

Dec. 30, 1952

T. PENNINGTON ET AL
APPARATUS FOR RELEASING SLIPS

2,623,593

Filed June 11, 1949

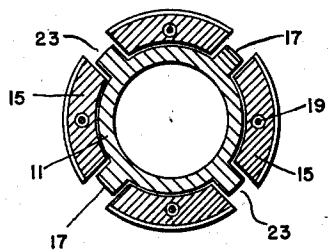


FIG. 1A.

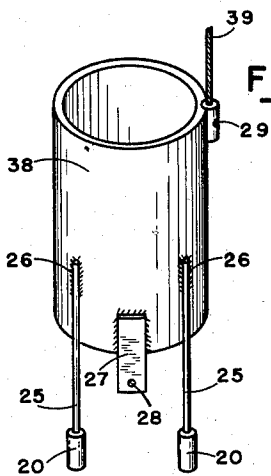


FIG. 2.

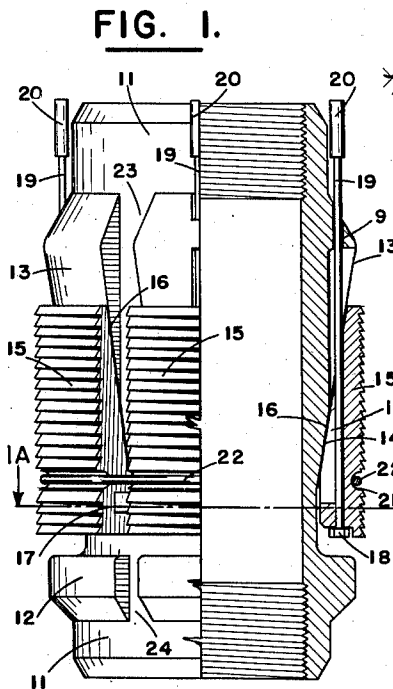


FIG. 1.

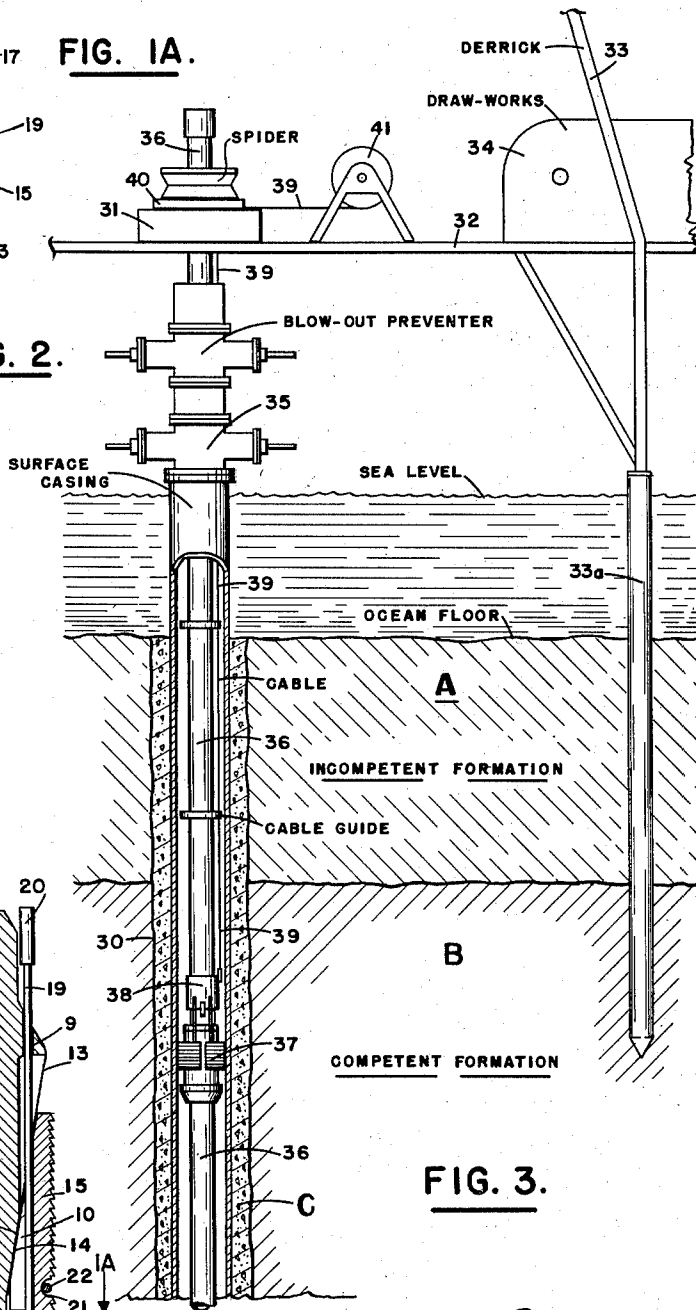


FIG. 3.

Thomas Pennington,
Marvin R. Jones
INVENTORS.

BY
Thomas B. McElderry
 AGENT.

UNITED STATES PATENT OFFICE

2,623,593

APPARATUS FOR RELEASING SLIPS

Thomas Pennington and Marvin R. Jones, Houston, Tex., assignors, by mesne assignments, to Standard Oil Development Company, Elizabeth, N. J., a corporation of Delaware

Application June 11, 1949, Serial No. 98,458

4 Claims. (Cl. 166—1)

1

This invention relates to new and useful improvements in pipe-suspending devices and relates particularly to devices for suspending and supporting tubular conduits, such as casing and tubing, within a borehole.

In the drilling of wells for oil, gas and other fluids, it is the general practice to employ casing or pipe to line the walls of the borehole, with successive inner casing strings of gradually diminishing diameter being run in as drilling proceeds. Ordinarily, as in land drilling, the well bore initially traverses a competent formation having sufficient strength to give lateral support to the outermost casing string and said outer casing is usually cemented within said formation. Because the competent formation extends substantially to the surface of the borehole and, therefore, substantially to the upper end of the casing, said casing has sufficient lateral reinforcement throughout its length to support effectively the weight of the inner casing or pipe strings which are suspended from its upper end thereof through the usual casing and tubing head arrangements at or near the derrick floor.

However, in the drilling of wells at sea or offshore, such as on the continental shelf in the Gulf of Mexico, off coastal Louisiana and Texas, the drilling operation is carried on over water of substantial depth. The borehole initially traverses the formations at the bottom of the ocean and this initial formation is largely of a mucky nature and of insufficient mechanical strength to impart the necessary or required lateral reinforcement or support to the outer casing. Thus, the first competent underground formation traversed by the borehole is located a considerable distance below the derrick floor and upper end of the outer casing so that when the outer casing is cemented or anchored in said competent formation, the point of anchorage of said casing is spaced well below the extreme upper end of the casing. The upper portion of the casing which extends through the upper incompetent formation and through the water is substantially unsupported laterally and is, in effect, a relatively long slender column which is obviously unstable. In addition, this unstable portion extending through the water and air to the derrick floor which may be as much as 50 feet above the level of the sea is subjected to wave action which imposes considerable lateral loads. Therefore, in marine drilling or in the drilling of a borehole where said borehole initially traverses an incompetent zone or formation, it is not practical to suspend or transfer the weight of the inner string of casing or pipe to the outer casing at the upper end of said outer casing through the usual casing and tubing head arrangements because of the instability, due to lack of lateral support, of the upper portion of said outer casing.

2

To transfer effectively the weight of the inner pipe or casing string to the outer casing and then to the competent formation, it is necessary to locate the point of suspension of the inner string at an elevation within the outer casing where said outer casing has sufficient strength to transfer the load to the formation. In marine drilling the initial formation below the ocean floor does not always impart the required lateral support although it may give some lateral reinforcement to that portion of the outer casing which extends therethrough. Thus, although it is probably preferable to locate the point of suspension of the inner string substantially opposite the competent formation to which the outer casing is anchored, said point of suspension may, in certain instances, be at an elevation above the competent formation. As the casing has sufficient strength at any selected point to transfer effectively the load to the competent formation, the inner pipe string may be suspended within said casing at that point. Since the point or elevation of support or suspension of the inner string is variable, the suspending means or device for said string must be capable of setting at a selected level; also, because the inner string is usually cemented or anchored at its lower end, the suspending device must be capable of being set without rotation or manipulation of the inner pipe string and for this reason, the usual hanger or slip-type supporting devices now in general use, are not applicable or satisfactory for supporting the inner string.

It is one object of the present invention to provide an improved device for suspending or supporting a pipe string within an outer pipe string at a desired level or elevation therein, which device is adapted to be actuated or moved into a set position without the necessity of rotating or otherwise manipulating the pipe string which it supports.

Another object of the invention is to provide an improved device for suspending an inner pipe string within an outer pipe string or casing which is adapted to operate within the annular space between said pipe strings, said device being actuated by a means controlled from the surface, whereby the device may be selectively set at any predetermined level or elevation without manipulation or rotation of the inner pipe string.

Still another object of the invention is to provide an improved device of the slip-type which will effectively transfer the weight of an inner pipe string to an outer pipe string.

Other objects and advantages of the present invention may be seen from the following description taken with the drawing in which

Fig. 1 is a front elevation in partial section of a preferred embodiment of the invention;

3

Fig. 1A is a sectional view taken along the line 1A—1A of Fig. 1;

Fig. 2 is an isometric view of the bridle arrangement employed with the device of the present invention; and

Fig. 3 is a sectional elevation of the device of the present invention arranged in a cased borehole showing the cable arranged in the annulus and connected to the slip arrangement and with the bridle device.

Referring now to the drawing and particularly to Fig. 1, the principal parts of the apparatus are the mandrel 11, slips 15, and the slip setting rods 19.

Mandrel 11 is provided with a shoulder 12 for supporting the slips when in a disengaged position and a tapered section 13 which defines an inwardly sloping surface 14 adapted to receive slip segments 15 which may be four in number or any number which may be desired. The slip segments 15 are also provided with a sloping surface 16 adapted to dovetail with the surface 14, the slip segments 15 being keyed to mandrel 11 with keys 17 to provide horizontal alignment and uniform radial pressure on the outer casing when the slips are in operative position. Such key means are shown more clearly in Fig. 1A where it will be seen that the key means 17 are arranged between the slip segments 15 in slots 23. The slip segments 15 are attached by nuts 18 to slip setting rods or elongated members 19 arranged in apertures 9 and spaces 10. The rods 19 are connected by cable coupling 20 to a bridle arrangement 38 and to a cable 39 for bringing the slips into operative position, employment of the bridle 38 being dispensed with if the cable 39 is connected directly to the slip device.

The lower portion of slip segments 15 define a groove 21 into which there is fitted a snap ring, or garter spring 22 or other releasable means such as a breakable wire, a deformable ring and the like, which holds the slips into retracted position when setting the slip arrangement on a tubing string down the hole.

The mandrel 11 also defines a first slot or passageway 23 in the tapered or sloping section 13 and a second slot or passageway 24 below slot 23 in shoulder 12 which allows circulation of fluid when the pipe on which the slips are arranged is being run and while cement is being placed. These slots define passageways permitting flow of fluid from above the device 37 to a point below it and from below the device 37 to the earth's surfaces as desired. The section 13 is preferably segmented by a plurality of slots 23 to provide a plurality of passageways and to receive the segmented slip segments 15. The shoulder 12 may similarly be segmented by a plurality of slots 24. The slots 23 and 24 will also allow a plurality of devices embodying slips in accordance with the present invention to be arranged in tandem in a tubing string since the slip setting rods 19 of the lower of a plurality of devices as described may be run through the slots 23 and 24 as desired.

It will be clear from the description taken with the drawing that the mandrel 11 and the section 13 thereof have a plurality of apertures 9 and that the section 13 and the shoulder 12 have a plurality of slots 23 and 24, respectively, which provide a passage for flow of fluid past the tubular member of the mandrel 11. Below the slip segments 15 are a plurality of spaces 10 which are defined by the interior surface of the slip segments 15 and an outer surface of the tubular

4

member. The apertures 9 and the spaces 10 below the slip segments 15 are in alignment with each other and together provide recesses to receive the elongated rod members 19.

Referring now to Fig. 2, numeral 38 designates a bridle arranged immediately above mandrel 11 and which may be constructed of a pipe section slightly larger than the casing string and the mandrel 11. The slip segments 15 on mandrel 11 are attached by nuts 18 to rods 19 arranged in a slot 9 of mandrel 11 and a slot 10 of slip segments 15. The rods 19 are connected by coupling 20 to rods 25 which, in turn, are connected to bridle 38 by a suitable fastening means 26. The bridle 38 is also held against mandrel 11 by a strap 27 and a shear pin 28 which is designed to shear under a tension of about 150 to 200 pounds. Cable or wire line 39 is attached to the bridle 38 by a second shear pin 29 which will shear under a pull of about 600 to 1200 pounds. Thus, when a tension of about 200 pounds is exerted on the cable 39, pin 28 shears allowing slip segments 15 to be raised. After the slips are set by setting down the tubing string the cable 39 may be pulled loose by exerting a greater pull thereon causing pin 29 to rupture.

Referring now to Fig. 3, numeral 30 designates a borehole which has been drilled below the ocean floor and which traverses an incompetent structure or sub-surface formation A and then traverses a competent formation or structure B. The borehole 30 is cased in accordance with conventional techniques and is provided with a wellhead 31 in a derrick floor 32. Derrick floor 32 is arranged in derrick 33 which is provided with drawworks 34 connected to the wellhead rotary by conventional means not shown. Derrick 33 rests on pilings 33a which are driven into the formations below the ocean floor and which preferably traverse formation A and extend into formation B. Cased borehole 30 is cemented in competent formation B as indicated by C. The incompetent formation A is usually of a mucky nature and although it might provide some lateral support for the casing 30 it is not sufficient to reinforce that portion of the casing to the point where vertical loads may be safely imposed thereon. The point of anchorage for the casing is at the cement C in the competent formation B, and this point is a considerable distance from the extreme upper end of the casing with the result that the entire upper end of the casing above the competent formation does not have any appreciable lateral support. For this reason, it is not practical to suspend an inner casing or tubing from the extreme upper end of the casing 30 as is the usual practice in land drilling. Immediately below the wellhead 31 are the conventional blowout preventers 35. An inner pipe or casing string 36 is arranged in the borehole 30 and may be suspended, prior to setting of the slips in accordance with the present invention, by elevators and the like. The inner pipe string 36 is provided with the device in accordance with the present invention which is illustrated schematically by numeral 37 and is arranged in the inner string 36. Immediately above the slips 37 is a tripping bridle 38 which is also shown schematically and is described in detail in Fig. 2. The slip arrangement 37 encompasses the apparatus described in Fig. 1 and is connected by the slip setting rods 19 through cable couplings 20 to the tripping bridle 38 by strap 27 and pin 28. The bridle 38 is merely a thin wall pipe sec-

tion slightly larger than the inner pipe or casing string being run and incorporates a receptacle at its upper end for attaching a special rope socket with a shear pin 29. The upper shear pin releases with an upward pull of approximately 1200 pounds while the lower pins on the slip arrangement 37 shear at approximately 200 pounds.

Thus, in accordance with the present invention, a device indicated schematically by 37 in Fig. 3 and shown in detail in Fig. 1 may be arranged in a casing string immediately below the tripping bridle 38 at a point where the cased borehole traverses a formation B competent to support the weight of the casing and the string of tubing. The cable 39 which is run through mat 40 to cable reel 41 then has a tension exerted on it sufficient to shear the pins holding slip arrangement 37 to the bridle 38 and allows the slips to be released for moving into position in engagement with the borehole 30. The mat 40 may be simply a board or plank having a travel slot in it for the cable 39 or may be a bearing or pulley for the cable 39 at the point it makes a 90° turn down the hole. This mat does not form an essential part of our invention and may be dispensed with. On setting down the inner casing string, the snap ring 22 is broken or deformed and the weight of the tubing string is transferred through the slip arrangement 37 to the casing 30 and thence to earth formation B competent to bear the weight. By exerting additional pressure on the shear pins connecting the cable 39 to the tripping bridle, it is possible to pull the cable from the annulus defined by the outer surface of the tubing string and the inner surface of the casing string.

The invention will now be described further by the following operations in which the device of the present invention was set down a borehole and successfully suspended pipe thereon. In this operation, the device described in Fig. 1 was installed in place of a coupling on an inner casing or pipe. The device was arranged in the outer casing at a distance substantially below the earth's surface and the rotary table. In running the inner casing string, embodying the device of the present invention, the slip arrangement was first set at a point less than 100 feet below the rotary table. After the slips had been set at this point, the inner casing was withdrawn and the slip arrangement of the present invention was run the desired depth below several joints of casing. Wall scratchers were used at the bottom of the inner casing and this necessitated raising and lowering the pipe through a space of about six feet approximately forty or fifty times, employing the elevators. While this operation was taking place, mud was being conditioned and cement was being placed. During this time, the pump pressure forcing the fluid upwardly in the annulus was sufficient to shear the equivalent of shear pin 23 and allow the fluid to act as a piston in the annulus against the slips and to cause the slips to be raised by hydraulic pressure and cause them to be engaged with the inner wall of the outer casing on the down stroke. The device of the present invention was thus intentionally set and released several times by hydraulic action of the fluid in the annulus.

After these several operations the cement was then located at the desired point, as shown at C in Fig. 3, and the slips were set by exerting upward tension on the bridle. Approximately

200,000 pounds of weight was suspended on the slips at one time. Finally, approximately 145,000 pounds was slacked off on the slip arrangement of the present invention and the cable was pulled free from the shear socket by exertion of tension on a cat line attached thereto.

It will thus be seen from the foregoing runs that the device of the present invention may be set by hydraulic action with the fluid acting as a piston in the annulus or that the device may be released to operative position by exerting an upward tension on a cable or wire line located in the annulus defined by the wall of the casing and the outer surface of the inner casing string.

From the foregoing description it will be seen that a simple and efficient pipe suspending device is provided for supporting an inner casing or pipe string within an outer pipe or casing string. The slips are restrained from moving into operating position by the restraining or tension means until such time as the device is located in the casing string at the point from which it is desired to suspend the inner string. When the device has been set at the desired location within the outer casing, operation may be effected without the necessity of rotating or otherwise manipulating the inner pipe string to which the device is attached. As long as the weight is imposed on the slips segments or members they will be maintained in the expanded or set position because of the co-action between the surfaces 14 and the inner surfaces of the slips 15. When it becomes necessary to remove the pipe suspending device, an upward movement of the pipe tends to cause surface 14 to move in a direction with respect to the slips 15 which allows slips to be released from engagement with the outer casing. It is to be emphasized that the device operates entirely within the annulus between two pipe strings even after the slip segments have been moved to and engaged in gripping position. By means of the tension device or spring the pipe suspending device is positively maintained in a non-operative position and the slip segments 15 cannot function to move into a gripping position on the surface 14 until an upward force is exerted on the bridle arrangement 38, as has been described.

It is pointed out that the device is illustrated in the drawings as being positioned substantially opposite the competent formation B and the transfer of the weight is at this point. Although the incompetent formation A may not provide sufficient lateral support to the outer casing to permit the transfer of the weight at the extreme upper end of the outer casing, said incompetent formation may impart some lateral support and the device 37 may, in some instances, be set at a point opposite the incompetent formation and probably nearer its lower portion. In actual practice, the device 37 is set at any point in the outer casing where said outer casing has sufficient lateral support to permit efficient transfer of the weight of the inner pipe string, through said outer casing and to the competent formation.

It will be apparent to the skilled workman that the foregoing description of the invention is given by way of illustration and not by way of limitation and the changes in the size and shape of materials, as well as details of the illustrated construction may be made within the scope of the appended claims without departing from the spirit of the invention.

The nature and objects of the present invention having been completely described and illus-

trated, what we wish to claim as new and useful and to secure by Letters Patent is:

1. A device for suspending pipe and the like which comprises, in combination, a tubular body member adapted to be connected into a pipe string having an outer sloping surface provided with a plurality of apertures and slots spatially removed from one another, said slots providing a passageway for flow of fluid past said tubular member, a plurality of slip segments slidably carried on said sloping surface, an inner surface of said slip segments and an outer surface of said tubular member providing spaces below and in alignment with said apertures, a plurality of elongated members connected to said slip segments slidably arranged in said apertures and spaces for moving said slip segments upwardly on said sloping surface into operative position, frangible means interconnecting said elongated members and said body member normally holding said elongated members in fixed relationship to said body member, means for shearing said frangible means on an upward pull on said elongated members and releasable means embracing said slip segments arranged for holding same in a retracted position while running said device in a well, said releasable means being released on shearing said frangible means and setting down weight on the pipe string.

2. A device for suspending pipe and the like which comprises, in combination, a tubular body member adapted to be connected into a pipe string having an outer upwardly sloping surface provided with a plurality of apertures and slots spatially removed from one another, said slots providing a passageway for flow of fluid past said tubular member, a plurality of slip segments slidably carried on said sloping surface, an inner surface of said slip segments and an outer surface of said tubular member providing spaces below and in alignment with said apertures, a plurality of elongated rod members connected to said slip segments slidably arranged in said apertures and spaces for moving said slip segments upwardly on said sloping surface into operative position, frangible means interconnecting said rod members and said body member normally holding said rod members in fixed relationship to said body member, means for shearing said frangible means on an upward pull on said rod members, releasable means embracing said slip segments arranged for holding same in a retracted position while running said device in a well, said releasable means being released on shearing said frangible means and setting down weight on the pipe string, and means arranged above said body member and frangible means connected to said frangible means for exerting an upward force on said rod members.

3. A device for suspending pipe and the like which comprises, in combination, a tubular body member adapted to be connected into a pipe string having an outer upwardly sloping surface extending a major length of said member and a shoulder adjacent a lower end of said member, said surface and said shoulder being provided with a plurality of slots providing passageways for flow of fluid past said tubular member, said surface being further provided with a plurality of apertures spatially removed from the slots in said surface, a plurality of slip segments slidably carried on said sloping surface, an inner surface of said slip segments and an outer surface of said tubular member providing spaces below and in alignment with

said apertures, a plurality of elongated rod members connected to said slip segments slidably arranged in said apertures and spaces for moving said slip segments upwardly on said sloping surface into operative position, frangible means interconnecting said rod members and said body member normally holding said rod members in fixed relationship to said body member, means for shearing said frangible means on an upward pull on said rod members, releasable means embracing said slip segments arranged for holding same in a retracted position while running said device in a well, said releasable means being released on shearing said frangible means and setting down weight on the pipe string, and means arranged above said body member and shearing means connected to said shearing means for exerting an upward force on said rod members.

4. A device for suspending pipe and the like in a borehole from a point intermediate a top and bottom thereof which comprises, in combination, a tubular body member adapted to be connected into a pipe string having an outer upwardly sloping surface extending a major length of said member and a shoulder adjacent a lower end of said member, said surface and said shoulder being provided with a plurality of slots providing passageways for flow of fluid past said tubular member, said surface being further provided with a plurality of apertures spatially removed from the slots in said surface, a plurality of slip segments slidably carried on said sloping surface, key means on said tubular body member arranged in the slots in said sloping surface in engaging relationship with said slip segments, an inner surface of said slip segments and an outer surface of said tubular member providing spaces below and in alignment with said apertures, a plurality of elongated rod members connected to said slip segments slidably arranged in said apertures and spaces for moving said slip segments upwardly on said sloping surface into operative positions, releasable means embracing said slip segments arranged for holding same in a retracted position while running said device in the borehole, said releasable means being released on setting down weight on the pipe string, a bridle member arranged above said tubular body member and connected thereto by a first frangible means, means connecting said elongated rod members to said bridle member, and a second frangible means connecting said bridle to a cable extending to the top of the borehole, said first and second frangible means being adapted to be sheared sequentially on first and second upward pulls on said cable, said first pull releasing said bridle from the body member for moving said slip segments upwardly on said sloping surface on setting down weight on the pipe string and said second pull releasing said cable from said bridle.

THOMAS PENNINGTON.
MARVIN R. JONES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
Re. 7,902	Cross	Oct. 2, 1877
1,092,159	McCurdy	Apr. 7, 1914
1,842,116	Rasmussen	Jan. 19, 1932