

April 23, 1963

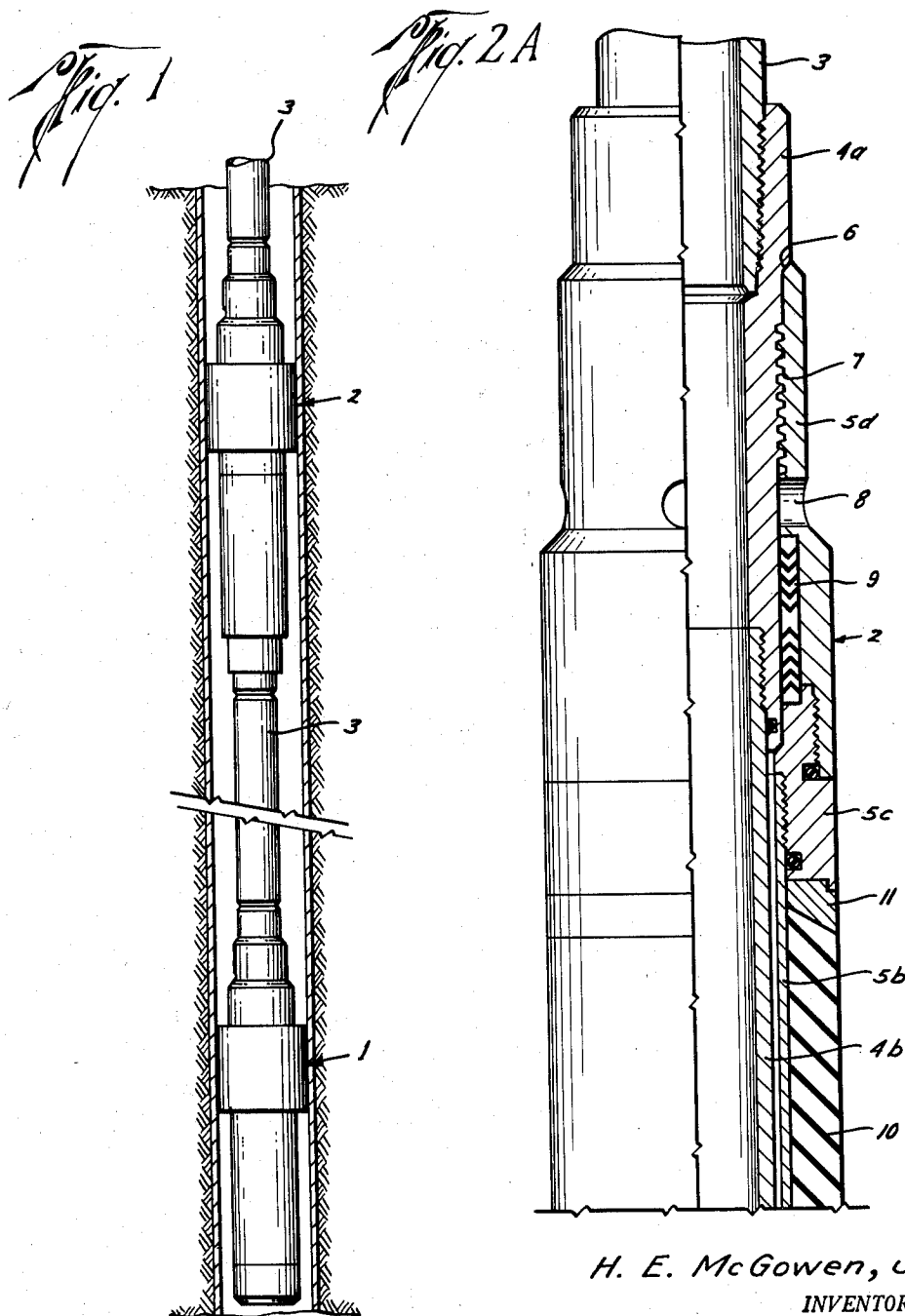
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3,086,589

MAGNETICALLY SET WELL PACKERS

Filed July 30, 1959

6 Sheets-Sheet 1



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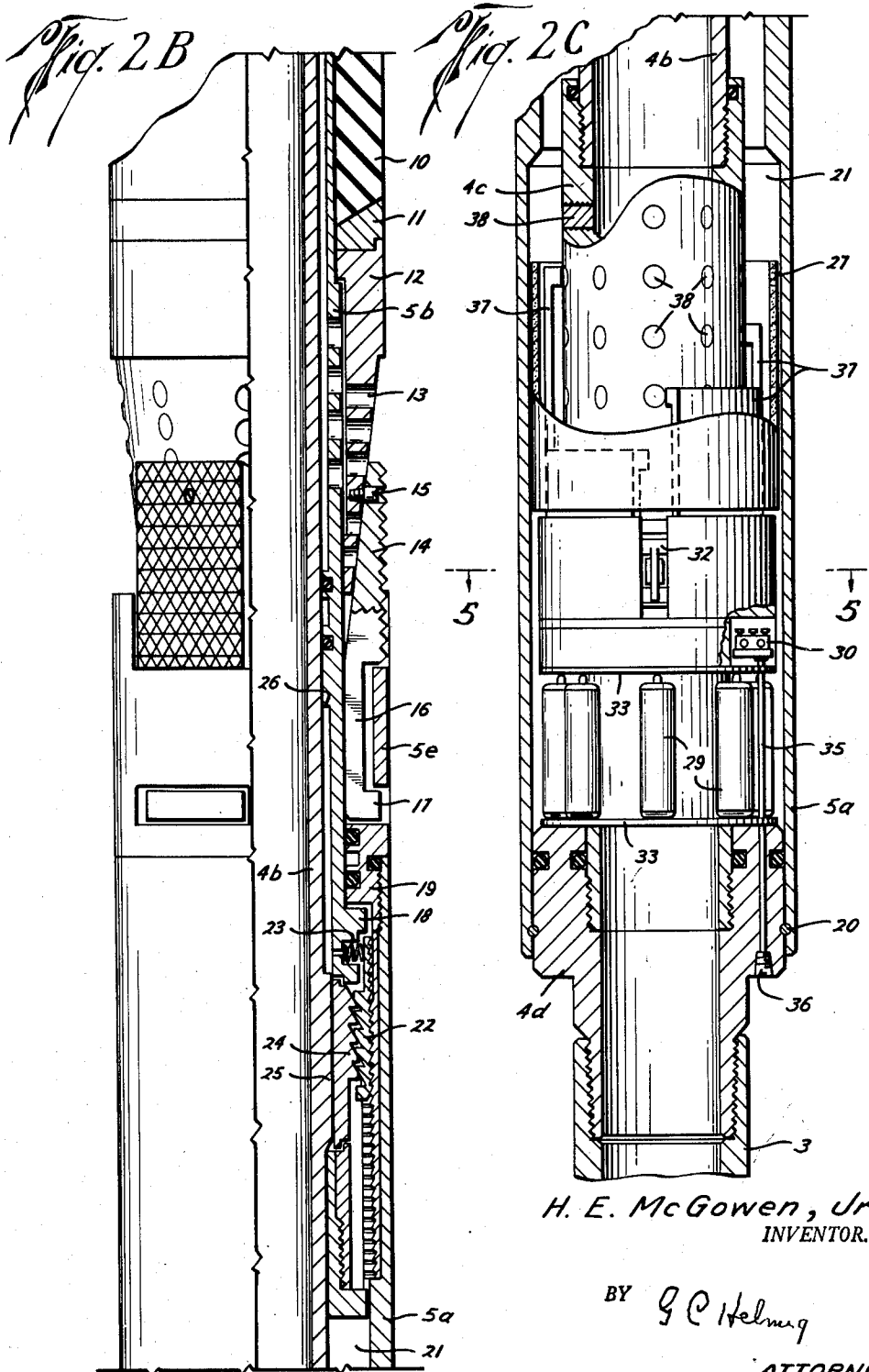
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MAGNETICALLY SET WELL PACKERS

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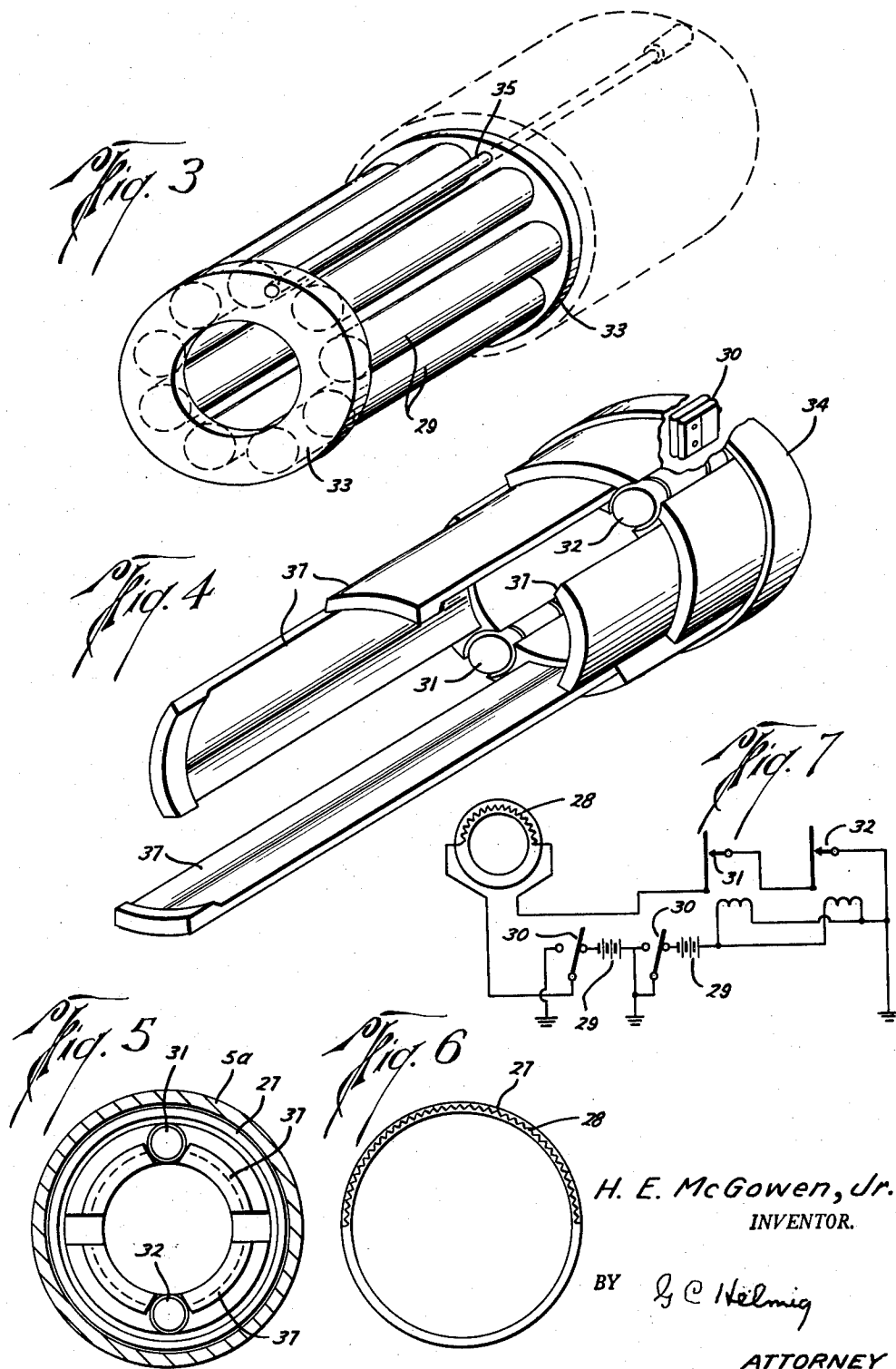
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6 Sheets-Sheet 3



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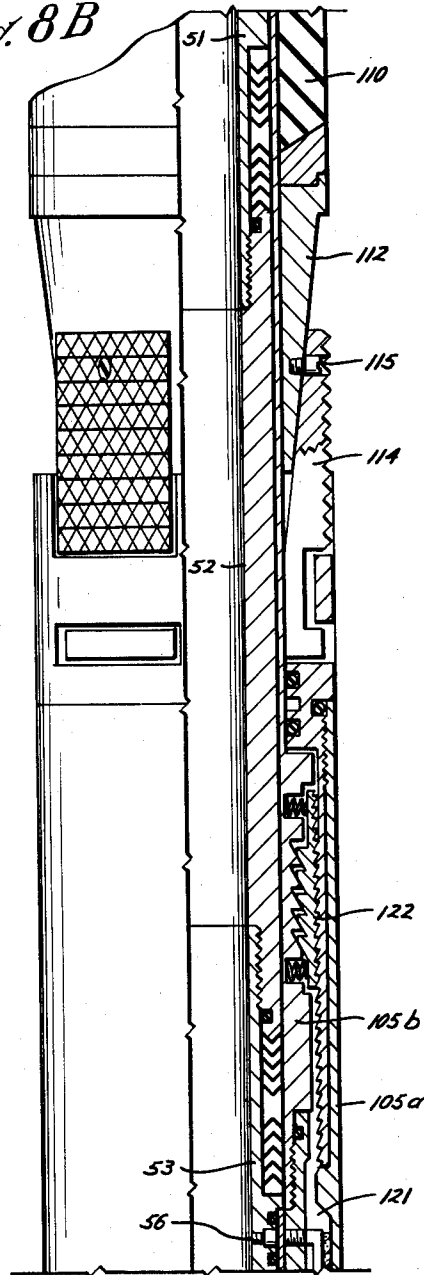
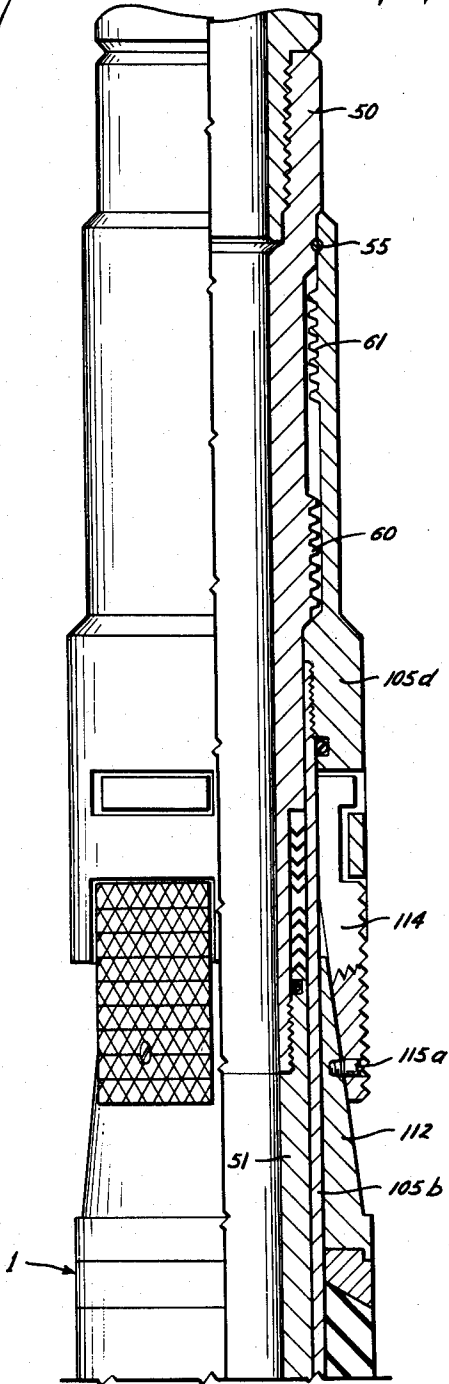
MAGNETICALLY SET WELL PACKERS

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Fig. 8A

Fig. 8B



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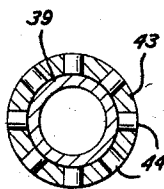
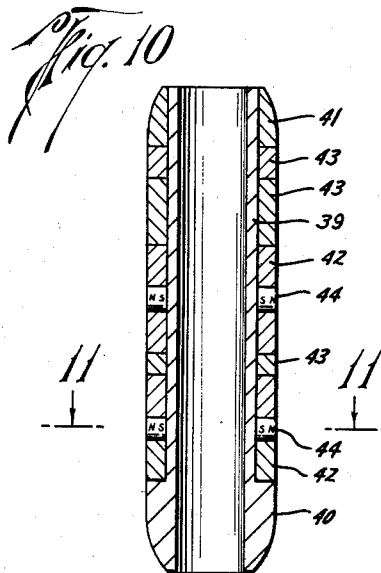
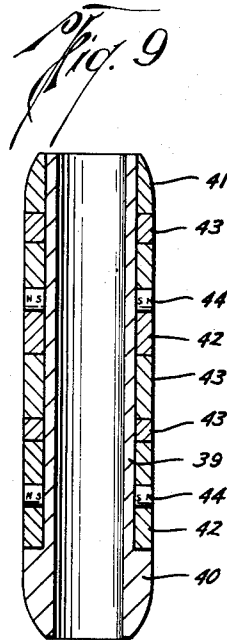
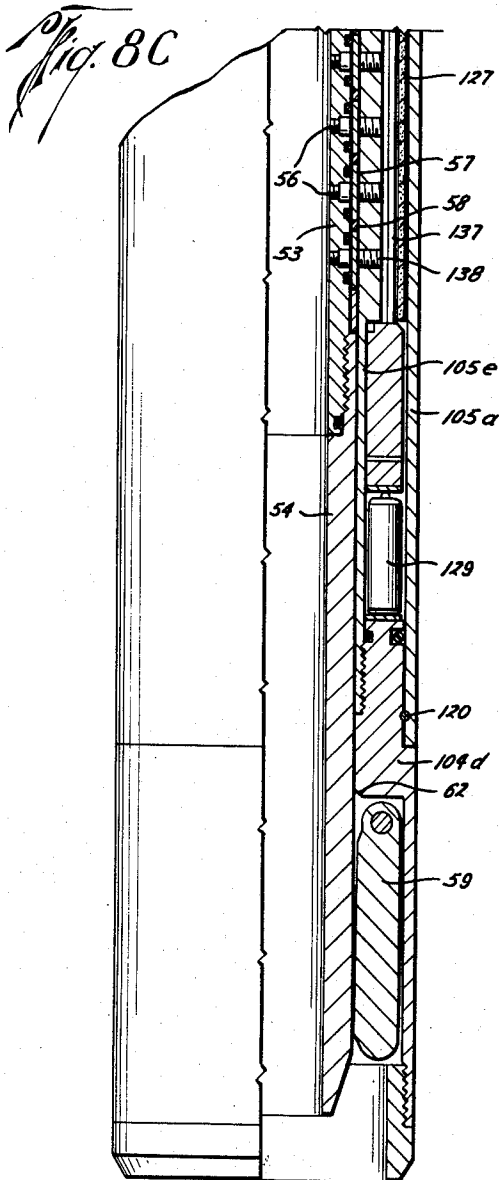
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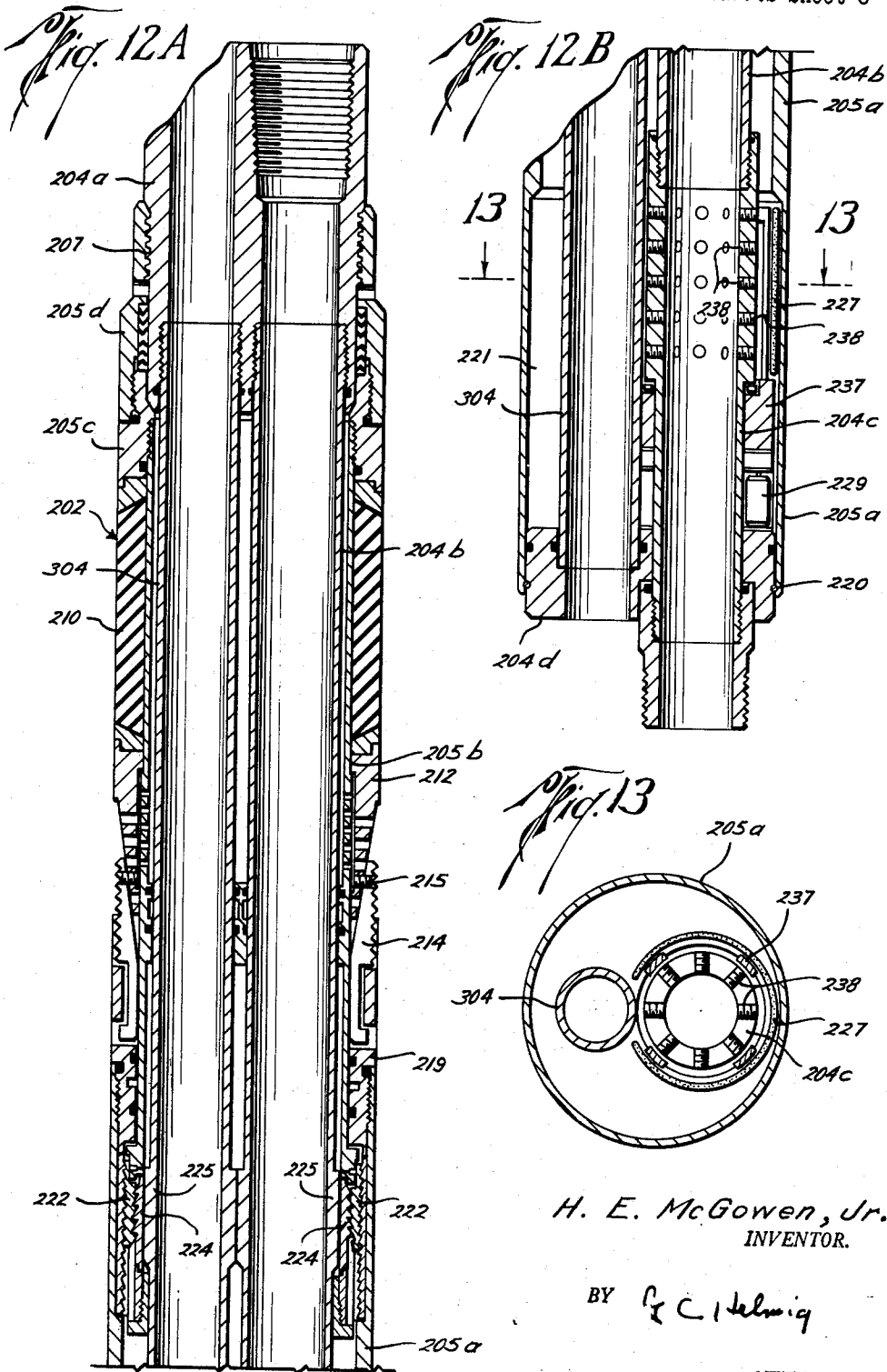
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MAGNETICALLY SET WELL PACKERS

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3,086,589

MAGNETICALLY SET WELL PACKERS

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20 Claims. (Cl. 166-65)

This invention relates to an improved well packer and more particularly to packer setting mechanism incorporated as part of the packer assembly itself and as a source of stored energy to be released or triggered into work performing action upon response of a signal receiving device coded for receipt only of a preselected signal. In a preferred embodiment, the energy to be released is a combustible or explosive charge confined within an expansible chamber and detonated or fired by electric current in a control circuit which is closed upon influencing one or more magneto devices having field pole pieces with terminal faces in a given spaced relation corresponding to the spacing of mating faces of a set of magnet pole pieces carried by a go-devil and which, after the packer has been properly located in a well, is permitted to travel into proximity to the packer for the alignment of the two sets of mating pole piece faces whereby lines of force from the magnet are extended or transmitted into the magneto device mechanism and signal or trigger the closing of the fire control circuit.

Wellpackers heretofore have been mechanically worked by tubing string movements and have necessitated careful handling during lowering through laborious and awkward surface manipulations for transmitting torsional and longitudinal reciprocatory forces through the long string at the time of setting a packer and if more than one packer is carried by the string, the difficulties are greatly multiplied. To minimize work and skill required for installing a well packer, and especially the setting of several packers in the same well hole, is a primary object of the present invention.

A further object of the invention is to provide an improved well packer having as a unitary assembly therewith a releasable force applying mechanism to set the packer and being coded to a particular actuating signal for response only to receipt of a selected signal transmitted thereto and without bodily shifting the entire tubing string and which can be installed in wells requiring a single packer and also in wells calling for a number of packers to be successively set in spaced apart relation in the same well hole, as will be facilitated by coding each packer assembly for selective setting in response to a signal different from the coding of other packer assemblies, whereby the several packers can be individually set in any desired sequence.

Another object of the invention is to provide a packer assembly embodying an expansible chamber actuated to set the packer under a rapidly expanding gas charge triggered into action by a control circuit which is closed by magneto switch means whose field pieces terminate in pole faces spaced apart in a predetermined relation for coded presentation to similarly spaced apart pole faces of one or more permanent magnets contained in a go-devil which, after the tubing string is in position, can be dropped to bring the magnet pole faces into proximity to and traverse of the packer mounted pole faces and supply a magnetic field relation at the magneto switch means.

Other objects and advantages will become apparent during the course of the following specification taken with the accompanying drawings, wherein FIG. 1 is a vertical section of a fragment of a well installation with a tubing string shown in elevation within the well bore; FIGS. 2A, 2B and 2C are side elevations with parts in section on a

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larger scale in companion relation, of one form of packer unit; FIGS. 3 and 4 are perspective views of the principal parts of the magneto devices; FIG. 5 is a transverse section as on line 5-5 of FIG. 2C; FIG. 6 is an end elevation of a cylindrical explosive charge; FIG. 7 is a wiring diagram of the control circuit; FIGS. 8A, 8B and 8C are companion side elevation and sectional views of another packer unit; FIGS. 9 and 10 are vertical sections of go-devils having permanent magnets differently spaced apart; FIG. 11 is a transverse view on line 11-11 of FIG. 10; FIGS. 12A and 12B are companion vertical sectional views showing an improved packer assembly for multiple tubing string well installations; and FIG. 13 is a transverse section on line 13-13 of FIG. 12B.

In the drawing, FIG. 1 is illustrative of a tubing string assembly made up of sections successively coupled together in end to end relation and lowered at the earth's surface through the top of a well bore until the length of the assembly reaches down to a desired depth. To partition or separate vertical zones of the annular space surrounding the tubing string, it is usual to employ one or more expansible packers in the string for distention into seal-off position. The number of packers so employed depends on well characteristics inclusive of whether the completion is a single of a multiple type. As distinguished from packers in common use and which are set in response to manipulative movement of a long and heavy tubing assembly, it is here proposed to simplify the packer setting operation and reduce time, effort and care by the provision of a packer unit having a self-contained source of releasable energy which is unaffected by and does not depend on surface applied movements of the string assembly but which can be set into action for distending the packer in response to receipt by an energy releasing device of a predetermined signal transmitted thereto following completion of the lowering operation.

Two of such packer units, 1 and 2, are shown in a predetermined spaced apart relation, together with tubing or casing sections or joints 3, all connected in end to end succession. The packer unit 1 is designed for what may be termed a permanent lower installation, while the structure of packer unit 2 is such that it and, if desired, others like it at upper levels, can be set and subsequently at any time restored to contracted relation upon a mechanical adjustment of the tubing string thereabove. While the packer units illustrated are especially intended for use jointly and in multiple in the same well, yet for many purposes either is adapted for installation singly in a well which calls for but one packer.

These two packer units differ in some detail but generally are similar and have the same force releasing and applying arrangement by which the setting of the packer is effected. Referring first to the packer unit 2, as seen in FIGS. 2A, 2B and 2C, there are involved a pair of concentric tubing assemblies slidably sleeved one on the other and each for convenience of manufacture and assembly being made up of separately formed parts and coupled end to end at the time of final assembly. In vertical succession, the inner tube includes an upper coupling portion 4a for threaded connection with an adjacent tubing string joint 3, an elongated tubular body 4b threaded at its upper end on the coupler 4a, a contact button carrying tube 4c threaded at its upper end on the tubular body 4b, and a lower coupling section 4d threaded at its upper end on the tube 4c and provided for threaded connection with an adjacent tubing string joint 3 therebelow. The outer tube assembly includes a lower tube 5a slidably sleeved at its upper end on the lower end of a tube 5b whose upper end is coupled by a collar 5c with a terminal tube 5d.

Initially, the upper terminal tube 5d has bearing abut-

ment at its upper end with a downwardly facing shoulder at 6 on the inner tube coupler 4a, and is detachably threaded at 7 on the coupler 4a. Additionally, the top tube 5d has one or more breather holes or ports 8 through its wall and has an internal cavity or groove to house packing rings 9 held in place by the collar 5c in sealed and sliding relation with the coupler 4a.

An annular resilient, expansible packing element 10 of rubber or other similar elastic deformable material surrounds the tube 5b and at opposite ends has seating rings 11 in retentive abutment with the fixed collar 5c and with a slip expander 12 in the form of a frusto-conical wedge slidably fitted on the outer tube 5b to control movement of the seating rings 11 toward and from one another and the application of axial compressive stress on the packer element 10 for its wall width expansion or radial distension throughout its circumference.

The tapered wall of the slip expander 12 is pierced by a number of breather ports 13 and is for co-operative engagement with similarly tapered internal faces on a set of expansible segmental slips 14 located in side windows at the upper end of the lower tube 5a. Initially and with all parts contracted, the slip expander 12 and each expansible slip 14 are tied together with a releasable motion transmitting link constituted by a connecting shear pin 15. A dependent leg 16 on each slip is housed within an upper extension 5e of the outer tube 5a and terminates in a lateral foot 17 retained in a window opening in the wall of the extension 5e.

Just above an external shoulder afforded by an upwardly projected or enlarged wall portion 18 of the upper tube 5b, the wall thickness of the upper extension 5e is increased and extends inwardly to form a head 19 in slide bearing relation with the tube 5b and preferably carries packing rings for a slide seal piston and cylinder relationship between the upper and lower sections 5b and 5a of the outer tube. At its lower end, the tube 5a is sealed and initially releasably held against slide travel upwardly relative to the inner tube section 4d by one or more shear pins 20 and the annular space from the tube section 4d to the head 19 on the tube 5a affords a closed expansible chamber 21. This chamber 21 is to contain a combustible charge to be ignited and burned as a source of expanding energy for the packer setting operation. When the chamber confined force is triggered into action for expanding the chamber 21 longitudinally and imparting upward slide travel of the outer tube 5a, it first severs the shear pin 20 and then movement is transmitted through the shear pins 15 and slip expander 12 for axially squeezing the deformable packer element 10 and increasing its wall thickness to pack-off relation, whereupon resistance to further upper travel of the slip expander 12 causes breakage of the frangible pins 15 and therefore an upward and outward displacement of the several slips 14 to an active clutching position.

For holding the packer and the slips expanded, a ratcheting mechanism is employed between the inner and outer tubes, as shown in FIG. 2B. A laterally shiftable ratchet pawl 22 housed within the expansible chamber 21 is formed on both its internal and external faces with axially spaced notches or teeth and is biased outwardly by a light coil spring 23 housed in an outwardly opening pocket in the inner tube wall enlargement 18. The external teeth have both upper and lower faces tapered and mating corresponding teeth are formed internally on the adjacent portion of the outer tube 5a and ride upward upon relative tube travel on the teeth of and depress the ratchet pawl 22 inwardly. Such depression is accompanied by a slight upward axial movement of the pawl 22 as accommodated by the tapered or wedging engagement between its internal upwardly tapered teeth and mating external wedging teeth on a positioning key 24 carried by the upper tube section 5b and whose tendency in co-operation with the light spring 23 is to wedge or

bias the pawl 22 outwardly and resist downward return of the outer tube 5a from packer setting position.

The positioning key 24 is laterally shiftable mounted in an opening through the wall of the upper and outer tube 5b but in the packer contracted position illustrated in the drawings the key 24 is held outwardly against inward displacement from co-operative bearing engagement of its external and upwardly tapered notches or teeth with the mating internal teeth of the pawl 22. The key 24 is so held by rearward abutting engagement of its inner face with a short length cylindrical or peripheral enlargement 25 on the inner tube 4b and whose length approximates that of the key 25 and affords a solid backing for the key. Removal of the backing will enable inward key displacement; and should it become desirable to release an expanded packer, such release is effected by imparting rotation to the tubing string to unthread the top connection at 7 between the inner and outer tubes, and with relative upward travel of the inner tube 4b the peripheral enlargement 25 will be raised out of backing alignment and engagement with the key 24. Continued lift of the inner tube then brings the upper shoulder of the backing enlargement 25 into contact with an internal suspension shoulder 26 on the outer and upper tube 5b for compelling unisonal further lift. As soon as the key 24 no longer is bucked outwardly, its inward displacement removes the security of the ratchet pawl 22 and the slidable outer tubes 5a will be free to move back to the limit afforded by their vertically overlapping wall portions 18 and 19. Lift of the inner tube transferred through the pickup shoulder 26 to the outer and upper tube 5b and to the upper packer bearing ring 11 assists in breaking packer expansion and slip anchoring action.

Coming now to the means for triggering the packer setting force into operation, reference will be made to FIGS. 2C and 7. The combustible charge as shown is an explosive and conveniently in the shape of a cylindrical package 27 placed within the expansible chamber 21. It is to be fired by electric current flow through a resistance wire 28 hooked into a control circuit substantially as diagrammed in FIG. 7. This circuit comprises batteries 29 and a pair of off-and-on safety switches 30, shown in their "on" position but which prior to the lowering of a packer unit are in a safety grounded "off" position. When closed, the switches direct current to pivoted coils of magneto devices having normally open circuit closing switches 31 and 32 in series connection within the circuit. So long as either switch is open, no current can flow in the control circuit containing the resistance wire 28.

The magneto devices operate on the principle of the D'Arsonval galvanometer and each coil is pivotally mounted and carries a switch contact in normally open position but under the influence of magnetic lines of force across the coil, will swing to close the switch. Only when both switches 31 and 32 are closed concurrently will the charge 27 be fired. Accordingly, by arranging the pole pieces for the magneto devices for presentation of their terminal faces on the inside of the tube 4c in given spaced relation, concurrent closing of the control circuit occurs only when those spaced faces are aligned with similarly spaced apart pole pieces of a pair of magnets. By this means there is provided a coded system whereby a number of packer units can be placed in a well and selectively actuated by a presentation in proximity to the respective packer units of a particular magnet carried go-devil introduced at the well head of a completed and properly located tubing string.

As shown, the magnet device is suitably housed within the expansion chamber and is mounted on and just above the tube coupler 4d. A number of small dry cell batteries 29 are clamped between conductor rings 33 and the upper ring bears on a nonmagnetic ring 34 supporting the safety on-and-off switches 30. A long shifter rod 35 extends through a longitudinal opening in the coupler 4d

as a means for closing the switches 30 immediately preceding the lowering operation of the packer and the opening is closed by a plug 36. Secured to and projected upwardly from the nonmagnetic ring 34 are two pairs of circumferentially spaced apart conductor arms or blades 37, one pair for each coil and series connected switch devices 31 and 32. Each such coil and switch device is located in the space between its pair of pole pieces afforded by the bottom segmental portions of the blades 37 and the upwardly extending portions of the blades are of relatively different lengths. In the drawing, the shortest blade and the next shortest blade constitute a co-operating pair and the other co-operating pair comprises the longest and the next longest blades and this setting provides one type of signal code. Other coding can be established by selectively varying the length relationships of the several blades. Conveniently, this merely involves interchangeable blades to be paired differently. Each blade terminates upwardly in a lateral foot for alignment and face to face contact with one or more magnetic buttons or contact posts 38 extended through the wall of the inner tube section 4c and ended at its inner face in flush relation with the inner surface of the tube. These posts are circularly spaced apart in several axially spaced apart zones.

A go-devil to present magnetic field relationship coded to a particular set of magneto device field pieces is provided, as in FIGS. 9 and 10. These illustrate two differently arranged sets of magnets but in each instance there is a tubular body 39 of magnetic material having a rounded nose head 40 at one end and a rounded nose retainer ring 41 press fitted or otherwise secured on the opposite end of the tubular body 39. Between the ends there are sleeved on the body a pair of spaced apart nonmagnetic rings 42 along with spacer rings 43 of magnetic material and of any predetermined length. Each nonmagnetic ring 42 has intermediate its length a circular succession of permanent magnets 44 in the form of cylindrical buttons or discs embedded in and extended through the wall of the nonmagnetic ring. These magnets present north and south pole faces on their outside and inside and the paths of magnetic lines of force are extended axially in both directions around the nonmagnetic carrier rings and through the magnetic spacers 43 and/or the heads 40 and 41, as the case may be. Thus, in the case of the upper row of magnets 44 in FIG. 9, each outer face is of opposite polarity to the spacers 43 above and below the nonmagnetic ring 42; and similarly the outer faces of the magnets in the lower set are opposite in polarity to the outside faces of the head 40 and the spacer ring 43 above the lower nonmagnetic ring 42. By a different mounting of rings 42 and 43, as illustrated in FIG. 10, the outer faces of opposite polarity magnet pole pieces can be variously spaced. In other words, the superposed rings 42 and 43 can be arranged for a pre-selected coding relation of the magnet pole faces to the pole faces on the contact buttons 38 for the transmission of lines of force as a signal for setting any one packer of a set.

If the go-devil of FIG. 9 is considered as being coded to the pole piece faces of FIG. 2c, then when the go-devil is dropped free or is lowered by a wire line or is pumped down hydraulically or is otherwise caused to travel through the inside of the tubing string, it eventually reaches the location of the packer unit and its peripheral pole faces will become aligned with the correspondingly spaced and the inwardly disposed pole faces of the magneto device mechanism. This will mean that the upper row of magnets will be aligned with the tip of the longest blade 37 and the inner tip face of the next longest blade 37 will be aligned with the outer face of the magnetic spacer ring 43 next adjoining and below the upper nonmagnetic ring 42 and the lines of force will travel across the coil of the switch unit 31 and close that switch. Simultaneously, the lower row of magnets 44 will be

aligned with the pole face of the shortest blade 37 and the face of the next shortest blade 37 will be traversed by and aligned with a magnetic ring 43 next adjacent and above the lower nonmagnetic ring 42 and the lines of force will be transmitted for influencing the coil and switch unit 32 for completing the closure of the firing control circuit containing the resistance 28. Since this go-devil is coded only to the particular magneto device, it can signal completion of the firing control of no other and differently coded packer unit. Similarly, the series switches in the arrangement of FIG. 2C will never be closed simultaneously in response to pole traverse by any other and differently coded go-devil, such as that shown in FIG. 10.

In a well installation containing a number of packing units each having a set of spaced apart terminal pole faces, the spacing of the pole faces in the several sets can be variously arranged. As before indicated, the spacing can be different in each packer and enable selective setting of the packers through the use of different go-devils. Optionally, two or more of the several packers can have the same pole face spacing from coded relation to the pole end faces of a single go-devil. Thus all of the packers may be differently coded, each to a different manually controlled go-devil, or all may be similarly coded to the same go-devil or the packers may be coded differently as to groups of one or more packers and with the packers of any group being coded alike.

The packer unit of FIGS. 8A, 8B and 8C is likewise provided with magneto devices for controlling the release of packer setting energy and the arrangement is generally as previously described. In this case, the expansible combustion chamber 121 containing an explosive charge 127, the batteries 129 and the field blades 137, of which only one is shown, as well as the magneto devices, not shown but arranged as previously illustrated, is formed within annular space between the outermost slidable tube 105a and an intermediate concentric tube 105e which is threaded on the lower end of a tube 105b and is a dependent continuation thereof. The annular packer 110 surrounding the tube 105b has slip expanders 112 at both ends for co-operation with upper and lower slips 114. Initially, a shear pin 115a secures together the upper expander and each slip of an upper set hung from a terminal collar 105d on the tube 105b. The lower set of slips and expander are initially releasably secured by frangible pins 115. An outwardly spring biased ratchet pawl 122 has exterior ratcheting notch or tooth formations for mating bearing engagement with interior teeth on the outer tube 105a and has interior outwardly wedging tooth formations fitted on upwardly tapered teeth exteriorly of the tube 105b.

Upon relative upward travel of the tube 105a in response to chamber expansion, the force first breaks a shear pin 120 between the bottom of the outer tube 105a and the tubular part 104d threaded on the bottom of the tube 105e. Relative travel of the outer tube accommodated by slippage on the ratchet pawl 122 is transferred through shear pins 115 and received by the upper shear pins 115a and longitudinally squeezes the packer 110 for its radial expansion. The shear pins 115a are weaker than the lower shear pins 115 and break at or near the end of packer extension. There follows a setting of the upper slips. Resistance to upward travel force in succession breaks the shear pins 115 for a setting action of the lower set of slips in the final portion of the travel range and thereafter the expanded parts are firmly located in expanded position by the ratcheting mechanism. In this case, the ratcheting mechanism is nonreleasable and should subsequent removal of the lower packer be called for, it will require a drilling out operation.

Concentrically fitted within the intermediate tube 105b is a stinger tube made up of threaded together sections 50, 51, 52, 53 and 54. Initially, this innermost or stinger tube is releasably fixed by a shearable pin 55 to the tube section 105d and its upper end is coupled to and con-

constitutes the lower end of the tubing string. In this fixed position, its section 53 has a number of longitudinally spaced apart circular rows of field posts 56 projected therethrough and the outer faces of the posts of each row engage a magnetic ring 57 peripherally mounted on the section 53. The several magnetic rings 57 are separated one from another by nonmagnetic rings 58 and each magnetic ring 57 is aligned with a set of field posts 138 arranged in spaced apart rows and projected through the wall of the intermediate tube 105e. Outwardly, the posts 138 are for co-operation with the field blades 137 constituting parts of the poles for the magnetically responsive firing devices. The arrangement completes a path for lines of magnetic force supplied by a magnet carried go-devil and whose field pole faces are in preset coded relation to the setting of the magneto pole pieces 56 and 137.

The lower terminal section 54 of the stinger is shown as projecting downwardly beside and holding open a laterally disposed flap valve 59 hung in the lower terminal section 104d of the intermediate tube. When it is desired to close or shut the production tubing string after the packer has been set in the well, an upward jar on the tubing string can be exerted to break the shear pin connection 55 and the stinger can be lifted slightly to bring together the exteriorly formed screw threads at 60 on the upper end of the stinger with the internally formed screw threads 61 on the tubing section 105d. Rotation of the tubing string will then engage the threads and enable further upward travel of the tubing string and the lower section 54 relative to the packer unit until the bottom edge of the tubing string rises above the flap valve 59. This enables the flap valve to swing inwardly and upwardly into passage closing and seating relation with a downwardly facing shoulder 62 on the tubing section 104d. With the well closed in, any repair, workover or other operation can be performed and at any later time the flap valve can be reopened on downward pressure applied through a stinger or other suitable means.

For setting packers in a multiple completion well and other installations having two or more tubing strings, the arrangement previously described needs but slight modification to accommodate projection of additional tubing string sections through the packer assembly. A multiple-tube packer arrangement in which one string only is for go-devil passage for packer setting purposes is illustrated in FIGS. 12A and 12B. Here the unit assembly 202 has end coupling heads 204a and 204d, each having in parallelism with and offset from its longitudinal center line a pair of bores therethrough for connection with adjoining sections of a pair of separate well tubing strings. Joining one of the bores in the coupling 204a with one of the bores in the coupling head 204d is a flow tube made up of end to end connected sections 204b and 204c, while the remaining bores through the coupling heads are joined by another tube 304.

Intermediate their lengths, the walls of the two tubes 304 and 204b have widened or external enlargements which co-operate to form backing ribs 225—225 generally similar to the enlargement 25 seen in FIG. 2B. These ribs have slide bearing engagement with inside faces of a pair of segments 224 laterally shiftably carried by the housing 205b. As illustrated, the ribs 225 normally hold the segments 224 against inward displacement from positions in which external camming teeth thereon are slidably engaged by mating teeth on longitudinally shiftable segments 222 having ratchet tooth engagement with a tubular housing 205a extending downwardly into sliding sleeve fit at its lower end with the coupling 204d. Shear pins, as at 220, initially releasably interconnect the housing 205a and lower coupling 204d against relative slide travel.

The space within the housing 205a and surrounding the parallel flow tubes provides an expansible chamber 221 in which are located an explosive charge 227, the

batteries 229 and the charge igniting mechanism corresponding to that described in connection with the packer unit 2 and of which only one of the pole pieces 237 is seen in FIG. 12B although a set of four such pole pieces is shown in FIG. 13. The upper ends of the several pole pieces are for selective co-operation with various contact pins 238 projecting radially through the wall of the tube 204c to present pole end faces internally of the tube. Such pole end faces are for co-operation with peripheral pole faces in a go-devil for directing magnetic fields to the magneto switch devices for firing the explosive charge 227 when the chamber is to be expanded in supplying a packer setting force.

The lower housing tube 205 telescopically fits and slidably overlaps at its upper end with the lower end of a companion housing tube 205b and carries an upwardly projecting bearing sleeve 219 within which are mounted a series of expansible slips 214. The interior tapered portions of the slips are for co-operation with a downwardly tapered portion of an expander collar 212 and initially these parts are secured against relative movement by shear pins 215. A rubber packer collar 210 surrounds the housing 205b and bears at opposite ends against the sleeve expander collar 212 and a coupling collar 205c, which joins the upper end of the housing 205b with a terminal sleeve 205d. The latter is internally threaded at 207 and engages corresponding threads on the coupling head 204a for detachably joining these parts at the time of final assembly of the packer unit.

The operation and use of the packer unit 202 corresponds to that of the packer unit 2, whose description as heretofore given will apply to the multiple tube packer. In the case of the latter, the flow production tubes can be of different diametrical sizes so long as the inside of the tube 204c accommodates free passage of the go-devil for use therewith. Furthermore, with only slight modifications of the end couplings 204a and 204d, there may be employed two or more tubing elements 304 in parallelism with the go-devil receiving tube 204c.

Various modifications of the structure as heretofore described can be made within the scope of the appended claims.

What is claimed is:

1. In combination, a well tubing string, vertically spaced apart expansible packers incorporated in the tubing string, force applying means at each packer for effecting expansion thereof, and signal responsive means connected with the force applying means at each packer and including an electrically actuated device for rendering the force applying means effective, an electrical control circuit therefor having series connected circuit control switches therein and each provided with switch closure means responsive to a signal transmitted thereto, signal transmitting devices leading to the closure means of the respective switches and being carried by the packer in predetermined spaced relation one to another and such predetermined spaced relation of the devices carried by one of the several packers differing from others and a set of go-devils for passage selectively through the tubing string and each having spaced apart signaling elements, which in different go-devils of the set are differently spaced apart and in coded mating relationship to said predetermined spaced relation of the signal transmitting devices of the several packers.

2. In combination, a well tubing string, a number of packer units incorporated in the tubing string in vertically spaced apart relation electrically controlled, packer setting means in each unit, an electrical control circuit controlling each setting means and having a plurality of circuit series connected switches, and switch actuating magneto devices for each switch and each having a pair of field pole pieces carried by the packer unit and terminated adjacent a side wall surface of said unit in end faces in predetermined spaced apart relation of the end

faces and which spaced relation differs in the several packer units and a set of go-devils for successive passage through the tubing string in the selective actuation of said magneto devices of the packer units and each having a number of magnets whose north and south pole pieces end in spaced apart relation differing respectively in the several go-devils and in coded correspondence with the predetermined spaced apart relation of the field pole piece end faces of the respective packer units.

3. In combination, an expansible well packer, a pair of tubular members slidably sleeved one on the other in motion transmitting relation to said packer for expanding the same on relative member slide travel, force supplying means located by the said members for co-action therewith to effect such relative member travel, means controlling effective action of said force supplying means and including magneto means responsive to the influence thereon of a magnetic field to render the force supplying means effective, means mounting said magneto means on one of said members for response to a magnetic field to be brought into influencing relation thereto and a magnet adapted to be dropped into a well following the lowering of said packer into desired position and to move into influencing relation with said magneto means.

4. In combination with claim 3 together with co-operating ratcheting elements carried by said members and accommodating their relative slide travel in the direction to set said packer and resisting member travel in the opposite direction.

5. The combination of claim 4 wherein said ratcheting elements are disposed laterally inwardly and outwardly of one another and the inwardly disposed element is laterally movable toward and from the outwardly disposed element together with a limit stop positioned inwardly of said inwardly disposed element for face to face contact in limiting inward displacement of the element, said face to face contact including a contact surface tapered in the direction of travel of the outwardly disposed element in the packer setting operation and a two-position stinger slidably mounted in said members and provided with stepped portions longitudinally spaced apart for limit stop alignment of one of the stepped portions in one position of the stinger and of the other stepped portion in the other position of the stinger and one of said stepped portions co-operating with the limit stop to hold it relatively outwardly disposed and the other stepped portion providing inward clearance for limit stop inward displacement.

6. The combination of claim 4 wherein the ratcheting element carried by the inner one of said members is laterally movable toward and from the other ratcheting element and carries on its inner face a succession of outwardly acting wedging teeth tapered in the direction of outer member travel in the packer setting operation, together with an inwardly disposed limit stop having outwardly facing tapered teeth in mating seating contact with said wedging teeth on the ratching element, a limit stop positioning abutment engageable with the limit stop and holding it against inward displacement and means shiftably mounting said abutment and enabling the shift thereof to render it ineffective against inward displacement of the limit stop.

7. For magnetically setting a packer in a well, a tubular member adapted to be lowered to a given position in a well, an annular packer element carried by said member, a fluid pressure responsive actuator also carried by said member and active on said packer element to set the same, an actuator control member adapted to be entered into the interior space of said tubular member, a combustible charge stored by one member and ignitable to supply pressure fluid to said actuator for setting action on said packer element, a charge igniting control device carried by said one member and operable to effect ignition of said charge in response to magnetic lines of force imposed on the device and permanent magnet

means carried by the other member and adapted to impose its magnetic lines of force on said device and influence response thereof upon entry of the actuator control member into the tubular member.

8. In combination, a well tubing string having a plurality of vertically spaced apart tubular members therein, an expansible packer element on each member responsive to the application of expanding force to the packer element, a combustible charge adapted upon ignition to supply expanding force on the packer element, a tool member to be lowered through the tubing string to said tubular members selectively, means storing said charge on one of the tool members and a selected tubular member, a pair of spaced apart magnetic field influenced devices carried by the charge storing member in operating serial connection with one another and with said charge and operative to ignite the charge upon being concurrently influenced by magnetic fields, means mounting said devices for selectively varying their spaced apart relation, a pair of vertically spaced apart magnets, each supplying a field for co-operation with said devices and means mounting said magnets in selectively variable vertically spaced apart relation on the other of the tool member and the selected tubular member and enabling the spacing of said magnets to be matched with the spacing of said magnetic field influenced devices.

9. In a well packer, a tubular body adapted for movement therein of a magnet, a resilient collar surrounding the body, a sleeve slidably fitting said body and co-operating therewith in forming an expansible chamber whose expansion causes relative slide travel of the sleeve and body, co-operating sleeve carried means and body carried means engaging spaced apart portions of the resilient collar and participating in relative sleeve and body travel to squeeze the collar therebetween for its distention, an electrically ignitable explosive charge housed within the chamber for supplying an expansion force to expand the chamber when fired, an electric circuit extending within the body and supplying current to fire said explosive charge and a magnetically responsive circuit control switch in said electric circuit carried by the body.

10. In a packer assembly to be positioned in a well hole, a distensible packing element, a pair of relatively movable members having force transmitting portions between which said packing element is located to receive distending force upon relative movement of the members, an expansible chamber having spaced apart chamber defining and relatively movable wall portions, motion transmitting connections joining one of said wall portions with one of said members and another of said wall portions with the other member to impart relative movement from said wall portions to said members, means carrying said packing elements, said members and the chamber wall portions in assembly relation, a source of stored energy positioned by one of said wall portions for supplying expansion force within the chamber upon controlled action of the energy source, an electric circuit control therefor including a magnetically actuated switch and means having fixed relation with one of said wall portions and mounting said switch for presentation within the field of a magnet which is passed within the well hole to the packer assembly after the latter has been located at the desired position in the well hole.

11. A well packer combination comprising a distensible packer element, an expansible chamber having relatively movable wall portions, a supporting body mounting the packer element and said wall portions in assembled relation, force transmitting means engaged with the packer element and mounted by and movable relative to the supporting body for application of distention force on the packer element, connection means joining said force transmitting means with the wall portions for transfer to the force transmitting means of relative movement of said wall portions and means active to effect such rela-

tive movement and comprised of an expanding gas producing inflammable charge housed within the chamber and provided with charge igniting means having a magnetically responsive control device and a magnet go-devil for co-operation with said control device in presenting thereto a magnetic field to which the control device responds in igniting said charge.

12. In a well tool, an expansible packing ring, a supporting assembly for the packing ring to be lowered into a well, a pressure generating inflammable charge contained within the assembly, means constituting a part of the assembly and engaged with the packing ring to expand the same in response to charge generated pressure, a charge igniting mechanism located in said supporting assembly and comprised of a circuit closing switch and a magneto switch setting device having connection with the switch to close the switch in response to actuation of said device and also having spaced apart pole pieces whose terminals are exposed at the surface of the supporting assembly and a go-devil to be lowered into the well following the lowering of said supporting assembly and embodying a magnet having pole pieces terminating in exposed faces in spaced apart relation corresponding to the spaced apart relation of the terminal faces of the pole pieces of said switch setting device and supplying a magnetic field at said device upon alignment of the exposed faces of said magnet terminals of the pole pieces with the pole pieces of said device to actuate said device and close the circuit closing switch.

13. In combination with a go-devil to be dropped into a well hole and a magnet carried by the go-devil, of a well packer assembly to be positioned in the well hole in advance of said go-devil and comprising an expansible chamber having wall portions which are relatively movable under chamber expanding force, a pair of relatively movable tubular members slidably sleeved one on the other and connected respectively with said wall portions for movement therewith, a distensible packing ring mounted between adjoining portions of said members for distention therebetween on member movement in response to chamber expansion, an inflammable force producing charge confined within the chamber to supply said chamber expanding force and charge igniting means having an actuating control which includes a magneto device and field pole pieces therefor carried by one of said tubular members and positioned thereby for extension of the magnetic field of the go-devil magnet when downward travel of the latter brings its poles into alignment with said field pole pieces.

14. The combination as in claim 13 wherein the magneto device comprises a set of series circuit connected and magnetically responsive switches, each with a pair of field pole pieces, said field pole pieces being in given spaced apart relation and wherein separate magnets for the respective switches are carried by the go-devil and present their poles in spaced apart relation coded to the spacing of said field pole pieces for effecting concurrent actuation of said switches.

15. For magnetically setting a packer in a well,
 - (a) a tubular member to be inserted in a tubing string as a part thereof,
 - (b) an expansible packer element carried by the tubular member and adapted to be set upon application thereto of an expanding force,
 - (c) a well tool member adapted to be lowered into predetermined position within said tubular member,
 - (d) magnetically actuated means carried by one of said members,
 - (e) magnet means carried by the other of the members and arranged to present magnetic lines of force to said magnetically actuated means for actuation thereof when said well tool member is in said predetermined position within the said tubular member,
 - (f) a releasable force applying means mounted by one of the members in force applying relation to the

packer element to impose thereon an expanding force upon release of said force applying means and (g) means effective to release said force applying means in response to actuation of said magnetically actuated means.

16. For magnetically setting a packer in a well,
 - (a) a tool member to be lowered into a well tubing string,
 - (b) a tubing string member to receive said tool member,
 - (c) an expansible packer element surrounding the tubing string member and having force receiving means to effect packer expansion upon receipt of force,
 - (d) releasable force storing means carried by one of the members and arranged to impose released force on said force receiving means,
 - (e) force releasing means controlling said storing means and its release of force including an actuator device therefor which is responsive to a magnetic field presented thereto and
 - (f) magnet means carried by the other member to present a magnetic field to said actuator device upon receipt of said tool member by the tubing string member.

17. In combination, a well tubing string, a number of packer units incorporated in the tubing string and arranged to be set selectively, separate go-devils for passage selectively through the tubing string, a plurality of magnets carried by each of the go-devils and each magnet having pole piece end faces at the side surfaces of its go-devil, said magnets in the go-devil being in spaced apart relation differing in the several go-devils, each of said packer units comprising an expansible packer element, force applying means effective on the packer element to set the same and means for actuating said force applying means and including a magnetic field responsive device having pole pieces terminated in a set of spaced apart end faces at the interior surface of the tubing string and adjacent the go-devil path of travel, the last mentioned end faces being spaced apart differently in the several packer units and in coded correspondence in the sets respectively to the pole end face spacing of a particular go-devil so that any given field responsive device responds only to the field of a particular set of magnets whose pole end faces are spaced in matched relation to the spacing of the pole end faces of the particular device traversed by the go-devils.

18. In combination, a well tubing string, a series of packer units assembled on the tubing string in spaced apart relation longitudinally of the tubing string, each packer unit including a packing member, mechanism operable on the packing member to set the same and including initially ineffective packer setting force supply means, control means therefor having a magneto device, means responsive to action of the magneto device in rendering effective said force supply means and pole pieces forming part of said magneto device and terminating in end faces mounted for receipt of magnetic lines of force at the interior face of the packer unit and in given spaced apart relation which is identical in all packer units of said series, together with a go-devil adapted to be passed through the tubing string for traversing said packer units successively and permanent magnet means carried by the go-devil and provided with pole pieces terminating in end faces at the peripheral surface of the go-devil and in spaced apart relation corresponding to the spacing between said end faces of the pole pieces of all of said packer units and imposing magnetic lines of force on the magneto device of each packer unit upon traverse thereof.

19. In combination, an expansible well bore packing element, a plurality of separate tubing string sections extending through said packing element, force applying means connected with the packing element and operable thereon to expand the same, means rendering effective said force applying means and including a magnetically

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responsive device having field pole pieces mounted in one of the tubing sections and terminated in spaced apart end faces interiorly of said one of the tubing sections, a member to be passaged through said one of the tubing sections, a magnet carried by said member and provided with pole pieces having end faces at the periphery of the member and in spaced apart relation corresponding to the spacing between said end faces of the first mentioned pole pieces for completion of a magnetic circuit to said device upon alignment of the magnet pole end faces with the pole end faces of said device by member passage through said one of the tubing sections.

20. A well bore packer assembly including a plurality of tubing string sections in side by side relation, an expansible bore closing packing member surrounding said tubing string sections, a sleeve slidably mounted by the tubing string sections in force transmitting relation with the packing member and co-operating with the tubing string sections to form an expansible chamber, a source of energy releasable in the chamber to expand said cham-

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ber and effect slide travel of said sleeve, means effecting release of said source of energy and including a magnetically responsive device having field pole pieces carried by one of the tubing string sections and terminated in spaced apart end faces on the inside of the tubing section and magnet means adapted for passage through said one of the tubing string sections and provided with pole pieces terminating in end faces spaced apart in correspondence with the spacing of the first mentioned end faces for aligned co-operation therewith and the completion of a magnetic circuit to said device upon passage through the tubing section of said magnet means.

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