June 27, 1939. J. W. MacCLATCHIE ET AL 2,163,885

LINER CONSTRUCTION

Filed Dec. 28, 1935

Fig. 1.

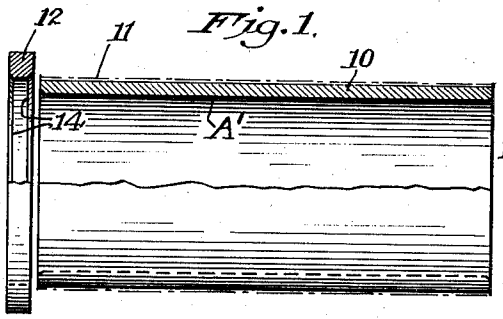


Fig. 4.

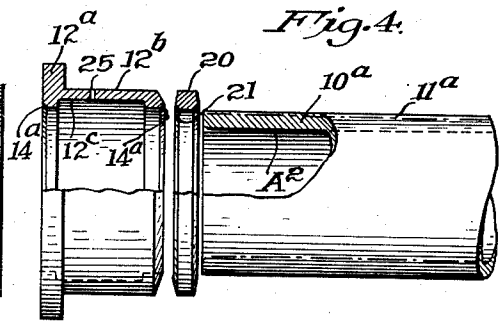


Fig. 2.

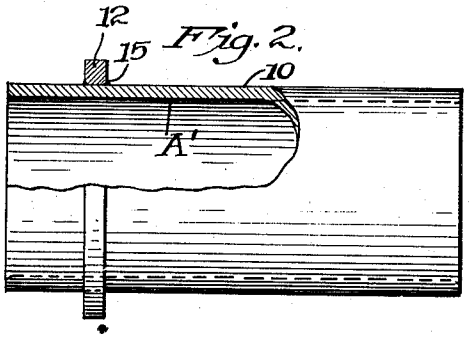


Fig. 5.

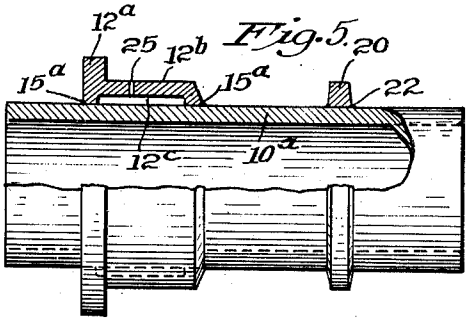


Fig. 3.

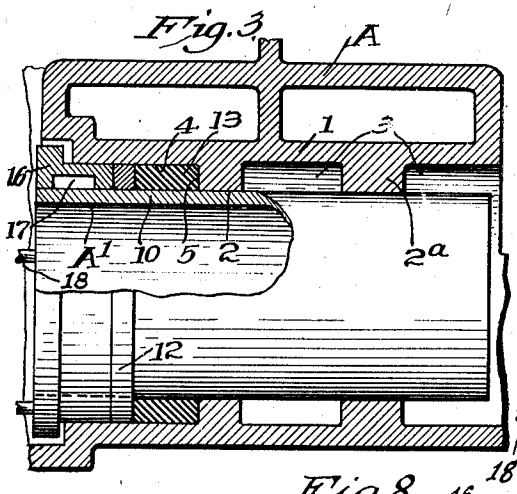


Fig. 6.

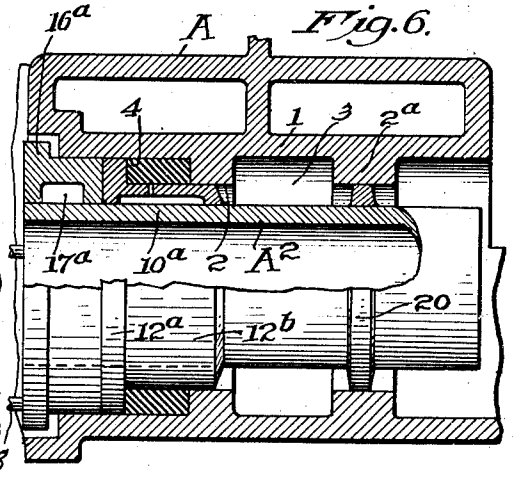


Fig. 7.

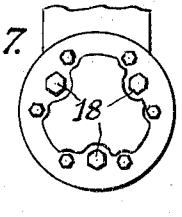
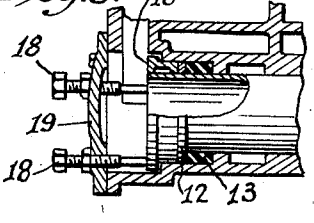


Fig. 8.



INVENTORS:
John W. MacClatchie,
Glenn D. Johnson,
Carl A. Thues.

BY R. W. Smith

ATTORNEY.

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UNITED STATES PATENT OFFICE

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LINER CONSTRUCTION

John W. MacClatchie, Los Angeles, Glenn D. Johnson, Compton, and Carl A. Thies, Huntington Park, Calif., assignors, by direct and mesne assignments, to MacClatchie Manufacturing Company of California, Compton, Calif., a corporation of California

Application December 28, 1935, Serial No. 56,486

12 Claims. (Cl. 29—156.4)

This invention relates to liner construction for the cylinders of pumps and the like, and has for its object to provide a series of readily removable liners of different size bores for each particular make and size of pump, and to manufacture the liners in a simple and inexpensive manner.

More particularly it is an object of the invention to employ economically and readily commercially available cylindrical tubing for the liners proper, this tubing being of wear resisting material of uniform and preferably comparatively thin wall section with no shoulders nor projections and preferably having the same wall thickness for liners of different bore, with retaining means cooperating with the liner proper and preferably made of less expensive material and being operatively assembled with relation to the liner proper in an economical and simple manner and providing for convenient removal and replacement of the liner.

It is a still further object of the invention to simplify the manufacture of a series of liners of different size bores for each of the various makes and sizes of pumps, the different pumps varying considerably in their dimensions so that in order for a liner to fit any particular pump it must have a specified length and a specified external diameter along its portion which is adapted to fit snugly in the pump cylinder, and its means for longitudinally engaging the cooperating abutment shoulder of the pump cylinder must be spaced a specified distance from the ends of the liner, all as determined by the dimensions of the particular pump for which the liner is designed, and in order that a series of liners of different size bores may be interchangeably mounted in the particular pump, these specified liner dimensions must be maintained throughout a series of liners of different internal diameter.

By the present invention a complete stock of liners of different size bores for each of the various sizes and makes of pumps may be economically manufactured, or a liner of specified bore and fitting a particular make and size of pump may be quickly fabricated if not in stock, it being simply necessary to have on hand tubing of different internal diameters corresponding to the various liner bores, with the different sizes of tubing preferably having the same wall thickness and being straight cylindrical tubing without external shoulders or projections. A length of tubing of specified internal diameter is used for all liners of that bore irrespective of the particular make and size of pump, and an annulus of less expensive material is fixed on this tubing in a simple and economical manner, with the annulus of such external diameter and so positioned on the tubing as to adapt the exterior of the fabricated liner for snug fit within the cylinder of the particular pump for which the liner is designed.

It is a still further object of the invention to provide a packing annulus for the fabricated liner whereby it may be packed off in the pump cylinder, and to interchangeably employ packers of the same size for all the liners of different size bores for any one particular pump.

It is a still further object of the invention to secure the fabricated liner and its packing annulus in the pump cylinder by means of a separate follower gland of inexpensive material which may be readily fixed in place or as readily removed for convenient withdrawal and replacement of the liner, the glands being manufactured in such different sizes as will provide a gland of proper dimensions for use with each of the series of liners of different size bore, for each particular make and size of pump.

Further objects of the invention will be readily understood from the following description of the accompanying drawing, in which:

Fig. 1 is a side elevation, partly in axial section, showing the tubing stock from which the liner proper is made, and showing the annulus which is to be fixed on the liner proper to form a master liner for a particular size and make of pump.

Fig. 2 is a side elevation of this fabricated master liner, partly in axial section.

Fig. 3 is an axial section through a cylinder of a pump, showing the master liner in operative position.

Fig. 4 is a view similar to Fig. 1, showing tubing stock and cooperating annuli employed in fabricating a reduced liner for the same pump.

Fig. 5 is a view similar to Fig. 2, showing this reduced liner.

Fig. 6 is a view similar to Fig. 3, showing the reduced liner operatively mounted in the pump.

Fig. 7 is an end view of part of a pump showing the cover and gland setting bolts.

Fig. 8 is a vertical axial section through a cylinder of a pump showing the master liner in operative position with the gland, master liner and packer fixed in position by means of the gland setting bolts.

Liners constructed in accordance with this invention are adapted for mounting in the cylinders of pumps and the like, particularly slush pumps used in oilfields, a cylinder of such a pump being shown at Figs. 3 and 6. The cylinder of the pump A has a usual bore 2 for a liner,

counterbored at its inner end 3 to provide clearance for the liner, and counterbored at its outer end 4 to form a shoulder 5. The bore 2 forms a guide bearing for transversely centering the liner and the shoulder 5 provides an abutment for longitudinally positioning the liner in the cylinder. Any particular make and size of pump is adapted to have either a master liner or any one of different sizes of reduced liners mounted in its cylinder. A master liner for the particular pump A has a master bore A^1 which is of a diameter merely twice the wall thickness of the liner less than the diameter of the bore 2 of the particular pump as shown at Fig. 3, and a reduced liner for the particular pump A has a reduced bore A^2 of any specified smaller diameter as shown at Fig. 6.

Heretofore one method of constructing liners has been the use of forgings or castings fitting snugly in the bore 2, with an integral external enlargement at the outer end of the forging or casting fitting in the counterbore 4, preferably with a packer sleeve mounted in the counterbore 4 between the shoulder 5 and the inner end of the integral enlargement of the liner. Liners of this type are made with bores of different diameters to provide either a master liner or various sizes of reduced liners, by employing forgings or castings all having the same external dimensions for the series of liners for a particular pump, but having different internal diameters providing the desired series of liner bores. This method results in a series of liners of different wall thickness depending upon their different bores, and is an expensive method in that a different forging or casting is required for each of the series of liners for each particular pump, and results in liners of excessive wall thickness, particularly in the reduced liners of small bore.

To overcome some of these disadvantages liners have been constructed with the liner proper of uniform external diameter throughout its length adapting it to fit snugly in the bore 2 of a particular pump, with a series of these liners having different internal diameters so as to provide both a master liner and a plurality of reduced liners for that particular pump, and with each of this series of liners externally threaded at its outer end for reception of a threaded gland which fits snugly in the counterbore 4 of the particular pump, leaving the desired space for a packer sleeve between the inner end of the threaded gland and the shoulder 5 of the pump cylinder. With such construction it is often extremely difficult if not impossible to remove the threaded gland after the liner has been in use and the liner proper has become worn so that it is necessary to replace it, and the walls of the series of liners for a particular pump are of different thickness according to the different bores of the series of liners, resulting in excessive wall thickness in the reduced liners of small bore and necessitating different tubing stock for each of the series of liners for each particular pump.

It has also been proposed to mount the liner proper in an adapter which fits in the bore 2 of the particular pump and extends the length of the pump cylinder, with an external enlargement at the outer end of the adapter received in the counterbore 4 and cooperating with a packer sleeve, and with internal flanges at the ends of the adapter clamping the ends of the liner proper. The liner proper may be tubing stock of uniform wall thickness without external projections, varying in internal diameter to provide the different liner bores and preferably also varying in external diameter to maintain substantially the same wall thickness in the different liners, and the internal flanges at the ends of the adapter are made in different sizes, interchangeable in the adapter to engage the different sizes of liner stock. Such a construction is expensive in that in addition to the liner proper, the adapter extends the full length of the pump cylinder, and a different adapter is required for each particular make and size of pump, and a packer sleeve of different size is required for each of the series of liners for each particular pump.

Liners have also been constructed wherein the liner proper has been of uniform wall thickness except for a slight external shoulder against which a separate annulus has been fixed, this annulus being adapted to properly position the liner in the pump cylinder. Such construction makes it necessary that for both master liners and for reduced liners one end of the liner stock be reduced in its external diameter to form the external shoulder, resulting in waste of material and requiring machining, with this machine operation different for the liners for each particular pump according to the particular spacing of the shoulder 5 from the ends of the pump cylinder, or the liner stock must be initially formed with the external shoulder, making it impossible to use drawn tubing and requiring different stock, with the shoulder properly positioned, for each different pump.

In the present invention the same tubing stock is employed for each size of liner bore irrespective of the particular make and size of pump in which the liner is to be used; and consequently it is only necessary to stock tubing with different internal diameters providing the different liner bores, without stocking tubing of different external diameters in each of these different bore sizes. The tubing stock of different bores may thus be of substantially the same wall thickness, making for economy in manufacture and providing liners none of which are of excessive wall thickness. The tubing stock is straight cylindrical stock of uniform diameter without external shoulders or projections. Drawn tubing may thus be employed, with the tubing stock manufactured in any convenient length, thus making for economy. The tubing stock is of suitable wear resisting material and is preferably of relatively thin wall section.

To fabricate a liner of specified bore for a particular make of pump, tubing stock of the specified bore is cut to the proper length to fit the particular pump. A length of stock to form a liner having master bore A^1 for a particular pump A is shown at 10 (Fig. 1). Since in the different makes of pumps the cylinder bore 2 may have a slightly different diameter for any particular master bore, the tubing for the liners is stocked in sizes whereby that tubing having any specified master bore has an external diameter adapting it for snug fit in the cylinder bore of that make of pump which has the largest bore 2 for that particular master size. The tubing stock may thus be used as it comes from the factory for all makes of pumps which have their bore 2 of this maximum size, but when used to fabricate a master liner for a pump which has a bore 2 of smaller diameter, the stock is first machined down slightly to the proper external diameter to fit in the particular bore 2, as indicated at 11 (Fig. 1).

An annulus which comprises an abutment collar

12 is fitted on this master liner, and as shown at Fig. 1 is of an internal diameter to just slide on the liner 10 and has an external diameter to just slide in the counterbore 4 of the particular pump A. The collar 12 is fixed on the liner at such distance from its ends as to cooperate with the shoulder 5 of the particular pump for properly longitudinally positioning the liner as shown at Fig. 3, preferably with a packer sleeve 13 between the collar 12 and the shoulder 5. The collar 12 need not be of the same wear resisting material as the liner 10 since it is not subject to wear, and therefore is preferably made of less expensive material than the liner proper. The collar may be fixed in place by welding it to the liner proper, the ends of the bore of the collar being preferably beveled as shown at 14 to receive the welding. The complete liner is shown at Fig. 2, collar 12 being welded as shown at 15.

When the liner is mounted in the pump as shown at Fig. 3, the external diameter of the liner proper fits snugly in the bore 2 for guiding and centering the inner end of the liner, and the collar 12 fits snugly in the counterbore 4 for guiding and centering the outer end of the liner. The packer 13 between the collar 12 and the shoulder 5 longitudinally positions the liner, and the packer is compressed and the liner held in place by a gland 16 which slides over the outer end of the liner proper and abuts the collar 12. The gland 16 being subject to no wear may be made of less expensive material than the liner 10, and in order to reduce its weight it may be internally recessed as shown at 17. As shown in detail in Figs. 7 and 8 the gland 16 is held in place by usual gland setting bolts 18 which extend through the closure cap 19 for the end of the pump cylinder, and which exert longitudinal pressure against the gland 16, which gland setting bolts 18 are maintained in position by usual lock nuts. By removing these bolts the liner may be readily replaced when worn, the gland 16 being readily removed from the liner proper due to its sliding reception thereon, so that the gland may be used again with a new liner 10—12. The packer 13 is also readily replaced when worn, by sliding it off the liner when the latter has been removed from the pump.

To fabricate a liner for the same pump A but having a liner bore A^2 which is smaller than the master bore A^1, tubing stock of the desired bore is cut to the proper length to fit the particular pump. A length of tubing to form a liner of reduced bore A^2 is shown at 10^a (Fig. 4). This tubing is that size which is stocked for making master liners corresponding in bore size to that bore A^2 which for the particular pump A is a reduced bore. This stock when used as a master liner for the corresponding smaller pump, may require slight reduction in its external diameter in order to fit the bore 2 of that particular pump as previously explained in connection with the master liner having the bore A^1, but when this stock is used to make a reduced liner for the pump A, the full external diameter of the stock is employed as indicated at 11^a (Fig. 4), requiring no machining of the tubing when making any one of a series of reduced liners.

An annulus, preferably of less expensive material than the liner proper, is fitted on the reduced liner 10^a and comprises an elongated spacer sleeve 12^b and a radially enlarged abutment collar 12^a. This annulus has an internal diameter adapting it for snug sliding fit on the tubing stock which has been used for the liner 10^a, and the spacer sleeve 12^b has an external diameter and is of a length adapting it for snug fit in the bore 2 of the particular pump A, while the collar 12^a has an external diameter adapting it for snug sliding fit in the counterbore 4 of the pump. The annulus is fixed on the liner at such distance from its ends as to position the collar 12^a in the same relative position as the collar 12 for the master liner which is shown at Fig. 2, whereby the reduced liner is adapted to be properly longitudinally positioned in the pump cylinder as shown at Fig. 6, with the same packer 13 which was employed in the construction shown at Fig. 3 also employed with the reduced liner, the packer being mounted on the sleeve 12^b between the collar 12^a and the shoulder 5 of the pump cylinder.

The annulus 12^a—12^b may be welded in place, its ends being preferably beveled as shown at 14^a to receive welding 15^a, and in order to reduce weight the annulus may be internally recessed as shown at 12^c. In order to still further reduce the weight of the annulus, and in order that it may not extend along that part of the cylinder bore which is counterbored as shown at 3 and where the spacer annulus would perform no useful function, the annulus is preferably of such length that its sleeve 12^b terminates just after it enters the bore 2 as shown at Fig. 6.

A gland 16^a preferably of less expensive material than the liner proper, slides on the outer end of the liner and cooperates with the collar 12^a for releasably securing the liner in the pump cylinder, the gland being releasably engaged by usual bolts (not shown) which project through the closure cap (not shown) of the pump cylinder. The gland may be internally recessed as shown at 17^a.

When the reduced liner is of appreciable length, it is preferably guided in the bore 2 at a point longitudinally spaced from the guide means which is formed by the annulus 12^a—12^b. As an instance of this arrangement an annulus comprising a collar 20 may be fixed on the liner adjacent its inner end. This annulus has an internal bore adapting it to be slid onto the liner 10^a as shown at Fig. 4, and is preferably welded to the liner as shown at Fig. 5, the bore of the annulus being preferably beveled at its ends as shown at 20 to receive the welding 22. The external diameter of the collar 21 is such as to fit snugly in the bore of the pump cylinder of the particular pump A, and when in accordance with usual practice the counterbore 3 is interrupted by a guide flange 2^a, the bore of which is a continuation of the bore 2, the collar 20 will have an external diameter adapting it for snug fit in the bore of this flange 2^a, and the collar is fixed on the liner at such point along its length as to transversely aline the collar 20 with the guide flange.

The welding 15 and 15^a is preferably continuous welding around the respective ends of annuli 12 and 12^a—12^b, eliminating leakage past these annuli, while the welding 22 need only be spot welding since leakage past the annuli 20 is of no consequence. After the annuli have been welded on the liners, each fabricated liner is heat-treated to provide a wear resisting liner of desired hardness, and since the welding 15^a is continuous around the respective ends of the annulus 12^a—12^b, there is possibility that gas developing during the heat-treatment may be trapped between the external periphery of the liner proper and the internal periphery of the overlying annulus 12^a—12^b. This might cause distortion of the annulus, and in order to avoid such distortion the space in which such gases might otherwise be

trapped is preferably vented, as for example by a vent 25 opening radially through the wall of the annulus 12a—12b, and through which such gases may readily escape during heat treatment of the liner. Another advantage of the recess 12c is that the distortion of the liner during the heat treatment is much less when such a recess is provided. The vent 25 preferably opens through that portion of sleeve 12b which the packer 13 overlies when the liner is in operative position in the cylinder of a pump, thereby effectively sealing this vent as shown at Fig. 6.

The annulus 20 being preferably only spot welded, there is no danger of gases being trapped under this annulus during the heat-treatment and therefore no vent need be provided through this annulus; and the annulus 12 being usually of comparatively short length, so that there is only a short length of this annulus between the welding 15 at its ends, there is no such danger of the heat-treatment resulting in gases being trapped under the short annulus 12 as to make it necessary to vent this annulus in the same manner as that of the longer annulus 12a—12b, and therefore in the illustrated embodiment of the invention no such vent for the annulus 12 is shown.

The invention as thus described provides for economical manufacture of liners of different bore, either master bore or reduced bore, for all different makes and sizes of pumps, it being simply necessary to stock tubing of uniform section without external projections, and having internal diameters corresponding to the different master bores, with the same tubing used for all liners of the same master bore irrespective of the make and dimensions of the particular pump, and with the same tubing which is used for liners of a specified master bore for a corresponding size of pump, also used in fabricating reduced liners for larger pumps.

The invention thus provides for economy in stocking such different sizes of liner tubing as will be adequate for fabricating a liner of any specified bore for any make and size of pump, and permits use of drawn tubing, with the different sizes of tubing of substantially the same wall thickness.

We claim:

1. In combination, a cylinder of a pump of specified dimensions and which is counterbored at the outer end of its main bore to form an abutment shoulder, a reduced liner, an annulus permanently secured on said reduced liner, the annulus forming a collar adapted for reception in the counterbore of the pump cylinder so as to provide a predetermined longitudinal space between said collar and said abutment shoulder when the liner is in operative position, the annulus also forming a sleeve adapted for snug reception in the main bore of the cylinder of the pump, a second annulus permanently secured on the liner stock and adapted for snug reception in the main bore of the pump cylinder, the first mentioned annulus having a vent opening through its sleeve portion, a packer on said sleeve sealing said vent and occupying the longitudinal space between said collar and said abutment shoulder when the liner is in operative position, a gland adapted to be slid onto the outer end of the liner for reception in the outer end of the counterbore of the pump cylinder, and means for maintaining longitudinal pressure against the gland to compress the packer against the collar and the abutment shoulder so as to seal off between the cylinder and the liner.

2. In the method of fabricating a liner for the cylinder of a pump, the steps of; welding a metal annulus on the exterior of a length of relatively thin-walled tubular metal liner stock of uniform external and internal diameters throughout its length to provide a liner positioning collar; heat treating the fabricated liner; and during the heat treatment venting the accumulated gases from the space formed between the inner surface of the metal annulus and the exterior surface of the thin walled liner stock.

3. In the method of fabricating a liner for the cylinder of a pump, the steps of; securing an annulus on and around a length of tubular liner stock by welding the opposite inner edge portions of said annulus completely therearound to form substantially continuous joints between the annulus and the liner stock; heat treating the fabricated liner; and during the heat treatment venting the gases that may accumulate in the space between the annulus, the liner stock and said welded joints.

4. In the method of fabricating a liner for the cylinder of a pump, the steps of; securing an annulus to form an abutment collar on and around the exterior of a length of liner stock by joining the annulus to the stock at spaced engagement surfaces around the inner side of the annulus and the stock to form substantially continuous joints there-around, providing a vent through the annulus in communication with the space between the annulus, said continuous joints and the liner stock; heat treating the fabricated liner; and during the heat treatment venting any gases from the space formed between the liner stock, said continuous joints and the annulus through said vent.

5. In the method of fabricating a liner for the cylinder of a pump, the steps of; securing an abutment collar forming annulus on and around the exterior of a length of tubular liner stock, said annulus having a recess in its inner side; heat treating the fabricated liner; and during the heat treatment venting any gases that may accumulate, from the space formed between the annulus and the liner by said annulus recess.

6. In the method of fabricating a liner for the cylinder of a pump, the steps of; providing a length of relatively thin-walled cylindrical metal tubing stock; securing a metal abutment collar forming annulus having a recess around its inner side, to and around the exterior of said length of tubing stock, heat treating the liner so formed; and during the heat treatment venting any gases that may have accumulated in the space formed by said recess between the tubing stock and the annulus.

7. In the method of fabricating a liner for the cylinder of a pump, the steps of; providing a section of metal tubing stock of uniform external and internal diameter throughout its length and which section has a length as required for the completed liner for the pump cylinder; positioning a metal annulus on and around the exterior of said length of tubing stock in a predetermined position relative to one end of said length of stock to provide a positioning collar for the liner; permanently securing said annulus in such predetermined position by forming substantially continuous joints between the opposite inner edge portions of the annulus and said liner, and then heat treating said fabricated liner.

8. In the method of fabricating a liner for the

cylinder of a pump, the steps of; providing a section of relatively thin-walled metal tubing stock of uniform external and internal diameter throughout its length and which section has a length that is required for the completed liner for the pump cylinder; securing a metal annulus to and around the exterior of said length of tubing stock to form an abutment collar in a predetermined, permanently fixed position relative to one end of said length of stock; heat treating said fabricated liner; and during the heat treatment thereof, venting any gases that may accumulate in the space between the metal annulus and the tubing stock to prevent distortion of the liner.

9. In the method of fabricating a liner for the cylinder of a pump, the steps of; securing a liner positioning collar forming annulus having a recess in its inner side, tightly on and around the exterior of a length of tubular liner stock with the recess substantially closed by the liner stock, heat treating the fabricated liner; and during the heat treatment venting any gases that may accumulate from the closed space formed by said annulus recess between the annulus and the liner stock.

10. In combination, a cylinder of a pump of specified dimensions and which is counterbored at the outer end of its main bore to form an abutment shoulder, a reduced liner, an annulus permanently secured on said reduced liner, the annulus forming a collar adapted for reception in the counterbore of the pump cylinder spaced a substantial distance from the abutment shoulder so as to provide a longitudinal space of substantial length between the collar and said abutment shoulder when the liner is in operative position, the annulus also forming a sleeve adapted for snug reception in the main bore of the cylinder of the pump, a second annulus secured on the liner stock and adapted for snug reception in the main bore of the cylinder of the pump, a packer of a longitudinal length at least equal to the longitudinal length of said collar on said sleeve adapted to extend between and occupy the longitudinal space between said collar and the abutment shoulder when the liner is in operative position, a gland adapted to be slid onto the outer end of the liner for reception in the outer end of the counterbore of the pump cylinder in position bearing directly against said collar, and means for maintaining longitudinal pressure against the gland to compress the packer between the collar and the abutment shoulder so as to seal off between the pump cylinder, the collar, the liner and the abutment shoulder.

11. In combination, a cylinder of a pump having a main bore which is counterbored at its outer end to form an abutment shoulder, a liner for said pump cylinder formed by a cylindrical metal tubular member, an annulus secured on the exterior of said tubular member in fixed position spaced from one end thereof to provide a collar around said member adapted for reception in the counterbore of said pump cylinder and spaced a substantial distance from said abutment shoulder, a packer of a longitudinal length at least equal to the longitudinal length of said collar around said member extending and occupying the space between said collar and the abutment shoulder formed by said counterbore, a gland member adapted to be positioned over the outer end of said tubular member within the outer end of said counterbore and in position bearing directly against said collar, and means for maintaining pressure against said gland member to force said gland member against the collar to compress the packer between the collar and the abutment shoulder so as to seal off between the pump cylinder and the liner.

12. In combination, a cylinder of a pump having a main bore which is counterbored at its outer end to form an abutment shoulder, a liner for said pump cylinder formed of a length of cylindrical metal tubing stock of substantially uniform external and internal diameters throughout its length, an annulus permanently secured on and around the exterior of said section of tubing in fixed position spaced from one end thereof to provide a collar around the tubing adapted for snug reception in the counterbore of said pump cylinder in position spaced a substantial distance from said abutment shoulder, a packer having a longitudinal length at least equal to the longitudinal length of said collar, said packer being mounted around the liner positioned in and substantially occupying the space between said collar and the abutment shoulder, a member adapted to be positioned on the outer end of the liner for reception in the outer end of the counterbore of the pump cylinder in position bearing directly against said collar, the said member being mounted for movement longitudinally of the liner, and means for maintaining pressure against said member acting longitudinally of the liner to force said member against the collar to compress the packer between the collar and the abutment shoulder so as to seal off between the pump cylinder, the collar, the liner and said abutment shoulder.

JOHN W. MacCLATCHIE.
GLENN D. JOHNSON.
CARL A. THIES.