Sept. 13, 1966 H. ALLEN 3,272,222

BLOWOUT PREVENTER

Filed Oct. 28, 1963 3 Sheets-Sheet 1

Fig. 1

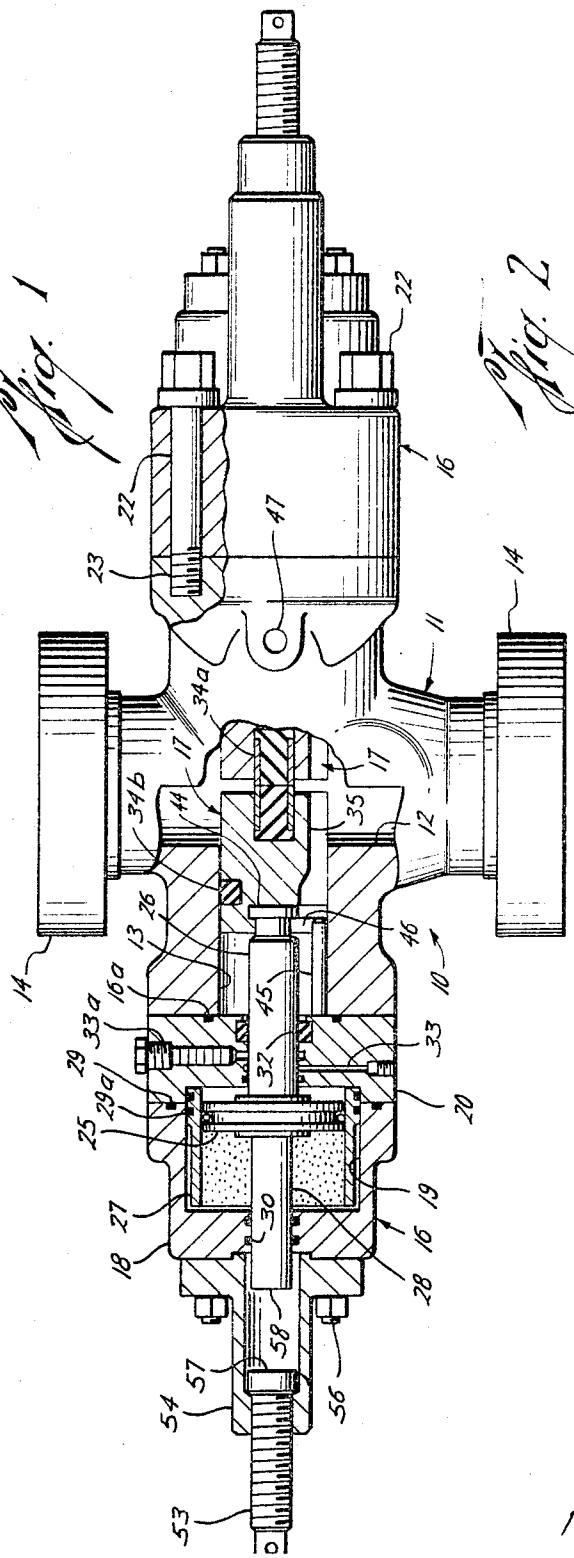
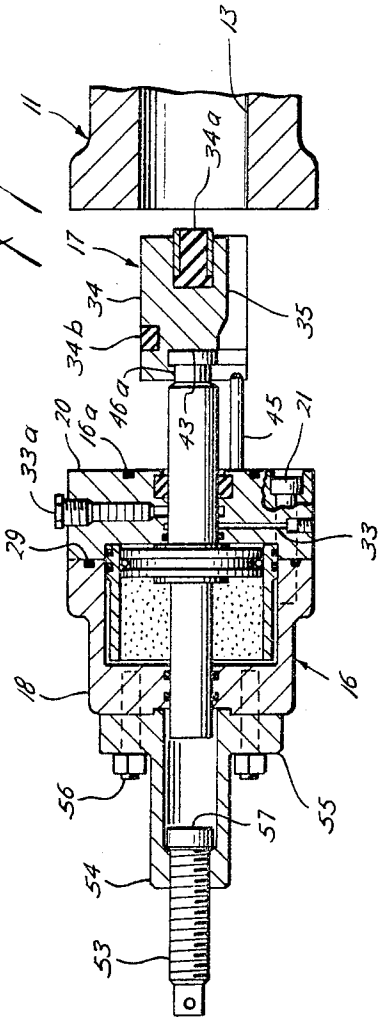


Fig. 2



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BLOWOUT PREVENTER

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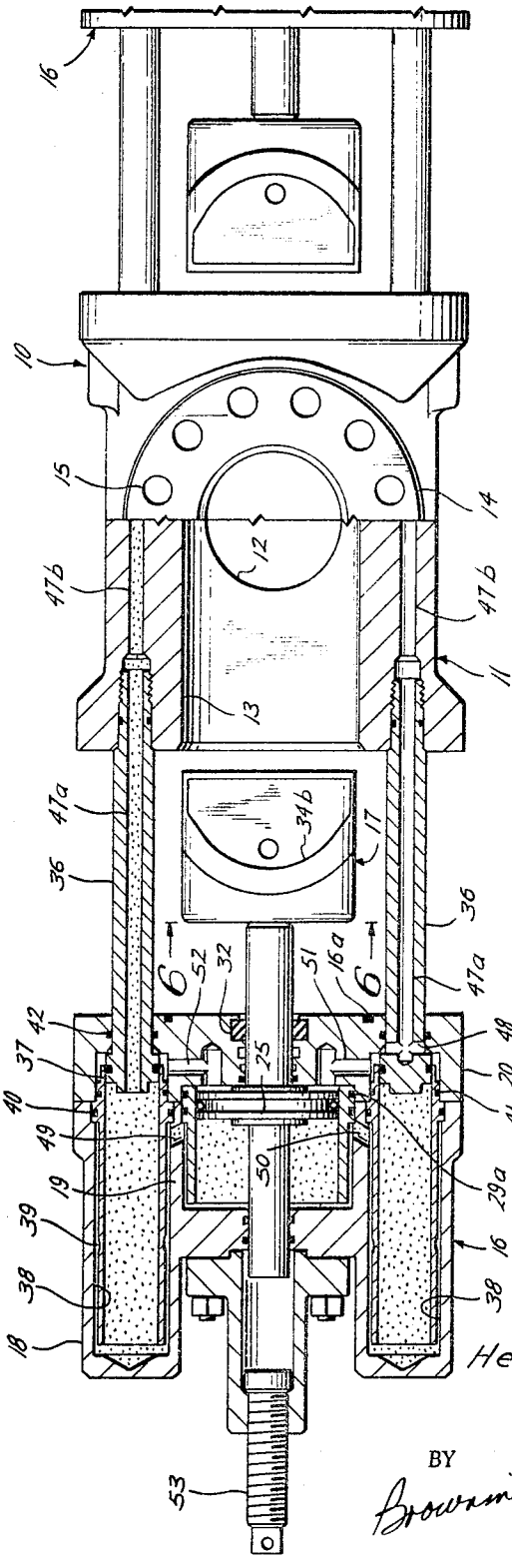


Fig. 3

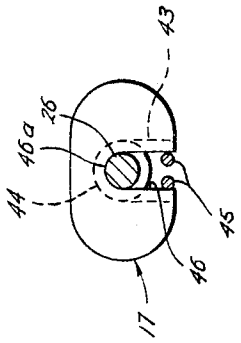


Fig. 6

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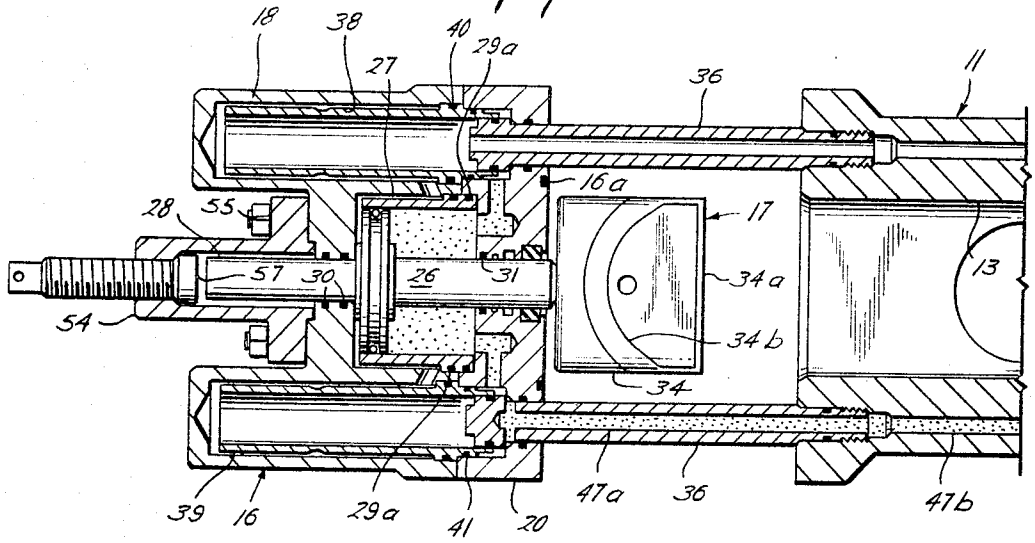
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BLOWOUT PREVENTER

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Fig. 4



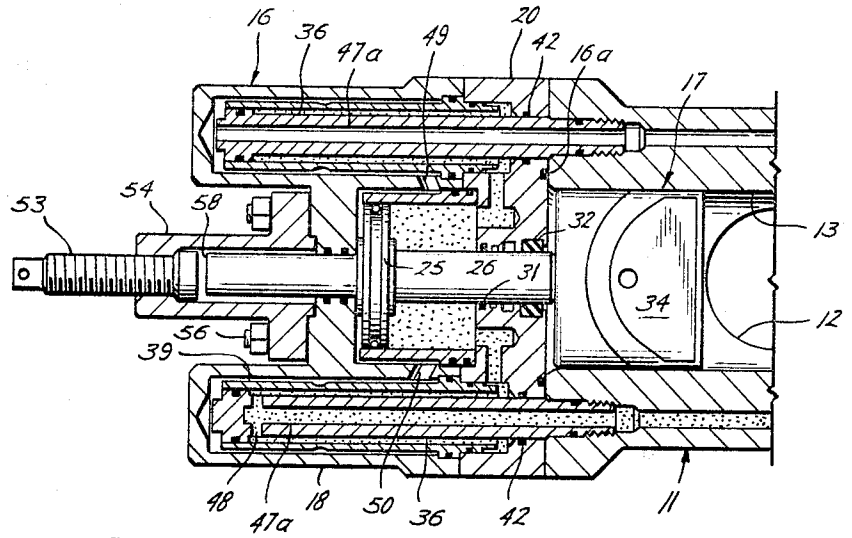


Fig. 5

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3,272,222

BLOWOUT PREVENTER

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Filed Oct. 28, 1963, Ser. No. 319,284
7 Claims. (Cl. 137—315)

This invention relates generally to blowout preventers used in the drilling of oil and gas wells and, more particularly, to improvements in blowout preventers of the type shown and described in U.S. Patent No. 2,912,214.

The conventional blowout preventer comprises a body having a bore through it and adapted to be connected to the wellhead stack with its bore forming a vertical continuation of the bore through the stack. As well known in the art, various pipes including the drill string are raised and lowered through the bore during drilling of the well. In the event of a blowout, rams carried within the body of the preventer may be closed about a pipe in the bore or upon one another when the bore is empty. For this purpose, guideways for the rams extend laterally from opposite sides of the bore and the rams are hydraulically connected to bonnets disposed across the outer ends of the guideways for moving them toward and away from the bonnets for opening and closing the bore, respectively.

Each bonnet is detachably connected to and supported from the preventer body in such a manner that, when detached therefrom, it may be moved away from the end of the body so as to open the guideway and withdraw the ram therefrom. When so withdrawn, the rams are, of course, accessible for replacement and repair. Upon completion of same, the bonnets are returned to positions reinserting the rams into the guideways and closing the outer ends thereof. Then, upon reattachment of the bonnets to the body, the preventer is again ready for normal preventer operation.

In the preventer shown and described in the aforementioned prior patent, each bonnet is moved between guideway opening and closing positions by separate hydraulic actuators which are disposed within the bonnet and preventer body in side-by-side relation to the ram actuator. This conserves space and also prevents damage to the actuators which might otherwise occur of they were arranged externally. More particularly, these ram and bonnet actuators are interconnected so that all may be operated by the same hydraulic system. In order to automatically locate the rams in position for replacement and repair as the bonnets are moved away from the preventer body, the actuators are so connected and arranged as to open the rams as the bonnets are opened.

Although this particular preventer represents a substantial advance over more conventional preventers, not the least of which is the above-described compact construction, it nevertheless has certain shortcomings, particularly upon return of the rams and bonnets to normal operating position. The ram actuators are considerably larger than the bonnet actuators due to the greater forces which are required in operating the rams than are required in operating the bonnets. Thus, when the rams have been repaired and replaced, and the hydraulic system is reversed so as to move the bonnets to closed positions, the rams necessarily move to closed positions prior to the bonnets.

As is common in this art, the inner end of each ram has an outwardly protruding seal portion for engagement with a similar portion on the opposite ram, as well as with a pipe in the bore of the preventer body, so as to permit these seal portions as well as additional seal portions between the rams and guideways to be deformed into tight sealing engagement with one another, the pipe and the guideways. This, of course, requires that the hydraulic actuator for each ram have a stroke which is somewhat longer than that required to bring the inner ends of the rams into initial engagement with one another. As a result, when the rams of the preventer shown and described in the aforementioned patent move to closed position prior to closing of the bonnets, at least one of the bonnets is prevented from reaching a fully closed position in which it may be reattached to the preventer body.

As is also common in this art, well fluid from the bore and beneath the closed rams has free access to the rear ends of the rams so as to supplement the force of the actuator in holding the rams closed. Thus, in the event that a well should blow while a bonnet is open and an attempt is made to close the bonnet, closing of the ram before the bonnet closes, as above described, will cause the well fluid to flow out between the bonnet and outer end of the preventer body with considerable velocity. This rush of fluid is extremely hard on sealing members, such as that commonly carried by the inner end of the bonnet for sealing about the outer end of the guideway in the preventer body, and, in many cases, the seal ring has actually been blown out by this well fluid, with the result that the bonnet cannot seal with respect to the preventer body even if it can be reattached thereto.

As is also well known in this art, preventers of this type are frequently stacked one above the other, whereby one such preventer may be supplied with so-called "blind" rams for closing an open bore and the other preventer may be provided with rams having shaped inner ends for closing about a pipe in the bore. In the preventer of this earlier patent, access may be had to the rams of the lower of the two preventers after withdrawal of the bonnets of both preventers from the ends of the body only upon prior removal of the rams from the upper preventer. This, of course, is time consuming and burdensome in the event that the rams of the upper preventer do not need replacement and repair.

An object of this invention is to provide a blowout preventer having at least many of the advantages of this earlier preventer construction without the above-described disadvantages.

Another object is to provide a blowout preventer of the type described, wherein this difficulty in reattaching the bonnets and in maintaining the seal member on the bonnet are overcome, and more particularly, wherein the bonnet is caused to move to closed position prior to closing of the rams.

Still another object is to provide a preventer of the type described in the foregoing object, wherein the rams of a lower preventer of a stack of preventers may be replaced and repaired without prior removal of the rams of the upper preventer.

These and other objects are accomplished, in accordance with the illustrated embodiment of the invention, by a blowout preventer in which the actuators for the rams are so constructed and arranged relative to the bonnet

actuators as to move the rams toward or retain them in their open positions prior to movement of the bonnets to guideway-closing positions. In this way, the rams are kept apart to leave the bore of the preventer body open at least until the bonnets have been moved to closed position against the ends of such body, whereby they may be reattached to the body without difficulty so as to prepare the preventer for normal operation. Furthermore, since there is no closure or choking down of the bore as the bonnets approach closed positions, there is no rush of well fluid past the bonnet seal which might otherwise damage or even blow the seal out.

In the preferred embodiment of the invention, the ram and bonnet actuators are so connected and arranged that operation of the fluid pressure system to open the bonnets will move the rams to closed positions, and operation thereof to close the bonnets will move the rams to open positions. Thus, with the ram actuators considerably larger than the bonnet actuators, the last-described operation will automatically move the rams toward the bonnets before the bonnets are moved against the ends of the preventer body to close the guideways, thereby effecting the improved function above described.

The rods connecting the bonnets to the preventer body are of such length that, when the bonnets are in wide open position, the rams are withdrawn from the body guideway whether in closed or open position, i.e., whether away from or toward the bonnet on which they are carried. Although this increases somewhat the space which is required for the preventer, it permits the rams of an upper preventer to be moved back to open position, in which they are still accessible between the end of the preventer body and bonnet, so as to facilitate access to the rams of a similar lower preventer, at least when the latter is in closed position. More particularly, this manipulation is possible merely upon an initial operation of the fluid pressure system in closing the upper bonnet, because the ram is first moved to open position due to its larger pressure-responsive area.

In the drawings, wherein like reference characters are used throughout to designate like parts:

FIG. 1 is a side view, partly in section and partly in elevation, of a blowout preventer constructed in accordance with the present invention, and with the rams thereof moved to closed position during normal operation;

FIG. 2 is a sectional view of one end of the preventer of FIG. 1, but with the bonnet detached from the body and moved to an open position in which the ram carried by the bonnet is in closed position but withdrawn from its guideway;

FIG. 3 is a top plan view of part of the preventer of FIGS. 1 and 2, with one end thereof in section and with the bonnets and rams in the position of FIG. 2;

FIG. 4 is a sectional view similar to FIG. 3, but with the ram carried by one end of the bonnet moved toward the bonnet in response to initial operation of the hydraulic system for returning the bonnet and ram to the normal operating positon of FIG. 1;

FIG. 5 is another sectional view similar to FIG. 4, but upon further operation of the hydraulic system to move the bonnet back to the end of the body of the preventer for reattachment thereto; and

FIG. 6 is a rear end elevational view of one of the rams, as seen along broken line **6—6** of FIG. 3.

With reference now to the details of the above-described drawings, the blowout preventer shown therein, and designated in its entirety by reference character **10**, includes a main body **11** having a vertical bore **12** therethrough and guideways **13** therein extending laterally from opposite sides of the bore (only the left-hand guideway being shown). There is a flange **14** on each of the upper and lower ends of the main body **11** of the preventer and a circle of bolt holes **15** in each flange for connecting the preventer in the wellhead stack with its bore **12** forming a continuation of the bore through the other wellhead members. Thus, as well known in the art and as previously noted, various pipes are lowered through the bore **12** of the preventer during the drilling of the well, and it may be desirable during this operation to close the bore in the event of a blowout.

In order to provide this closure, a bonnet **16** is supported from each end of the body and detachably connected across the open outer end of the guideway **13** therein, and a ram **17** is carried from each bonnet on the inner side thereof for reciprocation within the guideway during normal preventer operation. Thus, in a manner to be described more fully hereinafter, each ram **17** may be moved away from its bonnet **16** for extension into the bore to engage at its inner end with the ram **17** movable within the opposite guideway. When the rams are so engaged, as shown in FIG. 1, they close the bore **12**, either by engagement with one another when the bore is open, or by engagement about a pipe within the bore as well as with one another on each side of the pipe. On the other hand, each ram may be moved toward its bonnet and thereby fully withdrawn from the bore to open same, as shown in FIG. 5. The rams **17** of the illustrated preventer are of the so-called "blind" variety in that they have flat inner ends for engaging one another across an open bore. Thus, the illustrated preventer would normally be connected with another preventer of the same construction, except that the rams thereof would be shaped along their inner ends for fitting about a pipe in the bore and thereby closing the open annular area of the bore. More frequently, the two preventers are combined in a single housing or body to reduce their over-all height.

Each bonnet **16** includes a body **18**, a head **20** connected by bolts **21** across the inner end of the body **18**, and a cylinder **19** formed partly in each of the bonnet body and head. When closed, the bonnet is, in turn, releasably connected across the outer end of the guideway **13** by means of bolts **22** having their inner ends **23** threaded into sockets in the outer end of the preventer body, as shown in FIG. 1. When the bonnet is so connected, a seal member **16*a*** carried in a recess on its inner side engages with the end of the preventer body about the guideway **13** so as to close the guideway and contain well fluid pressure therein.

A piston **25** reciprocable within each cylinder **19** has a rod **26** extending from its inner side through the head **20** for releasable connection with the ram **17**. More particularly, each piston **25** is sealably slidable within a liner **27** removably disposed within the cylinder **19**, and has a tail rod **28** extending from its outer side through the outer end of the body **18** of the bonnet **16**. Thus, as will be apparent from the foregoing, when hydraulic fluid is admitted to the outer side and exhausted from the inner side of the piston **25**, as indicated by the stipling in FIGS. 1, 2 and 3, the piston is moved inwardly toward the head **20** of the bonnet so as to move the ram away from the bonnet and into closed position; and, when such fluid is admitted to the inner side of the piston and exhausted from the outer side thereof, as indicated by the stipling of FIGS. 4 and 5, the piston is moved outwardly or away from the head **20** of the bonnet so as to move the ram **17** toward the bonnet and into its open position.

As shown, the body of the bonnet is sealed with respect to the head thereof by means of a seal ring **29** carried on the inner end of the body for engagement with the opposing face of the head. A pair of seal rings **29*a*** are carried about the outer diameter of the liner **27** for sealing with respect to the cylinder **19** on both sides of the separation between the body **18** and head **20** of the bonnet **16**. Also, a pair of seal rings **30** are carried about the opening in the outer end of the bonnet body through which the tail rod **28** extends, and spaced-apart seal members **31** and **32** are carried about the opening in the bonnet head **20** through which the piston rod **27** extends, thereby sealing off the cylinder **19**. More particularly, and as shown in FIGS. 1

and 2, there is a vent **33** in the head which extends from the rod opening intermediate the seal rings **31** and **32** to the exterior of the head. Thus, well fluid which might leak from within the guideway **13** past the seal ring **32** will be vented to the atmosphere, rather than leak past the seal ring **31** into the cylinder **19** and thus move the piston **25** rearwardly so as to prematurely retract the rams. On the other hand, if desired, the outer end of the vent opening **33** may be plugged, and plastic packing may be injected through plug **33a** into the rod opening intermediate the seal rings.

Each ram is of conventional construction, including a main body **34** having a first sealing member **34***a* extending across its inner end and along opposite sides and a second sealing member **34***b* extending across its top side to form a continuous seal with the side portions of the first seal member **34***a*. As previously described, the seal member **34***a* protrudes from the inner face of the ram body **34** so as to initially engage with the corresponding face of the seal member **34***a* of the opposite ram as the two rams are moved to closed position, as shown in FIG. 1. As can also be seen from this figure, however, the inner side of the piston **25** for actuating the ram is still spaced somewhat from the inner side of the cylinder **19**. That is, upon this initial engagement of the rams with one another, there is still some ram stroke remaining, so that the protruding inner ends of the seal members **34***a* may be compressed inwardly upon further inward movement of the ram pistons.

As well known in the art, this deformation of the rubber on the seal members **34***a* not only provides a tighter seal between the faces of the rams and about a pipe, but also deforms the seal members along the sides and over the tops of the rams into tighter sealing engagement with the guideways **13**. As is also well known in the art, and as also previously mentioned, when the rams are closed, well fluid has access to the space within the guideways on the outer ends of the rams so as to supplement the force of the pistons **25** in holding the rams closed. Thus, the lower sides of the rams do not seal with respect to the guideway, but in fact have recesses **35** which actually facilitate the passage of well fluid to the outer end of the ram.

As in the blowout preventer of the earlier patent, each bonnet **16** is mounted upon rods **36** extending from the opposite ends of the preventer body for movement of the bonnet toward and away from such body. More particularly, a piston **37** is carried on the outer end of each rod **36** for reciprocation relative to and within cylinders **38** formed in the bonnet on each opposite side of the cylinder **19** for ram piston **25**. Thus, upon detachment of the bolts **22** from the preventer body **11**, pressure fluid may be admitted to the outer sides of the pistons **37** and exhausted from the inner sides thereof, as indicated by the stipling in FIG. 3, so as to move the bonnet **16** away from the end of the preventer body and to its open position of FIGS. 2, 3 and 4. In this latter position, which is determined by the engagement of the inner sides of the pistons **37** with the inner ends of the cylinders **38**, the rams **17** carried by the bonnets are withdrawn from the guideway **13** so that they may be repaired and replaced, as desired. Then, when the pressure fluid system is reversed to admit pressure fluid to the inner sides of the pistons **37** and exhaust it from the outer sides thereof, as indicated by the stipling in FIGS. 4 and 5, the bonnets **16** are moved back into engagement with the ends of the preventer bodies and then reattached thereto by means of the bolts **22** so as to close the guideways and return the rams to positions therein for normal preventer operation.

As in the case of the ram piston **25**, each bonnet piston **37** is sealably slidable within a liner **39** carried within the cylinder **38** for removal and replacement upon removal of the cylinder head **20**. As in the liner **27** for the ram piston, each liner **39** carries a pair of seal rings **40** and **41** about its circumference for sealing with respect to the cylinder on each side of the separation between the body **18** and head **20** of the bonnet. Also, the rod **36** upon which each piston **37** is carried is surrounded by a seal ring **42** carried within the opening of the bonnet head through which the rod extends.

Each ram **17** is connected to the inner end of its piston rod **26** for movement therewith by means of a "T" slot **43** in its lower side adapted to fit over a "T" head **44** on the inner end of the rod. Rotation of the ram about the rod **26** when withdrawn from the guideway is prevented by a pair of pins **45** (see FIG. 6) extending inwardly from the inner side of the bonnet head **20** along opposite sides of the slot **46** through which the reduced portion **46***a* of the inner end of the rod **26** adjacent the head **44** extends. More particularly, as can be seen from FIG. 2, the pins **45** are of sufficient length to maintain a bearing relation against the sides of the slot **46** and thus hold the ram upright during its travel toward and away from the bonnet. In the open position of the rams, the pins will extend from the slot into the recess **35** on the bottom side of the ram. From the foregoing, it is apparent that upon its withdrawal from the guideway **13**, each ram may be lifted from its connection to the piston rod **26** and may be returned thereto merely upon lowering of its "T" slot **43** over the "T" head **44** on the rod.

The cylinder **19** for the ram piston and the cylinders **38** for the bonnet pistons are connected in parallel so that hydraulic fluid may be introduced into each of them from a common source. More particularly, and as in the case of the preventer of the earlier patent, hydraulic fluid from a suitable source is introduced into and exhausted from ports **47** on opposite sides of the body **11** and connecting with the bonnet cylinders by means of fluid passageways **47***a* within the rods **36**. Thus, one such port connects with a fluid passageway **47***b* in the body leading to the fluid passageway **47***a* extending through the upper rod **36**, as seen in FIGS. 3, 4 and 5, and the other port connects with another fluid passageway **47***b* in the body leading to the fluid passageway **47***a* through the lower rod **36**, as seen in the same figures.

The fluid passageway **47***a* in the uppermost rod **36** extends all the way through the rod for connection with the outer side of the piston **37** on the end of such rod, while the fluid passageway **47***a* in the lowermost rod **36** connects with radial ports **48** in such rod connecting with the exterior of the rod on the inner side of the piston **37** thereon. Thus, as will be more apparent from the description to follow, while hydraulic fluid is admitted through the uppermost passageway **47***a* to the outer side of upper piston **37**, it is exhausted from the inner side of the lowermost piston **37** into the lower fluid passageway **47***a*, and this will cause the bonnet to be moved away from the end of the preventer body so as to withdraw the ram from the guideway. For this reason the upper body port **47** may be termed the "opening port." On the other hand, when the hydraulic system is reversed so that hydraulic fluid is introduced into the lower passageway **47***a* and exhausted from the upper passageway **47***a*, the bonnet is caused to move toward the end of the preventer body so as to reinsert the ram **17** within its guideway **13** and bring the inner side of the bonnet into engagement with the outer end of the preventer body. In this sense then, the lower body port **47** may be termed the "closing port."

Hydraulic fluid introduced into the opening port and thus to the upper bonnet cylinder **38** is admitted to the cylinder **19** for the ram piston by means of a port **49** connecting the annular spaces in the cylinders **19** and **38** about the liners disposed therein. More particularly, the port **49** connects with the cylinder **19** outwardly of the seal rings **29***a* so that the hydraulic fluid passing therethrough will be effective on the outer side of the piston **25**. This, of course, urges the piston inwardly so as to move the ram away from the bonnet from which it is

carried, i.e., to bore closing position when the bonnet is connected to the preventer body in normal operation.

This same hydraulic fluid passes from the cylinder **19** into the cylinder **38** for the lower piston **37** by means of a port **50** connecting with the annular space between the liner **27** and the cylinder **19**. More particularly, the outer ends of the port **50** connect with the cylinders **19** and **38** outwardly of the seal rings **29***a* and **40**, so that such hydraulic fluid is effective on the outer side of the lower piston **37**. Thus, the bonnet is moved away from the outer end of the preventer body by the combined forces of the two bonnet actuators.

On the other hand, pressure fluid introduced into the closing port and thus to the lower bonnet cylinder **38** passes into cylinder **19** through a passageway **51** connecting with the lower cylinder **38** inwardly of seal ring **41** and with the cylinder **19** inwardly of the seal rings **29***a* about the liner **27**. Thus, such hydraulic fluid is effective over the inner side of the piston **25** to urge it rearwardly within the cylinder **19** and thus move the ram **17** toward the inner side of the bonnet. This same hydraulic fluid is admitted to the inner side of the upper piston **37** by means of another fluid passageway **52** connecting with the inner side of the piston **25** on the inner side of the seal rings **29***a* about the liner **27** and with the cylinder **38** for the upper bonnet piston inwardly of the seal ring **41** about the liner. Thus, the same hydraulic fluid which acts on the inner side of the lower piston **37** will also act upon the inner side of the upper piston **37** to move the bonnet toward closed position on the end of the preventer body under the combined forces of the two actuators.

In summary, hydraulic fluid introduced into the opening port (upper) will act upon the outer sides of the pistons **25** while fluid on the inner sides thereof is being exhausted through the closing port (lower). As a result, when the preventer is in normal operating position, as shown in FIG. 1, the rams are moved to closed position. On the other hand, upon a reversal of the pressure system so as to introduce pressure fluid into the closing port and exhaust fluid from the opening port, such pressure fluid acts over the inner sides of the pistons **25** to move the rams to the open position of FIG. 5.

When it is desired to move the bonnets to open positions for replacing or repairing the rams, as shown in FIGS. 2, 3 and 4, the bolts **22** connecting each bonnet to the preventer body are first released so as to detach the bonnet from said body. Then hydraulic fluid is admitted to the opening port connecting with upper passageway **47***a* and exhausted from the closing port connecting with the lower passageway **47***a*. As a result, and as above described, hydraulic fluid acts over the outer sides of the bonnet pistons **37** as well as the outer side of the ram piston **25**. Assuming that the rams are closed, as shown in FIG. 1, the hydraulic fluid is then effective to move the bonnet **16** away from the end of the preventer body and into the position of FIGS. 2, 3 and 4. Assuming, on the other hand, that the rams are in the open position of FIG. 5, the hydraulic fluid will first be effective to move the rams to closed position since the effective pressure area of the outer side of the piston **25** is considerably larger than the combined effective pressure areas of the outer sides of pistons **37**.

As previously mentioned, when the bonnet has been moved away from the preventer body, the ram **17** will be withdrawn from the guideway **13**, even though the ram is moved away from the bonnet due to the application of hydraulic fluid to the outer side of the piston **25**. That is, as can be seen from FIGS. 4 and 5, the rods **36** are of such length as to maintain the ram accessible between the bonnet and end of the preventer body in either the open or closed position of the ram. If it is desired to repair and replace the rams of a preventer connected beneath the illustrated preventer, the upper and lower bonnets are opened and then the direction of hydraulic fluid pressure in the upper system is reversed, i.e., hydraulic fluid is introduced into the closing port so as to move the ram piston **25** of the upper preventer outwardly and thus move the ram **17** to its open position against the inner side of the bonnet. In this respect, and as previously noted, since the inner side of the piston **25** has an effective pressure area which is considerably bigger than the combined effective pressure areas on the inner sides of the pistons **37**, this reversal of the direction of hydraulic fluid will first actuate the ram piston **25** without actuating the bonnet pistons **37**. Then, by means of suitable controls, the hydraulic system may be shut off to prevent movement of the bonnets toward the ends of the preventer body. As previously described, this movement of the upper rams toward the bonnets from which they are carried facilitates access to the rams of the lower preventer, at least when the latter are in their inner positions.

When the ram repair and replacement has been accomplished, and the rams have been previously moved against the bonnet, as above described and as shown in FIG. 4, the continued introduction of hydraulic fluid into the closing port will move the bonnet back into engagement with the end of the preventer body. On the other hand, when the ram **17** is spaced away from the bonnet, as shown in FIG. 3, this operation of the hydraulic system will first move the ram back to the inner side of the bonnet and then move the bonnet inwardly into engagement with the outer end of the preventer body.

In either case, however, the ram **17** is moved toward open position before the bonnet is moved into engagement with the outer end of the preventer body. As a result, and as will be apparent from FIG. 5, the rams will not be moved across the bore **12** of the preventer body until the bonnet has been moved up against the end of the preventer body. As a result, there will be no choking down of the well fluid in the bore, which would divert it past the bottom side of the ram and out the opening between the inner end of the bonnet and outer end of the preventer body.

Furthermore, this retraction of the rams toward their open positions as the bonnets move inwardly toward the preventer body permits both of the bonnets to engage with the end of the preventer body so that they may be reconnected thereto by means of the bolts **22**. That is, there is no problem of the rams initially engaging one another prior to the complete closure of the bonnet against the preventer body, as would occur, for example, if the rams were first moved into engagement with one another, as shown in FIG. 1. In this latter case, one or both of the bonnets would be spaced from the end of the preventer body with which it is to be connected by a distance equal to the uncompleted stroke of the bonnet piston or pistons **25**. As previously described, this would make the bolting of such bonnet or bonnets to the preventer body extremely difficult.

It is often desirable to provide a means for holding the rams in closed position during normal preventer operation when, for example, the hydraulic system may fail. Thus, in the aforementioned earlier Patent No. 2,912,214, a locking screw is extendible into each bonnet for engagement with the ram carried by the bonnet to hold it in closed position. This, however, requires a seal about the bonnet opening through which the screw extends in order to contain well fluid within the guideway for the ram. Also, if it were desired to repair or replace the lock screw, as, for example, with one which is remotely operable for use in inaccessible locations, it would be necessary to remove one end of the bonnet.

In accordance with the present invention, however, a lock screw **53** is threadedly received within a tubular carrier **54** having a flange **55** on its inner end for bolting as at **56** to the outer end of the bonnet **16** in surrounding relation to the outer end of the tail rod **28**. Thus, as will be obvious from the drawings, the lock screw **53** may be moved inwardly so as to bring its inner end **57** into engagement with the outer end **58** of the tail rod **28** when

the ram is in its closed position during normal preventer operation. As will be apparent from the foregoing, there is no necessity for a seal about the lock screw **53** inasmuch as the interior of the bonnet is maintained pressure-tight by seal rings **30** disposed about tail rod **28**. Furthermore, in the event the lock screw **53** is to be replaced by another type of ram locking means, such as one (not shown) operable from a remote location, the lock screw **53** is easily and quickly removable with the carrier **54** from the end of the bonnet to permit the other lock means to be connected to the bonnet in its place. It will also be noted that the carrier **54** protects the end of the tail rod against damage.

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 apparatus.

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. A blowout preventer, comprising a body having a bore therethrough and guideways therein extending laterally from opposite sides of the bore, a bonnet detachably connected across the outer end of each guideway of the body for closing same, a cylinder in each bonnet and a piston reciprocable in each cylinder, a ram connected to each piston on the inner side of the bonnet for reciprocation of the ram toward and away from the bonnet so as to open and close the bore when the bonnet is connected to the body in normal preventer operation, cylinder means in each bonnet in side-by-side relation to the first-mentioned cylinder and piston means reciprocable within said cylinder means, means supporting each bonnet from the body and connected to the piston means within the cylinder means in said bonnet for reciprocation of the bonnet, upon detachment thereof from said body, between its position across the outer end of the guideway and a position spaced therefrom so as to withdraw the ram on said bonnet from its guideway, and means including fluid pasageways in each bonnet for introducing pressure fluid into the cylinder and cylinder means therein so as to move the bonnet between said positions and to move the ram between bore opening and closing positions during normal preventer operation and toward the bonnet prior to movement of the bonnet to guideway closing position.

2. A blowout preventer of the character defined in claim **1**, wherein said supporting means is of sufficient length that, when each bonnet is moved to its position spaced from the body, the ram is withdrawn from its guideway when moved away from said bonnet.

3. A blowout preventer of the character defined in claim **1**, wherein said fluid passageways connect each of said ram cylinders with the cylinder means in the bonnet from which the ram is mounted.

4. A blowout preventer, comprising a body having a bore therethrough and guideways therein extending laterally from opposite sides of the bore, a bonnet detachably connected across the outer end of each guideway of the body for closing same, a ram mounted on the inner side of each bonnet for reciprocation of the ram between positions toward and away from the bonnet so as to open and close the bore when the bonnet is connected to the body in normal preventer operation, a cylinder in each bonnet and a piston reciprocable in the cylinder and connected to the ram, means mounting each bonnet for reciprocation of the bonnet with respect to the body, upon detachment therefrom, between its position across the outer end of the guideway and a position spaced therefrom so as to withdraw the ram from its guideway, cylinder means extending parallel to each of the first-mentioned cylinders and having piston means reciprocable therein and connected to the bonnet mounting means, and means for introducing pressure fluid into said first-mentioned cylinder and into the cylinder means including passageways connecting them with one another so as to move the bonnet between said positions and to move the ram between bore opening and closing positions during normal preventer operation and toward the bonnet prior to movement of the bonnet to guideway closing position.

5. A blowout preventer, comprising a body having a bore therethrough and guideways therein extending laterally from opposite sides of the bore, a bonnet detachably connected across the outer end of each guideway of the body for closing same, a ram mounted on the inner side of each bonnet, a cylinder in each bonnet and a piston reciprocable in the cylinder and connected to the ram for moving said ram toward and away from the bonnet so as to open and close the bore when the bonnet is connected to the body in normal preventer operation, means mounting each bonnet for reciprocation of the bonnet toward and away from the body upon detachment of said bonnet therefrom, cylinder means extending parallel to each said cylinder and having piston means reciprocable therein and connected to the bonnet mounting means for moving said bonnet between its position across the outer end of the guideway and a position spaced therefrom so as to withdraw the ram from its guideway, and means for introducing pressure fluid into each of said cylinder and cylinder means on opposite sides of the piston and piston means therein, including a passageway connecting one side of each ram piston with one side of the bonnet piston means so as to move the bonnet away from the body and the ram away from the bonnet, and a passageway connecting the other side of each ram piston with the other side of the bonnet piston means so as to move the bonnet toward the body and the ram toward the bonnet, said other side of the ram piston having a larger pressure responsive area than the other side of the bonnet piston means so that the ram is moved toward the bonnet before the bonnet is moved to guideway closing position against the body.

6. A blowout preventer of the character described in claim **5**, wherein said cylinder means comprises a pair of cylinders in the bonnet, one on each side of the ram cylinder.

7. A blowout preventer, comprising a body having a bore therethrough and guideways therein extending laterally from opposite sides of the bore, a bonnet detachably connected across the outer end of each guideway of the body for closing same, a ram mounted on the inner side of each bonnet, a cylinder in each bonnet and a piston reciprocable in the cylinder and connected to the ram for moving said ram toward and away from the bonnet so as to open and close the bore when the bonnet is connected to the body in normal preventer operation, means mounting each bonnet for reciprocation of the bonnet with respect to the body upon detachment of said bonnet therefrom, cylinder means extending parallel to each said cylinder and having piston means reciprocable therein and connected to the bonnet mounting means for moving said bonnet between its position across the outer end of the guideway and a position spaced therefrom, and means for introducing fluid into each of said cylinder and cylinder means on opposite sides of the piston and piston means therein, including a passageway connecting one side of each ram piston with one side of the bonnet piston means so as to move the bonnet away from the body and the ram away from the bonnet, and a passageway connecting the other side of each ram piston with the other side of the bonnet piston means so as to move the

bonnet toward the body and the ram toward the bonnet, the one side of each ram piston having a larger pressure area than the one side of the bonnet piston means and the other side of each ram piston having a larger pressure responsive area than the other side of the bonnet piston means, so that each ram is moved away from the bonnet before the bonnet is moved to guideway opening position and the ram is moved toward the bonnet before the bonnet is moved toward the body to guideway closing positions, each said bonnet being spaced from the body when moved away from it a distance sufficient to withdraw the ram from the guideway when the ram is moved away from the bonnet.

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