

Nov. 11, 1958

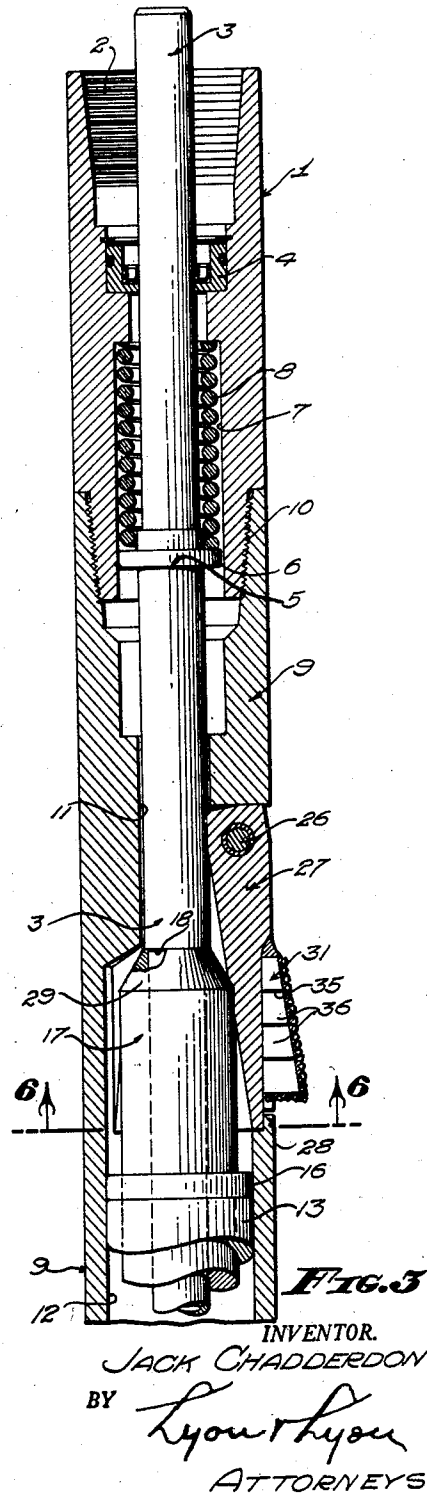
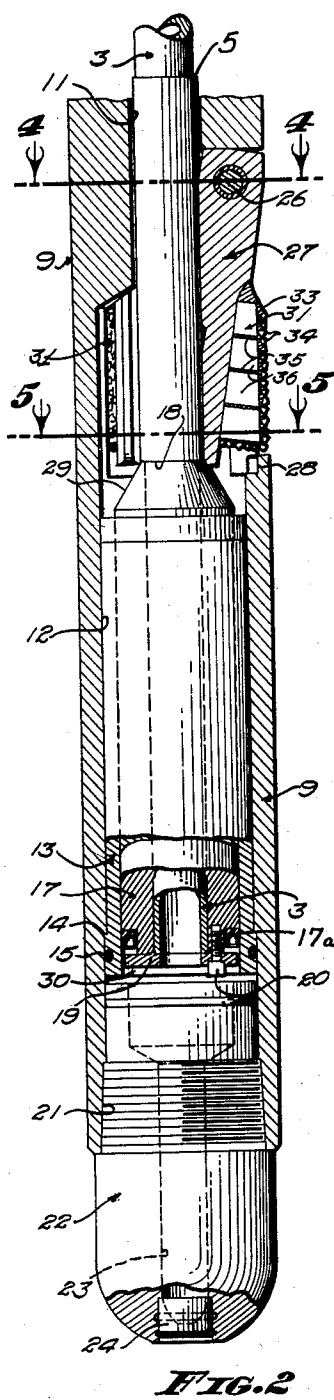
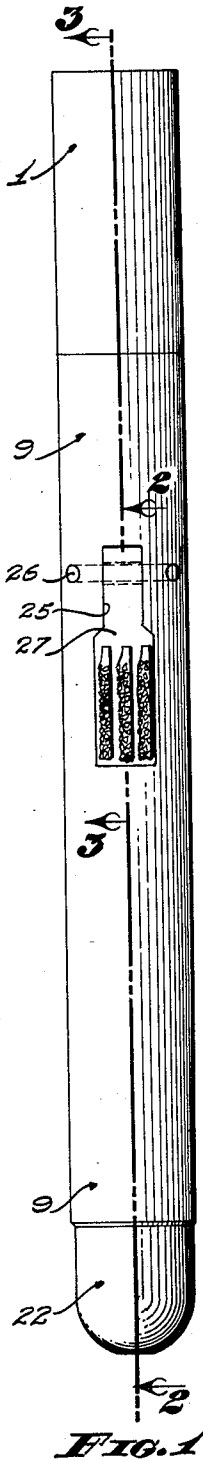
J. CHADDERDON

2,859,943

EXPANSIBLE MILL FOR WELL CASINGS

Filed Jan. 7, 1957

2 Sheets-Sheet 1



Nov. 11, 1958

J. CHADDERDON

2,859,943

EXPANSIBLE MILL FOR WELL CASINGS

Filed Jan. 7, 1957

2 Sheets-Sheet 2

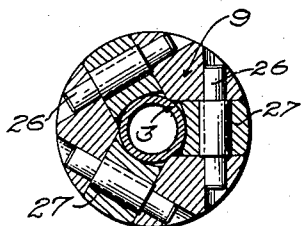


FIG. 4

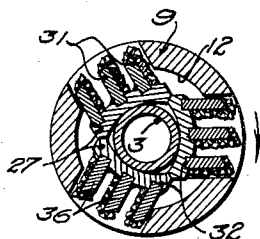


FIG. 5

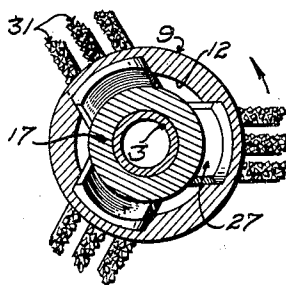


FIG. 6

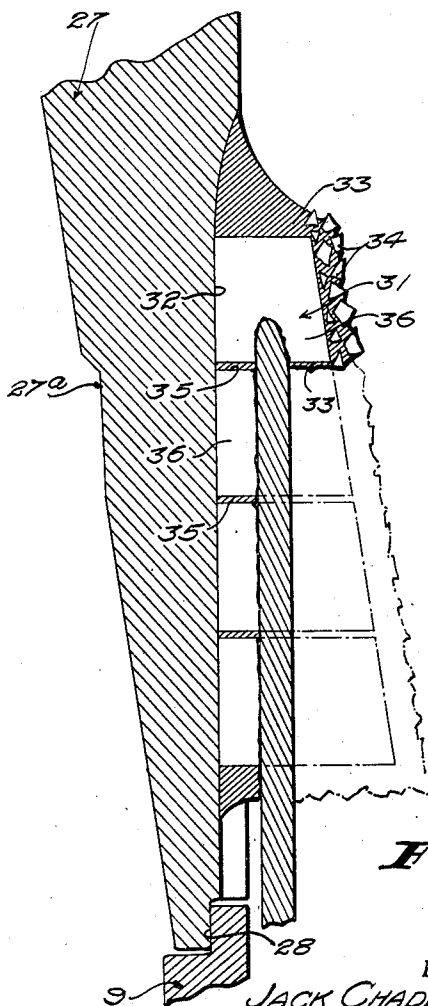


FIG. 7

INVENTOR.
JACK CHADDERDON
BY *Lyon & Lyon*
ATTORNEYS

1

2,859,943

EXPANSIBLE MILL FOR WELL CASINGS

Jack Chadderdon, Palos Verdes Estates, Calif.

Application January 7, 1957, Serial No. 632,931

1 Claim. (Cl. 255—76)

This invention is directed to expansible mills for well casings, that is to well tools which are adapted to be lowered into a well casing, or into engagement with the upper end of a well casing or liner, to mill out a section of the well casing or liner.

Included in the objects of this invention are:

First, to provide an expansible mill wherein milling cutters are movable between a retracted inoperative position within the tool body and an extended milling position, and wherein the exposed or extended portions of the milling cutters may be utilized until entirely abraded away, before the tool need be retrieved.

Second, to provide a casing mill wherein sets of milling cutters are mounted on supporting arms, which may be easily and quickly removed and installed without disassembly of the tool body.

Third, to provide a casing mill wherein circulation of drilling fluid is utilized to maintain a hydraulic force available to hold the milling cutters in their extended position.

Fourth, to provide on the whole an expansible casing mill which is particularly rugged of construction to meet the extreme demands placed on well tools, involving a minimum number of parts, and which is easily serviced.

With the above and other objects in view, as may appear hereinafter, reference is directed to the accompanying drawings in which:

Figure 1 is a side elevational view of the well casing milling tool;

Fig. 2 is an enlarged fragmentary, partial sectional, partial elevational view thereof, taken along the line 2—2 of Fig. 1 with the milling cutters shown in their retracted position;

Fig. 3 is a fragmentary, partial elevational, partial sectional view taken along the line 3—3 of Fig. 1, showing the milling cutters in their extended position;

Fig. 4 is a transverse sectional view through 4—4 of Fig. 2;

Fig. 5 is a transverse sectional view through 5—5 of Fig. 2;

Fig. 6 is a transverse sectional view through 6—6 of Fig. 3;

Fig. 7 is a further enlarged fragmentary sectional view of one of the milling cutters, showing the manner in which segments of the milling cutters are expended during the course of the milling operation.

The well casing milling tool includes a tubular upper body member 1 having internal screw threads 2 at its upper end for connection to a drill string. Slidably mounted within the body 1 is a tubular mandrel 3. A packing gland 4 is provided within the tubular body and disposed for sealing engagement with the upper portion of the tubular mandrel 3.

Adjacent the lower end of the tubular upper body 1 the mandrel 3 is enlarged slightly to form a shoulder 5 which supports a collar 6. The bore of the upper body 1 is counterbored, as indicated by 7, to receive the collar 6. A spring 8 is interposed between the collar 6 and

2

the upper end of the counterbore 7 so as to urge the tubular mandrel 3 downwardly with respect to the upper body 1.

The tubular upper body member 1 is connected to a tubular lower or main body 9 by means of a screw connection 10. The bore of the main body 9 includes a constricted section 11 and a counterbored lower portion 12.

The counterbored portion 12 receives a liner 13, which is fitted therein from the lower end of the main body 9. The counterbored portion 12 and liner 13 are provided with mating shoulders 14 so that the liner may be seated in a fixed position within the main body 9. A seal ring 15 is provided between the lower portion of the liner 13 and the main or surrounding body 9, and a packing ring 16 is provided at the upper end of the liner 13.

The lower end of the tubular mandrel 3 extends into the liner 13 and through a piston 17 slidably mounted within the liner. The piston 17 may be secured to the mandrel between a shoulder 18 engaged by the upper end of the piston and a retainer plate 19 secured to the lower end of the piston by bolts 20. The retainer plate 19 is apertured to communicate with the bore of the tubular mandrel 3. In addition or alternatively, the lower end of the mandrel may be welded to the piston 17. The piston is provided with a suitable sealing ring 17a adjacent its lower end.

The lower end of the lower or main body 9 is joined by a screw connection 21 to a nosepiece 22 having a bore 23 therethrough. Fitted in the bore 23 is an orifice plug 24.

The main body 9 is provided in the upper portion of the counterbore 12 with longitudinally directed cutter arm slots 25 which extend upwardly into the constricted bore section 11. The upper extremities of the cutter arm slots 25 are provided with transversely extending hinge pins 26 which pivotally support cutter arms 27. The cutter arms depend from the hinge pins 26 and their lower ends are movable radially about the axes of the hinge pins. In the construction shown, three such cutter arms are provided.

The lower or free extremities of the cutter arms 27 are preferably wider than their upper or hinged ends, and the cutter arm slots 25 are shaped to conform to the cutter arms. The cutter arm slots 25 are slightly less in length than the cutter arms so that the lower margins of the slots form stop shoulders 28 engageable with the lower or free extremities of the cutter arms, and thus limit their radially outward movement as shown best in Figs. 3, 6, and 7. The radially inner surfaces of the cutter arms 27 are cylindrically concave, and are adapted to rest contiguous to the tubular mandrel 3 above the piston 17 when the mandrel and piston are in their lower positions, shown in Figs. 2, 4, and 5.

The upper end of the piston 17 is tapered to form a cam cone 29 which is adapted, on upward movement of the piston relative to the cutter arms 27, to engage the lower or free extremities thereof and force the cutter arms outwardly from the position shown in Fig. 2 to the position shown in Fig. 3. This movement is accomplished by forcing drilling mud or other fluid down the drill string, through the tubular mandrel 3, and into a chamber 30 formed between the lower end of the piston and the upper end of the nosepiece 22.

By reason of the orifice plug 24 which limits flow of fluid from the nosepiece, a pressure differential is established between the chamber 30 and the exterior of the tool. This pressure is utilized to force the piston 17 upward relative to the main body 9 so as to force the cutting arms 27 outwardly. The cutter arms are provided with notches 27a, the radial outer surface of which

increases the bearing area on the piston as the arms reach their extended position.

Each cutter arm 27 is provided with a set of cutters. Each cutter comprises a cutter core blade 31 which is set in a longitudinal groove 32 provided in the exterior surface of the corresponding cutter arm 27. In the construction illustrated, each set of cutters comprises three cutter core blades 31. The cutter core blades are brazed or welded in place, preferably in such a manner that they may be removed for replacement by destroying their welded connections with the cutter arms. Each cutter core blade tapers upwardly from its lower end so that when the cutter arms are in their retracted position the cutter core blades 31 are completely within the boundaries of the main body 9.

Each cutter core blade 31 is covered with a matrix coating 33 on its lower edge, radially outer edge, and leading side. The leading side is the side facing the direction of rotation of the milling tool.

Embedded in the matrix coating 33 is a multiplicity of cemented carbide cutting fragments 34. The nature of the matrix employed and the properties of the carbide cutting fragments are more fully set forth in the copending application executed by Robert G. Owen, Serial No. 496,498, filed March 24, 1955, entitled "Hard Facing Material and Method of Making."

Each of the cutter core blades 31 is preferably divided transversely by a series of slits 35 to form segments 36. The slits become filled with the matrix coating 33 during the process of mounting the cutting fragments 34.

Operation of the well casing milling tool is as follows:

The well tool is lowered in a well bore and into the well casing or liner in which it is desired to mill an opening. Drilling fluid is supplied under pressure to force the cutter arms 27 radially outward against the surrounding casing or liner. At the same time the milling tool is rotated and fed downward so that the cutters progressively move outward until they have cut entirely through the casing or liner. Continuation of the milling operation effects complete milling of the entire circumference of the casing or liner; the tool being maintained in substantially centered condition by the portion of the body 9 below the cutters which serves as a pilot or guide.

During the course of the milling operation, the cutter core blades 31 and matrix 33 wear away, exposing the new cutting fragments as the previous fragments are obliterated. The milling operation may continue until the entire length of the cutter blades are cut through. That is, the entire exposed or protruding portions of the milling tool constitute expandable cutting elements, consequently, many feet of a casing may be milled before the milling tool need be withdrawn for replacement of the cutters.

Thus if the milling tool is employed until the milling cutters are completely destroyed, it becomes unnecessary to retract the cutter arms. However, should it be desirable to terminate the cutting operation before destruction of the cutting elements, circulation of the drilling fluid may be momentarily stopped, so that the spring 8 may force the piston 17 downward and permit the cutter arms 27 to retract.

The cutting elements per se which comprise the segmental cutter core blades 31, matrix 33, and cutting fragments 34 are the subject of my copending application, Serial No. 632,932, filed January 7, 1957.

With reference to Fig. 7, it will be observed that the outer portion of each segment falls away as the core blade is worn away. This construction minimizes the build-up of friction between the cutter and the casing or liner, so that the cutting action may continue until the entire cutter is destroyed. If the core blade is not divided into segments the friction increases, as the casing or liner wears away the core blade until the cutting efficiency is lost.

While a particular embodiment of this invention has been shown and described, it is not intended to limit the same to the exact details of the construction set forth, and it embraces such changes, modifications, and equivalents of the parts and their formation and arrangement as come within the purview of the appended claims.

What is claimed is:

A well casing milling tool, comprising: a tubular body structure adapted to enter a casing to be milled and having an open but restricted fluid outlet at its lower end and internally enlarged above said outlet to form a cylinder; a tubular mandrel slidably mounted in said body structure, having an enlarged piston at its lower end fitting said cylinder; a spring urging said mandrel downwardly relative to said body structure, said piston end and cylinder operable on application of fluid pressure in said cylinder to raise said mandrel in opposition to said spring; said body structure having cutter arm recesses formed in the side walls thereof above said cylinder; cutter supporting arms pivotally mounted on said tubular body within said recesses and movable between radially retracted and radially extended positions, wholly confined within the external surfaces of said body structure; stop means on said tubular body adjacent said recess and engageable with portions of said arms to limit outward movement of said arms and thereby confine those arms within said body; cam means on said mandrel for expanding said arms; sets of attritionable cutter core blades replaceably mounted on said arms, extending longitudinally of said body structure, and movable to radially outer positions, protruding from said body structure, for engagement with a casing in which said body structure is inserted; and a plurality of cutting elements supported on said blades and progressively exposed for cutting action on said casing, as said blades are progressively destroyed by attrition.

References Cited in the file of this patent

UNITED STATES PATENTS

1,611,282	Samuelson	Dec. 21, 1926
1,777,713	Braden	Oct. 7, 1930
2,427,052	Grant	Sept. 9, 1947
2,638,327	Baldwin	May 12, 1953

FOREIGN PATENTS

722,529	Great Britain	Jan. 26, 1955
---------	---------------	---------------