United States Patent [19]

Canal

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[54] **RAM BLOCK**

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[73] Assignee: **The Rucker Company,** Houston, Tex.

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[52] **U.S. Cl.** **277/126;** 277/236; 148/34; 29/196.6

[51] **Int. Cl.** **F16j 15/00**

[58] **Field of Search** 277/126, 127, 185, 236; 148/34; 29/196.6, 196

[56] **References Cited**

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[57] **ABSTRACT**

A ram block for a blowout preventer which can be used successfully in a hydrogen embrittlement environment. The body of the ram block is made of an alloy having an upper hardness level of Rockwell 22 on the C scale (Rc 22), and is provided with an inner supporting edge of a soft, relatively stress-free, work-hardenable alloy having an upper hardness level of about Rc22 which is capable of rapidly hardening on slight deformation at least about Rc 35 and upon engagement with and deformation by a tool joint and the load of the drill or other string of pipe forms a cutting and supporting edge of a hardness level sufficient to bite into the tool joint and support the heavy weight of the drill or other string of pipe. The relatively soft, work-hardenable alloy, may be deposited in place by welding and is soft enough to be readily machined to the desired shape. A number of embodiments and examples of the invention is disclosed.

10 Claims, 11 Drawing Figures

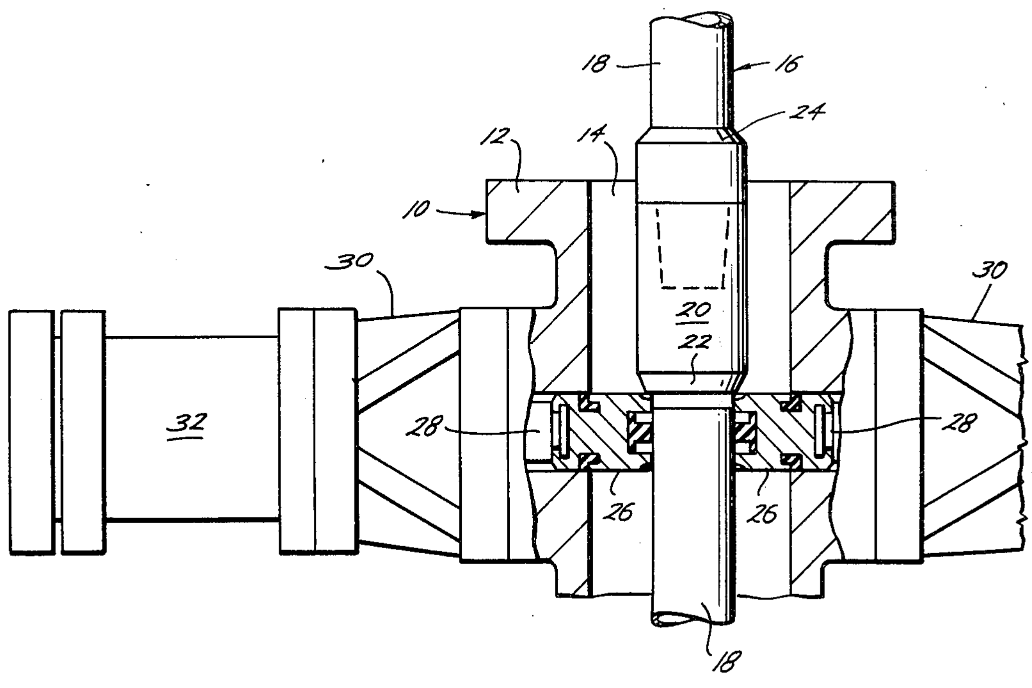
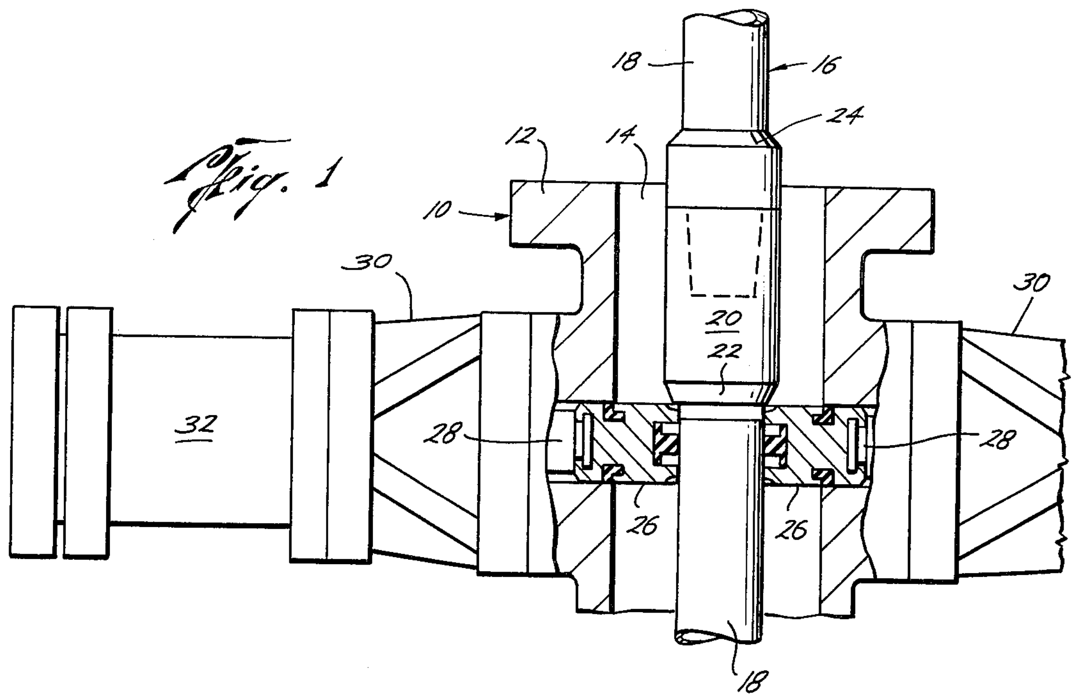


Fig. 1



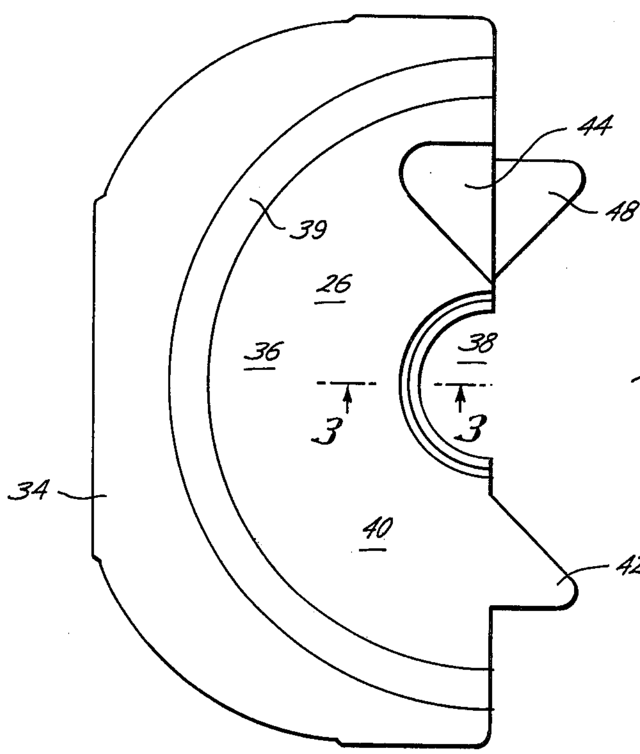
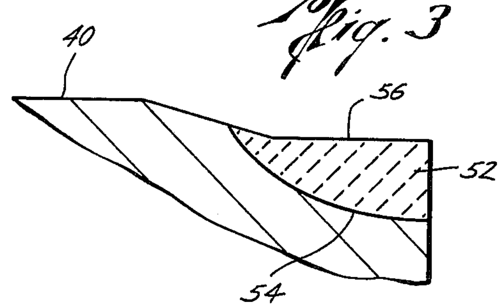
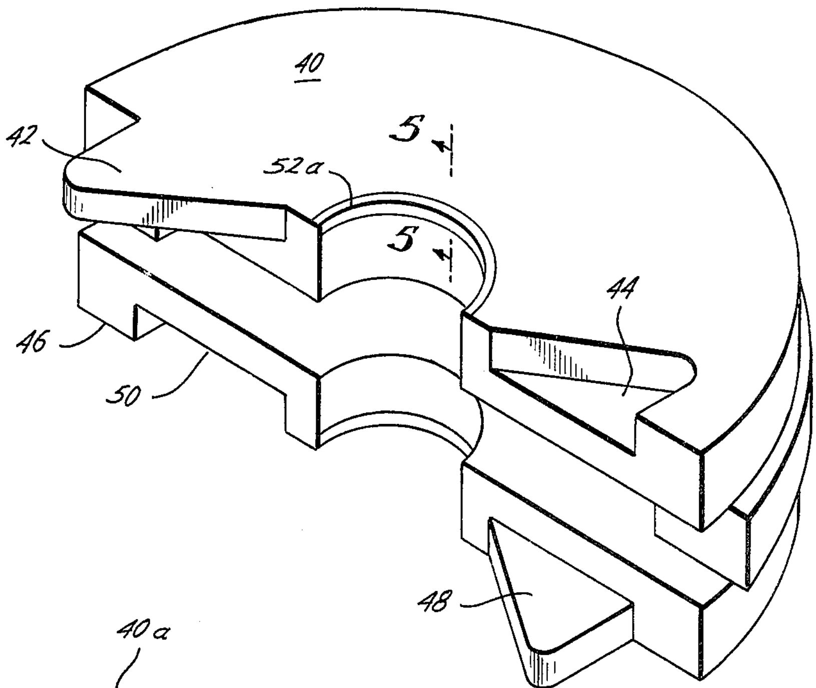


Fig. 2

Fig. 3





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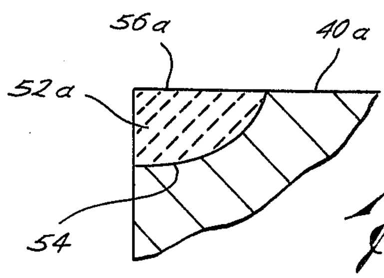


Fig. 5

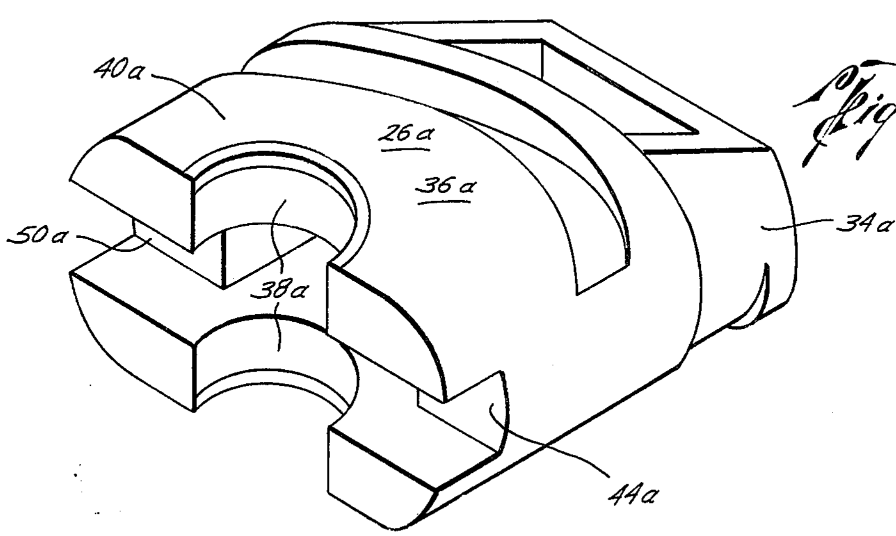


Fig. 6

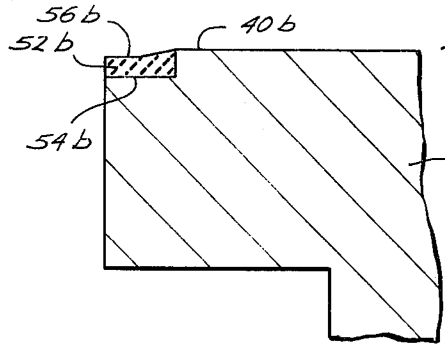


Fig. 7

Fig. 8

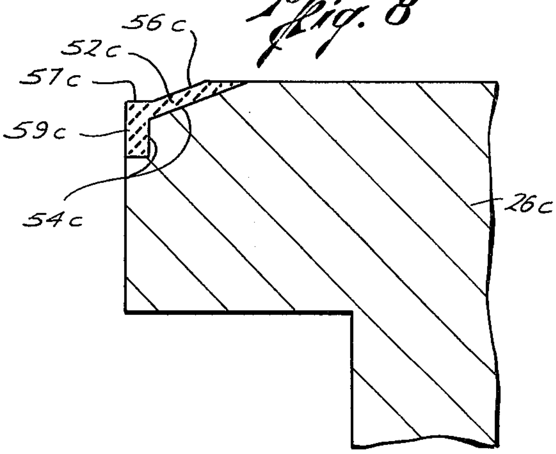


Fig. 9

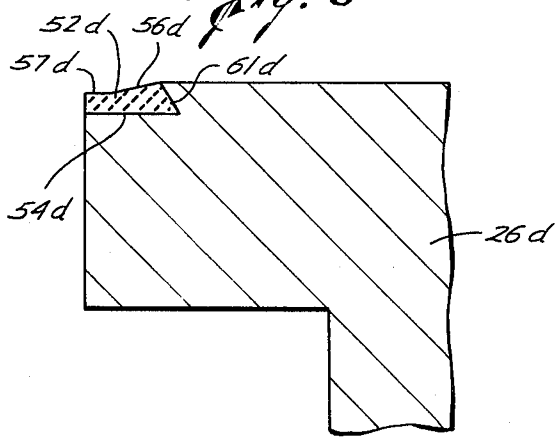


Fig. 10

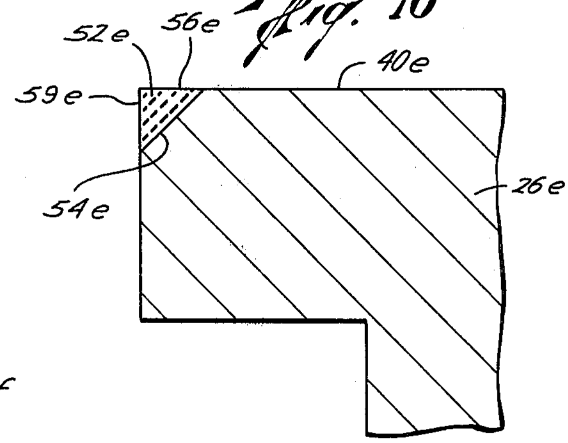
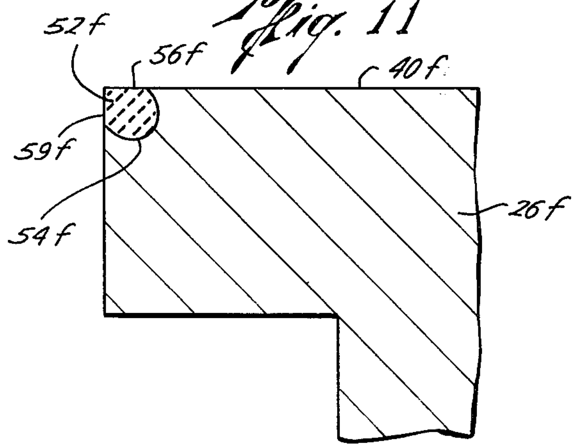


Fig. 11



RAM BLOCK

BACKGROUND OF THE INVENTION

Occasionally, in the drilling of oil and gas wells it is necessary, as an emergency procedure, to rely on the rams of a blowout preventer to support a string of drill pipe. Common practice is to close the pipe rams immediately below a tool joint and suspend the dill pipe load on the upper face of the ram blocks upon which the tool joint's shoulder is resting.

Deep drilling on land and especially offshore has resulted in very high load-carrying requirements for the ram blocks: for example, up to and in excess of 600,000 pounds of load. In drilling many wells, a hydrogen sulfide environment is encountered which causes hydrogen embrittlement and hence failure of ram blocks having a strength and hardness level sufficient to support these heavy drill string loads in a non-hydrogen embrittlement environment.

For example, when hydrogen sulfide contacts ram blocks made from a steel alloy having a strength and hardness level exceeding that of the tool joint, say Rc35-40, the hydrogen sulfide decomposes to form a metal sulfide and to liberate atomic hydrogen which diffuses into the metal lattice. The metal is then said to be hydrogen embrittled. If a metal is subjected to high stress, brittle failure occurs at stress levels many times lower than the stress required for failure in the absence of hydrogen.

It has been found that alloy steels not exceeding a hardness level of Rc22 may be used successfully in hydrogen sulfide environments since these alloys are tough and resist crack propagation and do not become hydrogen embrittled under stresses. Alloys of such a hardness level, however, have a strength and hardness level less than that of the tool joints in the drill string and, accordingly, upon engagement with a tool joint, these alloys are deformed by the tool joints and do not support the heavy drill string load. In order to support the drill string load, it is necessary that the hardness of the supporting edge and tool-engaging part of the ram block exceed the hardness of the tool joints in order to prevent deformation of the supporting portion of the ram blocks and to support the drill string load.

Ram blocks made of alloys of Rc45 have a strength and hardness which exceeds the hardness of the tool joints and thus are not deformed by and support the drill string load when engaged by a tool joint; however, such alloys are subject to hydrogen embrittlement when used in a hydrogen sulfide environment, and thus crack and fail under heavy drill string loads.

One solution to the problem is to make the ram blocks from exotic metals not subject to hydrogen embrittlement which do have a sufficient level of hardness to bite into the lower tapered shoulder of a tool joint and support the drill string without deformation of the load-supporting upper face of the ram block; for example, A-286, Waspalloy, Inconel, and René 41. However, these metals are extremely expensive.

What might appear to be a solution to the problem is to provide on a relatively soft ductile matrix, that is, one having an upper hardness level of about Rc22, a hard edge which is harder than the tool joint so that it will bite into the tapered lower end of the tool joint without losing its cutting edge or cutting ability. It would appear that such a hard supporting edge could be mechanically fastened to the ram block or friction

welded in place. Hard facing material of sufficient hardness to bite into the tool joint and support the drill string load could be welded on the relatively soft ram block. Such a hard supporting edge or hard facing, however, is subject to hydrogen embrittlement and fail when used in a hydrogen sulfide environment. In addition, hardfacing by welding is difficult to machine and cracks as it is being welded.

The foregoing problems and disadvantages are solved and overcome by the provision of, and the present invention is directed to, a ram block having a body of a relatively soft ductile material, that is, having an upper hardness level of Rc22, provided with a supporting inner portion of a relatively soft, work-hardenable alloy, which when relatively stress-free has an upper hardness level of about Rc22 and hence not subject to failure because of hydrogen embrittlement, is easily machined into the desired shape, and upon energizing the ram blocks to bring them into engagement with the tool joint, rapidly work-hardens sufficiently to indent itself into the tool joint and support the drill string load without substantial deformation. Thus, the supporting edge portion of the ram blocks is made of a work- or strain-hardenable alloy low enough in hardness in the welded condition to allow the metal to be easily machined and which upon slight deformation is capable of rapidly work hardening to stength levels of Rc35-40. At this hardless level the ram block supporting edge can "bite" into a normal tool joint and support the drill string load. The work-hardenable alloys almost immediately harden to a leval sufficient to bite into the tool joint upon very slight deformation by engagement with the tool joints so that there is only slight deformation of the work-hardenable supporting edges and, after work-hardening, the edges can bite into the tool joint and support considerable load: such as 600,000 pounds and more.

The inventor is not aware of any prior publications or uses of a ram block provided with a rather soft, stress-free deposit which is part of the supporting edge of a ram block and remains soft until the ram blocks are energized and upon engagement of the supporting edge with the tool joint, the surface of the supporting edge is deformed slightly and immediately becomes work-hardened sufficient to indent itself into the tool joint and support the drill string load. There are, however, publications which discuss work, precipitation or strain hardening of alloys and the structure of such alloys. For example, see *Dislocations and Plastic Flow of Crystals* by A. H. Cottrell, International Series of Monographs on Physics, published at Oxford, England, by the Clarendon Press and particularly Sections 12 and 14; and *Structure of Metals* by Barrett, Metallurgy and Metallurgic Engineering Series, 2d Edition, published by McGraw-Hill Book Company, Inc., New York, beginning at pages 221, 351 and 414.

SUMMARY

The present invention relates to ram blocks used in blowout preventers which may be used universally, that is, under all conditions, including conditions causing hydrogen embrittlement such as use in hydrogen sulfide environments, but yet when it is necessary to rely on the rams of the blowout preventer to support the drill pipe string, the ram blocks will bite into a tool joint of the drill string and support the drill string load without excessive deformation. More particularly, the present invention relates to such ram blocks which have a metal body having an upper hardness level of about Rc22, and hence not subject to failure by hydrogen embrittlement, provided with a relatively soft as deposited hardness which very easily meets the upper hardness level of about Rc22, is easily machinable, yet upon deformation is capable of work- or strain-hardening to a at least about Rc35, and upon engagement with and deformation by a tool joint and the load of the drill pipe string, work-hardens to level sufficient to bite into the tool joint without any further deformation and support the drill string load.

It is therefore an object of the present invention to provide ram blocks for use in blowout prevents capable of supporting substantial drill pipe weight, have the necessary hardness to bite into and support a drill pipe string by its tool joint and which can be used in a hydrogen sulfide environment.

A still further object of the present invention is the provision of ram blocks, the body of which is formed of an alloy having an upper a hardness level of about Rc22 and which has a relatively soft supporting edge which rapidly work- and strain-hardens upon slight deformation to a hardness level sufficient to bite into a tool joint and support an extremely heavy drill string load.

A still further object of the present invention is the provision of ram blocks for use in blowout preventers which are formed of an alloy having an upper hardness level of about Rc22 and which have supporting inner edges with a stress-free metal which stays in situ until the strength is needed and, by energizing the ram blocks to engage a tool joint, work harden upon slight deformation and indent themselves in the tool joint and have sufficient strength to support the drill string load.

Yet a further object of the present invention is the provision of such ram blocks in which a work-hardenable surface is deposited about the edge of the ram block to provide a work-hardenable supporting surface for the conditions of use and yet is soft enough when deposited to be readily machined without substantial cracking.

A still further object of the present invention is the provision of ram blocks for use in blowout preventers which may be used under all well conditions and which may be manufactured readily, easily and economically.

A further object of the present invention is the provision of ram blocks for use in blowout preventers, the body of which is formed of an alloy having an upper hardness level of about Rc22 and which has a weld deposit of work-hardenable material having an upper hardness level of about Rc22 and capable upon deformation of work hardening to a hardness level of at least about Rc35, machined to a desirable cutting edge on its inner surface and which upon deformation by engagement with a tool joint and the load of the drill string hardens to a level sufficient to bite into the tool joint of the drill string and to carry the heavy load of the drill string should it become necessary in the course of operation.

A still further object of the present invention is the provision of a ram block for use in blowout preventers which will support a heavy drill string load, should it become necessary in the course of operation, and which is not subject to hydrogen embrittlement when used in a hydrogen sulfide environment.

Other and further objects, features and advantages of the present invention are apparent from the abstract of the disclosure, the background of the invention, this summary, a brief description of the several views of the drawings, the description of the preferred embodiments, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a fragmentary, side view, partly in section, illustrating a blowout preventer having ram blocks according to the present invention shown supporting a drill string by engagement with a tool joint,

FIG. **2** is a plan view of one of the ram blocks, sealing rubber and ram holder illustrated in FIG. **1**,

FIG. **3** is a fragmentary, cross-sectional view taken along the line **3**—**3** of FIG. **2** and illustrates the work-hardenable supporting surface and edge of the ram block,

FIG. **4** is a perspective view of one of the ram blocks in FIG. **1**,

FIG. **5** is a vertical, sectional view of the work-hardenable supporting edge of the ram block of FIG. **4**,

FIG. **6** is a perspective view of another form of ram block having a work-hardenable supporting surface according to the invention,

FIG. **7** is a fragmentary, vertical sectional view illustrating a ram block having a modified form of work-hardenable supporting surface,

FIG. **8** is a view similar to that of FIG. **7** illustrating a still further modification of the work-hardenable supporting surface,

FIG. **9** is a view similar to that of FIGS. **7** and **8** illustrating a still further modification of a work-hardenable supporting surface,

FIG. **10** is a view similar to that of FIGS. **7**–**9** illustrating a still further embodiment of a work-hardenable supporting surface, and

FIG. **11** is a view similar to that of FIGS. **7**–**10** illustrating a still further embodiment of a work-hardenable supporting surface on a ram block

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings, and particularly to FIG. **1**, a conventional blowout preventer, generally indicated by the reference numeral **10**, is illustrated, which may be any conventional type blowout preventer, such as a Rucker-Shaffer LWS hydraulic blowout preventer. The blowout preventer **10** includes a central generally cylindrical body **12** having an enlarged passage **14** which is secured to conductor pipe or casing, not shown, used in drilling an oil or gas well. A drill string, generally indicated by the reference numeral **16**, and including the sections of drill pipe **18** connected by the tool joints **20** pass through the central opening or passage **14** in the body **12** of the blowout preventer **10** during normal operations. It is noted that the tool joints, or connections, **20** are of a larger diameter than the sections of drill string **18** and normally have tapered, outwardly-extending circumferential shoulders **22** and **24** at their lower and upper ends, respectively.

The blowout preventer **10** includes a pair of ram blocks or ram block assemblies **26** which are actuated to a closed and opened position by ram means, such as the ram shafts **28** movable within the ram bodies **30**, normally by a piston, not shown, in the ram piston chamber **32**. During normal operations, the ram blocks are in open position providing a generally unobstructed passage **14**, but upon actuation of the ram means the rams close the mating ram blocks **26** about the drill string, as shown in FIG. **1**.

No more description is given or deemed necessary of the blowout preventer and the manner of actuating the rams for opening and closing the ram blocks or ram block assemblies **26** as the ram blocks or ram block assemblies of the present invention may be used with any type of blowout preventer and may be actuated in any desired manner, many of which are well known to and used in the commercial drilling of oil and gas wells.

Referring now to FIG. **2**, a ram block assembly **26** is illustrated which is here illustrated as composed of three principal parts, a ram block holder **34**, the ram block **36**, provided with a generally arcuate opening **38**, and sealing member **39** fitted between the ram holder **34** and the ram block **36**.

In the ram blocks illustrated in FIGS. **2** and **4**, the upper surface **40** of the ram block **36** has an extending upper guide member **42** and a diametrically opposed upper recessed portion **44** for reception of the guide member on a mating ram block, not shown, making up a pair of ram blocks. Similarly, the lower face **46** is provided with a similar lower guide member **48** diametrically spaced from the upper guide member **42** and a lower space **50** diametrically spaced from the lower guide member **48** which receives an interfitting guide member, not shown, on the mating ram block of the pair of ram blocks.

The sealing member **39** provided on the circumference and the recess portion of the ram block **36** seals the cavity and around the drill pipe **18**. This effective seal is provided on actuating of the ram shafts **28** to close the ram blocks **26** together and about the drill pipe **18**, as illustrated in FIG. **1**. The ram blocks illustrated in FIGS. **2** and **4**, when without a work- or strain-hardenable inner supporting edge, are commercial ram blocks of Rucker-Shaffer.

The ram block may be made up of a series of parts in the form of an assembly or may be one integral piece and may take any desired shape. For example, and as illustrated in FIG. **6**, to which reference is now made, a ram block **26***a* is illustrated, which is a commercial ram block available on the market and sold by Cameron Iron Works of Houston, Texas. In this figure, the reference letter "a" has been added to numerals corresponding to like parts in Figures **1**, **2** and **4**. As illustrated, the ram block **26***a* is an integral member and is provided with the recessed portions **44***a* and **50***a* to receive a seal member, not shown.

No more description of ram block assemblies or ram blocks is given or deemed necessary as the present invention is applicable to all ram blocks and ram block assemblies which are provided with a generally circular opening, when in closed position, to provide an effective seal about the string of drill or other pipe in the well casing and which, when in open position, permit normal movement and operation of the drill string **16** and tool joints **20**.

For ram blocks to be used in a hydrogen embrittlement atmosphere, for example, in a hydrogen sulfide atmosphere, it is necessary that the steel alloy not exceed or have an upper hardness level of about Rc22. A tool joint, such as the tool joint **20** on the string of drill pipe **16**, as illustrated in FIG. **1**, has a hardness level well in excess of Rc22 and, accordingly, if it were necessary to support the heavy load of the drill string, such as weights up to and in excess of 600,00 pounds, by the ram blocks having an upper hardness level of about Rc22, the tool joint **20** would cut into and deform the inner surfaces **38** of the ram blocks **26** and thus would not support the heavy load of the drill string **16**. It is not feasible to form the ram blocks out of a steel alloy having a hardness level exceeding that of the tool joint, for example, Rc35-40, for use in hydrogen sulfide atmospheres because the hydrogen sulfide decomposes when it comes in contact with metal; for example, to form a metal sulfide and to liberate atomic hydrogen which diffuses into the metal lattice. The metal is said to be "hydrogen embrittled" when steels absorb hydrogen. When the metal is under a high tensile stress, such as when supporting a heavy load of a string of drill pipe, brittle failure does occur at stress many times lower than the stress required for failure in the absence of hydrogen. At normal temperatures, the hydrogen atom diffuses through the grain, tending to gather at the inclusion or other lattice defects. The metal fails in a transgranular mode (across the grain) under the influence of a stress. At higher temperatures, the absorbed hydrogen tends to gather in the grain boundaries and stress-induced cracking is then intergranular (between the grain). In either event, the ram blocks become brittle in the hydrogen sulfide environment and fail when under stress many times lower than the stress required for failure in the absence of hydrogen.

The use of a hard edge insert on the ram body at a hardness level above that of the tool joints becomes hydrogen embrittled when used in a hydrogen sulfide atmosphere and fails under heavy loads. Hardfacing the inner surface of the ram blocks provides too brittle a deposit and cracks during welding.

The present invention is based upon the surprising discovery that the base metal or matrix of the ram block can be made of an alloy having hardness level an upper or one not exceeding about Rc22 in surface hardness, to avoid stresses higher than the threshold for brittle failure, and be provided with a work-hardenable alloy deposit on its inner surface which, when in a relatively free-stress condition has hardness level an upper or one not exceeding about Rc22, but upon slight deformation due to stress the material will rapidly work harden to strength and hardness levels above that of the normal tool joint on a string of drill pipe, for example, to strength and hardness levels of Rc35-40. At these strength and hardness levels, the ram block edge surface can bite into a normal tool joint and support heavy drill string loads.

Preferably, the ram block is made of a low alloy steel with a controlled hardness preferably in the range of BHN 207–235 provided with a relatively soft, inner work-hardenable supporting edge surface.

For a discussion of alloy hardening, work hardening, precipitation hardening, the type of solid solutions important for the work-and strain-hardening concept, and the structure of cold worked metal, reference is made to the publications set forth in the section entitled "Background of the Invention." In general, however, any alloy which will harden on slight deformation and which can be deposited in a rather soft-stressfree deposit, that is, under an upper hardness level of about Rc22, is satisfactory in that when put into service in a hydrogen sulfide environment stays in situ until the increase in hardness and strength is needed and consequently does not fail because of hydrogen embrittlement. Upon energizing the ram blocks into engagement with the tool joints, the chemistry of the deposited alloy is such that the alloy immediately hardens to indent itself into the tool joint and by this action only becomes hard enough to repeatedly cut into a tool joint and to support the drill string load.

Terms such as "alloy hardening", "work hardening", "strain hardening", "precipitation hardening", "work hardenable", "strain hardenable" are used herein to describe the ability of an alloy to harden substantially upon deformation and are so used herein.

The following examples of work or strain-hardenable compositions satisfactory for use in the present invention are illustrated, in which all percentages are by weight.

EXAMPLE 1

Work-hardenable compositions satisfactory for use in the present invention are set forth in the following Table I.

TABLE I

Welding rod composition for the work-hardenable feature		
Carbon	0 – .10%	
Chrome	8 – 20%	
Molybdenum	10 – [illegible]	
Tungsten	2 – 6%	
Fe (Iron)	0 – 10%	residual
Silicon	1.2% max.	
Manganese	1.5% max.	
Nickel balance	41 – 78%	usually nickel should be 45% or greater to insure an austenitic structure

The compositions listed in Table I may be welded to the inner edge of the ram blocks in a relatively free-stress condition and may be readily machined to the desired shape. Upon slight deformation, these compositions almost immediately work harden or strain harden to a strength and hardness level of Rc35 and with very slight additional deformation have a strength and work hardness of about Rc45. These compositions may readily be in the form of a welding rod or wire for easy welding to the inner surface of the ram blocks.

EXAMPLE 2

In this example the work-hardenable alloy edge had a composition as set forth in the following Table II.

TABLE II

C=**.05**%, Cr=**15**%, Mo=**15**%, W=**4.5**%, Fe=**5**%, Si=**1.00** max.
Mm=**1.0** max., balance nickel
Residual P=**.010** max. S=**.005** max.

the as-deposited or welded hardness in relatively stress-free condition of the alloy in Table II was Rb90 (Rockwell B Scale). An average displacement of 0.015 inch increased the hardness to Rc35 and further work hardening increased the hardness to Rc45 with very little metal displacement.

EXAMPLE III

In this example the work-hardenable alloy edge had a composition as set forth in the following Table III.

TABLE III

C=**.02**%, Cr=**17.75**%, Mo=**15.8**%,
W=**3.80**%, Fe=**6.80**%, Si=**.80**%,
Mn=**.90**%, balance nickel.
Residual P=**.03**% S=**.025**%

The as-deposited or welded hardness in relatively stress-free condition of the alloy of Table III was Rb97. An average displacement of 0.020 inch increased the hardness to Rc34.2 and further work hardening increased the hardness to Rc39 with very little metal displacement.

EXAMPLE IV

In this example the work-hardenable alloy edge had a composition as set forth in the following Table IV.

TABLE IV

C=**.01**%, Cr=**15.6**%, Mo=**16.20**%,
W=**4.50**%, Fe=**5.00**%, Si=**1.05**%,
Mn=**1.02**%, balance nickel.
Residual P=**.035**% S=**.030**%

The as-deposited or welded hardness in relatively stress-free condition of the alloy of Table IV was Rb92. An average displacement of 0.030 inch increased the hardness to Rc34 and further work hardening increased the hardness to Rc41 with very little metal displacement.

From the foregoing examples and tables, a variety of alloys may be used, as desired, which work harden to the desired strength and hardness level upon engagement with and deformation by the drill string load.

The shape of the work-hardenable material may take a variety of forms, a number of which are illustrated in the drawings. For example, and with reference to FIG. **3**, the work-hardenable deposit **52** is illustrated in cross-section as having a curved base portion **54** with an upper or supporting surface **56** slightly below the upper surface **40** of the ram block **26**.

FIGS. **5, 7–11** illustrate a variety of shapes for the work- or strain-hardenable alloy forming the inner edge supporting surface, in which the reference characters "*a*", "*b*", "*c*", "*d*", "*e*" and "*f*" have been added to corresponding reference numerals for convenience of reference.

In FIG. **5**, the work-hardenable edge supporting surface **52*a*** is not recessed and has its upper surface **56*a*** flush with the surface **40*a*** of the ram block and is supported by a gently curved base portion **54**.

In FIG. **7** a still different form of work-hardenable insert **52*b*** is illustrated which is provided with an upper surface slightly lower or recessed with respect to the upper surface **50*b*** of the ram block **36*b***, but provided with a generally rectangular, viewed in cross-section, lower surface **54*b***.

A still further variation in shape or form of the work-hardenable insert **52*c*** is illustrated in FIG. **8** which has a downwardly and inwardly sloping upper surface **56*c*** terminating in the generally horizontal surface **57*c***, a vertical surface **59*c*** extending downwardly and provided with a lower inner surface having a vertical and upwardly extending legs **54*c***.

A still further variation in form or shape of the work-hardenable insert **52*d*** is illustrated in FIG. **9** which has the downwardly and inwardly sloping upper surface **56*d*** terminating in a generally flat horizontal surface **57*d*** and, when viewed in cross-section, has a generally straight lower surface **54*d*** and upwardly and inclined surface **61*d***.

With reference to FIG. **10**, a still further variation in shape or form of the work-hardenable inner edge insert

52*e* is illustrated which is generally of a triangular configuration, when viewed in vertical section, provided with the generally flat upper surface 56*e* level with and forming a continuation of the upper surface 40*e* of the ram block 26*e* and having a generally vertical flat side 59*e* and an angularly disposed lower inner surface 54*e* which forms what in effect is a base of a triangle when viewed in vertical section.

FIG. 11 illustrates a still further modification in the shape or form of the work-hardenable inner supporting insert 52*f* for the ram block 26*f* which is here illustrated as having a upper flat surface 56*f* level with and forming a continuation of the upper surface 49*f* of the ram block 26*f* and a vertical surface 59*f*, provided with a generally semi-eliptical inner surface 54*f*.

No more examples of the various forms or shapes the inner edge portion may take are illustrated as any desired shape or form may be utilized.

Preferably the work-hardenable inner edge is welded to a machined-out portion of the ram block and then is itself machined to the desired shape. The weld deposit may be one or many passes of weld deposit of the work-hardenable or strain-hardenable material until the desired thickness has been achieved. The proper cutting edge is then machined to the desired shape. The soft work- or strain-hardenable material may then be used in a hydrogen embrittlement atmosphere, such as in the presence of hydrogen sulfide, and will not fail due to hydrogen embrittlement. Yet, when it is necessary to support the drill pipe, the rams 28 are actuated to bring the ram blocks 26 into engagement with the drill string 18 and its tool joints 20, which upon slight deformation almost instantly and readily work hardens the material to a hardness level sufficient to bite into the shoulder 22 of the tool joint and support the drill string load.

The present invention therefore is well suited and adapted to attain the objects and ends and has the advantages and features mentioned as well as others inherent therein.

While a number of presently-preferred embodiments have been described and illustrated in the drawings for the purpose of disclosure, numerous changes in details and arrangements of parts may be made which are within the spirit of the invention as defined by the scope of the appended claims.

What is claimed is:

1. A ram block comprising,

a body portion formed of an alloy having an upper hardness level of about Rc22 and having an arcuate opening at its inner portion for engaging pipe and tool joints in a string of pipe, and

a supporting inner edge portion at its arcuate opening formed of a work hardenable alloy of an upper hardness level of about Rc22 when relatively stressfree and capable of work-hardening to a hardness level of at least about Rc35 upon deformation, engagement with and deformation by one of the tool joints by the load of the string of pipe work hardening the alloy sufficiently to indent itself into the tool joint.

2. The ram block of claim 1 where,

the body portion includes at least one guide member extending from its inner portion and at least one recessed portion for receiving a guide member or members of a mating ram block.

3. The ram block of claim 2 including,

sealing means disposed on the ram block for sealingly engaging the string of pipe.

4. The ram block of claim 1 where,

the work-hardenable alloy is welded to the upper surface of the arcuate opening, and is machined to shape.

5. In a blowout preventor for sealing off and engaging pipe and tool joints in a string of pipe,

a generally cylindrical body portion arranged to be connected to casing through which the string of pipe passes,

a pair of mating ram blocks arranged on opposite sides of the body portion so that when in open position the passageway through the body is open sufficiently to permit passage of the pipe and tool joints in the string of pipe and when in closed position engage one another to close the passageway through the body,

ram means operable to open and close said ram blocks,

each of said ram blocks comprising a body portion formed of an alloy having an upper hardness level of about Rc22 and provided with an inner arcuate opening, and

a supporting inner edge of the arcuate portion formed of a work-hardenable alloy of an upper hardness level of about Rc22 when relatively stress-free and capable of hardening to a hardness level of at least about Rc35 upon deformation, engagement with and deformation by one of the tool joints caused by the load of the string of pipe work hardening the alloy sufficiently to indent itself into the tool joint.

6. The invention of claim 5 where,

each of the pair of mating ram blocks has at least one guide member and a mating recess or recesses for receiving the guide member or members of the other arranged so that upon closing the ram blocks the guide member or members or each ram block is received in the recess or recesses of the other of the mating pair of ram blocks thereby guiding the pair of ram blocks into engagement about the tool joint and the string of pipe.

7. The invention of claim 6 including,

seal means on each of the ram blocks arranged to seal the space between engaging faces of the ram blocks and about the string of pipe and between the ram blocks and the body.

8. The invention of claim 5 where,

the work-hardenable alloy is welded to the body portion to provide the upper surface, and

is machined to shape.

9. The ram block of claim 1 where,

the work-hardenable alloy comprises, by weight,
from about 0 to about 0.10 percent carbon,
from about 8 to about 20 percent chromium,
from about 10 to about 20 percent molybdenum,
from about 2 to about 6 percent tungsten,
from about 0 to about 10 percent iron,
up to about 1.2 percent silicon,
up to about 1.5 percent manganese,
from about 41 to about 78 percent nickel.

10. The invention of claim 8 where the work-hardenable alloy comprises, by weight,
from about 0 to about 0.10 percent carbon,
from about 8 to about 20 percent chromium,
from about 10 to about 20 percent molybdenum,
from about 2 to about 6 percent tungsten,
from about 0 to about 10 percent iron,
up to about 1.2 percent silicon,
up to about 1.5 percent manganese,
from about 41 to about 78 percent nickel.

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