United States Patent

[11] 3,561,526

[72] Inventors Leonard E. Williams, Jr.;
Maurice J. Meynier, III, Houston, Tex.

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[73] Assignee Cameron Iron Works, Inc.
Houston, Tex.

[54] **PIPE SHEARING RAM ASSEMBLY FOR BLOWOUT PREVENTER**
4 Claims, 9 Drawing Figs.

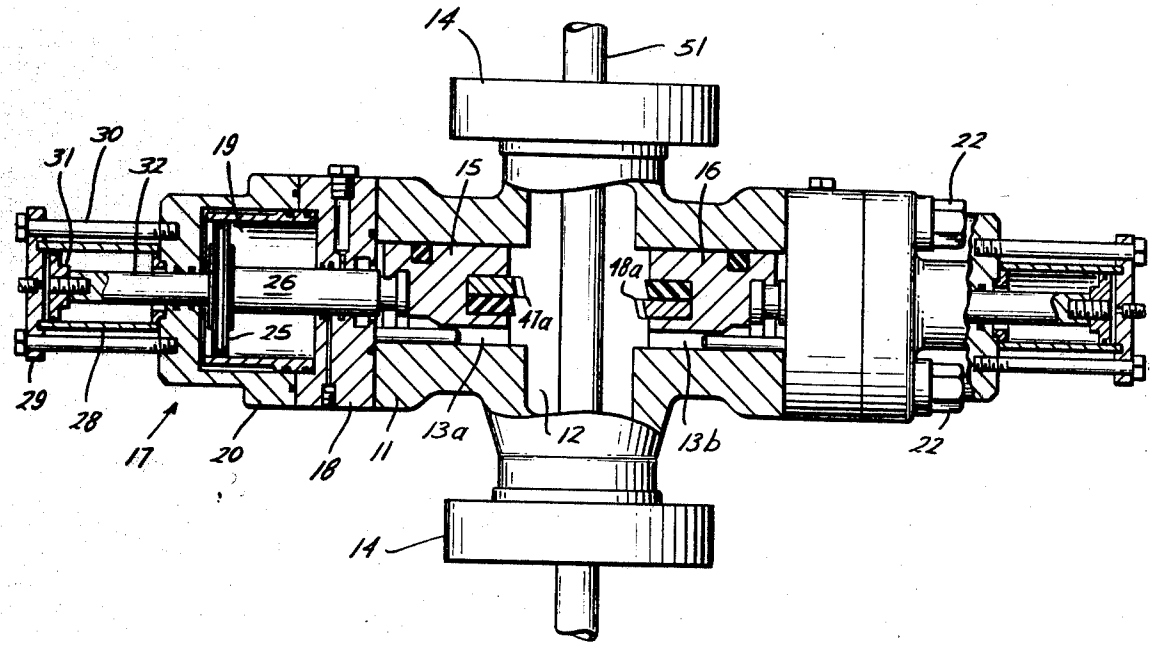
[52] U.S. Cl. 166/55, 137/68; 83/639; 251/1
[51] Int. Cl. E21b 29/00
[50] Field of Search 166/.5, 55, 55.1; 251/1; 137/67, 68; 83/639

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Primary Examiner—David H. Brown
Attorney—Hyer, Eickenroht & Thompson

ABSTRACT: A knife blade is carried by each of the two rams of the ram assembly of a blowout preventer. The knife blades overlap when the rams are closed with the cutting edge of one knife blade passing just below the cutting edge of the other knife blade to shear a pipe string extending through the preventer. Each knife blade engages a seal member on the other ram, when the rams are closed, to form two vertically spaced seals between the engaging faces of the rams.



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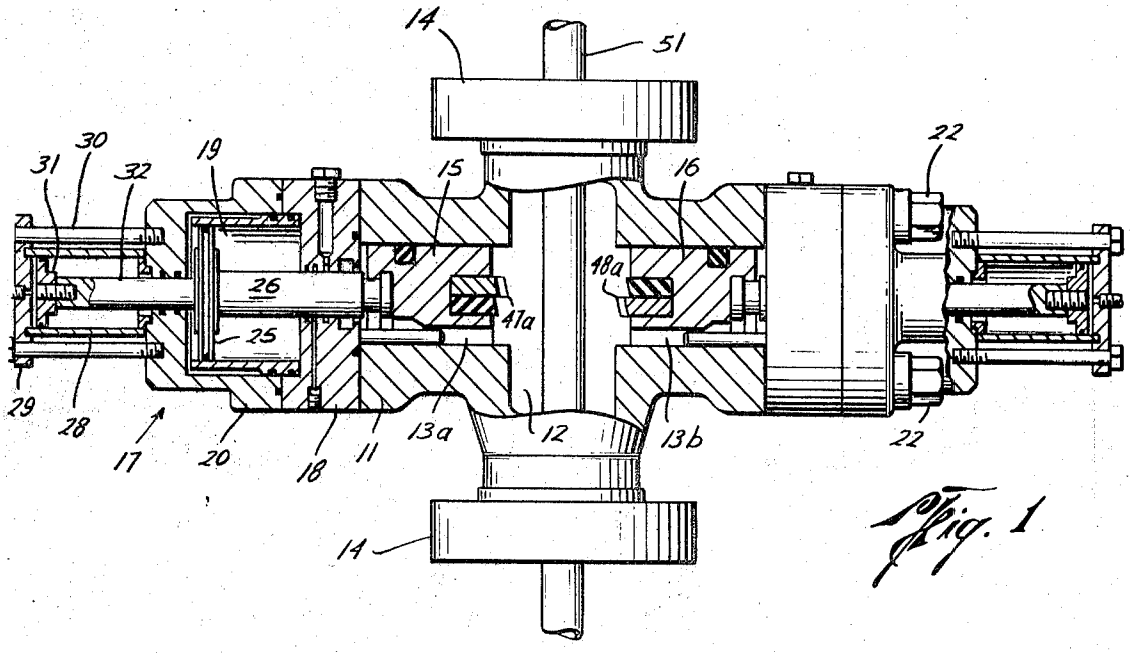


Fig. 1

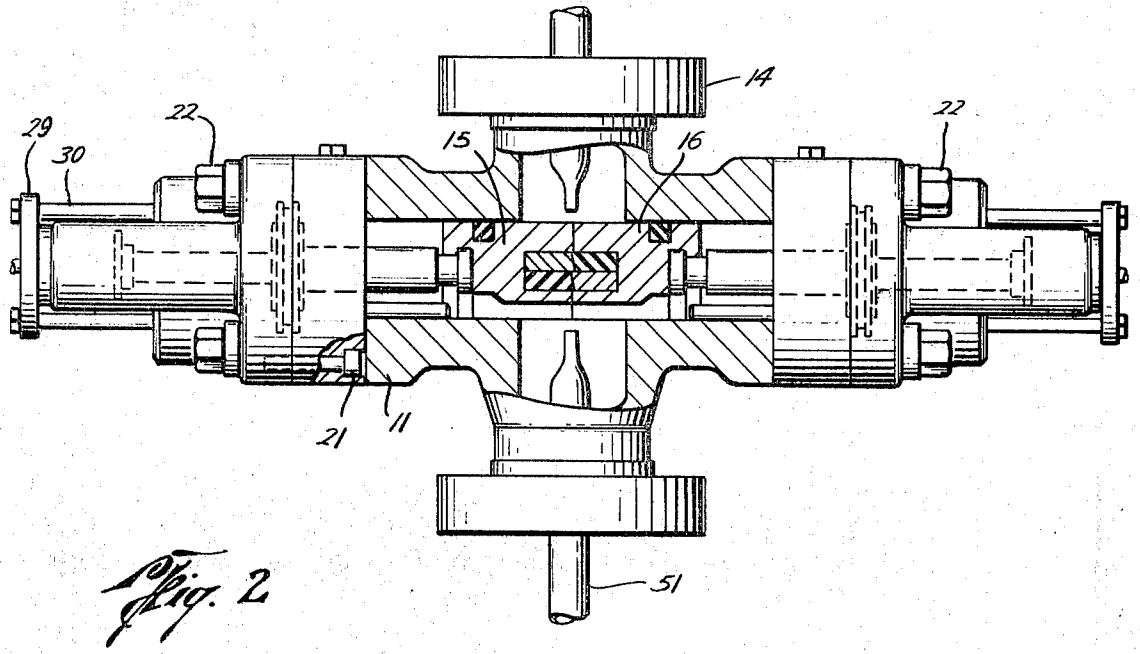


Fig. 2

Leonard E. Williams, Jr.
Maurice J. Meynier, III
INVENTORS

BY Hyer, Eickenroht & Thompson

ATTORNEYS

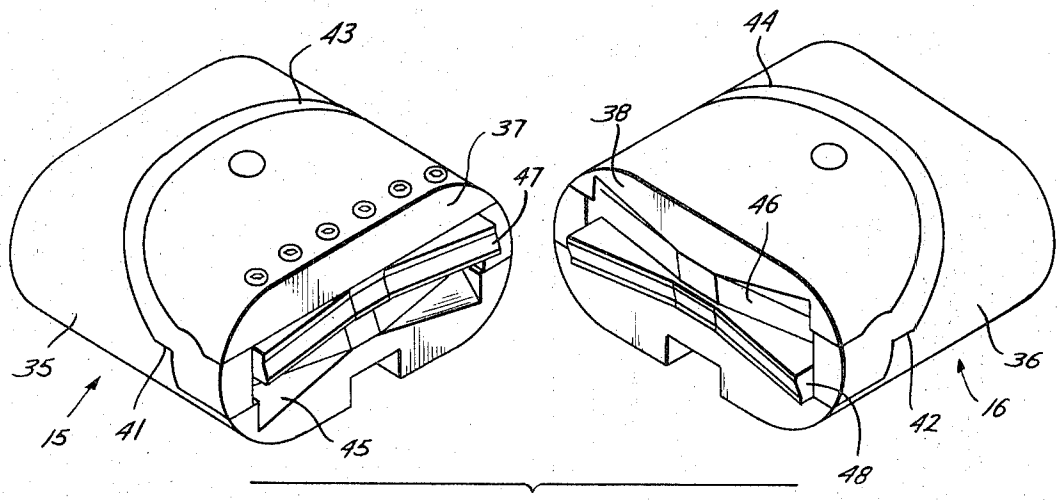


Fig. 3

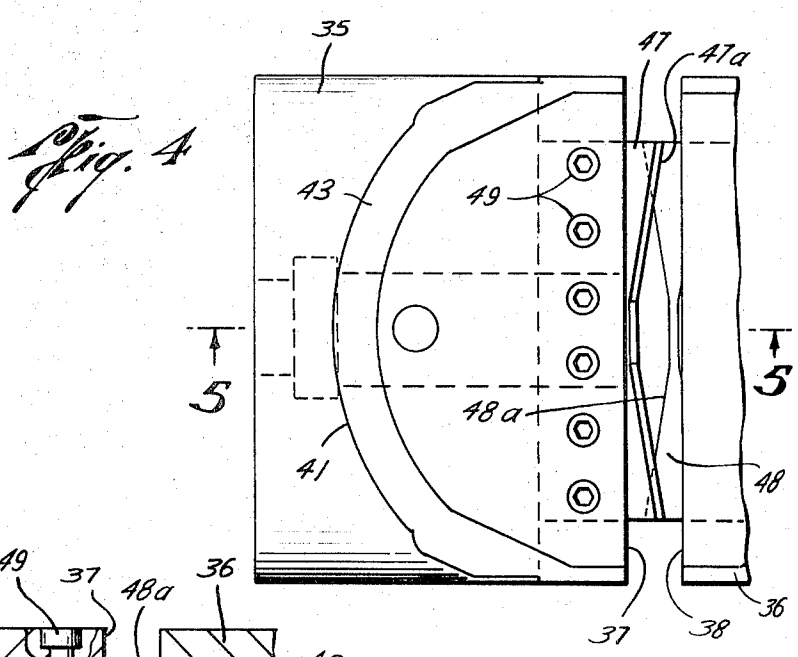
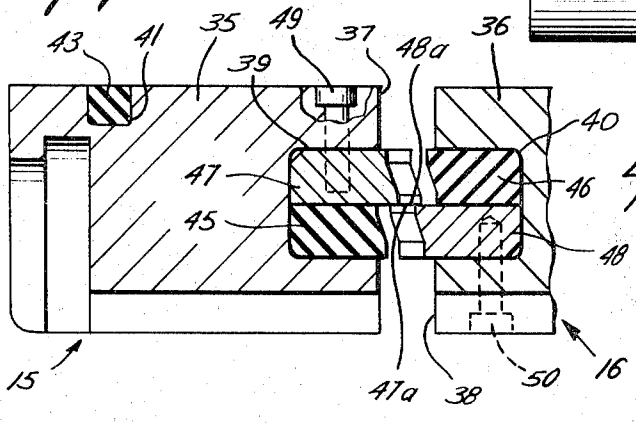


Fig. 4

Fig. 5



Leonard E. Williams, Jr.
Maurice J. Meynier,
INVENTORS

BY Dyer, Eickenroht & Thompson
ATTORNEYS

Fig. 6

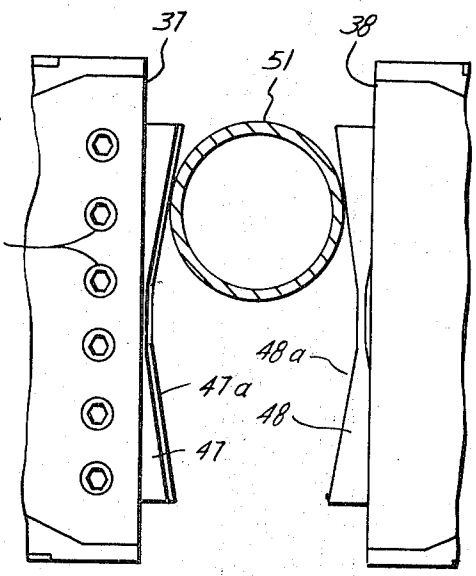


Fig. 7

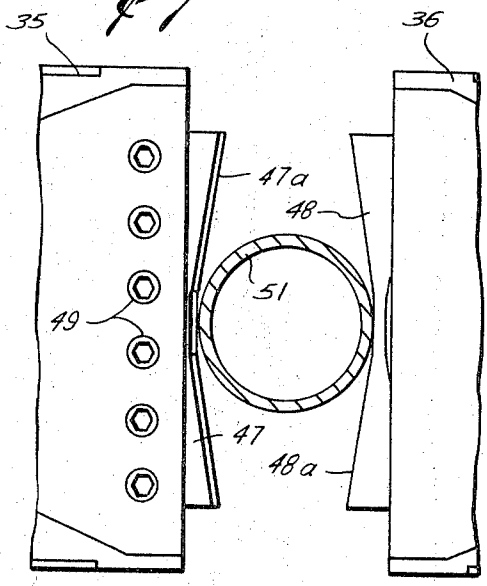


Fig. 8

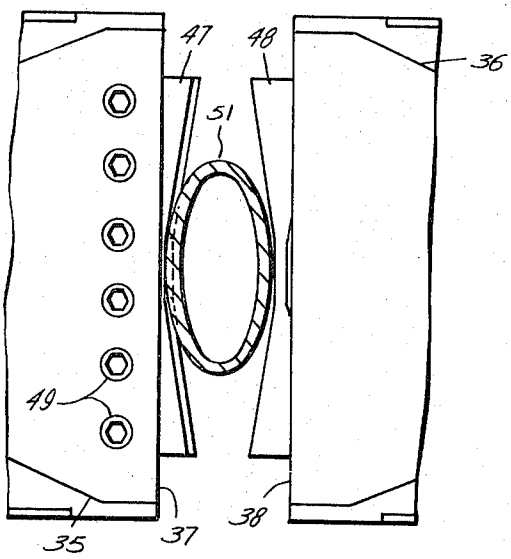
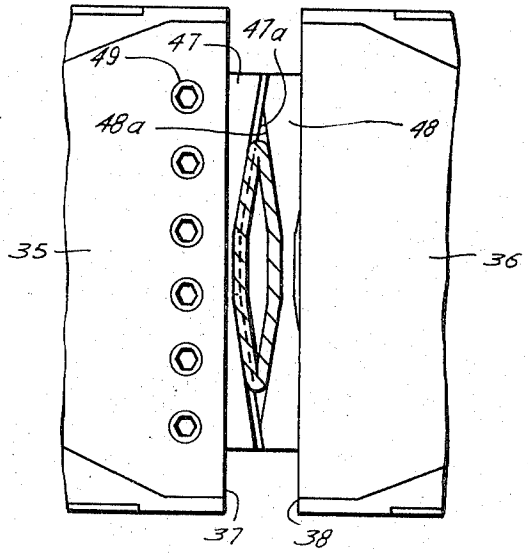


Fig. 9



Leonard E. Williams, Jr.
Maurice J. Meynier, III
INVENTORS

BY Hyer, Eickenroht & Thompson
ATTORNEYS

PIPE SHEARING RAM ASSEMBLY FOR BLOWOUT PREVENTER

This invention relates to blowout preventers generally and, in particular, to a ram assembly for a blowout preventer that will shear pipe extending through the preventer, when the rams of the assembly are moved together to close off the opening through the preventer.

Shear rams are installed in preventers where there is a possibility that it may be desirable to have the ability to cut the drill pipe or tubing. This would be done, in most cases, only to prevent irrevocable damage from being done to the well, the wellhead equipment, or the drilling rig. For example, if while operating offshore from a floating vessel, the anchor system should fail or for some reason be unable to keep the vessel over the hole and a string of pipe extends from the vessel into the hole; it would probably be better to shear the pipe string at the wellhead rather than to run the risk of damaging the wellhead or the vessel.

Shear ram assemblies for blowout preventers have been proposed before. For example, see U.S. Pat. Nos. 2,919,111 and 2,969,838 which issued on Dec. 2, 1959 and Jan. 31, 1961, respectively. It is the purpose of the rams described in these patents, as well as the rams of this invention, to not only shear the pipe string, but also to come together and form a seal between them and the preventer body to close off the opening through the preventer after the pipe has been sheared. The seal between the rams is formed by resilient sealing members that are compressed between the rams. Cutting a pipe string, such as a string of Grade E drill pipe, requires a substantial amount of force to be applied to the rams and usually the rams will flatten the pipe between them before they cut it. The end of the pipe will be above the bottom of the hole or in tension in most cases, so when it is finally sheared it will jump apart due to the weight of the pipe string extending below the preventer. As the pipe is flattened and sheared, it may be forced against one or both of the sealing elements and damage them. Further, the pipe could tear one or both elements as the pipe moves rapidly from between the rams when sheared. The danger here is that the sealing elements will be damaged to the extent that they will not seal and this function of the rams will be lost.

Therefore, it is an object of this invention to provide a shear ram assembly for a blowout preventer wherein the likelihood of damage to the ram sealing elements is reduced, when the ram assembly cuts a pipe string.

It is another object of this invention to provide a shear ram assembly for a blowout preventer that forms two, vertically spaced, pressure seals between the rams of the assembly, when the rams are moved into engagement to provide two chances for a seal instead of one.

It is another object of this invention to provide a shear ram assembly for a blowout preventer that will cut the pipe after it is flattened, from each side toward the middle of the flat sides of the pipe, to reduce the cross-sectional area in shear at any given time and the maximum force required to shear the pipe.

These and other objects, advantages, and features of the invention will be apparent to those skilled in the art from a consideration of this specification including the attached drawings and appended claims.

In the drawings:

FIG. 1 is a view partially in elevation and partially in vertical section of a blowout preventer equipped with the preferred embodiment of the shear rams of the shear ram assembly of this invention;

FIG. 2 is a view similar to FIG. 1 showing the shear rams closed after having sheared a pipe string;

FIG. 3 is an isometric view of the ram assembly of FIGS. 1 and 2;

FIG. 4 is a top view of one of the rams of FIG. 3 and part of the adjacent side of the other;

FIG. 5 is a vertical section through the rams of FIG. 4 taken along line 5–5;

FIG. 6 is a top plan view of the rams as they move together with a pipe string between them that is not in the center of the opening through the blowout preventer; and

FIGS. 7, 8 and 9 show sequentially the rams moving together to shear a pipe string.

The blowout preventer of FIG. 1 includes main body 11 through which extends vertical bore or opening 12. This is the opening through which pipe can pass through the preventer. Ram guide ways 13*a* and 13*b* extend laterally from opposite sides of bore 12. Flanges 14 on the upper and lower sides of the body connect the preventer in the wellhead stack in the conventional manner. The ram assembly of the blowout preventer comprising first and second rams 15 and 16 are located in ram guide ways 13*a* and 13*b*, respectively, on opposite sides of pipe opening 12.

Means are provided for moving the rams into engagement to close the pipe opening through the preventer and for moving them apart to open up the opening therethrough. The means for moving each ram is similarly constructed so only one such assembly will be described in detail. As shown in FIG. 1, bonnet 17 is attached to body 11 across the open end of ram guideway 13*a*. Bonnet 17 includes body 18 and head 20. Bonnet body 18 and head 20 are connected by a plurality of bolts 21 (FIG. 2). Bolts 22 releasably connect the bonnet assembly to main body 11 of the preventer.

Piston 25, located in cylinder 19, is connected to rod 26. The rod extends through bonnet body 18 and is releasably connected to ram 15. Hydraulic pressure on one side of piston 25 moves ram 15 laterally toward ram 16 and hydraulic pressure on the other side will retract the ram to the position shown in FIG. 1. For a complete description of this portion of the preventer, see U.S. Pat. No. 3,272,222 entitled "Blowout Preventer" that issued Sept. 13, 1966 to Herbert Allen.

The piston and cylinder arrangement just described may not be able to provide sufficient force to cause the shear rams to cut through a particular pipe string. This may be due to the thickness of the pipe or the lack of sufficient hydraulic pressure or both. If such a situation is likely, the preventer can be modified to provide additional force for shearing the pipe. As shown in FIGS. 1 and 2, cylinder 28 and cylinder head 29 are attached to head 20 of the bonnet by bolts 30. Piston 31 in cylinder 28 is connected to rod 32 with the rod extending through head 20 to engage or be connected to piston 25 as desired. Fluid pressure acting against piston 31 produces an additional force for urging ram 15 toward ram 16.

Referring now to FIGS. 3, 4, and 5, rams 15 and 16 include main bodies 35 and 36, respectively. The ram bodies are oval in vertical cross section, which is the shape of ram guide ways 13*a* and 13*b*. The rams, when positioned in the guide ways, have opposite faces 37 and 38 that engage and limit the distance the rams can be forced together. Extending laterally across faces 37 and 38 are grooves 39 and 40. These grooves in turn are connected to grooves 41 and 42 that curve over the top of the ram bodies and along the sides thereof to combine with lateral grooves 39 and 40 to provide a continuous groove across the front face of the rams, part way down the sides, and over the top. Sealing elements 43 and 44 are located in grooves 41 and 42, respectively. Sealing elements 45 and 46 are located in grooves 39 and 40 and extend laterally across opposite faces 37 and 38 of the rams. Also located in grooves 39 and 40 are knife blades 47 and 48.

The knife blades project from faces 37 and 38 of the rams and are positioned to overlap when the rams are moved into engagement, as shown in FIGS. 2 and 5. In FIG. 5, the rams are shown just before they move into engagement with the knife blades just beginning to overlap. Seal elements 45 and 46 are each positioned to engage the knife blade carried by the other ram, i.e., as shown in FIG. 5, knife blade 47 on ram 15 will engage and compress seal member 46, when the rams are moved together. Knife blade 48 on ram 16 will engage and compress seal member 45. Thus, vertically spaced seals are formed between the rams. This provides two chances for a seal to be formed between the mating faces of the rams or, stated another way, both sealing elements would have to be damaged by the pipe to keep a seal from being established between the rams.

The cutting edge of knife blade 47 is its lower outer edge 47*a*. The cutting edge of knife blade 48 is the upper outer edge 48*a*. As the rams move together, knife edge 47*a* passes just above knife edge 48*a* to shear any pipe string located in the pipe opening of the preventer. The knife blades are held in grooves 39 and 40 by bolts 49 and 50, respectively, as shown in FIG. 5.

Seal elements 45 and 46, which are made of a resilient material such as rubber, are compressed between the knife blades and the back of the grooves in which they are located. This compression causes each seal element to form tight seals along the back, top, and bottom of the groove in which it is located as well as to seal between the element and the knife blade. This compression and the accompanying deformation is transmitted to seal members 43 and 44 in side and top grooves 41 and 42 to hold them in sealing engagement with rams guideways 13*a* and 13*b*.

The cutting edges of knife blades 47 and 48 are generally concave, tapering inwardly from each side toward the center, as shown in FIG. 6. So shaped the blades will tend to urge pipe such as pipe string 51 shown in FIG. 6, toward the center of the blades as the blades are moved together by the rams.

There is another advantage in providing this shape for the cutting edges. The actual shearing of the pipe usually begins after the blades have flattened the pipe. This flattening is shown sequentially in FIGS. 7, 8, and 9. The actual cutting operation begins when the blades and pipe are as shown in FIG. 9. The cutting starts from each narrow side, which is probably split longitudinally by this time, and moves progressively inwardly from both directions toward the center as the blades move together. This reduces the actual cross-sectional area being sheared at any one time and reduces the actual force required to shear a given pipe string.

From the foregoing description of one embodiment of this invention by way of example, 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 and structure.

We claim:

1. A blowout preventer comprising a body having a pipe opening therethrough, ram guideways extending laterally from opposite sides of the pipe opening, a ram assembly comprising first and second rams, each located in one of the ram guideways, and means for moving the rams together to close off the pipe opening and for moving the rams apart to open the pipe opening, each ram having a knife blade attached thereto in position for the cutting edge of the blade on one ram to pass just below the cutting edge of the blade on the other to shear any pipe positioned in the pipe opening when the rams are moved together to close off the opening, and seal means on each ram positioned to engage and be compressed by the knife blade on the other ram when the rams engage to form a separate and independent seal between the knife blade on each ram and the seal means on the other.

2. The blowout preventer of claim 1 in which the cutting edge of each knife blade is generally concave, tapering inwardly from each side toward the center, to cause the blades to tend to center the pipe between the blades as the rams are moved together and to shear the pipe progressively from the sides toward the middle of the blades as the rams are moved together.

3. A ram assembly for positioning in ram guideways that extend laterally from opposite sides of a pipe opening in the body of a blowout preventer, comprising two rams for movement between an engaged position closing off such pipe opening to a spaced apart position opening such pipe opening to receive pipe, said rams having oppositely facing surfaces that engage when the rams close off the pipe opening, each said ram having a knife blade extending laterally across said surface with its cutting edge projecting therefrom, said blades being positioned on the rams for the cutting edge of one blade to pass just below the cutting edge of the other blade, when the rams are moved together through their respective ram guideways, to shear pipe positioned in the pipe opening, and seal means on the rams to seal off the pipe opening when the rams are in engagement, said seal means including a seal member extending laterally across the facing side surface of each ram to be compressed by the knife blade on the other ram as the rams move into engagement.

4. The ram assembly of claim 3 in which the knife blades taper inwardly toward the center thereof to tend to center pipe positioned between them and to shear the pipe progressively inwardly toward the center of the cutting edge as the rams are moved together.