March 12, 1968 J. C. WEBBER 3,372,649

WELL SWABS

Filed April 25, 1966 4 Sheets-Sheet 1

Fig. 1

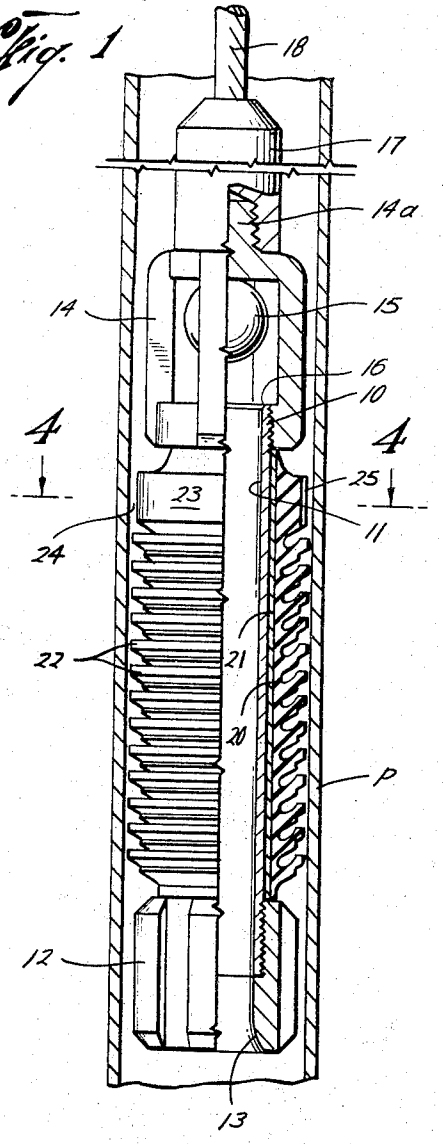


Fig. 2

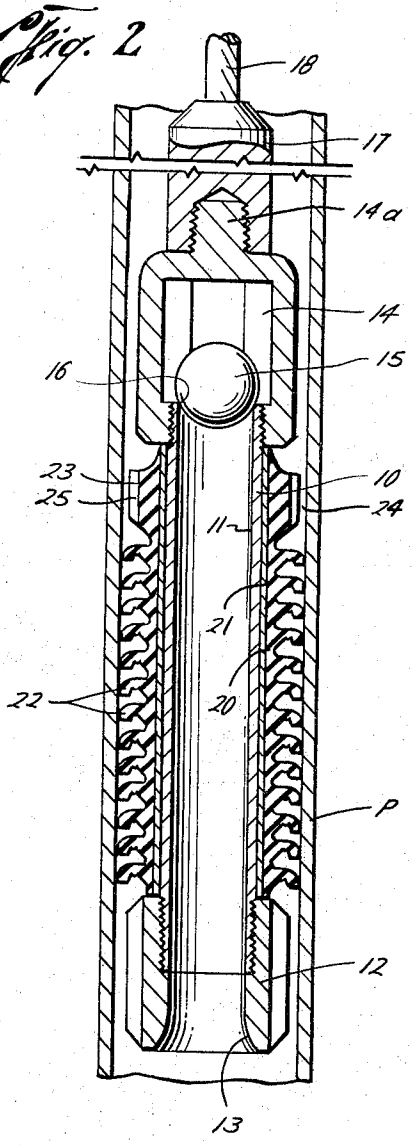
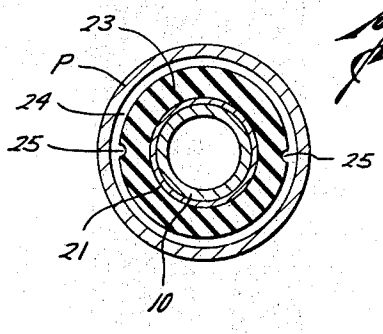


Fig. 4



Jack C. Webber
INVENTOR

BY Vincent Martin
Jos. E. Edwards
M. H. Gary
ATTORNEY

March 12, 1968 J. C. WEBBER 3,372,649

WELL SWABS

Filed April 25, 1966 4 Sheets-Sheet 2

Fig. 3

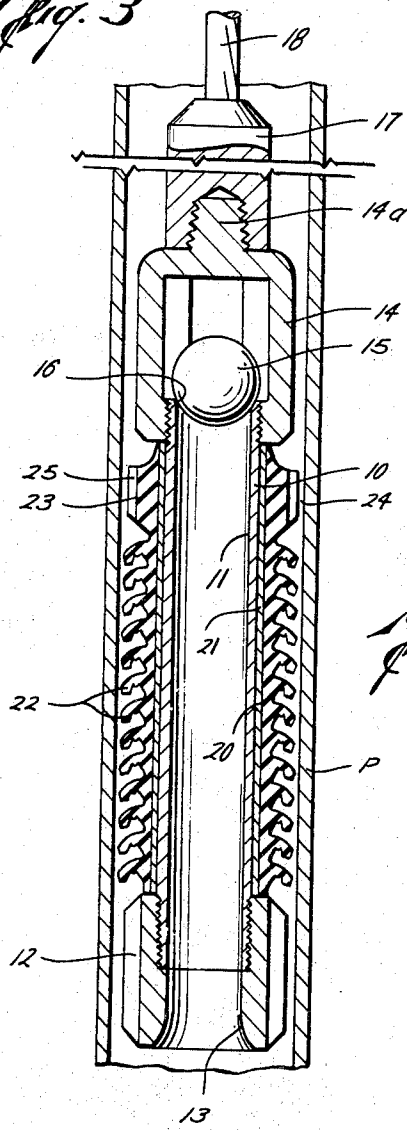


Fig. 5

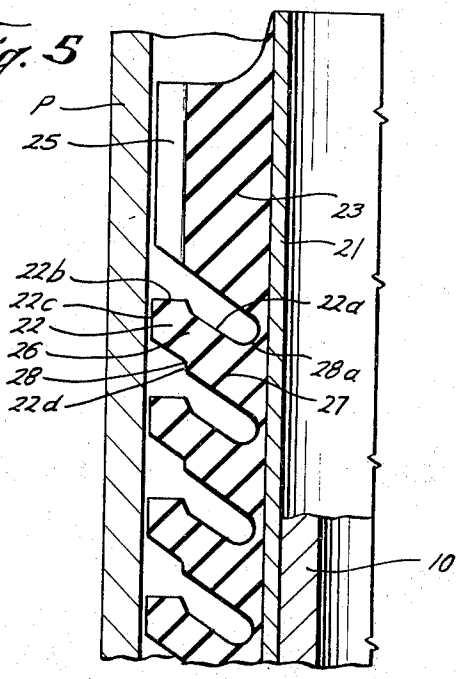
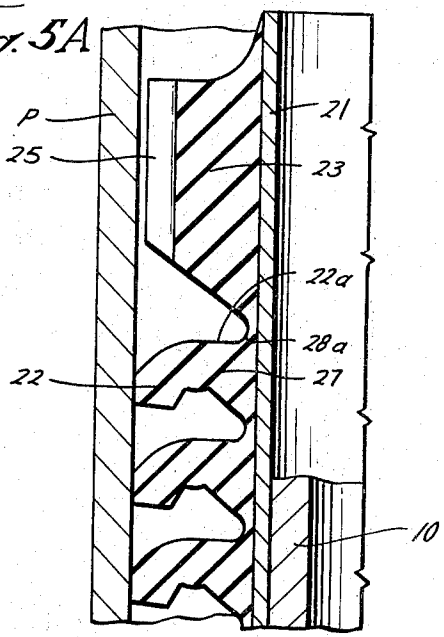


Fig. 5A



Jack C. Webber
INVENTOR

BY J. Vincent Martin
Jos E. Edwards
M. H. Gay
ATTORNEYS

March 12, 1968 J. C. WEBBER 3,372,649

WELL SWABS

Filed April 25, 1966 4 Sheets-Sheet 3

Fig. 6

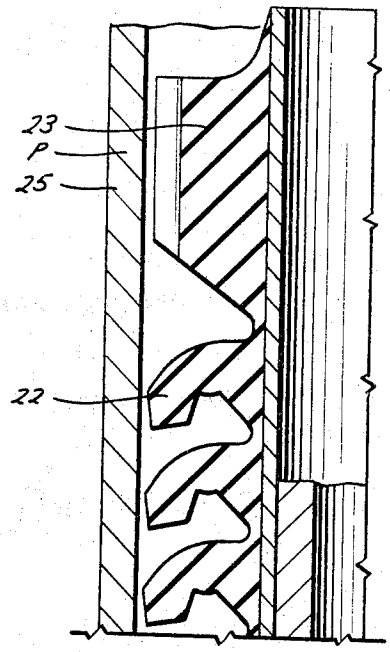


Fig. 7

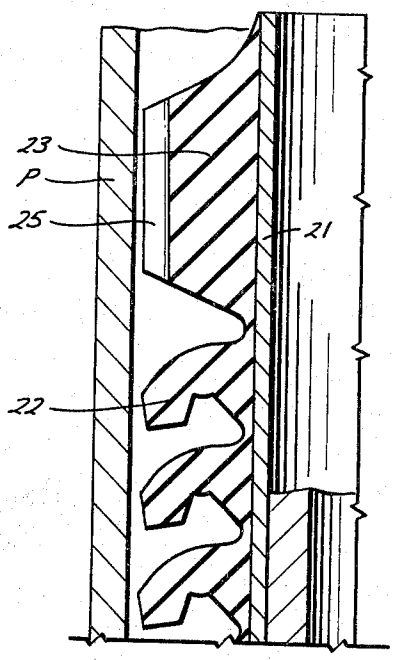


Fig. 8

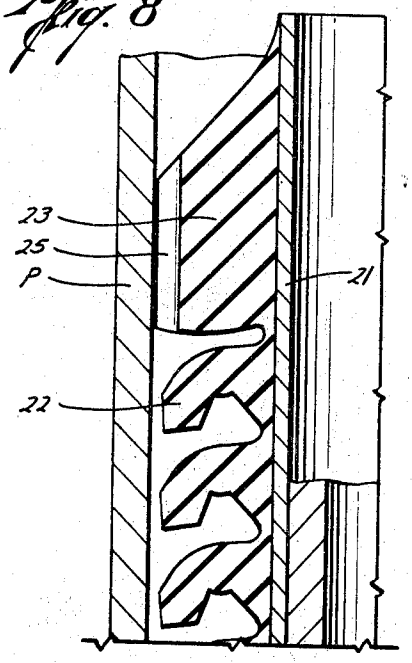
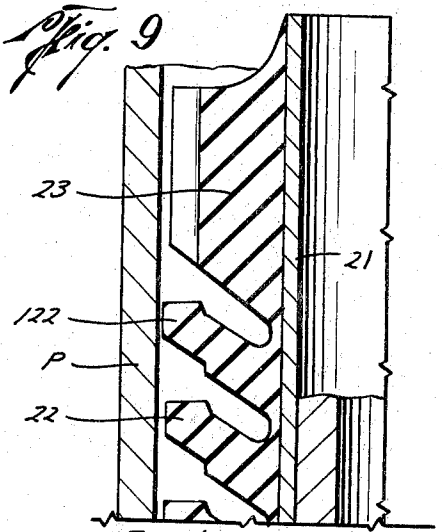


Fig. 9



Jack C. Webber
INVENTOR

BY J. Vincent Martin
Jos E. Edwards
M. H. Gary
ATTORNEYS

March 12, 1968 J. C. WEBBER 3,372,649

WELL SWABS

Filed April 25, 1966 4 Sheets-Sheet 4

Fig. 10

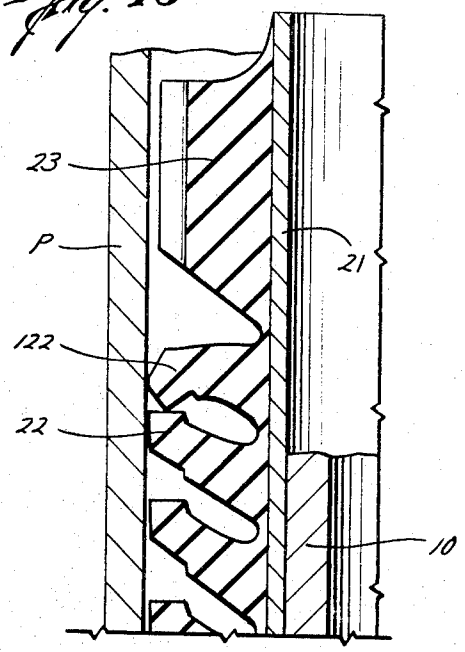


Fig. 11

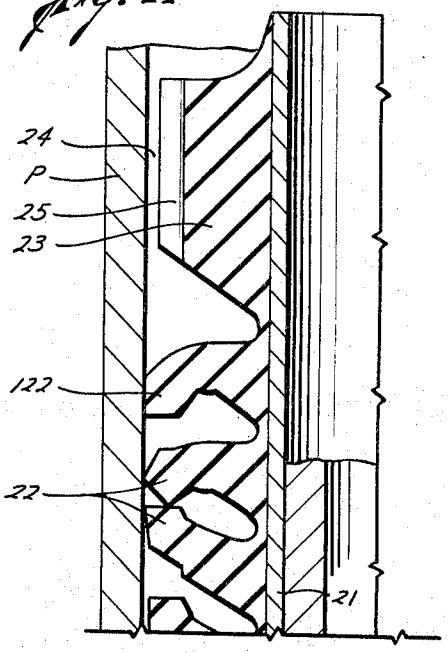


Fig. 12

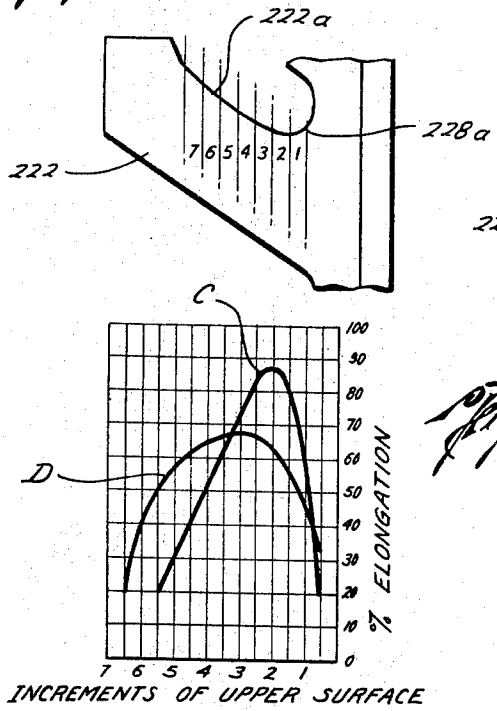


Fig. 13

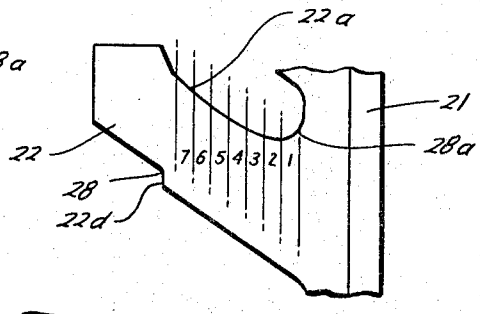


Fig. 14

Jack C. Webber
INVENTOR
BY J. Vincent Martin
Joel E. Edwards
M. H. Gay
ATTORNEYS

United States Patent Office 3,372,649
Patented Mar. 12, 1968

3,372,649

WELL SWABS

Jack C. Webber, 353 Dolphin,
Corpus Christi, Tex. 78411

Filed Apr. 25, 1966, Ser. No. 545,072
16 Claims. (Cl. 103—225)

ABSTRACT OF THE DISCLOSURE

This patent discloses a well swab in which the swab element has a plurality of flexible lips which turn down from an upwardly and outwardly extending configuration to support a load and extend further down to bypass or dump an overload. The swab element includes a choke which limits the rate of flow past the swab element and protects the lifting ribs from excessive overload conditions.

This invention relates to new and useful improvements in well swabs. The invention relates particularly to an improvement upon a multiple sealing element swab, such as is disclosed in my prior Patents Nos. 2,633,808 and 2,719,768.

In such prior swabs, a plurality of annular flexible sealing elements or lips are spaced longitudinally throughout the length of a swab unit. When the swab is lowered beneath the liquid in a well pipe and is pulled upwardly to lift the liquid, the liquid load is the energizing force which causes the sealing elements or lips to flex downwardly into sealing position with the pipe; if the liquid load is in excess of the capacity of the sealing elements, said elements flex downwardly to dump or release the excess liquid, after which the elements return to sealing position to accomplish the swabbing operation.

Experience has shown that in many instances the swab elements may be subjected to temporary or sustained overloads. For example, if the swab is lowered beneath more liquid than it has capacity to carry or if the operator, after lowering the swab below the liquid level, suddenly and rapidly begins the upward movement, the forces generated, by reason of having to overcome the inertia of a stationary column of liquid, are sufficient to move the sealing elements to a dumping position, thereby resulting in loss of some of the liquid load; if these forces are great enough, it may result in rupturing the sealing elements due to sudden and excessive flexing, or in permanent deformation of the elements which reduces the swab life. An excessive sustained overload may occur when the liquid being lifted encounters a back pressure at or near the surface of the well, as for example, where the liquid must be forced through a surface line having a back pressure therein or a line of relatively small diameter or of considerable length. Such sustained overload produces the same disadvantages of losing a portion of the liquid being lifted, thereby reducing efficiency or damaging the sealing elements by rupture or permanent deformation.

It is, therefore, one object of this invention to provide an improved well swab having, in combination with multiple spaced annular sealing elements or lips, a protective means which protects the sealing elements against excessive overload, whether such overload be temporary or sustained, whereby lifting efficiency is increased and damage to the sealing elements is obviated.

An important object of the invention is to provide an improved well swab having a protector member in the form of an annular collar of deformable material and also having a plurality of annular sealing elements which are more flexible than said collar; said elements and collar being so arranged with respect to each other that under an overload condition, the collar functions to lift liquid and at the same time protects the more flexible sealing elements from the excessive forces of said overload. When the overload condition is relieved, said collar becomes inactive for lifting purposes to permit the sealing elements to perform their normal lifting function.

Another object is to provide a well swab which includes a collar of elastic deformable material and a plurality of spaced annular flexible sealing elements which are associated in such manner that said collar functions as a choke means within the well pipe to control the bypass of liquid therearound. In its normal undistorted position, said collar permits sufficient flow of liquid past the collar to energize the sealing elements to a load-carrying position but upon an overload which would move the sealing elements to a dumping position, said collar is deformed substantially in proportion to the overload to reduce the bypass area therearound, whereby either a portion or practically all of said overload is thereafter carried by the collar and further deformation of the sealing elements due to such overload is limited to thereby protect said elements against excessive flexure or permanent deformation.

A further object is to provide a well swab of the character described wherein the deformable collar which is associated with the flexible sealing elements functions as a choke means within the well pipe and also assists in centering the swab within the pipe during its movement therein.

A particular object is to provide a swab unit construction which includes means for protecting the annular sealing elements from overloads, thereby permitting the sealing elements to be constructed with a greater degree of flexibility; the increased flexibility of each sealing element increasing the effective life of the swab unit by reason of reducing the unit bearing load against the pipe during lowering and raising of the swab within the pipe and also providing an element capable of being flexed without rupture many more times than a less flexible element; the flexibility of the sealing elements also facilitating movement of the unit through restrictions or tight spots in the well pipe.

Still another object is to provide a well swab, of the character described, wherein each sealing element is constructed to control the flexing thereof in a manner to distribute the stresses more evenly over the upper surface of the sealing element when it is energized by liquid and moved into sealing or dumping positions.

These and other objects of the present invention are hereinafter more fully described and explained.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof wherein an example of the invention is shown and wherein:

FIGURE 1 is a view partly in section and partly in elevation of a well swab assembly constructed in accordance with the invention and showing the parts thereof in the position each assumes during lowering within a well pipe,

FIGURE 2 is a transverse, vertical sectional view of the swab assembly, illustrating the parts of the swab unit in the position which they assume during the normal lifting of well fluid within the well pipe,

FIGURE 3 is a view similar to FIGURE 2 and illustrating the sealing elements in a dumping position,

FIGURE 4 is a horizontal cross-sectional view taken on the line 4—4 of FIGURE 1,

FIGURE 5 is a partial enlarged view of the upper portion of the swab unit illustrating the protective collar and the upper sealing elements in their normal position during lowering of the swab unit within the well pipe,

FIGURE 5*a* is a similar view with the sealing elements in load-carrying position,

FIGURE 6 is a view similar to FIGURE 5 and illustrating the sealing elements moved to a dumping position,

FIGURE 7 is a view similar to FIGURES 5 and 6 and illustrating the position of the protective collar in the position it assumes under one condition of overload,

FIGURE 8 is a view similar to FIGURE 7 and illustrating the position of said collar under excessively heavy overload conditions,

FIGURE 9 is a view similar to FIGURE 5 and showing a modification of the invention wherein the uppermost sealing element is of larger diameter than the other sealing elements of the swab unit,

FIGURES 10 and 11 are enlarged partial views illustrating the action of the uppermost sealing element, as well as the action of the other elements during a swabbing operation.

FIGURE 12 is an enlarged partial view of a sealing element having its entire cross-sectional area of substantially the same thickness,

FIGURE 13 is an enlarged partial view of a sealing element, constructed in accordance with the present invention, and

FIGURE 14 is a chart comparing the stress distribution across the upper surface of each of the sealing elements shown in FIGURES 12 and 13.

In the drawings, the numeral **10** designates an elongate, cylindrical mandrel having an axial bore **11** extending entirely therethrough; the mandrel forms the main support for the swab assembly. A guide shoe or nut **12** is threaded onto the lower end of the mandrel and has a central bore **13** communicating with the bore **11** of the mandrel. A valve cage **14** is secured to the upper end of the mandrel and a ball check valve **15** is confined within the cage. Said ball is adapted to seat upon an annular valve seat **16** formed at the upper end of the mandrel bore, whereby the ball valve may close the bore against downward flow but permits upward flow through said bore. A sinker bar **17** is threaded to an upstanding pin **14***a* formed on the valve cage and a cable **18** is attached to the upper end of the sinker bar, whereby the swab assembly may be lowered and raised within the bore **19** of a well pipe P. Although the particular mandrel and ball check valve has been found satisfactory, other well known types of mandrel and check valve means may be employed.

Mounted upon the exterior of the cylindrical mandrel **10** is the improved swab unit which is generally indicated by the letter A. As shown, the swab unit includes an elongate, cylindrical body portion **20**, formed of rubber or other elastic material which is preferably molded to a metallic sleeve **21**; the sleeve is slideable into position surrounding the main support or mandrel **10** and is confined thereon between the lower nut **12** and the upper valve cage **14**. A plurality of annular sealing elements or lips **22** are formed integral with the body portion **20** of the swab unit and are spaced from each other longitudinally of the unit. In its normal undistorted position, each sealing element is inclined upwardly and outwardly and its external diameter is slightly less than the diameter of the pipe bore **19**.

The metallic sleeve **21**, to which the body portion **20** and sealing elements **22** are molded, forms a part of the swab unit and has been found beneficial in providing a unitary construction; however, said sleeve is not essential and may be omitted.

As illustrated, a protector collar **23** which is also preferably integral with the body portion **20** and is of the same elastic material, is disposed above the uppermost sealing element. The collar **23** is of substantially greater length or thickness, in a longitudinal direction, than each sealing element **22**, so that it is stronger and considerably less flexible than said sealing elements. The increased length of said collar permits it to function as a centering guide for the swab assembly.

The external diameter of the collar is smaller than the diameter of the bore **19** of the well pipe to form an annular bypass area **24** around said collar; the diameter of the collar is also slightly smaller than the external diameter of the sealing lips when both are in a normal undistorted position. A pair of vertical grooves **25** are formed diametrically opposite each other in the exterior surface of the collar to provide a bypass area in addition to the annular bypass area **24**. Although the collar **23** is shown at the upper end of the swab unit, it will perform its functions just as well if it is located below the lowermost sealing element or at some point intermediate of the top and bottom sealing elements.

As will be explained, the collar **23** is adapted to be energized or deformed under overload conditions to protect the sealing elements against the forces generated by such overload; however, in normal swabbing operations performed by the sealing elements, it will retain its normal undeformed position as shown in FIGURES 1 and 5 and will act only as a choke means which permits a predetermined rate of flow of liquid through the bypass area **24** and grooves **25**.

As noted, each sealing element extends upwardly and outwardly when in its normal undeformed position. The sealing elements function in substantially the manner described in my prior Patent No. 2,633,808, being adapted to flex upwardly during lowering to bypass liquid. During raising, the elements flex downwardly to a sealing or load-carrying position to support a predetermined liquid load and then flex further downwardly to a dumping or nonsealing position to relieve an overload. Also, during raising, the sealing elements are flexed each time a coupling in the well pipe is passed. This constant flexing of the elements subjects the upper surface of each element to stresses and experience has shown that when the element is of substantially the same thickness throughout its radial length, a concentration of stress occurs to reduce the life of the unit.

The particular cross-sectional shape of each sealing element, as herein disclosed, accomplishes a more even distribution of elongation stresses over the upper surface of the sealing element when the element is energized or moved downwardly by the liquid load.

In accordance with the present invention and as shown in FIGURE 5, each sealing element **22** includes an upper surface **22***a* which terminates in a relatively short upper projection **22***b*; this projection provides additional material for sealing contact with the pipe. The external periphery **22***c* of each element is illustrated as lying in a plane which is substantially parallel to the inner wall **19** of the well pipe P but this is not essential since said surface could be inclined in a direction with its upper peripheral corner closer to the pipe wall than its lower peripheral corner when the element is in undeformed condition. The lower surface of the sealing element is formed with a step **22***d* which makes the outer portion **26** of each element of less thickness than its inner portion **27**. This thinner outer portion is therefore weaker than the inner portion and may fulcrum about the point **28**, adjacent the step at the same time that the entire element is pivoting from the point of attachment **28***a* to the body **20**. This imparts more flexibility to the element but more important and as will be hereinafter explained in detail, more evenly distributes the elongation stresses throughout the major portion of the upper surface **22***a* when the element is flexed downwardly. The net result is that the sealing element may undergo its required flexing an increased number of times without rupturing to thereby increase the life of the swab.

In the operation under normal swabbing conditions, when the assembly is lowered through the liquid within the bore of the well pipe P, said liquid will act upon the underside of the sealing elements **22** and the elements

may flex further upwardly to permit fluid to bypass said elements. The liquid can also bypass the protective collar **23** through the annular area **24** and vertical grooves **25** in said collar. Also the ball valve **15** will be lifted off of its seal **16** to allow bypass of liquid upwardly through the mandrel bore. During lowering, the collar **23** having a substantial thickness functions as a centering guide to assist in maintaining the unit centered in the pipe; this protects the relatively flexible sealing elements or lips from undue wear during lowering. The position of the sealing elements and the protective collar during lowering is illustrated in FIGURE 1.

When the swab assembly is raised by lifting the cable **19**, which is after it has moved below a predetermined column of liquid, the check valve **15** engages its seat to close the bore of the mandrel. The liquid above the assembly will act downwardly through the bypass area **24** and grooves **25** and upon the uppermost sealing element or lip **22** to deform the element downwardly to substantially the position shown in FIGURE 2, in which position the element has been flexed downwardly and outwardly and into sealing engagement with the wall of the pipe. This is its load-carrying position.

Each sealing element, being constructed of rubber and having substantial flexibility, is capable of supporting or lifting only a predetermined column of liquid. Any load in excess of that capacity will further flex the uppermost sealing element further downwardly and into a dumping position out of sealing engagement with the bore **19** of pipe P; this permits liquid to flow past the uppermost sealing element to the sealing element next below it. The second sealing element will then likewise be deformed downwardly, as was the uppermost sealing element, and the action will be repeated. Since all of the elements are of substantially the same dimension, each element will support substantially the same fluid pressure differential thereacross, and any differential in excess of such predetermined value will cause the sealing element to be deflected downwardly to a dumping position to permit the liquid to pass downwardly. Therefore, the total load of liquid will be borne in predetermined increments by each of the sealing elements.

It is apparent that the number of sealing elements and their respective load-carrying capacity determine the liquid column which the sealing elements will support. If there is an excess of the total capacity of the elements, there is an automatic movement of said elements to dumping position and then a return of the elements back to their load-carrying position when the excess has been relieved. The dumping position of the sealing elements is illustrated in FIGURE 3 and in the enlarged view FIGURE 6. As the swab unit is raised to lift liquid with no overload, the protector collar **23** is in its substantially undeformed position and acts as a centering guide during the lifting operation.

When the sealing elements of the swab unit are in load-carrying position lifting the liquid under normal swabbing conditions, as above described, the protector collar **23** remains in its substantially normal undeformed position; at this time the rate of flow past the collar allows the elements to perform the lifting function. If the load on the sealing elements exceeds their capacity, each element will flex further downwardly to assume a dumping position and immediately that this occurs, a reduction of pressure below the collar **23** takes place to create a greater pressure differential across said collar. The increased differential deforms the collar to increase its diameter and thereby reduce the bypass area therearound, which decreases the rate of flow past the collar. The decreased flow rate lessens the liquid load being applied to the sealing elements and prevents said elements from flexing excessively downwardly beyond the dumping position. The net result is that as soon as the sealing elements move to a dumping position, the collar **23** is actuated to limit further swinging or flexing of the elements to thereby protect the elements from damage due to overload. Of course, as soon as the overload condition is relieved, the sealing elements return to load-carrying position and the collar returns to its normal undistorted position and swabbing within the capacity of the sealing elements continues.

The protector collar is also actuated to protect the sealing elements and to assist in lifting the liquid by preventing excessive bypassing of liquid past the elements at any time overload conditions are encountered. Overload may occur if the swab is lowered beneath a column of liquid which is in excess of the capacity of the elements or if the swab is lifted or accelerated too rapidly after being disposed under a column of fluid. Also, if the swab encounters a back pressure as it nears the surface of the well, an excessive overload condition might be created.

Assuming that what might be termed a "moderate" overload condition occurs, the upper surface of the protector collar **23** is acted upon by this overload. This results in deforming the collar in the manner shown in FIGURE 7 to increase the diameter of the collar and thereby reduce the bypass area **24** to further restrict flow of liquid to the sealing elements **22**. Under this condition, a reduced rate of flow passes the collar and prevents excess bypass of liquid past the sealing elements. This reduced rate of flow is sufficient to move the sealing elements to their dumping position but is insufficient to overstress such elements because the forces generated by the overload are carried by the collar which is capable of withstanding such forces. The sealing elements **22** are, therefore, protected from excessive forces which might otherwise damage said elements by rupturing or permanently deforming the same and lifting efficiency of the swab is increased.

The deformation of the collar **23** will be in relationship to the overload imposed upon it. If a heavy overload should accur, the collar **23** will be deformed into the position shown in FIGURE 8. In such position, the external periphery of the collar may even engage the wall **19** of the well pipe P so as to substantially close the bypass area around said collar. However, even though the exterior surface of the collar is deformed into sealing engagement with the pipe wall, the vertical bypass grooves **25** in said collar still permit a sufficient bypass of liquid to urge the sealing elements to their dumping position. As in the case of more moderate overloads, the increased forces of the overload is taken by the collar **23** to prevent damage to the sealing elements and eliminate excessive bypass.

From the foregoing, it will be seen that a swab unit is provided in which a protector means, in the form of a choke means, is associated with a plurality of flexible sealing elements to reduce loss of liquid load due to excess bypassing and to protect said elements against overloads, whether temporary or sustained. Under normal operating conditions, the sealing elements will function to be moved downwardly to their sealing or load-carrying positions to lift a predetermined column of liquid; if the load is in excess of what the elements can carry, the elements move to a dumping position to relieve the excess load and substantially instantaneously the collar **23** is energized to decrease flow rate and thereby limit the further downward flexing of the elements to prevent damage by overstressing. When the excessive load is relieved, the elements return to load-carrying position.

In the event of an increased or heavy overload, either of a temporary or sustained nature, such overload acts upon the collar **23** and deforms the same downwardly to reduce or substantially close the bypass area **24** to decrease flow rate past the collar. In this way, the elements are protected against forces generated by such overload conditions which would otherwise damage said elements by rupture or permanent deformation.

Although the bypass grooves **25** have been found useful in assuring that liquid is at all times flowing past

the collar and acting upon the elements 22, even under tremendous overload conditions, such grooves may be omitted. In such instance the collar 23 will remain in sealing engagement with the wall of the well pipe until it moves opposite coupling collar (not shown) in the well pipe, at which time there occurs a bypass of fluid around the collar; such bypass gradually relieves the heavy overload, after which the collar returns to normal undeformed position and swabbing is continued by the elements 22.

It has been heretofore explained that the sealing element having the step or offset 22*d* in its under surface has its outer portion thinner in cross-section and is therefore more flexible than its inner portion. This is of particular advantage in distributing the elongation stresses across the upper surface 22*a* when the sealing element is deformed downwardly to either of the positions shown in FIGURES 2 and 3. The construction permits the outer thinner portion of each sealing element to fulcrum about the point 28 at the same time the entire element is pivoting about its root 28*a*, which is its point of attachment of the upper surface of the sealing lip to the body portion 20.

To illustrate the improved distribution of elongation stresses over the upper surface of the element, reference is made to FIGURES 12 through 14. FIGURE 12 illustrates a sealing element 222 having an upper surface 222*a* which will elongate under downward deformation. This area is shown as divided into seven equal increments indicated by the numerals 1 through 7. The sealing element has no offset or step in its undersurface but is of substantially the same thickness through its radial extent; therefore, when deformed downwardly, the element swings or pivots from its root or point of attachment 228*a* to the main body.

In FIGURE 13, the improved sealing element 22 is shown having the offset or step 22*d* in its under surface. Its upper surface 22*a* is also shown divided into seven equal increments. As has been described, the outer thinner portion may swing about point 28 at the same time that the entire element is swinging from point 28*a*.

FIGURE 14 is a chart illustrating the distribution of the elongation stresses across the upper surfaces of these two types of elements. Curve C represents the distribution of stresses upon surface 222*a* of the element 222; note the concentration between the points 1 and 3 of the increments of the upper surface. Curve D represents the distribution of stresses across upper surface 22*a* of the element 22. Such curve clearly shows the more equal distribution of the elongation stresses throughout substantially all of the increments 1 through 7 of said surface. By more equally distributing these stresses, the sealing element is capable of being flexed a maximum number of times before rupturing or breaking down and the use of the improved elements, as herein disclosed, provides a swab having a longer efficient life. Although the sealing elements have been shown as integral with each other and with the protector collar 23, each sealing element and the collar could be made separately and then mounted upon the main support; if desired, each part may be molded to a metallic insert to strengthen the same. In such case, the plurality of individual sealing elements and the separate protector collar would be confined on the main support between the lower nut 12 and the valve cage 14. The operation would be the same as heretofore described.

In FIGURES 1 through 8 the sealing elements 22 have been shown of substantially the same diameter. In FIGURES 9 through 11 is shown a modification of the invention in which the uppermost sealing element designated 122 is of slightly larger diameter than the diameter of the other elements 22. By making this lip of a slightly larger diameter, it will react to the liquid load substantially instantaneously because of the lesser clearance between its external periphery and the pipe wall.

Therefore, as soon as the swab begins its upward movement, the liquid bypassing the protective collar or choke means 23 is more than sufficient to move this uppermost lip 122 downwardly to its sealing or load-carrying position. This movement of the lip is illustrated in FIGURE 10 and as it moves into load-carrying position, the spacing between the lips is such that it physically engages the next below sealing element 22 and causes it to begin to move downwardly; thus the latter element is initially moved by the combined force of the liquid plus the actual physical contact which assures its proper energization. As the uppermost sealing element 122 continues its downward movement to a dumping position, additional liquid load is imposed on the next below element. The action continues progressively as illustrated in FIGURE 11 until all sealing elements are carrying their proportionate share of the liquid load.

By providing the uppermost sealing element of a slightly larger diameter than the other sealing elements, there is minimum delay in movement of the uppermost sealing element toward its sealing position, followed by rapid energization of all sealing elements. This results in a minimum loss of liquid past the swab unit as it first starts its upward movement. As noted, this construction is particularly satisfactory in lifting light loads. In this modification, the protective collar 23 will coact with the sealing elements in the same manner as has been described with respect to the first form of the invention.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What I claim is:

1. In a well swab for use in a well pipe wherein the swab includes a plurality of annular flexible sealing elements mounted upon a support in axially spaced relationship, with said elements being flexed downwardly by the liquid being lifted to a sealing position to support a predetermined liquid load and being flexed further downwardly to a dumping position under overload conditions, the improvement which comprises,

an annular elastic member mounted on the support and having a diameter in its normal undistorted position which is less than the inner diameter of the well pipe, said member extending radially when subjected to an overload of liquid during a swabbing operation whereby said member functions as a choke means to control the rate of flow of liquid past said member through the bypass area formed between said member and the pipe.

2. In a well swab for use in a well pipe wherein the swab includes a plurality of annular flexible sealing elements mounted upon a support in axially spaced relationship, with said elements being flexed downwardly by the liquid being lifted to a sealing position to support a predetermined liquid load and being flexed further downwardly to a dumping position under overload conditions, the improvement which comprises,

an annular elastic member mounted on the support and having a diameter in its normal undistorted position which is less than the inner diameter of the well pipe whereby said member functions as a choke means to control the rate of flow of liquid past said member through the bypass area formed between said member and the pipe,

said annular member having a lesser flexibility than the sealing elements and having its upper surface acted upon by the liquid being lifted during a swabbing operation so that an overload of liquid will deform said member in relationship to the overload and thereby reduce the size of the bypass area to further restrict the rate of flow past the member.

3. In a well swab for use in a well pipe wherein the swab includes a plurality of annular flexible sealing elements mounted upon a support in axially spaced relationship, with said elements being flexed downwardly by the

liquid being lifted to a sealing position to support a predetermined liquid load and being flexed further downwardly to a dumping position under overload conditions, the improvement which comprises,

an annular elastic member mounted on the support and having a diameter in its normal undistorted position which is less than the inner diameter of the well pipe whereby said member functions as a choke means to control the rate of flow of liquid past said member through the bypass area formed between said member and the pipe,

said annular elastic member being mounted at the upper end of support and having its upper surface acted upon by the liquid being lifted during a swabbing operation so that an overload of liquid will deform said member to reduce the bypass area and thereby protect the sealing elements from the forces generated by such overload.

4. In a well swab for use in a well pipe wherein the swab includes a plurality of annular flexible sealing elements mounted upon a support in axially spaced relationship, with said elements being flexed downwardly by the liquid being lifted to a sealing position to support a predetermined liquid load and being flexed further downwardly to a dumping position under overload conditions, the improvement which comprises,

an annular elastic member mounted at one end of the support and adjacent an end sealing element,

said member having less flexibility than the sealing elements and having its upper end exposed to the liquid to be lifted,

said member being so related to the inner diameter of the well pipe that when in its normal undistorted position, there is a predetermined bypass area for permitting a predetermined rate of flow of liquid past said member,

the exposure of the upper surface of said elastic member to the liquid resulting in a deformation of the member under overload conditions to a position which reduces said bypass area in relationship to the amount of overload.

5. In a well swab for use in a well pipe wherein the swab includes a plurality of annular flexible sealing elements mounted upon a support in axially spaced relationship, with said elements being flexed downwardly by the liquid being lifted to a sealing position to support a predetermined liquid load and being flexed further downwardly to a dumping position under overload conditions, the improvement which comprises,

an annular elastic collar mounted at the upper end of the support and spaced axially from the uppermost sealing element,

said collar having a diameter in its normal undistorted position which is less than the inner diameter of the well pipe to provide a bypass area around the collar and of an elasticity which will deform under overload conditions to reduce said bypass area, whereby said collar functions as a choke means to control the rate of flow past the collar,

the external peripheral surface of said collar being of a sufficient area to function as a centering guide during movement of the swab through the well pipe.

6. A well swab for use in a well pipe including,

a main support,

a plurality of annular flexible sealing elements mounted upon the support in axially spaced relationship,

said elements being movable downwardly by the liquid to be lifted to a sealing position to support a predetermined load and being moved further downwardly to a dumping position when the liquid load exceeds such predetermined load, and

choke means mounted on said support and spaced from the end sealing element for controlling the rate of flow of liquid acting upon the sealing elements to portect said elements from the forces generated by a liquid overload,

said choke means reducing the passageway between the choke means and the well pipe in relationship to the overload whereby the passageway area is controlled by the degree of overload.

7. A well swab as set forth in claim 6, wherein

said choke means is formed by an elastic annular collar having an external diameter less than the diameter of the well pipe,

said collar being substantially stronger and less flexible than any of the sealing elements and capable of supporting a greater liquid load.

8. A well swab as set forth in claim 6, wherein

said choke means is formed by an elastic annular collar having an external diameter less than the diameter of the well pipe,

said collar having a thickness in a plane longitudinally of the support which is greater than the radial extent of the collar from the support, whereby its external peripheral surface may function as a centering guide.

9. A well swab as set forth in claim 6, wherein

the upper most annular flexible sealing element is of a larger diameter than the diameter of the remaining sealing elements,

said sealing elements in moving to a fluid-lifting position engaging the next lower sealing element and urging it toward fluid-lifting position, each energized element above the lowest element energized spaced from each other and individually supporting a fluid load.

10. A well swab for use in a well pipe including,

a main support,

a plurality of annular sealing elements mounted on the support in axially spaced relationship,

each sealing element being constructed of elastic material and being upwardly and outwardly inclined with its peripheral edge in non-sealing engagement with the wall of the well pipe when the element is in normal undistorted position,

the upward and outward dimension of each sealing element being greater than the radial distance between the support and the wall of the well pipe,

each sealing element being capable of flexing in a downward direction under a predetermined load of liquid to effect a sealing engagement of the peripheral edge portion of the element with the wall of the pipe to support said liquid,

increase of said liquid load beyond the predetermined load, causing further flexing of said element in a downward direction to move said peripheral edge portion out of sealing engagement with the well pipe wall to permit escape of liquid past the element until the liquid load is reduced to said predetermined load, and

an annular elastic member mounted on the support and having less flexibility than that of the sealing elements,

the size of said member being so related to the inner diameter of the well pipe that a bypass of a predetermined rate of flow of liquid past said member may occur when the annular member is in a normal undeformed position.

11. A well swab for use in a well pipe including,

a main support,

a plurality of annular sealing elements mounted on the support in axially spaced relationship,

each sealing element being constructed of elastic material and being upwardly and outwardly inclined with its peripheral edge in non-sealing engagement with the wall of the well pipe when the element is in normal undistorted position,

the upward and outward dimension of each sealing element being greater than the radial distance between the support and the wall of the well pipe,

each sealing element being capable of flexing in a downward direction under a predetermined load of liquid to effect a sealing engagement of the periph-

eral edge portion of the element with the wall of the pipe to support said liquid,

increase of said liquid load beyond the predetermined load causeng further flexing of said element in a downward direction to move said peripheral edge portion out of sealing engagement with the well pipe wall to permit escape of liquid past the element until the liquid load is reduced to said predetermined load, and

an annular elastic member mounted on the support and having less flexibility than that of the sealing elements,

the size of said member being so related to the inner diameter of the well pipe that a bypass of a predetermined rate of flow of liquid past said member may occur when the annular member is in a normal undeformed position,

the upper surface of said annular member being acted upon by the liquid being lifted whereby a liquid overload condition will deform the member to reduce the bypass area and further restrict the rate of flow of liquid to protect the sealing elements against the forces generated by said overload.

12. A well swab as set forth in claim **10**, wherein

the uppermost annular sealing element is of a larger diameter than the diameter of the remaining sealing elements,

said sealing elements in moving to a fluid-lifting position engaging the next lower sealing element and urging it toward fluid-lifting position, each energized element above the lowest element energized spaced from each other and individually supporting a fluid load.

13. A well swab as set forth in claim **6**, wherein

the main support comprises a mandrel,

and a downwardly closing check valve means for permitting upward flow past the mandrel during lowering of the swab within the well pipe and for closing flow therethrough during lifting of said swab.

14. A well swab as set forth in claim **10**, wherein

the main support comprises a tubular mandrel,

and a downwardly closing check valve for permitting upward flow through the bore of the mandrel during lowering of the swab within the well pipe and for closing flow therethrough during lifting of said swab.

15. A well swab for use in a well pipe including,

a main support,

a plurality of annular flexible sealing lips mounted upon the support in axially spaced relationship,

said lips being movable downwardly by the liquid to be lifted to a sealing position to support a predetermined load and being moved further downwardly to a dumping position when the liquid load exceeds such predetermined load,

each sealing lip being inclined in an upward and outward direction when in a normal undeformed position,

and each lip having its outer portion of a substantially constant cross-sectional thickness and the remainder or inner portion of a cross-sectional thickness which does not decrease in a direction toward the root of the lip, the thickness of said outer portion being less than the minimum thickness of said inner portion, whereby when said element is deformed downwardly by the application of a liquid load the stresses occurring throughout the upper surface of the element by reason of said deformation are distributed throughout the major portion of said upper surface.

16. A well swab as set forth in claim **15**, wherein

the undersurface of each element is stepped to produce the thinner cross-sectional thickness of the outer portion thereof, the location of said step providing a fulcrum point about which said outer portion may swing as the element flexes in either direction.

References Cited

UNITED STATES PATENTS

2,719,768	10/1955	Webber	103—225 X
2,919,167	12/1959	Taylor	103—225 X
3,181,470	5/1965	Clingman	103—52
3,266,385	8/1966	Scaramucci	92—192
3,296,944	1/1967	Taylor	92—180

ROBERT M. WALKER, *Primary Examiner.*