

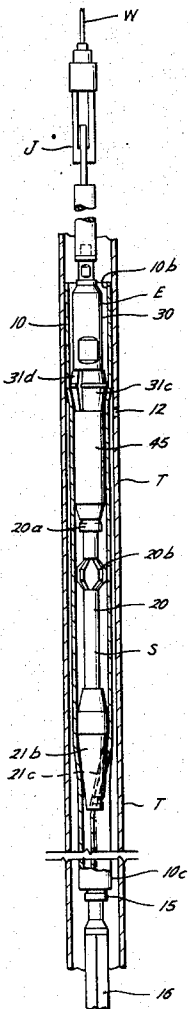
[54]	LINER EXPANDING APPARATUS	1,494,128	5/1924	Primrose.....	72/393
[75]	Inventors: Myron M. Kinley, Chickasha, Okla.; Charles W. Agee, Houston, Tex.	3,167,122	1/1965	Lang.....	166/277
		988,054	3/1911	Wiet.....	72/393
		311,960	2/1885	Cottrell.....	72/393
[73]	Assignee: John C. Kinley, Houston, Tex.				
[22]	Filed: Apr. 10, 1971				
[21]	Appl. No.: 242,712				
[52]	U.S. Cl.....	72/393	166/277		
[51]	Int. Cl.....	B21d 39/08			
[58]	Field of Search	72/393; 29/507, 523;	166/277		

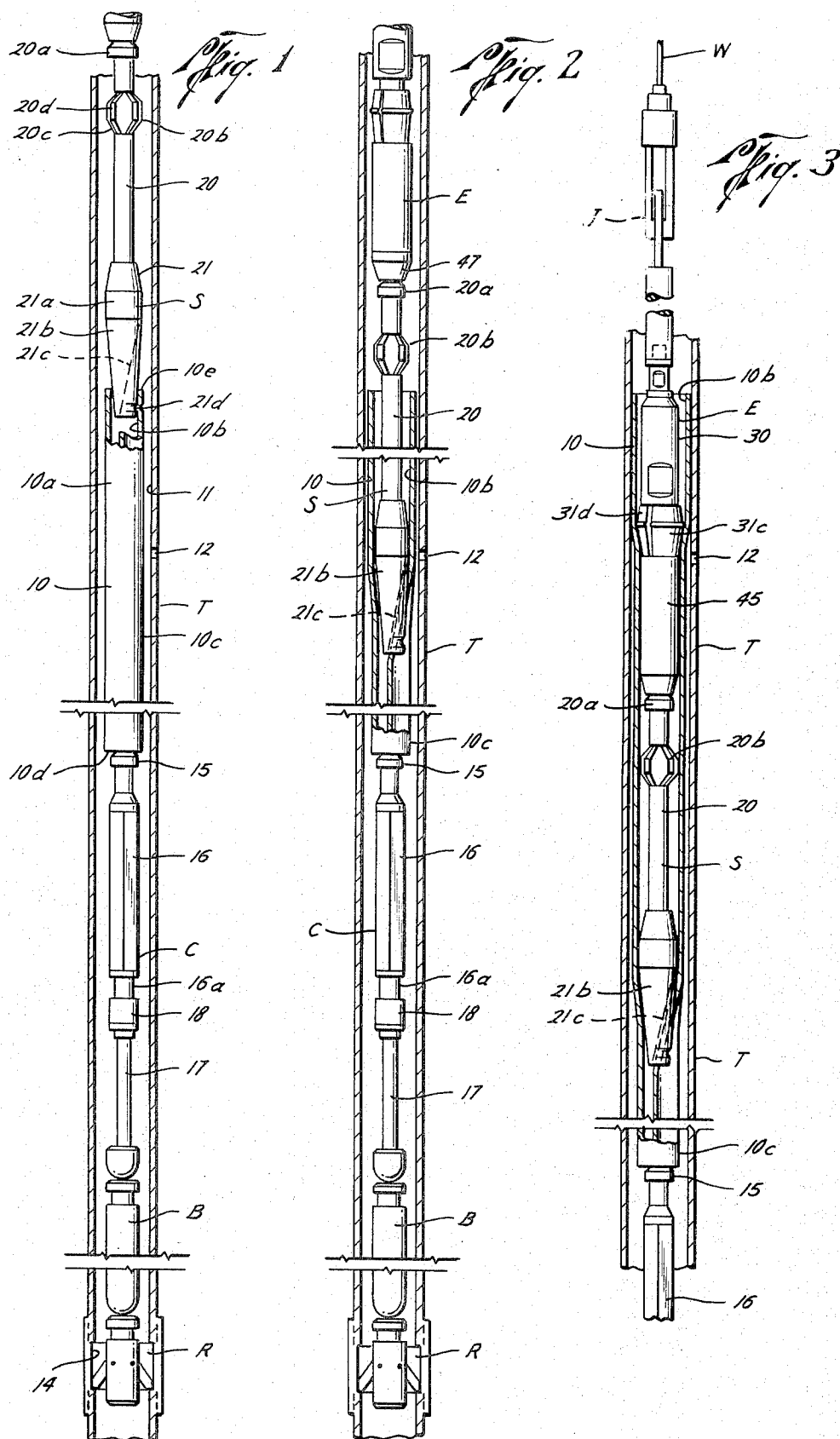
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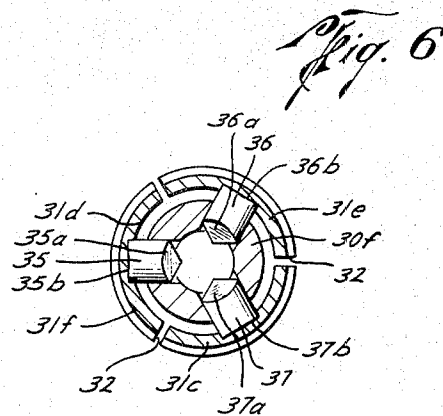
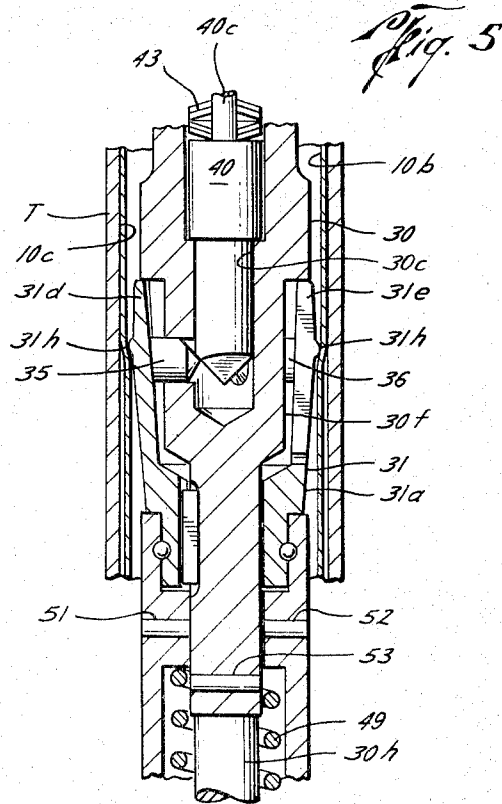
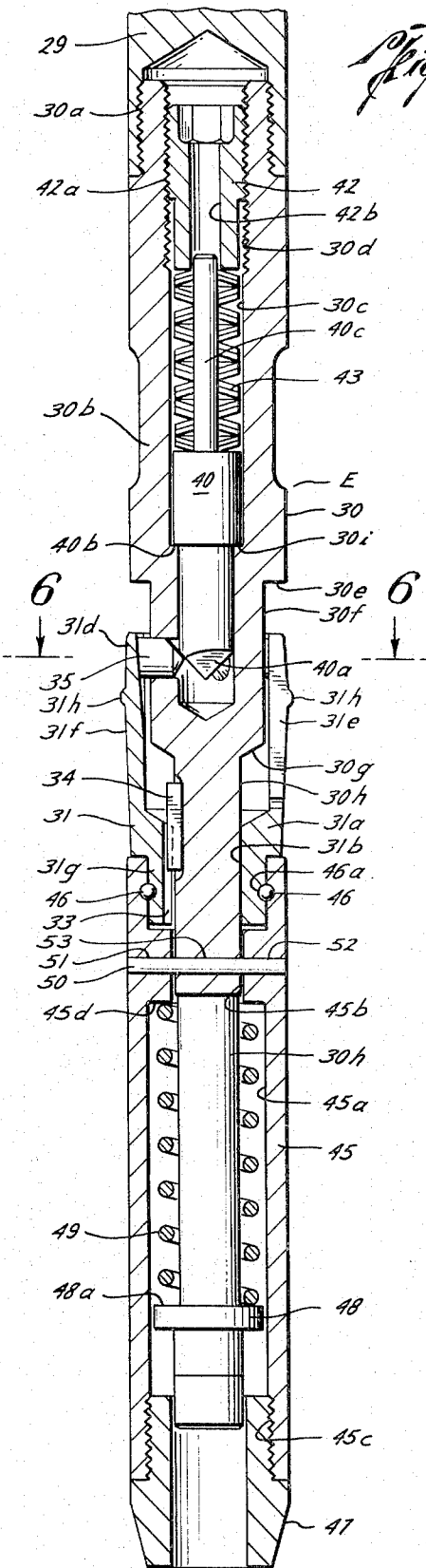
Primary Examiner—Lowell A. Larson
Attorney—Pravel, Wilson & Matthews

[57] ABSTRACT
Apparatus for repairing tubular members, such as oil well casing or tubing, wherein a malleable liner is expanded into sealed engagement with the inside of such tubular member in spite of variations therein, by driving a mandrel with a collet mounted thereon through the liner, the collet having flexible fingers extending therefrom into yieldable engagement with the liner.

12 Claims, 6 Drawing Figures







LINER EXPANDING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of this invention is apparatus for repairing a tubular member such as oil well casing or tubing.

2. Description of the Prior Art

It is sometimes necessary to patch a hole or other defect in oil well pipe such as casing or production tubing by expanding a malleable liner into sealed engagement with the inside wall of the pipe. Various devices have been devised for setting such liners in oil well pipe. In U.S. Pat. to M. M. Kinley, No. 3,191,677 the liner setting apparatus disclosed includes an expander ball which is driven through the liner by an explosive jar. U. S. Pat. to M. M. Kinley, No. 3,489,220 disclosed a method and apparatus for setting a malleable linear having a reverse bend therein over a hole in the pipe, removing a reverse bend from the liner to enlarge the diameter thereof to slightly less than the inside diameter of the pipe and expanding the liner to fit tightly in the pipe.

Pipe such as casing or tubing for oil wells may have variations in the inside wall which reduce or enlarge the inside diameter of the pipe. If such variations are present in an area of pipe which receives a liner, it is desirable to expand the liner to conform to such variations to provide an effective seal between the liner and the pipe.

A difficulty encountered in utilizing liner expanding tools in casing or production tubing is in removing the tool after the tool has been driven through the liner. If there are restrictions in the diameter of the pipe in or above the area covered by the expanded liner, there is more likelihood that the tool may hang up at the restriction and possibly even damage the liner as it is pulled therethrough.

SUMMARY OF THE INVENTION

The present invention is directed to a tool for expanding a liner to fit tightly against the inside wall of a pipe such as oil well casing or tubing in spite of variations in the inside diameter of the pipe. The tool of this invention includes a mandrel that is adapted to be driven through the liner after the liner has been positioned over the hole or other defect in the pipe. A collet having flexible fingers extending therefrom is mounted on the mandrel and resiliently mounted pins extend from the mandrel to urge the fingers outwardly into yieldable engagement with the liner such that the liner is expanded to conform to the inside wall of a pipe.

In another aspect of this invention, the collet is mounted for slidable movement with respect to the laterally extending pins so that the flexible fingers can be moved inwardly as the tool is lowered into or removed from the pipe thereby preventing the fingers from damaging the liner or otherwise hanging up in the liner or pipe.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of a partly removed section of oil well casing with the liner and setting tools disclosed herein positioned for installation over a defect;

FIG. 2 is a schematic view similar to FIG. 1 with a swaging tool driven partially down through the liner

such that the reverse bend in the liner has been partially removed;

FIG. 3 is a schematic view similar to FIGS. 1 and 2 with the liner expanding tool of this invention driven partially through the liner;

FIG. 4 is a sectional view of the expanding tool of this invention with the flexible fingers of the collet held in a withdrawn position;

FIG. 5 is a sectional view of the expanding tool with the flexible fingers bent outwardly into yieldable engagement with the liner; and

FIG. 6 is a sectional view taken along line 6-6 of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawings, a liner 10 is positioned downhole in production tubing T such that the liner, when expanded, will conform to and sealingly engage the inside wall 11 of the tubing T thereby sealing off hole 12 therein. The liner 10 consists of a thin-walled steel tube which is coated on the outside 10a with an oil-resistant elastomer and on the inside 10b with a slippery, fluoride plastic so that the tools of this invention may be driven therethrough. A reverse longitudinal bend 10c extends longitudinally throughout the length of the liner 10 in the pre-expanded position illustrated in FIG. 1. The reverse bend in the liner 10 substantially reduces the outer diameter so that the liner 10 may be easily lowered into position to seal off the hole 12. The liner is lowered into position by means of a swaging tool S which is supported on a wire line W such as illustrated in FIG. 3.

The liner 10 is supported in the tubing T from below by means of a retrievable stop R, a spacer bar B and a collapsible support C. The retrievable stop R is first lowered through the tubing T and is positioned at tubing joint 14 in a manner well known to those in the art. One or more solid spacer bars B are then lowered down the tubing T and positioned above the retrievable stop R. A collapsible support C is then lowered down the tubing T and is supported on the spacer bar B to provide an adjustable support for supporting the liner 10 in a position such that the hole 12 in the tubing T is approximately intermediate of the length of the liner 10. The collapsible support C, which may be the one disclosed in the U. S. Pat. to Kinley, No. 3,424,244, includes an anvil head 15 which is attached to an outer square tubular member 16 having an inner mandrel 17 mounted for slidable movement therein. For a thin wall liner 10, an additional liner guide (not shown) may be positioned above and supported on the head 15 to prevent distortion of the lower end of the liner 10 while it is being expanded. A retainer cylinder 18 is welded or otherwise attached to a cylindrical portion 16a of the square tubular member 16 and a shear pin (not shown) extends through the retaining cylinder 18 and one of a plurality of holes (not shown) in the inner mandrel 17 in order to support the inner mandrel 17 in an extended position such as illustrated in FIGS. 1 and 2. The collapsible support C is designed to collapse upon receiving a force of sufficient impact from above against the anvil head 15 such that the outer tubular member 16 telescopes over the inner mandrel 17 thereby providing operating space below the lower end 10b of the liner 10.

The swaging tool S is preferably of the type shown in FIGS. 8-10 of U.S. Pat. No. 3,489,220 and it includes a main body 20 and a lower body 21. An anvil head 20a is attached to the upper end of the main body 20 and a centering member 20b is mounted with the main body 20 and includes a plurality of radially extending plates 20c which end in flat surfaces 20d. The lower body 21 includes an upper cylindrical portion 21a and a lower tapered portion 21b.

The lower tapered portion 21b is substantially wedge-shaped so that the liner 10 may be gradually expanded as the swaging tool S is driven therethrough. A longitudinal recess 21c in tapered portion 21b is shaped to insure that the tool S does not engage the reverse bend 10c as it is gradually removed by the lower tapered portion 21b of the swaging tool S engaging the inside surface of the liner 10 at the area other than at the bend 10c, as the tool S is driven through the liner 10. The outer diameter of the cylindrical portion 21a of the lower body portion 21 is substantially equal to the diameter of the inside wall 10b with the reverse bend removed such that driving of the swaging tool S through the liner returns the liner to its original diameter, which is still slightly smaller than the diameter of the inside wall 11 of the tube T.

As previously mentioned, the swaging tool S is lowered through the tubing T by means of a wire line. In order to support the liner 10 as it is lowered on the swaging tool S, a horizontal groove 21d is provided in the tapered portion 21b of the lower body portion 21 and the liner 10 is crimped into the groove. The swaging tool is driven through the liner 10 by a rod, link or explosive jarring tool such as disclosed in the U. S. Pat. to Kinley, No. 3,191,677.

A liner expanding tool E is provided for expanding the liner 10 into sealed engagement with the inside wall 11 of the tubing T after the swaging tool S has removed the reverse bend 10c from the liner 10 thereby returning the liner to a substantially cylindrical shape. The liner expanding tool E is adapted to be suspended from a wire line W and a jarring tool J is interposed between the expanding tool E and the wire line W in order to provide the repetitious force of impact necessary to drive the expanding tool E through the liner 10. The jarring tool J may be a rod jar or link jar or perhaps an explosive jar.

The expanding tool E of the preferred embodiment of this invention yieldably engages the inside wall 10b of the liner 10 as it is driven therethrough in order to conform the liner to the inside wall 11 of the tubing T in spite of variations such as restrictions in the inside wall. The liner expanding tool E includes a mandrel 30 having male threads 30a at its upper end in order to be threadedly secured to an adapter 29 for jarring tool J. The mandrel 30 includes a main body portion 30b which has a longitudinal recess 30c which is generally cylindrical in shape and includes an upper threaded portion 30d. A downwardly facing annular shoulder 30e is at the upper end of an intermediate cylindrical body portion 30f and a downwardly facing inclined shoulder 30g is at the lower end thereof and at the top of a lower cylindrical body portion 30h having a smaller diameter than the intermediate body portion 30f.

A collet 31 includes a lower solid annular ring 31a having a bore or longitudinal opening 31b therethrough such that the collet is mounted for slidable movement

about the intermediate and lower body portions 30f and 30h of the mandrel 30. The collet 31 further includes a plurality of upwardly extending, flexible fingers 31c, 31d and 31e, preferably three in number, which are formed by machining or otherwise forming slots 32 in the upper portion 31f of the collet. The fingers 31c, 31d and 31e are thus integral with the lower portion 31a of the collet and, since the collet is made of resilient steel or other resilient material, the fingers 31c, 31d and 31e are bendable or extendible inwardly and outwardly of the intermediate mandrel body portion 30f. The collet 31 includes a slot 33 which receives a key 34 mounted in the lower mandrel body portion 30h so that the collet 31 is slidable longitudinally thereof but is secured by the key 34 against rotation with respect thereto.

A plurality of laterally or radially extending pins 35, 36 and 37 are mounted in the intermediate body portion 30f and extend into the bore 30c. The laterally extending pin 35 includes a tapered end 35a positioned in the recess 30c and has a flat tapered outer end 35b which extends into engagement with the flat milled out inside surface of flexible finger 31d. Similarly, the laterally extending pins 36 and 37 have tapered ends 36a and 37a which are positioned in the bore 30c and outer flat ends 36b and 37b which engage the inside surfaces of fingers 31e and 31c, respectively.

A driving pin 40 is mounted in the longitudinal bore 30c for slidable movement therein and it includes a tapered end portion 40a which engages the upper surfaces of the tapered ends 35a, 36a, and 37a of the laterally extending pins 35, 36, and 37, in such a manner that the position of the driving pin 40 in the recess 30b is dependent upon the lateral positions of the laterally extending pins 35, 36 and 37. With the driving pin 40 in the position of FIG. 4, a downwardly facing annular shoulder 40b of the pin 40 is engaging an upwardly facing annular shoulder 30i in the recess 30c such that the driving pin 40 cannot move the laterally extending pins 35, 36, and 37, further radially outwardly of the mandrel 30.

A nut 42 including an outwardly threaded surface 42a is threadedly mounted with the threaded portion 30d of the recess 30c. The nut 42 has a longitudinal opening 42b therethrough in order to receive an upper rod portion 40c of the driving pin 40. A plurality of belleville springs 42 or other suitable resilient means is mounted about the upper rod portion 40c and is positioned in compression between the driving pin 40 and the nut 42. The belleville springs 43 act to resiliently mount the driving pin 40 and urge the driving pin 40 to the position of FIG. 4 where the tapered end 40a of the driving pin 40 is positioned to displace the outer end surfaces 35b, 36b and 37b of the laterally extending pins 35, 36, and 37 radially outwardly of the intermediate mandrel body portion 30f. As will be described in more detail hereinafter, the resilient mounting of the laterally extending pins 35, 36 and 37 allows the flexible finers 31c, 31d and 31e to move inwardly in response to restrictions or other interference encountered in the tubing T thereby moving upwardly the driving pin 40 against the urging of the belleville springs 43 thereby transmitting forces acting against the flexible fingers 31c, 31d and 31e to the belleville springs 43. Slidable movement of the driving pin 40 is stabilized by the slidable mounting of the upper rod portion 40c of

the driving pin 40 for slidable movement in the longitudinal opening 42b in the nut 42.

A sleeve member 45 has a longitudinal opening 45a extending therethrough and is attached to the lower solid ring 31a of the collet 31 by means of assembly pins 46 which extend through openings (not shown) in the sleeve 45 into aligned grooves 46a in a lower necked portion 31g of the collet 31. The sleeve member 45 is mounted for slidable movement about the lower body portion 30h of the mandrel 30 at a restricted portion 45b of the longitudinal opening 45a in the sleeve 45. The longitudinal opening 45a further includes a lower threaded end portion 45c in which an adapter 47 is threadably mounted.

The lower body portion 30h, which is essentially a solid rod, includes a collar 48 welded or otherwise attached thereto. A coil spring 49 is mounted in compression between upper annular shoulder 48a of the collar 48 and a downwardly facing shoulder 45d in the opening 45a in the sleeve 45.

The collet 31 and sleeve 45 are movable between the down position of FIG. 4, where the fingers 31c, 31d and 31e are positioned radially inwardly with respect to intermediate mandrel body portion 30f, and the up position of FIG. 5 where the fingers 31c, 31d and 31e are positioned radially outwardly of the intermediate body mandrel 30f. With the fingers 31c, 31d and 31e in the radially outward position of FIG. 5, the fingers, in particular ridges 31h on the outside of the fingers, are in position to resiliently engage the inner wall 10b of the liner 10 and expand the liner 10 into sealed engagement with the inner wall 11 of the tubing T. The coil spring 49 acts to urge the sleeve 45 and the collet 31 to the up position of FIG. 5 after a shear pin 50 is severed as will be explained, so that by co-action with the outer tapered ends of the pins 35, 36, 37, the fingers are urged radially outward of the mandrel 30.

When the expanding tool E is being lowered into the tubing T, it is advantageous that the fingers 31c, 31d, and 31e be withdrawn to the radially inward, down position of FIG. 4 such that the fingers will not hang up on the inside wall 11 of the tubing T. In order to releasably hold the fingers 31c, 31d, and 31e in the down position, the shear pin 50 is mounted in holes 51 and 52 in the sleeve 45 and hole 53 which extends through the lower mandrel body portion 30h. With the sleeve 45 and collet 31 held in the down position of FIG. 4, the expanding tool E can be moved freely down through the tubing T to either contact the head 20a, as shown in FIG. 2, or engage the collet surfaces 31h with the upper end of the liner 10 at 10b (FIG. 3) if the head 20a is already down in the liner as shown in FIG. 3. The sleeve 45 and the collet 31 are moved to the up position of FIG. 5 where the fingers 31c, 31d, and 31e are extended radially outwardly into engagement with the liner 10 by shearing the pin 51 with the jarring tool J. Further, after the expanding tool E has been moved all the way through the liner 10 and it is desirable to remove the expanding tool E from the tubing T, the collet 31 and sleeve 45 will move downwardly toward the position of FIG. 4 against the urging of spring 49 in response to the fingers 31c, 31d and 31e being engaged by a restricted portion of either the inside wall 10b of the liner 10 or the inside wall 11 of the tubing T. In this manner, the expanding tool E can be removed from the tubing T without damaging the liner 10 or hanging upon either liner 10 or tubing T.

OPERATION

In the operation and use of this invention, the defect or hole 12 in the tubing T is first located. Then, the retrievable stop R is lowered into the tubing T and is positioned at a selected joint 14 in the tubing T below the hole 12. Spacer bars B and the collapsible support C are then lowered into the tubing T to provide support for the lower end 10d of the liner 10 such that the hole 12 is approximately intermediate of the liner 10. The liner 10 is normally 10 feet in length; however, the length of the liner need only be sufficient to effectively seal off the hole 12 in the tubing T.

The liner is crimped near upper end 10e into the groove 21d in the tapered portion 21b of the swaging tool S. The swaging tool S is then lowered by any suitable means such as wire line W into the tubing T with the liner 10 being suspended therefrom. Preferably, a conventional releasing tool (not shown) is releasably attached to the head 20a with a jarring tool J such as shown in FIG. 3 thereabove, supported by the wireline W. It is understood that the swaging tool S may be lowered into the hole by other means such as tubing itself if, for example, the tubing T is actually the casing in an oil well.

The swaging tool S is then driven downwardly into the liner 10 by any suitable means such as the conventional wire-line actuated jarring tool J, which is illustrated in FIG. 3. As the swaging tool S is driven downwardly, the reverse bend 10c in the liner 10 is pulled outwardly by the portion 21b of the tool S to return the liner to its original cylindrical shape. The diameter of the liner with the reverse bend removed is substantially equal to or slightly smaller than the diameter of the inner wall 11 of the tubing T.

The swaging tool S is driven approximately one-half of the way through the liner 10. Then, the wireline W is used to remove the jarring tool J and the releasing tool from the tubing T. The expanding tool E of this invention is then attached to the jarring tool J and is lowered down the tubing T on the wireline W such that the lower adapter 47 of the expanding tool E normally rests on top of the anvil head 20a of the swaging tool S (FIG. 2).

The jarring tool J is then activated to drive the expanding tool E and swaging tool S downwardly. With the initial blows of the jarring tool upon the mandrel 30 of the expanding tool E, the pin 50 is sheared so that the sleeve 45 and collet 31 are free to be moved to the up position of FIG. 5 under the urging of the spring 49. As the expanding tool E is driven downwardly into the liner 10, the ridges 31h on the flexible fingers 31c, 31d and 31e engage the inside wall lob of the liner 10 and expand the liner into sealed engagement with the inside wall 11 of the tubing T. If the liner 10 is to sealingly engage an area of the inside wall having a diameter which is smaller than the normal diameter of the inside wall, the flexible fingers 31c, 31d and 31e will encounter lateral resistance as the fingers move into this restricted area. The flexible fingers 31c, 31d and 31e are free to move inwardly at the point of restriction and, the laterally extending pins 35, 36 and 37 are moved inwardly with the flexible fingers. Radially inward movement of the laterally extending pins 35, 36 and 37 cause the driving pin 40 to be moved upwardly within the recess 30c against the urging of bellville springs 43. After the flexible fingers 31c, 31d and 31e have been moved past

the restricted area in the tubing T, the belleville springs 43 urge the driving pin 40 downwardly and thus move the laterally extending pins 35, 36 and 37 and the flexible fingers 31c, 31d and 31e radially outwardly. In this manner the flexible fingers 31c, 31d and 31e are continually urged into engagement with the inside wall 10b of the liner 10 in restricted as well as unrestricted areas of the tubing T so that the liner 10 is expanded to conform to the shape of the inner wall 11 of the tubing T in spite of variations therein.

Eventually the jarring tool J drives the tapered, wedge-shaped portion 21b of the swaging tool S against the anvil head 15 of the collapsible support C or a suitable liner guide therebetween, causing the shear pin (not shown) in the collapsible support C to shear so that the tubular section 16 telescopes down over the inner mandrel 17. The collapsing of the collapsible support C provides space for the jarring tool J to drive the swaging tool S all the way through the liner 10. In this manner, the swaging tool S is moved out of the lower portion of the liner so that the expanding tool E can be driven all the way through the liner 10 thereby expanding the entire liner into engagement with the inner wall 11 of the tubing T.

Thereafter, the expanding tool E may be removed up through the liner 10 in the tubular member T simply by lifting the tool E with the wire line W. As the expanding tool E is moved upwardly, the flexible fingers 31c, 31d and 31e may engage a restricted portion either within the liner 10 or within the tubing T, and in such event, the collet 31 and sleeve 45 are moved downwardly such that the flexible fingers 31c, 31d and 31e are moved toward the down position of FIG. 4 and thereby are withdrawn radially inwardly. In this manner, the upward movement of the expanding tool E may be continued out of the tubing T without hanging up on either the liner 10 or the tubing T. Not only does this slidable movement of the collet 31 and sleeve 45 allow the expanding tool E to be easily removed from the liner 10 and tubing T, but it also prevents the fingers 31c, 31d and 31e from damaging the liner 10 as the expanding tool E is removed.

It may be desirable to adjust the compression and thus the yieldability of the belleville springs 43. Such adjustment is accomplished by screwing the nut 42 downwardly or upwardly in the threaded portion 30d of the recess 30c. When the nut 42 is moved downwardly to a lower position than illustrated in FIG. 5, the compression of the belleville springs is increased and thus the yieldability of the lateral pins 35-37 and thus the fingers 31c, 31d and 31e is decreased. Conversely, if the nut 42 is screwed upwardly from the position illustrated in FIG. 4, the compression of the belleville springs is decreased and the yieldability of the flexible fingers 31c, 31d and 31e is increased such that the fingers will move inwardly in response to less lateral resistance than when the compression in the belleville springs 43 is greater.

The compression in the belleville springs 43 may be adjusted for, among other reasons, utilizing the expanding tool E to expand a liner 10 into sealed engagement with the inner wall 11 of the tubing T in stages. Thus in order to expand the liner 10 in a series of trips of the expanding tool E through the liner 10, the nut 42 is a first screwed upwardly so that the compression in the belleville springs is lessened. Then the expanding tool E is driven through the liner 10 and the liner 10 is

moved or expanded outwardly but not to a position in complete sealed engagement with the inside wall 11 of the tubing T. Then, the expanding tool E is removed from the liner 10 and the nut 42 is moved downwardly to a lower position than previously so that the compression in the belleville springs 43 is increased. In this manner, with the increased compression on the belleville springs 43, the finger 31c, 31d and 31e yield less as the expanding tool E is again driven through the liner thereby causing the fingers to expand or push outwardly the liner 10 further into engagement with the inner wall 11 of the tubing T. If desirable, the yieldability of the fingers 31c, 31d and 31e may be adjusted a series of times so that the liner 10 is expanded only a small amount each time the expanding tool is driven therethrough.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials as well as in the details of the illustrated construction may be made without departing from the spirit of the invention. For example, it is to be understood that the tubular member T, which is production tubing in the preferred embodiment of this invention, may be any tubular member into which a liner is placed. It is to be further understood, that the expanding tool E of the preferred embodiment of this invention may be used in combination with the tools other than those disclosed herein; it is also within the scope of this invention to utilize the expanding tool E as the only means for expanding a liner such as 10 into sealed engagement with a tubular member.

We claim:

1. A liner expanding tool for expanding a malleable liner positioned in a tubular member to conform said liner to the inside wall of said tubular member, comprising:

a mandrel adapted to be driven through said liner;
a collet mounted with said mandrel, fingers mounted with said collet for movement outwardly of said mandrel;

yieldable means mounted with said mandrel for urging said fingers outwardly into yieldable engagement with said liner whereby said fingers expand said liner to substantially conform to the inside wall of said tubular member, in spite of variations therein, as said expanding tool is driven through said tubular member; and

said yieldable means including laterally extending pins slidably mounted with said mandrel and extending into engagement with said fingers, and resilient means resiliently engaging said pins for urging said pins and fingers outwardly.

2. The structure set forth in claim 1, in which said resilient means includes:

adjustment means for adjusting the positions of said laterally extending pins whereby the position of said fingers with respect to said mandrel is adjustable.

3. The structure set forth in claim 1, in which said yieldable means includes:

a driving pin mounted for slidable movement longitudinally in said mandrel; and

a spring member urging said driving pin into yieldable engagement with said laterally extending pins whereby said driving pin cooperates with said later-

ally extending pins to transmit forces acting against said fingers to said spring member.

4. The structure set forth in claim 3, in which said yieldable means includes:

spring adjusting means for adjusting the compression 5
on said spring member to adjust the yieldability of said laterally extending fingers and said fingers.

5. The structure set forth in claim 1, in which said yieldable means includes:

said laterally extending pins having tapered surfaces; 10
and

a driving pin mounted for slidable movement longitudinally of said mandrel and including a tapered surface which engages said tapered surfaces of said laterally extending pins whereby the longitudinal 15
position of said driving pin determines the position of said laterally extending pins with respect to said mandrel.

6. The structure set forth in claim 1 including:

said collet assembly and said fingers being mounted 20
on said mandrel for movement between a first position wherein said fingers are positioned radially outwardly of said mandrel and a second position wherein said fingers are positioned radially inwardly such that said liner tool can be easily moved 25
through said tubular member; and

resilient means urging said collet assembly to said first position whereby said collet is yieldably movable toward said second position.

7. The structure set forth in claim 6, including: 30

a sleeve member slidably mounted on said mandrel for longitudinal movement with said collet;
said resilient means being a spring disposed between said mandrel and said sleeve member for urging said collet assembly to said first position. 35

8. The structure set forth in claim 6, including:

releasable means for releasably holding said collet in said second position.

9. The structure set forth in claim 1 in which said liner expading tool is used in combination with a liner 40
having a longitudinal reverse bend therein and a swaging tool, comprising:

a. a wedge-shaped body having a lower end adapted to be driven into the upper end of said liner with said reverse bend therein; and 45

b. said wedge-shaped body having a longitudinally extending, upwardly tapered recess for receiving said reverse bend.

10. A liner expanding tool adapted to be lowered on a wireline for expanding a malleable liner in a tubular 50

member to conform said liner to the inside wall of said tubular member, comprising:

a mandrel having a wireline therewith for suspending the mandrel in said tubular member from the wireline;

a collet assembly mounted with said mandrel, said collet assembly including fingers mounted for movement outwardly of said mandrel;

expander means engageable with said fingers for urging said fingers outwardly away from said mandrel upon a relative longitudinal movement between said fingers and said expander means; and

adjustment means operably connected with said expander means for adjusting the extent of outward movement of said fingers away from said mandrel to thereby obtain a predetermined amount of expansion of the liner for each setting of said adjustment means.

11. A liner expanding tool for expanding a malleable liner in a tubular member to conform said liner to the inside wall of said tubular member, comprising:

a mandrel having a wireline therewith for suspending the mandrel in said tubular member from the wireline;

a collet assembly mounted with said mandrel, said collet assembly including fingers mounted for movement with respect to said mandrel;

expander means engageable with said fingers for urging said fingers outwardly away from said mandrel upon a relative longitudinal movement between said fingers and said expander means; and

releasable lock means preventing longitudinal movement of said expander means relative to said fingers for maintaining said fingers in a retracted position inwardly from said liner expanding position until released by manipulation of said wireline for thereafter permitting relative longitudinal movement of said expander means relative to said fingers for expanding same.

12. The structure set forth in claim 10, including:

releasable lock means preventing longitudinal movement of said expander means relative to said fingers for maintaining said fingers in a retracted position inwardly from said liner expanding position until released by manipulation of said wireline for thereafter permitting relative longitudinal movement of said expander means relative to said fingers for expanding same.

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