, by brazing or soldering. If desired, the insert bushing 20 may be formed integrally with the member 15. The bushing 20 is provided with internal threads 22 for reception of the external threads 23 provided on the support member 24, and shoulders 25 on the insert 20 and support 24 meet in abutting relation. Disassembly of the threads 22 and 23 may be prevented by any convenient means such as, for example, by the pin 42.

A tapered bore 26 is provided in the upper portion of the support member 24 to receive the corresponding tapered section 27 on the valve stem 28. The lower portion of the valve stem 28 extends through the cylindrical bore 29 in the lower end of the support 24. From this description it will be understood that closing movement of the valve is limited by the engagement of the valve head 19 with the seat 17 while the opening movement of the valve is limited by engagement of the cooperating conical parts 26 and 27.

A plurality of lateral ports 30 are provided in the lower portion of the member 15 around the valve head 19, and these ports establish communication between the space 31 within the eduction tube and below the plunger 11 and the central opening 32 within the plunger 11. When the valve 18 is in its fully open position as shown in Figure 5, gas or well fluid or both may flow upwardly through the ports 30 and into the central opening 32 and thus permit the plunger 12 to descend within the eduction tube 10. If the valve 18 should accidentally be jarred into its closed position during such descent, gas pressure below the plunger might halt the descent prematurely and return the plunger to the surface with only a partial load. In order to prevent this action from occurring, means are provided for maintaining the valve 18 in its fully open position. As shown in the drawings this means includes an annular permanent magnet 33 which has a central opening 34 through which the valve stem 28 extends. The magnet 33 is provided with a conical surface 35 at its upper end which is adapted to engage under a shoulder 36 at the upper end of the bore 37 in the insert bushing 20. A resilient cushion or rubber washer 38 is positioned at the lower end of the annular magnet 33, and this washer 38 is distorted between the magnet 33 and the upper end 39 on the support member 24.

Since the material of which the magnet is constructed may be brittle, it is highly desirable

to impose only a minimum end load on the magnet to maintain it in place. Accordingly, the provision of the rubber washer 38 enables the insert 20, support 24 and magnet 33 to be manufactured with commercial tolerances, and yet avoid any possibility of fracturing the permanent magnet upon assembly into the insert bushing 20. Although the upper face 35 of the magnet 33 lies adjacent the back face 40 of the valve head 19, the parts do not contact, but on the contrary a clearance space 41 is provided. In other words, the tapered section 27 on the valve stem 18 engages the tapered bore 26 within the support 24 so that the valve head and magnet do not meet in metal-to-metal engagement, and the magnet is thereby further protected against shock loading or fracture. Even if such metal-to-metal contact should occur by reason of wear of the parts 26 and 27 the cushion 38 would absorb the shock and avoid damage to the magnet 33.

In order that accumulation of wax, paraffin or lime, or other foreign material within the eduction tube 10 may not interfere with normal travel of the plunger 11, scraper means are provided on the plunger 11 to remove such foreign material as it accumulates. As shown in the drawings, the sleeve 14 connecting the body portions 13 and 15 is provided with a plurality of straight slots 45 extending longitudinally and at an angle to the axis of the eduction tube 10. Each of these slots 45 may be formed with straight sides by means of a milling cutter if desired. Recesses 46 are provided along the length of the slots 45 for a purpose described below.

A scraper blade 47 is positioned within each of the slots 45 and is slidably received so that it may move radially within the slot. As shown in Figure 6, each of the blades 47 is provided with projections 48 at its opposed ends which are adapted to underlie annular lips 49 and 50 provided on the members 13 and 15 respectively. The purpose of these projections 48 is to limit outward radial movement of the blades 47. A band type spring 51 is received within a groove 52 provided in the sleeve 14, and this spring 51 simultaneously urges each of the scrapers 47 into contact with the inner surface 53 of the eduction tube 10. The pressure exerted by the spring 51 is of very small magnitude so that only a minimum frictional force is developed between the blades 47 and the eduction tube 10, and hence the travel of the plunger 11 within the eduction tube 10 is not materially affected. The band spring 51, which is split at 60, exerts unequal pressure on the four scraper blades 47, this function being characteristic of split band springs, since relatively little expansion force is available opposite the split part 60. The unequal loading of the blades 47 results in rotation of the plunger assembly as it moves vertically within the eduction tube.

It will be observed from a consideration of Figures 4 and 6 that the scraper blades and the band spring 51 are confined within the thickness of the tubular body member, and that a full opening is provided through the sleeve member 14. This is an important feature since it is necessary to avoid any restriction of the central opening 32 in order that certain appliances may be lowered into this opening should abnormal well conditions or other causes result in sticking of the plunger within the eduction tube, or failure of the plunger valve to operate properly.

The upper and lower contact edges 54 of each scraper blade 47 may be relieved as shown in order to avoid interference or fouling in the joints of the eduction tube 10. The clearances provided by these relieved portions 54 and the clearance between the projections 48 and lips 49 are exaggerated in Figure 6 for clarity of illustration. Furthermore, these upper and lower portions of the scraping edge may be beveled as shown at 55 in Figure 1 to reduce the blunt end of the blades 46 substantially to a point. In this way the accummulation of foreign matter at the blunt ends of the blades is avoided.

In operation the vertical movement of the plunger 11 within the eduction tube 10 causes the scraper blades 47 to remove any accumulation of wax, paraffin or other foreign matter from the bore of the eduction tube and to deposit it within the recesses 46 along the length of the slots 45. The foreign material thus removed from the internal wall of the eduction tube may pass inwardly through the recesses 46 into the central opening 32 or may remain in the recesses 46 and be redissolved into the well fluid when the plunger 11 returns to the lower end of its stroke.

It will be understood that the number of blades employed or the angle of the blades with respect to the axis of the eduction tube may be varied in order to sweep a full circle of the eduction tube if desired as the plunger moves therein.

Having fully described my invention, it is to be understood that I am not limited to any of the details herein set forth except as described in the following claims.

I claim:

1. A swab plunger comprising a tubular body member having a longitudinal passageway extending therethrough, said body member being provided with lateral ports near the lower end thereof, valve means for controlling flow through said passageway and ports, said valve means including a valve seat on the body member above the ports, said means also including a valve having a head and a depending stem, guide means on the tubular body member below the ports slidably engaging the stem to guide the valve for longitudinal movement with respect to the body member, the valve head being adapted to close into contact with said seat, an annular permanent magnet fixed on the body member and encircling the stem at a location between the guide means and said ports, the magnet acting on the valve head to maintain the valve in open position, and cooperating stop means on the valve and body member limiting opening movement of the valve and preventing contact between the valve head and the magnet.

2. A swab plunger comprising a tubular body having a longitudinal passageway extending therethrough, valve means near the lower end of said body for controlling flow through said passageway, said valve means including a valve seat on the body, said means also including a valve having a head and a depending stem, a support secured on the tubular body slidably engaging the stem to guide the valve for longitudinal movement with respect to the body, the valve head being adapted to close into contact with said seat, an annular permanent magnet clamped between the body and the support and encircling the stem, the magnet acting on the valve head to maintain the valve in open position, and cooperating stop means on the valve and support limiting opening movement of the valve to prevent contact between the valve head and the magnet.

3. A swab plunger comprising a tubular body having a longitudinal passageway extending therethrough, valve means near the lower end of said body for controlling flow through said passageway, said valve means including a valve seat on the body, said means also including a valve having a head and a depending stem, a support secured on the tubular body having a bore slidably engaging the stem to guide the valve for longitudinal movement with respect to the body, the valve head being adapted to close into contact with said seat, an annular permanent magnet encircling the stem, an annular resilient washer, the magnet and washer being clamped between the support and the body, the magnet acting on the valve head to maintain the valve in open position, and cooperating stop means on the valve and support limiting opening movement of the valve to prevent contact between the valve head and the magnet.

4. A swab plunger comprising a tubular body member having a passageway extending therethrough, a valve seat near the lower end of the body member, a valve having a head and a depending stem guided for movement on the body member, the valve head closing into contact with said seat to prevent flow through the passageway, an annular magnet on the body member encircling the stem and acting on the valve head to maintain the valve in open position, and cooperating stop means on the valve and body member limiting opening movement of the valve and preventing contact between the valve head and the magnet.

5. A swab plunger comprising a tubular body having a longitudinal passageway extending therethrough, valve means near the lower end of the body for controlling flow through said passageway, said valve means including a valve seat on the body member, said means also including a valve having a head and a depending stem, the body having a counterbore provided with an annular shoulder, a tubular support having a central opening receiving the valve stem, an annular magnet encircling the valve stem and positioned within the counterbore, the valve head closing against the seat, the magnet acting on the valve head to maintain the valve in open position, a resilient washer interposed between the annular magnet and the tubular support, and thread means connecting the tubular support and body for clamping the magnet between said annular shoulder and said resilient washer.

6. A swab plunger comprising a tubular body having a longitudinal passageway extending therethrough, valve means near the lower end of the body for controlling flow through said passageway, said valve means including a valve seat on the body member, said means also including a valve having a head and a depending stem, the body having a counterbore provided with an annular shoulder, a tubular support having a central opening receiving the valve stem, an annular magnet encircling the valve stem and positioned within the counterbore, the valve head closing against the seat, the magnet acting on the valve head to maintain the valve in open position, a resilient washer interposed between the annular magnet and the tubular support, thread means connecting the tubular support and body for clamping the magnet between said annular shoulder and said resilient washer, and cooperating means on the valve stem and support for limiting

opening movement of the valve independently of the annular magnet.

DONALD G. KNOX.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,758,105	French	May 13, 1930
1,905,058	Ricker	Apr. 25, 1933
1,934,548	Kellogg	Nov. 7, 1933
1,993,258	Bettis	Mar. 5, 1935
2,018,204	Evans et al.	Oct. 22, 1935
2,216,809	Derby	Oct. 8, 1940
2,346,904	Carlson	Apr. 18, 1944
2,353,740	Malone	July 18, 1944

FOREIGN PATENTS

Number	Country	Date
12,118	Great Britain	of 1911
74,521	Austria	Aug. 26, 1918
212,570	Germany	of 1909
298,852	Great Britain	of 1928