May 22, 1956 M. R. JONES 2,746,710

BLOWOUT PREVENTER AND RAM THEREFOR

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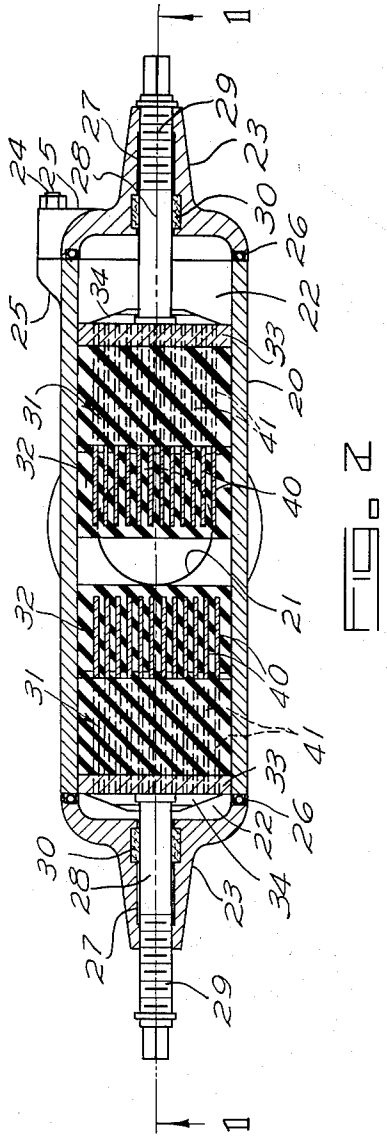


FIG. 2

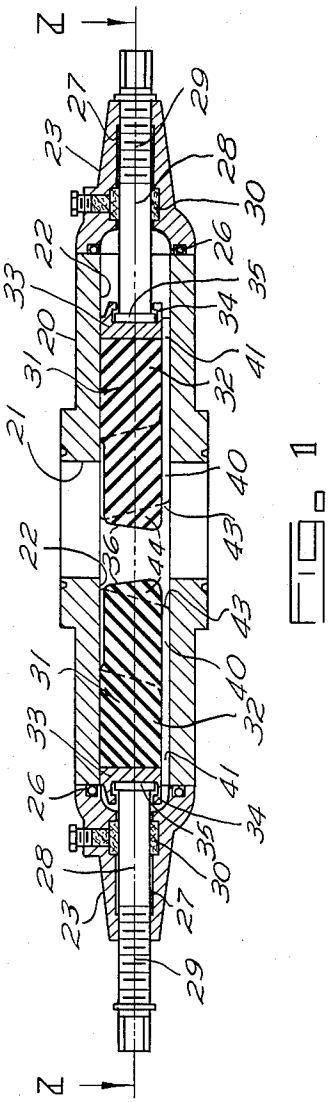


FIG. 1

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BLOWOUT PREVENTER AND RAM THEREFOR

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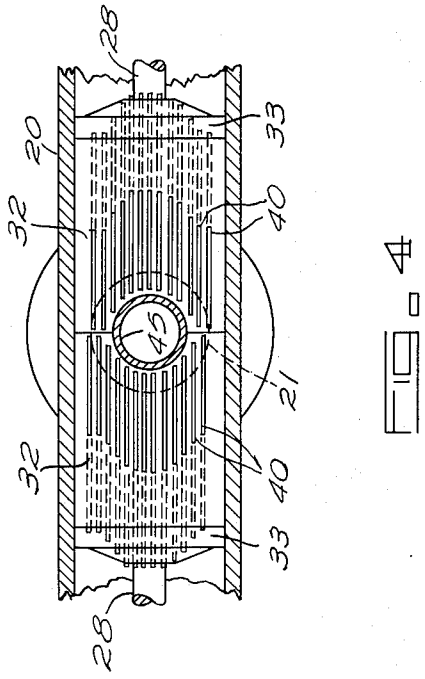


FIG. 4

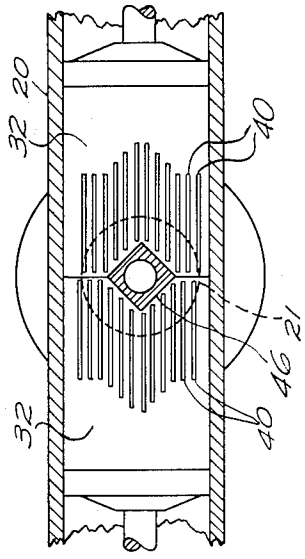


FIG. 6

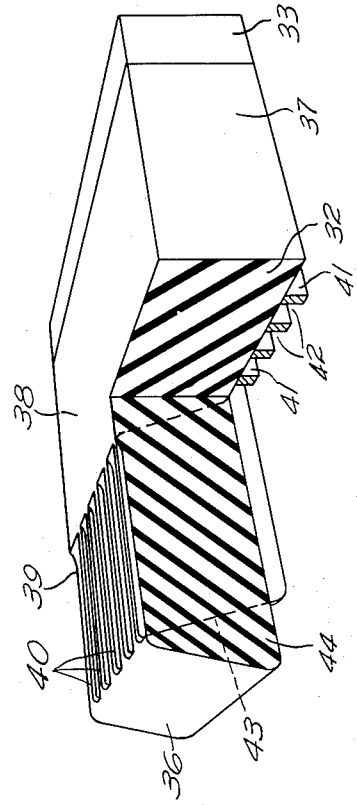


FIG. 5

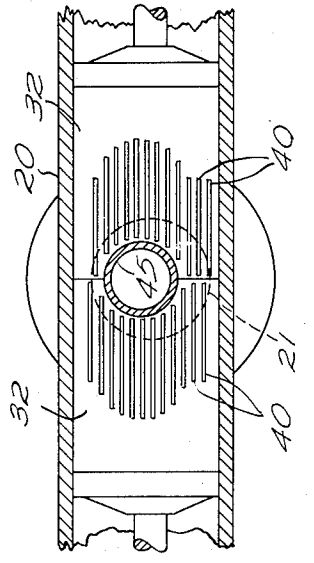


FIG. 7

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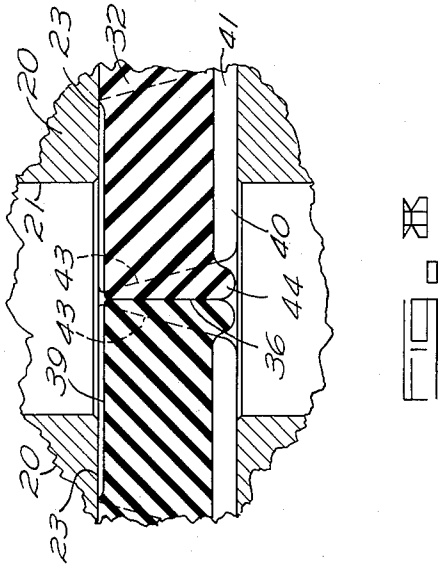


FIG. 8

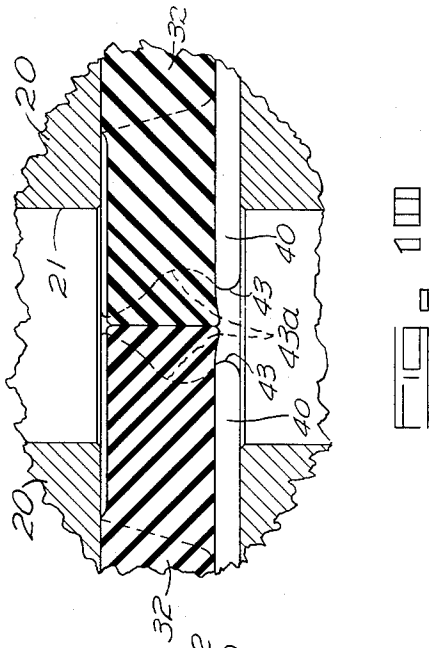


FIG. 10

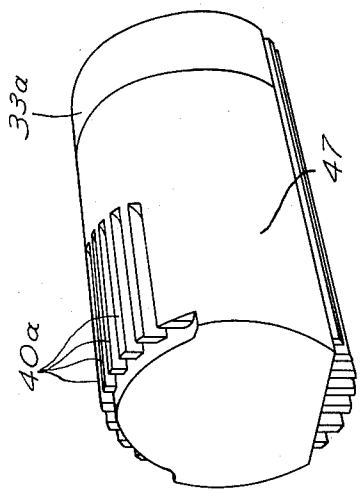


FIG. 7

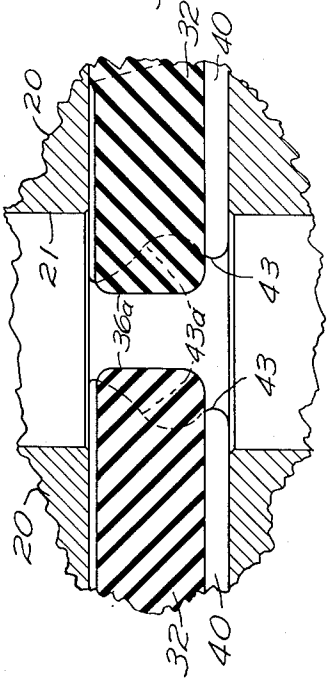


FIG. 9

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BLOWOUT PREVENTER AND RAM THEREFOR

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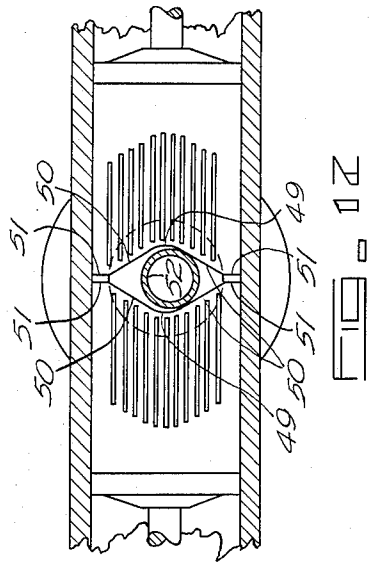


FIG. 12

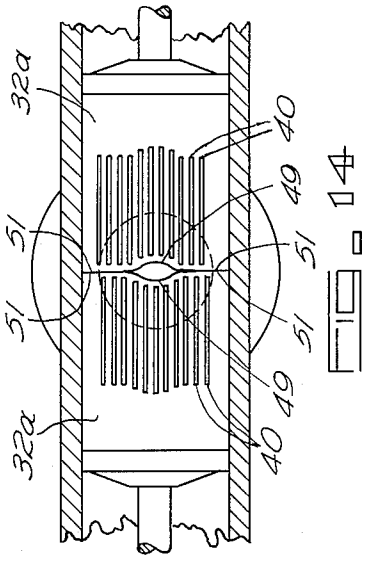


FIG. 14

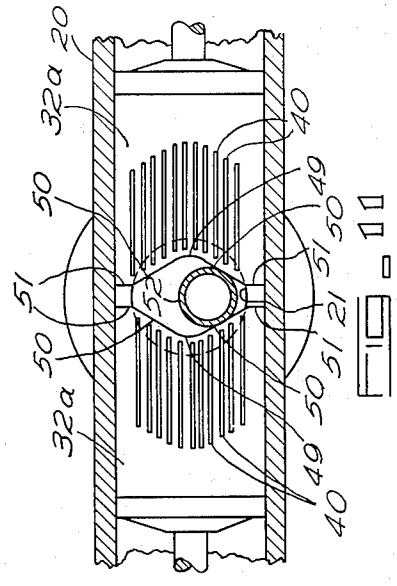


FIG. 11

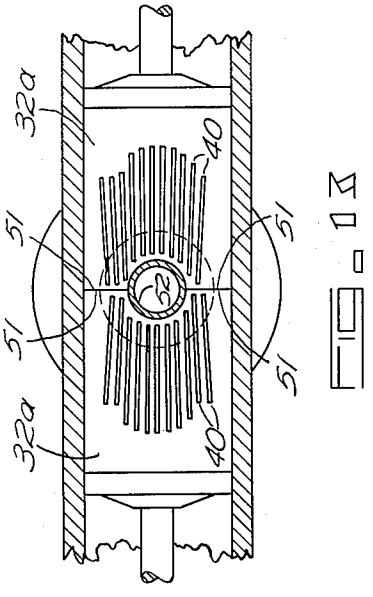


FIG. 17

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BLOWOUT PREVENTER AND RAM THEREFOR

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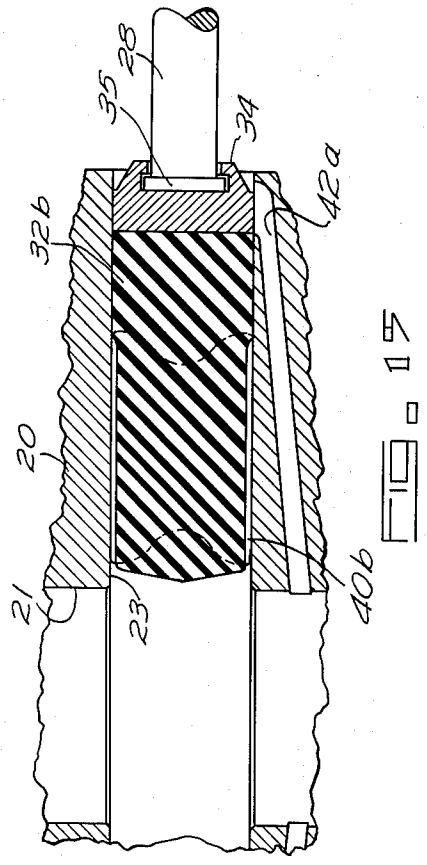


FIG. 15

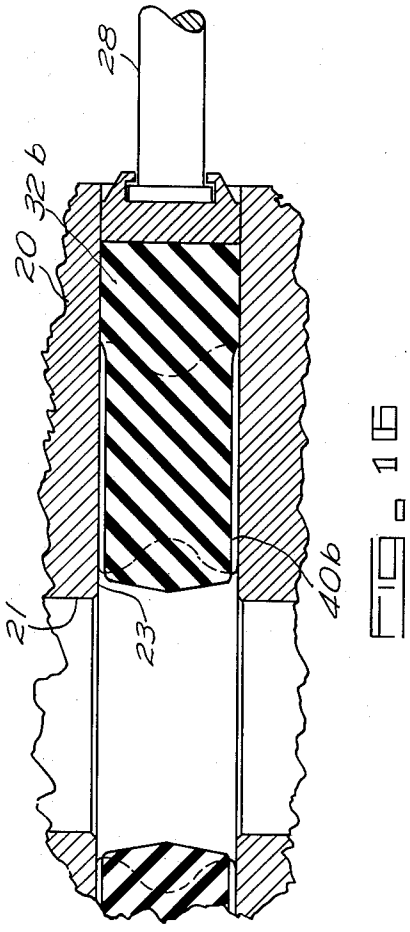


FIG. 16

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United States Patent Office 2,746,710 Patented May 22, 1956

2,746,710

BLOWOUT PREVENTER AND RAM THEREFOR

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Application October 29, 1952, Serial No. 317,490

13 Claims. (Cl. 251—2)

This invention relates to a valve or blowout preventer construction and particularly to the ram members thereof which are employed to close the passage through the preventer body.

Blowout preventers are conventionally employed in connection with the drilling and operation of wells, such as oil and gas wells, and are ordinarily mounted on the upper end of a well casing in position to close off the well bore in the event sudden increases in pressure within the well occur which would tend to cause blowouts of the well.

Blowout preventers conventionally include a valve body having a tubular passage registering with the bore of the well and complementary segmental valve members, commonly called rams, which are radially movable across the passage in end-abutting relation to close the passage. Such rams are ordinarily provided with complementary recesses in their abutting end faces which are shaped to complement the shape of the exterior of the drill pipe or other well tool which is being operated in the well bore, so that upon the appearance of conditions likely to lead to a blowout, the rams may be closed tightly about the inner string to thereby seal the well bore against such a blowout. Ordinarily, the recesses in the ram faces are semi-circular to correspond to the usual circular exterior of drill pipe or other pipe string extending into the well. In some cases, they may have polygonal faces as when necessary to close about polygonal surfaces of the Kelly joints of rotary drill strings. In still other cases where it is desired to provide a closure in the well bore when no tools are in the well, the abutting end faces of the ram may be substantially flat so as to be directly engaged entirely across their end faces. The latter form of ram is commonly termed a "blind" ram.

It will be understood that blowout preventers must ordinarily be designed to withstand often enormous pressures and to form effective seals between the rams and about the well tools irrespective of their shape, as even very small leaks under the very high pressures often encountered may result in cutting-out and destruction of the preventer which may be accompanied by destruction of the well and surrounding property and equipment as well as great hazard to personnel in the vicinity of the well.

Since the occurrence of a blowout cannot ordinarily be anticipated and blowouts may occur at any time while operations are being conducted in a well, there obviously will not be time or opportunity to change rams to match the shape of the particular well tool which may be in the well at the particular time or to install blind rams when there are no tools in the well. This means that a series of blowout preventers having different shaped rams must be included in the well head installation if complete protection under all conditions is to be assured, an arrangement which necessarily greatly increases the cost and complexity of such installations. Moreover, in many instances the pipe or other well tools may not be perfectly centered in the well when it is sought to close the rams about the tool and the rams must, therefore be provided with special centering devices or shapes which increase the cost and complexity of design of such rams.

Accordingly, the primary object of the present invention is to provide blowout preventers having ram construction which are of "universal" character, in that they are adapted to close about and form effective seals with well tools irrespective of their particular external shape or position and which may also serve as blind rams in the absence of well tools in the well bore.

An important object is to provide a blowout preventer ram which is self-adjustable to the shape of a well tool to be engaged thereby.

Another object is to provide a blowout preventer ram constructed of deformable resilient material, such as rubber and the like, having metallic reinforcing inserts molded therein so as to be automatically arranged in the ram body in accordance with the deformations of the ram body in order to provide effective reinforcement therefor under all conditions.

A more specific object is to provide a ram body constructed of deformable resilient material having molded therein a plurality of vertically disposed, spaced apart, parallel metallic reinforcing plates which are free to move and adjust themselves in accordance with the deformation of the ram body to thereby provide effective reinforcement irrespective of the final shape of the ram body.

Other and more specific objects and advantages of this invention will become more readily apparent from the following detailed description when read in conjunction with the accompanying drawings which illustrate several useful embodiments in accordance with this invention.

In the drawings:

Fig. 1 is a vertical sectional view of blowout preventer employing a ram construction in accordance with one embodiment of this invention, the view being taken generally along line 1—1 of Fig. 2;

Fig. 2 is a transverse sectional view taken generally along line 2—2 of Fig. 1;

Fig. 3 is a perspective view, partly in section, of one of the rams illustrated in Figs. 1 and 2;

Figs. 4, 5 and 6 are fragmentary top plan views of the blowout preventer rams illustrating their accommodation to well tools of different shapes;

Fig. 7 is a perspective view of another embodiment of a ram construction in accordance with the present invention;

Fig. 8 is a fragmentary vertical section illustrating the form of deformation occurring upon engagement of the end faces of a pair of rams of the kind illustrated in Fig. 3, particularly when employed as blind rams;

Figs. 9 and 10 are views similar to Fig. 8 showing non-engaged and engaged positions, respectively, of another ram embodiment in accordance with the present invention;

Figs. 11, 12 and 13 are fragmentary top plan views of another ram embodiment having end faces shaped to effect centering of an initially off-center pipe and showing the rams at several stages during closing about the pipe;

Fig. 14 is a view similar to Figs. 11, 12 and 13 illustrating the ram embodiment of the latter figures employed as blind rams and showing the rams in position just prior to attaining the fully closed position;

Fig. 15 is a fragmentary vertical sectional view of another modification of blowout preventer and ram in accordance with this invention;

Fig. 16 is a view similar to Fig. 15 of an additional

modification of blowout preventer construction in accordance with this invention.

Referring to the drawings and initially to Figs. 1, 2 and 3 thereof, there is shown a blowout preventer casing **20** of generally rectangular shape having a circular passage **21** extending vertically through the center thereof and adapted to register axially with the bore of well (not shown) when mounted in any suitable and generally conventional manner on a well casing. (Not shown.)

Generally rectangular ram chambers **22—22** extend from diametrically opposite sides of passage **21** through casing **20**. The outer ends of the ram chambers are closed by means of suitably shaped bonnets **23—23** which may be removably connected to the respective ends of the casing by any suitable and conventional means, as by bolts **24** extending through suitably apertured mating flanges or ears **25—25** mounted on the adjacent ends of the casing and bonnets. Sealing gaskets **26—26** may be installed between the engaging ends of the casing and the respective bonnets. Each of the bonnets has a longitudinally extending central stem passage **27** in which a stem **28** is mounted and extends from the exterior of each bonnet into the related ram chamber **22**. Stems **28** are arranged for reciprocation in passages **27** in any conventional and well known manner, which do not form any part of the present invention. For purposes merely of illustration, screw threads **29** are shown on the stems for engagement in the usual way with a correspondingly threaded member in the bonnets so that rotation of the stems will cause the stems to reciprocate through the bonnets. It will be understood that the stems may be reciprocated by any other conventional means, as by hydraulic or pneumatic means, all as well understood in the art. Packing **30**, of any suitable or conventional form, is arranged between stems **28** and the walls of stem passages **27** to provide fluid-tight seals therebetween.

A ram, designated generally by the numeral **31**, is slidably mounted in each of the ram chambers **22** for reciprocation relative to passage **21** by means of stems **28**.

Each of the rams **31**, illustrated in enlarged detail particularly in Fig. 3, comprises a block or body **32** composed of a deformable resilient material, such as natural or artificial rubber or like composition, of generally rectangular shape conforming generally to the cross section of the ram chamber. The rear or outer end of the ram has secured thereto a metallic head **33** of the same shape and dimensions as the rear end of body **32** so as to be circumferentially flush therewith, and is provided with a socket **34** in its outer end to receive an enlargement **35** mounted on the inner end of stem **28** to form an actuating connection between the stem and the ram.

The inner or forward end of each ram is provided with a flat end face **36** which, as illustrated, may be inclined downwardly and outwardly with respect to the end of the ram, but may be vertical if desired. The height or vertical thickness of ram body **32** may be made slightly less than the corresponding dimension of the ram chamber for purposes which will appear hereinafter. The width of the ram body will ordinarily be made such as to provide a snug sliding fit between the opposite sides **37** of the ram body and the adjacent side walls of chambers **23**. The overall length of ram body **32** will ordinarily be made such that it may be retracted into chamber **23** entirely out of passage **21**, as illustrated in the left-hand portions of Figs. 1 and 2. The upper face **38** of ram body **32** may be cut away on its forward portion **39** to reduce the level of this portion slightly below that of face **38**.

Molded or otherwise securely bonded within the resilient material composing ram body **32** are a plurality of flat metallic inserts **40** which are vertically disposed and arranged in parallel spaced-apart relation and which extend longitudinally from points slightly rearwardly of forward end face **36** to approximately the rearward end of portion **39**. Generally speaking, the length of inserts **40** will be made such that when the rams are in fully extended positions, at least a portion of the inserts will extend into chambers **23**. The vertical dimension of inserts **40** are preferably made substantially equal to that of chambers **23** so that the generally parallel upper and lower edges of the inserts will have a snug sliding fit with the upper and lower walls of chambers **23**. As noted previously, the vertical height or thickness of ram body **32** is made somewhat less than that of chamber **23** and this thickness is further reduced at its upper end at portion **39**. The inserts **40** will ordinarily be positioned in ram body **32** so that their upper edges will extend slightly above the upper surface of portion **39** while their lower edges will extend below the lower face of the ram body, as may best be seen in Fig. 3. The lower edges of inserts **40** are provided with integral elongated extensions or tongues **41** which extend rearwardly beneath the lower faces of the ram body and of head **33** and are free to move relative to these faces. Since, as noted, the lower edges of inserts **40** and tongues **41** extend beneath the lower face of ram body **32**, they may serve as vertical spacers between the lower face of ram body **32** and the adjacent bottom wall of chamber **23** and by their laterally spaced relation form a plurality of channels **42** providing communication between passage **21** and the portion of chamber **23** at the rear of head **33** for purposes to be described hereinafter. The forward edges **43** of inserts **40** may be downwardly and rearwardly sloped, as shown, to provide a nose section **44** on the inner end of the ram which is generally triangular in vertical section with its base along the lower face of the ram body and which provides a mass of plastic material which is relatively unreinforced and will, therefore, deform and flow more readily in response to pressure as will appear hereinafter

It will be understood that the lateral spacing of inserts **40** will be variable and will depend upon a number of factors. Generally speaking, the lateral spacing of the inserts will be such as to provide intervening sections of plastic material which will be strong enough to resist extrusion or blowing-out between the inserts by the pressures encountered while undergoing the requisite deformation and plastic flow for accommodation to the shape of the object to be sealed. This will necessarily involve consideration of a number of factors well understood by those skilled in the art and will be determined generally by the physical properties of the particular resilient plastic material employed, the pressures involved, the height of the inserts, and the vertical thickness of the intervening sections of the plastic material.

By means of the above-described construction the forward portions of the rams when urged toward each other, will engage an intervening object and by reason of their deformable and resilient character will readily accommodate themselves to the external shape of the object, particularly since the top, bottom and sides of the ram bodies are confined by the corresponding walls of chambers **22** and the rearward ends of the rams are confined by the heads **33** which urge the ram bodies toward passage **21**. The reinforcing inserts will be generally longitudinally displaced in accordance with the deformation of the forward portions of the ram bodies and their forward ends will assume positions about the object corresponding generally in configuration to that of the object about which the rams are compressed, as may be readily seen, particularly in Figs. 4, 5 and 6. At the same time the vertical position and lateral spacing of the inserts will be maintained so that the ram body will remain strongly reinforced internally and by engagement of the upper edges of the inserts with the upper walls of chambers **23** against upward displacement by pressure from the well. Tongues **41** are free to work beneath the ram bodies and heads **33** to accommodate the longitudinal displacement of the inserts as the rams are urged toward each other about the object. Channels **42** beneath the rams permit pressure from the well to flow into chambers **23** behind heads **33** and thereby aid in closing the rams as

soon as the first sealing engagement is made between the forward ends of the rams. Channels **42** will also permit escape of fluid which may become trapped in the ram chambers behind heads **33**, so that the rams may be readily retracted when desired. Under the pressures exerted in closing the rams about an object, the deformable material comprising the ram body and particularly that in nose portions **44** will be deformed and engage in plastic flow which will readily permit the end faces of the rams to accommodate themselves to the exterior configuration of the intervening object and form a strong fluid-tight seal about the object. When the pressure is relieved and the rams retracted, they will readily return to their original shape. The excess material provided in nose **44** also constitutes a reservoir, in effect, of such material which will compensate for wearing of the end faces of the ram.

Fig. 4 illustrates the positions of the rams and reinforcing inserts when the rams are closed about a pipe **45** which is centered in passage **21**. Fig. 5 is a view showing how the inserts accommodate themselves when sealing about pipe **45** when it is eccentrically positioned with respect to the axis of passage **21**. Fig. 6 illustrates the rams closed about a non-round object such as a conventional square Kelly joint **46** commonly used in rotary well drilling.

As illustrated in the several figures, the inserts **40** in one ram of each pair will usually be off-set or staggered laterally with respect to those of the other ram so that the adjacent forward ends of the inserts will be non-registering to thereby provide additional flexibility in the abutting end faces of the rams.

Fig. 8 illustrates the character of the deformation occurring in the nose portions **44** of the rams when the latter are strongly compressed, the excess material being thereby caused to flow into thick downwardly projecting lip portions from which excess material may, by plastic flow under pressure, move to fill any interstices or irregularities in and about an intervening object and in the ram chambers. Such excess material will also be available to compensate for wear of the end faces of the rams.

Fig. 7 illustrates another embodiment of ram in which the ram body **47** is made generally cylindrical rather than generally rectangular as in the previously described embodiment. The metallic head **33***a* will be of similar generally cylindrical shape. The metal inserts **40***a* will be varied in height and their upper and lower edges suitably shaped, as shown, so as to conform to the cylindrical periphery of the ram body. It will be understood that such cylindrical rams are adapted for use in conventional types of blowout preventers having cylindrical ram chambers. These cylindrical rams will function in the same manner as those previously described.

Figs. 9 and 10 illustrate a modification of the rams illustrated in Figs. 1 to 6 and 8. The modification consists in making the forward faces **36***a* of the rams vertical rather than forwardly inclined and providing recesses **43***a* in the forward edges **43** of inserts **40**. With this construction, when the rams are forced into abutting relation, recesses **43***a* cooperate to form a lateral channel for the deformable resilient material constituting ram bodies **32** through which the material may move readily in response to the applied pressure to accommodate itself about an intervening object.

Figs. 11, 12 and 13 illustrate another ram modification in which the forward faces of the rams are provided with central recesses **49** from each side of which extend forwardly and laterally tapering end walls **50—50** which merge at their side edges into flat sections **51—51**. The inserts **40** are positioned in the ram bodies **32***a* so that their forward ends will parallel the configuration of the forward end faces of the rams, as shown. In Fig. 11 a pair of rams in accordance with the present embodiment are shown engaging a pipe **52** which is initially off-center with respect to the axis of passage **21**. As the rams are urged toward each other about pipe **52**, sloping walls **50** coact with the pipe and with each other to force the pipe toward the central recesses **49** to thereby center the pipe between the rams. Fig. 12 shows the rams partially closed with the pipe urged to a position slightly in advance of the fully centered positon. In Fig. 13 the rams are shown fully closed about pipe **52**. It will be understood that side sections **51—51** of the rams will become engaged before closure is complete and as the closing pressure on the rams is increased, plastic flow of the material composing the ram bodies will urge wall **49—49** toward each other and about pipe **52** until a tight seal is formed about the pipe, the inserts **40** moving with the plastic flow to assume the general pattern shown in Fig. 13.

Fig. 14 illustrates the closing action of rams in accordance with the embodiment of Figs. 11 to 13 when employed as blind rams. As the rams are urged toward each other, the plastic flow of the ram material resulting from engagement of side sections **51—51** will fill recesses **49—49** until the forward faces of the rams are in sealing contact throughout their entire areas, Fig. 14 showing the compressed end faces slightly in advance of the fully closed position.

Fig. 15 illustrates another blowout preventer construction in which ram body **32***b* has a vertical thickness such as to provide a snug sliding fit between the upper and lower walls of chamber **22**. Inserts **40***b* have their upper and lower edges substantially flush with the upper and lower faces of the ram body and tongues **41** of the previously described embodiments are eliminated. In lieu of channels **42** formed in the previously described embodiments between the lower face of the ram body and the bottom wall of chamber **23**, channels **42***a* may be provided in casing **20** extending from passage **21** through the lower wall of chamber **23** to a point behind the ram. Channels **42***a* will serve the same function as channels **42** as set forth in connection with the earlier-described embodiments.

Fig. 16 illustrates a ram of the same form as ram **32** in a blowout preventer casing having no channels corresponding to channels **42***a*. This modification may be employed in cases where pressure-relief channels are not found necessary.

As will be evident from the foregoing, the present invention, in its several embodiments, provides improved blowout preventer rams possessing a high degree of plasticity and deformability which enables the rams to form strong fluid-tight seals in a well bore about objects, such as well tools, having varied peripheral shapes, and which are provided with strong internal reinforcement means which, in effect, float within the material composing the ram bodies and are freely movable therein in conformity with the deformation of the rams as they are compressed about such objects. The inserts will thereby maintain their reinforcement function in all positions in resisting pressures which might otherwise cause deleterious extrusion or destruction of the ram bodies. The rams in accordance with this invention are, therefore, of "universal" character in their self-adjustability for sealing about objects of varied external configurations.

It will be understood that various other changes and alterations may be made in the details of the several illustrative embodiments and modifications herein disclosed within the scope of the appended claims without departing from the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

1. A blowout preventer ram, comprising, a body composed of deformable resilient material having an object-engaging face on its forward end, and a plurality of free-floating flat metal plate members embedded in said body, said plate members being disposed in closely spaced-apart parallel relation substantially throughout the transverse section of said body and extending vertically substantially from the upper to the lower surfaces of said body and

longitudinally thereof from points adjacent said face to points intermediate the ends of said body, the arrangement of the plate members being such that when said face is engaged with an object the plate members will remain in substantially parallel relation.

2. A blowout preventer ram as defined in claim 1, wherein said body is substantially rectangular in transverse cross-section.

3. A blowout preventer ram as defined in claim 1, wherein said body is substantially circular in transverse cross-section.

4. A blowout preventer ram as defined in claim 1, wherein said object engaging face is a generally plane surface extending transversely across said forward end.

5. A blowout preventer ram as defined in claim 1, wherein said object-engaging face is a generally plane surface extending transversely across said forward end and is inclined forwardly and downwardly with respect to said forward end.

6. A blowout preventer ram as defined in claim 1, wherein said object-engaging face has a vertically extending medial recess therein having forwardly and laterally sloping side walls merging at their outer ends into flat end sections adjacent the opposite side edges of said face.

7. A blowout preventer ram as defined in claim 1, wherein the forward edges of said plate members are inclined downwardly and rearwardly.

8. A blowout preventer ram as defined in claim 1, wherein the forward edges of said plate members are provided with inwardly extending recesses.

9. A blowout preventer ram as defined in claim 1, having a rigid metal head secured to the rearward end of said body.

10. A blowout preventer ram as defined in claim 1, having a rigid metal head secured to the rearward end of said body, the configuration of said head conforming to the transverse cross-sectional configuration of said body.

11. A blowout preventer ram as defined in claim 1, wherein the rearward end of each of said plate members has elongated tongue portion extending rearwardly beneath the lower face of said body and movable with respect thereto.

12. A blowout preventer including a casing, a circular passage extending vertically through said casing and a pair of ram chambers extending from diametrically opposite sides of said passage, a pair of rams slidably mounted in said chambers for reciprocation therein relative to each other across said passage, each of said rams conforming in cross-sectional shape to that of said chambers and constructed of deformable resilient material having an object engaging face on its forward end, a plurality of free-floating flat metal plate members embedded in said body, said plate members being vertically disposed in closely spaced-apart parallel relation substantially throughout the transverse section of said body, said members extending longitudinally of said body from points adjacent said face to points intermediate the ends of said body and having a vertical height such that their upper and lower edges slidably engage the upper and lower walls of said chamber, the arrangement of the plate members being such that when said face is engaged with an object the plate members will remain in substantially parallel relation, a rigid metal head secured to the rearward end of said body, and means connected to said head and extending to the exterior of said casing for reciprocating said ram.

13. A blowout preventer as defined by claim 12 wherein said plate members in one of said rams are transversely staggered with respect to the plate members in the other of said rams.

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