Jan. 22, 1957 G. H. ALLEN 2,778,432

PACKER BRAID REINFORCING AND RETAINER

Original Filed March 22, 1951 3 Sheets-Sheet 1

Fig. 1

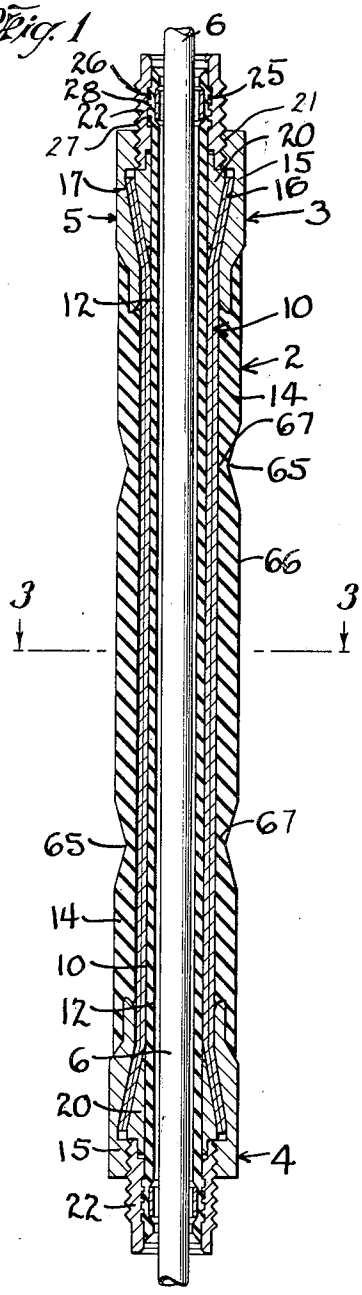
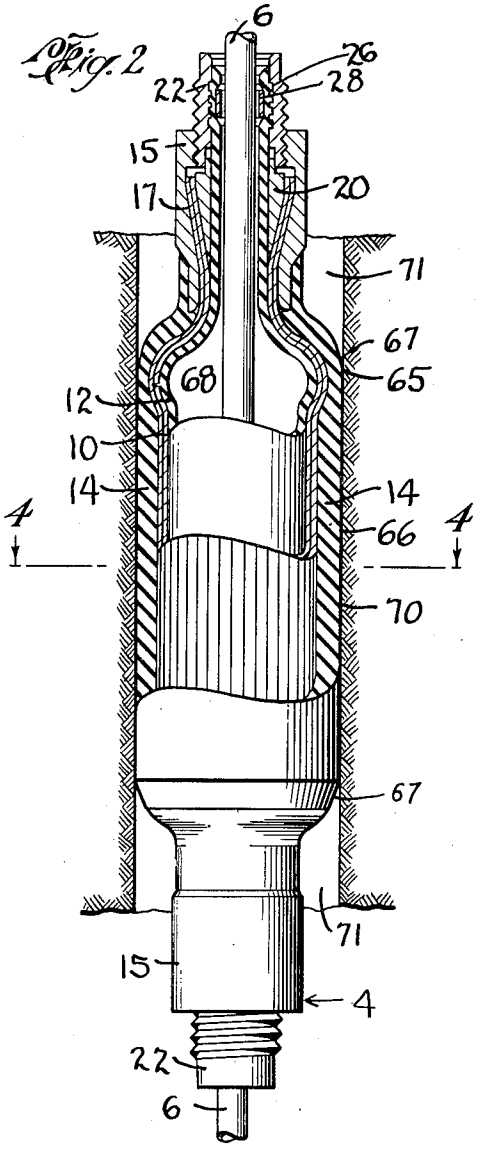


Fig. 2



GEORGE H ALLEN
INVENTOR.

BY Jacob W. Hayden

ATTORNEY

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PACKER BRAID REINFORCING AND RETAINER

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Fig. 3

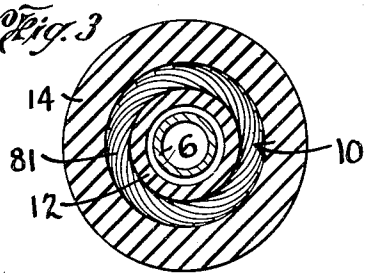


Fig. 4

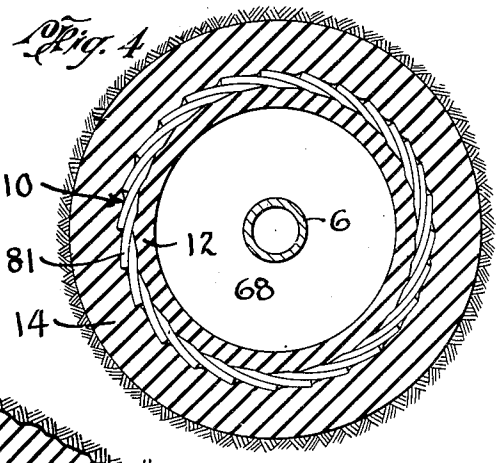


Fig. 5

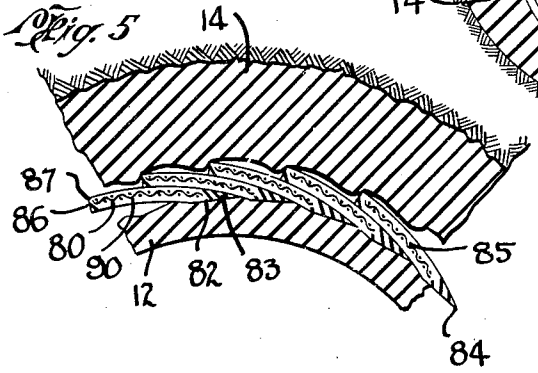


Fig. 6

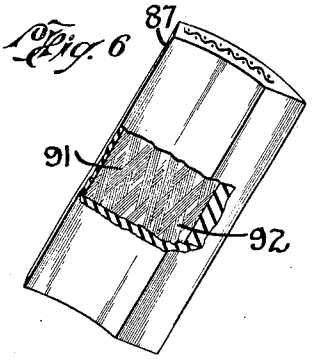


Fig. 7

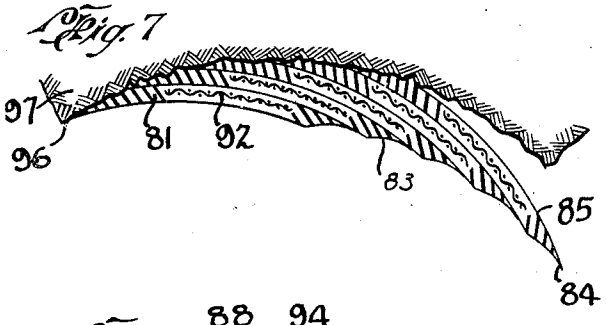
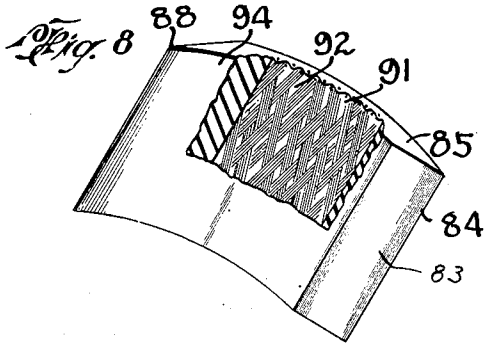


Fig. 8



GEORGE H. ALLEN
INVENTOR.

BY Jacks W. Hayden

ATTORNEY

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PACKER BRAID REINFORCING AND RETAINER

Original Filed March 22, 1951 3 Sheets-Sheet 3

Fig. 9

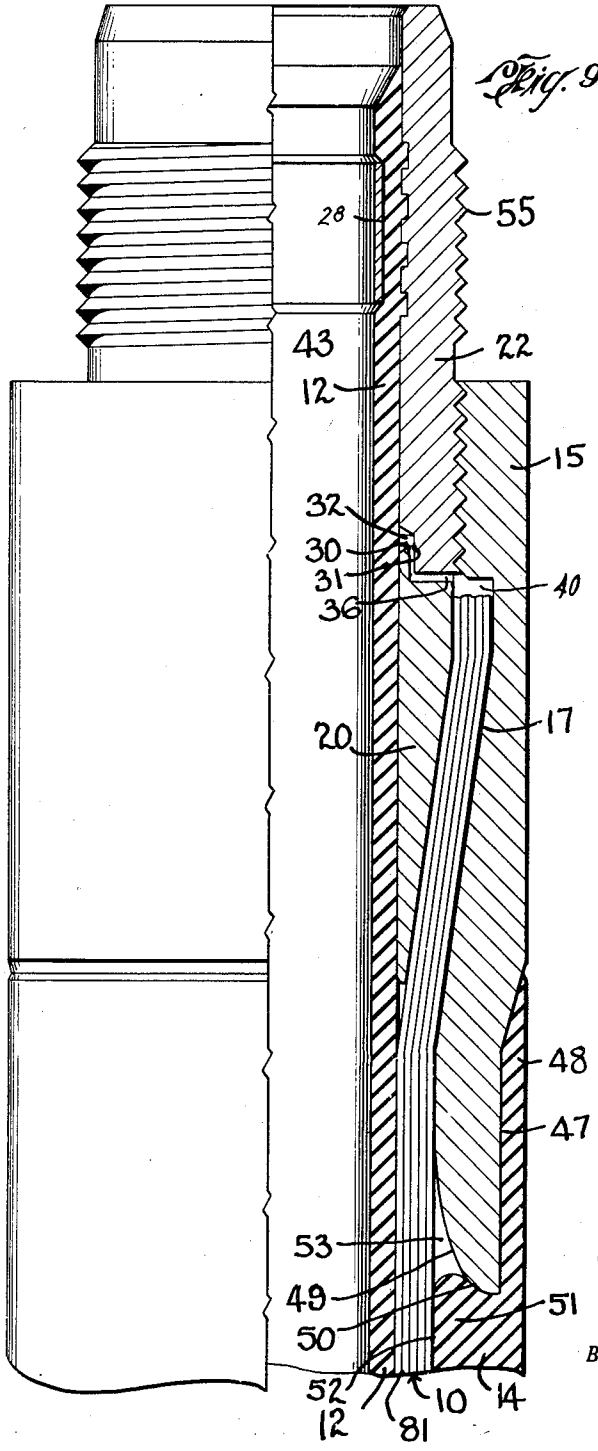
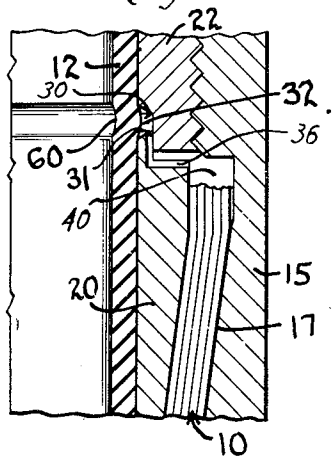


Fig. 10



GEORGE H. ALLEN.
INVENTOR.

BY James W. Hayden

ATTORNEY

United States Patent Office 2,778,432 Patented Jan. 22, 1957

2,778,432

PACKER BRAID REINFORCING AND RETAINER

George H. Allen, La Porte, Tex., assignor to Lynes, Inc., Houston, Tex., a corporation of Texas

Continuation of application Serial No. 217,015, March 22, 1951. This application March 15, 1956, Serial No. 571,660

15 Claims. (Cl. 166—187)

The invention relates to a braid reinforcing for hydraulically inflatable packers and to the anchor construction thereof.

This application is a continuation of my prior copending application Serial No. 217,015, filed March 22, 1951, now abandoned.

In hydraulically inflatable packers where the packer is lowered into a wall bore and then inflated to create a seal with the wall of the well bore or a pipe in the well, it is obvious that the packer may have to resist tremendous internal and external pressures and differential pressures across the seal.

It is desirable with an inflatable packer to provide a seal on the interior of the packer so as to prevent the leakage of fluid or pressure from the inside, and to maintain the packer inflated by preventing extrusion of the sealing liner from the interior of the packer sleeve assembly. On the other hand it is also desirable to prevent any inflow of fluid due to the tremendous pressures which may occur in the well bore and it is therefore desirable to cover the reinforcing sheath so that there will be no leakage of fluid into the packer. The external pressures must be overcome when the packer is to be inflated and such external pressures will cause a collapse of the packer when the internal pressure is reduced.

It is one of the objects of the invention to provide an anchor assembly for the end of the packer sleeve so as to resist the radial and axial stresses which are caused when the packer is inflated and to accomplish such anchorage the present invention contemplates the arrangement of a wedge in the end head of the packer.

Another object of the invention is to provide an anchor head at the end of a packer sleeve which will retain the internal sealing liner so as to maintain a seal of the interior pressure when the packer is inflated.

Another object of the invention is to provide a retainer sheath for a packer construction so that it will serve as a body or basis for the packer in order to prevent extrusion of the interior liner due to the internal pressures.

Another object of the invention is to provide a body or sheath for a packer so as to support the exterior covering and prevent any inflow or intrusion of the covering material.

A still further object of the invention is to provide a reinforcing sheath made up of a plurality of strips of braided wire where the strips have been treated with a coating material so as to make the sheath impervious and to permit relative circumferential and radial sliding of a plurality of lapped strips so that the sliding action may occur while maintaining a seal between the lapped strips or braids of wire.

A still further object of the invention is to provide a plurality of strips of braided or woven wire, each of which has been coated with a suitable material, which extends beyond the edges of the strips so as to provide a sealing lip at each edge of each strip so that any pressure on said lip will cause it to blend itself against

the surface of the adjacent lapped strip whereby a seal between the contacting surfaces of the lapped strips will be maintained even though the strips may slide both radially and circumferentially with respect to each other upon the inflation and collapsing of the packer.

A still further object of the invention is to provide a strip of reinforcing material for hydraulically inflatable packers where the wires of the strip have been coated with a suitable material to present a smooth impervious surface which will resist extrusion of the inner liner or the outer coating through the braid of the strip.

A still further object of the invention is to provide a wedge assembly in the end supporting head of a hydraulic packer construction wherein the head is made up of a nipple and a skirt construction having a slip or wedge bowl therein so that the reinforcing sheath end may be anchored and wedged in position while a seal is maintained between the inner liner and the outer covering.

A still further object of the invention is to provide an equalizing groove in the end head construction.

Another important object of the invention is to provide a covering for a hydraulically inflatable packer wherein spaced circumferential grooves are provided in the outer periphery of the covering for the packer whereby the covering material is thinned for a portion of its surface so as to provide a thinned covering at the area of greatest flexure when the packer is inflated. It has been found when the packer is inflated that such a groove provides an area on the exterior thereof which permits the retainer sheath and the interior sealing liner to bulge outwardly so as to form a dam against the surface being sealed and to thus confine the body of the covering throughout the central portion of the packer. This prevents undue stressing of the covering material which has been found to result in damage to and destruction of the covering.

A still further object of the invention is to provide a thinned area in the covering where the packer bridges the space from the surface being sealed to the retainer head so as to hold the parts in a balanced position and avoid undue destruction thereof upon wadding of the covering material at such location.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings wherein:

Fig. 1 is a vertical sectional view of the packer assembly with the parts in normal or collapsed position ready for insertion in a well bore for use.

Fig. 2 is a view of the packer of Fig. 1 but illustrating the inflated position of the various parts and indicating the arrangement of the particular details at the time the packer is inflated and maintaining a seal in the well bore.

Fig. 3 is a transverse section taken on the line 3—3 of Fig. 1 and illustrating the arrangement of the parts when the packer is collapsed.

Fig. 4 is a transverse section taken on the line 4—4 of Fig. 2 and illustrating the adjusted and balanced arrangement of the parts at the time that the packer is inflated.

Fig. 5 is a broken detailed enlarged sectional view illustrating the arrangement of the covering, the reinforcing lapped braided strips, and the inside sealing liner construction at the time the packer is in an inflated position.

Fig. 6 is a broken detailed view showing certain portions of the braid in section and particularly demonstrating the coating material and the lip of the coating material at the edge of the braided strand.

Fig. 7 is an enlarged detailed view illustrating a lip on the outer edge of the reinforcing strands so as to

improve the efficiency of the sealing effect of the reinforcing strips against the wall of the well bore if the packer were constructed without any covering other than the coating which is provided on the strips or braids.

Fig. 8 is a broken detailed view of the strip or strand of Fig. 7 illustrating the outside edge lip and sealing arrangement.

Fig. 9 is a side elevation with one half thereof in section to illustrate the arrangement of the parts of the anchor head and the assembly of the liner, reinforcing sheath, the wedge, and the skirt and covering details.

Fig. 10 is a broken detailed view of the anchor construction with the parts having been stressed so that they have moved to the anchoring position and illustrating the manner of sealing the wedge collar in place.

The packer is assembled in collapsed condition to be lowered into a well bore or to be used in any desired manner.

The packer is made up, generally, of a sleeve 2 which is cylindrical in nature and has the heads 3 and 4 affixed thereto at the upper and lower ends respectively. These parts 2, 3, and 4, therefore, make up the packer as indicated generally by the numeral 5.

Any suitable connections may be made above and below as may be desired and a pipe such as 6 may or may not extend through the packer for the circulation or movement of fluids and to inflate the packer as the case may be.

The sleeve 2 is generally made up of a reinforcing sheath 10 which is best seen in Figs. 5 and 7. This sheath has an inner liner 12 which lies close to the inner surface of the sheath in order to form a seal and to confine the internal pressure.

On the outside of the sheath 10, there is a covering 14 which prevents an inflow of pressure and serves to protect the sheath and the packer generally against the pipe or well wall surfaces which are engaged by the packer.

The general assembly of the packer therefore embodies the four principal parts, namely, the inner liner, the sheath, the outer covering and the upper and lower end heads. In actual practice, the packer will be assembled in the form shown in Fig. 1 where the sheath 10 will be formed of the braided strands of wires which have been coated and will be described in detail in connection with the structure of Figs. 3 through 8 inclusive. This cylindrical sheath will have the skirt portion 15 of the head 3 slipped down over the upper end 16 of the sheath 10 until the upper ends of the strips or strands are deposited in the tapered bowl 17 on the inside of the skirt which is formed in the hollow area of the bowl to the position shown in Fig. 1.

The next operation will then be to insert the wedge cone 20 down through the opening 21 in the skirt 15 until the lower end of the cone or collar has passed into the upper end 16 of the sheath. In this manner the sheath will be confined between the bowl 17 and the outer surface of the collar. The wedge collar may or may not be driven into position to wedge the sheath end in position. In either event, the next operation is to then thread the nipple 22 into the opening 21 in the upper end of the skirt 15 until such nipple moves downwardly and it may be threaded into position sufficiently to force the collar 20 into a wedging position as may be desired. This is the general assembly of the sheath and the head. The lower head will be assembled in a like manner.

The next operation is to insert the inside liner 12 which is a relatively long cylindrical flexible tube. The ends of such tube may have the outwardly projecting ribs 25 created by setting the internal brass ring 28 so as to cooperate with the inwardly extending ribs 26 formed on the inner periphery 27 of the nipple 22.

When the parts have been thus assembled, the next operation is to insert and expand a retainer collar 28 which may be of any suitable material. Brass has been found to be satisfactory. The purpose for expanding

this ring 28 is to force the resilient sealing material of the inner liner firmly against the ribs 26 so that a seal will be insured and so that there will be no leakage of fluid between the inner liner and the nipple and so that the inner liner will be firmly retained in position by such retainer collar 28.

Particular attention is directed to the relative positions of the collar 20 in Fig. 1 and Fig. 2, and also in Figs. 9 and 10 because it should be noticed that there is a space at 30 between the upper end 31 of the collar 20 and the upper portion of the recessed area 32 in the lower end of the nipple 22.

The upper end of the collar 20 has a groove 36 therein which extends across the transverse portion and upwardly along the extension so that any leakage of fluid or liquid occurring around the liner 12 may escape through this groove and move into the storage or escape area 40 at the upper end of the bowl 17 inside of the skirt 15 of the head 3. In this manner, the pressure exerted inside the passage 43 inside the liner 12 will not be equalized by pressure due to any small initial flow or condensation of fluid into annular groove formed between nipple 22 and collar 20 and an hydraulic seal will be effected along the inner edges of the annular groove.

Particular attention is directed to the fact that the inside liner 12 may flow slightly as at 60 in Fig. 10 due to the internal pressure to create a hydraulic seal against the lower end of the nipple and against the upper end of the wedging collar 20. With this arrangement, a seal along the liner is insured and there can be no leakage of fluid or liquid from the inside of the packer due to internal pressure.

When there is an axial pull on the head 3 or on the sheath 10, it seems obvious that this pull will be exerted so as to cause the collar 20 to move downwardly in the bowl 17 to securely wedge the sheath in position and insure its final anchor.

The skirt 15 is reduced at 47 so as to provide a space to receive the edge 48 of the upper end of the outer covering 14 as best seen in Fig. 9. The skirt has a lower inside beveled face 49 on the extreme end 50 so that the material 51 of the covering 14 can flow around the end of the skirt and bear against the outer surface 52 of the sheath 10.

Fig. 10 shows the same arrangement but it will be noted that the cone 20 has been moved downwardly a slight distance from the position in Fig. 9 due to the pull on the sheath and upon the head in excess of that required to place the parts in the relative positions shown in Fig. 9.

The lower head will be formed in a similar manner.

The outside covering may be applied either before the operations which have been described or thereafter as desired so long as such covering 14 is closely disposed about the sheath and serves as a covering therefor to protect the sheath and resist abrasion in the lowering and raising of the entire packer assembly in the well. Any suitable pipe connection may be made to the threaded exterior surface 55 on the nipple 22.

In Fig. 1, particular attention is directed to the recessed annular groove 65 which is provided in the outer periphery 66 of the covering of the packer. This is shown as a rather flat V-type or shape of groove where the covering material is rather thin at 67 so that there will be a lesser volume of material at this particular area.

Fig. 2 shows the particular reason for the thinning of this area at 67 when the packer is inflated.

Upon inflating the packer, the hollow chamber 68 in the packer will have liquid introduced therein so as to cause distortion of the packer including the inner liner, the sheath and outer covering. This distortion is a gradual distorting or enlarging movement which will cause the packer to enlarge radially and contract axially to such an extent that the outer periphery 66 of the outer covering 14 will move firmly against the surface 70 which is the wall of the well bore 71 to prevent the flow of fluid be-

tween the surfaces of contact such as the packer periphery 66 and the well surface 70.

The radial and axial movement of the packer causes the outer periphery to engage the well wall and the pressure will tend to cause the outer covering 14 to flow axially along the well bore so that it has a tendency to escape into the area 71 above and below the packer due to this radial pressure caused by the inflating of the packer.

In actual practice, it has been found that if the covering 14 is of a uniform thickness that there is excess extrusion of the covering material at the point 67 where the pressures are unrestricted due to the curvature of the reinforcing strands and due to the existence of lesser pressures in the chamber 71 above and below the packer.

It has been found also that the flexure of the inner liner, the sleeve and the covering is such that the parts take the curved position best seen in Fig. 2, and if the recess or groove 65 is provided, then there is a restriction at the point 67 so that the outer covering is held firmly in position and there can be no wadding or distortion of the covering material at such location.

The lower end of the packer is similarly formed as seen in Figs. 1 and 2.

Figs. 3 through 8 inclusive illustrate the construction and arrangement of the packer sleeve assembly and the association of the internal liner, the construction and arrangement of the sheath, and outer covering, as the parts are assembled and as they move to an operative position as the packer is inflated.

In Fig. 3 the parts are shown in collapsed positions and it seems obvious that there may or may not be included an opening through the pipe 6 inside of the packer, or the liquid may be circulated down through the pipe which is connected to the head 3 and through the head 4, if desired. Such an arrangement depends entirely upon the circumstances and characteristics of the packer and the use to which it is to be adapted.

Particular attention is directed to the arrangement of the strips or strands of braided material 81 which are arranged axially of the packing sleeve. Any suitable number of these strips may be employed depending upon the collapsed and expanded positions which the packer is to take. As seen in Fig. 3, these strips are lapped one over the other so that they overlap a substantial distance with the adjacent faces of the strands in close engagement with each other.

The strips as shown are arranged on an arc with respect to any radii so that the inner edge 82 of each strand is formed as a lip 83 which tapers to a relatively thin edge at 84 as best seen in Figs. 5 and 7.

While each strip is substantially of uniform thickness throughout the body portion 85, this inner lip 83 is tapered. The outer edge 86 may be substantially square as at 87 in Fig. 6 or it may be formed with a lip 88 as shown in Fig. 8. In either instance, it is intended that the strips will overlap each other.

Each strip 81 is formed with a braid or weave 90 of a suitable wire having a high tensile strength and may be braided as at 91 in Figs. 6 and 8.

These braids or individual portions of the wire mesh are relatively flexible and arranged so that they can follow the curvature created by the pressure internally and externally of the packer.

In order to prevent the extrusion of either the inner liner 12 or the intrusion of the outer covering 14 through the strands or wires of the strips, each of the strips has been coated with a suitable material which will fill the voids between the adjacent wires such as the openings 92 in Figs. 6 and 8. Any suitable material may be used but in actual use a form of nylon or hard rubber has been found to be exceptionally satisfactory in a well bore.

This material is coated on the strip of braided wire and then sufficient pressure applied to cause it to penetrate the various openings between the braids and to form a smooth outer surface 94 as seen in Fig. 8. These surfaces are relatively smooth so that the wires will not project and so that the adjacent strips may slide both radially and axially as the pressures require.

As seen in Fig. 5, the lips 83 merge gradually with the underlapping and overlapping strips and with the inner liner 12. In this manner, the strips are relatively free, it might be said, to slide one with respect to the other. For instance, when the packer sleeve is collapsed as in Fig. 3, there is a substantial overlapping of the various strips while when the packer is expanded as seen in Fig. 4, the amount of overlap has been substantially reduced. Fig. 3 shows as many as five laps of the strips in the collapsed position but this is merely illustrative whereas in Fig. 4 a majority of the lapped areas constitute only two overlapped strips. This arrangement can be varied, of course, depending upon the assembly of the strips in constructing the packer.

The inner liner and the outer covering are sufficiently flexible that they will merge in with the edges of the strips to form a substantially composite structure which will resist tremendous pressures.

As seen in Fig. 7 the lips 88 merge with the surface 96 against which the reinforcing sheath is to bear. It is to be definitely understood that in some instances there may not be any outer covering 14 provided and the strips may bear against a surface 96 which may be the earth formation 97 in the well bore.

Such surface 96 may be the inside of any pipe or any area which is to be sealed. In Fig. 5, the outer edge of the strips may be formed substantially square as at 87 and the outer covering 14 will merge therewith in accordance with the pressures which are being applied while the inner surface of the strips will merge with the inner liner 12 as the case may be.

In some instances such as Fig. 7 the seal of the strips is accomplished by the flexible lip constructions as at 84 and the inner liner 12 omitted.

The vertical section of Fig. 1 and of Fig. 2 show the section longitudinally through two overlapping strips but the invention is not so limited.

It is believed that the construction and arrangement will be readily understood from the foregoing description. While one manner of assembly has been explained, it is to be understood that the strips may be arranged and anchored as desired and that broadly the invention contemplates the arrangement of the assembly of structure to provide a packer which will resist tremendous internal and external pressures in actual operation.

What is claimed is:

1. A hydraulically inflatable packer comprising a composite sleeve like body, a head at each end thereof, said body comprising an inner resilient expansible and contractible liner, a reinforcing sheath thereabout, said sheath comprising a plurality of strips of coated wire extending longitudinally between said heads, said strips extending circumferentially of said liner and each of said strips overlapping the next adjacent strip the full length thereof between said heads whereby said sheath is expansible and contractible as said liner expands and contracts, and an expansible and contractible covering overlying said sheath, each head comprising a nipple, a hollow skirt thereon, an annular beveled face on the lower end of said skirt, a tapered bowl in said skirt, a wedge collar slidable into said skirt within said bowl, the end of said sheath extending into said bowl to receive said collar so that wedging of said collar in the end of said sheath and said sheath in the bowl provides an anchor to resist axial pull on said sheath relative to said head.

2. A hydraulically inflatable packer comprising a composite sleeve like body, a head at each end thereof, said body comprising an inner resilient expansible and contractible liner, a reinforcing sheath thereabout, said sheath

comprising a plurality of strips of coated wire extending longitudinally between said heads, said strips extending circumferentially of said liner and each of said strips overlapping the next adjacent strip the full length thereof between said heads whereby said sheath is expansible and contractible as said liner expands and contracts, and an expansible and contractible covering overlying said sheath, each head comprising a nipple, a hollow skirt thereon, an annular beveled face on the lower end of said skirt, a tapered bowl in said skirt, a wedge collar slidable into said skirt within said bowl, the end of said sheath extending into said bowl to receive said collar so that wedging of said collar in the end of said sheath and said sheath in the bowl provides an anchor to resist axial pull on said sheath relative to said head, said liner extending into said collar and into said nipple so that fluid pressure in the liner will seal the liner in the nipple and collar while the axial pull on said sheath will anchor the sheath and head together.

3. A retainer and reinforcing sheath for hydraulically inflatable packers comprising an annulus formed of a plurality of strips of longitudinally arranged strands of braided metal, each of said strips overlapping the next adjacent strip the full length thereof, and each strip being impregnated with a relatively thin coating of a material to flex with the strip, such coating extending laterally beyond the edge of the strip to provide an edge of sealing material to merge the lapped strips and to prevent leakage or extrusion at the edge of the lapped strips or therebetween.

4. In an anchor head for hydraulically inflatable packers, a nipple to support the packer, a depending skirt thereon, a bowl in said skirt, a wedge collar in said bowl, a lip on said collar, a recess in the end of said nipple for said lip, a radial groove down said lip and across said collar, a packer reinforcing sheath anchored in said bowl by said collar, said groove serving to equalize pressure across said collar.

5. A retainer and reinforcing sheath for an expansible hydraulic packer comprising a plurality of strips forming an annulus, each of said strips comprising strands of metal braided together, each of said strips extending continuously and longitudinally end to end of the annulus and overlapping the next adjacent strip along the length thereof, an anchor for the strips at each end of the annulus and each strip impregnated with a coating of flexible material with such coating extending beyond the edge of said strip to form a lip of sealing material therealong.

6. An inflatable hydraulic packer construction comprising an inner liner of expansible material, an expansible sheath surrounding said inner liner, a head overlying and receiving each end of said liner and said sheath, an expansible covering for said sheath, and an annular recessed portion on the outer periphery of said covering spaced longitudinally on said covering from each of said heads so as to be disposed at the external areas of greatest flexure of said packer to reduce the thickness of said covering whereby said sheath may flex outwardly to compress the covering against the surface being sealed and to thereby confine the covering between the upper and lower areas of greatest flexure.

7. An inflatable packer including an expansible sheath, said sheath comprising a plurality of longitudinally extending strips, each of said strips slidably overlapping the next adjacent strip, a covering material on said sheath to flex with said sheath, a head receiving each end of said sheath, and there being annular recessed portions on said covering material spaced longitudinally thereon from said heads whereby said sheath may flex outwardly about the areas of greatest flexure to aid in confining the covering between such areas.

8. An inflatable packer for a well bore including an expansible sheath, said sheath comprising a plurality of longitudinally extending strips, each of said strips movably overlapping the next adjacent strip, a resilient covering material on said sheath to flex therewith, and there being an annual or recessed portion on said covering material disposed about the external areas of greatest flexure of the packer to inhibit flow of the covering along the well bore.

9. An inflatable packer comprising, an inner liner of expansible material, an expansible sheath surrounding said inner liner, said sheath comprising a plurality of longitudinally extending strips, each of said strips overlapping the next adjacent strip, a covering material on said sheath to flex with said sheath, and there being an annular recessed portion on the outer periphery of said covering material spaced longitudinally on said covering material from each end thereof so as to be disposed about the external areas of greatest flexure of the packer to reduce the thickness of said covering whereby said sheath may flex outwardly at the areas of greatest flexure to confine the covering between such areas.

10. A retainer and reinforcing sheath for an expansible hydraulic packer comprising a plurality of strips forming an annulus, each of said strips comprising strands of metal braided together, each of such strips extending continuously and longitudinally end to end of the annulus and slidably overlapping the next adjacent strip along the length thereof, an anchor for the strips at each end of the annulus, and each strip being impregnated with a coating of flexible material.

11. A reinforcing sheath for an expansible packer comprising a pair of spaced heads, a plurality of strips forming an annulus, each of said strips comprising strands of metal braided together, each of said strips extending continuously and longitudinally of the annulus and slidably overlapping the next adjacent strip along the length thereof, means for anchoring the annulus to said heads, and each strip being impregnated with a coating of flexible material.

12. A reinforcing for an expansible packer comprising a pair of spaced heads, a plurality of strips forming an annulus, each of said strips comprising strands of material braided together, each of said strips extending continuously and longitudinally of the annulus and slidably overlapping the next adjacent strip along the length thereof, means for anchoring the annulus to said heads, and each strip being impregnated with a coating of flexible material.

13. An expansible packer comprising, a pair of spaced heads, a plurality of strips forming an annulus, each of said strips comprising strands of material braided together, each of said strips extending continuously and longitudinally of the annulus and slidably overlapping the next adjacent strip along the length thereof, each strip being impregnated with a flexible material, means for anchoring the annulus to said heads, and a covering of resilient material on the outside of the annulus.

14. An expansible packer comprising, a pair of spaced heads, a plurality of strips forming an annulus, each of said strips comprising strands of metal braided together, each of said strips extending continuously and longitudinally of the annulus and slidably overlapping the next adjacent strip along the length thereof, each strip being impregnated with a flexible material, means for anchoring the annulus to said heads, and a covering of resilient material on the outside of the annulus.

15. An inflatable packer comprising a pair of spaced heads, a plurality of flexible strips forming an annulus, such strips extending continuously and longitudinally end to end of the annulus, said strips arranged substantially parallel to the longitudinal axis of the annulus and slidably overlapping the next adjacent strip along the length thereof, a covering of resilient material on the exterior of said strips, and means for securing said annulus to said heads.

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