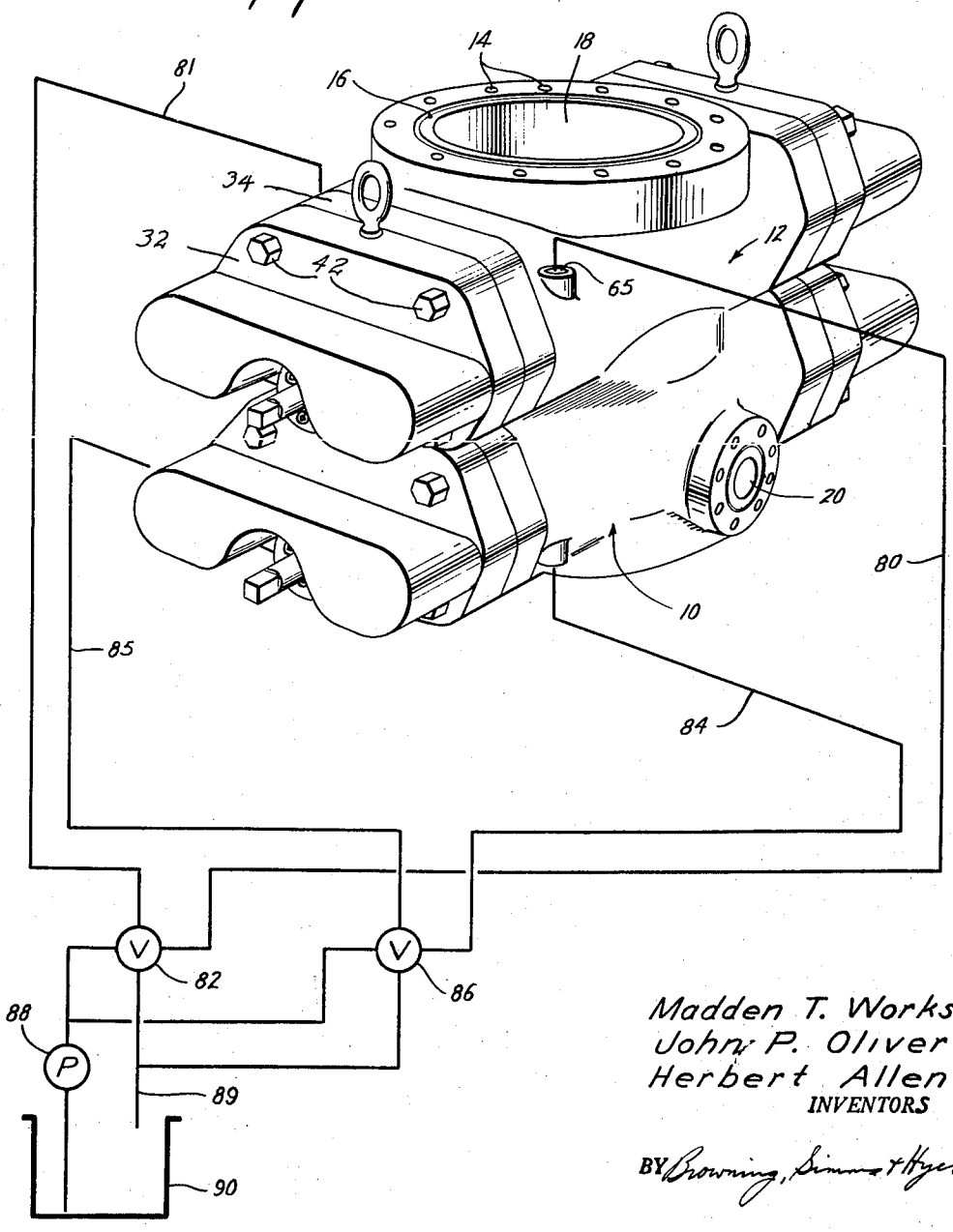
Nov. 10, 1959 H. ALLEN ET AL 2,912,214

BLOWOUT PREVENTER

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Fig. 1



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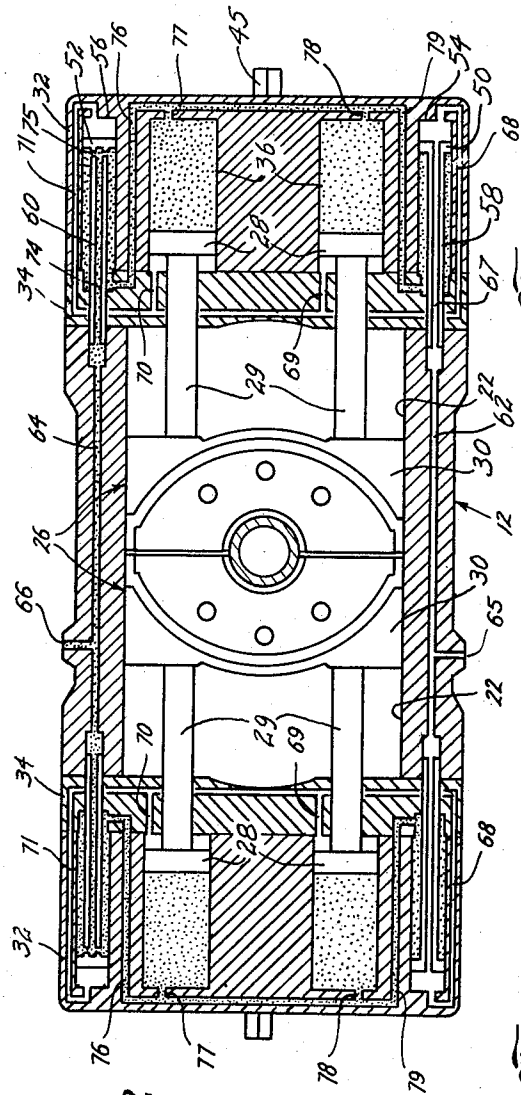


Fig. 2

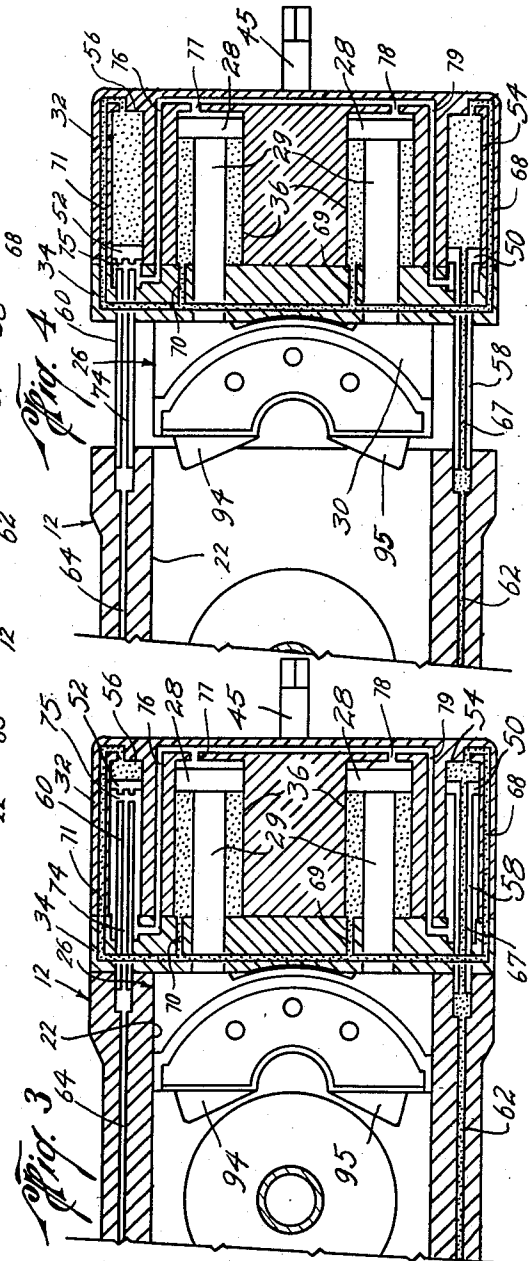


Fig. 4

Fig. 3

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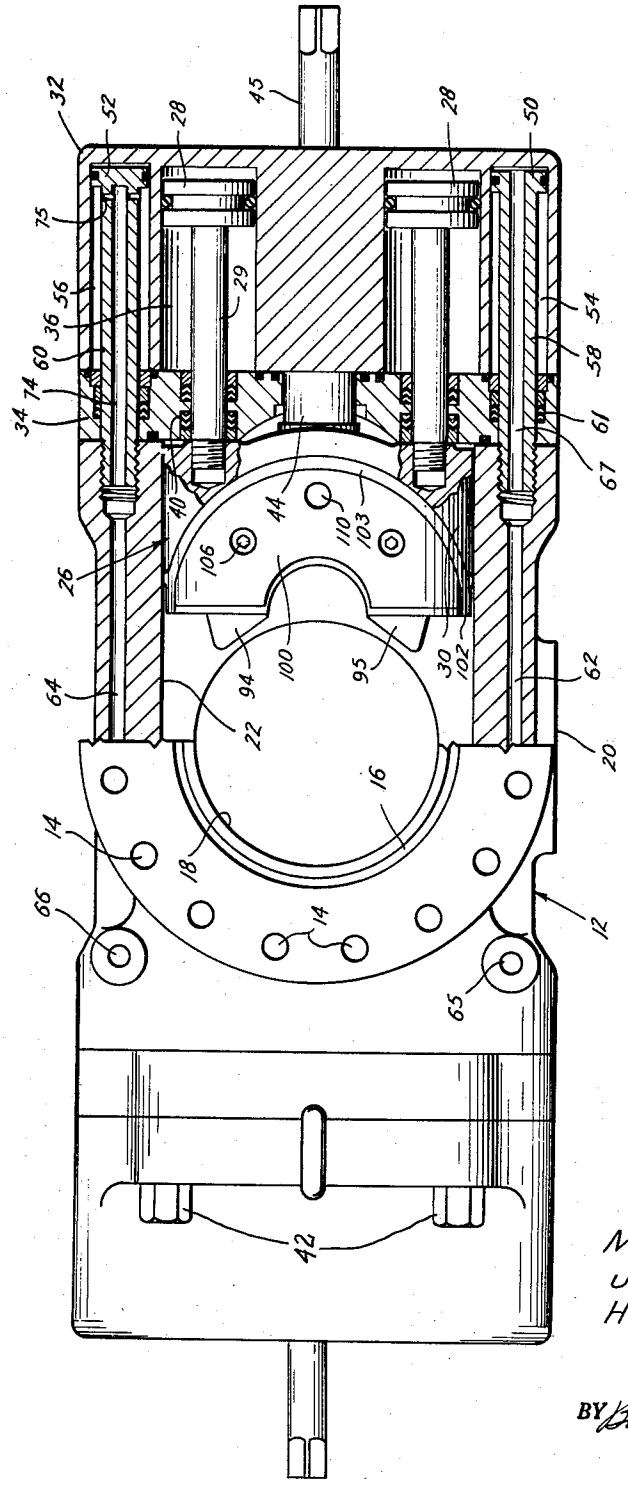


Fig. 5

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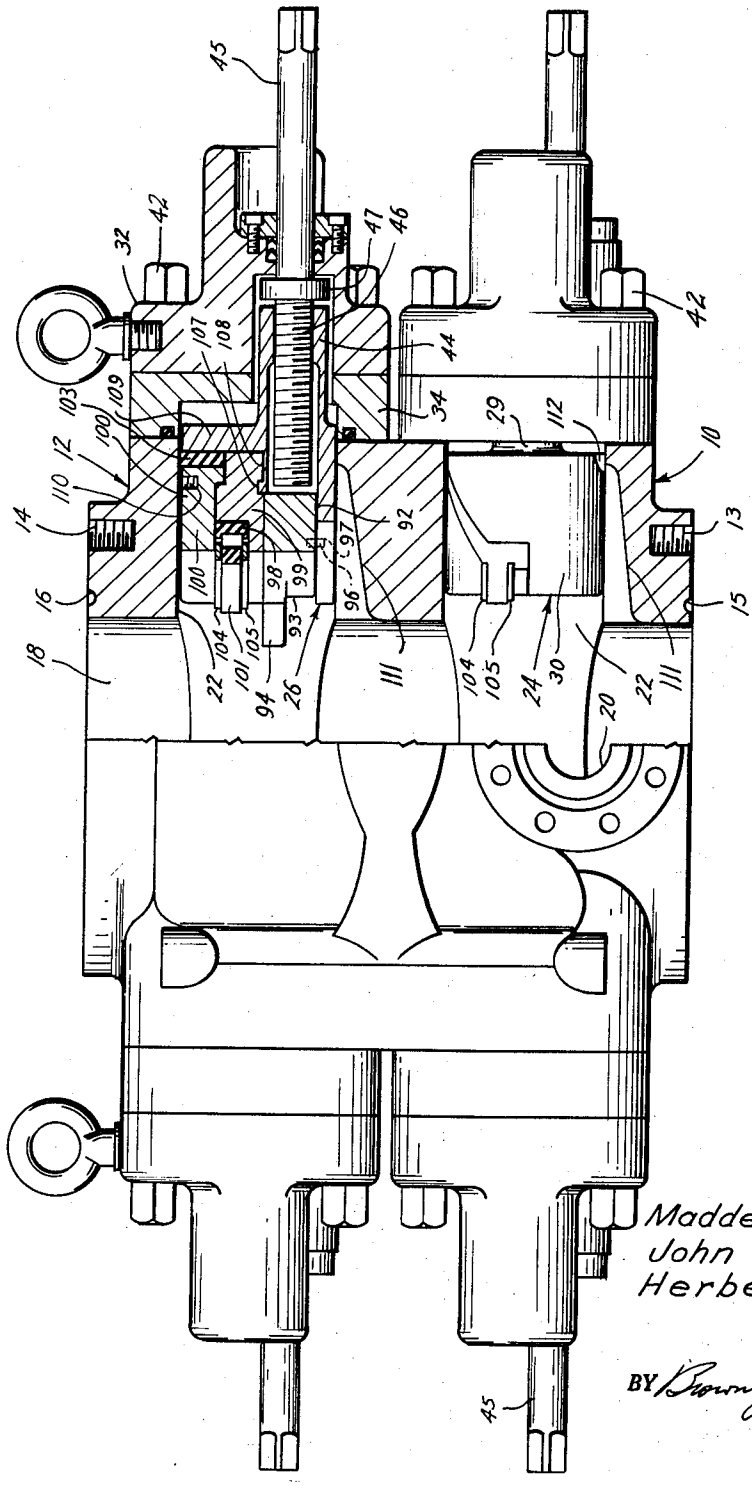


Fig. 6

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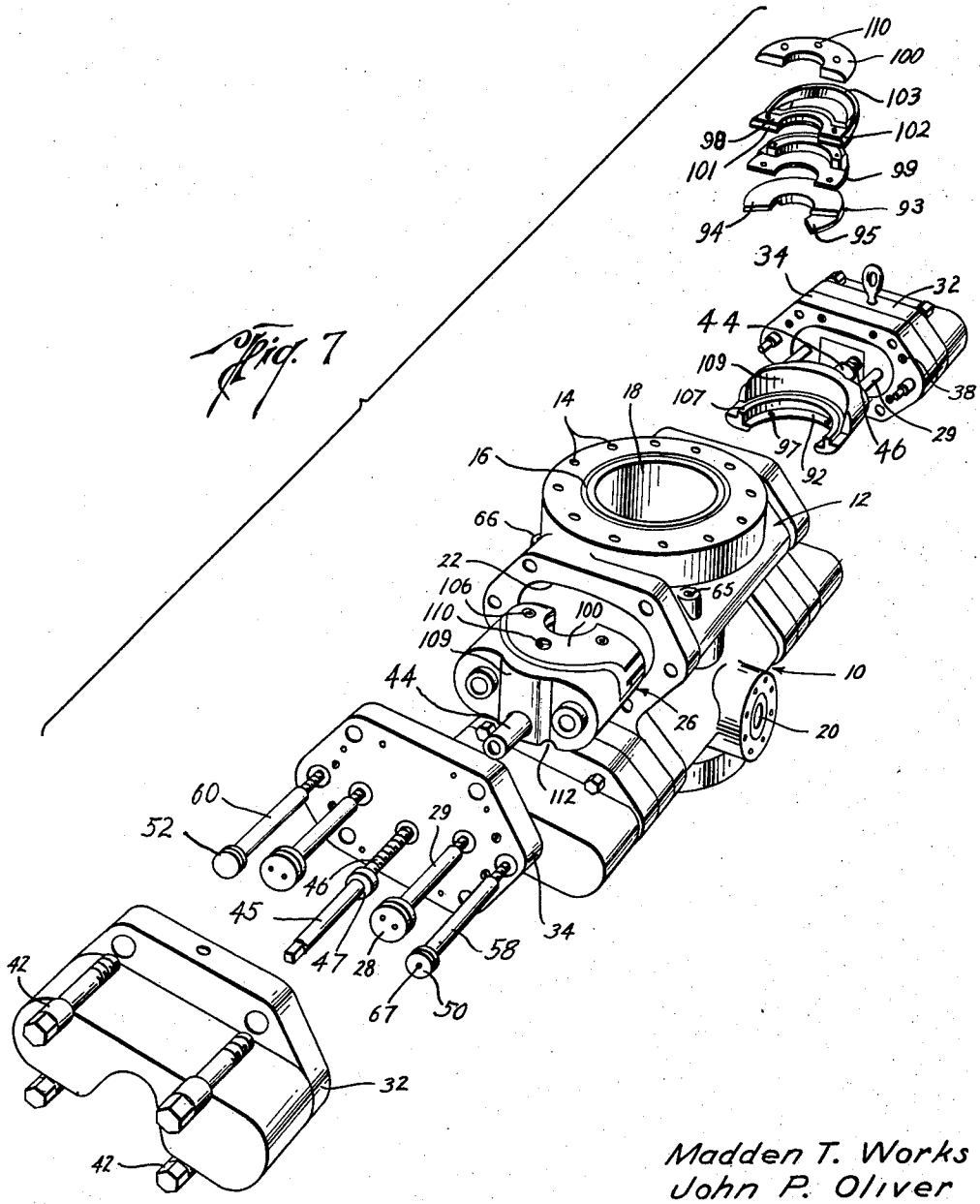
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Fig. 7



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Fig. 8

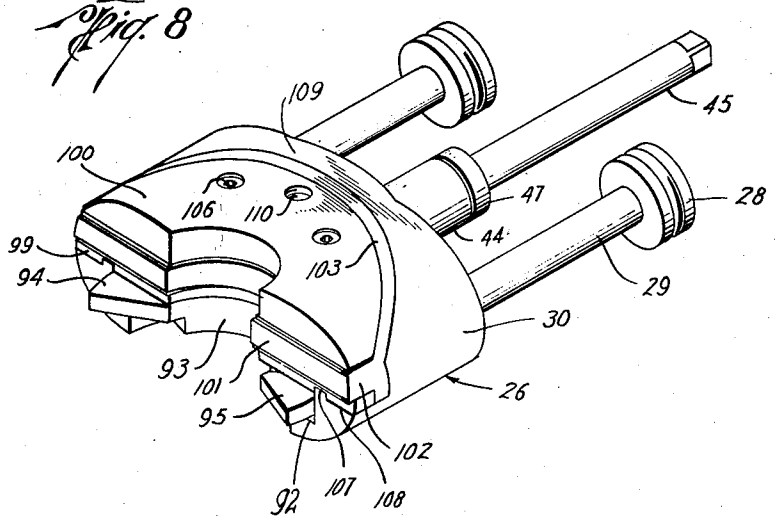
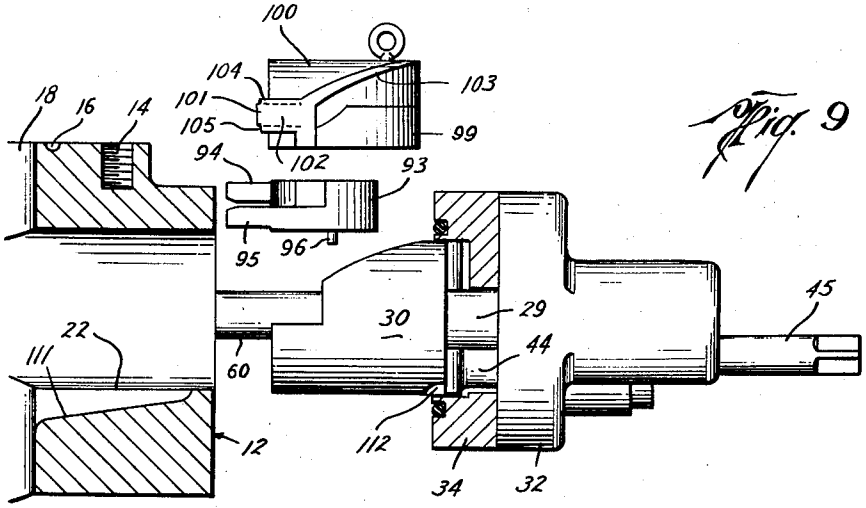


Fig. 9



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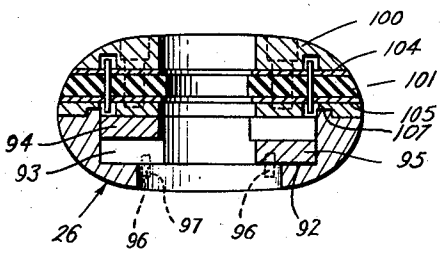
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BLOWOUT PREVENTER

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Fig. 10



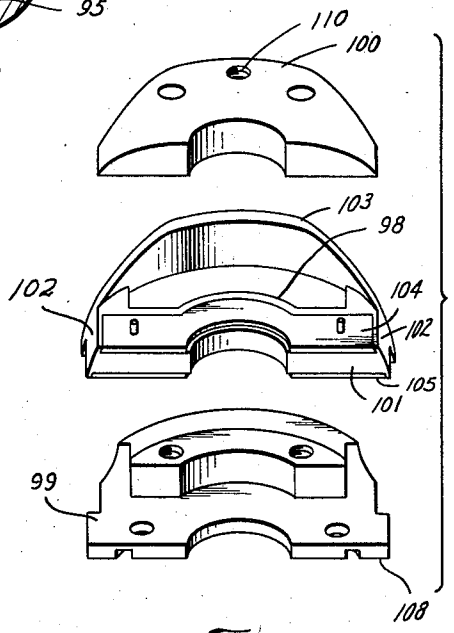


Fig. 11

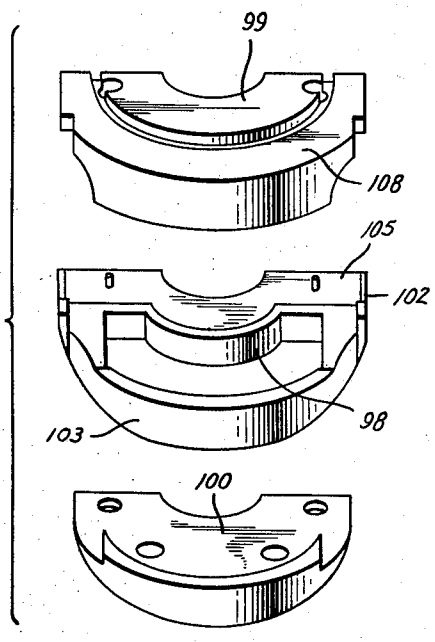


Fig. 12

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United States Patent Office 2,912,214
Patented Nov. 10, 1959

2,912,214

BLOWOUT PREVENTER

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Application March 1, 1954, Serial No. 413,114

20 Claims. (Cl. 251—1)

This invention relates to a blowout preventer which is primarily intended to be secured to the upper end of a well casing to provide for sealing or closing off the annular space between the well casing, or one of the larger pipes in a well, and the well tubing or one of the other smaller pipes in a well. When no smaller pipe is in the well extending through the blowout preventer, it is provided with so-called blank rams for closing off the opening through the blowout preventer through which the pipe might pass and, hence, closing off the opening through the well pipe on which the blowout preventer is mounted.

The major use of blowout preventers is during the drilling of a well by the rotary drilling method, during which the rotary drill pipe extends into the well through the open blowout preventer. The preventer is thus ready so that it may be closed about the drill pipe at any time when a blowout is threatened, thereby shutting off the annular space about the drill pipe, or, if no drill pipe is in the well, the preventer may be operated to close off the entire upper end of the well. The blowout preventer to which this invention relates is of the type having opposed rams which may be moved toward or away from the pipe opening through the preventer for the purpose of closing off or leaving clear the pipe opening through the preventer.

It is the general object of this invention to provide such a preventer which is lighter, more compact and safer, and on which it is easier and faster to change ram parts than on previous structures.

Blowout preventers of the type referred to have been used extensively in connection with deep wells for many years and improvements have been made therein heretofore which have brought them to a high degree of perfection. An example of one of the more modern and popular forms of blowout preventers of this type which has enjoyed extensive commercial success is that illustrated in Letters Patent United States No. 2,387,106, issued October 16, 1945.

However, blowout preventers heretofore employed have been somewhat large and bulky and have required considerable vertical space because of their height, and it has been found desirable to decrease the amount of vertical space required for a blowout preventer as well as to reduce the overall size of the preventer and its weight, without reducing its effectiveness and the efficiency of its operation. In the past, also, blowout preventers have been operated by fluid under pressure from suitable sources, but the provisions for supplying such fluid to the appropriate points in the blowout structure have entailed in most instances considerable piping and duct work in the space surrounding the main body of the blowout preventer. Also, other parts of the preventers employed in the past have protruded from various parts of the preventer and, with such pipes and duct work, have been exposed to possible damage from being knocked off in the moving of heavy equipment and the like.

It is an object of this invention to provide a blowout preventer which will be more compact in every respect than those heretofore employed for accomplishing substantially the same work.

It is a further object of this invention to provide such a blowout preventer in which there will be no projecting parts or duct work which are apt to be damaged by movement of heavy equipment in the space surrounding the blowout preventer.

Still another object is to provide a blowout preventer in which the controlling mechanisms are considerably simplified as compared to those heretofore employed.

Another object of this invention is to provide a blowout preventer and a ram construction therefor in which the changing of ram equipment for the purpose of enabling the preventer to accommodate different sizes of pipe, to replace worn parts, or to substitute ram portions capable of closing the entire opening through the preventer for those capable of closing the annular space about a pipe, may be more readily and simply accomplished.

In order to facilitate this description and the definitions of the invention in the appended claims, the terms "forward" or "front" will be used to designate those portions of the rams and guideways nearest the pipe opening of the preventer and "rearward" or "rear" to designate those portions more remote from that opening. "Upper," "lower," "horizontal," "vertical," etc., will be used to refer to parts so disposed or located when the preventer is in actual use on a well.

The foregoing and other objects of the invention are accomplished in general by the expedients of placing the operating and ram changing piston and cylinder arrangements in side by side relationship in substantially horizontal position, providing a pair of smaller diameter ram operating pistons instead of one larger piston, employing rams of oval cross section with the major axis of the oval horizontally disposed and embodying the entire arrangement in a unitary compact body and head assembly. In such an assembly, the passageways for supplying power fluid to the various piston and cylinder combinations are formed in the head and in the body of the preventer so as not to leave projecting parts and duct work which may readily be damaged by exterior movement of heavy equipment. In this connection, the ram locking screw customarily employed in connection with blowout preventers of the ram type for holding the rams in closed position is in this structure mounted between the two ram cylinders and is in use protected by said two cylinders against possible damage by external movement of heavy equipment.

Furthermore, the entire arrangement has been devised in such fashion that the same controls for applying power fluid for advancing and retracting the ram in ordinary use of the preventer may be employed also, in the same manner and without extra conduits, for moving the head structure away from the body of the preventer for the purpose of changing the packing assemblies and the like of the rams. Thus, the movement of the same control which retracts the rams toward the head is also operative to admit fluid under pressure for the purpose of retracting the head carrying the ram away from the body of the preventer so that the parts of the ram necessary to be removed and changed may be accessible.

In the accompanying drawings and following description, there is set forth one preferred embodiment of this invention by way of illustration and example. In these drawings, in which like numerals designate corresponding parts throughout:

Fig. 1 is a perspective view of an assembled blowout preventer constructed in accordance with this invention,

with flow connections for supplying power fluid to the preventer being shown diagrammatically.

Fig. 2 is a partially diagrammatic illustration of the flow passageways and piston and cylinder combinations embodied in the working parts of the blowout preventer shown in Fig. 1, the parts being illustrated in this figure in the position they would occupy with the preventer in use and the preventer rams closed about a pipe passing therethrough.

Fig. 3 is a view similar to the right hand portion of Fig. 2 but showing the ram retracted so as to leave open the annular space about a pipe passing through the preventer.

Fig. 4 is a view similar to Fig. 3 but showing the head structure carrying the piston and cylinder combinations and the ram moved away from the body of the preventer for the purpose of changing ram parts.

Fig. 5 is a view of the preventer partly in plan and partly in horizontal cross section through the pistons, cylinders and ram guideway of one end of the preventer.

Fig. 6 is a view of the preventer partly in side elevation and partly in vertical cross section through the preventer illustrated in Fig. 1, showing more in detail the structure of the rams and of the ram locking screws.

Fig. 7 is an exploded view in perspective illustrating the blowout preventer shown in Fig. 1 and depicting the relation of the parts to each other as they are assembled.

Fig. 8 is a perspective view of a blowout preventer ram with its ram operating pistons and ram locking screw, constructed in accordance with this invention.

Fig. 9 is a fragmentary view showing a vertical longitudinal cross section through one of the upper ram guideways, illustrating the manner of removal of the ram packer assembly and the pipe centering guide from the preventer.

Fig. 10 is a vertical cross section through the ram transverse to its direction of forward and rearward movement.

Fig. 11 is an exploded perspective view of the ram packer assembly, taken from above to show the upper surfaces of the parts.

Fig. 12 is a similar view of the same assembly but taken from below to show the lower surfaces of the parts.

Referring now more particularly to the drawings, it will be seen that the blowout preventer illustrated is actually in effect two blowout preventers, one above the other. It is customary in practice to place one preventer above the other and connect them together, but, in this instance, in order to provide a more compact structure and one which would not require so much head room under the derricks during drilling operations, two such units have been formed into a single body structure. The lower such unit is illustrated at **10** in Fig. 1 and the upper such unit at **12**. It will be understood that these two units are identical in structure except that in practice the lower one is customarily, though not necessarily, provided with blank rams or rams capable of closing off the entire space within the pipe opening through the preventer when no pipe is in place therein, while the upper preventer unit at **12** is customarily provided with rams capable of embracing a pipe when one extends through the preventer and closing off the annular space about the pipe. For the purpose of this description, reference will be made hereafter to only one of these units.

Through the body of this blowout preventer from top to bottom is an opening through which a pipe may be passed, which opening will be referred to in this application as a pipe opening **18**. The body around the lower end of this opening is adapted to be secured to a casing head or the like, the same being secured thereto by means of studs engaged in the tapped openings **13** in Fig. 6. Likewise, at the upper end of this opening such other equipment as desired may be secured by means of studs engaged in the tapped openings **14**. Conventional seal rings will be employed in grooves **15** and **16** in the lower and upper faces adjacent the tapped openings **13** and **14** in a manner well known. The pipe opening referred to which passes vertically through the preventer body is illustrated at **18**. It is also customary to provide a side outlet **20** with suitable means for connecting a pipe thereto, this outlet communicating with the pipe opening **18** at a point below the lower rams of the lower unit.

Intersecting and extending laterally in opposite directions from the pipe opening **18** are ram guideways **22**, in which the rams, which may either be blind rams generally designated at **24** in Fig. 6 or pipe embracing rams generally designated at **26** in Fig. 6, may be employed. These rams will be described more in detail hereafter, but are adapted to be moved forward and rearward toward and away from a position in which they will interrupt the pipe opening through the preventer body and thereby shut off flow either through the pipe opening without any pipe therein as by means of the blind rams **24**, or shut off flow through the annular space around the pipe therein as by means of the pipe rams **26**.

The rams are normally moved forward and rearward by means of ram pistons **28** operating in ram cylinders formed in a head structure which in normal operation of the blowout preventer is rigidly secured and sealed to the blowout preventer body transversely of the outer ends of the ram guideways.

Ram pistons **28** are carried on the ends of rods **29**, being rigidly joined thereto, and these rods are in turn threaded or otherwise rigidly joined to the ram carrier **30** which forms the major portion of the ram body.

The head structure referred to consists of a bonnet **32** and an intermediate flange **34**. The bonnet **32** has formed therein the ram cylinders **36** which receive and cooperate with the ram pistons **28**, and the open ends of these cylinders **36** are closed about the rods **29** by the intermediate flange **34** which is secured to the bonnet **32** by suitable means such as cap screws **38**. In the openings through the intermediate flange **34** surrounding the rods **29** are suitable packing **40** so that the ram cylinders **36** are closed at their rod ends about the rods **29** as well as at their opposite or head ends. Thus, there is provided a double acting piston and cylinder combination whereby the rams **26** may be moved both forwardly and rearwardly depending upon the direction of application of pressure to the pistons **28**.

It is to be noted that the rams **26** and their guideways **22** are made oval in cross section with their major axes disposed horizontally, which makes it possible to make a blowout preventer with a much shorter vertical dimension than with round rams, yet have the advantages which result from the elimination of flat bearing surfaces and corners or crevices on and in which sand, shale and other material may accumulate and interfere with the operation of the rams or cause excessive wear. Carrying this idea further, the power for the ram actuation is provided through two pistons and cylinders as above mentioned instead of one, and these are spaced apart and lie in substantially the same horizontal plane which is substantially the same as the plane of the major axis of the oval ram.

The composite head structure provided by the bonnet **32** and intermediate flange **34** secured together by the cap screws **38** as above described, is in normal operations of the preventer secured to the body in a position transversely of the ram guides **22** and across their outer ends by means of capstan screws **42** of which four are illustrated for each head. It will be seen that when the head structure is thus rigidly held with respect to the body of the preventer, the application of fluid under pressure alternately to the head ends and to the rod ends of the cylinders **36** will result in forward and rearward motion of the rams **26** in their respective guideways **22**. At this point it may be noted also that intermediate the rods **29**

each of the ram carriers **30** is provided with a boss **44** which is internally tapped and threaded to receive a locking screw **45**, the inner end of which is threaded at **46** to engage the tapped opening in the boss **44** and the outer end of which is in the form of a smooth stem with a non-circular configuration on its outer end so that it may be engaged by a wrench and rotated. Intermediate the threaded portion and the smooth portion this screw is provided with a laterally extending flange **47**. The bonnet **32**, intermediate the portions in which the cylinders **36** are formed, is provided with a recess and the smooth portion of the screw just described extends through an opening in the bonnet and into such recess so that although it is accessible from the exterior of the bonnet it is protected by the portion of the bonnet in which the cylinders **36** are formed. The action of this screw will be readily understood in that when the screw is in the position illustrated in Fig. 6, it may move forward and rearward with the ram **26** and will not interfere with such movement, but it may be used to manually close ram **26** or with the ram **26** in its closed or forward position the screw may be rotated by means of the noncircular portion until it is backed out of the boss on the ram carrier to engage the flange **47** with the inner surface of the bonnet. In this position the ram **26** will be locked closed and cannot be retracted.

While the head structure comprising the bonnet and the intermediate flange secured together is, during normal operation of the preventer, rigidly secured and sealed to the body by the capstan screws **42**, this head structure is also mounted on the body with a telescoping connection which, when the capstan screws **42** are released, permits movement of this head structure away from the body of the preventer by a distance which is not substantially less than the forward and rearward dimension of the ram **26**.

The telescoping connection just referred to is comprised of a pair of what may be termed "head" pistons **50** and **52** slidably carried in and forming a sliding seal within head cylinders **54** and **56** formed within the bonnet **32** with axes substantially in the same plane with the axes of cylinders **36** and on opposite sides thereof. These pistons **50** and **52** are carried on piston rods **58** and **60**, respectively, both of which are hollow and both of which extend through the intermediate flange **34** and are threadedly or otherwise rigidly secured to the body. The rod ends of the cylinders **54** and **56** are closed about the rods **58** and **60**, respectively, by means of suitable packing **61** within the intermediate flange **34**, thereby making the piston and cylinder combinations formed by head pistons **50** and **52** and the head cylinders **54** and **56** double acting. It will be seen that if fluid under pressure is admitted to the rod ends of these cylinders **54** and **56** it will tend to move the head structure into tight engagement with the body in which position it is shown, for example, in Fig. 5, but that if fluid under pressure be introduced into these cylinders in their head ends, such pressure will tend to move the head structure away from the body, and with the capstan screws **42** released, will move the head structure away from the body until such movement is stopped as by contact of the head pistons **50** and **52** with the closures of the head cylinders which are carried by the intermediate flange **34**. Such retractive position is illustrated in Fig. 9 and also in Fig. 4 and it will be appreciated on reference to these two figures that when the parts are in this position it is possible to remove by lifting upwardly the wearing and size determining parts of the ram, an operation which will be described more in detail in the later part of this specification.

Referring now more particularly to the means for applying fluid pressure to the various piston and cylinder combinations in order to actuate them as desired, this is shown insofar as the flow passages in the body and head structure are concerned in Figs. 2, 3 and 4. It will be appreciated that in these figures the passageways are shown for the purpose of convenience as lying all in one plane but that in actuality, while the passages shown as being within the head structures are actually within the head structures and those shown as being within the body are actually within the body, they do not necessarily lie in the planes where they are shown but are located in the head and body structures in positions most convenient from the standpoint of design but having no bearing on the patentability thereof.

First of all it is noted that the body has two operating fluid passageways **62** and **64**, each of which has an opening as indicated at **65** and **66**, respectively, so that it may be connected to an external conduit for supplying fluid under pressure thereto or for receiving fluid therefrom.

Next it is noted that the conduit **62** in the body is in communication with the passageway **67** through the hollow rod **58** and that this pasageway **67** leads through the head piston **50** and opens into the head end of the head cylinder **54**. Leading from the head end of the cylinder **54** there is a passageway **68** leading through the bonnet and intermediate flange and communicating through branch lines **69** and **70** with the rod ends of ram cylinders **36**, and also having communication to an extension **71** with the head end of head cylinder **56**. In this respect the opposite ends of each blowout preventer section are identical and it will be seen from this description that upon the application of pressure fluid through the opening **65** such pressure will be applied to the head ends of the head cylinders **54** and **56** and will tend to move the head structure away from the body, and such pressure will be simultaneously applied to the rod ends of the ram cylinders **36** which will cause movement of the ram **26** in a rearward direction until it engages the intermediate flange **34** as an abutment. It will be appreciated that in normal operation of the preventer, during which the head structure is secured to the body by means of capstan screws **42**, the pressure in the head ends of head cylinders **54** and **56** will be ineffective to move the head structure with respect to the body but that such pressure in ram cylinders **36** will retract the ram **26** to the position illustrated in Figs. 3 and 5, unless, of course, the ram is locked in its forward position by the screw **45**, in which event there will be no movement whatever resulting from the application of pressure as described.

If, on the other hand, the capstan screws be released, then upon application of pressure in the manner just referred to, the ram will be retracted into engagement with the intermediate flange as above described, and in addition thereto the head structure will be moved away from the body until it occupies the position illustrated in Figs. 4 and 9, in which position portions of the ram may be removed as hereinafter described.

Referring to the passageway **64** in the body, it is noted that this passageway is in communication with the hollow interior **74** of the rod **60**. This hollow interior **74**, however, does not open through the head piston **52** as does the hollow interior **67** through the head piston **50**. On the contrary, the head piston **52** is imperforate and small passageways **75** are provided between the interior **74** of the rod and the interior of the rod end of the head cylinder **56** so that pressure from opening **66** when applied thereto will be communicated to the rod end of the head cylinder **56**. This rod end of head cylinder **56** is connected through passageway **76** and branches **77** and **78** with the head ends of the ram cylinders **36**, and through an extension of the passageway **76**, indicated at **79**, the same is connected to the rod end of head cylinder **54**.

Thus, it will be seen that when fluid under pressure is applied through the opening **66**, this fluid under pressure will tend to act on the rod ends of the head cylinders **54** and **56** to move the head structure into tight engagement with the body, and to act on the head ends of the ram cylinders **36** to move the ram **26** forwardly to closed

position. During normal operation of the preventer with the head structure secured by the capstan screws 42 to the body, the only action resulting from the application of pressure fluid through the opening 66 will be to move the ram 26 forwardly to its closed position, but if perchance the capstan screws had previously been released and the head structure moved to positions spaced from the body as illustrated in Figs. 4 and 9, then the the application of the pressure through openings 66 would serve both to close the head structure against the body so that the capstan screws might be replaced to hold it in such position, and to advance the ram to closed position.

On reference to Fig. 1 the exterior connections for supplying fluid under pressure to operate the preventer are illustrated diagrammatically. From this figure it will be seen that only two exterior lines or conduits which are indicated by the numerals 80 and 81 connect respectively to the openings 65 and 66 and are all the connections which need be made to the preventer for operating the upper unit thereof. These lines are connected to a control valve 82 which controls the entire operation of the upper unit by movement selectively to either of two positions. In one of these positions it serves to connect the conduit 80 to the pump 88 which draws fluid from the reservoir 90 and forces it under pressure through the valve 82 and the line 80 into the opening 65 with the results heretofore described, while the line 81 is connected through the valve 82 to the discharge line 89 which empties into the reservoir 90 and permits the return of spent fluid from the respective cylinders. In the other position of valve 82 it connects conduit 81 to pump 88 to supply power fluid under pressure to opening 66 with the results heretofore described, while line 80 is connected to discharge line 89 to permit return of spent fluid from the cylinder ends in communication with opening 65.

The operation of the lower unit likewise is controlled through two conduits 84 and 85 and a valve 86 which serves to connect them alternatively to the pump 88 and to the discharge line 89, respectively.

Reference will now be had more in detail to the structure of the rams which is highly advantageous particularly in connection with the blowout preventer construction which has been described.

As above mentioned, each of the rams has a body which is oval in cross section in a direction transverse to its direction of forward and rearward movement so that it will take up as little vertical space as possible but yet so that it will have the advantage of providing no flat surfaces and corners that would tend to accumulate grit and the like. This body is provided in major portion by a ram carrier 30 to which the ram operating rods 29 are rigidly connected as heretofore described. This ram carrier is not intended to be removed under any ordinary circumstances and its removal is unnecessary for the purpose of either changing the ram packing assembly from one size to another or to provide a blank for closing off the entire pipe opening, or for the purpose of changing the pipe centering guide to accommodate a different size of pipe. As illustrated in Figs. 7, 8, 9 and 10 the upper forward portion of this carrier is cut away to provide for the reception of the pipe centering guide and of the ram packer assembly which, together with the carrier, make up the complete ram. The carrier has a forwardly extending ledge 92 on which the pipe centering guide 93 is adapted to rest. This guide is in the form of an arc, the interior curvature of which is of a size to fit the pipe with which the ram is to be used and the outer curvature of which is of a size to fit within the recess provided for the guide in the ram carrier. On the forward ends of the guide 93 are projections which actually provide the pipe centering guides, that on one end being adjacent the upper surface of the guide member as shown at 94 and that on the other end being adjacent the lower surface of the guide member as shown at 95. These project in advance of the forward face of the ram and are adapted to match with corresponding recesses on an identical pipe centering guide on the opposed ram so that when both rams are closed these projections will overlie and underlie each other. The pipe centering guide is not secured to the carrier by means of bolts or other holdfast means but is provided with interlocking means in the form of dowels 96 which engage within dowel openings 97 formed in the carrier so that as long as the pipe guide is held downwardly against the ledge 92 on the carrier it will be prevented from movement with respect to the carrier.

The ram packer is embodied in an assembly which comprises a packer proper 98 and lower and upper ram segments 99 and 100, which are of rigid material, such as steel, as contrasted with the flexible, resilient material such as synthetic rubber of which the packer proper is mainly constructed. The packer is preferably of molded construction in the form of an endless strip which is so disposed as to form a sealing strip 101 across the forward face of the ram, a rearwardly extending portion on each end of the forward sealing strip 101 as indicated at 102, and a part which curves upwardly and rearwardly across the top of the ram to provide a sealing strip across the top of the ram as indicated at 103. This is preferably molded in one piece and forms an endless strip of sealing material. Completing the packer proper are pressure plates 104 and 105 countersunk in the upper and lower surfaces, respectively, of that portion 101 of the resilient packer which extends across the front face of the ram. These pressure plates terminate short of the rear surface of this portion of the packer member and their rear surfaces bear against the resilient packer material so that when they are forced rearwardly they tend to force the material of the packing to flow out between them.

The upper and forward portion of each ram is provided by the upper segment 100 whereas the base of each packing assembly is provided by the lower segment 99. These two segments are so formed that they extend into the opening provided by the endless packer element and completely fill this opening as well as confine the forward strip portion 101 of the packing element on both its upper and lower surfaces and provide a support for the rear portion of this forward strip. The upper segment 100 likewise provides a limiting wall for the forward surface of the curved strip 103 of packing material which extends up and across the top of the ram, and the lower segment extends underneath this strip 103 to provide a limiting wall for its undersurface. The upper and lower segments, after being assembled with respect to each other and with respect to the packing element in the manner indicated, are secured together by means of cap screws 106, the heads of which are countersunk into the outer surface of the upper segment and threaded into suitable tapped openings in the lower segment. It is to be noted that these cap screws serve merely to secure these segments together and not to secure them to the remainder of the ram.

In this latter connection, it will be seen that the ram carrier is provided with an upstanding substantially semicircular ridge or flange 107 which projects just above the upper surface of the pipe centering guide when it is in place in the ram carrier, and which provides a semicircular recess behind this flange 107. The lower segment 99 is provided with a complementary formation which includes a downwardly extending flange like portion 108 adapted to fit the groove behind the flange 107 so that when the ram packer assembly as above described is put into position on the ram carrier, the ram packer assembly, like the pipe centering guide, will be free to move upwardly away from the ram carrier but will be interlocked with portions of the ram carrier to prevent it from moving forwardly and rearwardly with respect to the ram carrier. The ram carrier also has an upstanding

rear portion **109** which forms a rear abutment for the packer assembly and particularly for the packer element along the strip **103**.

Thus, it will be seen that when this ram as described is in place within its guideway in the body the pipe centering guide **93** will be held in place by the ram packer assembly and the ram packer assembly in turn will be held against movement upwardly and away from the carrier by engagement with the ram guideway so that the entire ram will operate as a unit. In this connection it is noted that the ram guideway is formed so that it closely embraces and fits the ram throughout the upper circumferences and throughout the lengths of both of them, so that the ram packer and pipe guide will be held in place on the carrier throughout the travel of the ram in the guideway. On the other hand, when the ram is withdrawn from its guideway by the action of the ram pistons **28** and the head pistons **50** and **52** with the capstan screws disconnected, the ram packer assembly first, and, when it is desired, also the pipe centering guide may be removed from the ram by simply lifting it upward. For this purpose and to make easier the removal of the ram packer assembly, the upper segment **100** is provided with a tapped opening **110** with which a lifting eye may be engaged.

The ram guideways also closely embrace the entire circumferences of the respective rams when rams are in their most rearward positions within the guideways, but forwardly of their rear ends the guideways have their lower surfaces flared away from the rams in an inward and downward direction as shown at **111**, thereby avoiding collection of sand or debris below the rams and in cooperation with relief slots **112** in the ram carrier, assuming that pressures on its forward and rear faces will be substantially equal. The packer strip portion **101** and the parts extending therefrom rearwardly along the sides of the rams are located above the major axis of the oval of the rams. This makes for better balance of pressures on front and rear surfaces of the rams when closed, in that the required opening force is only that of the well pressure on an area substantially equal to the area of the forward face of the ram above the packer.

When employed as a ram within the ram guideway, this composite ram may be advanced until it comes in contact with the pipe and/or the opposed ram, at which point the packing material will be completely confined and additional movement of the ram will drive the pressure plates **104** and **105** into the confining space thereby displacing the confined packing material and increasing pressure therein to cause it to seal at all contacting surfaces. These confining surfaces are provided by the segments **99** and **100**, the rear portion **109** of the ram carrier, the pressure plates **104** and **105**, the adjacent surrounding surface of the guideway, and the surface of the pipe or opposed ram against which the face **101** is abutted.

The operation of this device is believed to be clear from the foregoing but may be briefly reviewed as follows:

The blowout preventer, mounted upon a well casing as previously described, may have a drill pipe or the like extending therethrough or may have nothing extending through it. For this reason the rams of one blowout preventer unit are customarily provided with forward faces adapted to engage the forward face of the opposed ram completely across such forward faces and thus to close off the pipe opening when no pipe is in place. This may be accomplished by operation of the valve **86** so as to connect to the pump **88** that one of the lines **84** or **85** which leads to the passageway communicating with the head ends of the cylinders **36**. The capstan screws **42** being secured to the body of this blowout preventer unit, the head pistons and cylinders will remain inactive while the ram pistons will be caused to force the rams forwardly to closed position. During this movement flow from the other of the lines **84** or **85**, as the case may be, will take place as the pistons **28** move to reduce the size of the ram cylinders **36** on their rod ends.

The same operation will take place under the control of the valve **82** employing the upper blowout preventer unit in the event a pipe is in place in the blowout preventer.

If now it be desired to replace a worn ram packer element or to replace both the ram packer and the pipe guide for the purpose of changing the ram to engage a different size of pipe, the capstan screws **42** on the head structures of that preventer unit will be disengaged and the valve **82** or **86** will be operated so as to turn pressure fluid into the head ends of the head cylinders and the rod ends of the ram cylinders and so as to vent fluid from the opposite ends of said cylinders. This will cause the retraction of the rams into engagement with the intermediate flanges and will cause the retraction of the head structure including the intermediate flanges, the bonnets and the rams in a direction away from the blowout preventer body until the upper surface of the ram is exposed upwardly. Thereupon, if only the ram packer assembly is to be changed, a lifting eye may be engaged with the threaded opening **110** and the ram packer assembly lifted out as a unit. The pipe centering guide then may or may not be removed and replaced depending on what is desired. A new ram packer assembly may be then put in place and upon operating the appropriate valve **82** or **86** to reverse the direction of application of fluid under pressure, the head structure will be moved back into engagement with the body and the ram will be moved to its most forward position overlying the pipe opening. The capstan screws **42** may then be replaced and the structure is ready for operation.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the structure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. In a blowout preventer comprising a body having a pipe opening therethrough and a ram guideway extending laterally from said pipe opening, a ram movable in said guideway to and from a position interrupting said pipe opening, the improvement which comprises a head detachably secured to said body, a cylinder formed in the head, a piston slidable within the cylinder and connected to the ram for moving said ram in its guideway in normal preventer operation, passageways in the head connecting with the cylinder for supplying power fluid to opposite sides of the piston, and piston and cylinder means interconnecting said head and body for moving said head with respect to said body.

2. A blowout preventer according to claim 1, in which said first-mentioned cylinder and the cylinder of said piston and cylinder means are disposed side by side with their axes substantially in a plane transverse to the axis of the pipe opening.

3. A blowout preventer according to claim 1, in which said piston and cylinder means includes another cylinder formed in the head, a piston slidable in said other cylinder, and a rod connecting the last-mentioned piston to the body, and said power fluid passageways connect with said last-mentioned cylinder in series with the first-mentioned cylinder.

4. A blowout preventer according to claim 3, in which

there are power fluid passageways in the body and said piston of said piston and cylinder means is hollow for supplying power fluid from the passageways in the body to the passageways in the head.

5. In a blowout preventer, a body having a pipe opening therethrough and a ram guideway extending laterally from said pipe opening, a ram movable in said guideway to and from a position interrupting said pipe opening, a head removably secured to said body across the outer end of said guideway and having a ram cylinder formed therein, and a ram piston in said cylinder connected to said ram, said head having two power fluid passageways therein open into the opposite ends respectively of said ram cylinder and each also open through the surface of said head toward the adjacent portion of said body, said body having two power fluid passageways therein connected respectively to the last mentioned openings of the passageways in said head when said head is mounted in operative position on said body, and each of said passageways in the body having another opening to the exterior of said body to receive and connect to an external conduit, and piston and cylinder means connecting the head and body for moving the head toward and away from the body.

6. In a blowout preventer, a body having a pipe opening therethrough and a pair of ram guideways extending laterally in opposite directions from said pipe opening, a ram movable in each of said guideways to and from a position interrupting said pipe opening, a head removably secured to said body across the outer end of each of said guideways, each head having a ram cylinder formed therein, a ram piston in each of said cylinders and a rod connecting each ram piston to the corresponding ram, each of said heads having two power fluid passageways therein, said passageways in each head being open into the opposite ends respectively of the cylinder in the corresponding head and each also open through the surface of such head toward the adjacent portion of the body, said body having two power fluid passageways therein, one such passageway in the body being connected to the last mentioned openings of the passageways leading to the head end of the cylinder in each of said heads and the other of such passageways in the body being connected to the last mentioned openings of the passageways leading to the rod end of the cylinder in each of said heads when the heads are mounted in operative position on said body, and each of said passageways in said body having a third opening to the exterior of said body to receive and connect to an external conduit, and piston and cylinder means connecting the head and body for moving the head toward and away from the body.

7. A blowout preventer as claimed in claim 5, in which there is a telescoping connection between each of the passageways in said head and the corresponding passageway in said body.

8. A blowout preventer as claimed in claim 5, in which said piston and cylinder means includes a telescoping connection between each of the passageways in said head and the corresponding passageway in said body including another cylinder formed in said head in communication with the passageway in said head, a piston slidable in said other cylinder, a hollow rod connecting said last-mentioned piston to said body and having its interior in communication with the passageway in said body and with the interior of said cylinder, and means forming a sliding seal about said piston rod within said head.

9. In a blowout preventer, a body having a pipe opening therethrough and a ram guideway extending laterally from said pipe opening, a ram movable in said guideway to and from a position interrupting said pipe opening, a head removably secured to said body across the outer end of said guideway and having a ram cylinder and a pair of head cylinders formed therein, a ram piston in said ram cylinder and a rod connecting said piston to said ram, said head having two power fluid passageways therein open into the opposite ends of said ram cylinder respectively, said body having two power fluid passageways therein each having an opening to the exterior of said body to receive and connect to an external conduit, a pair of hollow piston rods on said body having their respective interiors at one end in communication with the respective passageways in said body and extending into one of said head cylinders, a sliding seal in said head about each rod at the entrance to its head cylinder, and a head piston on each rod in sliding sealing engagement with the interior of its head cylinder, the interior of one of said rods being in communication with the interior of its head cylinder on the rod side of its head piston and the interior of the other of said rods being in communication with the interior of its head cylinder through its head piston to the head side thereof, and one of said passageways in the head being in communication with the rod ends of both head cylinders and the other of said passageways in the head being in communication with the head ends of both head cylinders.

10. A blowout preventer as set forth in claim 9, in which the passageway connected to the head end of the ram cylinder is also connected to the rod ends of said head cylinders and the other passageway connected to the rod end of the ram cylinder is also connected to the head ends of the head cylinders.

11. In a blowout preventer, a body having a pipe opening therethrough and a ram guideway extending laterally from said pipe opening, a ram movable in said guideway to and from a position interrupting said pipe opening, a head removably secured to said body across the outer end of said guideway and having a pair of spaced ram cylinders formed therein, the axes of said ram cylinders lying in a plane substantially normal to the axis of said pipe opening, a ram piston in each ram cylinder connected to said ram, said head having a recess in its external surface between said cylinders, and a locking screw extending from said recess through said head to engage said ram for locking it in closed position, said screw lying partly in the recess between said cylinders.

12. In a blowout preventer, a body having a pipe opening therethrough and a ram guideway extending laterally from said pipe opening, a ram movable in said guideway to and from a position interrupting said pipe opening, a head removably secured to said body across the outer end of said guideway and having a ram cylinder formed therein, a ram piston in said cylinder connected to said ram, a head cylinder in said head, a head piston in said head cylinder, a rod connecting said head piston to said body, each of said piston and cylinder combinations being double acting, means for supplying power fluid under pressure simultaneously to said ram cylinder in a direction to move said ram away from said head and to said head cylinder in a direction to move said head toward said body, other means for supplying power fluid under pressure simultaneously to said ram cylinder in a direction to move said ram toward said head, and to said head cylinder in a direction to move said head away from said body, and means for removably securing said head to said body.

13. In a blowout preventer, a body having a pipe opening therethrough and a ram guideway extending laterally from said pipe opening, a ram movable in said guideway to and from a position interrupting said pipe opening, a head removably secured to said body across the outer end of said guideway and having a ram cylinder formed therein, a ram piston in said ram cylinder connected to said ram, said head having also a pair of head cylinders in said head on either side of said ram cylinder, a head piston in each of said head cylinders, a rod connecting each of said head pistons to said body, each of said piston and cylinder combinations being double acting, means supplying power fluid under pressure simultaneously to said ram cylinder in a direction to move said ram away from said head and to said head cylinders in a direction

to move said head toward said body. other means for supplying power fluid under pressure simultaneously to said ram cylinder in a direction to move said ram toward said head and to said head cylinders in a direction to move said head away from said body, and means for removably securing said head to said body.

14. In a blowout preventer, a body having a pipe opening therethrough, a ram guideway extending laterally from said pipe opening, a ram movable in said guideway to and from a position interrupting said pipe opening, a head removably secured to said body across the outer end of said guideway and having a pair of ram cylinders formed therein, a ram piston in each of said ram cylinders connected to said ram, said head also having a pair of head cylinders in said head on either side of said ram cylinders, and a head piston in each of said head cylinders, a rod connecting each of said head pistons to said body, each of said piston and cylinder combinations being double acting, means for supplying power fluid under pressure simultaneously to said ram cylinder in a direction to move said ram away from said head and to said head cylinders in a direction to move said head toward said body, other means for supplying power fluid under pressure simultaneously to said ram cylinder in a direction to move said ram toward said head and to said head cylinders in a direction to move said head away from said body, said head having a recess in its outer surface between said ram cylinders, a locking screw extending from said recess through said head into engagement with said ram to lock the same in position interrupting said pipe opening, and means for removably securing said head to said body.

15. In a blowout preventer, a body having a pipe opening therethrough and a ram guideway extending laterally from said pipe opening, a ram movable in said guideway to and from a position interrupting said pipe opening, a head removably secured to said body across the outer end of said guideway and having a ram cylinder formed therein, a ram piston in said ram cylinder connected to said ram, a head cylinder in said head, a head piston in said head cylinder, a rod connecting said head piston to said body, each of said piston and cylinder combinations being double acting, and means for selectively supplying power fluid under pressure to each of said cylinders in either direction.

16. In a blowout preventer, a body having a pipe opening therethrough and a ram guideway extending laterally from said pipe opening, a ram movable in said guideway to and from a position interrupting said pipe opening, a head removably secured to said body across the outer end of said guideway and having a ram cylinder formed therein, a ram piston in said ram cylinder connected to said ram, a head cylinder and piston combination interconnecting said head and body, each of said piston and cylinder combinations being double acting, and means for selectively supplying power fluid under pressure to said piston and cylinder combinations respectively in either direction.

17. As a subcombination, a head for a blowout preventer comprising a body having a pair of ram cylinders therein and a pair of head cylinders therein, the axes of all of said cylinders being in substantially the same plane and said ram cylinders being spaced apart and having a recess therebetween in the outer surface of the head, and a locking screw disposed partly in said recess and extending from said recess through said head.

18. In a blowout preventer comprising a body having a pipe opening therethrough and a ram guideway extending laterally from said pipe opening, a ram movable in said guideway to and from a position interrupting said pipe opening, the improvement which comprises a head detachably secured to said body, piston and cylinder means interconnecting said head and ram for moving said ram in its guideway toward and away from the head in normal preventer operation, and other piston and cylinder means interconnecting said head and body for moving said head toward and away from said body when detached, the pressure responsive areas of the piston of said first-mentioned piston and cylinder means for moving said ram toward and away from the head being greater than that of the piston of said last-mentioned piston and cylinder means for moving said head toward and away from the body, respectively.

19. A blowout preventer according to claim 18, wherein said first-mentioned piston and cylinder means includes a cylinder formed in the head, a piston slidable within the cylinder and connected to the ram, and passageways in the head connecting with the cylinder for supplying power fluid to opposite sides of the piston.

20. A blowout preventer according to claim 18, wherein both of said piston and cylinder means are connected in series.

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