

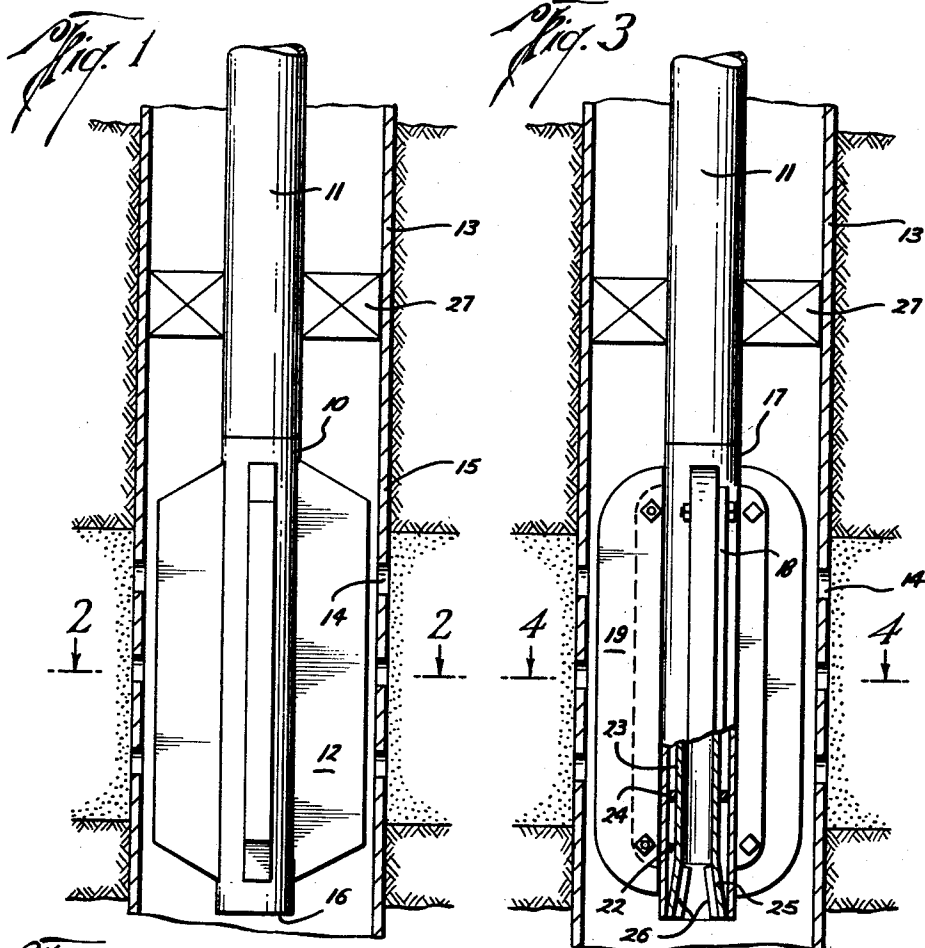
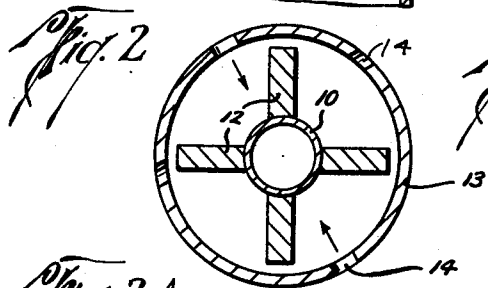
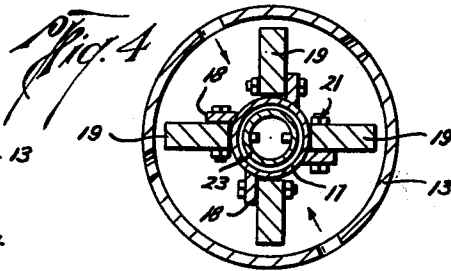
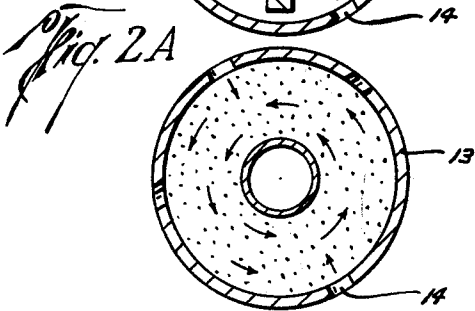
Jan. 15, 1963

A. L. SMITH
METHOD AND APPARATUS FOR DECREASING OIL AND
GAS RATIO OF A PETROLEUM WELL

3,073,393

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3 Sheets-Sheet 1



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Fig. 5

Fig. 6

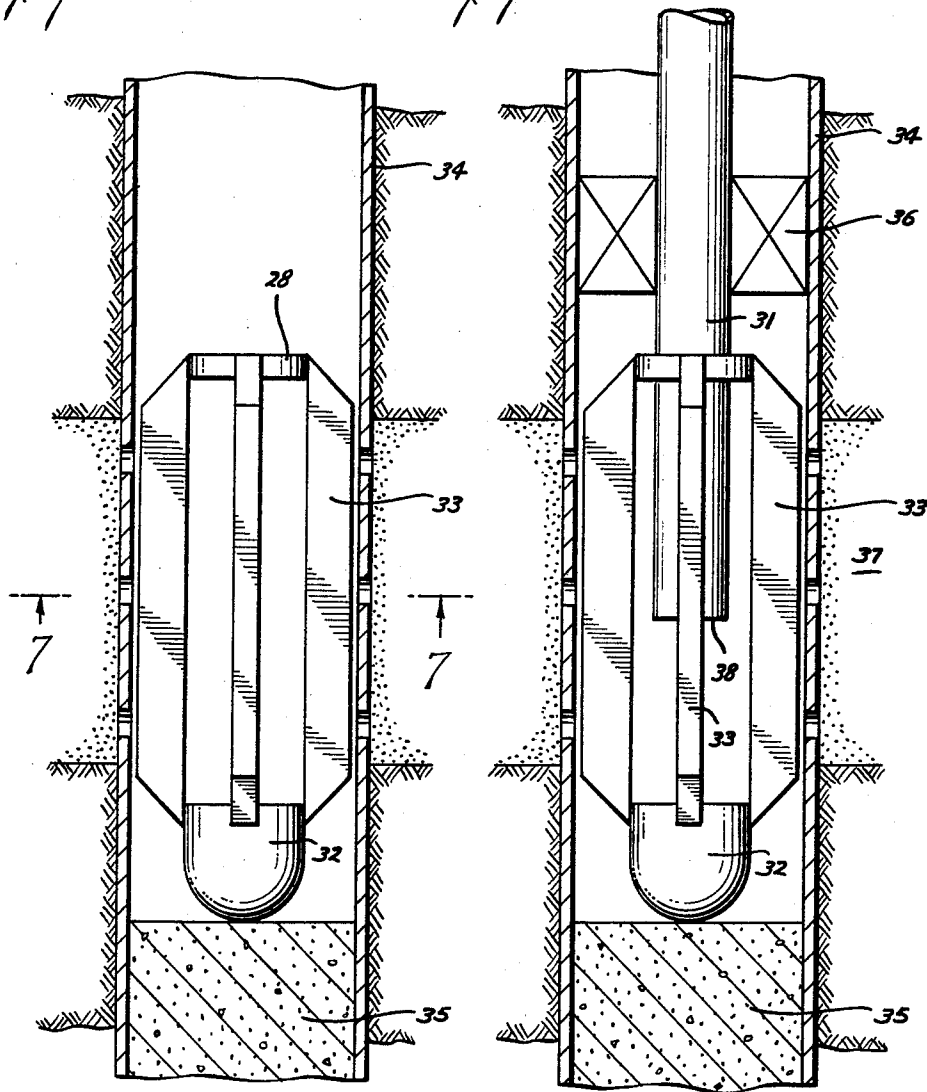
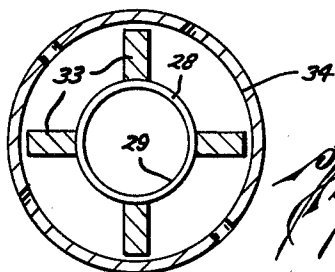


Fig. 7

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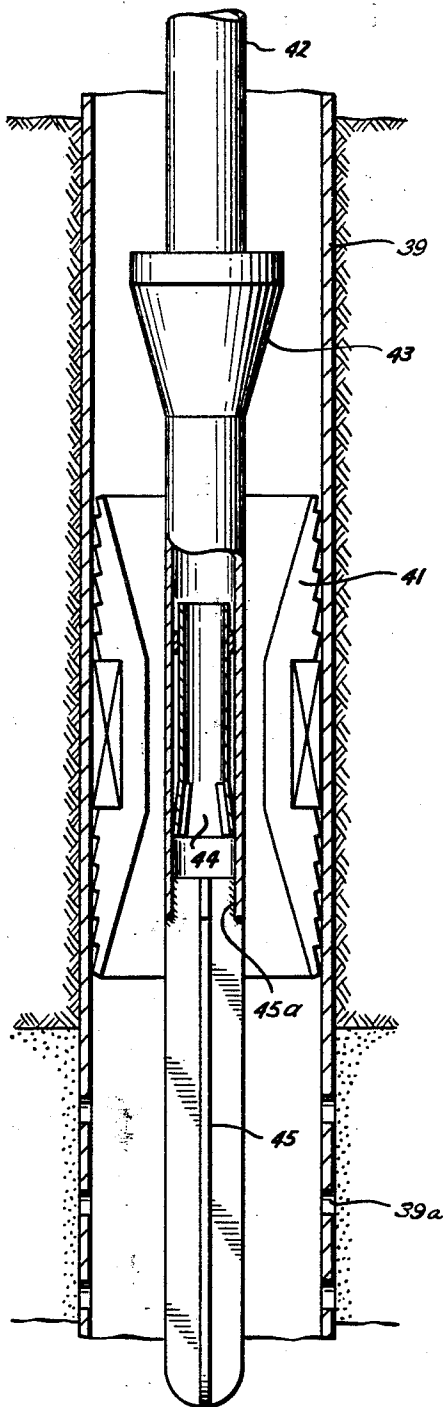
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METHOD AND APPARATUS FOR DECREASING
OIL AND GAS RATIO OF A PETROLEUM WELL
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This invention relates to methods and apparatus for decreasing the oil and gas ratio of a petroleum well.

In the production of oil and gas wells large volumes of gas are produced per barrel of oil. The relationship of the amount of oil to the amount of gas is known in the industry as the gas-oil ratio.

In all major petroleum producing states, state agencies control the production of oil and gas, and for conservation reasons refuse to permit the production of oil with an excessive gas-oil ratio unless the well owner can find a market for the gas. This is not always possible due to the cost of gathering and transmitting the gas. While the amount of gas is large in comparison to the amount of oil produced in many wells, the total amount of gas produced is not such as to attract purchasers of gas.

It has been known for years that the gas-oil ratio might be reduced by employing chokes to maintain a back pressure on the formation. However, production of the well with chokes which will reduce the gas-oil ratio to a required value will not always permit the operator to produce the amount of oil allocated to his well by the state agency, known as the "allowable."

It is an object of this invention to provide a method and apparatus for reducing the gas-oil ratio of wells without reference to the rate of flow of the well.

Another object is to provide a method and apparatus for reducing the gas-oil ratio of wells by preventing the swirling effect of incoming fluids, preferably over the full diameter of the casing, and at least immediately adjacent the opening into the production tubing.

Another object is to provide a method and apparatus for reducing the gas-oil ratio of wells by preventing swirling of fluids as they enter the production tubing.

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

Modern day wells are completed by first setting a casing opposite the producing formation and then perforating the casing and formation with a gun. For various reasons the perforations are made in a manner which causes the gas to swirl as it flows into the casing. For instance, the gun may be off center at the time of firing so that the holes are not positioned on radiuses of the casing. Fluid striking the side wall of the casing at an angle is caused to immediately swirl. The presence of the production tubing accentuates this swirling action as the incoming gas strikes the tubing, and tends to flow in a circular manner through the casing tubing annulus.

The action described above results in the liquid within the hole moving in a swirling fashion and being constantly thrown away from the entrance to the production tubing. In other words, a vortex is formed in the liquid. The result is that the gas flows to the tubing in a swirling fashion constantly pushing the liquid in the hole away from the tubing, and a high gas-oil ratio is obtained.

It has been found that if this swirling action is prevented, the gas-oil ratio will be substantially reduced. The swirling action of the gas as it flows to the inlet of the production tubing may be readily overcome or prevented by placing an obstruction in the well which will interrupt the swirling action. For instance, a vane may be placed in the casing tubing annulus in the path of the swirling fluid to interrupt the circular flow of the

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fluid. This interrupting vane should be provided immediately adjacent the inlet to the production tubing, as this will straighten flow of the fluid immediately before it enters the tubing. If desired, the inlet to the tubing may be provided with a vane which will straighten the fluid as it enters the tubing and prevent swirling action which might be induced by gas flowing into the tubing. Where a preset packer prevents placement of other types of obstruction in the well, vanes may depend from the tubing and be stabbed through the packer.

Reference is now made to the drawings, wherein illustrative apparatus is shown for carrying out this invention, and wherein like reference numerals indicate like parts:

FIGURE 1 is a view in vertical cross section through a cased well showing a stabilizer and flow tubing therein in elevation;

FIGURE 2 is a view along the lines 2-2 of FIGURE 1;

FIGURE 2a is a view along the lines 2-2 of FIGURE 1 with the straightening vanes omitted and indicating the swirling action of fluid which will increase the gas-oil ratio;

FIGURE 3 is a view similar to FIGURE 1 showing a modified form of this invention;

FIGURE 4 is a view along the lines 4-4 of FIGURE 3;

FIGURE 5 is a view in section through a well hole and showing in elevation a modified form of stabilizer to be used where the production packer is to be positioned in the hole independent of the production tubing;

FIGURE 6 is a view similar to FIGURE 5 showing the packer and tubing in place;

FIGURE 7 is a view along the line 7-7 of FIGURE 5; and

FIGURE 8 is a diagrammatic view partly in section and partly in elevation of a further modified form of this invention.

Reference is first made to FIGURE 2a which illustrates the action of the well fluid when the well is not equipped with this invention. It will be noted that the holes in the casing were perforated by an off-center gun which results in a circular motion of the well fluid as it flows into the casing tubing annulus.

In FIGURE 2 this same well is illustrated with interrupting vanes in accordance with this invention, and it will be seen that the well fluid is forced to flow vertically in a casing tubing annulus and cannot flow in a circular fashion as the vanes extend over a substantial percentage of the casing tubing annulus.

The vanes may be positioned in the well in any desired manner. In FIGURE 1, a tubular body 10 is shown secured to the lower end of production tubing 11. The tubular body may be a length of tubing of the same size as the production tubing 11. A plurality of vanes 12 are carried on body 10. It will be appreciated that only one vane is necessary to stop the circular movement of well fluid, but a number are preferred as they will center the tubing in the perforate section 15 of casing 13 and prevent any swirling action from occurring. They will also prevent the high velocity fluid striking them from cutting either the tubing or the opposite side of the casing when they are in the direct path of the fluid entering the well from the formation.

While the vanes are shown opposite the perforations 14 in the perforate section 15 of casing 13, it will be appreciated that they should be positioned closely adjacent the inlet 16 of the tubular body 10. This will prevent the swirling action at the inlet to the tubular body 10, which is the critical point. Of course, if the vanes are extended to the perforated section of the casing, all swirl-

ing action will be stopped. However, the perforated formation may extend over a substantial distance, and in such cases the stabilizer of this invention will provide the desired results by the vanes being positioned adjacent the inlet to the body 10 of the stabilizer.

The vanes 12 may be welded or otherwise secured to the tubular body 10, and preferably extend radially almost to the perforate section 15 of casing 13. The vanes have a substantial longitudinal dimension to prevent the tendency of the well fluid in the casing-tubing annulus to swirl. For instance, a stabilizer for a 2 3/4" tubing might employ vanes extending approximately fifty inches in length, to insure complete interruption of any swirling action.

Referring now to FIGURES 3 and 4, there is shown a stabilizer which is readily adapted to use in different sized holes. In this instance, a single central body 17 is adapted to be secured to the lower end of the production tubing 11, and has provided at circumferentially spaced points ears or vertically extending flanges 18 to which the vanes may be attached. The detachable vanes 19 may be warehoused in various sizes and assembled with the body 17 when needed. This will substantially reduce the inventory of parts, and reduce the storage area necessary to warehouse these parts. The vanes may be secured to the flanges 18 in any desired manner, such as by the bolt and nut connections indicated generally at 21.

In order to obtain maximum flow through the stabilizer body with minimum turbulence, there is provided within the body 17 a flow nozzle indicated generally at 22. This nozzle has a constant diameter portion 23 which is sealingly secured to the tubular body 17 by one or more spanners 24. At the inlet end of the nozzle a frusto-conical portion 25 is provided to obtain the desired nozzle action. Within the frusto-conical portion 25, one or more vanes 26 are provided to prevent any swirling action of the well fluid as it enters the nozzle 22.

In the use of either of the FIGURE 1 or FIGURE 3 forms of stabilizer, the tubing is made up with a conventional hook wall packer shown schematically at 27, and the stabilizer of either FIGURE 1 or FIGURE 3 is made up on the free or lower end of the production tubing 11. The tubing is run into the hole, the production packer 27 set, and the tubing suspended at the desired elevation for production through the casing perforations 14.

As the well fluid enters through the perforations 14, it will be forced to flow vertically in a non-circular path by the vanes downwardly to the inlet of the stabilizer. As the swirling action normally present in the hole will be prevented, the fluid level will be immediately adjacent the inlet to the stabilizer, no vortex will be present in the surface of the liquid in the hole, and a relatively low gas-oil ratio will be obtained.

It is sometimes desired to leave the production packer within the casing and provide for the tubing to be pulled. In this instance, the packer is usually set in the hole before the tubing is run. For well completion of this type, the stabilizer shown in FIGURE 5 may be used. This stabilizer has a body provided in part by an upper portion 28 which is tubular in form to provide a central bore 29 through which the production tubing 31 may pass. The remainder of the body is provided by a lower member 32 which has a diameter preferably the same as the outer diameter of tubular member 28.

To prevent the swirling action of fluid flowing into the well, one or more vanes 33 extend between the body portions 28 and 32. The vanes have a substantial radial dimension to extend them to points adjacent the casing 34, and have a substantial longitudinal dimension to insure interruption of any swirling action of the fluid passed to the tubing 31. While there may be a slight space between the several vanes 33 and the tubing, the swirling action will be substantially interrupted due to the centrifugal forces induced by the swirling fluid urging it outwardly into contact with the vanes 33. However, if de-

sired, the vanes could be positioned more closely to the tubing than shown in the drawing to prevent any possibility of a swirling action. The weight of the stabilizer and frictional contact between it and the casing, tubing, and/or plug 35 hold the stabilizer against any substantial rotation.

In the use of this form of the invention, the stabilizer may be dropped into the hole and will pass through the fluid in the hole to the bottom of the hole, where it will rest on the cement plug 35 as shown. Thereafter, the packer 36 may be run in the hole and landed above the producing formation 37. Then the tubing 31 is run into the hole and passes through the packer and into the stabilizer, so that fluid flowing to the inlet 38 of the tubing will be prevented from swirling at the entrance to the tubing, in accordance with this invention. Of course, the nozzle shown in FIGURE 3 might be employed at the inlet of tubing 31, if desired.

Referring now to FIGURE 8, another modification of this invention is shown. In some instances a packer is set in the well and thereafter it is desirable to run a tubing through the packer. If at this time it is desirable to provide vanes for decreasing the swirling action of incoming fluid, the apparatus of FIGURE 8 may be used. While it will not entirely stop the swirling action of incoming fluids, it will stop swirling action of fluids immediately adjacent the inlet of the body at the point at which the tubing is being loaded, and this will decrease the gas-oil ratio.

In conventional manner the well shown in FIGURE 8 has been cased with a casing 39 and perforated as at 39a. A packer 41, which may be of the well known wireline type, has been set in the well. The production tubing 42 is shown being run in the well, and will be lowered until the tubing packer seat 43 engages the casing packer.

As shown in dashed outline, a flow nozzle 44 may be provided in the tubing, if desired. This flow nozzle could be identical with the flow nozzle shown in FIGURE 3, except that, in view of the vanes to be described, it would not be necessary to provide vanes at the inlet to the nozzle.

One or more vanes 45 are provided for preventing or reducing swirling of well fluids. These vanes may be depended from the tubing 42 in any desired manner, as by welding them to the open end of the tubing as shown. Preferably, the vanes extend into the interior of the tubing a short distance to prevent swirl of fluid as it enters the mouth of the tubing. The portion 45a of the vanes extending into the tubing will function to straighten flow of fluid entering the tubing in a comparable manner to the vane 26 in the FIGURE 3 embodiment.

Preferably, the vanes 45 are four in number and radiate from the center line of the tubing out to the full outer diameter of the tubing 42. By utilizing the full diameter of the tubing, substantial straightening of fluid will be obtained, and yet the vanes 45 may be easily stabbed through the packer 41.

The vanes 45 have a substantial longitudinal dimension, that is, lengthwise of the tubing, to obtain substantial straightening of the well fluids. While this type of vane will not prevent all swirling in the casing, as the incoming well fluids may rotate in the annulus between the vanes and the casing, they will stop swirling in the center of the tubing and prevent the formation of a large vortex in the surface of the liquid within the well. The prevention of this vortex is the primary consideration in decreasing the gas-oil ratio, and therefore considerable decrease in the gas-oil ratio may be obtained by using the structure shown in FIGURE 8.

In operation, the packer is first set and then the tubing 42 is run in the well with the vanes 45 depending from its lower end. The vanes will be positioned in the well by the tubing packer seat 43 landing on the packer 41.

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It will be apparent that, if desired, the stabilizer of FIGURES 5 and 6 could be dropped in the well, the wireline packer set, and then the stabilizer of this figure inserted into the stabilizer of FIGURE 6. The use of both forms of stabilizers would absolutely prevent all swirling in the section of casing which they occupy and in the inlet to the tubing.

The foregoing disclosure and description of the invention is 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 claim without departing from the spirit of the invention.

What is claimed is:

A flow control stabilizer for wells comprising, a tubular body adapted to be secured to the lower end of a production tubing and conduct fluid thereto, at least one vane secured to the body and extending radially therefrom beyond said body, said vane having a substantial longitudinal dimension and preventing swirling of

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well fluids about the body, a nozzle providing an inlet into the lower end of the body, and at least one vane in the nozzle preventing swirling of well fluids entering the nozzle.

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