Aug. 2, 1960 H. ALLEN 2,947,508

BLOWOUT PREVENTER AND RAM THEREFOR

Filed April 6, 1956 2 Sheets-Sheet 1

Fig. 1

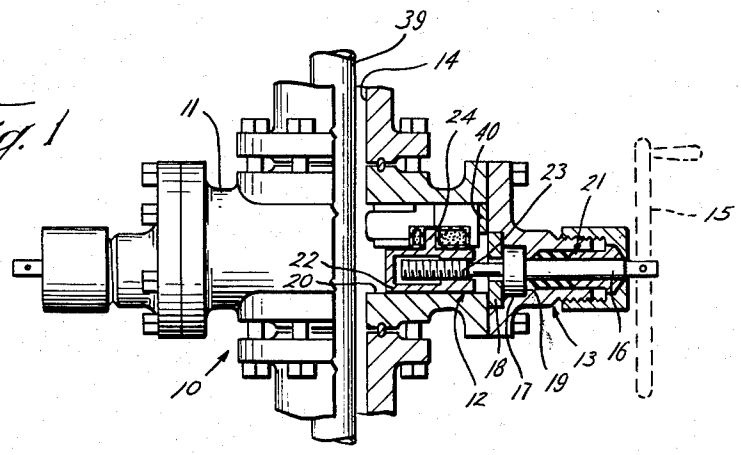


Fig. 3

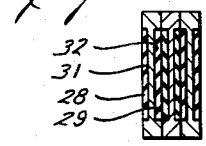


Fig. 2

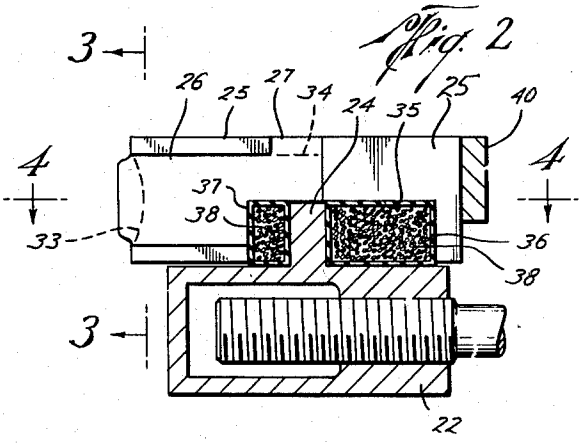
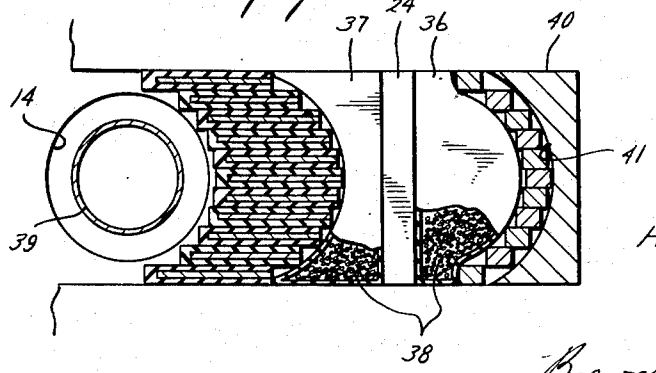


Fig. 4



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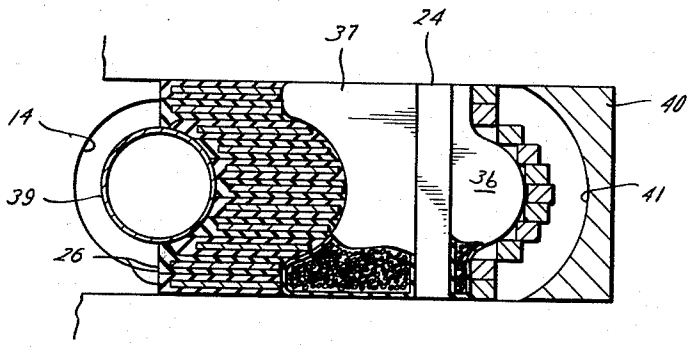


Fig. 5

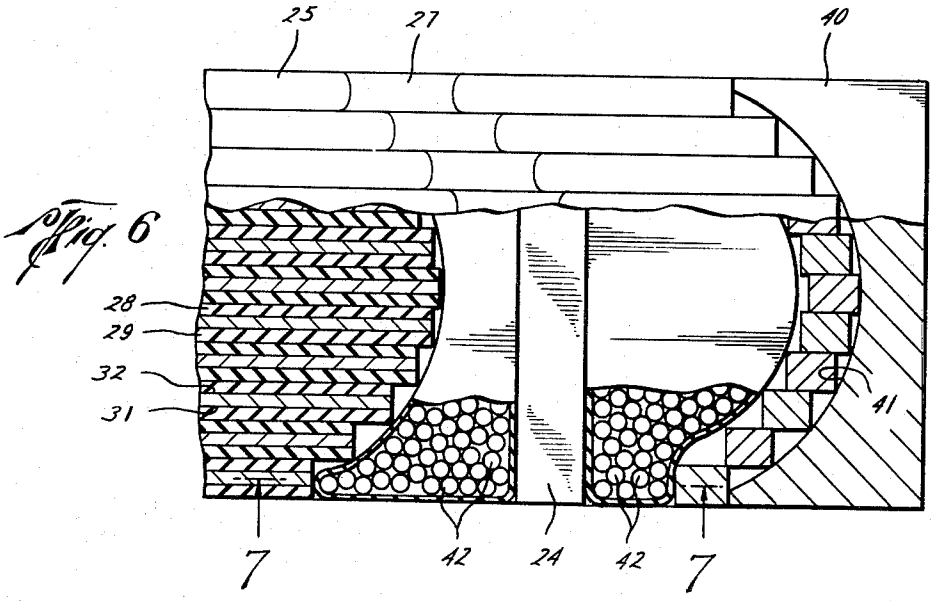


Fig. 6

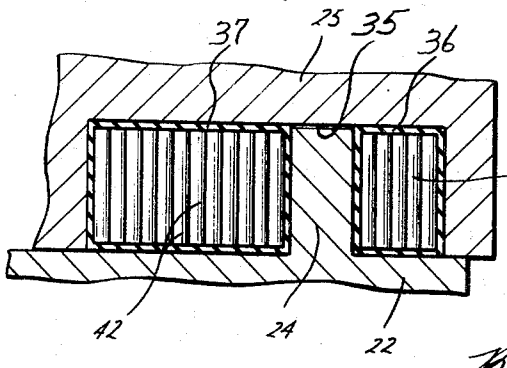


Fig. 7

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2,947,508

BLOWOUT PREVENTER AND RAM THEREFOR

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7 Claims. (Cl. 251—2)

This invention relates to control of well pressure while a well is being drilled, and more particularly to a blowout preventer which will seal in the well when the blowout preventer bore is empty as well as when a length of tubing or the kelly of a drill string is in the bore without storage of excessive stress energy in the ram.

Universal type of rams for use in blowout preventers to seal an open bore or to seal about a section of tubing or the kelly of a drill string require storage of a large amount of strain energy in distorting the ram packing to provide a seal. The amount of strain energy necessarily stored in deforming the packing is so large that manual operation is almost completely impractical.

It has recently been proposed that a universal ram be provided by a plurality of ram segments movable longitudinally relative to each other in combination with an equalizer for equalizing the pressure on the several ram segments while permitting them to move relative to each other and assume the contour of an object within the blowout preventer bore.

It is an object of this invention to provide a simple inexpensive equalizer for use with the multi-segment type of universal ram.

Another object is to provide an equalizer for use with a multi-segment ram of the universal type which is mechanical but acts in the manner of a fluid equalizer to hydraulically apply force equally to the several ram segments while permitting them to assume the contour of an object in the blowout preventer bore.

Other objects, features and advantages of the invention will be apparent from the specification, drawings and claims.

In the drawings, wherein like reference numerals indicate like parts and wherein there is shown by way of illustration two embodiments of this invention:

Fig. 1 is a view partly in elevation and partly in vertical cross section through a blowout preventer constructed in accordance with this invention;

Fig. 2 is a view in vertical cross section on an enlarged scale through the ram and back stop of the blowout preventer of Fig. 1 with one of the ram segments shown in elevation;

Fig. 3 is a sectional view along the lines 3—3 of Fig. 2;

Fig. 4 is a sectional view along the lines 4—4 of Fig. 2 with the ram retracted and the segments positioned to give a ram front contoured to the blowout preventer bore as shown;

Fig. 5 is a view similar to Fig. 4 showing the ram segments in sealing position about a pipe in the blockout preventer bore.

Fig. 6 is a view similar to Fig. 4 illustrating a modified form of equalizer; and

Fig. 7 is a fragmentary sectional view along the lines 7—7 of Fig. 6.

The blowout preventer indicated generally at **10** has a body **11** of more or less conventional form adapted to be flanged to a wellhead in the conventional manner.

Rams, one of which is indicated generally at **12**, are reciprocated in the body by a force transmitting mechanism indicated generally at **13** to move the rams into and out of engagement with each other or a drill string in the blowout preventer bore **14**.

The power transmission mechanism may be operated by hand wheel **15** or it may be operated by power as is well known to those skilled in the art. The power transmission shaft **16** is journaled for rotation in the body by journal **17** which is held against reciprocation by a stop ring **18** and a shoulder **19** in the body. A suitable packing arrangement indicated generally at **21** seals about shaft **16**.

It has been proposed that the segmented type of ram be used as a secondary ram in the nature of ram front packing as illustrated in the specification of M. R. Jones, Serial No. 576,637 filed on even date herewith, now Patent No. 2,855,172, granted Oct. 7, 1958 or as a ram in which the segments provide the entire seal for the ram. The latter form of ram is illustrated in the drawings but it will be understood that this invention may be used with either form of ram. Where the ram segments form the entire seal, they are preferably mounted on a carrier **22** which is reciprocated by the shaft **16** as by the threaded connection **23** between the shaft and carrier to move the carrier in ram bore **20** toward and away from the central blowout preventer bore **14**. The carrier is provided with an upstanding laterally extending flange part **24** which extends completely across the top of the carrier and acts as a pusher to reciprocate the ram segments with movement of carrier **22**.

Each of the ram segments is formed with a one-piece rigid body **25** provided with resilent material **26** at the nose of the ram and along at least one side face of the ram as well as at the top of the ram at a point spaced from the nose as indicated at **27**. Preferably the seal material **26** covers both side faces of the ram segment as indicated at **28** and **29** of Fig. 3. It is further preferred that the rigid body **25** be formed with grooves **31** and **32** in its opposite side faces, with a groove **33** in its nose and a groove **34** in the top of the body **25** all intercommunicating with each other and having the seal material **26** bonded therein. The exterior surface of the seal material is flush with the adjacent surfaces of the body except at the nose where it bulges outwardly to provide material to contact an object in the blowout preventer bore.

The opening and closing force for the ram segments is transmitted from carrier **22** through pusher **24** to the several ram segments through a mechanical equalizer which functions in a hydraulic manner. Each of the ram segment bodies **25** is provided with a notch **35** in its undersurface which extends laterally through the body and is adapted to receive pusher **24** with the distance between the side walls of notch **35** being considerably greater than the width dimension of the pusher **24** to provide spaces between the ram segments and pusher **24** on both sides of pusher **24**. When the rams are inserted in the ram bores these spaces are completely enclosed by the wall of the ram bore, the carrier **22**, pusher **24**, and the flexible walls formed by the ram segments **25**.

The enclosures so provided contain the mechanical equalizers for reciprocating the ram segments. The equalizer comprises a plurality of smooth wall elements which will move over each other in horizontal planes. Preferably these equalizer spaces are lined with resilient flexible wall envelopes **36** and **37**. However, it will be understood that such envelopes need not be resilient as long as they are flexible. Each of the envelopes **36** and **37** has a wall in force transmitting relationship with each ram segment and is filled with smooth wall elements through which a force may be applied from

pusher 24 to the ram segment. In one form of the invention, these elements are provided by granular material, preferably small steel balls or like members which will move over each other in the manner of a fluid to change their position when resistance to movement of the ram segments by pusher 24 is in unequal amounts as by one or more of the ram segments coming into abutment with an object in the blowout preventer bore. In other words, the action is hydraulic in nature. The mechanical equalizer will provide a substantially equal force on the several ram segments as the ram moves out into the blowout preventer bore while permitting the segments to assume the contour of an object in the blowout preventer bore. By "Filling" is meant to substantially fill that portion of the enclosures necessary for function of the equalizer. Preferably, the enclosures are no larger than necessary to perform this function. However, they could be larger and filled with equalizer elements from a number necessary for the equalizer to function, to a number necessary to completely fill the enclosures. By way of example reference is made to Figs. 4 and 5. Fig. 4 illustrates the retracted position of the ram segments. Fig. 5 illustrates the position of the ram segments when they are sealing about a tubing in the blowout preventer bore. In moving from the Fig. 4 to the Fig. 5 position, the ram segments are permitted to reciprocate relative to each other as they come into contact with an object in the central bore such as tubing 39. Very little force is exerted on the ram segments in engagement with the tubing until after all of the ram segments have been extended to strike either the tubing or the opposing ram. When all of the ram segments are held against further forward movement, pressure exerted through the granular material 38 in envelopes 37 will be exerted substantially equally on the several ram segments to force them into sealing engagement with the opposing ram and with the tubing in the central bore. As this pressure increases, the bulge of seal material 26 in the nose of each ram segment causes the seal material to flow rearwardly along each ram segment and press against an adjacent segment so that a seal will be formed between adjacent ram segments. The seal material exposed at the top of each ram segment in groove 34 is firmly pressed against the ceiling of the ram bore 20. The equalizer is preferably in contact with seal material 26 and compresses it to assist in providing the desired seals. A seal is thus made between a ram and the roof of a ram bore and between adjacent rams. The ram segment at the sides of the ram likewise engage the side walls of ram bore 20 and seal therewith to form a complete seal in the conventional manner.

On opening of the ram bore, the pusher 24 exerts a force on envelope 36 which is transmitted through granular material 38 to the several ram segments to cause them to move rearwardly in ram bore 20.

To reduce the necessary throw of the rams, it is desired to have the ram segments conform to the central bore 14 when retracted. For this purpose a stop 40 in the ram bore is provided in a position to engage the ram segments as they are withdrawn. Stop 40 has a curved abutment face 41 against which the several ram segments abut when they are in a retracted position, and due to the contour of abutment surface 41 are forced to assume the contour of the blowout preventer bore 14.

Referring to Fig. 6, there is shown a form of this invention in which rollers 42 replace the granular material 38 as a means of transmitting the opening and closing force to the rams while permitting them to move relative to one another. The rollers have a length dimension which will substantially fill the vertical distance between the body of the ram segments and the platform on top of carrier 22. The space within envelopes 36 and 37 is completely filled with these rollers so that they cannot tilt from their vertical axes. As these rollers are circular in a plane perpendicular to the blowout preventer bore 14 they will move relative to each other in transmitting a reciprocating force to the segments as the segments change their relative position. The use of rollers 42 will permit reciprocation of the ram segments without the reciprocating force tending to lift the ram segments vertically off the carrier 22 as will be present in the form shown in Fig. 1 through 4.

While the flexible wall envelopes are preferred with either illustrated form, it will be appreciated that they may be omitted where the size of the equalizing elements is such that the elements cannot force their way into cracks between the several elements of the enclosure. The flexible wall envelopes contain the equalizing elements when the rams are out of the ram bores and therefore simplifying assembly procedure, but this function might be performed in other ways.

From the above, it will be seen that the objects of this invention have been attained. There has been provided a simple inexpensive mechanical equalizer for a multi-segment ram which will equalize the pressure on the several segments while permitting them to move relative to each other. While the equalizer works in a hydraulic manner, it is mechanical in nature and lends itself to simple fabrication and assembly. It does not employ a liquid which might leak out and render the ram inoperative.

This invention may be utilized with a rotatable blowout preventer as shown in my application for Blowout Preventer Serial No. 576,629 filed on even date herewith, now Patent No. 2,877,977, granted March 17, 1959, or as ram front packing as shown in the application of Marvin R. Jones identified herein above.

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.

I claim:

1. A blowout preventer comprising; a housing; a central bore through the housing to be closed; a plurality of transverse ram bores radiating from the central bore; a ram in each ram bore including a plurality of ram segments arranged side-by-side across the ram and individually reciprocal toward and away from the central bore; said ram segments forming a pair of flexible walls, means sealing between the ram segments, and between the ram and ram bore, and between the ram segments and an object in the central bore when the segments are forced against said object to seal off the central bore, and sealing ram to ram when the central bore is empty and the rams are forced together; and means for reciprocating each ram segment including a force applying means, and a plurality of smooth wall solid members having a circular wall in at least the plane perpendicular to the axis of the central bore filling spaces formed between the force applying means and each of the flexible walls; said members in one of said spaces transmitting a closing force to the ram segments while permitting them to move relative ot each other and the ram fronts to abut when the central bore is empty or to assume the contour of an object in the central bore; and said members in the other of said spaces transmitting an opening force to the ram segments while permitting them to assume the contour of the blowout preventer bore.

2. A ram for a blowout preventer comprising a plurality of ram segments arranged side-by-side across the ram and having a side wall and nose section of resilient sealing material for sealing between adjacent ram segments, and means including a force applying means and a pair of envelopes filled with substantially spherical solid particles for distributing an opening and a closing pressure on the ram substantially equally to the ram segments, each envelope having a flexible wall in engagement with a ram segment and another wall in engagement with the force applying means, one of said envelopes transmitting a closing pressure to the ram segments while permitting them to move longitudinally relative to each other and the other envelope transmitting an opening pressure to each ram segment while permitting the segments to move longitudinally relative to each other.

3. A ram for a blowout preventer comprising, a carrier, an upstanding pusher attached to the carrier and extending transversely across the carrier, two envelopes filled with substantially spherical solid particles arranged one on each side of said pusher and extending the width of the carrier, a plurality of ram segments notched to receive said pusher and envelopes, said segments supported on the carrier with each envelope having a wall in force transmitting relationship with the segments to move the segments and another wall in force transmitting relationship with the pusher longitudinally upon movement of the pusher, each segment having a side wall and nose section of resilient sealing material for sealing between adjacent ram segments.

4. A blowout preventer comprising; a housing; a central bore through the housing to be closed; a plurality of transverse ram bores radiating from the central bore; a ram in each ram bore including a carrier operably connected to the exterior of the blowout preventer through a power transmission means; an upstanding pusher extending across the width of the carrier; said ram also including a plurality of ram segments arranged side-by-side and individually reciprocable toward and away from the central bore and having grooves extending laterally thereacross; said pusher received within said grooves to form spaces at the front and rear of the pusher; envelopes lining each of said spaces and filled with a plurality of smooth wall solid members having a circular wall in at least the plane perpendicular to the axis of the central bore; one of said envelopes having a flexible wall in abutment with the front of the pusher and the other of said envelopes having a flexible wall in abutment with the rear of the pusher; and means sealing between the ram segments, and between the ram and ram bore, and between the ram segments and an object in the central bore when the segments are forced against said object, and sealing ram to ram when the central bore is empty and the rams are forced together.

5. A blowout preventer comprising; a housing; a central bore through the housing to be closed; a plurality of transverse ram bores radiating from the central bore; a ram in each ram bore including a carrier operably connected to the exterior of the blowout preventer through a power transmission means; an upstanding pusher extending across the width of the carrier; said ram also including a plurality of ram segments arranged side-by-side and individually reciprocable toward and away from the central bore and having grooves extending laterally thereacross; said pusher received within said grooves to form spaces at the front and rear of the pusher; a plurality of smooth wall solid members filling said spaces and having a circular wall in at least the plane perpendicular to the axis of the central bore; and means sealing between the ram segments, and between the ram and ram bore, and between the ram segments and an object in the central bore when the segments are forced against said object, and sealing ram to ram when the central bore is empty and the rams are forced together.

6. A ram for a blowout preventer comprising; a carrier; an upstanding pusher on the carrier and extending transversely across the carrier; a plurality of ram segments notched to receive said pusher and form enclosures at the front and rear of the pusher; and a plurality of substantially spherical solid particles filling each of said enclosures to move the segments longitudinally upon movement of the pusher; each segment having a side wall and nose section of resilient sealing material for sealing between adjacent ram segments.

7. A ram for a blowout preventer comprising; a carrier; an upstanding pusher on the carrier and extending transversely across the carrier; a plurality of ram segments notched to receive said pusher and form spaces at the front and rear of the pusher; each segment having a side wall and nose section of resilient material for sealing between adjacent ram segments; and a plurality of cylindrical rollers arranged with their rotational axes parallel to the plane of the side walls of the segments and filling said spaces to move the segments longitudinally upon movement of the pusher.

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