April 27, 1965 H. C. BRIDWELL 3,180,440

DRAG BIT

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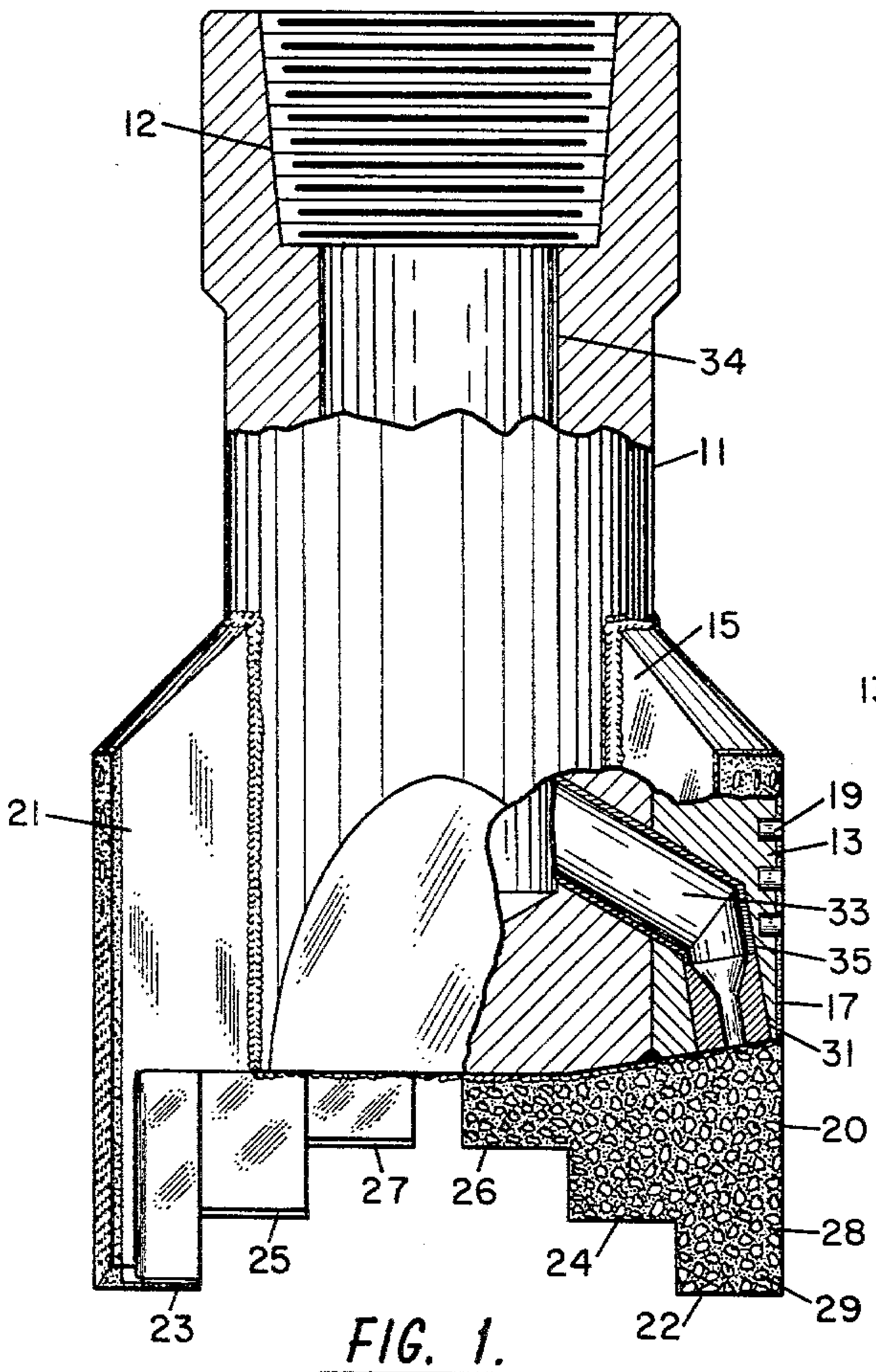

FIG. 1.

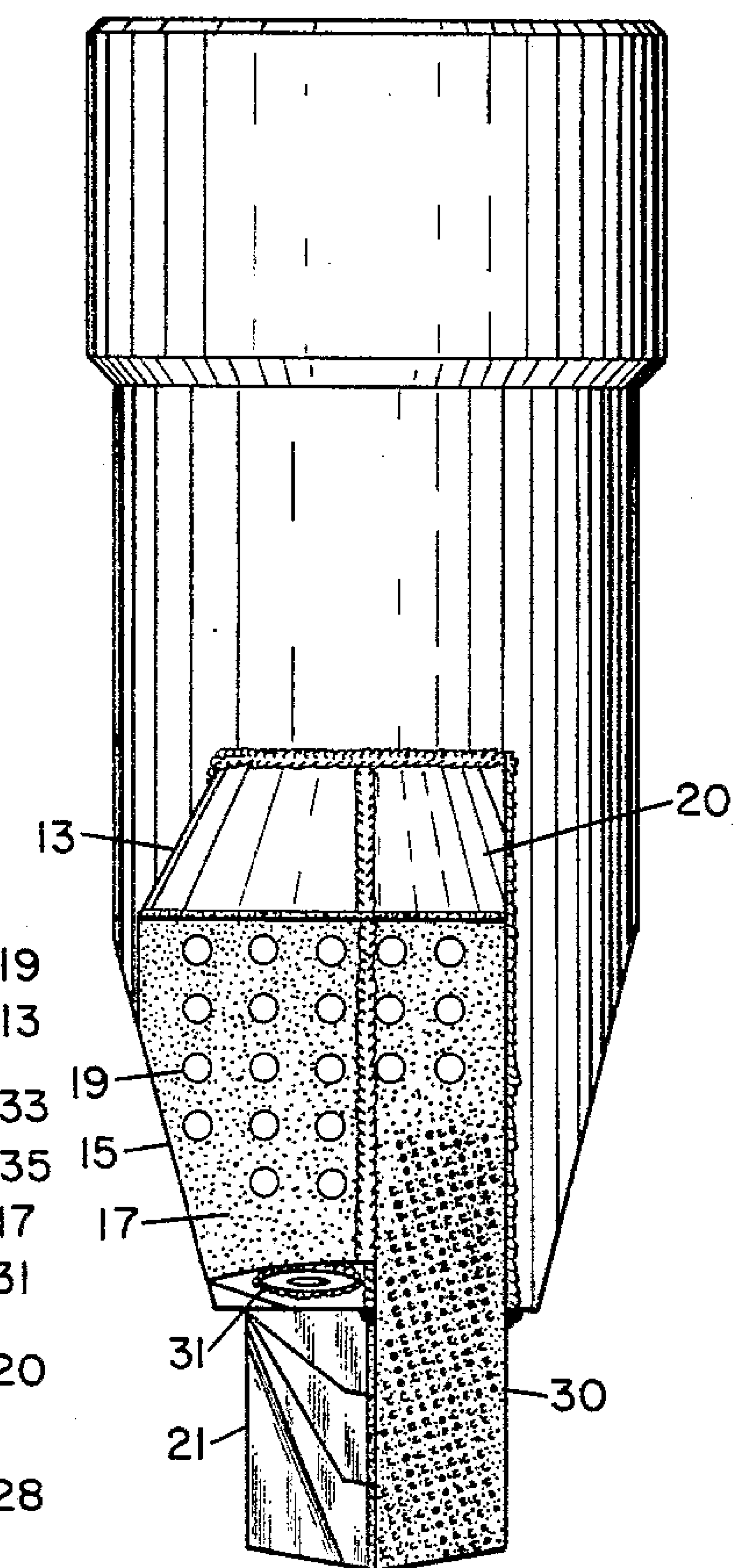

FIG. 2.

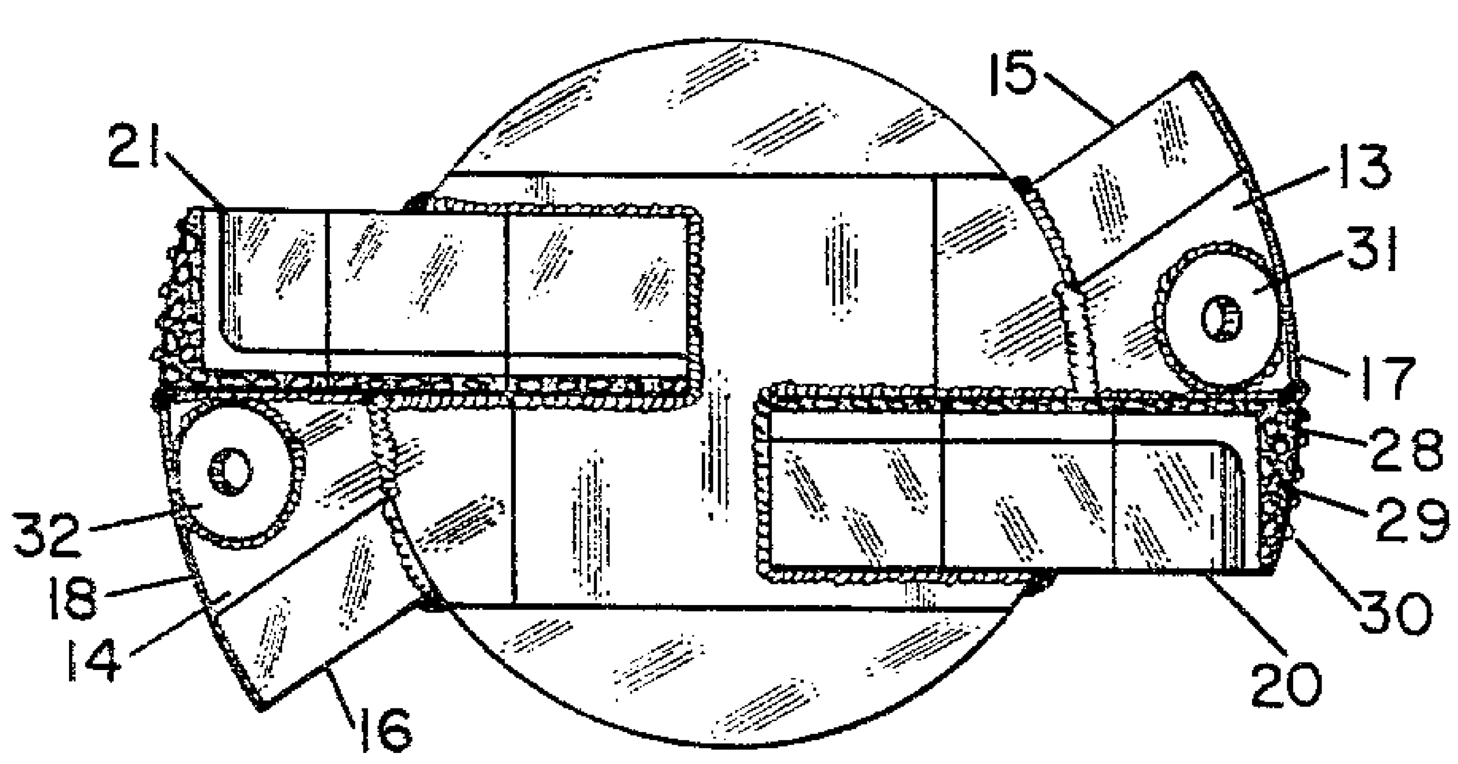

FIG. 3.

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DRAG BIT

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The present invention relates to rotary drill bits and is particularly concerned with an improved drag bit for drilling oil wells, gas wells and similar boreholes.

Many of the difficulties encountered with drag bits used in the mining and petroleum industries are due to failure of the blades at the gage surfaces. Experience has shown that gage wear is generally severe with such bits, in part because of continued impact of the blades against the borehole wall and the entrapment and regrinding of cuttings between the gage surfaces and adjacent formation. Such wear results in a reduction in bit diameter and promotes the formation of a rounded contour at the lower end of the tool. The reduced bit diameter normally produces a corresponding change in the diameter of the borehole which may necessitate reaming of the hole before the next bit can be lowered into place. Wedging of the bit in the borehole may occur as a result of the rounded blade contour unless bit weight is controlled and penetration rates are kept low. Efforts to avoid these and related problems attributed to gage wear by increasing blade thickness and employing tungsten carbide or a similar abrasion-resistant material on the gage surfaces have been only partially successful and hence the use of drag bits has generally been restricted to relatively soft, non-abrasive formations.

It is therefore an object of the present invention to provide an improved drag bit which will wear less rapidly at the gage surfaces than drag bits available in the past. Another object is to reduce gage wear caused by impact of the blades against the borehole wall and the accumulation and regrinding of cuttings between the gage surfaces and formation. A further object is to alleviate the necessity for reaming the borehole and unduly restricting bit weight during drag bit drilling operations. Still other objects will become apparent as the invention is described in greater detail hereafter.

In accordance with the invention, it has now been found that many of the difficulties due to gage wear encountered with drag bits available in the past can be alleviated by providing laterally-projecting surfaces or pads in front of the blades and mounting nozzles in the pads near the gage edges. Studies have shown that such pads contact the borehole wall in advance of the blades and thus reduce impact loading. The mounting of nozzles in the pads near the gage edges of the blades so that the fluid discharged impinges against the formation near the lower gage corner of each blade minimizes the entrapment and regrinding of cuttings between the blades and formation and provides much more effective cleaning near the gage edges than is generally obtained with conventional tools. Due to the reduced impact and better entrainment of cuttings adjacent the blades, the rate at which gage wear occurs is significantly reduced and hence the difficulties outlined above are to a large extent avoided.

The nature and objects of the invention can best be understood by referring to the following detail description of a preferred embodiment of the improved drag bit and to the accompanying drawing, in which:

FIGURE 1 is a vertical elevation, partially in section, of a drag bit provided with pads containing nozzles mounted in front of the blades near the gage edges;

FIGURE 2 is a vertical elevation of the bit shown in FIGURE 1 rotated 90° about the longitudinal axis; and,

FIGURE 3 is a bottom view of the bit shown in FIGURES 1 and 2 of the drawing.

The bit depicted in FIGURE 1 of the drawing includes a hollow body member 11 constructed of steel, cast iron or similar material. The body member is of generally cylindrical shape and includes a standard A.P.I. tool joint box 12 near the upper end to permit its connection to the lower end of a rotary drill string. Other connecting means may be used in lieu of an A.P.I. tool joint if desired. The lower portion of the body member is provided with lateral projections or pads 13 and 14, only one of which appears in FIGURE 1. Each pad projects outwardly from the body member through a horizontal angle of from about 15° to about 90° and extends vertically from a point near the bottom of the body to a point about midway between the bottom and the lower end of the tool joint. Pads extending through an angle between about 15° and about 45° are generally preferred. The leading faces of the pads, indicated by reference numerals 15 and 16, preferably extend radially from the body as shown in FIGURE 3 in order to prevent wedging of cuttings between the pads and the borehole wall. The upper end of each pad may slope backwardly to produce a spiral configuration if desired. The pads may be cast or machined as integral parts of the body, may be produced separately and then welded in place as shown, or may be fabricated with and attached as parts of the blades of the bit.

The gage surfaces of the pads on the bit shown are hard surfaced with tungsten carbide or a similar abrasion-resistant material indicated by reference numerals 17 and 18 in order to reduce gage wear. The tungsten carbide or other hard metal may be applied to the pads with a torch or may be bonded in place by infiltration or a similar technique. Inserts 19 of sintered hard metal carbide or similar material are embedded in the gage surfaces to further increase resistance to abrasion.

Blades 20 and 21 are connected to and depend from body member 11 adjacent the pads. As indicated in FIGURES 2 and 3 of the drawing, each blade is mounted at the rear of a pad and projects outwardly to the gage surface of the pad. The blades shown are cast or machined to fit closely against the body and pads and are welded in place. Alternatively, each blade and the corresponding pad may be fabricated as an integral unit and the entire structure may then be welded or otherwise mounted in the proper position on the body member. The blades shown are stepped across the bottom and are thus provided with lower cutting edges 22 and 23, intervening cutting edges 24 and 25, and upper cutting edges 26 and 27. This results in the maintaining of a stepped core below the body which assists in centering the bit in the bore hole and generally promotes smoother operation. The rear surface of each blade is preferably tapered above each cutting edge in order to reduce the blade area in contact with the formation at the bottom of the borehole and thus permit higher drilling rates than might otherwise be obtained.

The leading faces of the blades on the bit shown in the drawing are hard surfaced with a binder metal 28 containing particles 29 of tungsten carbide, a tungsten carbide alloy, or a similar abrasion-resistant material preferably having a Rockwell A hardness in excess of about 85. A variety of metallic binders may be employed, including copper-nickel alloys, copper-nickel-tin alloys, copper-nickel-manganese alloys, iron-carbon alloys, iron-nickel-manganese alloys, S-monel and the like. Powdered tungsten carbide or similar hard metal granules may be added to the matrix metal to increase its strength and abrasion resistance. The hard metal particles on the faces of the blades shown are irregularly-shaped particles or chips of tungsten carbide or the like ranging between about ⅛ and about $\frac{3}{16}$ inch in size. The gage edges are hard surfaced with similar material and in addition contain cubes of sintered tungsten carbide 30 embedded in a regular pattern on the lower portions of the blades in order to further increase abrasion resistance. Embedded diamonds may also be employed on the gage edges.

Nozzles 31 and 32 are mounted in the lower surfaces of the pads in front of the blades. Each nozzle is located in a passageway 33 which extends from the interior 34 of the body to an opening in the pad near the gage edge of the adjacent blade. These passageways are preferably lined with tubes 35 of tungsten carbide or the like in order to reduce erosion by the drilling fluid. The nozzles are made of similar erosion-resistant material and may be either welded in place as shown or secured by means of snap rings, pins or other members which fit into recesses in the body adjacent the outer surfaces of the nozzles. The use of replaceable nozzles held in place by snap rings or the like permits nozzle changes in the field and is therefore preferred. The nozzle axes extend in a substantially vertical direction toward points a short distance in front of the blades near the lower gage corners. Fluid discharged from the nozzles thus passes substantially parallel to the face and gage surfaces of the blades and impinges against the formation adjacent the outer step of each blade.

The bit shown in the drawing may be utilized with a conventional rotary drill string and ordinary surface equipment. The bit is connected to the lower edge of the drill string and lowered into the borehole in the usual manner. Drilling fluid is circulated downwardly through the string and returned through the annulus between the drill string and the borehole wall. Once circulation has been established, drilling is commenced by rotating the string from the surface. During normal operation, the bit runs smoothly in the borehole. The large area presented to the borehole wall by each of the pads limits the lateral drilling action of the blades and prevents the drilling of an oversized hole. The pads also assist in minimizing gage wear of the blades. Drilling fluid discharged downwardly in a direction substantially parallel to the gage surfaces and the faces of the blades prevents the entrapment of cuttings between the gage surfaces and borehole wall. The cuttings dislodged by the blades are entrained in the fluid jetted against the formation and are carried upwardly around the pads projecting in front of the blades. This prevents the accumulation of cuttings adjacent the upper sections of the blades and reduces the normal tendency of drag bits to "ball up" at high drilling rates. The jetting effect of the fluid against the outer section at the bottom of the borehole where drilling is normally most difficult also improves the cutting action of the hard metal particles on the face of the blades and improves the drilling rate.

Due to the presence of dipping strata at the bottom of the borehole or for other reasons, one blade of the bit will sometimes tend to penetrate more deeply into the formation than does the other and the bit will therefore tend to pivot about the more deeply embeded blade. This normally leads to a sharp impact between the face or gage edge of the opposing blade and the borehole wall. Fracturing of the hard surfacing material on the face or gage edge of the blade may result. The pads in front of the blades on the bit of the invention avoid this. As the bit tends to pivot about one blade, the pad on the opposite side of the body contacts the borehole wall before contact is made by the gage edge of the opposing blade. Once the pad strikes the wall, the embedded blade is dislodged and normal rotation of the bit continues. High impact loadings which are likely to damage the face and gage surfaces of the blades on a conventional drag bit are thus avoided.

It will be apparent from the foregoing that the pads and nozzle arrangement described serve to stabilize the bit, reduce gage wear, minimize fracturing of the gage surfaces due to high impact loadings, permit more effective cleaning of cuttings from beneath the bit, and provide smoother operation than can generally be obtained with conventional drag bits. The invention has been described in terms of a two-way drag bit provided with diametrically opposed pads but is equally applicable to three-way and four-way drag bits. It may also be applied to bits provided with extensible blades. Various modifications and modes of construction utilizing pads containing nozzles mounted in front of the blades near the gage edges will be apparent to those skilled in the art.

What is claimed is:

1. A rotary drag bit comprising a hollow body provided with means for connecting said bit to the lower end of a drill string, said body including a plurality of laterally projecting pads extending part way about the body at spaced intervals and extending longitudinally from points near the bottom of said body to intermediate points thereon; blades connected to and depending from said body behind said pads, said blades including gage edges laterally coextensive with said pads; and a plurality of nozzles mounted in said pads in front of said blades, said nozzles communicating with the interior of said body and each nozzle being mounted in a substantially vertical position in front of a blade near the gage surface thereof.

2. A bit as defined by claim 1 wherein each of said pads extends from about 15° to about 90° about said body.

3. A bit as defined by claim 1 wherein each of said pads has a leading face extending from said body in a substantially radial direction.

4. A rotary drill bit comprising a hollow body member provided with means for connecting said member to the lower end of a drill string, said body member including a plurality of laterally projecting pads extending through horizontal angles of from about 15° to about 90° at spaced intervals about the body and extending vertically from points near the lower end of said body to points near the middle of said body and each of said pads containing a passageway for conveying fluid from within said body to an outlet near the outer surface of said pad; blades connected to and depending from said body at the rear of said pads, said blades including gage edges extending outwardly adjacent the outer surfaces of said pads; and a nozzle located in the outlet in each of said pads, said nozzle being mounted in a substantially vertical position whereby fluid may be directed downwardly in front of a blade near the gage surface thereof.

5. A bit as defined by claim 4 wherein said passageways are provided with erosion-resistant liners.

6. A bit as defined by claim 4 wherein said pads are welded in place.

7. A rotary drill bit comprising a hollow body member provided with means near the upper end thereof for connecting said member to the lower end of a drill string; a plurality of pads projecting outwardly from said body member at intervals about said member, said pads extending vertically from points near the lower end of said member to intermediate points thereon, and said body member and pads containing passageways extending from the interior of said member to outlets in the lower sur-

faces of said pads near the outer edges thereof; nozzles located within the outlets of said passageways in said pads, the axes of said nozzles extending downwardly toward the outer part of the formation beneath said bit; and a plurality of blades attached to and depending from said body member and pads, said blades including gage surfaces extending outwardly adjacent to the outer surfaces of said pads and each blade extending downwardly adjacent to and behind a nozzle.

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