May 21, 1968 M. W. HAINES 3,384,179

COMBINED ANCHOR AND PUMP SHOE

Filed March 16, 1966 2 Sheets-Sheet 1

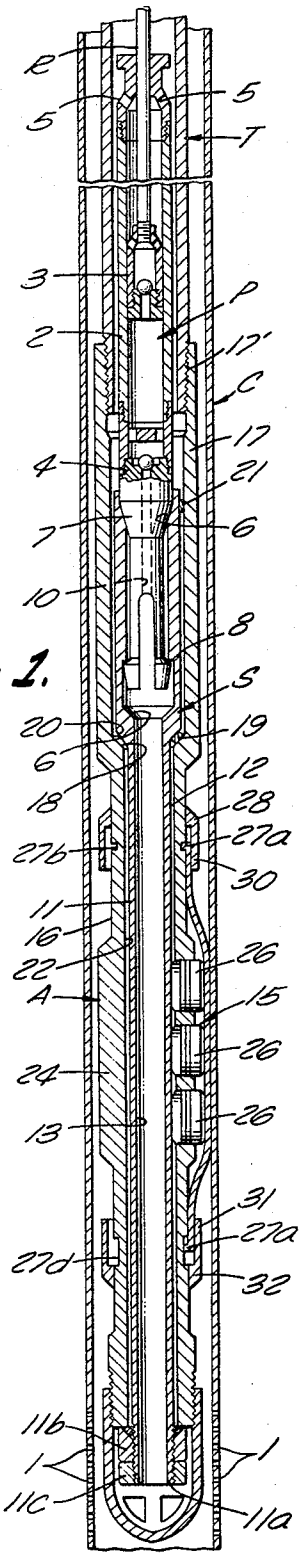

FIG. 1.

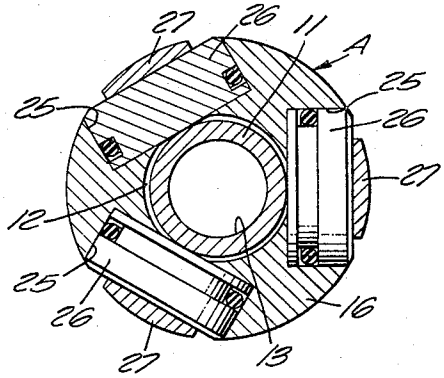

FIG. 3.

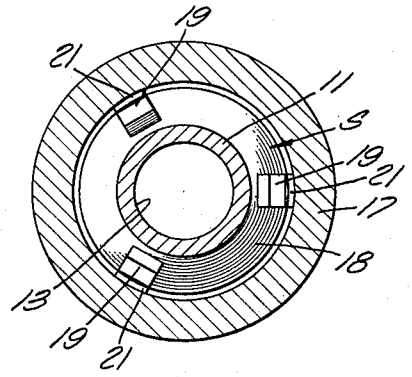

FIG. 4.

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COMBINED ANCHOR AND PUMP SHOE

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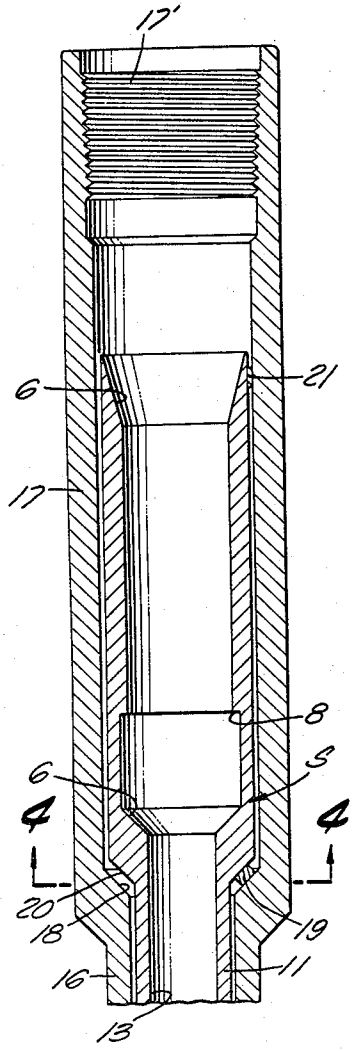

FIG. 2a.

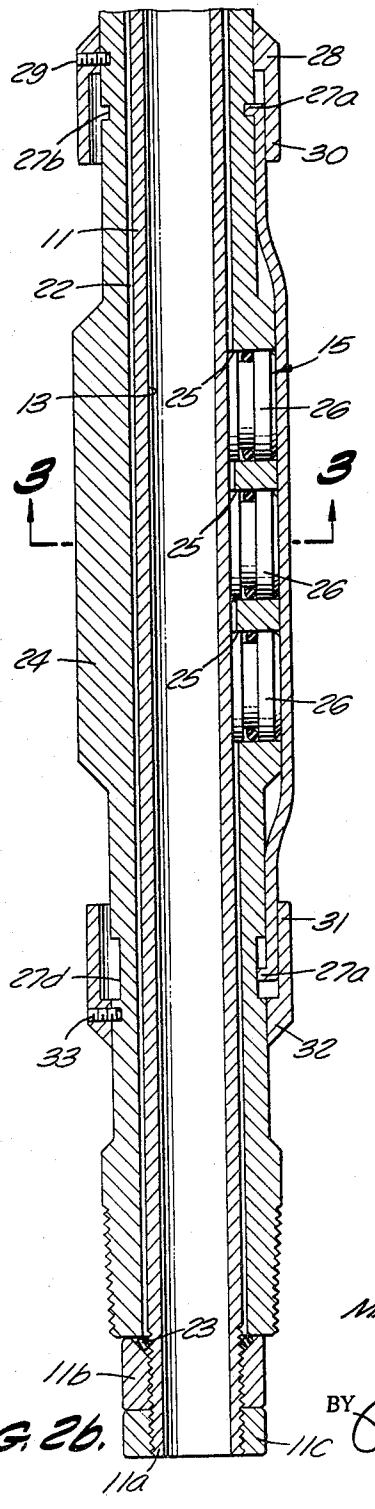

FIG. 2b.

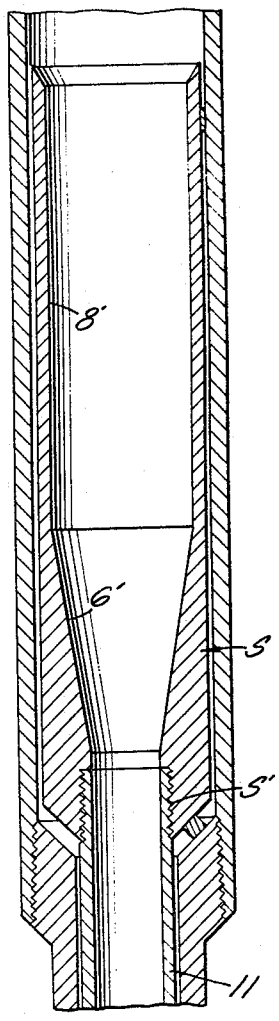

FIG. 5.

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COMBINED ANCHOR AND PUMP SHOE

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8 Claims. (Cl. 166—212)

The present invention relates to anchors for use in oil wells and more particularly to a combined anchor and pump shoe adapted for use in connection with holding or anchoring the well production tubing within the well pipe or casing so as to prevent working of the tubing with the typical reciprocating pump employed to lift the production fluid through the tubing to the earth's surface.

More recently it has become the practice to drill relatively small diameter well bores which are cased with small diameter well piper or casing and the production pipe or tubing employed to conduct the well fluids to the surface is also of comparatively small diameter, posing problems in respect of the conventional equipment to be employed in the production of the well, including the reciprocating or sucker rod pump assemblies and devices for anchoring the tubing against working with the pump. Working of the tubing with the pump involves the cyclical stretching and contraction of the tubing as the rod pump is reciprocated. In normal well applications it is the practice to install in the tubing an anchor which may either be mechanically or hydraulically actuated into anchoring engagement with the well casing or liner so as to anchore the tubing against such working.

An example of such a tubing anchor is shown in my prior Patent No. 2,874,783, granted Feb. 24, 1959, wherein an hydraulically actuated friction anchor is illustrated as being installed in the production tubing above a sucker rod pump.

With the advent of smaller diameter wells the maintenance of adequate passageway through tubing anchors both of the kind disclosed in my above mentioned patent and in other kinds of hydraulic or mechanically actuated anchors whereby retrievable pump assemblies may be run and retrieved has posed a problem which the present invention obviates.

An object of the present invention is to provide a combined tubing anchor and pump shoe assembly adapted to be employed in a well to hold the tubing against working with the pump and wherein the anchor is hydraulically actuated so as to have an anchoring action which is proportional to the hydrostatic head acting thereon and wherein the anchor is so disposed relative to the pump shoe that the typical sucker rod pump assembly may be run and retrieved and engaged and disengaged from the shoe without interference from the anchor, even in the small diameter wells.

In accomplishing the foregoing, it is a further objective to provide a unitary and simple assembly comprising an elongated tubular anchor body having adjacent its upper end and interally thereof a typical API pump shoe, and having within the body means which cooperate with the body to define a first fluid passage adapted to establish communication between the well below the anchor and the pump shoe and to define a second fluid passage or chamber which communicates through the body with the tubing above the shoe, the anchor body having fluid pressure operated anchor means thereon adapted to be actuated into engagement with the well casing responsive to the pressure of fluid in the just mentioned second fluid passage or chamber, this pressure being a function of the hydrostatic head of fluid in the tubing.

Other objects and advantages of the invention will be hereinafter described or will become apparent to those

skilled in the art, and the novel features of the invention will be defined in the appended claims.

In the accompanying drawings:

FIG. 1 is a view in longitudinal section illustrating the disposition in a well casing of a combined anchor and pump shoe made in accordance with the invention, with a typical sucker rod pump seated in the shoe;

FIG. 2*a* is a view in vertical section and on an enlarged scale of the upper end assembly of the combined anchor and shoe shown in FIG. 1;

FIG. 2*b* is a downward continuation of FIG. 2*a*;

FIG. 3 is a transverse sectional view as taken on the line 3—3 of FIG. 2*b*;

FIG. 4 is a transverse sectional view as taken on the line 4—4 of FIG. 2*a*; and

FIG. 5 is a view corresponding to FIG. 2*a*, but illustrating a modified form of pump shoe.

Like reference characters in the several views of the drawings and in the following description designate corresponding parts.

Referring first to FIG. 1, there is generally shown a representative installation of a combined anchor and shoe made in accordance with the invention in a well pipe or casing C which has been perforated as at **1** to provide openings through which well fluids may flow from the subsurface formation into the casing for subsequent production. It will be understood that other known modes of producing the well may be availed of, namely the fluids may flow into an open or uncased hole or the production sands may be retained behind a liner or gravel pack, all as known in the art, and a perforated casing is merely exemplary. In the illustration the well fluids are to be produced by a pump P comprising a typical working barrel **2** having reciprocable therein a valve plunger **3**. At the base of the barrel **2** is a typical standing valve assembly **4** adapted to permit the entry of well fluids into the working barrel **2** when the plunger **3** and its travelling valve are moved upwardly by a string of sucker rods R. At the upper end of the working barrel **2** are suitable passages **5** through which produced fluid will pass into the production tubing generally denoted at T.

Connected to the tubing T is the anchor A of the combined anchor and shoe of the present invention and within the anchor A is the shoe S in which the pump P seats.

The shoe S may be of any desired type but, as illustrated, would preferably be of a standard API type such as a bottom lock shoe having at its upper extremity a tapered seat **6** in which the lower tapered extremity **7** of the pump standing valve engages, and also having an internal shoulder **8** with which typical latching fingers below the pump standing valve will engage to latch the pump assembly P on the tapered seat **6** of the shoe. The pump latch assembly has flow passage **10** so that well fluids may pass through the standing valve assembly into the pump barrel **2**.

Depending from the shoe S is an elongated tubular member **11** which extends in the illustrative embodiment the full length of the anchor A and is connected to the anchor body in such a manner as will hereinafter be more particularly described as to provide between the shoe and its depending extension **11** a chamber **12** which opens at the upper end of the shoe into the tubing T so that the pressure of fluid in this chamber is a function of the hydrostatic column in the tubing. The depending member **11** has a central passage **13** therethrough which at its lower end communicates with the open well pipe or casing C so as to receive well production fluids passing into the casing through the perforations **1**.

It will now be understood that well fluids are produced upwardly through the depending extension **11** through the bottom lock for the pump P through the standing

valve by the travelling valve and plunger assembly in response to reciprocation of the rod string R. Carried by the anchor A are anchor means generally denoted at **15** which, as will be hereinafter more fully described, are hydraulically actuated by the pressure of the column of fluid acting in the chamber **12**.

Referring now to FIGS. 2*a* through 4, the details of construction of the illustrative embodiment of the combined anchor and shoe will be better understood. It will be noted that the anchor A comprises an elongated body **16** having adjacent its upper end an enlarged body section **17** provided with thread means **17'** for connection to the tubing T. Internally of the enlarged body section **17** is a shoulder **18** which, as seen in FIG. 4, has suitably provided thereon a suitable number of spacers **19** adapted to be engaged by a tapered surface **20** at the bottom of the pump shoe S. In addition, suitable spacers **21** may be provided adjacent the upper end of the pump shoe so as to dispose the pump shoe S concentric within the body section **17** of the anchor, thereby assuring the provision of an annular space therebetween.

Extended through the body **16** of the anchor is a bore **22** in which is disposed the aforementioned depending extension **11** of the shoe S. This extension **11** passes through the lower end of the body **16** of the anchor and is provided with a threaded lower extremity **11***a* engageable by a nut **11***b* and a jam nut **11***c* whereby to securely load the shoe S against the stops **19** described above and so as to positively secure the shoe and its extension **11** within the anchor. Sealing means in the form of a sealing ring **23** are provided, as for example between the nut **11***b* and the lower end face of the anchor **16**, so as to separate the chamber **12** within the body **16** from the well bore outside of the anchor.

The anchor body **16** has a central section **24** of enlarged cross sectional configuration provided with a suitable number of radially extended bores **25** in each of which is disposed a piston **26**. As best seen in FIG. 3, the pistons and bores **25** are preferably symmetrically arranged about the anchor so that in addition to providing the anchoring effect desired the assembly will also be substantially centralized within the casing C when anchored in the latter.

In the illustrative embodiment of the anchor, longitudinally extended friction anchor members **27** extend longitudinally and in overlying relation to the outer ends of the pistons **26**. At the upper extremities of the anchor members **27** each is provided with an inturned flange **27***a* adapted to engage in a groove **27***b* in the anchor body **16**. A retaining collar **28** suitably mounted upon the anchor body **16** by fastening means **29** is provided with a skirt **30** which engages the ends of the anchor members **27** retaining the same in place on the body **16**. At the lower extremities of the anchor members **27**, they are provided with inturned flanges **27***a* which engage in an elongated groove **27***d* in the anchor body **16**, these lower ends of the anchor members **27** being retained by a skirt **31** provided on a collar **32** which is secured to the body **16** by fastening means **33**.

It will be noted that this construction of the anchor members **27** and the means for attaching the same to the anchor body will allow for lateral deformation of the anchor members **27** responsive to forces applied outwardly by the pistons **26**. It will also be understood that the effect of pressure differential acting on the pistons **26** is a function of the difference between the pressure of the fluid column in the tubing T and the column of fluids within the casing C outside of the anchor.

Referring to FIG. 5, the upper end of a modified assembly is shown, this assembly being identical to that previously described with the exception of the shoe S which, in the embodiment of FIG. 5, is provided with a conical seat **6'** adjacent the lower end of the shoe, there being a substantially cylindrical wall **8'** above the conical seating wall **6'** adapted for sealing engagement with the sealing elements of a pump assembly having an hydraulic bottom lock. Such a lock, as known in the art, is provided with swabs which cause the pump to be held against the seat by differential pressure. Such differential pressure would be the same pressure which in the present invention actuates the anchor. In addition, in the embodiment of FIG. 5 it will be noted that means are provided for separably connecting the shoe S to the downward extension **11**, such means comprising a threaded upper end on the extension **11** engaged in complemental threads on the lower end of the shoe, all as indicated at S'. With such a construction it will be understood that various types of pump shoes may be employed in connection with the anchor A, as may be dictated by the type of pump to be employed.

In use, the anchor and shoe assembly will be connected in a string of well tubing T and run into the well casing to the desired depth as customary. The lower end of the anchor assembly may be either connected to a downward extension of the tubing or the well production fluids may enter the lower end of the anchor assembly as specifically illustrated.

Thereafter, the pump assembly P will be run into the tubing on the sucker rod string until the working barrel and more particularly the lower extremity of the pump assembly lands upon the seat provided by the pump shoe. In the structure of FIG. 1, it will be noted that the pump assembly will be positively latched in place upon landing in the shoe but will be retrievable upon pulling upwardly on the rod string a distance greater than its permissible travel within the working barrel of the pump. In the case of a shoe of the type shown in FIG. 5, the pump will land in the shoe but differential pressure will retain the pump in the shoe after the pump commences to operate.

Upon operation of the pump each stroke of the pump will displace fluid from the pump barrel into the tubing above the pump barrel and such fluid will fill the chamber between the pump shoe and the downward extension **11** so as to act upon the inner ends of the pistons **26**. As the column of fluid in the tubing T increases in height, the differential pressure acting across the pistons will correspondingly increase so as to force the friction anchor member **27** outwardly into engagement with the well casing C. It will also be understood to be within the purview of the invention that the outward extremities of the pistons themselves may provide the friction surfaces engageable with the casing, or indeed, the invention contemplates the use of more positive anchoring elements having typical wickered surfaces for biting into the well casing. It is preferred, however, that friction anchor elements be employed so as to avail of the advantages ascribable thereto in terms of certainty of release when it is desired to pull the anchor assembly from the well bore, as well as in terms of provision of predictable holding or anchoring effort based on the area of frictional contact and a known anchoring pressure.

While specific structural details have been shown and described, it should be understood that changes and alterations may be resorted to without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. A combined anchor and pump shoe for use in a well to anchor well tubing against working with a pump relative to the well casing, comprising: a tubular anchor body adapted to be connected in the well tubing; a pump shoe connected to said body; means defining a production fluid passage through said body to said pump shoe and a chamber in said body separated from said passage and opening between said body and said shoe for communication with the well tubing above said shoe; and anchor means carried by said body and operable responsive to fluid pressure in said chamber to be forced outwardly into anchoring engagement with the well casing.

2. A combined anchor and pump shoe as defined in claim **1**, wherein said anchor means comprises a plurality

of circumferentially spaced pistons; and radial bores in said body in which said pistons are reciprocable; said bores communicating with said chamber.

3. A combined anchor and pump shoe as defined in claim 1, wherein said anchor means comprises a plurality of circumferentially spaced pistons; radial bores in said body in which said pistons are reciprocable; said bore communicating with said chamber; and friction anchor means movable by said pistons for frictional engagement with said well case.

4. A combined anchor and pump shoe as defined in claim 1, wherein said means defining said production fluid passage comprises a tubular member depending from said shoe and connected to said anchor body below said anchor means; and means providing a seal between said extension and said anchor body.

5. A combined anchor and pump shoe as defined in claim 4, wherein means are provided for separably connecting said shoe to said downward extension.

6. Apparatus as defined in claim 1, wherein said anchor body is provided with a seat for said shoe and including means concentrically disposing said shoe in said seat and providing for the passage of fluid therebetween; and said means defining a production fluid passage through said body including a downward extension on said shoe; and means for connecting said downward extension to said anchor body and holding said shoe on said seat.

7. A combined anchor and pump shoe for use in a well to anchor well tubing against working with a pump relative to the well casing, comprising: a tubular anchor body adapted to be connected in the well tubing; said body having an opening therethrough; means defining a seat for a pump shoe in the upper end of said body; a pump shoe

disposed on said seat; a downward extension depending from said shoe; means at the lower end of said extension for connecting said extension to said body; means defining a seal between the lower end of said extension and said body; said body between said shoe and the lower end of said extension having a chamber opening between said body and said shoe for communication with the well tubing; and fluid pressure operated piston means carried by said body and exposed to said chamber and operable to effect anchoring of said anchor body in the well casing.

8. A combined anchor and pump shoe for use in a well to anchor well tubing against working with a pump relative to the well casing, comprising: a tubular anchor body adapted to be connected in the well tubing; said body having an opening therethrough; means defining a seat for a pump shoe in the upper end of said body; a pump shoe disposed on said seat; a downward extension expending from said shoe and opening at its lower end for communication with the well below said shoe; means connecting said shoe to the body; and anchor means carried by said body and actuatable outwardly for anchoring engagement with said well casing.

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