Jan. 10, 1939. G. D. JOHNSON 2,143,072

LINER

Filed Dec. 9, 1936 2 Sheets-Sheet 1

Fig. 1.

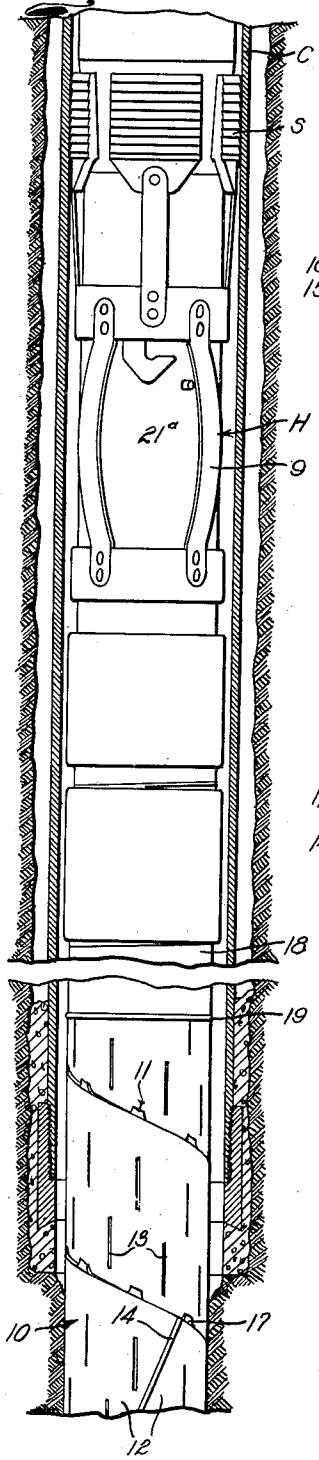


Fig. 2.

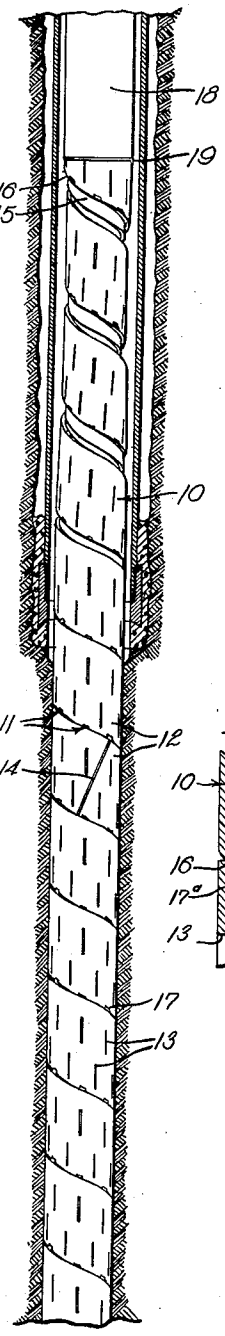


Fig. 3.

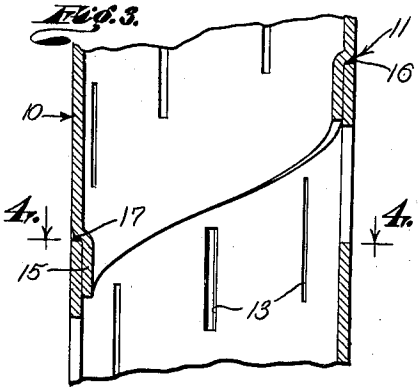


Fig. 4.

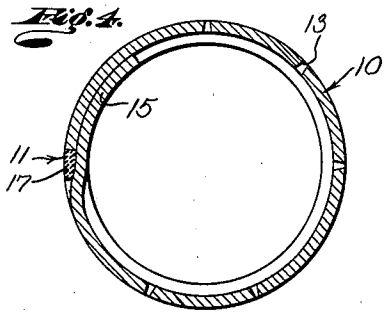


Fig. 5.

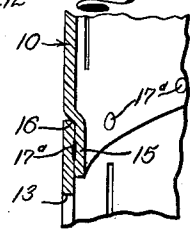
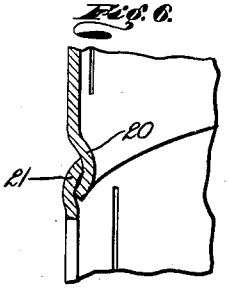


Fig. 6.



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Fig. 7.

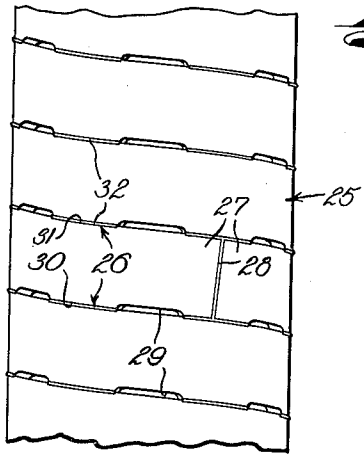


Fig. 8.

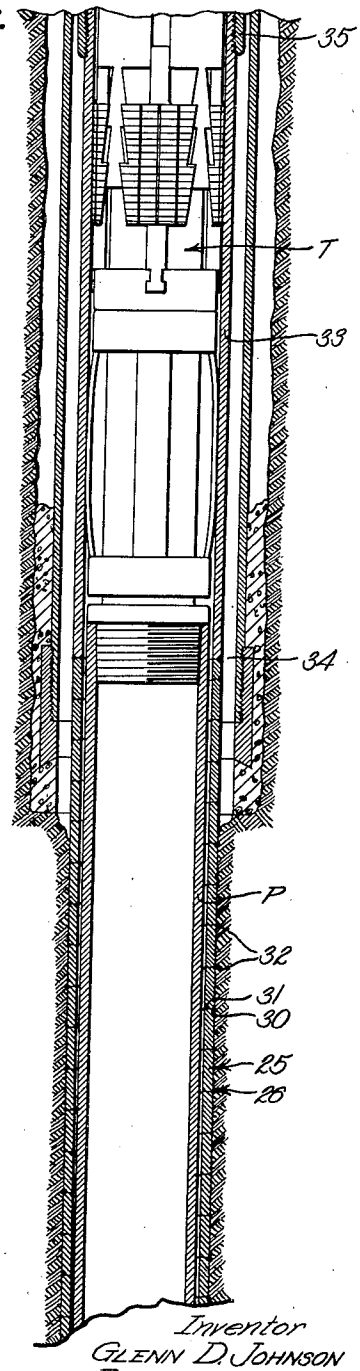


Fig. 9.

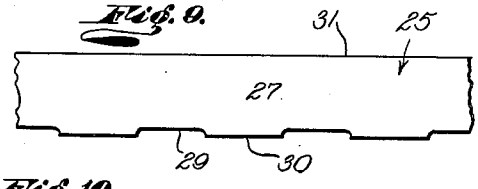


Fig. 10.

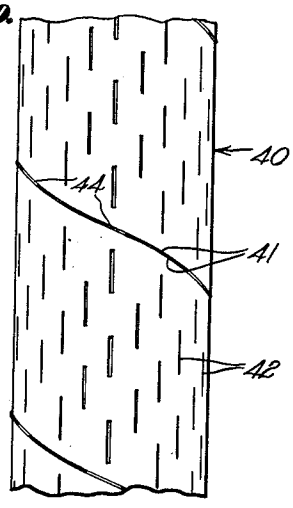
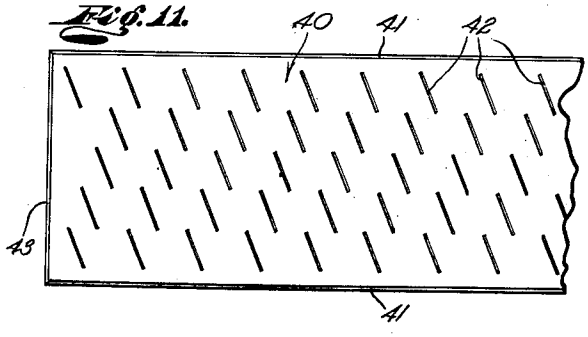


Fig. 11.



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UNITED STATES PATENT OFFICE

2,143,072

LINER

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Application December 9, 1936, Serial No. 114,992

7 Claims. (Cl. 166—4)

This invention relates to well equipment and relates more particularly to screen casings or liners for a practical effective well liner that may be easily and quickly removed from the well.

In the production of an oil well it is the usual practice to set a perforated casing or liner in the producing zone of the well to admit the well fluids and to prevent caving and sanding up of that portion of the well. The fluid enters the perforations in a well liner at a high velocity and the small particles of sand entering with the fluid soon enlarge the perforations so that excessive amounts of sand are allowed to enter the casing. When this occurs it is necessary to remove the worn liner and replace it with a liner having perforations of the proper size. Further, it is often necessary to remove a well liner and reset it at a new location to assure the maximum production. A well liner quickly becomes tightly sanded in the well and a typical well liner can only be removed from the well with great difficulty.

Another object of this invention is to provide a well liner that is long wearing and strong and that may be very easily and inexpensively removed from the well for replacement or to leave the well bore clear for deepening the well, or the like.

Another object of this invention is to provide a well liner that is formed of steel or the like to resist the abrasive action of the sand in the well fluid and that is fabricated to resist the stresses to which it may be subjected and yet may be readily reduced in diameter for easy removal from the well.

Another object of this invention is to provide a well liner that may be freed from the sand and reduced in diameter and quickly withdrawn from the well by simple or conventional fishing tools.

Another object of this invention is to provide a well liner of the character mentioned that is less expensive and more economical to manufacture than the usual or typical liners.

Another object of this invention is to provide a well liner that comprises a length of perforated metal helically wound into a tube and maintained in this form in such a manner that it may be readily reduced in diameter for easy removal from the well by the application of a twisting force or a longitudinal force, or both.

Another object of this invention is to provide a well liner of the character mentioned that may be easily and quickly assembled or made up at the well to meet the exact installation requirements.

Another object of this invention is to provide a well liner of the character mentioned in which the perforations may be inexpensively punched in the metal strips when in a flat state, thereby overcoming the difficulties experienced in perforating typical tubular liners.

A further object of this invention is to provide a well liner of the character mentioned that will not break or kink when being unwound and recovered from the well.

The various objects and features of my invention will be fully understood from the following detailed description of typical preferred forms and applications of the invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is a side elevation of one form of the invention arranged in the operative position in a well. Fig. 2 is a reduced side elevation similar to Fig. 1 showing the liner being untwisted for removal from the well. Fig. 3 is an enlarged fragmentary longitudinal detailed sectional view of the liner illustrated in Figs. 1 and 2. Fig. 4 is a transverse detailed sectional view taken as indicated by line 4—4 on Fig. 3. Fig. 5 is a fragmentary longitudinal detailed sectional view illustrating a modified means for connecting the convolutions of the strip forming the liner. Fig. 6 is a view similar to Fig. 5 illustrating another means for connecting the convolutions of the strip. Fig. 7 is a fragmentary side elevation of another form of liner of the invention. Fig. 8 is a reduced longitudinal detailed sectional view of the liner illustrated in Fig. 7 in position in the well illustrating a fishing tool in position to recover the liner from the well. Fig. 9 is a fragmentary elevation view of the strip of which the liner illustrated in Figs. 7 and 8 is formed. Fig. 10 is a fragmentary side elevation of another form of liner of the invention, and Fig. 11 is a fragmentary elevation view of the strip of which the liner illustrated in Fig. 10 is formed.

The liner of the present invention illustrated in Figs. 1 to 4, inclusive, of the drawings includes a helically wound perforated strip 10 and releasable or frangible means 11 maintaining the strip 10 in the form of a tube.

The strip 10 of which the liner is formed is a length of plate or metal of the desired thickness and of the selected material. In practice the strip 10 may be made up of several lengths or sections 12 of 20 to 30 feet in length. These sections 12 of the strip 10 are elongate and rectangular and may be of the same size. In accordance with the invention the sections 12 are perforated while in a flat state. This may

be readily and inexpensively accomplished by a simple punching process. The perforations in the sections 12 of the strip 10 may be of any desired or required character and size. In the form of the invention being described the perforations in the strip 10 are in the nature of elongate openings or slots 13 located to be substantially axial or vertical when the strip 10 is wound into the form of a tube. The slots 13 are provided to pass or admit the gas, oil or other fluid from the earth formation into the liner. In practice the slots 13 are offset or staggered, as illustrated in the drawings. The several sections 12 forming the strip 10 may be rigidly and permanently connected together to form a liner of the desired length, or the liner may be formed of tubular lengths of one or more strip sections 12 which lengths may be delivered to the well to be welded together to constitute a liner to meet the particular installation requirements. The ends of the sections 12 constituting the strip 10 may be secured together by butt welds 14. The welds 14 are such that they permanently and securely connect together the several sections 12. In accordance with the invention the strip 10 is twisted or wound helically to constitute a tube. The strip 10 is rolled or wound into a cylindrical tube of the desired or required diameter.

The means 11 connects the edge portions of the convolutions of the wound strip 10 to maintain the strip in the form of a tube. It is a feature of the invention that the means 11 is such that it will fail or release under certain conditions to allow the strip 10 to be wound apart and stretched out whereby the liner may be easily removed from the well. In the form of the invention being described the means 11 includes an indented or bent-in lip 15 extending along one edge of the strip 10 to lap within the other edge portion of the strip when the strip is rolled into a tube. The lip 15 is pressed or bent inwardly to conform to and evenly bear against the internal surface of the opposite edge portion of the strip 10. A rounded shoulder 16 occurs on the strip 10 where the lip 15 joins the body of the strip.

The means 11 further includes welds 14 between the shoulder 16 and the opposing longitudinal edge of the strip 10. The welds 17 may be in the nature of spot welds spaced along the seam between the convolutions of the strip 10. There may be as many spot welds 17 as necessary to normally prevent opening of the seam and to properly maintain the strip 10 in its tubular form. Due to the relationship between the shoulder 16 and the opposing longitudinal edge of the strip 10 the welds 17 may be fully recessed or inset from the periphery of the liner so that the liner presents a smooth regular outer surface. The lip 15 lapped within the adjacent or opposing edge portion of the strip 10 engages against said portion so that the liner effectively resists collapsing forces. It will be noted that the helically wound strip 10 constituting the liner may may be devoid of collars and other projecting parts that might interfere with its removal from the well. The spot welds 17 are such that they dependably maintain the wound tube 10 in its tubular form but release or fail when the liner is subjected to a substantial pulling force or a torsional force, or both, tending to separate the convolutions of the wound strip 10.

When the liner is delivered to the well in sections or tubular lengths as described above the adjacent ends of the tubular lengths may be welded together, that is, the opposing ends of two such lengths may be connected together by a butt weld 14 and the opposing convolutions of the lengths may be welded together by spot welds 17 of the character described above. In this manner a liner of the desired length may be easily fabricated at the well. The lower end of the liner is preferably straight and in a plane normal to its longitudinal axis. A plain tubular nipple 18 is preferably secured to the upper end of the liner. The upper end of the strip 10 is preferably straight so that it may be connected with the nipple by an annular weld 19. The nipple 18 may be of sufficient length to receive a spear or other fishing tool for removing the liner from the well.

In use or operation, the liner made up or assembled as described above may be lowered into the well and set in any of the well known manners. In Fig. 1 the liner is set or hung in the well by a liner hanger H. The hanger H has a tubular body 21^a connected with the upper end of the nipple 18, and slips S cooperating with a tapered portion of the body 21^a. The slips S are operable to grip the interior of the well casing C to suspend the liner. A tail piece 9 controls the slips. The hanger H is released by an up pull. When in position in the well the liner operates to prevent caving and excessive sanding up of the producing portion of the well and admits the well fluids into the well casing. The well fluids are admitted through the longitudinally and circumferentially spaced slots 13. The lapped and welded together longitudinal edges of the strip 10 maintain the strip in its wound tubular form and resist collapsing due to accumulations of sand about the liner. It may become desirable to remove the liner from the well to re-locate it, to replace it, or to permit deepening of the well or similar operations. When it is desired to remove the liner from the well a spear or other fishing tool is lowered into the well to enter the nipple 18. The fishing tool is preferably such that it is operable to transmit turning forces as well as lifting forces to the liner. When the fishing tool has been tripped or operated to grip the interior of the nipple 18 an upward strain is applied to the liner to release the slips S of the hanger H. An upward strain or a torsional strain, or both, are applied to the fishing string. The torsional strain thus applied is preferably in a direction to cause separation of the convolutions of the helically wound strip 10. The forces transmitted to the liner 10 from the fishing tool and through the nipple 18 break the welds 17. As these forces are applied at the upper end of the liner the upper welds 17 are the first to fail.

The torsional force and the upward force thus applied to the liner from its upper end cause the strip 10 to spiral so that its longitudinal edges separate. This unwinding of the strip 10 is accompanied by a substantial reduction in the diameter of the unwound portion of the strip 10. Fig. 2 of the drawings illustrates the manner in which the strip 10 separates and becomes reduced in diameter when the liner is being withdrawn from the well. The separating or parting of the longitudinal edges of the strip 10 and the reduction in diameter of the wound strip fully frees the liner from the accumulation of sand that may have packed about it. The upward force and the torsional strain may be applied to the liner until all of the welds 17 have failed and until the longitudinal edges of the strip 10 have parted throughout the length of the liner. The parting of the welds 17 and the separating of the

edges of the strip 10 is accompanied by the marked reduction in diameter of the strip 10 constituting the liner. Thus when all the welds 17 have been broken and when the edges of the strip 10 have been separated throughout the length of the liner, the liner is free for easy withdrawal from the well. The butt welds 14 and 19 are sufficiently strong to withstand the vertical forces and the twisting forces to which they are subjected during the recovery of the liner. Accordingly, the liner 10 may be withdrawn from the well as a single unit. The liner is such that it may be easily and quickly freed from a tightly packed accumulation of sand. The reduction in diameter of the wound strip 10 resulting from inward spiralling of the strip fully frees the liner strip from the packed accumulation of sand. The removal of the liner from the well in the manner just described leaves the open or producing portion of the well entirely clear and unobstructed for further operations.

Fig. 5 of the drawings illustrates a slight modification of the structure illustrated in Figs. 1 to 4, inclusive. The longitudinal edges of the strip 10 are the same as described above, one edge of the strip having the indented lip 15 lapping within the other longitudinal edge portion of the strip. The welds 17a instead of occurring between the shoulder 16 and the opposing edge of the strip 10 occur between the opposing surfaces of the lip 15 and the other edge portion of the strip 10. The welds 17 are spaced along the seam joining the convolutions of the strip 10 to dependably maintain the strip in its wound tubular form. The spot welds 17a are sufficiently strong to withstand the forces to which the liner may be subjected when in use, but are such that they fail when the liner is subjected to a substantial pulling force or a substantial torsional force whereby the liner may be readily recovered from the well, as described above.

Fig. 6 of the drawings illustrates still another form of releasable seam or joint connecting the longitudinal edges of the helically wound strip 10. The seam illustrated in Fig. 6 includes what I will term an inner lip 20 extending along one edge of the strip 10 and an outer lip 21 extending along the other edge of the strip. The inner lip 20 is concaved, curving inwardly from the body of the strip and then outwardly to its longitudinal edge. The outer lip 21 curves outwardly from the body of the strip 10 and then inwardly to its longitudinal edge. The two edge portions or lips 20 and 21 of the adjacent convolutions of the strip 10 are lapped together in hooked or gripping relation. The inturned lip 21 extends inwardly into the concave inner lip 20 while the edge portion of the inner lip 20 hooks outwardly into the concave inner side of the lip 21. The hooked lapped lips 20 and 21 extend along the edges of the strip 10 to connect its convolutions to maintain the strip 10 in the form of a tube and to prevent collapse of the tube. The edge portions or lips 20 and 21 may be pulled apart or unhooked by a substantial longitudinal pulling force or a substantial torsional force on the liner or both. In practice a pulling force as well as a torsional untwisting force is applied to the liner to disengage or release the overlapping lips 20 and 21 so that the convolutions of the strip 10 pull apart to effect the reduction in diameter of the liner. The seam illustrated in Fig. 6 of the drawings does not require welds, but the lips 20 and 21 may be welded together by releasable or frangible welds, if desired. It is believed that it will be apparent how the lapped seam illustrated in Fig. 6 may be embodied in the above described liner in place of the means 11.

Figs. 7 to 9, inclusive, of the drawings illustrate another form of the invention. The improved liner illustrated in Figs. 7 to 9 of the drawings includes a notched strip 25 helically twisted or rolled into a tube and frangible or releasable means 26 connecting the edges of the convolutions of the strip 25.

The strip 25 of which the liner is formed is an elongate member of one or more initially flat elongate plates or sections 27. In practice several of these sections are secured together by butt welds 28 to form the long strip 25. The strip 25 may be somewhat narrower than the above-described strip 10 and may be imperforate. At least one longitudinal edge of the strip 10 is notched or provided with longitudinally spaced notches 29 which form the fluid admitting perforations or orifices of the liner when the strip 25 is made up into the liner. The notches 29 may be varied in size to suit the particular installation. In the case illustrated the notches 29 are relatively shallow and are elongated longitudinally of the strip 25. The notches 29 are preferably equally spaced apart and are spaced so that the edge 30 in which they are formed has portions between the adjacent notches of substantial length. In the construction illustrated the strip 25 has its edge 30 provided with the notches 29 while its other edge 31 is plain or unnotched. It may be preferred to bevel or round off the outer corners of the edges 30 and 31. It will be noted that the strip 25 may be easily and inexpensively formed of the sections 27 which are cut to have the notches 29.

The strip 25 is helically wrapped or wound into the form of a tube to have the longitudinal edges 30 and 31 of its convolutions in abutment. This relationship of the edges 30 and 31 effects closing of the open ends or sides of the notches 29. Thus where the notches 29 occur in the lower edge 30 as illustrated the upper edge 31 closes the lower sides of the notches 29 so that the notches constitute perforations or orifices of the desired capacity.

The frangible or releasable means 26 for connecting the longitudinal edges 30 and 31 of the strip 25 includes welds 32. The welds 32 connect the edges 30 and 31 of the adjacent convolutions of the strip 25 to maintain or assist in maintaining the strip 25 in the form of a tube. The welds 32, of course, occur between the notches 29 and there may be as many welds 32 as necessary to maintain the edges 30 and 31 together and to keep the strip 25 in its proper condition. The welds 32 are preferably on the exterior or periphery of the liner but need not form large projections on the liner. In accordance with the invention the welds 32 are such that they fail or break when the liner is subjected to a pulling force and a torsional force in a direction to separate the convolutions of the strip 25.

The lower end of the strip 25 wound in tube form may be finished as desired, for example, it may be cut off to lie in a plane transverse of the longitudinal axis of the tube. A plain or seamless nipple 33 is provided on the upper end of the liner. The nipple 33 may be connected with the upper end of the liner by an annular weld 34. It is preferred to cut the upper end of

the strip 25 so that the liner presents a plain flat upper end for ready connecting with the nipple 33. The nipple 33 is sufficiently long to fully receive a fishing tool T as will be hereinafter described. The upper end of the nipple 33 may be provided with a collar 35 for connecting the liner with a tubing or may be provided with the adapter of a liner setter or with similar means for facilitating the setting of the liner.

The liner illustrated in Figs. 7 to 9, inclusive, of the drawings, is constructed of the strip 25 helically wound or wrapped into tube form. The strip 25 may be made up of a multiplicity of sections 27 and may be delivered to the well in the form of tubular lengths each comprising one or more helically wound sections 27. These lengths of tubing may be connected together by welding to constitute the liner. In welding together the tubular lengths welds 28 may connect the abutting ends of the sections 27 at the ends of the said lengths and welds 32 may connect the adjacent edges of the convolutions of the joined lengths. In this manner the liner may be made up at the well to any desired length. The liner may be run into the well and set in any of the well known manners.

After extended use it may be desired to remove the liner for replacement or for resetting, or the like. When it is desired to remove the liner a suitable fishing tool T such as a spear, is run into the well on a fishing string. The tool T carries a wash pipe P having an external diameter somewhat smaller than the internal diameter of the liner. This wash pipe P projects downwardly from the lower end of the tool T. The fishing tool is lowered until it is fully within the nipple 33. When the tool T is in this position the pipe P projects downwardly through the liner. The fishing string carrying the tool T is then manipulated to set or actuate the tool T and an upward strain is put on the fishing string in an attempt to pull the liner from the well. In some instances the liner may be free for removal from the well on the fishing string, while in other instances the liner may be caught or fast in the well. In the latter event an upward pull and a torsional strain are put on the fishing string to be transmitted from the tool T to the liner. The torsional strain thus applied effects spiralling of the strip 25 forming the liner. The forces thus applied to the liner from its upper end break the welds 32 so that the convolutions of the strip 25 unwind or separate. This spiralling of the strip 25 is accompanied by a marked reduction in diameter of its convolutions. The strip 25 is wrapped upon the pipe P as it separates. The upward strain and the torsional force is maintained on the liner until all of the welds 32 are broken and the strip 25 is wrapped upon the pipe P. As the strip 25 becomes smaller in diameter and wraps upon the pipe P it fully frees itself from the accumulated sand that may be packed about it. Thus when the liner 25 is completely wrapped upon the pipe P it is fully freed from the sand to be readily withdrawn from the well on the fishing tool T. The pipe P extending through the liner prevents the strip 25 from kinking or breaking as it is wound in by the forces applied through the fishing tool T. It is to be understood that the fishing tools employed to recover the several forms of liners of the invention may be equipped with pipes similar to the pipe P.

Figs. 10 and 11 of the drawings illustrate a modification of the form of the invention illustrated in Figs. 7 to 9. The embodiment of the invention illustrated in Figs. 10 and 11 includes a perforated strip 40 wrapped or wound into the form of a cylindrical tube to have its longitudinal edges 41 in abutment. The strip 40 may be somewhat wider than the above described strip 25. A multiplicity of perforations 42 is provided in the strip 40. In the particular case illustrated the perforations 42 are in the nature of slots. The perforations or slots 42 may be easily and inexpensively punched in the strip 40 when the strip or its sections are in a flat state. The slots 42 may be located in the strip 40 to be substantially vertical or axial of the liner when the strip is wound into the form of a tube. The strip 40 may be made up of several welded together sections in the same manner as the strip 25. The longitudinal edges 41 of the strip 40 and the end edges 43 of the sections constituting the strip 40 have their outer corners bevelled off as best illustrated in Fig. 11 of the drawings.

The strip 40 is helically wound or wrapped into a cylindrical tube to have its longitudinal edges 41 in abutment. The edges 41 are connected by butt welds 44. The welds 44 are longitudinally spaced along the seam connecting convolutions of the strip 40 and there may be as many welds 44 as necessary. The welds 44 are provided in the groove occurring between the bevelled off outer corners of the edges 41. Accordingly, the welds 44 may be flush with the periphery or outer surface of the liner. In accordance with the invention the welds 44 are frangible or releasable to fail when the liner is subjected to a substantial longitudinal pull and a substantial torsional strain tending to separate the convolutions of the strip 40. The liner illustrated in Figs. 10 and 11 may be made up in the same manner as the previously described forms of the invention to be of any desired length. The liner may be recovered or removed from the well in the same manner as the above described liners.

Having described only typical preferred forms and applications of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. A well liner comprising, a pre-perforated strip helically wound into a tube, and frangible welds connecting the convolutions of the strip.

2. A well liner comprising, a pre-perforated initially flat strip helically wound into tube form to have its edges abut, and frangible welds connecting said edges.

3. A well liner comprising, an initially flat strip helically wound into tube form to have its edges in adjacent relation, at least one of said edges having notches, and frangible welds connecting said edges.

4. A well liner comprising, a pre-perforated initially flat strip helically wound into tube form, edge portions of the convolutions of said strip being in lapped relation, and frangible welds connecting said portions.

5. A well line comprising, a pre-perforated strip helically wound into tube form, and hooked together lips on the edges of the strip releasable by a torsional strain on the strip.

6. A well liner comprising, a pre-perforated strip helically wound into tube form, means connecting the edges of the strip and releasable by a strain on the tube, and a seamless nipple on the

upper end of the tube for facilitating its connection with a well string.

7. In combination, a well liner comprising a strip helically wound into the form of a tube, and means connecting the adjacent edges of the convolutions of the strip releasable by a strain on the tube, which strain reduces the diameter of the tube, and a mandrel entering the tube from its upper end on which the tube contracts when reduced in diameter by said strain.

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