Nov. 17, 1953

S. B. SCHNITTER

2,659,438

MEANS FOR CEMENTING WELLS

Filed Aug. 16, 1946

4 Sheets-Sheet 1

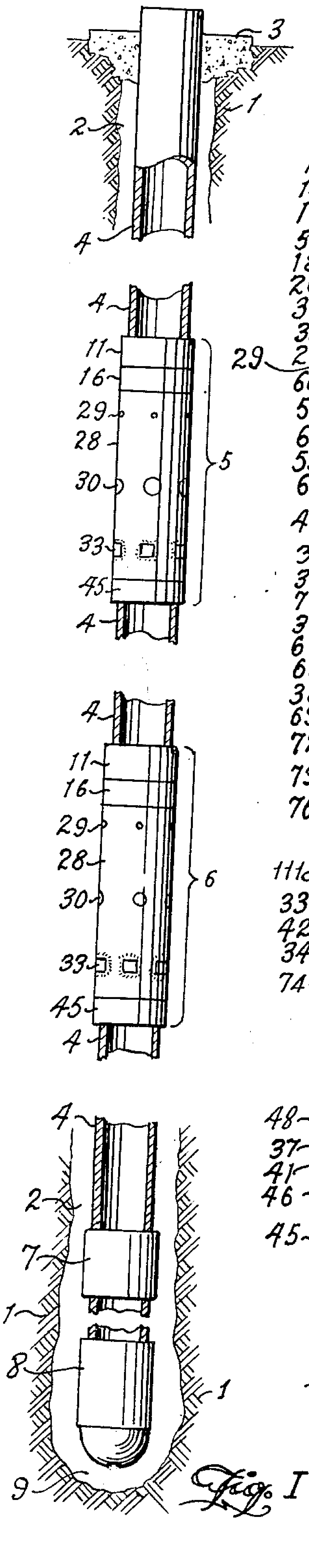

Fig. I

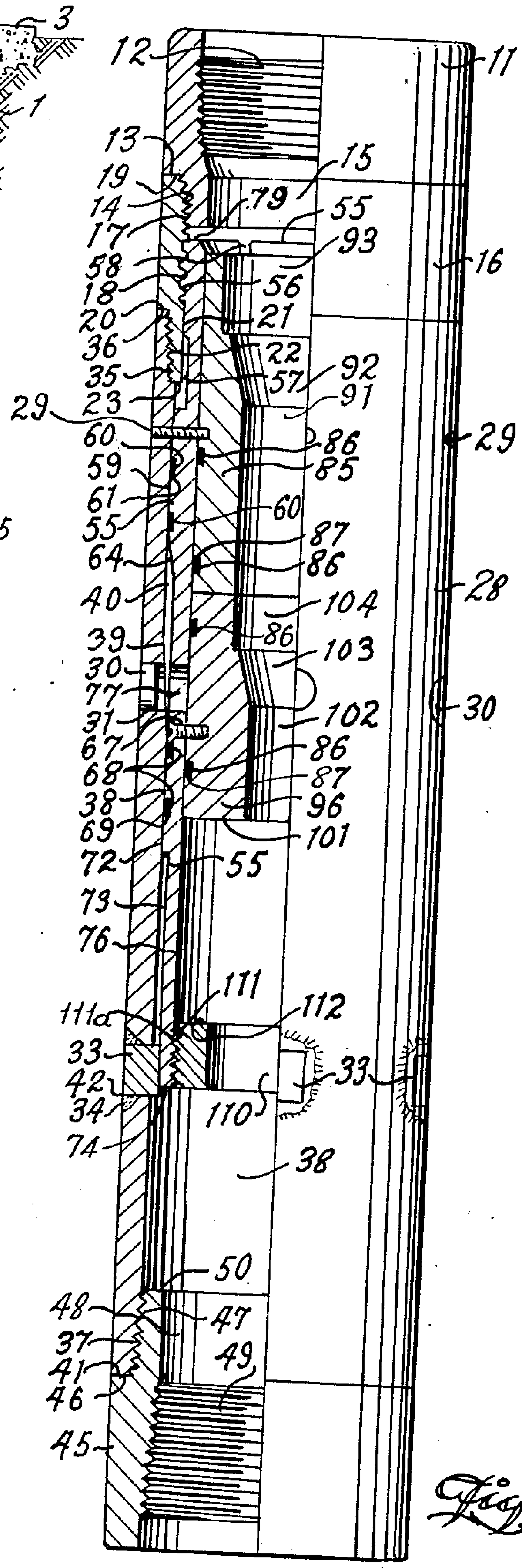

Fig. II

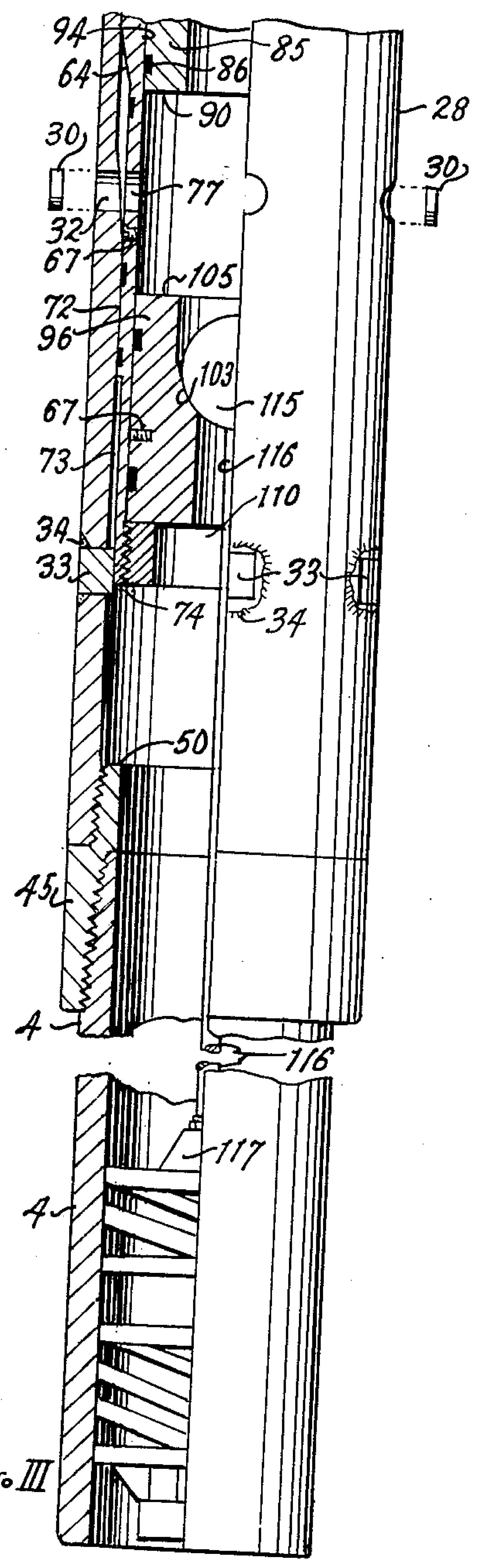

Fig. III

Sylvester B. Schnitter
INVENTOR.

BY [signature]

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4 Sheets-Sheet 2

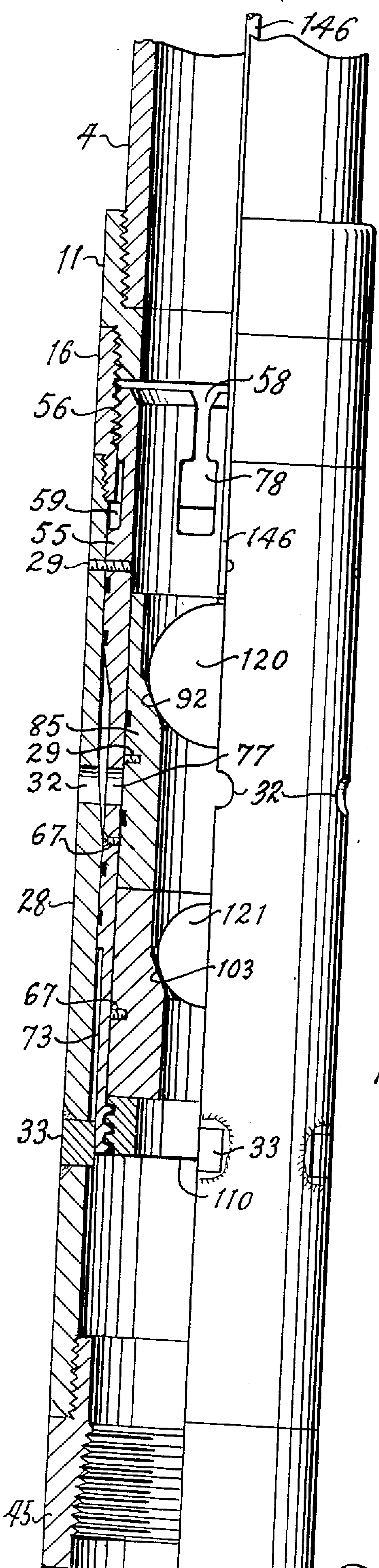

Fig. IV

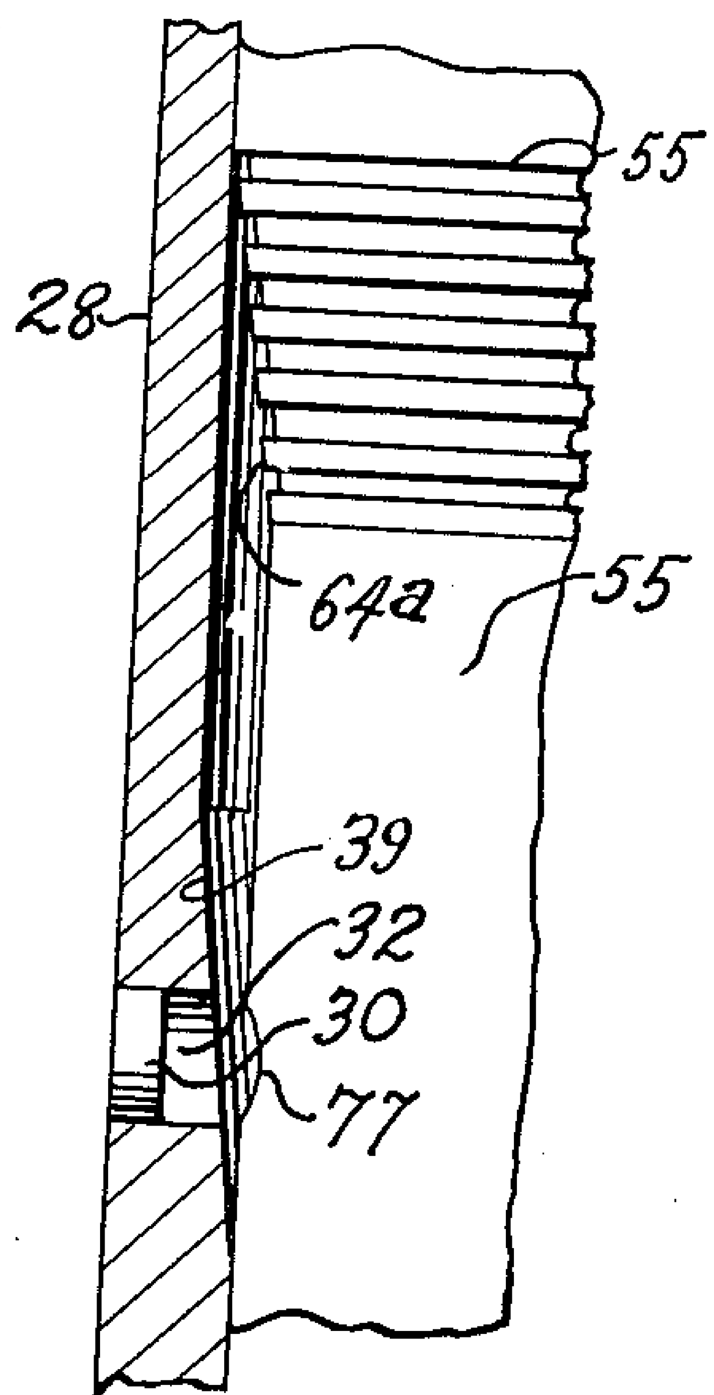

Fig. XII

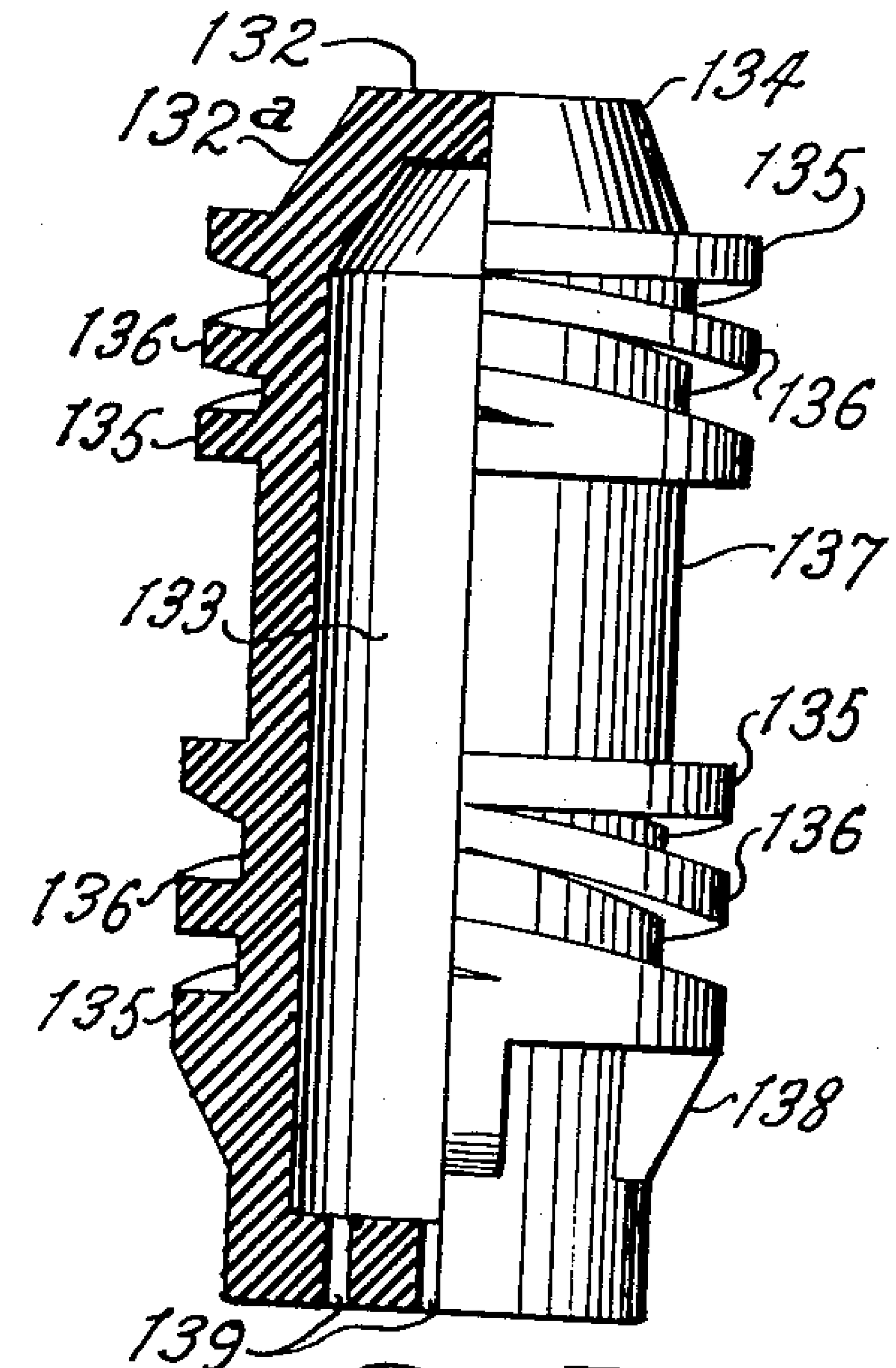

Fig. VI

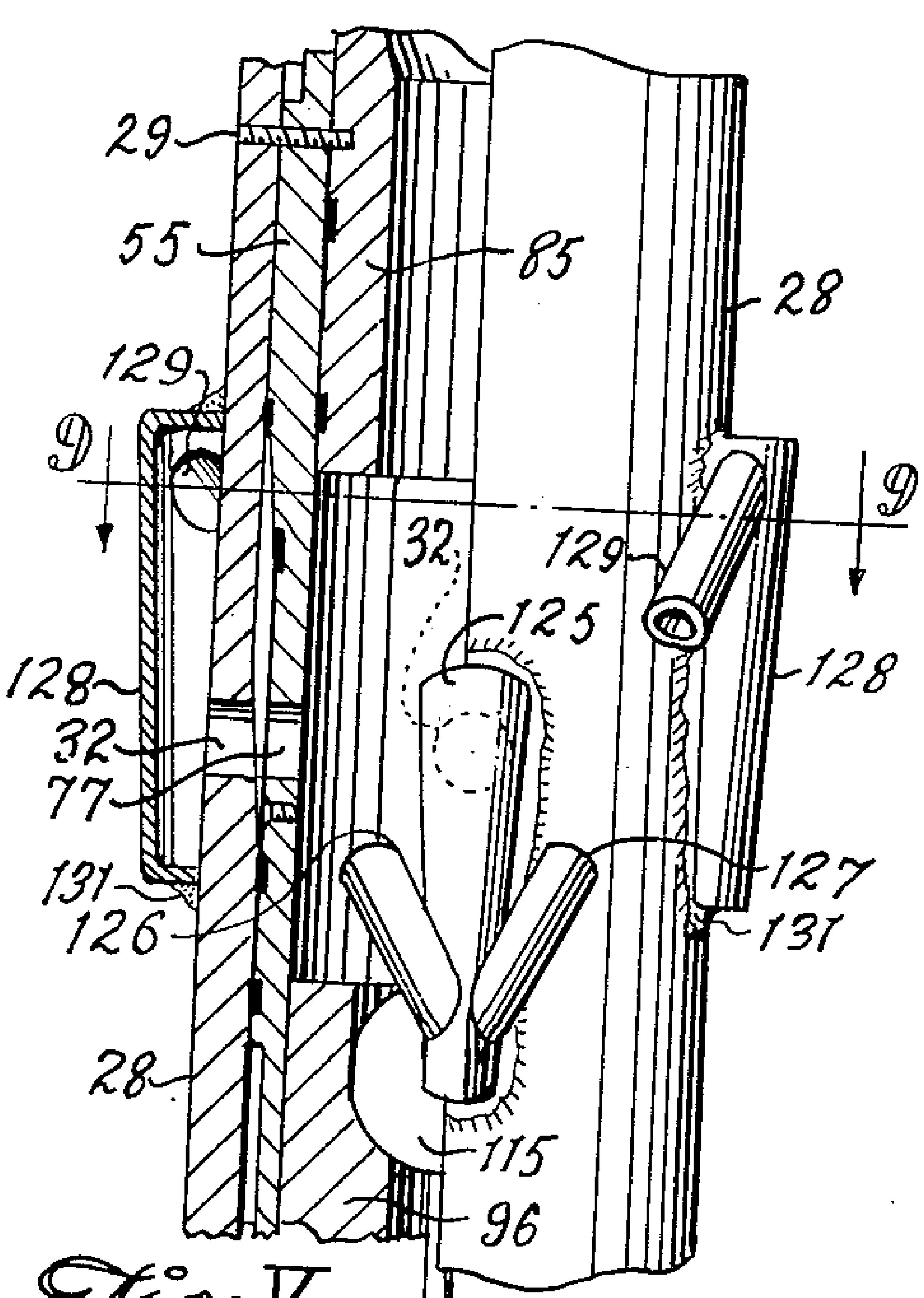

Fig. V

Sylvester B. Schnitter
INVENTOR.

BY [signature]

ATTORNEY

Nov. 17, 1953

S. B. SCHNITTER

2,659,438

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Filed Aug. 16, 1946

4 Sheets-Sheet 3

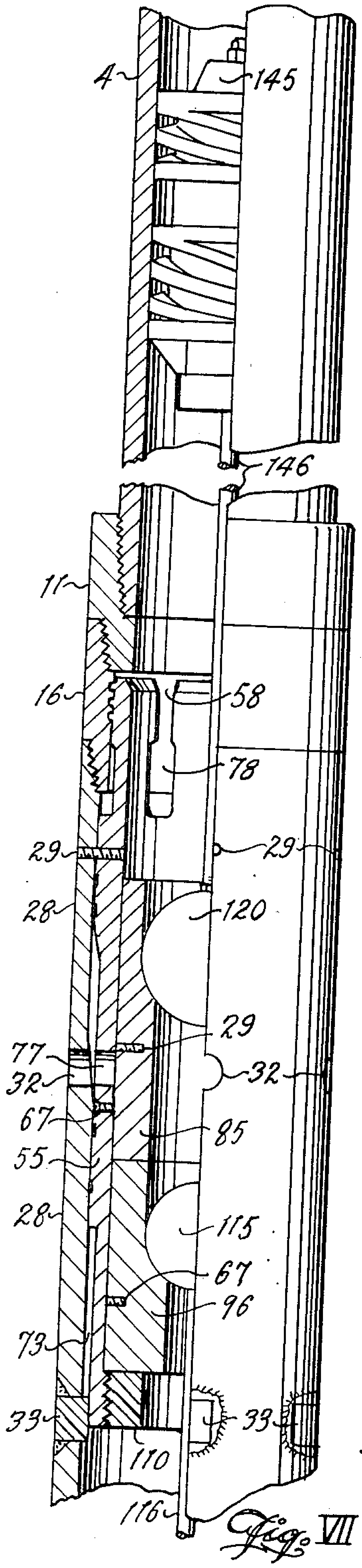

Fig. VII

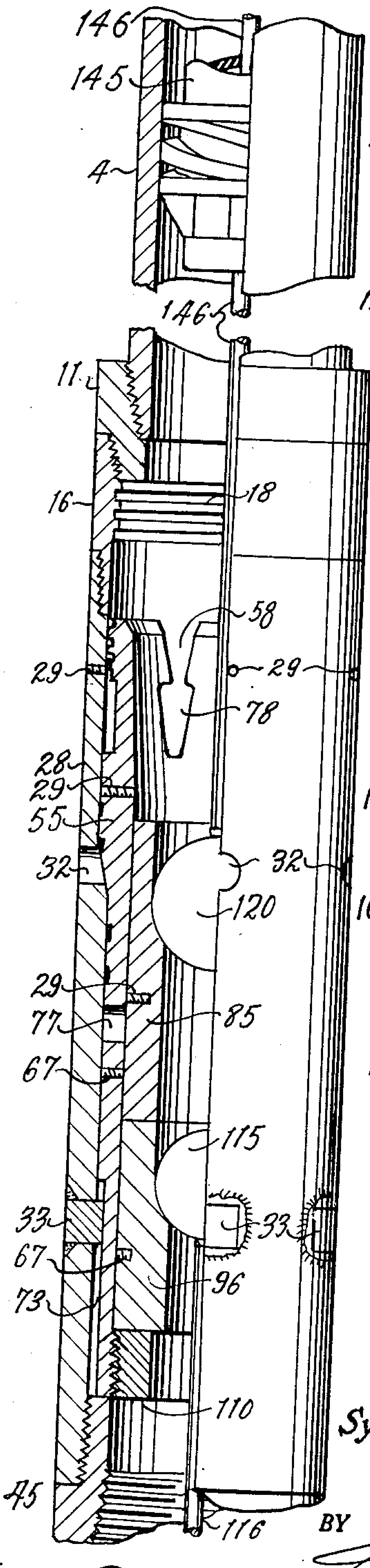

Fig. VIII

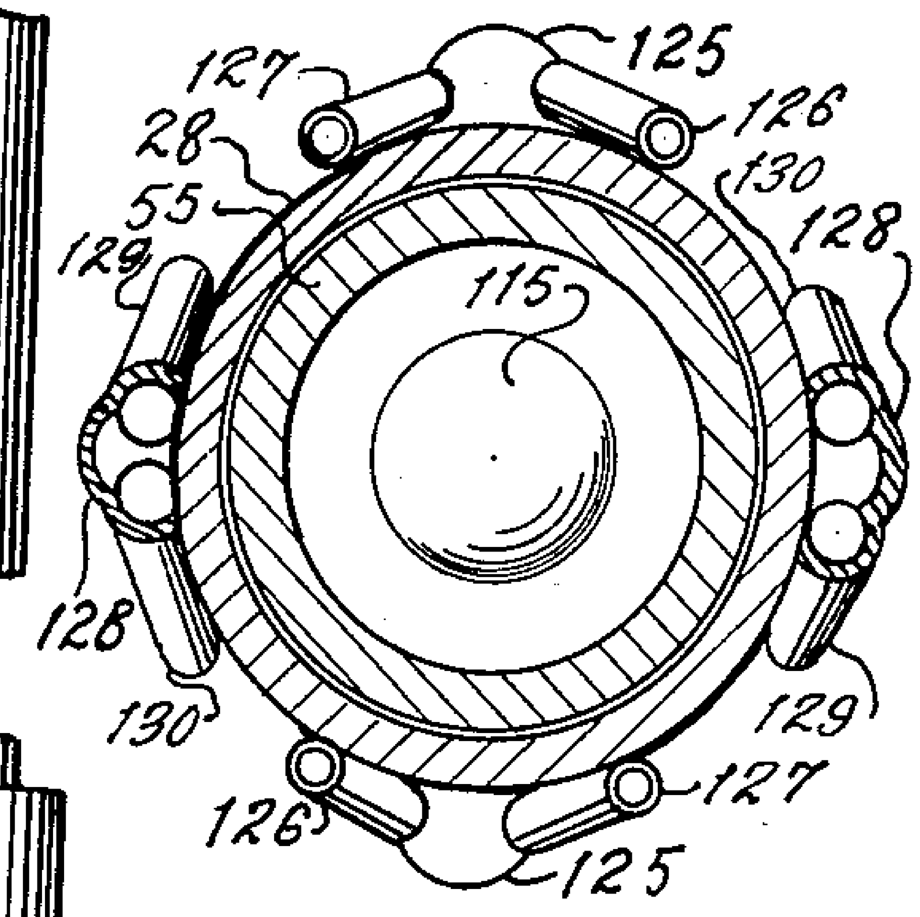

Fig. IX

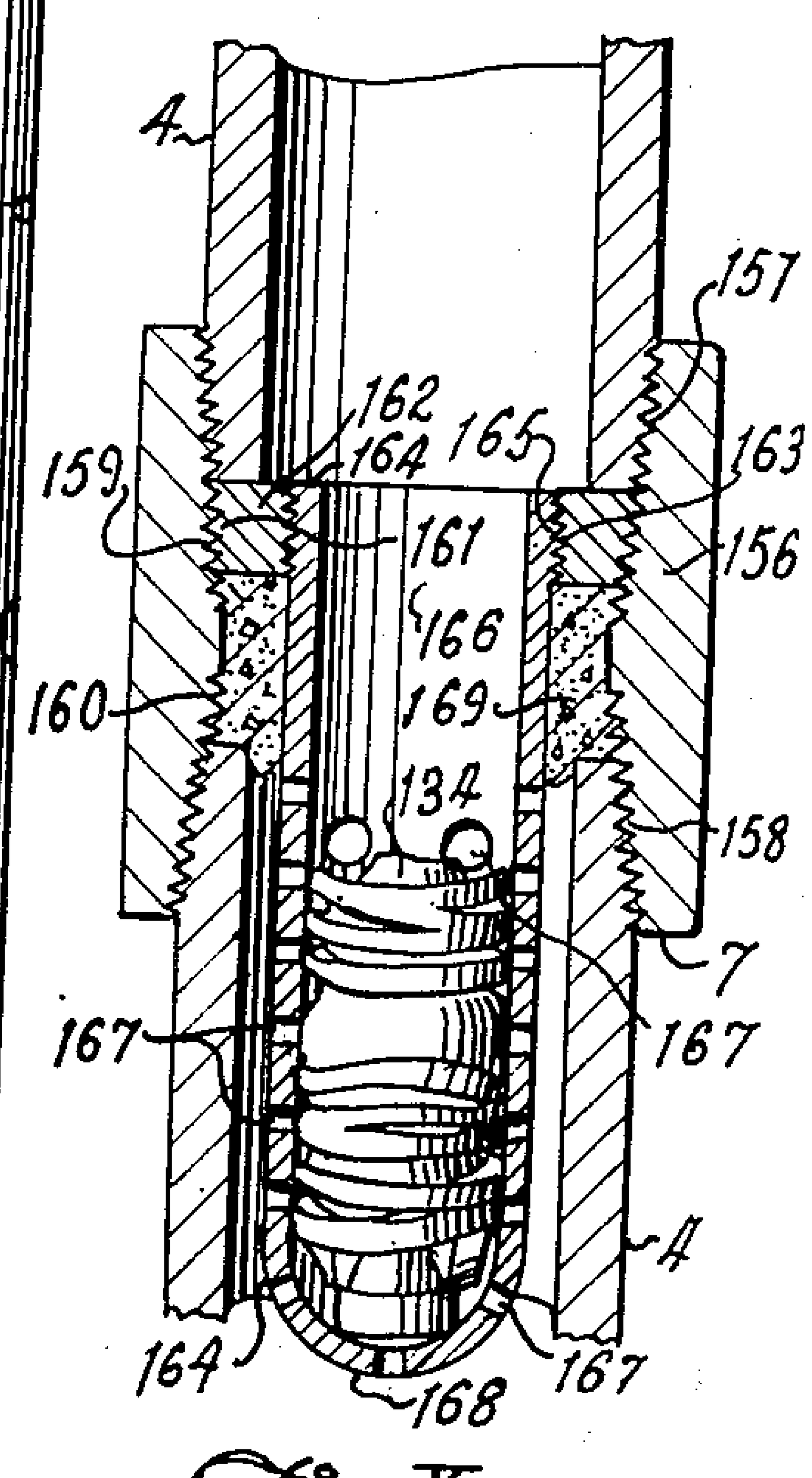

Fig. X

Sylvester B. Schnitter
INVENTOR.

BY [signature]

ATTORNEY

Nov. 17, 1953

S. B. SCHNITTER

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2,659,438

Filed Aug. 16, 1946

4 Sheets-Sheet 4

Fig. XI

Sylvester B. Schnitter
INVENTOR.

BY [signature]

ATTORNEY

Patented Nov. 17, 1953

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UNITED STATES PATENT OFFICE

2,659,438

MEANS FOR CEMENTING WELLS

Sylvester B. Schnitter, Dallas, Tex., assignor to L. L. Rector, Tarrant County, Tex.

Application August 16, 1946, Serial No. 690,969

7 Claims. (Cl. 166—1)

1

This device is primarily intended for the cementing of casing or pipe strings, commonly used in bored holes penetrating the earth's strata. The operations herein contemplated include interval cementing which constitutes the art of discharging slurry from and around a pipe string at more than one elevation along the vertical axis of a bored hole.

The primary object is to provide an apparatus for cementing casing at more than one level within the hole; and in practice it provides control mechanism through which the lower level is first cemented, and thereafter an upper level, or upper levels may be cemented.

There appears never to have been used, before my invention, a positive sealing-closure of the discharge ports which is effectively operated while all pressure present is maintained within the casing.

It should be obvious that it is very undesirable to have to rely upon a lessening or withdrawing of pressure within the casing in order to close the discharge ports of a cementing collar. This is so because whenever pressure is reduced or no longer maintained within the casing, there is an inevitable lessening of pressure within the bored hole, and immediately within the area of the discharge ports. Attempting closure by lessening the pressure creates an action of water-hammer or hydraulic shock, with attendant damaging effects on the slurry.

In short, at the very point and place where it is most desired that firmness be maintained by the cement in place, the former methods for attempting closure have lessened the pressure; and the very important port-and-strata-sealing that was sought after, by the cementing operation, was weakened and made non-dependable. In the former systems, at the time of the aforesaid pressure reduction designed to accomplish port closure, there was an appreciable reversal of movement in the slurry after it was put in place; and such reverse movement has decidedly injurious effects on the partially dehydrated and setting slurry. Disturbance of integrated cement destroys its value. Reversal of movement within the area adjacent to the discharge ports will transmit and continue such injurious effects well above the ports.

In my method the slurry is placed and maintained without such reversal of movement; and I prevent this reversal of movement, which is created when port closure is brought about by the reduction of pressure within the casing, a practice inherent in the methods of these old devices.

2

It is of no little consequence that no satisfactory and absolute closure of the discharge ports can be found in the present mechanisms known to be in use. Absence of positive closure has resulted in the breakage and leakage of the cementing job adjacent to the ports, either during or subsequent to the testing of the ports in the technique applied for the winning of the minerals sought after (that is to say before or during the production of oil, gas, sulphur or other minerals sought).

Leakage through the discharge ports may be either from the inside of the casing outwardly; or, it may be from the outside of the casing inwardly. Port-sealing to be effective must preclude the passage of fluid of any nature, in either direction through the ports, at the time, and after, the cementing operation is completed. Therefore, these old devices are particularly unsatisfactory in that they provide neither a positive seal inside nor outside of the discharge ports after they have functioned.

The instant invention is designed to afford both inside and outside seals; and when used there is no chance of a disruption of the integrated cement plug within the area of my cementing collar by subsequently found pressure, either within the casing or within the bore thereabout.

In light of this specification, there will be found among the objects of my invention, the following:

(a) A method for cementing pipe in any well by discharging slurry at a level, or successively at different levels, whereby the slurry is introduced into the hole annulus to achieve complete peripheral dispersal about the cementing collar, and then the slurry is made to reform into a uniform and homogeneous mass.

(b) A method for cementing pipe in any well to prevent a gyrating action within the discharged slurry; and to prevent any spiraling of such slurry about the vertical axis of the pipe.

(c) A method for cementing pipe in any well by directing the flow of the slurry in such a manner as to create turbulence; and which turbulence is reduced to a uniform leveling-off by the action of the slurry in a meeting and contacting of opposed flows, at a point closely adjacent to and beyond the point of discharge.

(d) a method for cementing pipe in any well at two levels without any time lapse in the continuity of its first shoe slurry placement and of its subsequent cementing collar slurry discharge; or, alternatively, at two levels, with a selective time lapse between the first shoe placement and the subsequent cementing collar discharge of slurry; and either procedure being elective by the operator, based on physical conditions encountered.

(*e*) A method for cementing pipe in any well, wherein a volume of slurry is maintained between a pair of collapsible cementing plugs, prior to discharging the slurry from the casing; and in which no amount of slurry is permitted at any time to pass through the primary plug preceding the slurry.

(*f*) A method for cementing and immediately re-cementing pipe in any well by discharging slurry from casing below and across and above a selected level of precarious characteristics (hereinafter described); and which slurry placement is followed, in immediate succession, by a second discharging slurry from casing, below and across and above the same selected level of precarious characteristics, the whole operation resulting in the complete integration of all cement placed.

(*g*) A method for cementing pipe in any well in which is employed hydraulically operated means for opening the terminal ports of the cementing collar; and other hydraulically operated means, for closing and sealing the terminal ports of the cementing collar.

(*h*) A method for cementing pipe in any well employing activated means to provide egress from the casing; and employing other activated means to shut-off such egress; and further employing still other activated means to permanently seal-off such egress from the casing, and analogically and conversely shutting off all subsequent ingress thereto.

(*i*) A method for cementing pipe in any well, employing means for closing and sealing the terminal ports of the cementing collar to be accomplished within a defined area having a constant pressure therein, being the same pressure at which the slurry is finally discharged through the terminal ports; such pressure-balancing within the area precluding any variation of pressure, the action of which is damaging to slurry in place.

(*j*) A method for cementing pipe in any well, in which the final pressure developed by the pump on the casing may be retained, or released, wholly or in part, without any damage to the slurry in place.

(*k*) A method for the interval cementing of pipe in any well, employing casing cementing plugs, whereby the terminal ports of a cementing collar, unopened for any reason whatever prior to the drilling out of the cement in the casings, may be effectively sealed against leakage from within and from without the casing; and which sealing does not require an after-cementing operation of any nature.

(*l*) In the cementing of wells, a cementing collar provided with port means which, when opened, will permit a reversal of the direction of flow of the well fluid, if required for any purpose whatever.

(*m*) A port-carrying collar capable of such flexibility of use and operation that it may be made to provide a single means for closing and sealing the discharge ports; or to carry a plurality of different means for such purpose; and when provided with plural means, one such may effect temporary closure of the ports, and another effect permanent closure and sealing.

(*n*) A port carrying collar provided with means for opening ports, and other means for closing ports, operation of the collar being so simple that it may be safely and effectively used by untrained labor and yet result in most dependable operation.

My method and my device, and its construction, operation and use, is illustrated in the accompanying drawings, which disclose a satisfactory and preferred form of my device. It is to be understood, however, that I can practice my method effectively and satisfactorily with devices which incorporate and use the same, notwithstanding that such devices may be in forms and arrangement somewhat different from the structures illustrated in the accompanying drawings; and such departure from the structures delineated will not depart from the spirit and essential principles of my method.

In the accompanying drawings:

Fig. I is a partially sectionalized elevation of a typical installation of a pair of my cementing collars carried by casing in place below the earth's surface, to provide three-stage cementing, through the shoe and the collars.

Fig. II is a partially sectionalized elevation of a typical cementing collar, before the cementing operation is performed.

Fig. III is a partially sectionalized elevation of a cementing collar, connected to and above a casing which carries a collapsible cementing plug with rod extending into the collar to carry a trip member; and in which the terminal port discs have been dislodged.

Fig. IV is a partially sectionalized elevation of a cementing collar in which the baffles have been forced to lower position, closing the sleeve passage.

Fig. V is a partially sectionalized elevation of a part of the collar in which discharge flow dispersal mechanism is disclosed.

Fig. VI is a partially sectionalized elevation of a typical collapsible cementing plug.

Fig. VII is a partially sectionalized elevation of a cementing collar carried by and below a casing in which a collapsible plug is provided with a rod extending into the collar to carry a trip member.

Fig. VIII is a partially sectionalized elevation, comparable to Fig. VII except that the sliding sleeve has been forced downwardly into final position, sealing the terminal ports.

Fig. IX is a plan view of the structure shown in Fig. V, taken along the line **9—9** thereof.

Fig. X is a sectionalized elevation of a trapping collar, in which the collapsible plug shown in Fig. VI has been trapped.

Fig. XI presents schematic drawings depicting seven stages in the disposition of parts of my device at various steps in plural cementing operations.

Fig. XII is a partially sectionalized view of the tapered wall of the collar and a modified form of the tapered wall of the sleeve.

In the drawings the various parts and elements of structures employed in the practice of my method and in the construction and operation of devices required thereby are indicated by numerals; and numeral **1** indicates the earth's strata; and the numeral **2** identifies the bored hole of a well, whether it be an oil well, a gas well, a water well or other. The surface casing foundation **3** supports the machinery used in drilling operations; and the well casing **4** has been lowered into the drilled hole to the desired depth, usually to a point near the bottom of the hole **9**.

In Fig. I a typical string of casing is in place, and carries upper cementing collar **5**, lower cementing collar 6, trapping collar 7 and a conventional shoe 8; these members being disposed in spaced relation along the casing 4; and the intervals between them are such as to allow a plurality of successive cementing operations at predetermined points or elevations within the hole. For instance, the first cementing operation is carried on through the shoe 8; and the next cementing operation is carried on through collar 6, further up the hole; and a third cementing operation may be brought about through the use of collar 5, which is still higher on the casing string.

Further cementing operations may be brought about by including in the make-up of the well casing, before it is lowered into place, such additional cementing collars (and attendant and requisite mechanism), as may be desired, limited only by the possible scope of tolerances in the internal diameters of the baffle devices in each such cementing collar. The lowermost collar carries movable baffles having a smaller diameter than that of the baffles in the cementing collar appearing next above it in the casing string; and the diameter of the baffles increases in the succeeding upper collar, or collars, so that the collar placed highest in the string carries baffles of the greatest diameter.

The arrangement heretofore indicated, and particularly that depicted in Fig. I, is intended for plural or multiple cementing operations. However, it must be well understood that, where the job demands it, a single collar can be used, together with the conventional shoe 8, to effect a dual cementing operation. Further typical cementing collars are simply added to the string of casing at the several levels where further cementing is to be done.

Referring now particularly to the structures and elements depicted in Fig. II (and also in Figs. III and IV), it will be found that upper sub 11 is provided in the form of a short cylindrical connector, to attach casing string 4 to the sub 16, which is in turn connected to body 28 of a typical cementing collar (such as is indicated by numerals 5 or 6 in Fig. I). Below the typical cementing collar there is disposed a lower sub 45, for further connection of the collar to the casing string. There is some difference in the construction of these connecting subs, as will be made more apparent hereinafter.

The upper sub is provided with female top threads 12, which comprise companion threads for attachment to threads at the end of a length of casing.

Sub 11 is provided with a square shoulder 13, for horizontal locking and frictional engagement with the mating surface provided by the square shoulder 19 on the sleeve locking sub 16, the latter being used as a connector for attaching sub 11 to body 28.

Sub 11 is provided with male bottom threads 14, to engage female threads 17 on the sleeve locking sub 16. Sub 11 is provided with an inner bore 15, which has a diameter similar to the bore of casing 4 which carries the cementing collar.

Sleeve locking sub 16 is provided with a series of horizontally disposed female serrations 18. These are preferably slightly rounded so that their indentations may more easily mate and form locking engagement with complementary male serrations 56 in the top of movable sleeve 55.

The sleeve locking sub 16 is provided with a square shoulder 20 for horizontal locking and frictional engagement to a similar mating surface 36 on the upper face of the body 28. This sleeve locking sub is provided with internal bore 21 of appropriate diameter to receive the outer extremities of sleeve serrations 56 when the sleeve 55 is moved downwardly, and after the upper end of this sleeve has been contracted inwardly by such downward movement. There is a certain capacity of recoil, or springlike action in the end of the sliding sleeve itself, so that, after passing to its final resting place (as will be hereinafter explained), the upper end of the sliding sleeve, having a square shoulder 79 will eventually become lodged and locked beneath lower shoulder 23 of the sleeve locking sub 16.

The sleeve locking sub is provided with lower male threads 22 to engage complementary threads 35 on the top part of body 28, which body is the long cylindrical member threadedly connected to subs 16 and 45, and which houses most of the operating mechanism of the cementing collar (5 or 6) of which it is a part.

There are shearing screws 29 passing through the walls of body 28, and through the wall of sleeve 55 and into the wall of the upper baffle 85, so constructed and disposed that when this baffle is moved downwardly these screws are sheared. Also when the sleeve 55 is moved downwardly (an operation subsequent to the movement of the baffle 85) the remaining part of these screws are again sheared. Therefore, it will be seen that screws 29 (of which there are several) perform the function of holding together in proper relation, and in their initial positions, the members 85 and 55 in positions related to the body 28. Through the wall of body 28 there are provided terminal ports 32, arranged for the final discharge of the flow stream from within cementing collar 5 or 6, into open hole 2. These terminal ports are provided with removable closure discs 30, which blank them off, to close and seal them, until sufficient pressure on the flow stream is exerted to open them by forcing discs 30 out of position.

Discs 30 may be kept in place until the stage of operations is reached which requires their dislodgement; and in order to have them properly and safely maintained meanwhile they may be removably attached to the body 28 by some suitable ferrous or non-ferrous compound, or they may be yieldably and temporarily fused in position and in attachment to the body 28 by the use of suitable fusible material; and whatever material is so used the same is indicated by numeral 31.

There are provided, through the wall of the body 28, certain keys 33, which extend beyond the internal face of this wall and into certain key ways or milled grooves 73 provided in the external face of movable sleeve 55. These grooves will allow very limited vertical movement of the sliding sleeve; but they are narrow, and their width conforms to the width of keys 33; so that while the sleeve may slide vertically along these keys, the sleeve may not rotate or turn, because of the pressure of these keys.

These provisions for keys and grooves are required, because whenever a cementing operation is completed, through the use of any cementing collar, it is necessary for the cement to be allowed to set and harden; and a lertain quantity of cement will be found to have set and hardened within the cementing collar; and all such cement therein must be later drilled out with a bit which rotates. Were it not for the provision of keys 33 and grooves 73, the sleeve 55 might have a tendency to turn within the body 28, and this would render it impossible, or at least difficult, to drill out the cement. In this connection it is to be noted also that the baffles, which are employed to receive force for moving the sliding sleeve, must themselves be made of drillable material. They will be drilled out, along with the cement accumulated and hardened within the cementing collar.

Some suitable bonding or fusing material 34 is employed to hold and maintain keys 33 in proper place and position. These keys may be made of any irregular shape. For instance, they may be made square, or rectangular or hexagonal, etc. Two of them will be sufficient; and they must be lined up perfectly with the groove 73. For this reason, among others, it is desirable that keys 33 be set exactly in their proper places and depths, and welded firmly there. This practice is recommended, notwithstanding that the keys may be threaded in place, if such operation is found desirable by the manufacturer. In any event, a suitable aperture 42, of proper shape and contour, is made through the body wall 28 to receive and hold keys 33.

Bore 38 in the lower part of body 28 is of slightly smaller diameter than the bore 40 of the upper part of this body. This arrangement is made because of the fact that, between these two bores, there is a tapering bore 39 which is preferably arranged to extend an equal distance above and below body terminal port 32. This tapering bore is accurately finished and made to gradually increase in diameter as it extends upwardly. The degree of the tapering is small; and it is provided to afford a final resting place for a wall section of complementary inclination (that is of wedgelike inclination) on the outside of the sliding sleeve. The taper on this sleeve is indicated as at 64; and between these two tapered and complementary surfaces there will eventually be made a locking and wedging and mating contact, to effect final and permanent engagement between sliding sleeve 55 and body 28.

Body wall 28 terminates at its lower end in square shoulder 41, which will lock in frictional engagement with a complementary shoulder 46 in lower sub 45.

This lower sub is carried by the lower end of body 28; and it is provided with male threads 47 on its upper end; and these threads find engagement with the companion threads 37 of body 28. The internal bore 48 of the lower sub 45 corresponds in diameter with the bore of the casing 4, to which it is attached through the use of female threads 49. The shoulder 50, constituting the upper face of lower sub 45, has a special function in that it fixes the farthest limits of the movement of slidable sleeve 55 in its downward progress; and the squared end 74 of this sleeve finally comes to rest on this shoulder. This shoulder 50 prevents any undue stress which may otherwise come about between the tapered faces 39 and 64; and it is so positioned as to prevent any wire drawing or other damage of the tapered faces. Such irregularity or deformity would be undesirable, and may be the occasion of leak between these faces, if allowed to occur.

The movable sleeve 55, having the form of an elongated cylindrical member mounted within the bore of body 28, of a typical cementing collar, is an item of major importance in the use and operation of this device. Its general structure and appearance is indicated in Figs. II, IV, VII and

VIII. Its internal diameter is constant, being substantially that of the casing 4, which carries the cementing collars 5 and 6. However, its external diameter is greater at the top of the sleeve than at the bottom; and the sleeve is fixed within the body 28 of the collar in an initial position, from which it will be moved downwardly later to be wedged into its final position, sealing and closing body terminal ports 32, as will be hereinafter pointed out in detail.

Below serrations 56 the outer wall of the sleeve is provided with undercut 57, horizontally disposed, and made to lessen the cross section of the sleeve wall, the better to provide spring action when serrations 18 and 56 are disengaged (upon the downward movement of the sleeve), and also to allow the upper wall of the sleeve to spring into position after its downward movement. This springing recoil may be provided for by a pre-set expansion of the top of the sleeve outwardly, to a slightly greater diameter than its normal original diameter; and this pre-set expansion may extend through and to a point slightly below the section of the sleeve carrying serrations 56.

There are vertically placed slots 58 through the end of the upper side wall of sleeve 55, so arranged as to facilitate the disengagement of the serrations 56 and 18. These slots terminate in lower enlargements 78, which are provided to further lessen the material in the wall of the sleeve in the vicinity of the pre-set expansion, so that spring action may better be accomplished in such area of the sleeve wall.

The upper outer wall 59 of the sleeve has a diameter closely approximating that of the upper inner bore 40 of body 28, so that the sleeve may fit closely within this body, and yet be allowed to move downwardly therein when sufficient force is exercised therefor.

The diameter of the lower bore of the body 28 is less than the diameter of the upper bore of this body; and a complementary construction will be found in the sleeve itself, because the latter must eventually move downwardly within this body. The external diameter of the lower part 72 of the sleeve member therefore closely approximates the internal diameter of the lower bore of the body 28.

The tapered wall section 64 of the sleeve, so made to provide a wedgelike member, to fit tightly against the tapered section 39 of the wall of body 28, when the sleeve is forced into its lowermost position.

Above the tapered section of the sleeve one or more grooves 61 may be machined around the outer diameter of the sleeve; and these grooves carry resilient material formed to provide sealing rings 60. Sealing rings are thus arranged to prevent the passage of fluid between the wall of body 28 and the wall of the sleeve member.

One or more sealing rings 68 may be arranged below the tapered section of the sleeve, comparable to sealing rings 60. Such a lower ring may be carried in a horizontally disposed groove 69, which is comparable, except for size, with groove 61. It is good practice to place a pair of these rings above the tapered section of the sleeve, and another pair of such rings below such section.

A plurality of shear screws 67 holds the lower baffle 96 to the sleeve, until this baffle is moved from its place of original position in the sleeve; and in such movement the screws are sheared in response to force placed thereagainst.

Within the bottom end of the sleeve there is provided a baffle stop 110, which is a short cylindrical ring of drillable material; and it is provided with external threads 111 for engagement with companion threads 111a in the inner wall of the sleeve. This baffle stop fixes the limit of the downward travel of lower baffle 96; and this baffle is provided with a lower face 101 which will come to rest on upper face 112 of the baffle stop. It is to be noted that the internal bore 76 of the lower part of the sleeve is the same as the inside diameter of casing 4.

The sleeve is provided with passageways 77; and these are initially aligned with terminal ports 32, which are arranged through the wall of the body 28.

Passageways 77 are closed by lower baffle 96 before any actual cementing is done. Therefore, this baffle must be moved downwardly to open the passageways; and the lower baffle is thus moved by the action of hydraulic force (as will be hereinafter explained); but even at this point in the operation, port 32 remains sealed with disc 30 for a time; and the latter must be forced outwardly by hydraulic pressure from within the cementing collar. After the yielding of disc 30 the casing flow stream can and will flow through passageway 77, and be discharged out of port 32 into the open hole 2, of the well surrounding casing 4.

Within the upper section of the sleeve there is provided upper baffle 85, which is a short cylindrical member of drillable material. The outside wall face 94 of the upper baffle has a diameter equal to that of the internal diameter of the sleeve, over the inner wall of which this baffle may be made to slide downwardly. In its initial position (before sliding downwardly) the outer wall of the upper baffle lies against the inner wall of the sleeve, and aids the keeping of engagement between the serrations 59 and 18.

Sealing rings 86, carried in grooves 87 are disposed about the circular periphery of upper baffle 85 and of lower baffle 96 to prevent the passage of fluid between the outer walls of these baffles and the inner face of the sleeve before and after and during the movement of these baffles.

The lower shoulder 90 of upper baffle 85, and the upper shoulder 105 of lower baffle 96 meet in a common horizontal plane, so that these baffles remain in close contact while in their initial position; and also after their final movement.

At the very top of the upper baffle 85, there is a straight vertical bore 93, which is slightly less in diameter than the diameter of the casing 4. There is a tapered bore 92 in the upper baffle, terminating in straight bore 91 of this baffle. There is a straight bore 104 in lower baffle 96; and this straight bore is of the same diameter as the straight bore 91 in the upper baffle. There is a tapered bore 103 in the lower baffle 96, and it ends in the straight vertical bore 102 of this baffle.

The tapering of bores 92 and 103 within baffles 85 and 96 is not relied upon to provide or assist passage of collapsible plugs. These plugs, on the other hand, have inherent characteristics and design allowing them to conform to retaining walls and pass through openings having smaller measurements than the plugs themselves. Note that the angle of inclination of the lower ribs 138 on a typical collapsible plug, as in Fig. VI, does not conform to that of the taper in the baffles.

From the foregoing description of the several bores and diameters of the adjacent baffles, it will be seen that the internal diameters of the passageways through these baffles presents an opening of greater diameter at the top of the upper baffle 85 and an opening of considerably less diameter at the bottom of the lower baffle 96; and the tapered walls of these baffles will furnish lodgment or resting places for certain trip members, which are designed to receive hydraulic force with the object of moving these baffles; and typical of these trip members finding such lodgment is trip member 115, which comes to rest upon the walls of tapered bore 103.

Trip member 115, which articulates with lower baffle 96, is made of material which may be drilled out, after the cementing job is done. It constitutes a nesting and sealing device to close off the opening in the bottom of the lower baffle. It will be noted from the drawings (and the foregoing explanation) that the member 115 has a diameter small enough to pass by the upper baffle without lodgment; and it is necessary that it also pass downwardly through the casing, from the surface, and through all cementing collars carried by the casing above the particular collar under consideration, without being obstructed in its downward movement. That is to say, the lower cementing collars in a string of casing will be provided with baffles having internal diameters smaller than those found in the upper collars.

A trip member, such as 115, 120 and 121, may be formed in the shape of a ball, or cone, or have the appearance of an inverted frustum of a cone. Or it may be a flat disc having bevelled edges. In any event it must constitute means, designed and made to find lodgment upon the shoulder or tapered bore of a particular baffle, which will later be caused to move by the force of hydraulic pressure exerted thereupon (or upon other members of this class).

In Fig. III it will be noted that trip member 115 has an extension device or rod 116 connected to its under side and to the collapsible cementing plug 117 below, so that members 115 and 117 are fixed on the opposite ends of this rod.

The plug 117 is so made that it will have a snug fit in passing downwardly through the casing 4, and will collapse inwardly and become elongated when passing through cementing collars 5 and 6.

In speaking of the plug 117 as being collapsible, it is to be understood that what is meant is that such member has the capacity to take on the irregular shape of any opening or passage through which it may be forced to move, but that it is capable of springing back to its former shape. Therefore, when collapsible plug 117 comes into position in casing 4, below any cementing collar, it will be found to fill the inside of the casing so as to prevent the passage of fluid around or about the plug.

Trip member 115 is not collapsible; and when it finds lodgment upon the internal taper of a baffle it will receive the full force of the hydraulic pressure exerted upon it from above.

It is to be noted that member 115 comes into its resting place on tapered wall 103 of the lower baffle 96 because of hydraulic pressure exerted on the plug 117; and thereafter this pressure is received by both the member 115 and the member 96.

When such pressure on member 115 and member 96 is sufficient it will cause the downward movement of lower baffle 96 from the position indicated in Fig. II, until it reaches the position indicated in Fig. III, where it rests upon baffle stop 110.

It must be borne in mind that all of the baffles indicated in this specification, and all of the trip members, of which **115** is typical, and all of the rod members, such as **116**, and all of the collapsible plugs, such as **117** or **134** or **145**, must be made of drillable material. That is to say, the drilling bit must be able to cut them away, along with any cement around them, after the cementing job is done. This is done because, when the work of cementing is finished, there must be a free and unobstructed conduit or passageway through all of the cementing collars employed, not less in diameter than the bore of the casing **4**.

Trip member **120** corresponds in general structure, appearance and function to member **115**, except that member **120** is larger and will come to rest upon the inclined wall **92** of upper baffle **85**. It is to be noted also that member **120** is connected to a rod-like or tubular member **146**, extending above it; and this last named member is fastened to collapsible plug **145**. (See Figs. VII and VIII.)

In Fig. IV will be found a special trip member **121**, which is not connected to any rod or tube structure (such as **116** or **146**); nor is it connected to any collapsible plug. It is made of drillable material, having such shape and size as will allow it to come to rest upon the inclined wall **103** of the lower baffle, blocking and closing the passageway within this baffle. This special trip member is employed only when it is found desirable that there be a lapse of time after the completion of the first and lowest cementing level, and before the beginning of cementing operations at a second and upper level. This particular member may be used in place of the combined members **115**, **116** and **117**, in second level cementing operations; and when so used the trapping collar **7** is not used in the casing string. Therefore, member **121** is an alternate for use in second level cementing operations. However, it is a requisite in third level cementing operations, and in other cementing operations above the third level. The trip member **121** is simply dropped into the casing fluid at its surface; and then it is allowed to gravitate to its final position.

In the discharge of the flow stream from body terminal ports **32**, after they have been opened, as hereinabove explained, it should be evident that such flow stream can be allowed to fix and find its own direction, without the intervention of any means for conditioning the direction of the flow; and it is true that my apparatus may be used without any such means. There may be physical conditions under which it may not be found practical to provide such means on the outside of the cementing collar, because the inclusion of such means will increase the overall diameter of the tool. Whenever such means may not be employed advantageously, for this or any other reason, my standard cementing collar, without such means, may be used. However, there are reasons for the provisions of such means; and it is recommended that such means be used whenever possible. Otherwise, the discharge of a high velocity flow stream, directly out of the ports, may cause a cutting action on the walls of the drilled hole of the well. In any such cut-away section of the wall, the slurry coming from the ports may find escape in a direction not desired; and this may result in channeling (an evil hereinabove discussed, which is to be avoided if possible). Also, the dislodged portions of the stratum forming the wall of the well bore may become intermingled with the slurry introduced, and result in an impairment of the strength of the latter.

Therefore, I employ special dispersal means for controlling and regulating the direction and velocity of the flow from the terminal ports, and to effect uniformity and complete integration in the discharged slurry as it is being placed.

Such means may take many forms; and a typical form of such means is disclosed in Figs. V and IX, wherein there are several runways, arranged to communicate with the terminal ports; and these runways constitute conduits. For purpose of greater clarity the vertically disposed runways are called shank runways, of which members **128** and **125** are typical; and the oblique runways, which are inclined from the vertical, are called arm runways, of which **126**, **127**, **129** and **130** are typical.

Shank runway **128** receives flow at its lowermost end, and discharges flow, from its uppermost end, into communicating arm runways. Shank runway **125** receives flow at its uppermost end, and discharges flow, from its lowermost end, into communicating arm runways.

In a typical arrangement there will be found a pair of oppositely disposed shank runways **128**; and likewise there is a pair of oppositely disposed shank runways **125**.

Each arm runway is so positioned and inclined as to have a companion arm runway disposed at the same angle and arranged to discharge flow in the exact opposite direction of the flow from the arm runway first mentioned. Each arm runway has a cross-sectional area slightly less than one-half of the cross-sectional area of its communicating shank runway.

The net result of such an arrangement is to create initial turbulence, and to prevent undesired channeling. The velocity of the flow of two opposing streams meeting between the outlets of opposed arm runways is dissipated; and the turbulently intermingled flow stream resulting from a combination of these opposite forces will then proceed to the points of least resistance, and completely fill the area about the cementing collar. Such an arrangement and operation will make and produce a far more homogeneous placement of a slurry mass than may be had without such means. Uniformity in the density of this mass in the discharging area is a most desirable objective indeed; and my structure and method have been found to fully effect such objective.

The structure immediately hereinabove discussed is more than means for deflecting the flow leaving the discharge ports in the cementing collar. It has all the advantages of a baffle or a deflector; but it has far greater advantages than either, in that the dissipation of the velocity of the discharge stream is effected; and an orderly and uniform integration and placement of homogeneous slurry results. Also there can be no cutting away of the walls of the surrounding earth's stratum as a result of high velocity discharge.

While the device illustrated in Figs. V and IX may have the construction therein shown, it is to be noted that instead of tubular members for the runways there may be used rectangular channels, or conduits of any desired shape. For instance, a flattened or elliptical tube may be employed, or an arc of a tube may be employed. The conduits must be finally built and securely fastened together and well attached to the body

28 of the cementing collar. For this purpose the use of welding 131 is ideally suited. However, conduits may be fashioned as a part of the body itself.

It should be obvious, of course, that the special dispersal means, which I have just described, may be employed as an attachment to a conventional shoe 8 which is placed on the lower end of the casing near the bottom of the hole. Also, it may be attached about the wall of a simple length of casing which has been previously provided with suitable discharge ports, so that these ports may communicate with my dispersal means.

In other words, such means may be used in connection with my cementing collar 5 or 6; or it may be used in connection with any suitable perforated pipe employed for flow, delivery and placement of fluid. When so used the same advantages will be found as are hereinabove claimed for its use with my cementing collar.

The collapsible cementing plugs herein referred to, of which that shown in Fig. VI is typical, may be made in a variety of shapes and sizes; and the one illustrated is merely a preferred form. It is required that the plug be made of resilient material, because it must be collapsible. Perhaps the best material for such use is rubber, natural or synthetic; and the formula used to produce the rubber should result in a composition of relatively soft and yielding nature, yet capable of withstanding considerable abrasive action.

Typical plug 134 is made with a hollow interior 133. A solid top 132 may be provided with a bevelled side wall 132a. The plugs are usually made with a solid top, because they can be used without any connection or attachment thereto. When it is desired to attach rod 116 or 146 to the plug, a suitable hole may be drilled through the top, at its center, to receive such rod or tubular member; and such member may be fastened in place with nuts and lock washers.

These plugs are used to shut off, space, or segregate fluids of the same or different characteristics. For instance, when a plug is placed, there may be found above or below it well fluid of normal character, or slurry.

In order to more effectively separate the fluids lying on either side of the plug, special arrangements have been made to produce a substantial seal. Among these are horizontal wipers 135. They are in fact lips which extend from the hollow core of the plug outwardly to fit closely the bore of a casing string.

Circumferential wipers are preferably arranged on the plug in two groups, with a space between the groups. This space constitutes a recess 137 within the wall of the plug, which lessens the thickness of the cross-section of the resilient material forming the wall in that area. It is particularly in this area that the plug reacts responsively to effect partial collapse and elongation, when it is required to suffer deformity in passing through restricted openings.

Between each pair of horizontal wipers 135 there are arranged diagonal wipers 136, which reinforce the former; and these diagonal members also closely fit the bore of the casing string.

Receding or dished ribs 138 are arranged below the lowermost horizontal wiper, and they extend toward the base of the plug. Such ribs limit the tendency of the lower wiper to separate from the wall of the casing as a result of great pressure upon the top of the plug. My construction prevents the undesirable deformation of greater deflection of the bottom wipers; and the ultimate object in using this construction is to prevent "rimming" through the fluid in such a manner as to leave a deposit on the bore of the casing, which deposit may be well fluid, slurry, or both, in separated or combined form.

Through the bottom of the plug there is provided a plug port 139 which communicates with a hollow interior 133 of the plug body. When desired a plurality of such ports may be employed. The centermost port 139 becomes the aperture through which extension 146 protrudes when the assembly of members 145, 146 and 120 is required. These ports are designed to allow the introduction of a non-compressible fluid (such as water) to fill the hollow space within the plug body. This fluid is introduced before the plug is placed in the flow stream; and to temporarily maintain this fluid within the plug so that there will be no air trapped therein, the bottom of these ports may be sealed with courtplaster or adhesive tape.

Through the use of this arrangement the plug will not carry a column of air within itself. However, upon the collapse, or partial collapse, of the plug in its downward travel through the casing and through the cementing collar, the weak sealing means used to close these ports temporarily may be easily ruptured to accommodate the requisite escape and subsequent refilling of the non-compressible fluid incident to such collapse.

I wish to make clear that the plug, the construction and arrangement of which I have just described, may be used within any pipe, casing or other conduits to separate fluids therein, regardless of the fact that there may be no restrictions whatsoever within the diameter of such conduits and regardless of the fact that the plug may not be required to collapse while being moved to the place of its final use. That is to say, the plug is quite effective as a means for substantially sealing off the contents of a conduit at whatever places or intervals may be desired.

In Fig. X is indicated trapping collar 7 which is employed to stop the progress and to contain in irregular form, a typical collapsible cementing plug 134. The plug so used is not equipped with any rod, such as 116 or 146, or other connection; and it does not carry trip member 115 or any other trip member.

The collapsible plug so trapped comes to rest in the bottom of the trapping collar below some of the perforations 167, which are numerously disposed through the side wall of drillable nipple 164. Perforations 167 are sufficiently numerous to allow the passage of the entire flow stream; and they are of sufficiently large size as not to retain flow stream debris, such as drill bit cuttings or other foreign materials.

The trapping collar assembly 7 is provided with cylindrical body 156 which carries upper female threads 157 and lower female threads 158 to engage companion threads on the ends of upper and lower casing 4.

Below the end of upper casing 4 the body 156 is further provided with internal threads 159 to engage external threads 161 on the drillable bushing 162. This bushing also is provided with female threads 163 for engagement with male threads 165 on the upper end of the perforated trapping collar nipple 164.

Internal bore 166 of this perforated nipple is of smaller diameter than that of the casing 4. However, its diameter is greater than the straight bore 102 of the lower baffle 96 and greater than the straight bore 91 of the upper baffle 85.

Perforated nipple 164 is provided with a perforated bottom 168. The bottom of this nipple may be closed by causing V-shaped segments thereof to be cut out of the end wall of a straight nipple; and the remaining segments may be heated and turned inwardly to substantially close the nipple and form its bottom. After being thus formed the segments are welded together to strengthen the bottom wall.

The trapping collar body 156 is provided, in its mid-section, with internal and horizontally disposed serrations 160 which supply anchorage and bearing for the concrete fill 169 which is tamped and embedded below bushing 162 and behind the wall of nipple 164, so as to strengthen and support these last two named members. It is to be noted that this concrete and the bushing and the perforated nipple are all made of drillable material, and can be cut away by the drill bit when desired.

Operation

The steps by which my method may be employed in a typical cementing operation around the casing of a well, in successive stages, so that cementing can be done at three levels in succession, can be better understood by referring to Fig. XI of the drawings, where typical members, which may be employed in the method, have been indicated, especially with reference to the relative locations of these several members at various intervals of time.

Fig. XI is a schematic or diagrammatic arrangement, designed more to illustrate the steps employed, and the order thereof, then to delineate the details of any of the mechanism therein indicated.

In the schematic arrangement of Fig. XI there are seven views, marked from A to G, inclusive; and the letters of the alphabet indicate by their usual sequence the sequence of the seven steps carried out from the beginning to the ending of a typical cementing operation of three stages.

In each of the views in Fig. XI there are indicated a casing string 4, upper cementing collar 5, lower cementing collar 6, trapping collar 7 and a conventional shoe 8.

Certain operative elements of the cementing collars are indicated by the numerals given them earlier in this specification, though no attempt is being made to detail such elements in Fig. XI. Also indicated are collapsible cementing plugs 134, 117 and 145, as used in the views or steps; and there is a free ball or trip member 121, unattached, which is first introduced in view F and appears also in view G. In the latter view there is an extra and uppermost cementing plug 145 carrying a rod or tube 146 so as to connect it with a typical trip member 120*a*, and the only difference between the upper member 120*a* and the lower member 120 in view G is that the former is larger in diameter.

The direction of the flow stream is indicated by appropriate arrows in the views of Fig. XI. The progressive employment of the members indicated in Fig. XI is as follows:

The casing string 4 is lowered into the bored hole 2 to the required depth. As this string is placed in the hole it is made up to receive the shoe 8, the trapping collar 7, cementing collar 6 and cementing collar 5, in the order named; and these members are spaced in the string the required distances so that they will thereafter function at the predetermined levels at which cementing, and operations incident thereto, are required to be performed.

The level around shoe 8 and above is to be cemented first, and this is called first stage cementing. The level around collar 6 and above it is to be cemented next; and this is called second stage cementing. The level around collar 5 and above is to be cemented last; and this is called third stage cementing.

The vertical distances between these three cementing stages is fixed at the discretion of the operator; and they may be such that the cementing from any lower stage may continue upwardly to and overlap the cementing in the next upwardly succeeding stage; or it may not, as physical conditions may require or good practice dictate.

It is customary practice to carry out fluid circulation for a requisite period to determine that the casing and the discharge ports from the shoe are fully open and that the fluid flows evenly behind the casing to the surface source. When cementing operations are commenced there is no obstruction to the flow stream in the casing nor in the bored hole area surrounding the casing. This is the situation in view A.

In Fig. XI the moving well fluid is indicated by single pointed arrows and the moving slurry by double pointed arrows.

Next, in view B, cementing slurry has been introduced into the casing until it has been forced by the pump through shoe 8 and upwardly around the casing. The operator knows the cubic content of the desired fill behind the casing; and only such quantity of slurry has been placed through the shoe. On top of that slurry an independent and unattached collapsible plug 134 was previously introduced into the flow stream and forced downwardly by the action of the pump, until it came to lodgment in or above trapping collar 7. The operator determines the quantity of well fluid to be introduced above the plug 134, by computing the cubic contents of the casing per foot thereof. He uses that volume necessary to fill the casing bore from trapping collar 7 to cementing collar 6. When all of such volume has been pumped above plug 134, then collapsible plug 117 is placed in the flowstream. The relation, therefore, between collapsible plug 134 and collapsible plug 117, within the casing string, is that vertical distance between trapping collar 7 and cementing collar 6.

This stated relation provides for the simultaneous arrival, or nearly so, of plug 134 at trapping collar 7, and plug 117 (with extension 116 and trip member 115) at the cementing collar 6. During this operation, and until plug 117 and its trailing member 115 are finally lodged in collar 6, there continues to be stream circulation through trapping collar 7, notwithstanding that plug 134 is or is not in trapped position, as disclosed in Fig. X. This arrangement is made to compensate for any over or under measurement of the volume of fluid required for spacing between cementing collar 6 and trapping collar 7. At any rate, when trip member 115 is stopped by baffle 96, the first stage cementing operation has been completed.

When trip member 115 is nested in lower baffle 96, as shown in view C, then the pump pressure, and its increase applied thereabove, will cause this baffle to be driven downwardly, shearing screw 67, and opening sleeve passages 77 to the introduction of fluid.

This exposes for the first time the ports 32, and their closing discs 30; and the increased pump pressure will expel the latter. Thereafter slurry, at the second stage, is discharged through cementing collar 6, as indicated in views C and D. Slurry for this purpose has been introduced above plug 117 and below plug 145.

The volume of slurry for the second stage operation, which is introduced into the casing between plugs 117 and 145, is again at the control and discretion of the operator, in exactly the same manner as hereinbefore explained in the determination of the volume of slurry introduced into the casing for the first stage. Well fluid is pumped above plug 145.

The pressure of the pump continues to force downwardly plug 145 (above which is typical well fluid) and the slurry below this plug is forced outwardly through ports 32, until trip member 120 is nested in upper baffle 85. Continuing pressure, with its increase, will move this upper baffle downwardly, shearing screw 29 which held the upper baffle 85 to the sleeve 55; and the upper baffle 85 is driven over sleeve passage 77 closing it.

Continuing pressure from above will further drive downwardly the plug 145 and trip member 120 carrying with it sleeve 55 (to have sheared segmented screw 29, and released serrations lock on the sleeve). This closes discharge ports 32 with a very tight wedging action, as explained in detail earlier in this specification.

It is to be well understood that the pressure below upper baffle 85, trip member 120 and sleeve 55, has not been changed, despite the increase of pressure above to move these members downwardly.

This then completes the second stage cementing, as indicated in view E. The completion of second stage cementing is indicated by the pressure rise on the pump at the surface. It will be noted that the operation to cement the first and second stage is that of the continuous method.

The third stage cementing operation is then begun. The final pressure on the casing, which completed the second stage operation, having been released, the trip member 121 is then dropped into the casing to gravitate in the well fluid. A sufficient time lapse is allowed to enable trip member 121 to fall to its tapered mating point in lower baffle 96, in cementing collar 5.

Then the pump pressure is applied to the casing; and this will cause lower baffle 96 to be driven downwardly, shearing screw 67; after which sleeve passages 77 are opened to the introduction of fluid.

This exposes the ports 32 for the first time, and also their closing discs 30; and increased pump pressure will expel the latter. Thereafter, fluid at the third cementing stage is discharged through cementing collar 5.

It is customary to carry out fluid circulation through cementing collar 5 for a requisite period. This is done to ascertain if the fluid in the circulation stream has retained all of its desired characteristics of weight and viscosity during the time lapse in which it was not moving.

The cementing slurry is next introduced into the casing. The volume of slurry is again determined by the operator for the fill desired behind the casing. When this proper amount of slurry has been introduced into the casing, collapsible plug 145, with extension 146 and trip member 120*a*, is introduced into the casing above the slurry. Well fluid is introduced into the casing above plug 145.

The pressure of the pump continues to force plug 145 downwardly, and the slurry below this plug is forced outwardly through ports 32, until the trip member 120*a* is nested in upper baffle 85. Continuing pressure with its increase will move this upper baffle downwardly, shearing screw 29 which held upper baffle 85 to the sleeve 55; and the upper baffle is driven over sleeve passage 77, closing it.

Continuing pressure on the casing will further drive downwardly the plug 145 and trip member 120*a*, carrying with it sleeve 55 (to have sheared segmented screw 29 and released serrations lock on the sleeve). This closes discharge ports 32 with a very tight wedging action.

Again it is to be understood, despite the pressure increase in the area above upper baffle 85, trip member 120*a* and sleeve 55, there is no change of pressure in the area below these members. This latter pressure is constant with the pressure adjacent to ports 32, through which upper baffle 85 and sleeve 55 move to provide closure and seal.

This third stage cementing completion is indicated by the pressure rise on the pump at the surface. The method outlined for this third stage cementing, having a time lapse between the second and third stage operations, is that of the intermittent method.

It will be seen that I may confine slurry between a pair of collapsible plugs, during its movement within a casing string, discharging the slurry from a cementing collar disposed on the casing string slightly above the shoe. This practice pertains to single stage, long section cementing behind casing.

For this practice, the primary collapsible plug 117, with trip member 115, precedes the slurry; and the secondary collapsible plug 145, with trip member 120, follows the slurry. These respective members open the cementing collar to discharge the slurry, and close the cementing collar to prevent further discharge. It will be noted that in such practice, no slurry finds passage through the primary collapsible plug. Such plug, during the discharging period, being disposed away from the path of the slurry stream, prevents damage which otherwise could be caused by distortion or fracture of a primary plug, were it disposed within the path of the discharging slurry stream.

It is very practicable to employ the practice of confining the slurry between a pair of collapsible plugs, both of design of plug 134, during the slurry movement within a casing string, so as to discharge the slurry through the shoe. In such practice, the primary plug 134, preceding the slurry in its movement within the casing string, becomes trapped in the trapping collar 7, thus to allow the slurry stream to flow around the plug and dishcarge from the shoe; and the secondary plug 134, following the slurry in its movement within the casing string, stalls above the primary plug and stops within the bore of the trapping collar nipple. This creates pressure rise on the pump at the surface to denote completion of the slurry discharging.

The above described practice, employing identical collapsible plugs 134 to confine slurry therebetween for discharging at the shoe, may become the procedure for a first stage cementing of a multi-stage operation. For this purpose then, the trapping collar nipple would be made of such length that both the primary and secondary collapsible plugs could become trapped therein; and the flow stream would continue past the secondary plug through added openings provided on the longer trapping collar nipple for this purpose.

In my method employing the cementing collar in multi-stage cementing, it will be noted that the second stage cementing does confine the slurry between a pair of collapsible plugs in continuous cementing practice.

Conditions and circumstances may occasionally be found in which my cementing collar, with ports open, may be used to receive fluid into the casing from the well bore. Whenever it shall have been determined that such situation is to be met, then my cementing collar is placed on the casing string, at the desired level; and this collar is so placed without having any port discs; that is, the ports are open when the collar is placed; and no baffles are carried within this collar.

This stripped collar is so used whenever it is desired that any fluid be caused to flow from the well bore into the collar. The following are indicated as examples of such use.

(A) Water or well fluid may be forced downwardly through special means which may be employed to cause the flow to be discharged out of the shoe at the bottom of the casing, and into the well bore, from which it may return into the casing through the open ports of my collar.

(B) Slurry may be caused to flow in the same manner, and be received back through the ports of my collar, into the casing, for the purpose of cementing a liner therein.

When either of the operations indicated under (A) or (B) above are carried out, it will be necessary to provide within the casing an auxiliary, or secondary and smaller, string of pipe, extending from the earth's surface to a point well below my collar; and such auxiliary conduit is indicated by the word "means" under the heading (A) immediately above. Such auxiliary means is sealed to and retained within the casing, at a point below my collar, in the conventional manner, or in such manner as the operator may elect. In any event when the fluid or slurry (as the case may be) returns from the well bore into my collar it will fill the region within my collar immediately about the auxiliary string, and pass upwardly within the casing. Incidentally, during this operation, the fluid returning into the casing through my opened collar, will allow for the "sampling" of such fluid, to determine whether it be oil or other fluid.

In the employment of the sliding sleeve member within any collar to be used in my method, a modification may be made in the outer tapered wall section of this sleeve, if desired. This modification is indicated in Figure XII, wherein a series of circumferential grooves **64a** may be provided. Within these grooves there is space in which may be accommodated any minor foreign materials to be found between the tapered faces of the sleeve and of the wall of the collar. This construction will then provide a number of lands, each of which will more effectively lock and seal the tapered faces.

In the event it should be desired, the sliding sleeve in my device may be shortened and made to include only such structure and design in the sleeve as will be found in the upper part thereof above the passageways through its walls; and when so constructed no passageways are needed. Also my sleeve may be made in two pieces, by dividing it on a horizontal line at or below the base of the inclined side wall of the sleeve; and when thus made in two pieces they may be joined together by the use of threads, or other means of joinder.

I claim:

1. In apparatus for cementing pipe in a well bore, a collar provided with ports through its walls; a slideable cylindrical sleeve disengageably carried within said collar and having passageways through its walls, said sleeve being provided with an internal shoulder, the said ports and passageways being initially in communication; a lower baffle disengageably secured in the sleeve and initially closing the passageways; means for disengaging the lower baffle and for moving it downward into a position of support by the shoulder to open the passageways; an upper baffle disengageably secured in the sleeve above the lower baffle; means for disengaging the upper baffle from the sleeve and for moving it downward into engagement with the lower baffle to close the passageway and for disengaging the sleeve from the collar to move it downward to close the ports.

2. In apparatus for cementing pipe within a well bore, a collar provided with ports through its walls; serrations on the inner wall of the collar; a slideable cylindrical sleeve carried within the said collar and provided with passageways through its walls, said sleeve having complementary serrations on its outer wall disengageably attached to the serrations on the collar, the sleeve being so placed as to align its passageways with said ports when the serrations are engaged; moveable means disengageably attached within the sleeve for opening the passageways; moveable means disengageably attached within the sleeve for closing the passageways; means to disengage the first named moveable means and move it downward to open the passageways; means to disengage and move the second named moveable means downward to close the passageways; and pressure actuated means for disengaging the serrations and sliding the sleeve downwardly to close the ports.

3. In apparatus for cementing pipe within a well bore, a collar adapted to be incorporated in a string of well casing so as to form a part thereof and having discharge ports through its walls said ports being in communication with the well bore when disposed therein; a slidable sleeve arranged within the collar and provided with passageways through its walls; a movable annular baffle disengageably attached within the sleeve in position to initially close the passageways and adapted to open the passageways when moved downwardly; and means to disengage the baffle from the sleeve and move same downwardly to open the passageways.

4. In apparatus for cementing pipe within a well bore, a collar adapted to be incorporated in a string of well casing so as to form a part thereof and having discharge ports through its walls said ports being in communication with the well bore when disposed therein; a slidable sleeve arranged within the collar and provided with passageways through its walls; and a movable annular baffle disengageably attached within the sleeve in position to initially close the passageways and adapted to open the passageways when moved downwardly; means to disengage the baffle from the sleeve and move same downwardly to open the passageways; the outer wall of the

baffle being provided with sealing rings to frictionally engage the walls of the sleeve.

5. In apparatus for cementing pipe within a well bore, a collar provided with cylindrical walls, having a plurality of discharge ports therethrough; a slideable cylindrical sleeve disengageably attached to the inner wall of said collar, and provided with passageways through the walls, the ports and passageways being initially in communication, the sleeve being so constructed as to close the ports when it is moved downwardly within the collar; means for moving the sleeve downwardly in the collar to close the ports; and the inner wall of the collar being provided with a tapered area, and the outer wall of the sleeve being provided with a tapered area, the two said areas being complementary and so arranged and constructed that they will effect wedgelike frictional engagement when the sleeve is forced downwardly.

6. In apparatus for cementing pipe within a well bore, a collar provided with cylindrical walls, having a plurality of discharge ports therethrough; a slideable cylindrical sleeve disengageably attached within the collar, and provided with passageways through its walls, the ports and passageways being initially in communication the sleeve being so constructed as to close the ports when it is moved downwardly within the collar; means for moving the sleeve downwardly in the collar to close the ports; and the inner wall of the collar being provided with a tapered area, and the outer wall of the sleeve being provided with a tapered area, the two said areas being complementary and so arranged and constructed that they will effect wedgelike frictional engagement when the sleeve is forced downwardly, the beveled area of the sleeve being provided with a series of circumferential grooves.

7. In apparatus for cementing well pipe within a well bore, a cementing collar provided with cylindrical walls having a plurality of discharge ports therethrough; a slideable cylindrical sleeve disengageably attached to the inner wall of said collar and provided with passageways initially in communication with said ports, said sleeve being so constructed that when it is caused to move downwardly within the collar it will close the ports; means for disengageably attaching the sleeve in the collar; a moveable cylindrical lower baffle within said sleeve disengageably attached to the walls thereof and so arranged as to initially close said passageways and so constructed that it will open the same when moved downwardly; means for disengageably attaching the lower baffle to the sleeve; a longitudinal passage extending through the lower baffle; a movable cylindrical upper baffle within said sleeve disengageably attached to the walls thereof and initially arranged above said passageways and so constructed that it will close the same when it is moved downwardly; means for disengageably attaching the upper baffle to the sleeve; a longitudinal passage extending through the upper baffle; a trip ball arranged to enter the lower baffle and being of such size that it will not pass through the lower baffle so that it will cause the disengagement and downward movement of said baffle in response to pressure exerted within the well pipe from above; separate trip ball means of such size that it will not pass through the upper baffle so that it will cause the disengagement and downward movement of said baffle in response to pressure exerted within the well pipe from above; and stop means carried by said sleeve and so arranged as to limit the downward movement of said baffles, so that increased pressure exerted against the last named trip means will cause the disengagement and downward movement of the sleeve to close the ports.

SYLVESTER B. SCHNITTER.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
Re. 19,570	Halliburton	May 14, 1935
1,499,316	Oliphant	June 24, 1924
1,941,406	Manning	Dec. 26, 1933
2,155,609	McClendon et al.	Apr. 25, 1939
2,168,735	Gilstrap	Aug. 8, 1939
2,191,750	Brown	Feb. 27, 1940
2,244,354	Boggs et al.	June 3, 1941
2,310,483	Wickersham	Feb. 9, 1943
2,315,931	Burt et al.	Apr. 6, 1943
2,330,266	Burt	Sept. 28, 1943
2,368,419	McGivern et al.	Jan. 30, 1945
2,370,833	Baker	Mar. 26, 1945
2,435,016	Pitts	Jan. 27, 1948