

May 27, 1958

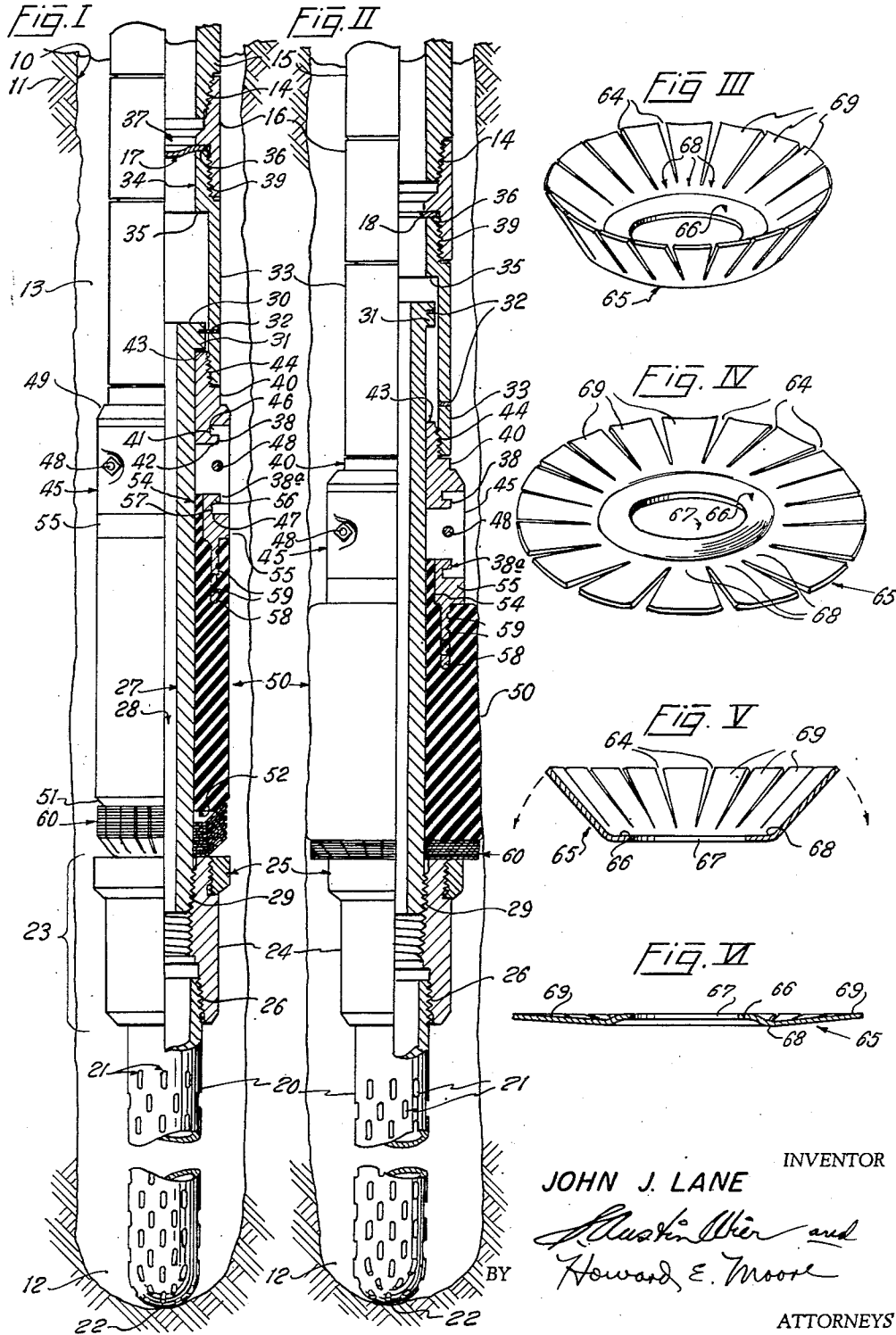
J. J. LANE

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ANNULUS PACKER

Filed Oct. 30, 1953

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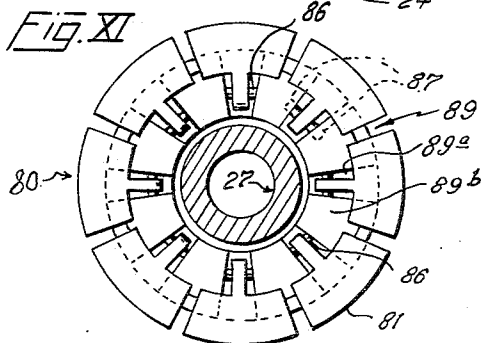
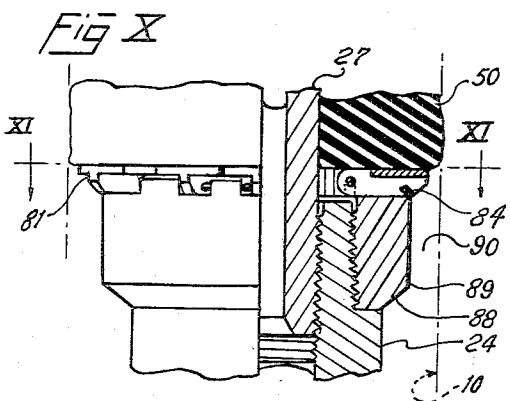
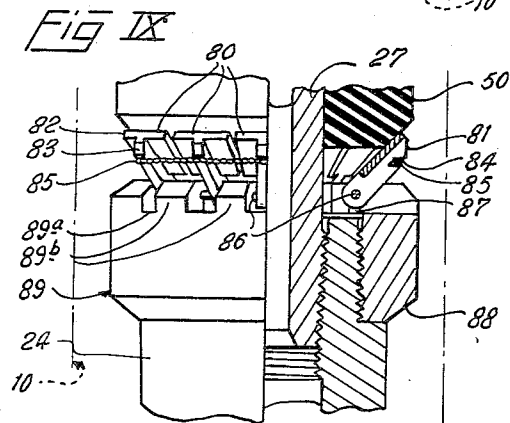
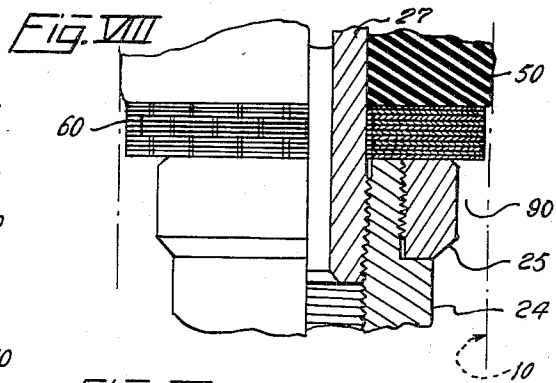
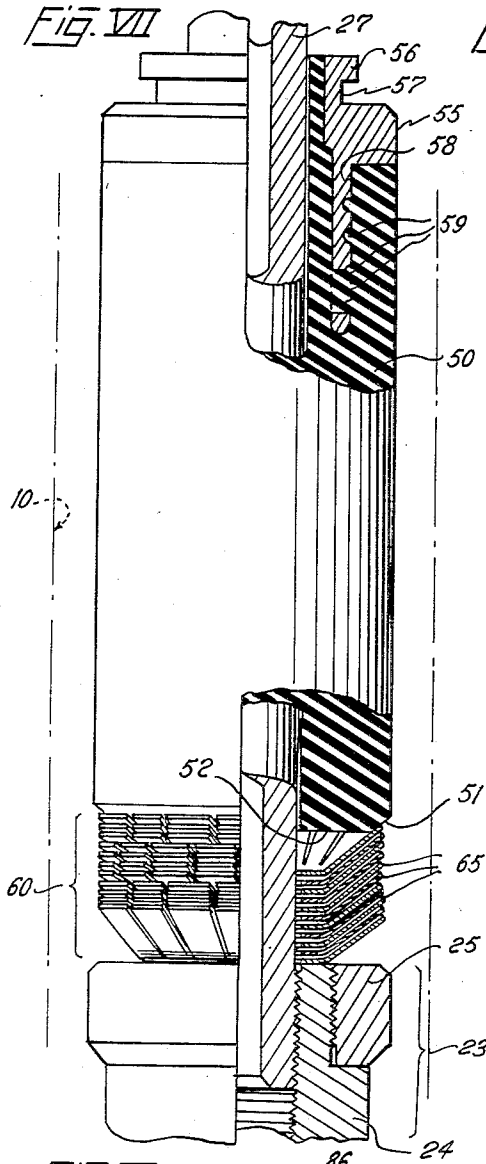
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3 Sheets-Sheet 2



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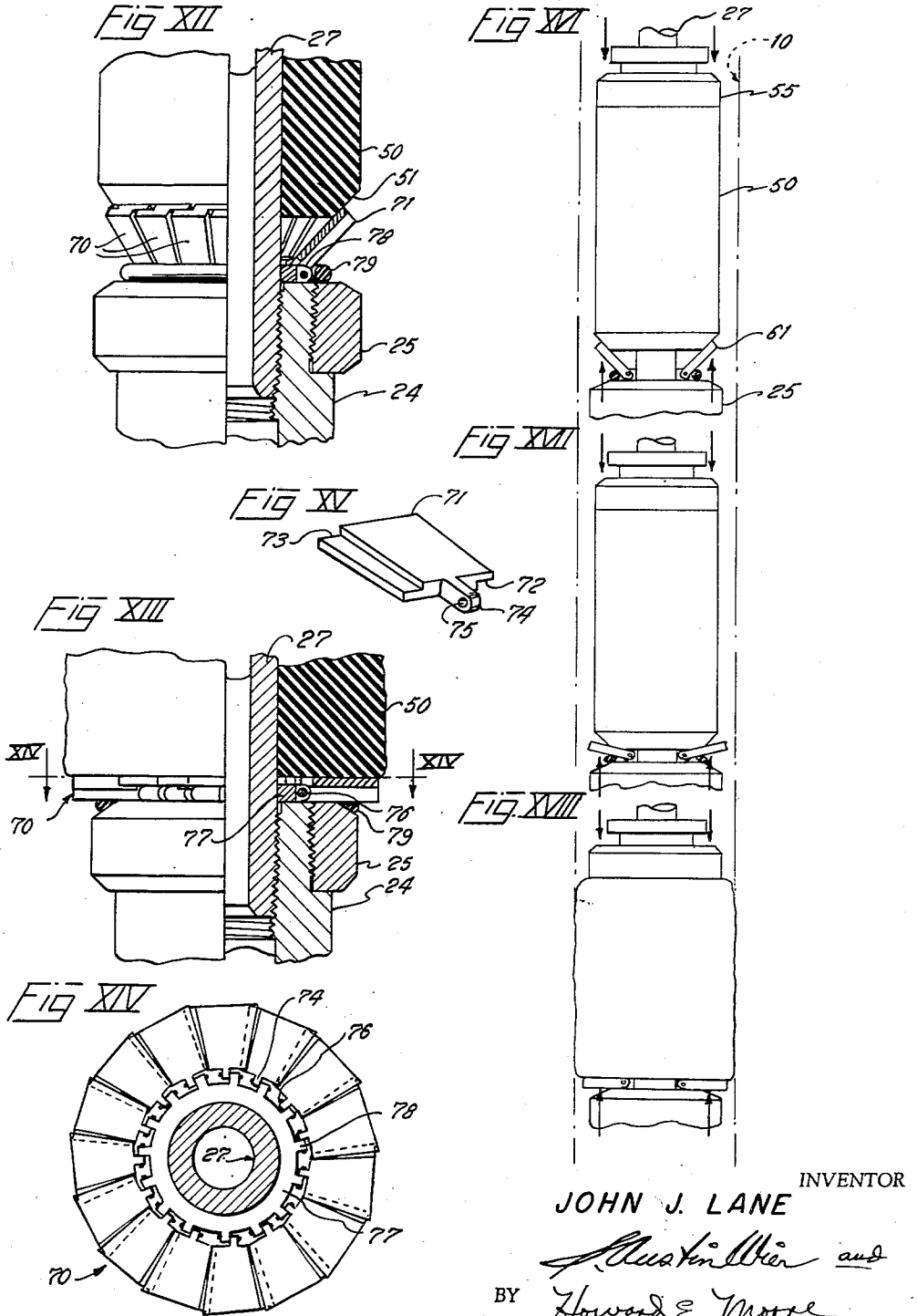
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3 Sheets-Sheet 3



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2,836,252

ANNULUS PACKER

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11 Claims. (Cl. 166—204)

This invention is concerned with well packers and is particularly concerned with apparatus for packing and sealing the annular space between conduits in a well.

The packer mechanisms and associated assembly, illustrated and disclosed in this application, have particular application in sealing and closing the annular space between a pipe and the walls of a well bore for the purpose of isolating a zone below the packer from a zone above the packer, so that a so-called "open hole test" may be made of the lower zone to determine the contents of such zone.

However, these illustrations are not to be understood as limiting the use of the apparatus to such purpose. The invention can obviously be employed to close the annular space between any two conduits for any purpose.

A common problem in the setting of rubber packers about a pipe in an open hole has been the tendency and capacity of the rubber to flow excessively over the supporting shoe at the lower end of the rubber, thus resulting in an imperfect seal and the tearing and "chewing up" of the rubber when the packer is being set and when it is in use and when it is pulled out of the hole.

My invention overcomes this undesirable result. By the use of my device, the packer can be run with maximum protective clearance, allowing for increased expansion of the rubber, and still prevent excessive extrusion of the rubber over the shoe.

A primary object of my invention is to provide apparatus for sealing the annular space between conduits wherein the sealing material is evenly distributed about the annular space when expanded into sealing engagement.

Another important object of my invention is to provide apparatus for sealing the annular space between conduits wherein the sealing material is prevented from flowing excessively past the packer shoe while such material is being expanded into sealing engagement.

A further object of my invention is to provide apparatus for sealing the annular space between conduits wherein greater clearance is provided between the sealing material and the outer conduit while the packer is being run into the conduit.

Another object of my invention is to provide apparatus for sealing the annular space between conduits wherein greater expansion and travel of the sealing material is attained without causing or permitting it to flow excessively past the packer shoe.

A specific object of the invention is to provide apparatus for expanding a rubber-like packer element against cantilevered support, so as to evenly distribute the rubber-like material during its expansion and thereby center the material in an annular space between two conduits and prevent excessive flow of the rubber past the support.

Other and further objects and advantages of the invention will become apparent upon reading the following detailed specification and by referring to the drawings annexed hereto.

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Examples of some suitable embodiments of the invention are set forth in the drawings, in which:

Fig. I is a partially sectionalized semi-schematic elevational view of a typical annulus packing tool device, with associated mechanism, which has been lowered to the bottom of a well hole with the resilient elastic packing element normally relaxed to minimum diameter and suspended above a nest of packer basket units, contracted to minimum diameter, each separate basket unit having its individual lever arms initially inclined upwardly.

Fig. II is a view similar to Fig. I, except that the resilient elastic packing element has been vertically compressed and laterally expanded and the lever arms of the basket have become laterally extended over the annulus, forcing the elastic material to become wedged against the wall of the hole; and the valve disc in the top of the tool has been ruptured to allow communication between the drill pipe above the tool and the perforated tail-pipe below the tool.

Fig. III is a perspective view of a typical single basket unit having multiple levered arms hingedly set in normally inclined position to provide a contracted basket of minimum diameter.

Fig. IV is a perspective view of the basket unit shown in Fig. III, with the levered arms lowered and laterally extended to increase the radius of the support provided thereby.

Fig. V is a cross-sectioned elevational view of a single basket unit, contracted as shown in Fig. III.

Fig. VI is a cross-sectioned elevational view of a single basket unit, extended as shown in Fig. IV.

Fig. VII is a partially sectionalized elevational view of a typical packing assembly, showing the plastic packing element slideably carried on the mandrel in relaxed position and suspended above a nest of contracted supporting basket units, having individual levered arms hinged upwardly above the packer base.

Fig. VIII is a fragmentary and partially sectionalized view of the packer base and the lower end of the plastic packing element which has become laterally expanded and supported by the levered arms of the nested baskets, shown in Fig. VII, such arms being now laterally extended to provide maximum support for the plastic mass.

Fig. IX is a modified form of supporting basket shown in partially sectionalized elevation with its levered arms contracted and held in upwardly inclined position by an elastic band, such arms being individually hinged to the cap of a modified packer base.

Fig. X is a view of the structure shown in Fig. IX with the lever arms laterally extended and so supporting the plastic packing element as to cause its expansion against the walls of a surrounding conduit.

Fig. XI is a plan view of an extended supporting basket unit overhanging the packer base, the view being taken along line XI—XI of Fig. X.

Fig. XII is a partially sectionalized fragmentary elevational view of another modified form of the packing tool, in which is shown a single unit supporting basket, having overlapping lever arms hinged to a lugged ring encircling the mandrel, the arms being contracted and held in normally inclined position by an elastic band arranged about the region of their hinged ends.

Fig. XIII is a view of the structure shown in Fig. XII in which the overlapping arms of the basket unit have been laterally extended by being cantilevered beyond the packer base to afford greater support for the expanded plastic packing element.

Fig. XIV is a plan view showing the modified basket of Fig. XII with overlapping arms extended, the view being taken along line XIV—XIV of Fig. XIII.

Fig. XV is a perspective view of an individual lever

arm of overlapping character, such as is employed in making up the basket shown in Fig. XII.

Fig. XVI is a schematic view showing opposing forces, indicated by arrows, in which a normally relaxed resilient and elastic packing element is suspended above the contracted individual lever arms hinged radially to a circular keeper resting on the packer base.

Fig. XVII is a schematic view showing opposing forces, indicated by arrows, in which the down-thrust of pressure on the elastic packing element is resisted by the up-thrust of the partially lowered supporting lever arms which are in process of being laterally extended.

Fig. XVIII is a schematic view showing opposing forces, indicated by arrows, which have caused the elastic packing element to be shortened and laterally expanded into sealing engagement with a conduit surrounding it, such element being supported by cantilevered arms which have now become laterally extended to furnish maximum support to the packing element.

The apparatus of this invention is ordinarily employed and the method of this invention is ordinarily practiced in packing off and sealing the annulus between a pipe lowered into a well hole and the surrounding walls on the hole, in such an advantageous manner as to allow the rapid descent of the packing tool and mechanism incident thereto without damage to such tool and mechanism, and especially without damage to the setting basket or the lever arms thereof and especially without causing the premature extension outwardly of such lever arms, even when the packing tool is raised before it is desired to set and expand its rubber-like sleeve.

The packing assembly disclosed herein may be run with a minimum diameter, and provides supporting means whereby the packer will be supported, centered, and evenly distributed, in the annular space between the packer support and the well bore.

The cantilevered lateral projection of the multiple arms of the basket substantially bridges the annulus on all sides of the packer in a uniform manner.

The uniform expansion laterally of the rubber-like packing material finally completes the centering of the packer in the hole.

The cantilevered bridge afforded by the projected arms of the basket provides a resisting force sufficient to prevent the unwanted flow of the rubbery material of the packer below the level of such arms, which ultimately assume a substantially horizontal position. Therefore, the packing element is undamaged in its expanded use in that it does not suffer extrusion below or beyond the radially extended basket nor around the packer shoe by which the multiple-armed basket is supported.

Referring now to the drawings in some detail, the numeral 10 indicates an open hole drilled in the earth, with surrounding earth formations shown as at 11, and the closed bottom of the hole indicated by the numeral 12.

Annulus 13 surrounds the well pipe and tools which have been lowered in the hole. Such well pipe 15, which may be drill stem or other conduit, has an open bore therethrough. Connecting means 14 is provided for attaching well pipe 15 to valve-connector sub 16. Such means may take the form of companion threads, as shown on the members joined. Sub 16 affords the housing for a test-valve. Such valve is usually provided with frangible disc 17, which closes the bore of the well pipe.

After the packer is properly centered and firmly set and the annulus is closed off, the disc 17 is ruptured, so that the formation immediately below the packer is thereby opened to atmospheric pressure. Emanations from formations below the packer, such as oil, gas, or other fluid, are thus allowed to immediately flow into the well pipe. Such pipe is usually provided with another valve (not shown) which is then closed in order to hold the entrapped well fluids which have risen in the pipe. Upon removal of the well pipe from the hole, such trapped fluids may be taken, tested, sampled, and examined.

A tail pipe 20, provided with perforations 21, and having a closed lower end 22, is usually arranged below the packer and maintained in free communication with the open bore 28 of packer mandrel 27.

Usually, tail pipe 20 comes to rest upon the bottom of the drilled well hole 10 before testing operations begin. When so rested, tail pipe 20 supports the packer and its associated mechanism.

However, the packer can be operated and tests may be made without tail pipe 20 resting on the bottom of the hole. In such event, suitable apparatus is provided to support the tail pipe, and/or such other well pipe as may be carried by the tool below the packing tool. A hook wall anchor of conventional character may be employed to provide the required support.

Packer shoe 24 is removably attached to tail pipe 20 through the use of any suitable attachment means. Such means may take the form of companion threads 26 on the members joined. Shoe 24 has an open bore therethrough which is in communication with the tail pipe and with bore 28 of mandrel 27. The latter may be placed in communication with the bore of well pipe 15 through the rupture of disc 17 or through the non-use of such disc, if this be desired.

Shoe 24 is provided with an adjustable and removable cap 25. This cap may be made in different diameters, as may be selected for appropriateness in use with the variously designed supporting baskets of the tool, one form of which is basket 60. Other forms of the cap member for the packer shoe are shown in the drawings and discussed in this specification.

Collectively, shoe 24 and its cap, such as cap 25, constitute the packer base 23 of the packing tool.

Mandrel 27 is provided with suitable attachment means so that it may be connected to shoe 24. Such means may take the form of the companion threads 29 shown in the drawings. By the use of any such attachment, the mandrel may be made to suspend the shoe, or to be supported thereby.

The mandrel is provided with an enlarged head 30, having thereon a lateral shoulder 31, whereby telescopic travel of the mandrel within travel coupling 33 may be limited.

Initially, that is while the packing tool is being lowered in the hole, the mandrel may be pinned to travel coupling 33 through the use of one or more shear pins 32, which pass through the wall or coupling 33 and into the head 30 of the mandrel. The shear pins may be broken, after the packer is set, by lowering thereagainst the weight of well pipe 15. When these pins have been sheared, it is to be observed that the mandrel becomes one member of a telescoping device made up in part by the packer sleeve 50 and the travel coupling 33. Such coupling is connected to sub 16 at one end and to the packer hanger head 40 at the other.

Suitable means for making this connection, such as the companion threads shown as at 44.

Travel coupling 33 is provided with an internal projection 34 of substantial nature at its upper end. The travel stop shoulder 35 thereof fixes the farthest limit of travel between such coupling and the mandrel, these members being slideably related. Projection 34 is provided with shoulder 36, on which the peripheral edge of frangible disc 17 may rest and be secured. Disc ledge 37, arranged within sub 16, cooperates with shoulder 36 to firmly hold and retain the disc.

Companion threads 39, on the outer face of coupling 33 and the inner face of sub 16, allow these two members to be made up in a tight and leak-proof joint, in which the peripheral edge of the disc incidentally serves as a sealing gasket.

Sliding movement is initiated between travel coupling 33 and mandrel 27 by the operation of letting down upon the former sufficient weight of the usually long and heavy well pipe 15 to break shear pins 32. In such operation,

the tail pipe is resting on the bottom of the well or otherwise held so as to support packer shoe 24 and mandrel 27 carried thereby, such three members being rigidly (although separably) connected, as shown in the drawings in Figs. I and II and in other views.

The relation between the last three named members, as a stationary unit on the one hand, and travel coupling 33, with its depending attachments, as a potentially slideable unit, before the shearing of pins 32, is shown in the somewhat schematic arrangement set forth in Fig. I.

The telescopic movement of travel coupling 33, and its depending attachments (members 40, 45, 50 and 55), after shear pins 32 are severed, is indicated in Fig. II of the drawings.

While in relaxed condition, the packer element 50 is protected from abrasive and undue contact with the walls of the well, as the packing tool is being lowered into place for subsequent lateral expansion.

The guiding and protecting of the rubber-like packing element is further insured by the presence below it of shoe cap 25, which ordinarily has an external diameter equalling that of the relaxed packing element (and may be made slightly larger, the caps being adjustably replaceable in various sizes).

Cap 25 is ordinarily of somewhat larger diameter than the packer shoe 24 on which it is adjustably carried; and both of these members should be beveled around their lower outer edges, as shown in the drawings, to make their guiding movement smoother and to prevent them from hanging on any projections in the well.

Further protection is afforded the resilient packer element 50 by the provision thereof of a circular metallic member, such as split clamp 45, which is employed as a removable member for attaching packer hanger head 40 to metallic bushing 55 carried in the end of plastic sleeve 50. This clamp is preferably made of a diameter at least as great as that of packer sleeve 50 when the latter is in relaxed condition, so that the clamp may perform the function of a protective guide member.

The exposed upper edge of hanger member 40 should be beveled, as at 49, so that it will not strike or hang against projections or formations in the well.

The clamp may take several forms, one of which is indicated by numeral 45 in Figs. I and II, wherein it is shown to be constructed of two identical halves, with flat contacting faces. The halves are removably secured together by the use of appropriate fastening means, such as bolts 43.

Packer hanger head 40 is provided with external groove 41 and external band 42. Lip 46, turned inwardly of clamp 45, fits into hanger groove 41, and hanger band 42 fits into clamp groove 38, which is immediately below clamp lip 46.

Split clamp 45 may quite conveniently be made with identical ends. The construction of one such end has been described above. On the other end of the clamp, an internally turned lip 47 is indicated. Immediately next to lip 47, and partly defined thereby, is internal groove 38a of the clamp, comparable to groove 38, on the opposite end of the clamp.

Shelf 43, provided by the upper end of hanger head 40, suspends the mandrel. Enlarged mandrel head 30 overhangs this shelf. Such head and shelf carries the weight of the mandrel, the packer shoe and the tail pipe, when the tool is being removed from the well.

The resilient elastic packing sleeve 50 is formed of rubber or rubber-like material or other plastic. Such sleeve is slideably carried on mandrel 27. The sleeve bushing 55 is removably attached, by the use of clamp 45, to packer hanger head 40, and the latter is secured to travel coupling 33, which responds to the down-thrust and up-lift of the well pipe, to which it may be secured directly, or through the use of valve sub 16, depending on the use to which the packing tool is to be put.

It is desirable that the elastic packing sleeve 50 be

beveled at its lower end, as at 51. The bevel face thus provided insures suitable contact when the sleeve is thrust downwardly against the free ends of the lever arms of the packer baskets, such as baskets 60, 70 and 80. Such arrangement and construction minimizes the possibility of the arm ends "biting" into the rubber-like sleeve 50. The protection thus afforded the sleeve by its beveled end is always present, even though the elevated ends of the arms have a contracted diameter little less than the diameter of the relaxed sleeve.

Elongated sliding sleeve 50 is capable of unusual lateral expansion when vertically compressed, and it attains uniform distribution throughout the annular space of the conduit into which its flow is guided and deflected by the resisting force of the lever arms when they are extended across the annulus just above the base of the packer tool.

At its extreme lower end, the plastic sleeve 50 should be provided with a flattened bottom, as at 52, which will spread outwardly across the upper face of the enlarged packer basket when opposed vertical forces are brought into operation against opposite ends of the sleeve.

Metal bushing 55, provided at the top of packer sleeve 50, is fixedly attached to the plastic mass of the sleeve by being bonded therewith or molded thereabout. In fixing the bushing into the plastic mass, it is preferred that a relatively thin section 54 of the elastic material of the sleeve be arranged inwardly of bushing 55, so as to provide a continuous rubber-like inner face of sleeve 50 to be presented to the outer face of mandrel 27, for sealing engagement therewith when packing sleeve 50 is compressed axially and expanded laterally. Thereby a relatively greater surface of the mandrel is uniformly sealed off and rendered incapable of fluid leak thereabout.

Bushing 55 may take any one of several suitable forms. It should be provided with suitable means for attaching it to hanger head 40. It may be held fast in a coupling or clamp, of which split clamp 45 is an example.

For use with clamps of the character shown as at 45 in the drawings, the bushing 55 is provided with an externally overhanging rim 56, below which is arranged an external recess 57. Such rim and recess of the bushing receive, respectively, a complementary clamp groove 38a and a complementary clamp lip 47, both of which are arranged around the inner face of each duplicate half of clamp 45.

It is advisable that a deformed projection 58 of bushing 55 be made to extend into and be bonded with the plastic material of sleeve 50. Suitable deformations 59, in projection 58 of the bushing, may take the form of ribs, and/or grooves and/or perforations, as indicated somewhat schematically in the drawings.

The purposes and function of the packer baskets may be achieved and served with basket structures and assemblies having various forms. Different designs, modifications and variations in suitable basket units and assemblies have been indicated in the drawings. For instance, one form of suitable levered basket units is shown as at 60. Such levered units are capable of being introduced in relaxed position into the bore of a conduit and of being later extended laterally therein to provide cantilevered bridging of the annulus. Several views of this type of basket are shown in Figs. I to VIII, inclusive.

Like purposes and results are accomplished through the use of a basket of quite different design, such as that shown as at 80. Details of its construction are set forth in Figs. IX, X and XI.

A different basket of simple and advantageous design and construction, which is capable of performing the functions desired, is shown in the drawings as at 70. Some details of the levered arms and of other elements of such basket are set forth in Figs. XII to XV, inclusive.

A further satisfactory form of basket assembly is indicated in Figs. XVI to XVIII, inclusive, as at 61.

All mechanisms and apparatus comprising basket struc-

tures are introduced into the conduit bore while they are so contracted that the free ends of the levered arms of the basket substantially define an approximate circle of predetermined minimum external diameter, which diameter is substantially less than the approximately circular pattern later established by the basket when the free ends of the arms thereof are lowered and laterally extended across the annulus to provide a strong cantilevered bridge capable of resisting and sustaining the relatively great pressure exerted thereagainst by the resilient packing sleeve 50 being driven downwardly and spread outwardly across the cantilevered bridge structure until the thus deformed sleeve is forced into wedging engagement with the inside walls of the outer conduit, while at the same time becoming pressed tightly against the outer walls of the inner conduit, thus completely plugging and sealing the annulus against fluid flow.

The relation between the initially contracted basket and the normally relaxed elastic packing sleeve 50 is such that the external diameter of the relaxed sleeve is greater than that of the contracted basket. The latter is thereby fully protected against damage, distortion and premature spreading, when lifted and/or lowered in the well, preparatory to the setting and expanding of the packer, as aforesaid.

The resilient packer sleeve 50 is in turn protected against damage while being lowered into the well by reason of the protective shield or cover afforded by the upwardly inclined plates or arms of the baskets, shown in Figs. VII, IX and XII, in that rocks, large well cuttings and other rough abrasive well refuse frequently encountered in the well fluid is not permitted to flow or lodge against the protected bottom of the rubber-like sleeve to do it damage or later interfere with its setting.

Each form of packer basket (60, 70 and 80) carries means whereby its lever arms are hingedly attached to a central ring of the basket, or to other retainer elements, disposed inwardly of the hinge region of the basket, and lying outwardly of the inner conduit 27, which extends through the basket, and which partly defines the annular space to be closed off by the packing tool.

Furthermore, all forms of the baskets are provided with suitable temporary restraining means, whereby the free ends of the basket levers may be initially elevated and contracted within a relatively narrow diameter, and whereby they may be maintained in such contracted condition during the entire time that the complete packing tool is being lowered and finally stationed in a well, at the place where packing operations are to be carried out. Such temporary restraining means may take various forms, as indicated in the drawings of the several different baskets shown. However, all such temporary restraining means permit the flattening out of the lever arms of the basket-like structure when the rubber-like packing element is thrust thereinto and thereagainst.

The restraint offered by such temporary means is overcome and entirely destroyed when the basket arms are being flattened out by the movement of the rubbery mass of sleeve 50 downwardly into the basket and outwardly across its arms.

The individual basket units 65 are made of such material, and they are so constructed, that the lever arms thereof are initially inclined upwardly and maintain their contracted condition until superior force changes their position by bending them downwardly at their hinge regions. However, once the basket arms are flattened out, they remain in such flattened position, and they are withdrawn from the well in such position.

The two forms of temporary restraining bands or rings, shown as at 79 and 85, are expendable. They serve no purpose after the arms of basket units 70 and 80 have been flattened out by pressure of the rubber sleeve 50 thereagainst. In fact, these temporary bands or rings become cut, broken or otherwise destroyed when the lever

arms are lowered to horizontal position. Once flattened out, baskets of the type shown as at 70 and 80 remain flattened, and they are withdrawn from the well in such condition.

The circular or centrally arranged retaining rings or members (66, 77 and 89b, as the case may be) to which the inner ends of lever arms are hingedly affixed, are supported, in the case of each basket assembly shown, by a packer shoe, which is carried by the inner conduit. This shoe may be provided with an integrally made cap section thereof. Such a shoe cap, in whatever way provided, affords further control and support of the laterally extended basket. However, it is desirable that the shoe cap be removably affixed to the upper end of the shoe, as a separate member of the shoe assembly. Such arrangement and construction permits the size, width and strength of the cap to be easily changed and fitted to needs and conditions which may be met in bridging annular areas having different diameters. Interchangeable shoe caps permit the use of different types of baskets, as may be best fitted to serve the requirements of the packing job to be done.

All baskets of the types contemplated in this invention are provided with hinged lever arms, having their outer or free ends initially elevated and temporarily so maintained.

All baskets open upwardly, and the rubber material of the packer sleeve 50 initially flows into the vacant space in the open baskets, and thence flows outwardly across basket arms which have been lowered and flattened to a substantially horizontal plane by the down-thrusting force of the descending packer sleeve which is made to slide down around mandrel 27, until the opposing force and resistance of the outwardly projected cantilevered arms of a flattened basket cause lateral flow of the mass of rubber packing material to seal the annulus above the cantilevered bridge formed by the mechanism described.

The flattened and outwardly projected arms of the packer baskets do not dig into the earth formations which comprise the outer conduit when my packing tool is used in drill stem tests, such radially extended arms being of no greater diameter than the bored hole. Therefore they are easily withdrawn from the hole when there is no longer any need to maintain packing in the well annulus. The pressure above the packing tool is then simply released, and the packing element 50 is allowed to relax, and the entire tool and its associated mechanism is drawn up and out of the well easily and without hanging up.

A nest of typical baskets for controlling the movement of the resilient packing element when it is subjected to deforming forces as shown as at 60, in Figs. I to VIII, inclusive. Such a nest is made up of a number of single basket units 65, placed within and above like elements until the nest has been built up to desired size and strength. Selective basket strength is thus permitted.

The maximum number of individual basket units required to be made into a nest, as at 60, will be that number which will support and successfully resist the greatest down-thrust of the expanded and deformed rubber-like element 50 when it is fully expanded by the maximum load to be carried thereby.

When a nest 60, of typical individual basket units 65, is so made up, and when all of such units have become substantially flattened out, through the lowering of the free ends of the lever arms thereof, into a substantially horizontal position, it will be found that the vertical height of the flattened nest is approximately equal to the width of the annulus bridged thereby. That does not mean that an operator may not make up a nest having more than the number of individual basket units thus indicated. However, any greater number of such units will be unnecessary to resist the loads and thrust which

laterally extend the lever arms in placing, setting, and maintaining the packer to seal off the annulus.

Also, it is to be noted, the use of any greater number of individual units than that indicated immediately above as being sufficient, will not increase the scope of lateral extension possible in the levered arms. Therefore, such build-up will not produce a nest which will extend into the earth formations.

Each of the multiple levered arms 69 is hingedly held by the inner connector-ring 66 of basket unit 65. Such ring has a central hole 67, for fitting it around mandrel 27. The hinge section is shown as at 68, lying between ring 66 and the extensible body of arm 69.

It is desirable that each arm 69, of basket members of the type shown as at unit 65, be made with a slight concavity or trough along its face, when seen from above. This will give added strength to each individual levered arm so made. The entire arm will then remain straight and move as a non-flexing unit about its hinge, thus allowing an even distribution of rubber over each arm of the unit.

Multiple lever arms 69 are initially inclined so as to encompass a substantially frustro-conical form having defined base areas, and the arms are capable of being so laterally extended as to define a plane area greater in extent than that of the larger of the two bases initially formed.

The spaces or slots 64 between the individual arms 69, of each basket unit 65, are narrow and quite limited in width, even when all arms are lowered to form a flat cantilevered bridge.

It is to be noted that such narrow slots, indicated by the numeral 64, are not sufficiently wide to permit any excessive or damaging amount of rubber material of the resilient packer sleeve 50 to flow therethrough.

On the other hand, the radially disposed slots 64, of a flattened basket unit 65, such as shown in Fig. IV, considering it to be the uppermost basket unit in the nest, will effectively guide the outward flow of the mass of the rubber material of sleeve 50. The rubbery material of this mass tends to flow where least opposed, and will flow outwardly in increasing quantities as down-thrusting force from above increases against resilient sleeve 50.

However, it is to be borne in mind that apertures 64 must at all times be arranged, constructed and maintained within such limits of width that no undue amount of rubber material may be permitted to flow therein and therealong. If such admonition be observed, there will be no damage to the rubber material whatsoever, and the relatively small quantity of such material which shall have flowed into such apertures will return therefrom when pressure on sleeve 50 has been released, preparatory to removing the packer tool from the well.

Force is initially exerted on the arms by the downwardly descending plastic material of sleeve 50 striking them first near the outer or free ends of the arms, whereby they are easily lowered by the exertion thereagainst of relatively little force in the process of pressing them down to a substantially horizontal plane. This is so because of the lever principle involved, it being noted that the inner ends of the arms are hingedly fixed.

Narrow apertures 64 should be uniformly and evenly distributed about each unit 65. Such arrangement and construction will aid in the uniform distribution of the rubbery mass of sleeve 50 over the upper face of the topmost basket member 65 of nest 60.

When all apertures 64, of basket units 65, are made equally narrow, then no particular unit need be selected to be the topmost, or guide unit, of nest 60.

Uniform distribution of the mass of the rubber, above the face of the uppermost basket in the nest 60, is readily initiated, during its early stages, by the downward movement of sleeve 50, into the vacant space existing below the flattened bottom 52, of sleeve 50 in normally relaxed

condition. Such space lies above the upper face of ring 66 of the uppermost basket in the nest, when the downward movement of the sleeve is begun.

When the downward thrust of sleeve 50 is first exerted against the topmost basket of nest 60, it is to be observed, the beveled edge 51, of sleeve 50, presents the area of first contact between sleeve and basket.

Thereafter, a slight flow of rubber material soon creates a series of small corrugations externally of the beveled face 51, each such corrugation flowing slightly into an aperture 64. This is followed by a flow from sleeve bottom 50, into the small spaces 64, and outwardly therealong and thereabout, until the cantilevered bridge is covered with rubber material and the latter becomes packed tightly against the walls of the annulus above the bridge.

Inevitably, such initial flowing, from the base of sleeve 50, leads to a tendency on the part of the entire wall of sleeve 50 to flow outwardly and against the walls of the annulus, as force from above thrusts this body downwardly.

Arms 69 are lowered by the same force which spreads the rubber material into engagement with the surrounding conduit.

In baskets of the type shown as at 65, it is considered advisable, when placing individual baskets in forming a nest, to have the first few baskets at the top of the nest (say about three, depending on the thickness of the material) so arranged that their respective apertures 64 are placed in line, one above the other. This will furnish a series of radial grooves of slightly greater depth than would be provided if all individual basket units were staggered in arrangement. The slightly deepened grooves thus formed would provide better guides for the initial outward flow of the plastic material of sleeve 50 than would be provided by grooves having only a depth equal to one thickness of the material.

A modified form of basket, shown as at 70 in Fig. XII, may be made with overlapping arms 71, which are provided with overlap part 72 and underlap part 73. Such construction allows for uncommonly strong lever arms. The thickened central portion, lying between the overlapping sections of the arm, provides an element of increased strength in this specially designed lever arm.

Projecting inwardly from the central part of each lever arm 71 is an ear 74, having a hole 75 arranged through it laterally, to receive hinge pin 76. This arrangement provides one form of suitable construction for hingedly attaching the several lever arms 71 to modified central ring 77, which is provided with a central hole therethrough so that such ring may be made to encircle mandrel 27.

Central ring 77 has outwardly projecting therefrom a series of spaced attachment lugs 78. Each such lug is provided with a hole or groove therein to receive and hold hinge pin 76.

Lying about the hinged ends of overlapping arms 71 is a resilient ring 79, which may be made of elastic material so as to thereby urge and temporarily maintain the elevation of the free ends of the lever arms.

However, elastic ring 79 is so yieldable as to allow its expansion to permit the downward and outward movement of the free ends of the lever arms upon the thrusting thereagainst of the free end of the suspended resilient packing sleeve 50, in the process of setting the packing tool and expanding the packer sleeve.

When modified basket 70 has been fully expanded and flattened, as shown in Fig. XIV, it will be noted that relatively narrow grooves appear radially across the upper face of the basket. The compressed rubber of the bottom of sleeve 50 flows outwardly over this grooved face, becoming keyed in equal distribution therearound.

When basket 70 is flattened to cantilevered bridging position in setting the packer, the yieldable temporary

ring 79 is broken, and it is usually lost, being of no further use.

Another modified form of basket is shown as at 80, and in Figs. IX, X and XI. It is provided with a multiplicity of ribbed plate lever arms 81, each such arm being individually hinged in assembling basket 80.

A flat plate member 82 provides the upper surface of arm 81. It is strengthened and supported by rib 83, which is arranged below the plate and extended inwardly to provide the attachment end for hinging the levered arm. Hinge studs 86 are carried by rib 81, being laterally extended from the attachment end of such arm. The projecting studs 86 are held in recesses 87, which are provided in the underface of an inward projection of the shoe cap 89 to receive such studs. This construction is detailed in the drawings.

Special shoe cap 89 is made integral with its downwardly extending skirt 88. The cap so formed is disposed about the top of shoe 24, to which it may be removably attached by any suitable means, as by pins or machine screws or by companion threads, the latter being shown as the attachment means in Figures IX and X. Special member 89 is a turreted cap, employed in assembling and maintaining the modified packer basket 80.

The topmost part of cap 89 is provided with a series of slots 89a, radially extending in spaced relation across its upper face, leaving therebetween the islands 89b. Such islands carry hinge recesses 87, into which hinge studs 86 are fitted from below, before special cap 89 is placed around mandrel 27.

Each rib 83 is provided with a notch 84, on its underside. Into this notch is fitted an elastic retaining band 85, which may take the form of an endless coil spring or any other suitable elastic member. Member 85 initially holds the free ends of lever arms 81 in an upwardly inclined position. This is the position in which they are placed and maintained while the packing tool is being lowered into the well.

It is to be noted that modified basket 80 presents a series of narrow radial grooves on its upper face when flattened out.

When basket 80 is flattened to form the cantilevered annulus bridge in setting the packer, the yieldable temporary band 85 becomes broken and lost, and is of no further use.

It is of importance to understand that, whatever the form of packer basket used, there are a plurality of hinged arms which are cantilevered outwardly to overhang the annulus beyond the peripheral face of the packer base (made up of packer shoe and its cap). The numeral 90 has been employed in some of the drawings to indicate the region of this outwardly overhanging cantilevered extension of the arms, which are a necessary part of a packer basket. Such extension is accomplished by the lowering of the free ends of levered arms in response to force exerted thereagainst.

It is in region 90, of the thus extended support asserted by the projected arms, that the annulus surrounding the packer base is closed against the down-flow movement of the elastic plastic material of packing element 50.

The resistance and support of the lowered and extended lever arms in the bridged annulus region 90 forces the expansion of the plastic material outwardly and into intimate contact and sealing engagement with the surrounding conduit.

The operation of bridging the annulus with a cantilevered resisting force is a pre-requisite to the spreading of the resilient packer element outwardly.

The downthrust of the resilient packer element is initiated by the lowering thereagainst of the weight of well pipe 15, together with the weight of the members of the tool which are connectively arranged between the end of the well pipe and the head of the packer, they all being suspended by the well pipe.

The rubber-like material of packer element 50 can not move inwardly, because such movement is completely resisted by the outer walls of mandrel 27 against which it is forceably slid.

The vertical compression and lateral expansion of resilient packing sleeve 50 is completed by the great weight of well fluid in the hole above the packing tool whenever the packing element is expanded into contact with the walls of the surrounding conduit, whether it be the wall of an open hole of a drilled well, or the wall of well casing or other pipe.

Opposing forces, thus indicated, are diagrammatically shown in Figs. XVI, XVII and XVIII, wherein the latter figure shows these opposing forces to have finally come to rest, upon the complete sealing of the annulus through the operation of the method and use of the apparatus herein disclosed.

Having described my invention, I claim:

1. In a packer assembly, a mandrel; an elastic sleeve slideably disposed on the mandrel; a supporting base carried by the mandrel said base having a horizontal upper face thereon; a plurality of levered arms carried about the mandrel and having a supporting ring portion resting on said base, said arms being initially inclined and adapted to support the said elastic sleeve; and means to force said elastic sleeve against the arms to lower and extend them outwardly to a position of horizontal support on the base; the extended arms being greater in diameter than the base whereby the arms extend beyond the base to provide a cantilever support for the elastic sleeve.

2. A packer assembly for sealing an annular space between two conduits comprising, a mandrel adapted to be supported by the inner conduit; an elastic sleeve slideably disposed on the mandrel; a supporting base carried by the mandrel said base having a horizontal upper face thereon; a plurality of nested basket-like members carried about the mandrel and resting on said base, said basket-like members having horizontal central ring portions with arms extending upwardly therefrom, the arms having free ends arranged to engage the sleeve member, and said arms being bendable arcuately downwardly and outwardly in response to downthrusting force applied to the elastic sleeve to a position of horizontal support on the base, the extended arms being greater in diameter than the base whereby the arms extend beyond the base and provide a cantilever support for the sleeve.

3. In a well packer, a mandrel; a shoe carried by the lower end of the mandrel forming a horizontal base; a nest of basket-like members disposed about the mandrel, each having a plurality of arms spaced thereabout and initially extending upwardly, the base of said nest of baskets resting upon the shoe; an elastic sleeve slideably carried about the mandrel, the lower end of said sleeve being arranged to engage the up-raised arms of the uppermost basket member; and means at the upper end of the mandrel for suspending it on a well pipe; said arms being bendable arcuately downwardly and outwardly in response to downthrusting force applied to the elastic sleeve to a position of horizontal support on the base; the extended arms being greater in diameter than the base whereby the arms extend beyond the base and provide a cantilever support for the elastic sleeve.

4. In a packer assembly, a mandrel; an elastic sleeve slideably disposed on the mandrel; a supporting base carried by the mandrel; a plurality of levered arms carried about the mandrel and having a supporting ring portion resting on said base, said arms being initially inclined and adapted to support the sleeve; said sleeve having a flattened end face with a beveled surface at the outer periphery thereof, the beveled surface being arranged and adapted to engage the outer ends of the arms, and means to force said elastic sleeve against the arms to lower and extend them outwardly to a position of support on the base.

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5. In a packer assembly for closing the annulus between a well bore and a pipe extending into the well bore, a mandrel adapted to be carried by the pipe; an elastic packing sleeve slideably carried by the mandrel; a supporting shoulder carried by the mandrel said base having a horizontal upper face thereon; a plurality of nested basket-like members carried about the mandrel and supported on said shoulder, each such basket-like member having a plurality of initially up-raised arms spaced thereabout; the lower end of the elastic sleeve being formed so that the outer edge thereof will initially engage the outer ends of the arms of the top-most basket member; and means for applying sufficient force to the upper end of the sleeve to lower the arms in the annulus to substantially horizontal position to a position of support on the base and to expand the sleeve against the lowered arms to close the annulus the lowered arms being greater in diameter than the base to thereby provide a cantilever support for the expanded sleeve.

6. The combination called for in claim 5 wherein the diameter of the lowered arms are slightly less in diameter than the well bore.

7. A packer assembly for closing the annulus between a well bore and a pipe extending into the well bore comprising, a mandrel carried by the pipe; an elastic packing sleeve slideably carried by the mandrel; a supporting shoulder carried by the lower end of the mandrel said shoulder having a horizontal face thereon; a basket-like member carried about the mandrel and supported on said shoulder, the said basket-like member having initially up-raised arms spaced thereabout; the lower end of the elastic sleeve being arranged to engage the outer ends of the arms, and means to apply force to the elastic sleeve sufficient to lower the arms in the annulus to substantially horizontal position to a position of support on the base and sufficient to expand the rubber against the lowered arms to fill the annulus; the expanded arms being larger in diameter than the shoulder to thereby provide a cantilever support for the sleeve.

8. In a packer tool for closing the annulus between two conduits, one within the other, a slideable mandrel; a telescopic tubular member carrying the mandrel; an elongated elastic packing sleeve slideably arranged about the mandrel and dependingly carried by the telescopic member; a supporting base carried by the mandrel said base having a horizontal upper face thereon; a ring surrounding the mandrel and supported by the base; a plurality of radially disposed cantilever arms attached to the ring, the free ends of the arms being initially disposed upwardly from the ring and adapted to be initially contacted by the outer part of the lower end of the sleeve

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when the latter is moved by downthrusting force; and the arms being of sufficient length to extend horizontally beyond the base when lowered thereagainst and provide a cantilevered bridge substantially spanning the annulus when flattened by the force of the descending sleeve.

9. In a packer assembly, a mandrel; an elastic sleeve slideably arranged about the mandrel; a supporting base carried by the mandrel said base having a horizontal upper face thereon; a plurality of radially disposed arms arranged about the mandrel below the sleeve and supported by the base, said arms being initially inclined upwardly; and the sleeve being arranged to slide downwardly and lower the arms by engaging them to a position of horizontal support on the base, the base being less in diameter than the lowered arms to provide a cantilever support for the elastic sleeve.

10. In a packer assembly, a mandrel; an elastic sleeve slidably disposed on the mandrel; a supporting base carried by the mandrel; a plurality of levered arms carried about the mandrel and having a supporting ring portion resting on said base, said arms being initially inclined and adapted to support the sleeve; said sleeve having an end face so formed that the outer edge thereof initially engages the outer ends of the inclined arms; and means to force said elastic sleeve against the arms to lower and extend them outwardly to a position of support on the base.

11. In a packer assembly for closing the annular space between a well pipe and a well bore, a mandrel; an elastic sleeve slidably arranged about the mandrel; a supporting base carried by the mandrel; a plurality of radially disposed arms arranged about the mandrel below the sleeve and supported by the base, said arms being initially inclined upwardly and the sleeve being arranged to slide downwardly and lower the arms by engaging them to a position of horizontal support on the base, the base being less in diameter than the lowered arms and the lowered arms being less in diameter than the well bore to provide a cantilever support for the packer.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,836,252

May 27, 1958

John J. Lane

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 13, lines 5, 16, 18, and 36, for "base", in each instance, read -- shoulder --.

Signed and sealed this 12th day of August 1958.

(SEAL)

Attest:

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