AUTOMATIC SELF-SETTING SLIP-TYPE STEAM PACKER
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ABSTRACT OF THE DISCLOSURE
A multiple rubber cup packer mounted on a tubular mandrel suspended from the lower end of a tubing string and through which steam is passed downwardly to rise upwardly from beneath and heat and set the rubber cups of the packer; slips suspended from the packer which are expanded automatically by upward movement of the packer produced by the steam, thereby locking the packer against vertical movement in the casing.

BACKGROUND OF THE INVENTION
Field of the Invention
While deep well packers are used in a multitude of drilling, testing and production operations, the present invention relates particularly to the preparation of a well for renewing production therefore after there has been a substantial depletion in the flow of oil from the oil bearing strata.

Description of the prior art
Packers which are adapted to be set by fluid expansion produced by the introduction of fluid downwardly through the tubing string on which the packer is supported have been extensively developed. A well known packer of this type in general use in the petroleum field being that manufactured by Lyne's, Inc., P.O. Box 12486, Houston, Texas, 77017 which includes a tubular rubber packer element which is expanded like a balloon by the introduction of fluid under high pressure into the space within the packer element and confining the fluid so introduced by a check valve which maintains the packer in expanded condition until a vertical movement of the mandrel, effected from the top of the well, connects the space within the packer element with the bore of the well thereby deflecting the packer and permitting it to be withdrawn from the well. The Lyne's packer element is provided with a set of slips at each end thereof which are set in the casing by expansion of the packer element and are retracted out of engagement with the casing when the packer is deflected.

SUMMARY OF THE INVENTION
Fluid operated packers in the prior art being expensive to construct, it is an object of the present invention to provide a relatively simple packer comprising conventional structural elements generally available in the oil industry but which may be set in a well incidentally to the initiation of a steaming operation for reactivating the flow of oil in a well whereby production therefrom may be resumed.

Another object of the invention is to provide such a steam packer having slips and means for automatically setting said slips incidental to the functioning of the packer in response to the delivery of steam thereto.
A further object of the invention is to provide such a steam packer with means for optionally equalizing the pressures in the well beneath the packer and above the packer to prevent a pump installed in the packer mandrel from vapor locking.

Yet another object of the invention is the provision of such a steam packer in which the slips thereof may be readily withdrawn from engagement with the surrounding casing by merely lifting on the packer mandrel.

BRIEF DESCRIPTION OF THE DRAWING
FIGURES 1a, 1b and 1c comprise separate sections of a single vertical sectional view through an oil well casing and a preferred embodiment of the present invention being lowered through said casing.
FIGURE 2 is an operational vertical sectional view of a lower portion of the steam packer of the invention illustrating the manner in which the slips of the packer are set against the well casing.
FIGURE 3 is a cross-sectional view taken on the line 3—3 of FIGURE 1a, and illustrates the fluid bypass vents provided in the outer surface of the packer mandrel.
FIGURE 4 is a horizontal sectional view taken on the line 4—4 of FIGURE 2 and illustrates the mounting of the slips on the tubular body of the packer.

DESCRIPTION OF THE PREFERRED EMBODIMENT
Referring specifically to the drawings, and particularly to FIGURES 1a, 1b and 1c, a steam packer 10, comprising a preferred embodiment of the present invention, is there shown being lowered through a well casing 11 into a position where said packer may be expanded and set in place in said casing.

The packer 10 has a mandrel 12 which is simply a piece of tubing, portions on opposite sides of which are milled away to provide fluid release passages 13, said mandrel at its upper end being connected by a collar 14 with the lower end of a tubing string 15 which extends upwardly to the surface of the well. The lower end of the mandrel 12 is connected by a collar 16 with a tailpipe 17.

The packer 10 also includes a tubular body 18 which slidably fits the external surface of the mandrel 12, said body 18 having an annular enlargement at its upper end forming an internally threaded cup 19 for receiving the upper end of the shell 20 of a packing gland 25 is screwed downwardly. This packing gland includes a nut 26 which screws downwardly into the internally threaded upper portion of said shell to compress packing 27 against the outer surface of the mandrel 12 and thus form a liquid tight seal therewith.

Mounted in consecutive arrangement on the packer body 18 is a multiple (at least two) conventional rubber cup packer assemblies 28 and 29, each of which has a metal bonnet 30 and a rubber packer cup 31, the two assemblies 28 and 29 being spaced apart by a metal spacer sleeve 32. Surrounding the body 18 and extending downwardly from assembly 29 is a spacer sleeve 33, the lower end of which is externally threaded and provided with a nut 34. The lower end of tubular body 18 is externally threaded and has screwed thereon a slip mounting sub 40. This sub has an upper portion 41 having a series of circumferentially arranged vertical holes 42 and counter bores 43 for receiving screws 44, the heads 45 of which are vertically slideable in said counter bores while said screws extend downwardly through holes 42. Sub 40 also has a lower portion 46 of somewhat reduced outside diameter and this portion is divided from section 41 by a series of radial horizontal recesses 47 which are separated by interposing vertical webs 48. Sub portion 46 has vertical holes 49 which are in alignment with holes 42 so that screws 44 extend downwardly through the recesses 47 and through the holes 49. The lower ends of these screws are threaded and screw into suitable tapped holes provided in the upper surface of a conical slip expander 50 which is slidably mounted on the mandrel 12. Trapped by the screws 44 in the radial recesses 47 are
slotted lugs 55 which extend inwardly from the upper end of an annular series of slips 56. The slip expander 50 has a tapped counter bore 57 at its upper end into which the tubular stem 58 of an expansible spring retainer 59 screws. The stem 58 has an annular head 60 at its lower end, and a ring 61 is slideable on said stem, said ring and head being connected by a series of outwardly bowed springs 62 which engage the well casing 11 and frictionally retard longitudinal or rotational movement of said retainer in said casing.

Following the assembly of the steam packer 10, the nut 34 is adapted to be turned on the threaded lower end of the spacer sleeve 33 to take up any play in the packer assemblies 28 and 29.

OPERATION

Owing to the friction produced between the retainer 59 and the well casing 11, a certain amount of weight has to be applied from the tubing string 15 through the collar 14 thereof as shown in FIGURE 1a, to force the packer 10 downwardly through the casing 11. When the packer, in such downward movement, has arrived at the desired position in the casing 11 for starting the operation of steam being delivered, steam is delivered downwardly through the tubing string 15 and the mandrel 12 so that this heats the tubing string and packer 10 causing the tubing string to be elongated and the collar 14 to push the packer further downward in the casing. This flow of steam, for the first 30 minutes, is at a relatively slow rate so as to heat the tubing string approximately to the steam temperature and thus produce the maximum practical elongation of the tubing string during the entire operation as well as producing a high degree of steam penetration of the oil bearing strata beneath the packer, without having produced a substantial degree of steam pressure in the well bore beneath the packer.

The expansion produced in the tubing string, and transmitted through the coupling 14 and the stuffing box 25 to the packer 10 so as to force this further down the well, does this without imposing too great a retarding force on the lower end of the tubing string so there is no tendency of the latter to buckle in the well.

At this point in the operation the rate of introduction of steam is increased to the point where a substantial steam pressure is built up in the well bore beneath the packer which forces the packer like a piston upwardly in the casing 11. Inasmuch as the coupling 14 still bears against the upper end of the stuffing box 25, this upward movement of the packer is only possible by virtue of the fact that the heated and somewhat elongated tubing string 15 is susceptible to a certain amount of vertical compression without setting up a buckling action in this. Furthermore, the packer 10 is only able to move upwardly a relatively short distance under the impulse of steam pressure until it sets the slips 56 against the casing 11 and sets the packer itself against further vertical travel.

Thus the slips 56 are set in a fixed relation with the casing 11 after such a short upward travel of the packer 10 that the upward pressure thus applied through the coupling 14 to the tubing string 15 is insufficient to have any damaging effect on the latter. Should it be desired, however, to completely relieve the tubing string 15 from any upward pressure, through the collar 14, incidental to the setting of the packer 10, the tubing string 15 may be lifted, just before the steaming of the well is speeded up, so that the collar 14 will be several inches above the upper end of the stuffing box 25 but not far enough to uncover the upper ends of the passages 13. Under these circumstances, as the increased amount of steam delivered into the well causes raising of the pressure to a point where this forces the packer 10 upwardly in the casing and sets the slips 56 against the casing (thus halting upward travel of the packer), the setting of the packer in its final position for the high pressure steaming of the well, will have been effected without applying any upward pressure through the collar 14 to the tubing string 15.

The packer 10 now being expanded into tight fitting relation with the casing 11 and locked therein by the setting of the slips 56 at a position in the casing where the tubing string 15, already fully elongated, by having been heated approximately to the steam temperature, is available as a medium of transmitting steam at high pressure and in relatively larger quantities downwardly through the packer 10 and into the portion of the well bore there beneath which communicates with the oil bearing strata.

As before noted, the packer when thus set is also within a relationship with the coupling 14 that positions the mandrel 12 of the packer in such a manner as to cover the upper ends of the passages 13 so that no escape of steam upwardly through these passages is possible during the balance of the steaming operation.

The high pressure steaming of the oil bearing strata beneath the packer 10 having been completed, the steaming of the well is halted and a production pump run downward through the tubing string 15 and the mandrel 12 into the tail pipe 17 and the production pumping of the oil thus released by the steaming operation commences. The cooling of the tubing string 15 following the steaming operation, causes a contraction of this tubing string sufficiently to withdraw the mandrel 12 from the upper end of the stuffing box 25 a sufficient distance to expose the upper ends of the by-passes 13 above the stuffing box. The passages 13 thus set up a communication between the area 64 in the casing 11 below the packer 10 and the area 63 in the casing 11 above said packer. The passages, thus afforded by the passages 13, during the pumping of the well prevent a vapor lock developing in the operating of the oil pump.

When the packer 10 of the present invention has been set in a well casing 11 as above described to facilitate the high pressure steaming of the oil bearing strata in the well beneath the lower end of said casing, and, following the steaming operation a pump has been introduced into the well to pump out the oil thus loosened, the packer remains available for subsequent steaming operations. Each of the latter may be effected merely by withdrawing the pump from the tubing string and repeating the steps followed in the first steaming operation. Thus subsequent steaming operations start with approximately 30 minutes of slow steaming which elongates the tubing string and shuts off the by-passes 13, after which the high pressure steaming of the oil bearing strata may be carried out. The packer 10 of course had previously been set and remains set in its original position without being disturbed in any way by subsequent steaming operations.

After each of the subsequent steaming operations takes place and the oil pump is returned downwardly through the tubing string for resuming the pumping operation, the cooling off of the tubing string again withdraws the packer mandrel upwardly to expose the upper ends of the passages 13 and thus re-establish fluid by-passes between the well areas above and below the packer 10. Thus each time the pumping is resumed there is no danger of a vapor lock.

Not until the oil bearing strata of the well have become practically exhausted, therefore, is it necessary to remove the packer 10 of the present invention. To do this, the pump is withdrawn from the tubing string 15 and the latter is then withdrawn from the well. As the string starts up, the collar 16 engages the retainer 59 which lifts the slip expander 56, freeing the slips 56 and packer 10 for removal with the tubing string.

We claim:

1. In an automatic slip-setting steam packer, the combination of:
   a tubular mandrel;
   an expansible rubber cup packer means slideably mounted on said mandrel;
an expansible slip means suspended from said packer means;
retarder means slideably mounted on said mandrel beneath said packer means; and
slip expander means mounted on said retarder means
and normally located within said slip means in non-actuating relation therewith, said rubber cup packer means being subject to fluid pressure created beneath said packer means by fluid delivered downwardly through said mandrel into the space beneath said packer means to cause upward travel of said packer means which is transmitted to said slip means causing relative axial movement between said slip means and said slip expander means resulting in the setting of said slip means in a casing surrounding said packer;
said mandrel being provided with recess means formed in the outer surface thereof adapted to set up a communication when properly located relative to said packer means between the space within said casing below said packer means and space within said casing above said packer means for relieving a differential pressure between said two spaces and thus avoiding vapor locking of a pump installed in said well for pumping oil therefrom.

2. In an automatic slip-setting steam packer, the combination of:
a tubular mandrel;
an expansible rubber cup packer means slideably mounted on said mandrel;
an expansible slip means suspended from said packer means;
retarder means slideably mounted on said mandrel beneath said packer means; and
slip expander means mounted on said retarder means
and normally located within said slip means in non-actuating relation therewith, said rubber cup packer means being subject to fluid pressure created beneath said packer means by fluid delivered downwardly through said mandrel into the space beneath said packer means to cause upward travel of said packer means which is transmitted to said slip means causing relative axial movement between said slip means and said slip expander means resulting in the setting of said slip means in a casing surrounding said packer;
a secondary collar means being provided for connecting the upper end of said mandrel with the lower end of a tubing string, said secondary collar means engaging said packer and pushing the same downwardly in said casing as said string is being run into said well and thus determining the location of said packer in the well where it is desired to set the same;
said secondary collar means pushing said packer a short distance further down in the well when said string is elongated by the introduction of steam downwardly through said string and said mandrel, said packer being responsive to a substantial increase in fluid pressure from beneath, produced by stepping up said steaming operation, to rise a short distance in said casing and thereby set said expansible slip means to fix said packer in that location in said casing.

3. A combination as recited in claim 5 wherein said mandrel is provided with recess means formed in the outer surface thereof which set up a communication between the spaces within the casing above and below the packer, for preventing vapor locking of a pump installed in said well to pump oil therefrom, said communication being set up by the shrinking of said tubing string as it cools following cessation of said steaming operation, and consequent withdrawal of an upper portion of said mandrel upwardly to expose the upper end of said recess means to the space above said packer.

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JAMES A. LEPPINK, Primary Examiner

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

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It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 20, claim reference numeral "5" should read -- 2 --.

Signed and sealed this 24th day of November 1970.

(SEAL)

Attest:

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Commissioner of Patents