Dec. 21, 1943. L. E. TOMLINSON 2,337,429

GRAVEL PACKING VALVE

Filed March 29, 1941

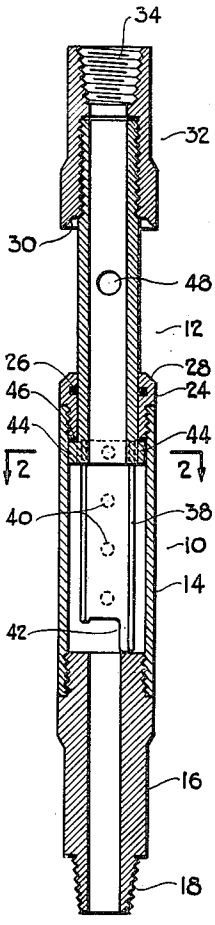



FIG. 1

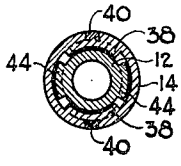



FIG. 2

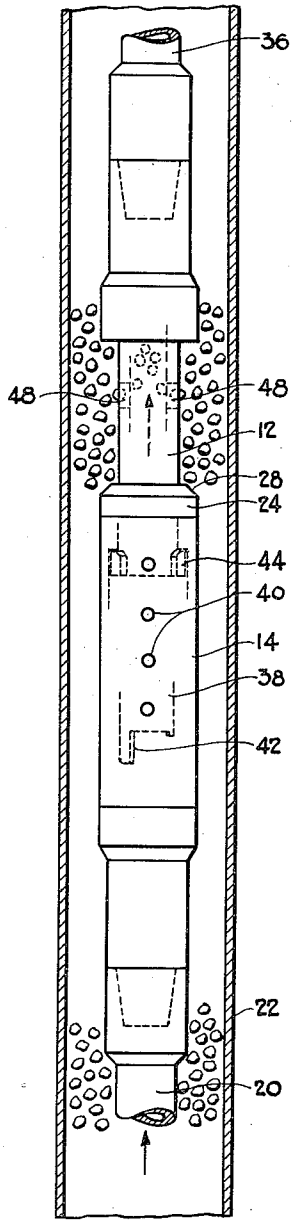



FIG. 4

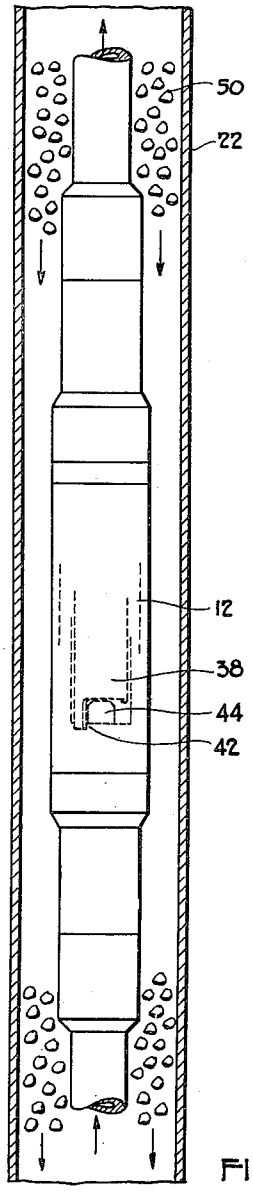



FIG. 3

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Patented Dec. 21, 1943 2,337,429

# UNITED STATES PATENT OFFICE

2,337,429

## GRAVEL PACKING VALVE

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Application March 29, 1941, Serial No. 385,833

2 Claims. (Cl. 137—34)

This invention relates to a valve device used in connection with the graveling or gravel packing of a well, and more particularly to a device adapted to be disposed in a string of well tubing and controlled from the surface for indicating when the gravel being deposited has reached predetermined height in the well hole.

The principal object of the invention is the provision of a device which will not obstruct or interfere with the graveling operations in any manner, and which can be actuated easily from the surface to provide a positive indication as to whether or not the gravel has reached a desired level.

One of the most successful ways of forming gravel filter packs in a bore hole or well is known generally as the "reverse circulation method." In accordance with this method, a perforated liner or screen is usually suspended from, or at least attached to, the lower end of a string of tubing extending from the surface downwardly through the casing of the well to the producing formation or well cavity. The gravel, mixed with a carrier fluid such as drilling mud or oil, is then pumped downwardly through the annular space between the tubing and the casing, the carrier fluid entering through the liner perforations and passing upwardly to the surface through the tubing string, while the gravel is screened off and remains in the space around the liner.

It is often difficult to determine when sufficient gravel has been placed in the hole or, in other words, when the top of the gravel deposit has reached a predetermined level in the hole. The placing of an unnecessarily large amount of gravel would, of course, be wasteful, and the placing of too little gravel might mean that the gravel does not cover all of the upper perforations of the liner. Sand from the formation would thus enter the liner with the oil or other liquid to be produced, through these uncovered perforations, and because of the abrasive action of the sand the liner perforations would be enlarged and the effectiveness of the liner impaired. This passage of the sand with the oil would also tend to cause the walls of the formation to slough off to the damage of the well cavity.

In accordance with the present invention, a device is provided which can be attached so as to form a part of the tubing string at a predetermined point above the liner and which can be actuated from the surface so as to provide a positive indication when the gravel level has reached that point. The device comprises a telescoping sleeve valve adapted to be locked in its closed position when the tubing is being run into the hole or at any other desired time, and to be moved to its open position merely by raising the tubing string slightly. When the gravel has reached a height approximating that of the indicating valve and the valve is opened, some of the gravel will be forced into the tubing string through the open valve, and will thus return to the surface thereby providing an indication that the gravel has reached a level sufficiently high.

For a better understanding of the invention, reference may be had to the accompanying drawing in which

Figure 1 is a vertical longitudinal section of the valve device showing the valve in open position,

Figure 2 is a sectional view taken on the line 2—2 of Figure 1 looking in the direction of the arrows,

Figure 3 is a view of the device in its closed position during the placing of the gravel, and

Figure 4 is a view similar to Figure 3, but showing the valve in its open position.

Referring to the drawing, the valve device comprises a lower tubular body member 10, and an upper tubular member or mandrel 12, the mandrel being adapted to slide into the body member in telescoping relation thereto. The body member 10 comprises a sleeve 14 having a threaded connection at its lower end to an extension 16 provided in turn at its lower end with a tool joint pin 18 adapted to be connected to a sub or a section of tubing 20. It is understood that the tubing section 20 is connected to the liner or screen member, not shown, located in the hole below the casing 22. An annular plug 24 is threaded into the upper end of the sleeve 14 and is preferably provided with packing 26 adapted for friction engagement with the exterior surface of the mandrel. The upper side of the plug 24 is preferably beveled as at 28 to fit a corresponding beveled flange 30 on an extension 32 secured to the upper end of the mandrel 12. The extension 32 is provided with threads 34 and adapted to be connected to the lower end of the tubing string 36 extending upwardly to the surface.

A pair of splines 38 are secured as by spot welds 40 to the inner surface of the sleeve 14 and the lower ends 42 of each of these splines are shaped as the letter J. A pair of lugs 44 are secured to the inner or lower end of the mandrel 12 in such a manner as to fit the splines 38 and also to abut against the shoulder 46 formed by the plug 24 to prevent the complete separation of the mandrel from the body member. When the mandrel

is lowered into the body member and rotated a quarter revolution to the right, the lugs 44 will engage the J-shaped ends 42 of the splines 38 so as to lock the mandrel and body member together. In this position the flange 30 will engage and tightly fit against the shoulder 28 so as to prevent leakage into or out of the valve device. The mandrel 12 is provided substantially midway of its length with one or more lateral openings 48, affording communication with the interior of the mandrel and thus the tubing string 36 when in the position shown in Figures 1 and 4.

In operation, the device is attached or made up in the tubing string by means of the threaded connections 18 and 34 at a point above the liner where it is desired to have the upper level of the gravel pack. The mandrel 12 and body member 10 are placed in their retracted position and locked by means of the engagement of the lugs 44 and the lower ends of the splines 38, after which the liner and tubing string are run into the hole. The gravel 50 is then circulated as shown in Figure 3, downwardly between the tubing string and the casing 22, and the gravel collects around the liner and builds up in the annular space. When it is thought that the gravel may have reached the desired level, the tubing string is rotated a quarter rotation to disengage the lugs 44 from the J-shaped ends 42 of the splines 38, and the tubing is then raised a short distance of approximately 10 inches into the position shown in Figure 4 in which the openings 48 in the mandrel will be uncovered. In case the gravel 50 has reached a level such as is shown in Figure 4, some of the gravel will be forced through the openings 48 and carried upwardly to the surface through the tubing string 36 with the carrier fluid thus providing an indication that the gravel has reached the level of the indicating valve. In case no gravel returns to the surface an indication will be had that the level of the gravel is lower than the valve openings 48 and the tubing will then be lowered to close the valve after which additional gravel will be pumped into the hole and the operation repeated until it is found that sufficient gravel has been placed.

It will be seen that the device does not interfere in the graveling operations nor does it weaken or have any other detrimental effect on the tubing string.

Obviously, many modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. A valve device adapted to be connected in a string of tubing to provide communication to the interior thereof when said device is in its open position comprising a pair of tubular telescoping members, means for connecting each of said members to a section of said tubing, one of said members being provided with a lateral opening adapted to be uncovered when said members are extended and covered by the other member when said members are in their retracted position, and means cooperating with said members for limiting the relative longitudinal and rotational movement thereof, said last-named means comprising a longitudinal spline on one of said members, and a lug on the other member, said spline having at one end a lateral notch adapted to be engaged by said lug when the two members are in their retracted position and slightly rotated with respect to each other, and a shoulder on the splined member at the end opposite said notch and adapted to be engaged by said lug when said members are in their extended position.

2. A valve device adapted to be connected in a string of tubing to provide communication between the interior and exterior thereof when said device is in its open position comprising a pair of tubular telescoping members, means for connecting said device in said tubing string, a lateral port in one of said members adapted to be uncovered to permit communication between the outside and the inside of the tubing string when said members are extended, and covered by the other member when said members are in their retracted position to prevent said communication, and means cooperating with said members for limiting the relative longitudinal and rotational movement thereof, said last-named means comprising a spline extending along the interior surface of the outer of said members, said spline having a J-shaped projection at the end opposite to said inner member, an internal shoulder at the end of said outer member nearer to said inner member, a lug secured to the end of said inner member and adapted to cooperate with said shoulder to prevent said members from being separated and with said J-shaped projection to lock said members in their retracted position when the members are relatively rotated part of a revolution.

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