Oct. 16, 1956 J. S. ROBBINS 2,766,977

ROTARY CUTTER HEAD FOR BORING TYPE CONTINUOUS MINING MACHINE

Filed Dec. 8, 1954. 3 Sheets-Sheet 1

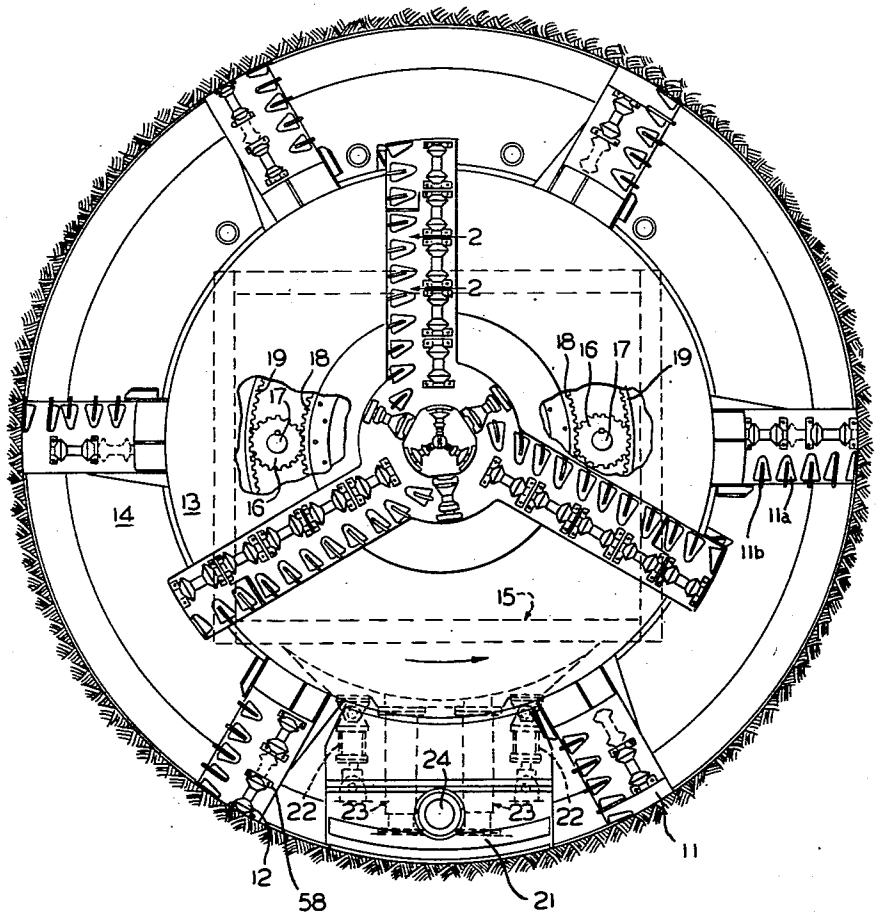


Fig. 1

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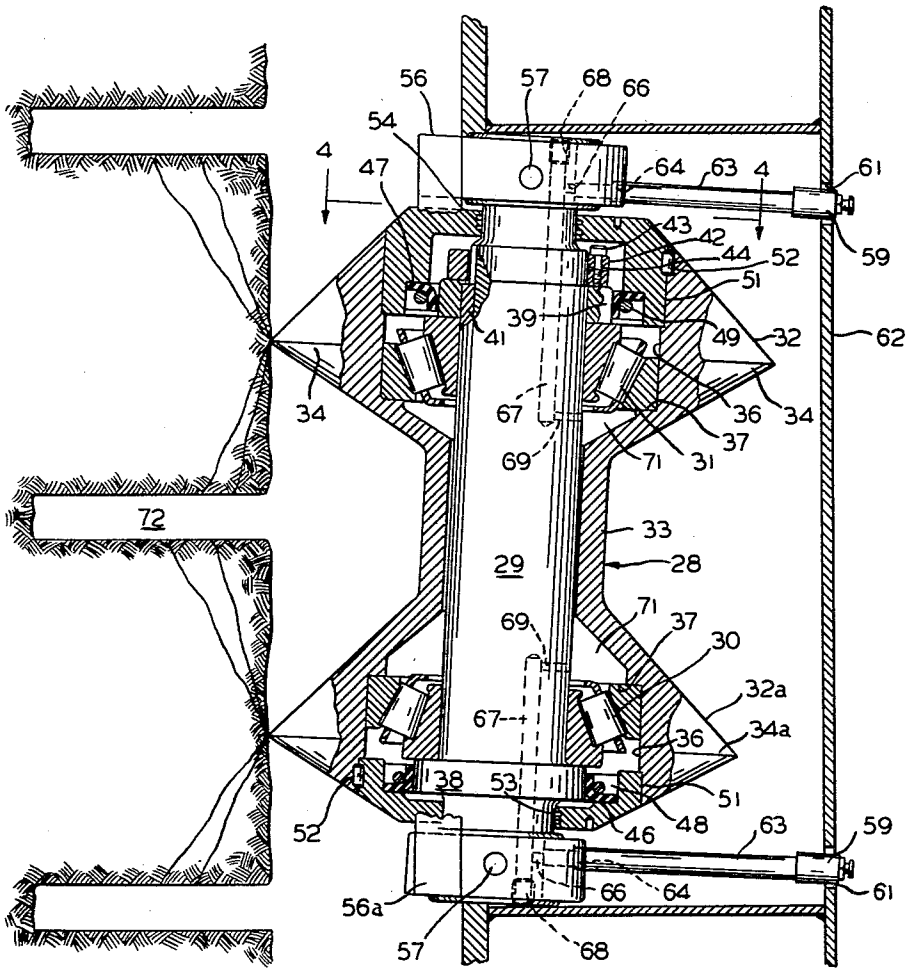


Fig. 2

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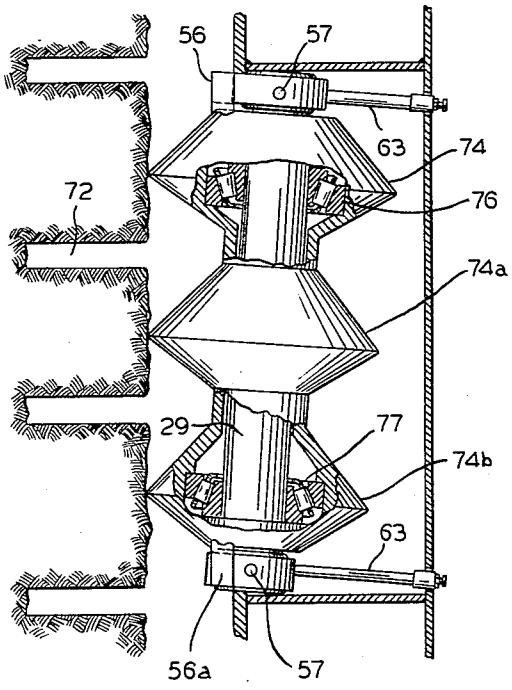


Fig. 3

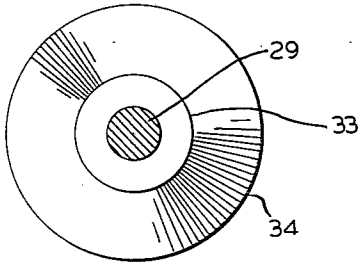


Fig. 4

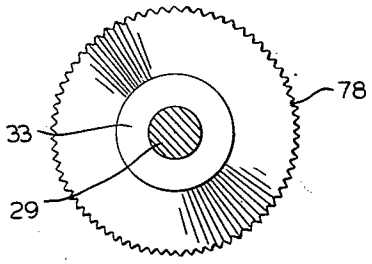


Fig. 5

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2,766,977

Patented Oct. 16, 1956

2,766,977

ROTARY CUTTER HEAD FOR BORING TYPE CONTINUOUS MINING MACHINE

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Application December 8, 1954, Serial No. 473,847

6 Claims. (Cl. 262—7)

This invention relates to boring machines of the type commonly used for driving tunnels in rock, coal, or the like, and has particular reference to improvements in the rock cutting and breaking devices for such machines.

The main object of this invention is to provide an improved form and arrangement of devices for breaking down the cores that are formed between the kerfs made by rotating cutter arms or blades.

Another object of this invention is to provide an improved construction of roller type core breakers which will be capable of withstanding the severe stresses imposed upon such devices in this type of service.

Because of the rigid space limitations, it has heretofore been deemed impossible to provide a core breaking or splitting roller in which the span of the supporting bearing was great enough to give the required stability to the roller for operating in solid rock. It is evident that the stability of such a device is directly proportional to the length or span of the supporting bearing or bearings, and inversely proportional to the diameter of the roller.

One object of this invention is to provide an improved construction of core breaking roller in which the ratio of the bearing span to the roller diameter is such that said roller will be inherently stable.

A further object of this invention is to provide an improved construction of core breaker units each comprising a plurality of integrally connected wheels or rollers which cooperate with each other to effect a plurality of cutting and breaking actions against adjacent cores, causing the cores to break easily and continuously, thereby allowing rapid and continuous advance of the boring machine.

The invention may best be understood by reference to the accompanying drawings, in which:

Figure 1 is a front view of the cutting head of a boring machine of the class described, with certain parts broken away.

Figure 2 is an enlarged sectional view through one of the core breaking devices or rollers taken generally along the line 2—2 of Figure 1, and showing the relationship of the core breaking device to the cutter bits and the working face while the machine is in operation.

Figure 3 is a longitudinal section of a modified form of core breaking device or roller having three cutting edges instead of two edges as in the form shown in Figure 2.

Figure 4 is a diagrammatic view, showing in outline one form of core breaking roller in which the cutting edges are circular.

Figure 5 is a diagrammatic view, showing in outline a variant form of core breaking roller having toothed or serrated or cutting edges.

Referring now to details of the embodiment of the invention shown in the drawings, Figure 1 shows a cutting head of a boring or tunneling machine having a plurality of kerf cutters 11 and core breakers 12 mounted on the front face thereof. The cutting head is comprised of a circular inner portion 13 surrounded by an outer ring-like portion 14 which portions are rotated in opposite directions so as to equalize the torque on the machine frame 15.

The inner head portion 13 and outer head portion 14 are driven by pinions 16, 16 on frame 15 keyed to shafts 17, 17 which are suitably connected to a pair of motors (not shown). Pinions 16, 16 mesh with a large external ring gear 18 on the inner head portion and with an internal ring gear 19 on the outer head portion.

The front end of the machine frame is supported by a sliding shoe 21 which is adjustable in a vertical direction by means of hydraulic cylinders 22, 22. Thrust on the shoe 21 is transmitted to the machine frame 15 through a pair of extensible guides 23, 23.

A third hydraulic cylinder 24, disposed horizontally and longitudinaly within the shoe 21, is used for pushing the machine back from the working face when it becomes necessary for a workman to change cutting tools or core breakers.

The machine frame 15 may be bodily advanced or retracted in the bore by any suitable jack devices (not shown) of the kind well known in the tunnelling machine art.

In the form shown herein each of the kerf cutters 11 consists of a base plate 11*a* having an upstanding forwardly projecting cutter blade 11*b* fixed thereon.

In the illustrative form of core breakers 12 shown in detail in Figure 2, each core breaker unit consists of a hollow shell 28 rotatably mounted on a stationary shaft 29 by a pair of spaced tapered roller bearings 30 and 31. Shell 28 is formed with a plurality of enlarged roller members, herein two in number, which comprise enlarged end portions 32, 32*a* connected by a hollow hub portion 33. Each roller member is formed with converging inner and outer faces so as to be wedge-shaped in cross section. The peripheries of said end portion roller members constitute two cutting edges 34 and 34*a*.

The ends of shell 28 are bored as at 36, 36 to receive the bearings 30 and 31. Shoulders 37, 37 at the inner ends of bores 36, 36 serve to position the bearings substantially in the planes of rotation of the two cutting edges 34, 34*a* of roller members 32, 32*a*. A flange 38 on shaft 29 abuts against the inner race of bearing 30 and serves to position the shaft within the shell 28. A spacer 39 keyed at 41 to the shaft abuts against the inner race of bearing 31 and is held in position by a slotted nut 42 screwed on the shaft. A cap screw 43 extends through slot 44 in the nut 42 to lock the nut on the shaft, thereby securing the shaft and bearings within the shell.

The outer sides of bearings 30 and 31 are covered by retaining rings 46 and 47, respectively. Oil seals 48 and 49 of conventional form are pressed into the retaining rings 46 and 47, respectively, to engage the flange 38 and spacer 39. The retaining rings are screwed into threaded portions 51, 51 of bores 36, 36 in the ends of the shell 28, and are locked in place by set screws 52, 52. Grooved lips 53 and 54 on retaining rings 48 and 49, respectively, fit over the protruding ends of shaft 29, to exclude dust and dirt from the bearings.

The ends of shaft 29 are supported on the cutter head by brackets 56, 56*a* and are secured in said brackets by dowel pins 57, 57. The brackets 56, 56*a* are fastened to the cutter head by cap screws 58 (Fig. 1). Grease fittings 59 protruding through holes 61 in the rear face 62 of the cutter head are connected to grease lines 63 which are screwed into threaded holes 64 in brackets 56. Holes 64 communicate with radial holes 66 drilled in each end of the shaft which in turn lead to longitudinally drilled passages 67 in each end of the shaft. The outer ends of passages 67 are plugged by screws 68, while the inner ends lead through radially drilled holes 69 to annular grease reservoirs 71 on the inner sides of bearings 30 and 31.

The kerf cutters **11** are arranged in generally radial side-by-side relation to cut a plurality of thin circular kerfs **72** in the working face. The core breaker units **12** are so disposed in immediately following relation to the kerf cutters **11** so that each of their cutting edges **34** and **34***a* will engage the face intermediate each pair of adjacent kerfs formed by the preceding adjacent kerf cutter **11**, to break off the cores left between said kerfs in a manner to be presently described.

As the core breakers are primarily designed to roll against the working face in circular paths, the diameter of the outermost cutting edge **34** of wheel member **32** is preferably made somewhat larger than the diameter of the innermost cutting edge **34***a* of the wheel member **32***a*, so that the action of the two edges against the face may approximate a true simultaneous rolling motion. Also, each core breaker is mounted in its bracket **56**, **56***a* with the axis of the core breaker disposed at a slightly inclined angle to the face. With this arrangement both cutting edges **34** and **34***a* rotate with substantially the same peripheral speed in the same plane perpendicular to the axis of the cutting head, when the cutting edges of each core breaking roller are, in effect, disposed coincident with the surface of a cone having its apex at the axis of rotation of the cutting head.

I have found, however, that under many working conditions, improved core breaking action can be obtained by providing a slight variation in the ratio of the diameters of the cutting edges from those prescribed above for true simultaneous rolling action of both cutting edges. In other words, if the diameters of the cutting edges **34** and **34***a* are not exactly coincident with the surface of a cone having its apex at the axis of rotation of the cutting head, then only one of the two cutting edges tends to have true rolling contact against the working face at any one instant, while the other cutting edge tends to be rotated by the cutter head at a slightly different, partly slipping, circumferential speed, relative to the face (either faster or slower than that of the first cutting edge), depending upon which cutting edge meets with the most frictional resistance against the face at any given instant.

It appears that in practice, this slight difference in circumferential speeds of the two cutting edges usually tends to alternate from one cutting edge to the other as the greater relative frictional resistance changes from one cutting edge to the other, when the faces of their respective cores alternately give way to said cutting edges. Thus one or the other cutting edge may be either dragging behind or moving ahead of the other cutting edge at any one instance, so as to produce especially effective alternating cutting and wedging actions upon the cores between the kerfs.

In all cases, however, the thrust of the sharp cutting edges against the face in circumferentially following paths between adjacent kerfs will produce highly localized stresses in the cores of a magnitude sufficient to cause the cores to fracture progressively along planes extending forwardly and outwardly on either side of said cutting edges, as exemplified by lines of fracture indicated at X, X in Figure 2.

For example, the planes of fracture produced in cutting shale with my rollers are similar to those found in concrete which has failed under a localized compressive load, the failure consisting of shearing along planes disposed about 45° from the direction of the applied load.

It will be further observed that the arrangement and cutting action of the core breaking devices just described are quite different from those commonly used in certain types of boring machines, where core breaking rollers are arranged to follow in kerfs previously formed by cutter bits. In such cases, the rollers merely serve as wedge devices, breaking the cores laterally away from the kerf. With the core breaking devices of the present invention, the cutting edges of the rollers enter the face between adjacent kerfs, and break the cores toward the adjacent kerfs.

Figure 3 shows a modified form of core breaking unit similar to the core breaking unit **12** shown in Figure 2, except that the roller body is elongated to accommodate three cutting edges **74**, **74***a* and **74***b* instead of the two cutting edges of the form shown in Figure 2. In such case, it is also preferable to provide an intermediate roller bearing (not shown) in radial alignment with the center cutting edge **74***a* in addition to the bearings **76** and **77** in alignment with the end cutting edges **74** and **74***b*, as shown.

In the form of cutting edge for the core breakers shown in Figures 2 and 3, each cutting edge is formed on a continuous circle, with a V-shaped cross section about its entire periphery, as indicated in Figure 4. Figure 5 shows an alternate or variant form of cutting edge having a series of teeth or serrations **78** about its periphery. This form has advantages in cutting certain kinds of mineral.

From the foregoing description it will be apparent that I have a new and novel core breaking mechanism which has great inherent stability due to the wide spacing of the supporting bearings; one which exerts simultaneously a plurality of cutting and breaking actions against the core; one which is adaptable to a wide variety of mining and tunneling conditions; one which is easily replaceable; and one in which the rollers are interchangeable over a wide range of radii of the cutting head.

Although I have shown and described certain embodiments of my invention, it will be understood that I do not wish to be limited to the exact construction shown and described but that various changes and modifications may be made without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. In a rotary cutter head for a mining or cutting machine, having a plurality of radially spaced cutter bits arranged to cut a series of circular kerfs in a working face, the improvement which consists of mounting a plurality of rotatable core breaking units on said cutter head in following relation to said cutter bits, each of said core breaking units comprising a plurality of roller members having individual peripheral cutting edges generally V-shaped in cross section, said roller members being integral with and axially spaced along a hub for mutually interdependent rotation with each other, the axis of said hub being approximately parallel to the cutting plane of said cutting head, each of said roller members having their peripheral cutting edges disposed in a circumferential path approximately midway between two preceding adjacent cutter bits, to engage the intermediate face of the core left between the circular kerfs formed by said preceding cutter bits.

2. The structure of claim 1, wherein the rotatable mounting for each core breaking unit includes an anti-friction bearing disposed substantially in the plane of rotation of the cutting edge of each roller member on its mounting.

3. The structure of claim 1, wherein each core breaking unit has two roller members, disposed at opposite ends thereof, and the rotatable mounting for the core breaking unit includes an anti-friction bearing disposed substantially in the plane of rotation of the cutting edge of each roller on its mounting.

4. The structure of claim 1, wherein the successive cutting edges along a core breaking unit are of gradually reduced diameter toward the axis of the cutter head.

5. The structure of claim 4, wherein each core breaking unit is also mounted on an axis inclined to the axis of the cutter head, to afford approximately true simultaneous rolling action of the several cutting edges against the working face formed by said cutter head.

6. The structure of claim 5, wherein the diameters of the successive cutting edges and the inclination of the

axis of the core breaking unit is such as to afford an approximate but not a true simultaneous rolling action of all the cutting edges against the working face formed by the cutter head so as to set up alternate peripheral rolling and sliding actions of the several cutting edges, depending upon variations in relative frictional resistance on the peripheries of the cutting edges on the working face during rotation of the cutter head.

References Cited in the file of this patent

UNITED STATES PATENTS

1,603,621	McKinlay	Oct. 19, 1926
2,100,640	Efromson	Nov. 30, 1937
2,297,192	Reed	Sept. 29, 1942
2,550,202	Robbins	Apr. 24, 1951