

Aug. 9, 1966

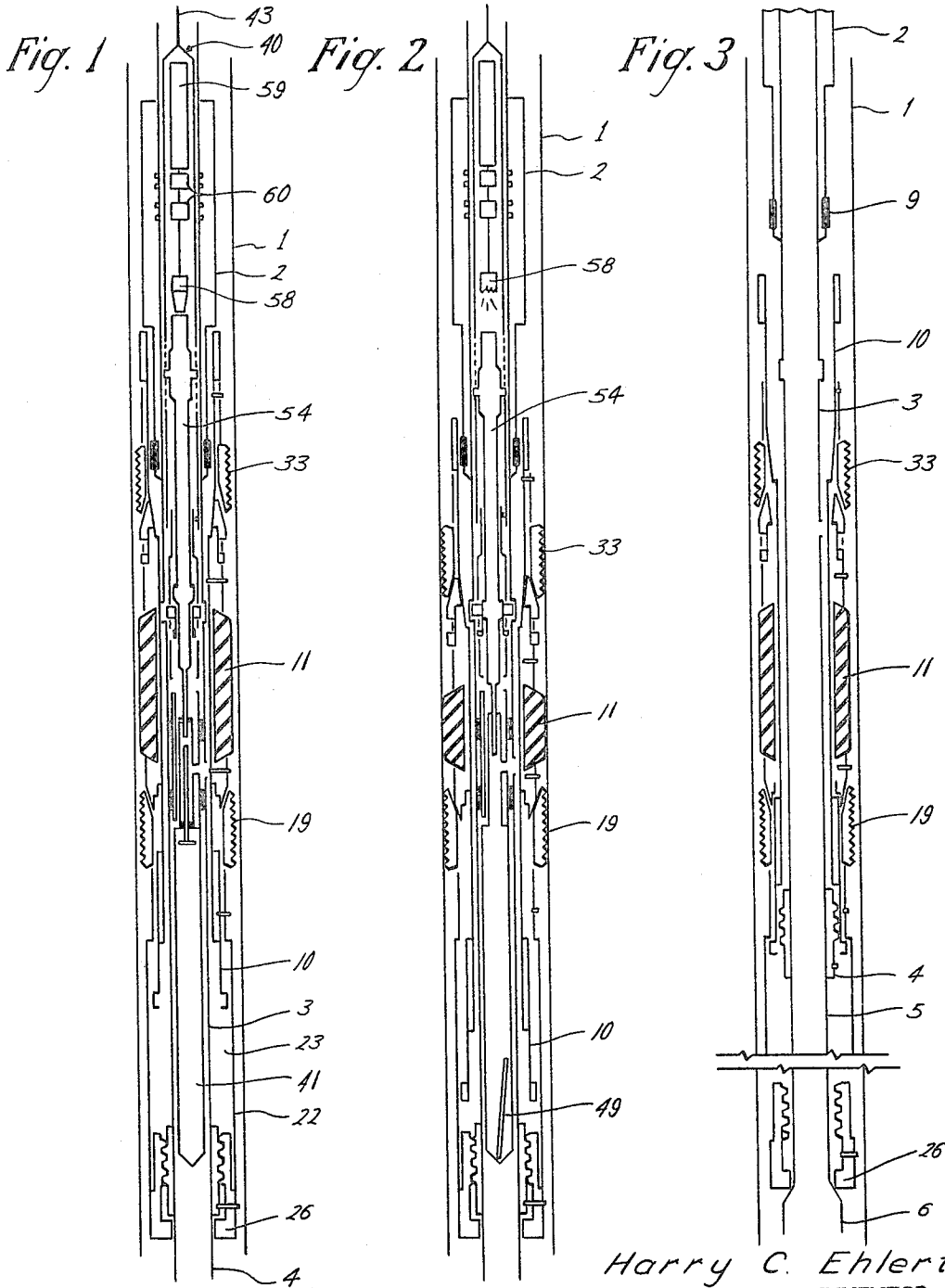
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3,265,131

WELL PACKER

Filed Sept. 13, 1963

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

Fig. 4A

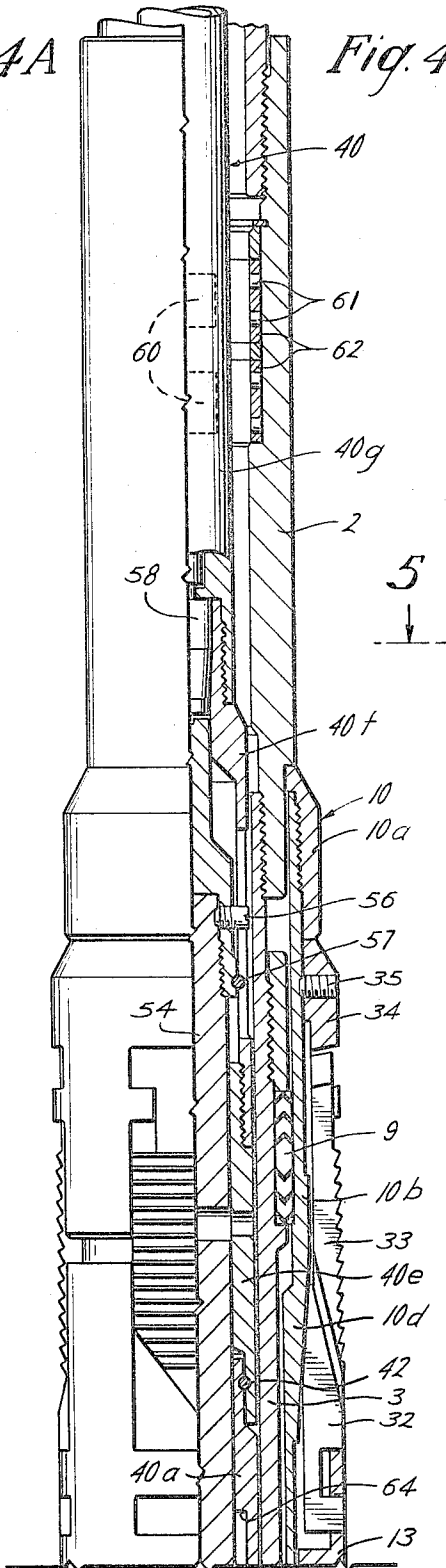
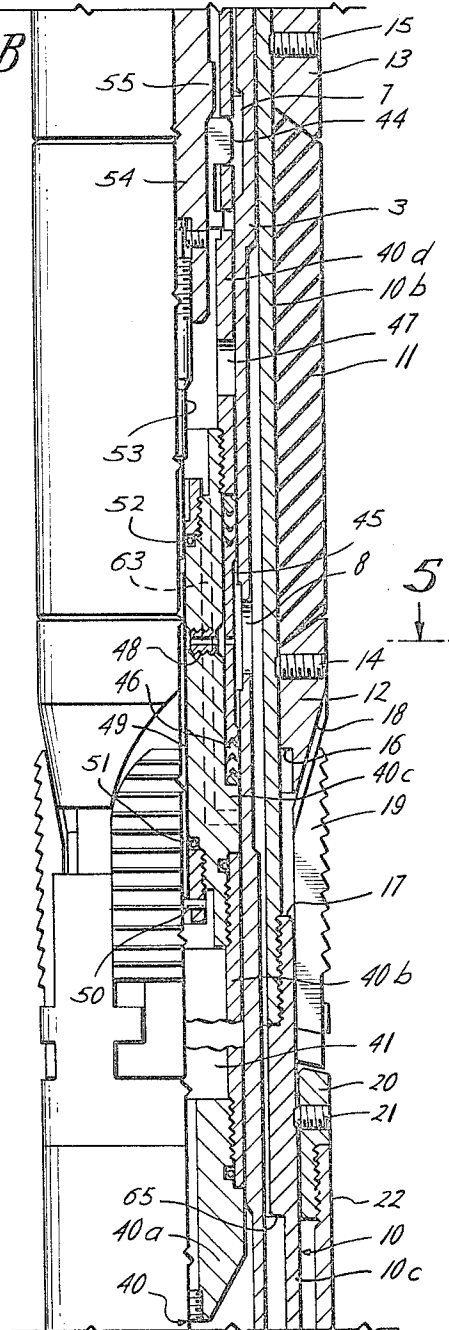


Fig. 4B



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Fig. 4C

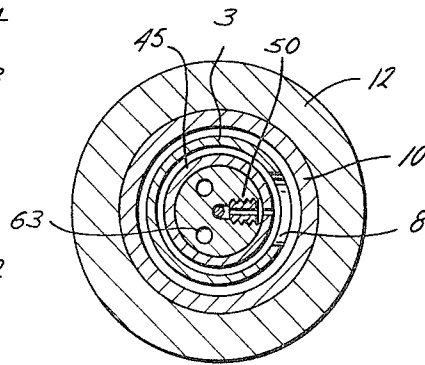
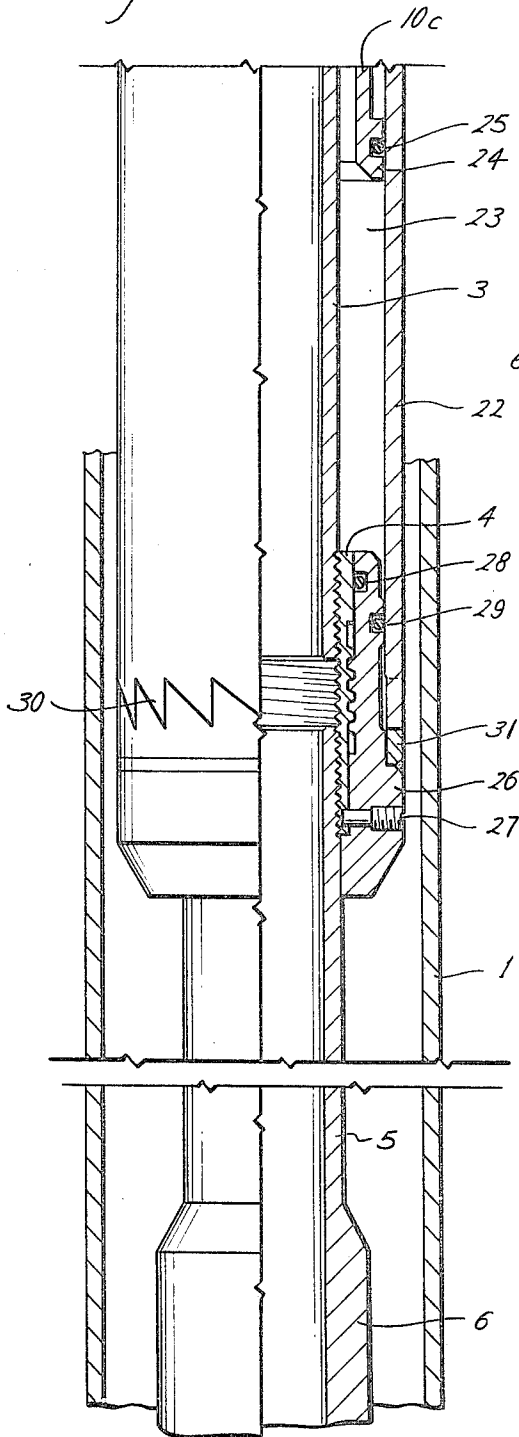


Fig. 5

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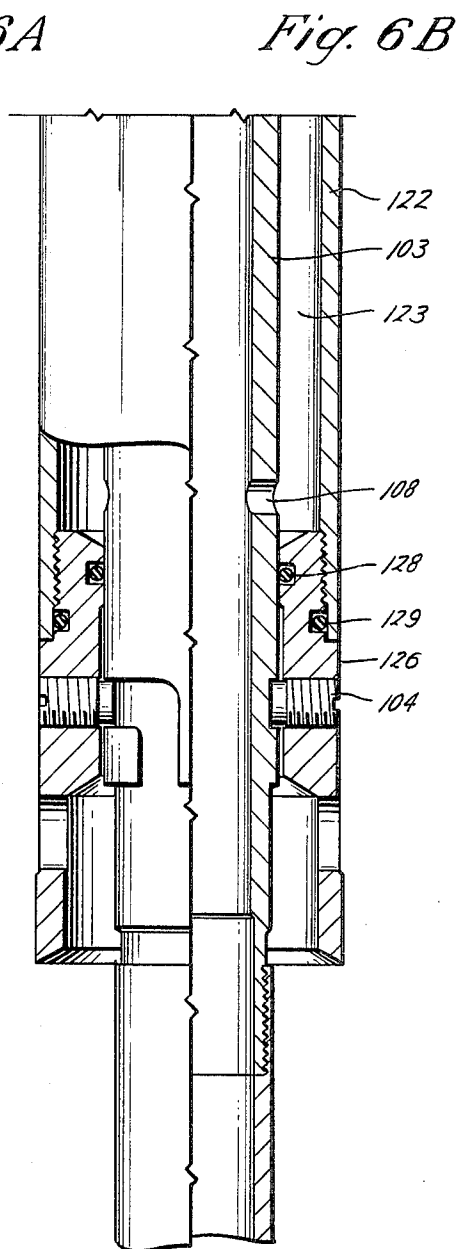
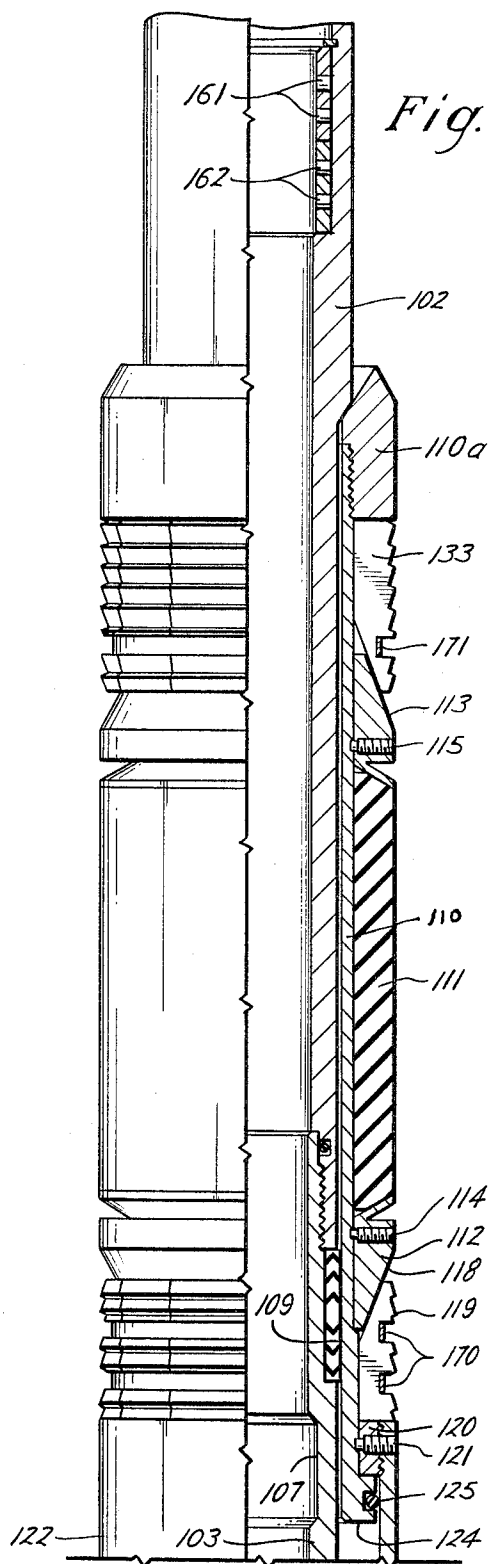
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WELL PACKER

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4 Sheets-Sheet 4



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3,265,131

WELL PACKER

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19 Claims. (Cl. 166-120)

This invention relates to well tools and more particularly to equipment which facilitates placement and removal of subsurface devices such as packers which are to be set in the annulus space surrounding a tubing string in a well hole.

The invention has for an object the provision of improved apparatus utilizing hydrostatic pressure to energize down hole well devices.

A further object is to provide a down hole tool containing a work producing cylinder and piston assembly in which the side of the piston within the cylinder and the side of the piston outside the cylinder are both exposed to well fluid pressure until work is to be performed whereby relative piston and cylinder movement is effected under differential pressure across the piston created by evacuating the cylinder and transferring pressure fluid therefrom into a depression chamber of relatively low internal pressure whereby fluid pressure on one side of the piston is reduced for utilization of the higher hydrostatic well pressure on the other side as the motive force productive of a desired relative travel.

Another object of the invention is to provide apparatus which is to be submerged in well fluids consisting largely of substantially incompressible liquid freely admitted into the piston cylinder for maintenance of force balance on opposite sides of the piston in advance of work performance and which liquid outside the cylinder provides an effective hydrostatic head for performance of work when liquid entry into the cylinder is cut-off and the cylinder contained liquid is displaced into a vacuum or depression chamber.

Other objects and advantages will become apparent in the course of the following specification taken in connection with the accompanying drawings wherein FIG. 1 is a diagrammatic line drawing illustrating as in vertical section a portion of a well having the improved packer assembly and a setting tool therefor positioned with the contracted packer collar and other parts ready for the operation of packer setting; FIG. 2 is a diagrammatic line drawing showing the parts in vertical section immediately following the operation of setting the packer; FIG. 3 is a diagrammatic line drawing in vertical section of the packer assembly in condition for removal from the well following collapse of the packing unit; FIGS. 4A, 4B and 4C are companion views half in side elevation and half in vertical cross section of the parts as in FIG. 1 but on a larger scale; FIG. 5 is a transverse section taken on 5-5 of FIG. 4B, and FIGURES 6A and 6B are companion views, in part elevation and vertical section of a modified packer assembly.

In a preferred embodiment of the invention as illustrated, a tubing string packer assembly is shown in down hole position at which it is desired to block off the annulus space between the tubing string and the well bore wall or liner casing 1. In the usual manner the tubing string consists of a number of hollow pipe sections screw threaded connected in end-to-end succession and the present packer assembly includes a nipple section 2 joined to the upper end of a special mandrel 3 whose lower end is

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coupled by a sleeve 4 to a lower tube section 5 which terminates at an upwardly shouldered coupling head or box 6.

Interiorly of the mandrel 3 there is a latched dog keeper formation or annular groove 7 and spaced a given distance below the keeper groove is a fluid transfer means consisting of internal and external annular grooves connected by one or more side ports 8 through the mandrel wall. In the regions seen in FIG. 4B and immediately above and below the side port 8, the internal face of the mandrel is of slightly reduced diameter and is machine finished to provide a smooth sealing surface for a purpose to be discussed later. Near its upper end the mandrel 3 carries a suitably located peripheral wall packing 9 for slide bearing contact with the upper terminal portion of an elongated tubular piston 10 in concentric sleeved relation on the mandrel. For convenience of assembly the piston comprises sections 10a, 10b and 10c threadedly connected in end-to-end succession.

As a subassembly with and surrounding an intermediate portion of the slide piston 10 is a packing collar 11 of rubber or other elastic deformable material capable of growing in wall thickness or expanding radially into contact with the casing wall in response to application of axial pressure on its opposite ends. End contact is through a lower stop abutment ring 12 and an upper abutment ring 13 which initially are releasably secured by connecting shearable pins 14 and 15, respectively, to the piston. The lower abutment ring 12 has a bottom internal counterbore providing a downwardly facing pick-up shoulder 16 engageable for a slip release operation by an upwardly facing shoulder 17 on an adjacent portion of the piston. Additionally the lower abutment ring 12 has a downwardly tapered peripheral surface 18 on which similarly inclined and adjoining surfaces of a group of slips 19 ride. For relative radial movement these slips have conventional tongue and groove connections with a retainer ring 20 which initially is releasably secured by a shearable pin 21 to the slide piston.

The lower slip retainer 20 is threaded into and forms a part of the upper end of the wall of a cylinder 22 spaced radially outwardly from the mandrel 3 to receive the lower end of the piston and to cooperate with both the piston and the mandrel in affording a variable volume pressure fluid chamber 23 communicating with the interior of the hollow mandrel 3 by way of the side port 8. This chamber 23 is sealed from the exterior of the packer assembly. Thus, the lower end of the piston terminates in a head 24 for a close sliding fit with the cylinder wall and the piston head carries an O-ring seal 25. The bottom of the chamber 23 is normally closed by a collar 26 surrounding and detachably screw threaded on the coupling sleeve 4 and being further secured thereto by a shearable pin 27. Internal and external O-ring seals 28 and 29 on the collar respectively contact the coupling sleeve 4 and the cylinder wall 22. At its lower end the wall 22 terminates in one-way clutch teeth 30 engaging mated teeth on a clutch ring 31 preferably formed separately from and welded on the outside of the collar 26. Completing the initial closure of the piston chamber from outside the assembly is the previously referred to packing seal 9 at the top of the interspace between the piston and the mandrel.

The upper packing abutment ring 13 mounts for limited radial movement, a number of slip expander segments 32, each having an upwardly tapered outer face

and a downwardly tapered inner face. The inner face of each expander slidably bears on a frusto-conical portion 10d of the piston for an outwardly wedging action on relative downward piston travel transmitted through the outer face of the expander to a similarly inclined surface on an adjacent one of a group of slips 33 hung for lateral displacement by tongue-and-groove connections with retainer collar 34. This retainer collar in initial assembly bears upwardly on the mandrel section 10a and is releasably secured by a shear pin 35.

As thus far described, the condition of the components of the packer assembly is that in which the assembly is incorporated as part of a tubing string and then lowered to a predetermined subsurface location within a well and submerged in down hole well fluid. With the piston chamber 23 in free open communication through the side port 8 with the interior of the tubing whose lower end is open to the well hole the same hydrostatic pressure exists on opposite sides of the piston and with the downwardly facing internal piston areas equal in size to the upwardly facing piston exterior areas exposed to the annulus space, the well fluid pressure across the piston will be balanced so that the initially elevated piston is free of forces urging the piston to move relative to the mandrel and piston cylinder. To produce such movement and a resultant axial squeezing of the packing collar between the piston and cylinder for setting the packing at a pre-selected depth, it is here proposed to provide for fluid pressure reductions within the piston cylinder. Chamber evacuation means to be timely triggered into action could be built into the packer assembly but desirably is embodied in a separate setting tool arranged to be lowered by conventional wire line method into cooperative relation with the chamber side port and to be retrieved and removed from the tubing string after performance of its setting function.

Referring in detail to the setting tool there is involved a tubular body 40 made up of a number of sections joined end-to-end and comprised in upward succession of a body nose closure plug 40a; an elongated cylinder wall 40b enclosing a depression chamber 41 of slightly greater volume than the chamber 23; a chamber closure and eduction passage containing member 40c; a latch dog carrier tube 40d; a coupler tube 40e having a shearable pin connection 42 with the tube 40d; a longitudinally slotted tube 40f and an upper terminal housing 40g to which a wire line 43 is secured.

Latch dogs 44 are retained within the body tube 40d and are projectable laterally through windows for cooperation with the keeper groove 7 of the mandrel and spaced below the dogs a distance corresponding with the axial spacing between the keeper groove 7 and the side port 8 is a side port through the spacer tube 45 which locates a pair of peripheral packing rings 46—46 on opposite sides of the port for sealing against the interior of the mandrel when the setting tool has been inserted within the mandrel to the operative position illustrated. Above the packing rings a vent port 47 is cut through the latch dog carrier tube 40d at the bottom of a plunger receiving space.

A valved eduction passage in the member 40c leads to depression chamber 41 and includes a lateral or side extension containing a replaceable flow meter orifice or choke 48 aligned with the side port of the spacer tube 45 and a central bore within which is fitted a closing valve consisting of a knock-out pin 49 seated downwardly on a shearable pin 50 carried by a gland which locates an O-ring seal 51 surrounding the knockout pin 49. A similar O-ring seal 52 is mounted at the upper end of the central bore through the member 40c to bear on a reduced end portion of a striker pin 53 carried by a depressible force transmitting plunger 54 slidably fitted within the tool body sections 40d, 40e and 40f and provided with a latch dog engageable and expander enlargement 55.

Near its upper end the plunger 54 has a locating pin 56 slidably received within a longitudinal slot in the body

section 40f to which the plunger is releasably secured by a shear pin 57. Housed by the upper terminal of the body section is an expendable cartridge 58 housing an electrically ignitable explosive charge which furnishes motive power for plunger depression. The firing circuitry for the cartridge can be that disclosed in co-pending patent application Serial No. 803,049 filed March 30, 1959 by W. G. Ownby. It is self-contained within the upper body section 40g and includes a battery source 59 of current and a pair of series connected magneto actuated switch units 60—60. The switch units are preset a given axial distance above the latch dogs 44 and also in spaced-apart relation one to another to match the distance above the keeper groove 7 and the axial space between a pair of inwardly protruding magnetic fields provided each by a set of upper and lower rows of annularly spaced permanent magnets 61—61. These magnets in the lower row of each set have their north poles facing inwardly and those magnets in each upper row have their south poles facing inwardly. Conveniently the magnets in each set are positioned by spacer tubes 62 of non-magnetic material seated internally of the tubing nipple section 2. With such given spaced relationship it follows that insertion of the setting tool 40 into the mandrel 3 to a position in which the latch dogs 44 are radially aligned with the keeper groove 7, then the series connected field responsive magneto switch units 60—60 will also be aligned with the two sets of magnets 61—61 and will effect closing of the explosive charge actuating circuit. Concurrently therewith, the internal port 8 in the wall of the mandrel will be closed between the seals 46—46 from well pressure fluid and will be open and in radial alignment with the metering orifice 48 of the lateral extension of the eduction passage leading to the depression chamber 41 and the several components will be conditioned for the operation of evacuating the piston chamber at the orifice controlled rate of pressure fluid transfer through the previously valved eduction passageway.

In the installation and use of the described packer equipment the mandrel 3 with the contracted packer collar and associated parts releasably secured in unitary assembly is incorporated in a predetermined portion of the length of a string of tubing made up at the wellhead and lowered into the well hole until the packer assembly reaches the region to be packed off. Up to this time the exterior and the interior of the piston are closed off across the piston at the upper and lower packing seals 9 and 25 and the same hydrostatic head of well fluid within the surrounding annulus and within the piston chamber 23 acts on the effective upwardly facing exterior piston area and on the effective downwardly facing interior piston area but the opposite facing effective areas balance one another and the opposing forces on the slide piston are equal.

With the packer assembly ready to be actuated its piston chamber 23 will need to be evacuated for piston travel under differential pressures thereon. For that purpose the setting tool with its parts in their initial relations as previously described will be lowered by the suspension line 43 into the tubing string. Since the spacing between the magneto switch units 60—60 will match the spacing of the magnetic fields provided by the two sets of magnets in the tubing string concurrent responses of the circuit closing switches will occur during relative tool travel at the instant the latch dogs 44 and the lateral extension of the eduction passage come into alignment respectively with the keeper groove 7 and the side port 8. Although for some installations a tubing string may have a number of similar but differently spaced sets of magnetic field stations the permissible spatial coding of the magneto switches enables selection of the station at which the work is to be performed all as described in said co-pending patent application.

Upon such selective responses of the serially connected switches the firing circuit through the cartridge 58 will be

completed and with ignition of the charge its explosive expansion imparts downward force on the plunger first breaking the shear pin 57 and then depressing the plunger 54 to bring the expander 55 behind and project the latch dogs 44 into tool latching retention within the keeper groove 7 of the mandrel and also to bring the bottom tip of the striker pin 53 forceably against the top of the knock-out pin 49 for a shearing of the retainer pin 50 and the dropping of the knock-out pin from the eduction passage and into the depression chamber 41. With the eduction passage cleared and the keeper secured latching dogs positioning the lateral extension of the passageway in aligned communication with the mandrel side port 8 which now is sealed off from the interior of the tubing string by the upper and lower packing seals 46—46, the relatively higher pressure fluid within the piston chamber 23 will transfer to the depression chamber at a rate controlled by the metering orifice 48 to cushion piston response in a timed sequence of packer setting actions.

The strength of the several shear pin connections in relation to resistance to piston travel will be selected so that as piston cylinder pressure is reduced, the annulus pressure on the outside of piston 10 will first effect breakage of the pin connection 21 between the piston and the wall of the piston cylinder 22. As the piston moves into its cylinder the stop abutment ring 12 is carried down until its wedge surface 18 presses the slips 19 outwardly into tight clutched engagement with the wall of casing 1. Firm setting of the slips 19 resists further downward movement of the stop abutment 12 and results in breakage of the shear pin 14 and piston release for continued downward travel of the piston and the application of axial squeezing force on the packer collar 11 between the stopped abutment ring 12 and piston carried upper abutment ring 13. Consequently the deformable packer ring increases in width and expands radially into tight sealing relation with the casing wall and also into snug slide bearing contact with the adjacent surface of the piston and thereafter resists further movement of the abutment ring 13 with the piston which results in a shearing of the releasable pin 15. Upon immobilization of the ring 13 its segmental slip expanders 32 will shift radially outwardly through their slide bearing and wedging engagement on the downwardly moving frusto-conical portion 10d of the piston and such outward displacement of the expanders 32 along with their upwardly tapered bearing contact with the downwardly carried upper slips 33 forces the slips outwardly into tight clutching fitment with the casing wall. This completes the packer setting operation with the parts then positioned as in FIG. 2, it being understood that the depression chamber will have a volume to receive all liquid of the well fluid which is displaced from the piston cylinder and also that the initial sealed-in pressure of the depression chamber needs to be sufficiently below well fluid pressure at the packer as to maintain an operating differential across the piston to the end of its packer setting travel.

On the other hand, it is conceivable that there may be well conditions and design considerations which result in or call for completion of a packer setting operation in stages effected through a succession of reruns of the setting tool. Thus, in one use of the setting tool the level of pressure within the tool depression chamber may be related to the hydrostatic head of well fluid at the packer so as to produce only partial setting of the packer. Upon setting tool retrieval and with equal pressures across the piston, the packer components will remain in any new position. Thereafter, either the same setting tool or another like tool, and with pressure within the depression chamber at a selected negative value in relation to the downhole pressure head, can be lowered into co-operative communication with the piston chamber for an additional increment of piston travel. Reruns can be repeated as often as required to final packer setting.

Once the packer and slips have been set, the assembly will remain locked up against unintentional piston upward movement, not only because of the slip clutching action but also because the inclined angle of the interengaged wedging surfaces at the frustum 10d has been chosen for maintenance of wedging action.

Following completion of the packer setting operation, the setting tool is removed from the well tubing. An upward pull or jar transmitted through the suspension line 43 will first break the shear pin connection 42 between the upper tool body section 40e and the still latched-in body portion 40d. The plunger carried pin 56 at the bottom of its locating slot in the tool body section 40f will then raise the plunger 54 with suspension line retrieval and immediately elevate the latch expander 55 to allow retraction of the dogs 44 and also elevate the striker pin 53 above the seal 52 and out of the eduction passage. The opening of the eduction passage will then equalize pressure across the piston by communicating the piston cylinder chamber 23 with the vent port 47 above the uppermost of the annular packings 46 and with the passage 63 leading downwardly below the lowermost of the packing rings 46. This passage 63 together with the side port 47 serves as an open by-pass at all times for equalizing well pressure across the seals during setting tool travel and while the seals are in bearing contact with the smooth internal sealing surface of the mandrel adjacent the side port 8. Line retrieval can continue and bring the upwardly facing shoulder of the enlargement 55 into pick-up relation with the internal downwardly facing shoulder 64 of the body section 40d and lift the tool from the tubing string at the wellhead. The tubing string interior is now cleared or open for well flow or for other work operations.

Should tubing string removal from the well be required at any later time, the expanded packer collar 11 can be released by first rotating and then lifting the tubing string. Tubing string and mandrel rotation relative to the well bore and the expanded packer applies force to shear the pin connection 27 with the tubing coupling sleeve 4 and then unthreads the sleeve from the clutch collar 26 and also elevates the mandrel for extending the packing ring 9 above the upper end of the piston as seen in FIG. 3. When the collar 26 is freed, it drops away from the piston cylinder wall 22 and is caught by the tubing head 6. Lift on the mandrel now brings the top of the coupling sleeve 4 into contact with the pick-up shoulder 65 on the piston and then elevates the piston with the mandrel as the shear pin connection 35 is jarred loose for movement of the frusto-conical wedge 10d out from under and allowing inward release of slips 33. Additional upward piston travel brings its shoulder 17 into bearing with the pick-up shoulder 16 of the lower slip stop abutment 12 to thereby release the lower set of slips 19 and allow the packer collar to contract radially and elongate axially. The head 24 at the bottom of the piston picks up the lower edge portion of the slip retainer 20 and all of the collapsed parts will ride up with the mandrel as the tubing string is lifted from the well hole.

A packer assembly to be lowered to a given depth location within a well hole as part of the tubing string and then set to seal off the annulus as by means of the setting tool, all as previously described but in which the expanded packer collar is not subsequently to be collapsed and withdrawn upon tubing string removal, is also disclosed in the drawings. In such modified embodiment, the tubing string is detachable from the packer components for elevation out of the well and the packer components remaining in place can easily be destroyed or drilled out if the well is to be reworked. In such embodiment, a mandrel to be incorporated as part of a tubing string includes a pair of tubular members 102 and 103 in end to end threaded connection and locating therebetween an external packing ring 109 for slide seal

bearing on the interior of a tubular piston 110 sleeved on the mandrel.

Below the packing ring 109 the piston terminates in a peripherally enlarged head 124 having an external annular groove locating an O-ring 125 in slide bearing engagement with the interior surface of a cylindrical wall 122 which is radially spaced from the mandrel member 103 to co-operate therewith and with the piston in affording a variable volume cylinder or piston chamber 123. At its lower end, the piston cylinder is plugged by a closure collar 126 threaded into the wall 122 and closely sleeved on the mandrel member 103, there being O-rings 128 and 129 carried inside and outside of the collar to seal on the cylindrical wall and the mandrel member. A clutch pin 104 fixed on the collar projects inwardly for reception within a downwardly open J-slot on the exterior of the mandrel member as a releasable coupling.

The wall of the mandrel member 103 has a communicating port 108 therethrough near the bottom of the piston chamber 123 and has an internal latch dog keeper groove 107 spaced axially a given distance above the port. In given axially spaced relation above the keeper groove, the mandrel member 102 positions internally thereof two sets of permanent magnets 161 and 162. Each set comprises upper and lower rows of magnets with the north poles in one row facing inwardly and the south pole in the other row facing inwardly to provide inwardly protruding magnetic fields or markers with the two sets in given axially spaced apart relation and whose purpose is to signal actuation of a packer setting tool in the manner above described and which tool is constructed and arranged with a lateral eduction passage leading to a depression chamber; latch dogs and a set of magneto switches axially spaced apart to correspond with the spacing between the port 108; the keeper groove 107 and the magnets 161 and 162.

Surrounding an intermediate portion of the tubular slide piston 110 is a deformable packer sleeve or collar 111 positioned between upper and lower abutment and slip expander rings 112 and 113 which respectively are initially secured releasably by shear pins 114 and 115 to the piston. A downwardly tapered wedge surface 118 on the lower abutment ring 112 engages similarly inclined back faces of a set of outwardly projectionable segmental slips 119 which are pocketed below the ring 112 and against the top edge of the cylinder 122. At the time of assembly, these slips 119 are held contracted by one or more encircling bands 170 of frangible cast iron or of suitable malleable material which either break or deform to accommodate subsequent outward wedged movement of the slips. Increased bearing area for the slips 119 is afforded by an internal enlargement or ring 120 threaded into the top end of the cylinder wall 122. A radially extended frangible pin 121 is threaded through the cylinder 122 and ring 120 and the pin tip releasably secures itself to the piston 110 as a shearable connection.

The upper portion of the upper abutment ring 113 is a frustum affording an upwardly and inwardly inclined wedging face for bearing on mating back surfaces of a set of segmental slips 133 initially held contracted by retainer band means 171 similar to the band 170. Each slip 133 is hung for outward projection by interlocking tongue and groove connection with a terminal head 110a on the upper end of the slide piston and which for convenience of assembly is formed separately and threaded in place on the piston. Such threaded attachment of the terminal head 110a is the last step after other components have been sleeved on the piston as a subassembly therewith and in the unstressed relationship shown. The piston subassembly is to be sleeved on the preassembled mandrel members 102 and 103 and connected through the J-slot and pin 104 for completing the packer unit.

In use, the packer arranged as described has its mandrel coupled in a tubing string and as part of the string is lowered into a wellhole to a desired depth location.

Downhole fluid pressures acting on the exteriorly exposed areas of the slide piston and on the internal piston faces exposed within the chamber 123 through its open port 108, or, in other words, on the oppositely facing and equal piston areas separated by the seals 109 and 129, are balanced and impose no displacement push on the piston. Differential pressure across the piston occurs when the cylinder is evacuated as by means of a co-operating depression chamber brought into action by a setting tool in the manner heretofore explained and the response is to break the shearable connection 121 and allow piston descent through a first increment of travel in which the lower slips 119 are wedged outwardly into set clutching contact with the wall of the well. Thereafter, the set slips 119 and their expander ring 112 against which the packer collar 111 now bottoms and is stopped, offer resistance to downward forced travel of the abutment ring 112 with a resultant breakage of the connection 114 with the piston. Continued relative descent of the piston and packer collar upper abutment ring 113 axially squeezes and radially deforms the packer collar tightly against the wall of the well and when solid resistance to further collar deformation is reached, the shear pin 115 between the piston and the upper abutment ring and slip expander 113 responds by breakage to accommodate additional descent of the piston and the upper set of slips 133 whereby the upper slips ride out on the wedging faces of the ring 113 and into secure clutching contact with the wall of the well. This completes the setting operation.

At any subsequent time and without disturbing the slip-held packer subassembly, the mandrel and the entire tubing string can be removed from the well after a part rotation of the tubing and the J-slot relative to its coupling pin 104 along with the application of lifting force to clear the slot of the pin and to raise the tubing to the wellhead.

While the foregoing description has been limited to a preferred structural embodiment of the invention and for packing off the annulus surrounding a production string, it is adaptable for packing around a well casing and other tubular assemblies and various modifications may be made as come within the scope of the appended claims.

What is claimed is:

1. Well packer equipment of the character described including a deformable packing member arranged for radial expansion in response to axial squeeze pressure applied on opposite ends thereof, first abutment means and second abutments engageable with opposite ends of the deformable packing member, the first abutment means including a slidable piston member having opposing head surfaces for exposure to pressure fluid which controls piston slide position, the second abutment means including a chambered member receiving one of the piston head surfaces and co-operating therewith to define a variable volume pressure fluid chamber and means to evacuate pressure fluid from said variable volume chamber and thereby effect relative movement of the piston and chamber members and a responsive deformation of the packing member.

2. Well packer equipment as in claim 1, said means to evacuate the variable volume chamber including an initially closed and relatively low pressure chamber, a flow valve controlling communication of the low pressure chamber with the variable volume chamber member and selectively operable means to open said valve.

3. Well packer equipment as in claim 1, said chamber member including a tubular mandrel section of a well tubing string and whose wall has a lateral communicating port into the variable volume chamber and a latch dog receiving internal keeper spaced a predetermined axial distance from said port and the evacuating means comprising a setting tool to be lowered into the tubing string and enclosing a relatively low pressure chamber with a lateral eduction opening for alignment with said lateral

port, a projectable latch dog carried by the tool and spaced axially from said eduction opening a distance matching the space between said port and said nipple, means initially sealing said eduction opening, a plunger having formations to engage and project said latch dog and concurrently to open the sealing means in response to forced plunger depression and plunger operating force applying means housed within said tool.

4. Well packer equipment including a tubular mandrel constituting a section of a well tubing string and having a side port through the wall thereof, an elongated tubular piston slidably surrounding said mandrel and having an internal slide seal fit near one end with the mandrel, a deformable packing collar sleeved on an intermediate portion of the piston, an annular wall surrounding and having a slide seal fit with the other end of the piston externally thereof and being radially spaced from and joined to the mandrel for co-operation therewith and with the piston in providing a variable volume pressure fluid chamber in open communication with said side port, an abutment stop positioned by said wall and engageable with one end of the packing collar, an abutment member engageable with the other end of the packing collar and carried by the slide piston in its movement toward said abutment stop for application of deforming force to expand the packing collar, said piston having radially disposed surface areas in oppositely facing relation for exposure to action thereon of well pressure fluid and such areas which face oppositely being respectively exposed internally of the variable volume chamber and exteriorly of the mandrel and means to evacuate said chamber for an imbalance of fluid pressures on said oppositely facing areas and to which said piston responds and transmits deforming force on the packing collar.

5. Packer equipment of claim 4 together with a pair of outwardly projectable slip devices, one of the slip devices being interposed between said wall and the abutment stop and having tapered wedge bearing engagement with the abutment stop through which slip device projection is effected and the other of the slip devices being interposed between the piston and said abutment member and having tapered wedge bearing engagement with the abutment member through which slip device projection is effected.

6. Well packer equipment including a tubular mandrel constituting a section of a well tubing string and having a side port through the wall thereof, an elongated tubular piston slidably surrounding said mandrel and having an internal slide seal fit near one end with the mandrel, a deformable packing collar sleeved on an intermediate portion of the piston, an annular wall surrounding and having a slide seal fit with the other end of the piston externally thereof and being radially spaced from and joined to the mandrel for co-operation therewith and with the piston in providing a variable volume pressure fluid chamber in open communication with said side port, an abutment positioned by said wall and engageable with one end of the packing collar, an abutment member engageable with the other end of the packing collar and carried by the slide piston in its movement toward said abutment stop for application of deforming force to expand the packing collar, said piston having radially disposed surface areas in oppositely facing relation for exposure to action thereon of well pressure fluid and such areas which face oppositely being respectively exposed internally of the variable volume chamber and exteriorly of the mandrel and means to evacuate said chamber for an imbalance of fluid pressures on said oppositely facing areas and to which said piston responds and transmits deforming force on the packing collar, said means comprising a body for insertion within the mandrel and containing an initially closed chamber whose internal pressure is less than piston responsive well pressure fluid, an eduction passageway leading to the last mentioned chamber and for communication with the side port of

the mandrel upon insertion therein of the body, valve means initially closing said passageway and valve opening means operable when said passageway communicates with the side port for transfer of well pressure fluid from within the variable volume chamber.

7. Well packer equipment including a tubular mandrel constituting a section of a well tubing string and having a side port through the wall thereof, an elongated tubular piston slidably surrounding said mandrel and having an internal slide seal fit near one end with the mandrel, a deformable packing collar sleeved on an intermediate portion of the piston, an annular wall surrounding and having a slide seal fit with the other end of the piston externally thereof and being radially spaced from and joined to the mandrel for co-operation therewith and with the piston in providing a variable volume pressure fluid chamber in open communication with said side port, an abutment stop positioned by said wall and engageable with one end of the packing collar, an abutment member engageable with the other end of the packing collar and carried by the slide piston in its movement toward said abutment stop for application of deforming force to expand the packing collar, said piston having radially disposed surface areas in oppositely facing relation for exposure to action thereon of well pressure fluid and such areas which face oppositely being respectively exposed internally of the variable volume chamber and exteriorly of the mandrel and means to evacuate said chamber for an imbalance of fluid pressures on said oppositely facing areas and to which said piston responds and transmits deforming force on the packing collar, said annular wall being joined to the mandrel by a detachable connection whose detachment enables the mandrel to be moved axially relative to the annular wall and thereby to slide the piston and the piston carried abutment in a direction away from said packing collar abutment.

8. Well packer equipment including a tubular mandrel constituting a section of a well tubing string and having a side port through the wall thereof, an elongated tubular piston slidably surrounding said mandrel and having an internal slide seal fit near one end with the mandrel, a deformable packing collar sleeved on an intermediate portion of the piston, an annular wall surrounding and having a slide seal fit with the other end of the piston externally thereof and being radially spaced from and joined to the mandrel for co-operation therewith and with the piston in providing a variable volume pressure fluid chamber in open communication with said side port, an abutment stop positioned by said wall and engageable with one end of the packing collar, an abutment member engageable with the other end of the packing collar and carried by the slide piston in its movement toward said abutment stop for application of deforming force to expand the packing collar, said piston having radially disposed surface areas in oppositely facing relation for exposure to action thereon of well pressure fluid and such areas which face oppositely being respectively exposed internally of the variable volume chamber and exteriorly of the mandrel and means to evacuate said chamber for an imbalance of fluid pressures on said oppositely facing areas and to which said piston responds and transmits deforming force on the packing collar, said means comprising a body for insertion within the mandrel and enclosing a chamber whose internal pressure is preset below known well pressure at the region at which the packing collar is to be set, an eduction passageway leading to the chamber from an opening in the side wall of the body for alignment with said side port, a closure in the passageway, a laterally projectable latch dog carried by the body and spaced axially from said opening, a dog keeper formation in the mandrel axially spaced from said side port in correspondence with the space between the latch dog and said opening and actuating means operable to project the latch dog into said keeper formation upon alignment therewith and concurrently open the passageway closure.

9. Packer equipment as in claim 8 together with a pair of axially spaced apart sealing surfaces carried by the body on opposite sides of its said opening and in sealed bearing contact with the mandrel when said opening is aligned with the side port and means to equalize tubing string pressure on opposite sides of said sealing surfaces and comprising an open duct extended within the body in by-pass relation with the sealing surfaces.

10. Well tool equipment including a tubing string mandrel, work performing piston member and cylinder member carried by the mandrel, one of said members movable relative to the other member, a surface on the movable member exteriorly of the cylinder member exposed to the action on said surface of well pressure fluid to effect such relative movement in response to differential pressure forces interiorly and exteriorly of the cylinder member, said cylinder member having a pressure equalizing port for initially equalizing pressures interiorly and exteriorly of the cylinder member and means operable to close said port and evacuate pressure fluid from the interior of the cylinder member.

11. Well tool equipment as in claim 10 wherein said means includes a body insertable within the mandrel into port blocking relation, a depression chamber contained within the body, a valved passageway leading to the chamber and being arranged for communication with said passageway upon body insertion within the mandrel and means for opening the valve passageway upon its communication with said port for pressure reduction within the interior of the cylinder member.

12. Well tool equipment as in claim 11, said passageway containing flow metering means which control the rate of cylinder evacuation.

13. In a well packer assembly, a mandrel, a tubular piston slidably sleeved on the mandrel, an annular wall surrounding one end of the piston and combining with the mandrel to afford a variable volume piston cylinder, means providing an external slide seal between said one end of the piston and the annular wall and providing an internal slide seal between the opposite end of the piston and the mandrel so that the external and internal piston surfaces are separated from one another and exposed respectively externally of the assembly and internally of the piston cylinder, port means normally opening the cylinder to surrounding pressure fluid and permitting withdrawal of pressure fluid from within the cylinder, a deformable packing ring surrounding the piston, a stop abutment positioned by said annular wall and engageable with one end of the packing ring and a pressure transmitting abutment movable with the piston toward the stop abutment and engageable with the other end of the packing ring.

14. In a well packer assembly as in claim 13, a radially projectable slip connected with the piston at said opposite end thereof, a slip expander connected with the pressure transmitting abutment and provided with a wedge portion interposed between adjacent portions of the slip and the piston, said wedging portion of the expander having internal and external bearing surfaces extended in convergent relation to one another in a direction away from the packing ring and the adjoining portion of the slip and the piston having expander bearing surfaces divergently related to one another and mating with the convergently related expander surfaces.

15. A well packer tool to be lowered into a well hole to the region of a tool responsive marker at a packer assembly whose actuation is influenced by evacuation of a pressure fluid contained chamber, said tool comprising a body enclosing a depression chamber, and eduction passage extended in the body to said depression chamber and from an inlet thereto, an initially closed valve for said eduction passage, projectable latch means carried by the body for anchoring the same in a packer assembly with said inlet positioned in communication with the pres-

sure fluid contained chamber, a depressible plunger slidably mounted in the body between an inoperative position and a position which projects said latch means and opens and valve and marker responsive means housed by the body for action on marker traverse by the body to apply force on the plunger for movement to its last mentioned position.

16. A well tool for setting a downhole packer assembly by evacuating pressure fluid from a variable volume chamber and comprising a body to be lowered in a well hole to a previously located well packer assembly, a depression chamber within the body, said depression chamber having an internal pressure less than the pressure in such said variable volume chamber and having an initially closed eduction passageway, means to position said body for communication of its eduction passageway with the chamber of a packer assembly and operating means to effect opening of said eduction passageway.

17. In a subsurface well tool, a tool body having in axially spaced succession a depression chamber and a venting chamber and a laterally projectable latch dog, an axial passageway in the body connecting said chambers and having a lateral entry port intermediate its ends, a knockout pin fitted in and sealing the passageway between the entry port and the depression chamber, a striker pin fitted to and sealing the passageway between the entry port and the venting chamber, a depressible plunger carried by the body and connected with the striker pin and provided with a latch dog expander, motion transmitting means operable on the plunger to project the same in one direction to laterally move the latch dog and to move the striker pin into engagement with said knockout pin thereby removing the knockout pin from the passageway between the entry port and the depression chamber and means to retract the previously projected plunger and thereby retract the striker pin out of the passageway and the expander from latch dog projecting relation.

18. In a well packer assembly, a tubular mandrel for connection in a tubing string and for reception of a retrievable packer setting tool, a slidable piston sleeved on the mandrel, a cylindrical wall surrounding the mandrel in radially spaced relation thereto and enclosing one end of the slidable piston in co-operating relation with the cylindrical wall and the piston defining a variable volume piston chamber, a deformable packer collar embracing the piston, an abutment bearing positioned by the cylindrical wall in bottoming contact with the packer collar, a packer abutment ring movable with the piston toward said abutment means, port means in the wall of the mandrel communicating the piston chamber with the interior of the mandrel and being adapted to be closed off from the mandrel interior upon reception therein of a setting tool and to be aligned with an eduction passage leading to a tool contained depression chamber for evacuation of the piston chamber and packer deformation upon piston movement into said chamber and a detachable coupling connection joining the cylindrical wall to the mandrel and being detachable to enable the tubing string mandrel to be lifted completely clear from and without disturbing removal of the packer collar after being set and its associated piston and cylindrical wall.

19. In a subsurface well tool, a tool body, a depression chamber contained within the body, an eduction passageway leading to said chamber from a lateral entry port, said passageway having a portion thereof extended axially of the body from the eduction chamber to a vent in the body and having said entry port leading laterally into said portion at a point intermediate its axial length, an initially closed valve for said passageway including a knockout pin fitted within the axially extended portion between the entry port and the eduction chamber; and valve actuator mechanism including a striker pin slid-

ably and sealably fitted within the axially extended portion between the entry port and said vent and motion transmitting means connected with the striker pin for moving the striker pin in one direction to engage and project the knockout pin from the passageway and thereby clear the same between the entry port and the chamber and for moving the striker pin in the other direction out of and clearing the passageway between the entry port and said vent.

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