July 10, 1956 J. T. GARDINER 2,753,942

BRIDGING PLUG

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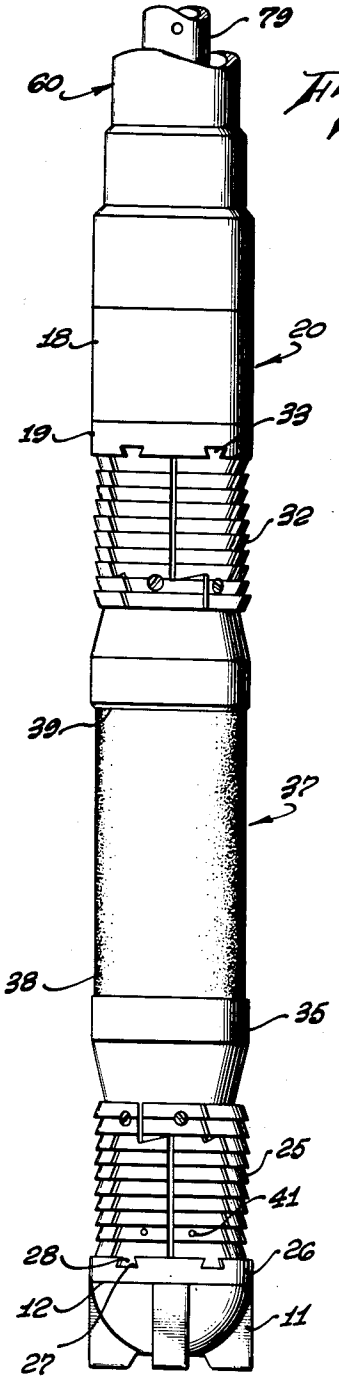

Fig. 1.

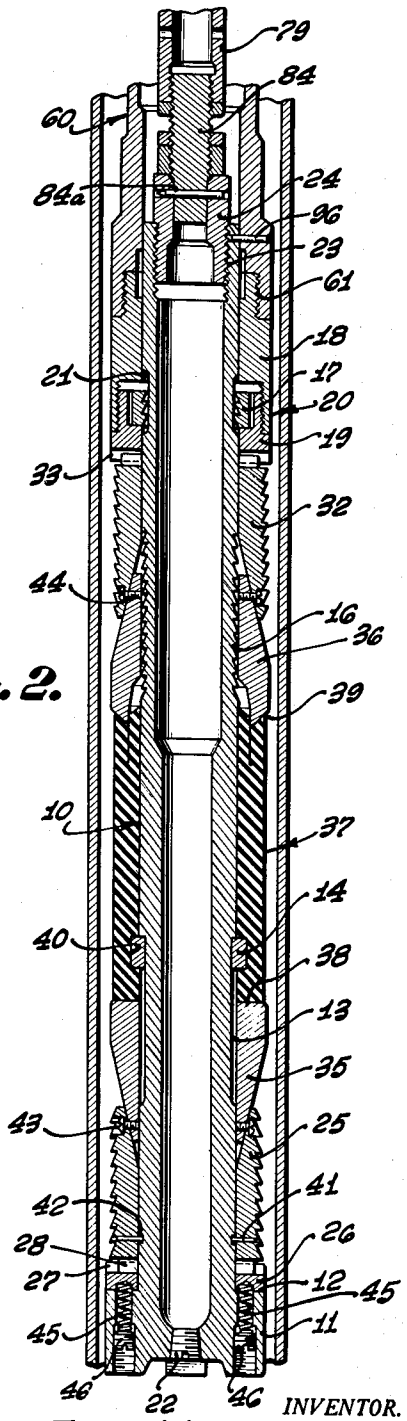

Fig. 2.

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Fig. 3.

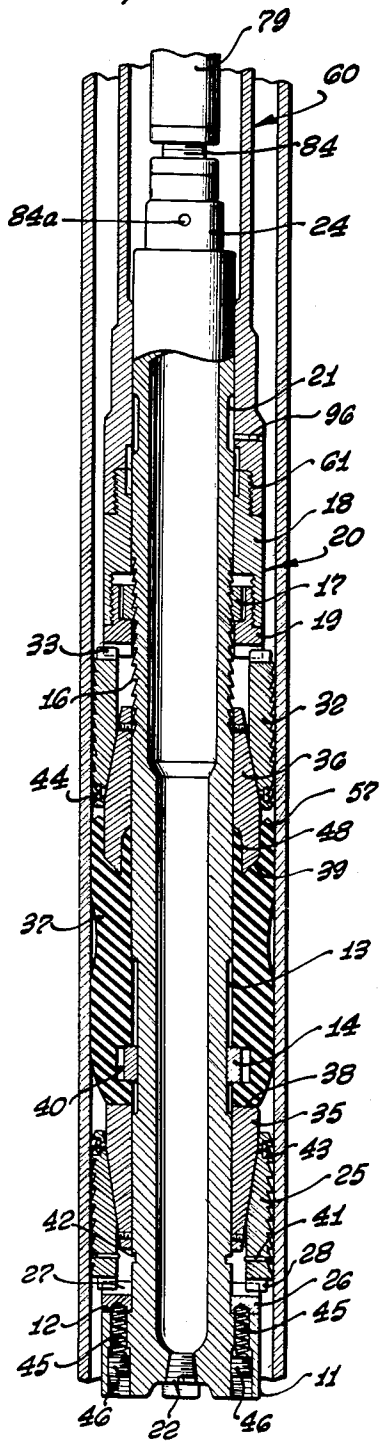
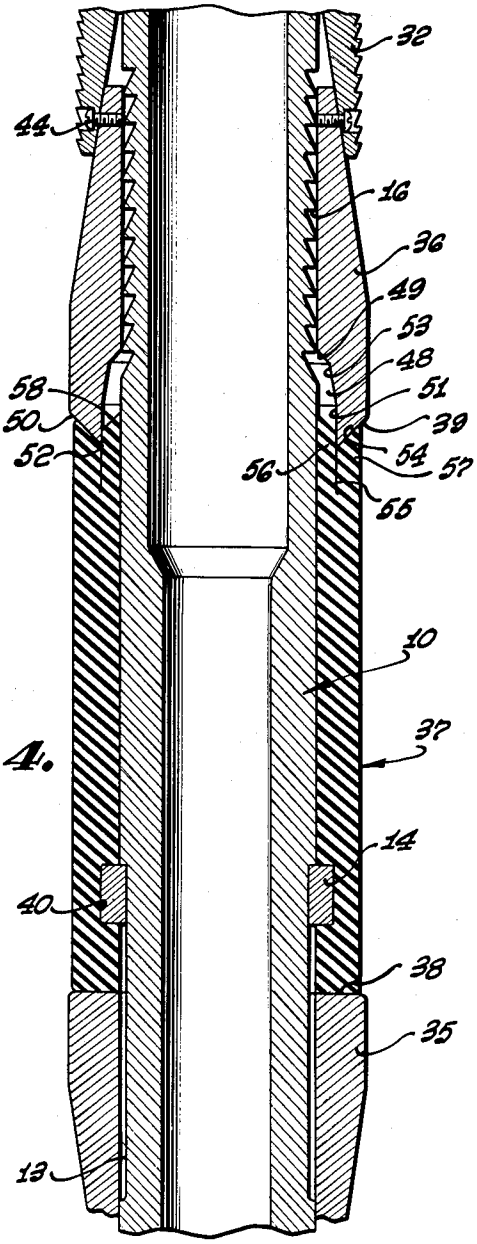


Fig. 4.



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2,753,942

BRIDGING PLUG

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Application July 23, 1948, Serial No. 40,252

11 Claims. (Cl. 166—123)

This invention relates generally to well packing devices and more particularly to bridging plugs and the like apparatus adapted to be set within well boreholes and casings.

Packer devices particularly of the bridging plug type are usually employed for the well known purpose of closing or sealing off a lower portion of the well or to separate upper and lower sections thereof for various purposes. Such bridging or plugging operations are often employed, for example, when a lower zone in an oil well has ceased to be sufficiently productive, or where the well bore has been found to extend into water-producing zone or thief sands, or for any other reason it becomes desirable to plug back or close-off a lower zone or portion of the well and produce from a higher zone in the well. In some such cases where the bottom zone into which a well has been drilled fails or ceases to be sufficiently productive, it may be desirable to explore and test a number of higher zones in relatively rapid succession for their possible productivity and this may require plugging operations for each such test.

Heretofore the process and apparatus required for lowering, positioning and setting bridging plugs in wells and for releasing the setting tools has been more time-consuming than is desirable, particularly in extremely deep wells of the present day. Such bridging plugs after being set must be capable of withstanding tremendous differential pressures without displacement and with as little leakage as possible. In addition to these qualities, it is desirable that such bridging plugs be capable of being set by suitable setting tools exerting relatively low setting forces and at the same time be capable of being run into fluid-containing, deep well bores at relatively high speed without the packing body being caused by the resultant fluid forces and pressures to expand and set the plug prematurely at some undesirable point in the well.

In bridging plugs of the usual type employing double ended packing sleeves and a pair of sets of oppositely-acting casing gripping devices such as serrated slips, it frequently happens that premature setting of the plug in the well occurs as a result of exceeding a limited rate of lowering the plug into the well. Such premature setting of the plug has been found to be caused, in some cases, by the pressure and fluid forces exerted upon the packer body by the relatively high velocity of flow of fluid around and past the plug as it is lowered therethrough or, in other cases, by shocks or acceleration forces caused by sudden changes of lowering rate attendant upon impact of the plug with a fluid surface or with sand bridges or other obstructions in the well. In an effort to improve the holding ability of bridging plug packings and to render them practically non-leaking, the packing sleeves have often been constructed in such manner as to be substantially free-floating upon the body or mandrel of the plug and formed in such manner as to tend to be self-sealing by the action of the differential fluid pressure impressed across them after being initially expanded.

However, by so doing, such packing devices have been rendered more susceptible to premature setting in the wells as hereinbefore mentioned. Such premature setting of a bridging plug in a well is usually extremely time consuming and expensive often requiring that the plug be removed by drilling.

It is, accordingly, an object of this invention to provide a bridging plug in which many of the undesirable and limiting features heretofore prevalent in briding plugs and the like packer apparatus have been eliminated.

It is also an object to provide a bridging plug of novel and improved construction which will be resistant to premature pack-off and setting by the effects of high velocity relative to the fluid in the bore hole or by acceleration forces to which it may be subjected during lowering in a well bore hole.

It is a further object of this invention to provide a well bridging plug which will have improved holding and sealing capabilities under high differential pressures.

The objects of the invention are accomplished, in general by an improved packing sleeve, packing expander and packer body design in which the said sleeve is so formed as to be set with relatively low setting force yet is restrained upon the packer body in such manner as to be less susceptible to undesirable deformation and premature setting under the hydraulic, inertia and frictional forces to which a packer may be subjected by rapid running in a fluid filled well.

These and other objects, advantages and features of novelty will be evident hereinafter.

In the drawings which show by way of illustration, preferred embodiments of the invention, and in which like reference characters designate the same or similar parts throughout the several views:

Figure 1 is a longitudinal elevational view of the general assembly of the bridging plug as it appears when assembled ready to be lowered into a well or when being lowered or suspended within a well casing just prior to setting.

Figure 2 is a longitudinal sectional view of the apparatus of Figure 1 showing its assembled appearance and position of its parts just prior to setting in a casing.

Figure 3 is a longitudinal sectional view of the apparatus showing its appearance and positions of its parts just after completion of setting in a casing.

Figure 4 is an enlarged longitudinal sectional view of a fragmentary portion of the central part of the bridging plug.

The apparatus is as follows:

Referring now to the drawings and primarily to Figures 1, 2 and 4, the main structure of the apparatus comprises a centrally located, elongated, tubular body or mandrel **10** of substantially uniform external diameter throughout its length and terminating at its lower end in a nose piece or shoe member **11** of slightly increased diameter, an upwardly facing annular shoulder **12** being thus formed at the junction of said mandrel body and said shoe member. A plug **22** threaded into the bottom of the shoe **11** closes a threaded opening which may be employed for attachment of other apparatus such as, for example, a lower string of tubing or a circulating valve not shown. At a lower intermediate portion, the mandrel is formed with a short section **13** of slightly reduced diameter serving as a groove about which a split ring **14** is placed and is retained therein with freedom for limited longitudinal sliding motion to act as a means for retaining an annular packing body **37** in place and in proper longitudinal position upon the mandrel as more fully described hereinafter. At an upper intermediate portion of the external cylindrical surface of the mandrel a length of downwardly facing ratchet grooves or buttress threads **16** is provided, and these

grooves or threads are adapted to ratchet through and make one-way locking engagement with a correspondingly toothed split lock ring **17**. The lock ring **17** is retained in an inwardly facing, annular groove formed between upper and lower, threadedly interconnected halves **18** and **19** respectively, of a lock ring adapter fitting **20** hereinafter also more fully described. A shallow annular groove **21** is formed in the upper portion of the mandrel **10** adjacent the upper end thereof which serves as a detent to receive the inner toothed portion of the lock ring **17** when the packer is in the unset condition as illustrated in Figures 1 and 2.

The upper end of the mandrel **10** is provided with internal threads **23** into which a relatively short, externally threaded connector sleeve **24** is screwed.

A plurality of lower, wedge shaped slips **25** having downwardly facing serrations or wickers are normally positioned about a lower, upwardly diverging slip cone **35** carried upon the lower end of the mandrel **10** as best shown in Figure 2 and retained there by a slip retainer ring **26**, attachment between each of said slips and said retainer ring being effected by a dove-tail interconnection comprising a radially directed dove-tail slot **27** formed in the upper face of the retainer ring **25** into which a dove-tail **28**, formed on the lower base end of the slip, fits and has limited freedom for radial sliding motion therein to permit radial expansion of the slip.

A like set of upper slips **32** having upwardly facing serrations is provided about an upper, downwardly diverging slip cone **36** carried upon an intermediate portion of the mandrel **10** adjacent the lower end of the beforementioned lock ring adapter fitting **20** and these slips are similarly provided as shown at **33** with dove-tail connections to the lower half **19** of the lock ring adapter fitting **20**, permitting radial expansive movement of said slips.

Intermediate the beforementioned sets of upper and lower slips are the beforementioned lower, upwardly diverging slip cone **35**, the upper downwardly diverging slip cone **36** and the resilient, sleeve shaped packing element **37** positioned intermediate the said slip cones, all longitudinally slidably retained upon the mandrel **10** except as initially restricted by various releasable interconnecting means hereafter described. The upwardly facing base end **38** of the lower slip cone **35** and the downwardly facing base end **39** of the upper slip cone **36** serve respectively as lower and upper abutments or expander rings between which the resilient packer element **37** is retained and in operation is adapted to be compressed longitudinally for deformation or expansion radially into sealing engagement with a surrounding borehole wall or casing.

The bore of the packing sleeve **37** is formed or molded with an inner annular groove **40** adjacent its lower end to receive the outer portion of the hereinbefore mentioned retaining ring **14**. The retaining ring **14** which is made of a suitable metal, preferably a metal such as brass or cast iron which may be easily drilled-up is usually placed in the molded groove in the packer body after its manufacture although it may, if desired, be placed or molded in place in the packer body at the time of its manufacture and thus in the latter case may be firmly bonded thereto to form a unitary part thereof.

Several of the lower slips **25** are provided with a positioning pin fixed therein as shown at **41**, having its inner end extending with a relatively loose fit into a shallow annular groove formed in the mandrel as shown at **42**. Each of the slips of both the upper and lower set of slips is initially anchored to the slip cone face upon which it slidably bears, by means of a shear pin or screw as shown respectively at **43** and **44**.

The lower set of slips **25** is urged upwardly by means of a plurality of coil springs **45** retained in circumferentially spaced holes extending axially through the flanged or shouldered portion **12** of the nose piece **11** and each

acts under compression between the lower face of the slip-retainer ring **26** and a threaded, spring-retainer plug as shown at **46**.

As best shown at Figure 4, the lower packer-abutting end **39** of the upper slip cone **36** which as beforementioned serves as an upper abutting member or expander ring for the packing sleeve, is formed with a short counterbore **48** preferably having, as viewed in the drawing, an outer or lower cylindrical entrance portion **51** of uniform inside diameter, an intermediate portion **53** of inwardly or upwardly diverging tapered form and an inner or upper end portion terminating in a chamfer or upwardly converging conical shoulder **49**. The counterbore may be formed, if desired, with a uniform diameter throughout its depth with satisfactory results in operation. In either construction it has been found to be advantageous to have an outer portion of the recess of uniform diameter for a sufficient depth to permit the outer lip portion of the packing body to move freely into packing position between the outside of the slip cone and the inside surface of the casing as hereinafter more fully described. The outer, lower end portion of the slip cone surrounding the before-mentioned counterbore is formed with a downwardly converging conical surface as shown at **50** terminating at its intersection with the inside cylindrical surface **51** of the counterbore **48**, in a downwardly directed, relatively sharp, beveled edge **52**.

The upper, adjacent end of the resilient packing sleeve **37** is preferably formed with an outer conical end portion **54** or corresponding slope and adapted to fit and normally abut the before-described conical surface **50** of the slip cone **36**. The packing sleeve is also provided with a longitudinally directed cylindrical slit **55**, commencing at the inner terminus of the conical end surface **54** of the packer and extending longitudinally and coaxially inward or downward as viewed in Figure 4, for a short distance preferably along a cylindrical surface formed by the downward projection of the inside cylindrical surface of the slip cone counterbore **48**. A pair of separate, concentric, annular projections or lips are thus formed on the upper end of the packing sleeve, separated from one another by the slit **55**, but joined together at the inner terminus thereof, the inner annular lip **56** being positioned at the entrance to the counterbore **48** and initially projecting a short distance within the outer cylindrical portion **51** and thereby being in position to be wedgingly thrust into the inner tapered portion of the annular space within the counterbore **48** around the packer mandrel. The upper end of the said inner annular lip **56** is preferably, although not necessarily, formed with a conical or beveled end as shown at **58** adapted to fit the chamfered end **49** of the annular recess **48** when the packing is fully set as illustrated in Figure 3. The outer annular lip portion **57** of the packing sleeve is likewise in position to be expanded over the beveled surface **54** and thrust into the outer annular space formed between the outside surface of the lower end portion of the slip cone **36** and the inside surface of a surrounding casing as, shown in Figure 3, upon application of longitudinal compressive force to the packing sleeve **37**. The lower circumferentially overlapping ends of the slips **32** serve to seal off the upper end of this outer annular space into which the packer is thrust as shown in Figure 3.

Referring now primarily to Figure 2, a lower fragmentary portion of a tubular ram adapter sleeve of a setting tool is shown at **60** extending upwardly from a separable coupling connection **61** located at the top of the bridging plug locking ring adapter fitting **20**.

A lower tubular strut portion of the setting tool is also shown fragmentarily at **79**. Adjustably threaded into internal threads formed in the lower end of the strut portion **79** of the setting sleeve is a short, externally threaded connector member **84** the lowermost unthreaded end portion of which extends or plugs into the top open-

ing of the beforementioned connector sleeve **24** and is secured there by means of a shear pin **84***a* which extends crosswise through holes drilled through both the connector sleeve **24** and the connector member **84**. The adapter sleeve **60** and the setting sleeve strut **79** may comprise the outer sleeve extension of the cylinder and the inner piston parts respectively of a setting tool of any suitable type, for example, as disclosed respectively at **60** and **79** in Forsyth et al. Patent No. 2,566,323, at **11** and **13** in Spangler 2,326,404 or at **6** and **16** in Batchelder 2,382,770.

A shear pin **96** making a light driving fit through a drilled hole in the lower end portion of the adapter sleeve **60** extends into an aligned, drilled hole or socket formed in the upper end of the mandrel **10**. The shear pin **96** serves as a means for initially positioning and locking the packer mandrel relative to the setting mechanism and to support the weight of the sleeve **60** and other portions of the setting tool thereabove which might otherwise tend to force the upper slips **32** and slip cone **36** downward against the packer sleeve **37** and thus tend to cause premature setting of the packer.

The operation is as follows:

In running in and setting the bridging plug apparatus of this invention the bridging plug, assembled as shown in Figures 1 and 2 is lowered into the borehole upon a suitable setting tool as hereinbefore mentioned, to the point at which it is desired to bridge the well. Setting force is then applied to the bridging plug from the setting tool, an upward tension being thereby transmitted through the setting strut **79**, the connector member **84** and thence through the shear pin **84***a* and the connector sleeve **24** to the top of the bridging plug mandrel **10** such upward tension being balanced by an equal downward, compressive force applied from the said setting tool through the ram adapter sleeve **60** and coupling **61** to the body of the bridging plug. The upward force thus applied to the bridging plug mandrel **10** tends to move the said mandrel **10** upward with respect to the adapter sleeve **60** to a position such as that illustrated in Figure 3. However, shear pin **96** initially resists such relative motion until the upward force applied to the mandrel **10** reaches a value equal to the shearing strength of the pin. Upon shearing of the pin **96** the upward force thus applied to the bridging plug mandrel **10** is suddenly transferred downward through the lower portion of the mandrel to the nose or shoe **11** and from there is transmitted upward from the shoulder **12** through the bottom slip retainer ring **26**, lower slips **25**, shear pins or screws **43**, lower slip cone **35**, packing element **37**, upper slip cone **36**, shear pins or screws **44**, upper slips **32**, and thence through the lock ring adapter fitting **19** and **20** and the coupling **61** to the adapter sleeve **60** of the setting tool. The force thus applied after first shearing the positioning pin **96** next results in shearing of the upper slip shear screws **44**, followed soon thereafter by the shearing of the lower slip shear screws **43**, thereby permitting the upper and lower slips **32** and **25** to move outward upon the sloping surface of their respective slip cones **36** and **35** into gripping engagement with the inside surface of the well casing. Following this and upon further application of the upward force through the mandrel **10**, the slip cone **35** is caused to move upward relative to the slip cone **36** a distance sufficient to thrust the inner annular lip **56** firmly into the annular recess **48** to form a fluid-tight seal between the inside of the slip cone **36** and the surface of the mandrel **10** and at the same time to expand and thrust the outer lip **57** out and into the annular clearance space formed between the outside surface of the slip cone **36** and the inside of the surrounding casing and to some extent compressing laterally and thereby deforming the resilient or deformable packing sleeve **37** into sealing engagement with the inside surface of the surrounding casing, all as best illustrated in Figure 3. In so doing as before stated, the inner annular lip **56** of the upper end of the packing is first thrust farther into the tapered annular recess **48** from the initially entered position shown in Figures 2 and 4 to that shown in Figure 3 to form a tight fluid seal between the bore of the slip cone **36** and the outside surface of the mandrel **10** and at the same time firmly anchor the upper end of the packing sleeve to the end of the slip cone, against radial displacement or pulling away from the mandrel, both before and after the setting operation. A particular feature of this invention resides in this arrangement whereby the inner annular lip **56** of the packing sleeve is initially entered into the annulus **48** prior to setting whereby rolling up, radial expansion or over-riding of the adjacent end of the slip cone by the packing sleeve material is avoided upon subsequent application of longitudinal setting pressure to the packing sleeve either inadvertently during lowering in a well or intentionally during normal setting operations.

At the same time, while the inner annular lip of the packing sleeve is being thrust into the annulus **48**, as before-described, the outer annular lip **57** is divided therefrom along the slit **55** by the beveled end **52** of the slip cone and thereby expanded and thrust into the annular clearance space surrounding the outside surface of the slip cone **36** and the inside surface of the surrounding casing to form a fluid tight seal therebetween, as shown in Figure 3. The principal sealing effect of the packing sleeve thus occurs at upper end portion of the packing sleeve adjacent to and surrounding the lower end portion of the upper slip cone **36**. This type of seal has been found to possess so-called self-sealing characteristics such that fluid pressure differentials in either direction across the plug tend to set the packing seal more firmly the greater such pressure may be.

Another important feature of this invention resides in the employment of the retaining ring **14** adjacent the lower end of the packing sleeve. Initially prior to setting the packer it is to be noted that the retaining ring **14** occupies its uppermost possible position in the ring groove **13** of the mandrel **10**. The packing sleeve is thus initially anchored to the mandrel **10** against upward motion thereon prior to setting, and is thus prevented from being forced upward against the abutting end of the upper slip cone **36** when lowered at high speed through well fluid in a well or by frictional contact with obstructions in the well and is thereby prevented from being prematurely expanded. The forming of the packing sleeve with a flat or square cut lower end as shown at **38** also assists in preventing the development of combined radial and upwardly directed forces, both mechanical and hydraulic, tending to move the packing sleeve upward and outward into setting position.

The hereinbefore described arrangement results in a packing which has the highly desirable characteristics of being readily deformed and thus sensitive to setting pressures and therefore capable of being set to form a good fluid seal in the well with relatively low setting forces, while at the same time being relatively insensitive to high running-in speeds in fluid-containing wells and the effect of obstructions and the like difficulties.

The location of the retaining ring **14** near the lower end of the packing sleeve is advantageous in preventing the packing sleeve from being subjected to longitudinal compression by fluid forces or frictional contacts to which it may be subjected during running-in operations as would be the case with the ring located in a higher position. With the retaining ring **14** positioned adjacent the lower end, the packing body is placed in longitudinal tension by any upward drag from the fluid or other frictional effects during such operations.

At this stage in the before-described setting process the bridging plug mandrel **10** will have been moved upward relative to the lock ring adapter fitting **20** a distance sufficient to carry the ratchet grooves or buttress threads **16** of the mandrel **10** upward through and into locking engagement with the lock ring **17**. The bridging plug

is thereby locked in the set condition within the casing with both the upper and the lower sets of slips **32** and **25** in holding engagement with the inside surface of the casing as shown in Figure 3.

After setting the apparatus in the casing as hereinbefore described, continued and increased setting force is applied from the setting tool finally resulting in the shearing of the pin **84***a* thereby resulting in the disconnection and separation of the setting strut **79** and the associated connector member **84** from the connector sleeve **24** permitting the entire setting tool including the setting tool ram which bears upon the ram adapter sleeve **60** to part from the briding plug at the separable joint therebetween, not shown and to be withdrawn from the well, leaving the bridging plug set in the casing. If desired a set of jars of any well known type such as, for example, that shown in the United States patent to H. C. Otis, No. 1,920,103, may be placed immediately above the setting tool to facilitate this latter disconnecting operation. The several retainer members, shear pins and screws hereinbefore mentioned are designed to shear in the order named, namely, first the pin **96**, followed by screws **44** and **43** and finally pin **84***a*. Normally pins **41** are not sheared but merely move outward laterally with the lateral motion of the slips **25**, thereby simply withdrawing the inner ends of the pins from the groove **42** in the mandrel. The pins **41** serve, prior to setting of the packer to hold the slips **25** retracted and bottomed against the shoe shoulder **12** against the upward force of coil springs **45**. The force of the coil springs **45** is thus prevented from being applied against the bottom of the packing sleeve **37** prior to the setting operations which might otherwise result in premature setting of the packing sleeve and lower slips during lowering of the device into the well.

Ordinarily the lower slips **25** and their retaining ring **26** remain, before and after setting, bottomed upon the upper surface of the shoulder **12** of the shoe **11**. However, in event movement of the plug should occur after setting such that the resultant relative motion between the lower slip cone **35** and the shoulder **12** tended to release the lower slips **25**, then the coil spring **45** would force the said slips to follow any such motion of the slip cone and remain in wedging position between the slope of the cone and the inside surface of the surrounding casing.

In a bridging plug of the type herein disclosed substantially all of its principal parts are preferably constructed of materials which are relatively easily drillable by ordinary well drilling tools whereby the bridging plug after being set can, if necessary, be removed by drilling. All of the parts except the packing sleeve and the small springs are therefore preferably made of soft metals such as cast iron, brass and the like. The packing sleeve may be molded rubber, preferably a synthetic rubber such as neoprene resistant to the solvent effects of petroleum and having a shore hardness of approximately 60.

It is to be understood that the foregoing is illustrative only and that the invention is not limited thereby but may include various modifications and changes made by those skilled in the art without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. In a bridging plug: a mandrel; an expander body encircling said mandrel and formed with a counterbore extending upwardly from the lower end thereof, said counterbore defining with said mandrel a coaxial annular recess; a packing sleeve encircling said mandrel below said expander body and having a concentric cylindrical slit extending axially downward from the upper end thereof adjacent said expander body and dividing said packing sleeve end into inner and outer concentric annular lips joined together at the lower termination of said slit; and means positioning said packing sleeve on said mandrel relative to said expander body initially with the upper end of said outer annular lip in end to end abutment with the lower end surface of the portion of said expander body surrounding the entrance to said annular recess and with the upper end portion of said inner annular lip extending partially into the said annular recess.

2. In a bridging plug: a mandrel; an expander body encircling said mandrel and formed with a counterbore extending upwardly from the lower end thereof, said counterbore defining with said mandrel a coaxial, annular recess and the lower end portion of said expander body surrounding the entrance to said annular recess being beveled in an upwardly diverging direction with respect to the entrance to said recess; a packing sleeve encircling said mandrel below said expander body and having a concentric cylindrical slit extending axially downward from the upper end adjacent said expander body and dividing said packing sleeve end into inner and outer concentric annular lips joined together at the lower termination of said slit, said outer annular lip terminating at its upper end in a downwardly converging beveled end surface; and means positioning said packing sleeve relative to said expander body initially with the upper bevel of said end of said outer annular lip in abutment with the bevel of the said lower end portion of said expander body surrounding said annular recess entrance and with the upper end portion of said inner annular lip extending partially into the said annular recess.

3. In a bridging plug: a mandrel; an expander body encircling said mandrel and slidable longitudinally thereon said expander body being formed with an inwardly tapering counterbore extending inwardly from one end thereof, said counterbore defining with said mandrel a coaxial annular recess; a packer sleeve encircling said mandrel and having one end flat and in the other end a concentric, cylindrical slit extending axially inward from the end adjacent said expander body and having a diameter substantially equal to the maximum inside diameter of said annular recess, said slit dividing the end portion of said packing sleeve into inner and outer concentric annular lips joined together at the inner termination of said slit; means positioning said packing sleeve relative to said expander body initially with the outer end of said outer annular lip in end to end abutment with the end portion of said expander body surrounding the entrance to said annular recess and with the outer end portion of said inner annular lip extending partially into the said annular recess; and anchoring means adjacent the said flat end of said packing sleeve associated with said packing sleeve and said mandrel to limit the longitudinal sliding motion of said packing sleeve relative to said upper expander body.

4. In a bridging plug: a mandrel; an expander body encircling said mandrel; a packing sleeve encircling said mandrel and positioned in end to end abutment with said expander body; releasable means to lock said expander body against longitudinal movement on said mandrel toward said packing sleeve; means to lock said packing sleeve to said mandrel with freedom for limited longitudinal sliding motion thereon, said last mentioned means preventing said packing sleeve initially from being forced against the abutting end of said expander body with sufficient force to deform said packing sleeve; and means to release said releasable means to permit said expander body to be moved into forceful engagement with the abutting end of said packing sleeve.

5. In a bridging plug: a deformable tubular packing sleeve, one end of said sleeve being flat and lying substantially in a plane perpendicular to the longitudinal axis of said sleeve and the other end of said sleeve being formed with a concentric cylindrical slit extending axially inward from the said end thereof and dividing the said end portion of said sleeve into inner and outer concentric annular pressure lips joined together at the inner

termination of said slit; an inwardly facing annular groove formed in the bore of said sleeve adjacent the flat end thereof; and a ring in said groove, said ring having a radial thickness greater than the depth of said groove.

6. In a bridging plug: a deformable tubular packing sleeve, the lower end of said sleeve being flat and lying substantially in a plane perpendicular to the longitudinal axis of said sleeve and the upper end of said sleeve being formed with a concentric cylindrical slit extending axially inward from the said end thereof and dividing the said end portion of said sleeve into inner and outer concentric annular pressure lips joined together at the inner termination of said slit; an inwardly facing annular groove formed in the bore of said sleeve adjacent the flat end thereof; a ring in said groove, said ring having a radial thickness greater than the depth of said groove; a mandrel extending through said packing sleeve, an axially elongated groove formed around said mandrel with said ring extending into and longitudinally slidable therein; an expander body initially fixed to said mandrel and abutting the upper end of said packing sleeve, said groove and said expander body being located relative to one another initially with said ring positioned at the upper extremity of said groove to prevent said packing ring from being forced upwardly on said mandrel into forceful engagement with said expander body but permitting said mandrel to be moved upwardly relative to said packing sleeve for a distance determined by the length of said groove.

7. In a bridging plug: a mandrel; upper and lower expander bodies on said mandrel and slidable longitudinally relative to one another, the lower expander body being formed with a substantially flat upwardly facing end surface and the upper expander body being formed with a counterbore extending upwardly from the lower end thereof said counterbore defining with said mandrel a coaxial annular recess; a packing sleeve encircling said mandrel intermediate said expander bodies and having the lower end thereof substantially flat and adapted to abut the said upwardly facing end surface of said lower expander body and in the upper end of said packing sleeve a concentric cylindrical slit extending axially downward from the upper end thereof adjacent said upper expander body and having a diameter substantially equal to the inside diameter of said annular recess, said slit dividing the upper end portion of said packing sleeve into inner and outer concentric, annular lips joined together at the lower termination of said slit; and means positioning said expander bodies relative to said packing sleeve initially with the lower end of said packing sleeve in abutment with the upper end of said lower expander body and with the upper end of said outer annular lip of said packing sleeve in end to end abutment with the lower end portion of said upper expander body surrounding the entrance to said annular recess and with the upper end portion of said inner annular lip extending partially into the said annular recess.

8. In a bridging plug: a mandrel; upper and lower expander bodies on said mandrel and slidable longitudinally relative to one another, the lower expander body being formed with a substantially flat upwardly facing end surface and the upper expander body being formed with a counterbore extending upwardly from the lower end thereof said counterbore defining with said mandrel a coaxial annular recess; a packing sleeve encircling said mandrel intermediate said expander bodies and having the lower end thereof substantially flat and adapted to abut the said upwardly facing end surface of said lower expander body and in the upper end of said packing sleeve a concentric cylindrical slit extending axially downward from the upper end thereof adjacent said upper expander body and having a diameter substantially equal to the inside diameter of said annular recess, said slit

dividing the upper end portion of said packing sleeve into inner and outer concentric, annular lips joined together at the lower termination of said slit; means positioning said expander bodies relative to said packing sleeve initially with the lower end of said packing sleeve in abutment with the upper end of said lower expander body and with the upper end of said outer annular lip of said packing sleeve in end to end abutment with the lower end portion of said upper expander body surrounding the entrance to said annular recess and with the upper end portion of said inner annular lip extending partially into the said annular recess; and anchoring means included in said positioning means located adjacent the said lower end of said packing sleeve and extending between said packing sleeve and a longitudinally elongated slot in said mandrel initially to prevent upward longitudinal sliding motion of said packing sleeve relative to said mandrel but permitting limited upward sliding motion of said mandrel relative to said packing sleeve.

9. In a bridging plug: a mandrel; upper and lower expander bodies on said mandrel and slidable longitudinally relative to one another, the lower expander body being formed with a substantially flat upwardly facing end surface and the upper expander body being formed with a counterbore extending upwardly from the lower end thereof said counterbore defining with said mandrel a coaxial annular recess; a packing sleeve encircling said mandrel intermediate said expander bodies and having the lower end thereof substantially flat and adapted to abut the said upwardly facing end surface of said lower expander body and in the upper end of said packing sleeve a concentric cylindrical slit extending axially downward from the upper end thereof adjacent said upper expander body and having a diameter substantially equal to the inside diameter of said annular recess, said slit dividing the upper end portion of said packing sleeve into inner and outer concentric, annular lips joined together at the lower termination of said slit; means positioning said expander bodies relative to said packing sleeve initially with the lower end of said packing sleeve in abutment with the upper end of said lower expander body and with the upper end of said outer annular lip of said packing sleeve in end to end abutment with the lower end portion of said upper expander body surrounding the entrance to said annular recess and with the upper end portion of said inner annular lip extending partially into the said annular recess; frangible means initially fixing said upper expander body to said mandrel and a projection extending inwardly from said packing sleeve into a groove in said mandrel said groove being located in said mandrel in position initially to prevent upward movement of said packing sleeve relative to said upper expander body while said upper expander body is fixed to said mandrel.

10. In a bridging plug apparatus according to claim 7 in which the upper and lower expander bodies comprise upwardly and downwardly converging slip expander cones respectively; upper and lower slips on said cones; and resilient means urging said lower slips upwardly on said lower slip cone.

11. In a bridging plug apparatus according to claim 7 in which the upper and lower expander bodies comprise upwardly and downwardly converging slip expander cones respectively; upper and lower slips on said cones; resilient means urging said lower slips upwardly on said lower slip cone; upper and lower slips on said slip cones; a slip retainer ring positioned around the lower portion of said mandrel below said slips; radially slidable dove-tail connections between said slip retainer ring and the bottom ends of said lower slips; and resilient means acting between said retainer ring and said mandrel urging said retainer ring and said slips attached thereto by said dovetail connections, upwardly relative to said mandrel.

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