Jan. 10, 1967 J. WOHLMEYER 3,297,101

APPARATUS FOR BORING A HOLE IN ROCK

Original Filed April 26, 1962 4 Sheets-Sheet 1

FIG.1

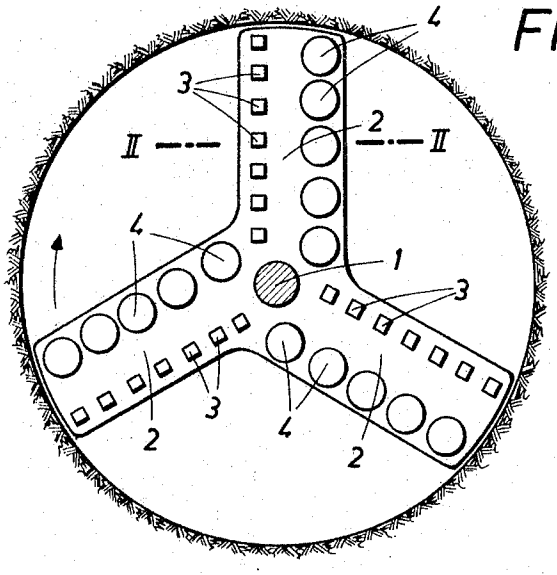


FIG.2

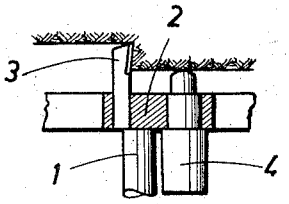


FIG.8

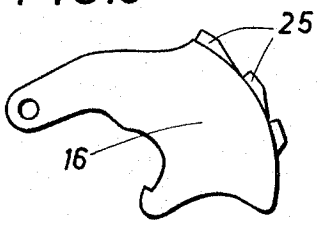


FIG.9

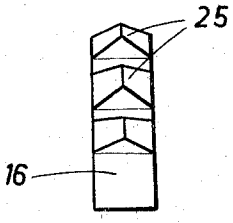


FIG.10

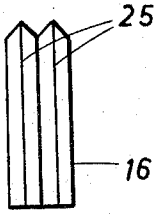


FIG.11

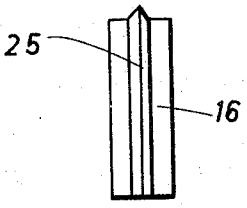
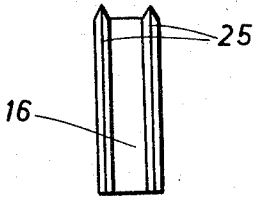


FIG.12



APPARATUS FOR BORING A HOLE IN ROCK

Original Filed April 26, 1962 4 Sheets-Sheet 2

FIG. 3

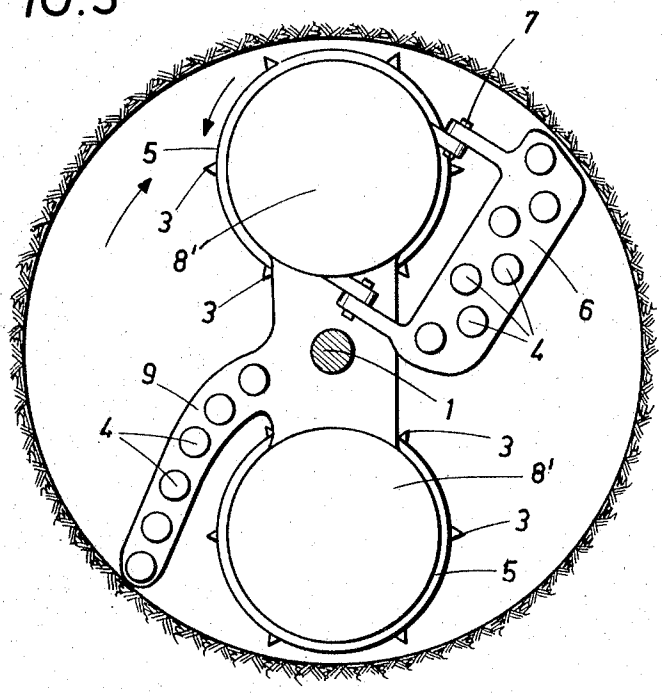
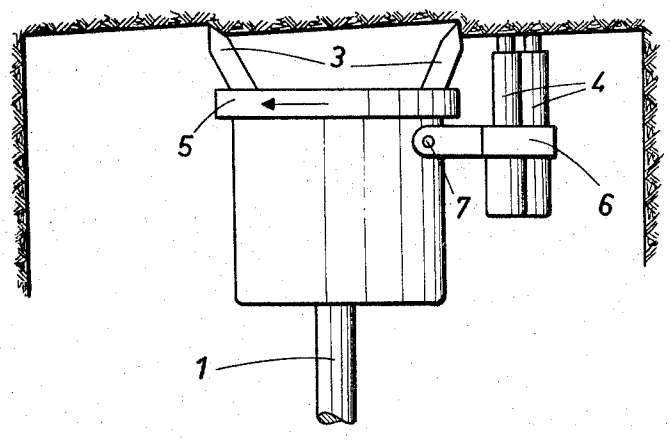


FIG. 4



APPARATUS FOR BORING A HOLE IN ROCK

Original Filed April 26, 1962 4 Sheets-Sheet 3

FIG.5

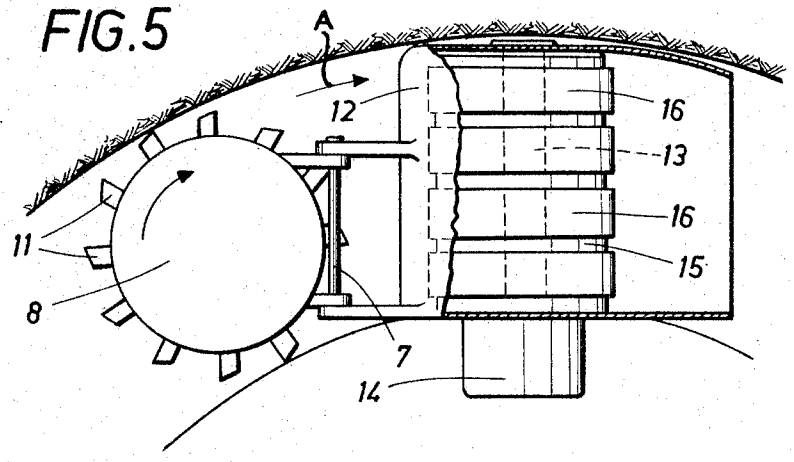


FIG.7

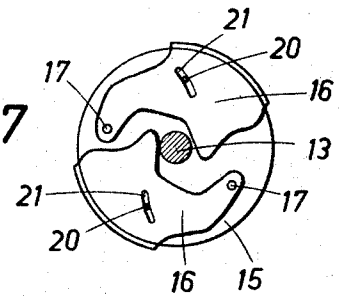
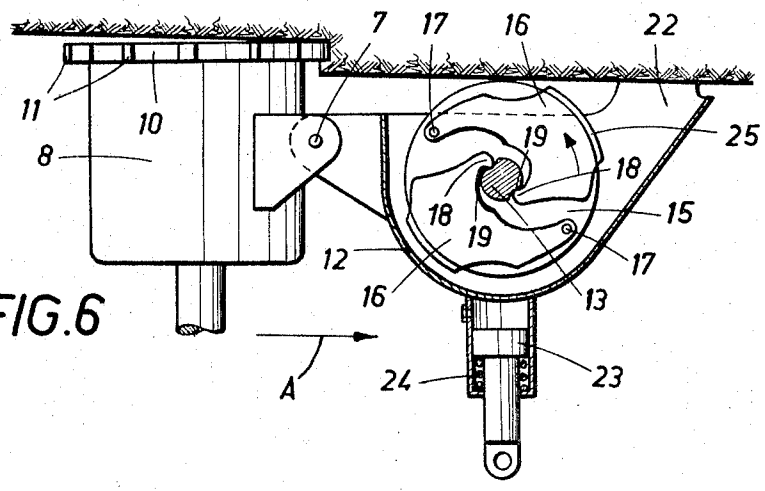


FIG.6



APPARATUS FOR BORING A HOLE IN ROCK

Original Filed April 26, 1962 4 Sheets-Sheet 4

FIG.13

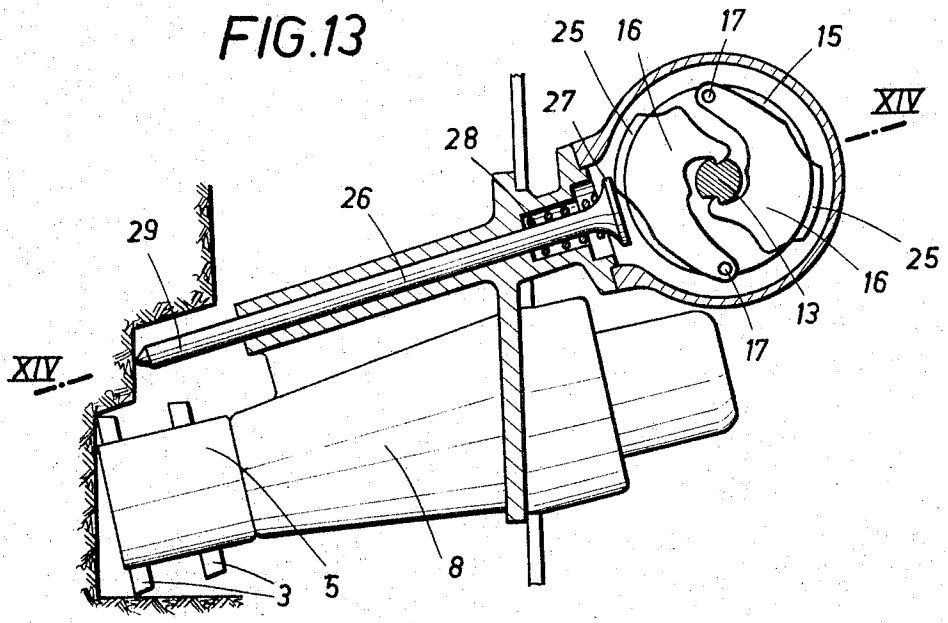
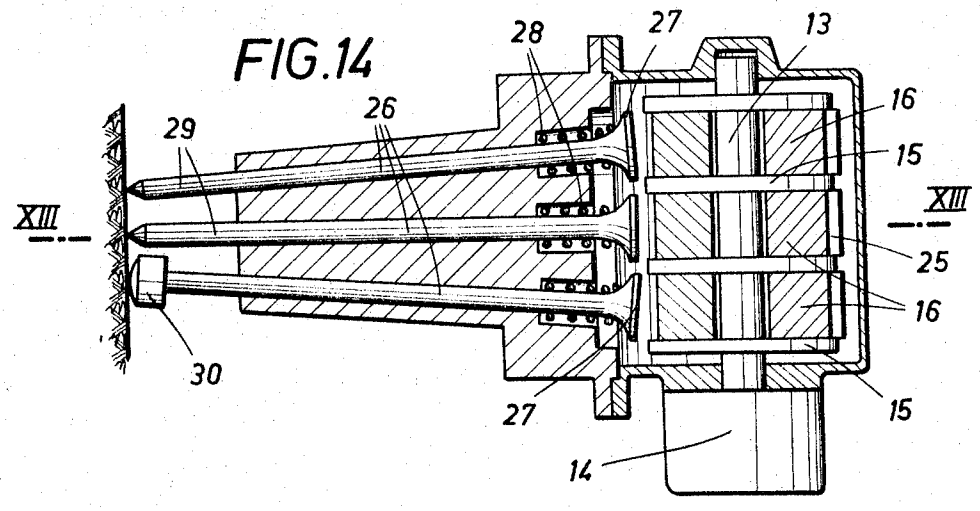


FIG.14



United States Patent Office 3,297,101
Patented Jan. 10, 1967

3,297,101

APPARATUS FOR BORING A HOLE IN ROCK

Josef Wohlmeyer, Blaasstrasse 13, Vienna, Austria

Original application Apr. 26, 1962, Ser. No. 190,285.
Divided and this application Oct. 16, 1964, Ser. No. 412,274
Claims priority, application Austria, Apr. 27, 1961, A 3,295/61
7 Claims. (Cl. 175—415)

This application is a division of my copending application Ser. No. 190,285, filed on Apr. 26, 1962, and now abandoned.

This invention relates to apparatus for boring a hole in rock.

In boring a tunnel or the like, it is known to chip the rock from the face of the tunnel by cutters or chisels. This method has previously been employed, however, only in rock of low to medium hardness. As the hardness of the rock increases, the economic efficiency decreases because in actually hard rock the wear of the cutting edges or the consumption of hard metal increases greatly and the advantage residing in that the driving rate is higher than during blasting is lost since a frequent replacement of cutters is required. When boring with roller chisels, as have been employed with success in hard rock and with small bore diameters, the tool consumption is still so considerable that the boring costs are relatively high. Besides, the boring with roller chisels in hard rock, particularly with larger bore diameters, requires the application of high pressure so that the machine and power expenditures are so high that the economic efficiency no longer exceeds that of the blasting method.

The invention remedies this situation by a method which enables the economical boring of galleries, tunnels, ducts, wells or the like with the aid of machining tools, such as cutting, milling or coal-cutting knives, roller chisels and the like, also in hard rock, hard ore etc., and which substantially accelerates such work and reduces the cost thereof when applied in medium and light rock.

The method according to the invention resides essentially in that the rock zone to be machined is prepared and loosened by hammer blows before it is engaged by the detaching tools. To simplify and accelerate the method, the hammering and detaching operations are suitably performed at the same time but so as to succeed each other in the feeding direction of the detaching tools. The more or less quickly succeeding hammer blows change and loosen the structure of the rock and cause the formation of hairline cracks, cracks, gaps, notches, incisions and the like so that the subsequent detachment of the rock layer by cutting, milling, undercutting, planing, roller-chiseling etc. and the breaking off of lands of rock are greatly facilitated and accelerated. The difficulties previously encountered in hard rock are thus overcome and a faster and less expensive work is enabled also when boring in medium and light rock.

The apparatus for carrying out the method according to the invention is characterized by the combination of striking and detaching tools in a unit which performs a common, preferably rotary feed movement, the striking tools being arranged to precede the detaching tools so as to act on that rock zone which is immediately thereafter acted upon by the detaching tools. The hammers may be driven by compressed air, electric power or directly by mechanical means. A particularly suitable design will be obtained if a motor-driven hammer shaft, which extends approximately parallel to the tunnel face or the like, is provided with striking weights which are urged outwardly by centrifugal force against stop means

and which strike upon the rock either directly or through the intermediary of displaceable chisel rods. The hammer shaft is driven by an electric motor, a compressed-air motor, a pressure oil motor or the like. The drive may alternatively be derived from the transmission of the detaching machine. To enable an adjustment of the striking frequency to the often varying nature of the rock, it is suitable to provide for a speed control for the hammer shaft. This speed control may operate in steps.

Further features of the invention are apparent from the drawing, in which several embodiments of the invention are shown diagrammatically and by way of example.

FIG. 1 is an elevation showing a tunnel boring machine.

FIG. 2 is a sectional view taken on line II—II of FIG. 1.

FIGS. 3 and 4, respectively, are an elevation and a top plan view showing a boring machine having rotary inserted-tooth cutters.

FIGS. 5 and 6, respectively, are an elevation and a top plan view partly in section and showing the inserted-tooth cutter and the striking device of another boring machine.

FIG. 7 is a view similar to FIG. 6 showing a modification.

FIG. 8 is a side elevation showing a striking weight alone.

FIGS. 9, 10, 11 and 12 show modified striking weights in views taken onto the hammer face.

FIGS. 13 and 14, respectively, are a fragmentary sectional view taken on line XIII—XIII of FIG. 14 and a section view taken on line XIV—XIV of FIG. 13 and show a device which is suitable, e.g., for acting on the central zone of the duct face.

According to FIGS. 1 and 2, the main shaft **1** of a boring machine is attached to three radial carries arms **2**, in which machining tools of any desired kind, e.g., cutting tools **3**, are mounted, which cut annular recesses through sequential portions of the tunnel face arranged in a closed circular loop. The cutter arms **2** revolve in the direction of the arrow. The arms **2** carry hammers **4** preceding the tools **3** in this direction and acting on that surface portion of the rock which is immediately thereafter acted upon by the cutting tools **3**. The boring machine according to FIG. 3 has independently rotating, diametrically opposite inserted-tooth cutters **5**, which gyrate in unison about the axis of the main shaft **1** and cut and remove the rock in inersecting cycloidal paths. The striking hammers **4** may be mounted in a common frame or housing **6**, which is pivoted to the bearing housing **8** of the inserted-tooth cutter on pivot pins **7** whose axis is approximately parallel to the tunnel face. Alternatively, the striking hammers **4** may be mounted on a rigid carrying arm **9**, which follows the circular movement about the axis of the main shaft, as is shown in the lower half of FIG. 3.

According to FIGS. 5 and 6, the inserted-tooth cutter **5** is replaced by a cutter disc **10**, the axis of which is somewhat inclined relative to the tunnel face in a known manner so that the cutters **11** cut and undercut the rock and additional breaking is possible. A rigid housing **12** which is open toward the tunnel face is hinged to the transmission housing **8** which supports the cutter disc **10** and a hammer shaft **13** extending also approximately parallel to the tunnel face is mounted in said housing **12**. The hammer shaft **13** is driven by a motor **14** at a controllable speed and carries discs **15**. Pairs of diametrically opposite striking weights **16** are pivoted on eccentric pins **17** between adjacment discs **15**. These striking weights **16** are designed to fill the available space as completely as possible so that a heavy weight and a great striking force are achieved. The striking weights

16 have hook-shaped extensions 18, with which they bear on noses 19 formed by recesses in the hammer shaft 13 to limit the outward pivotal movement caused by centrifugal force.

The housings 8, 12 are parts of the carrier structure of the boring machine, not otherwise shown, which is fed forward in the direction of the arrow A by the main drive shaft of the boring machine, not visible in FIGS. 5 and 6, in a manner evident from FIGS. 1 and 3.

According to FIG. 7, two additional shafts 20 extend parallel to the hammer shaft 13 and serve to limit the outward pivotal movement of the impact weight 16. These shafts 20 extend parallel to the hammer shaft 13 through slots 21 in the striking weights. The shafts 20 and pins 17 are evenly radially spaced from the hammer shaft and are angularly offset 90° relative to the axis of the shaft 13 so that pairs of striking weights disposed one beside the other in the axial direction may also be installed so as to be offset by an angle of 90° and may be alternatingly mounted on the shafts 17 and the shafts 20. Because the impact of each striking weight causes the balance of the centrifugal force, which balance is due to the arrangement of the striking weights in pairs, to be discontinued for an instant and causes all striking weights disposed one beside the other to impinge at the same time, the released centrifugal forces of all impinging striking weights will be summed up twice during each revolution if the weights are carried only by the shafts 17. However, if the pairs of striking weights are offset by an angle of 90°, the total centrifugal force released at a time will be reduced to one half, but such release will occur at each quarter turn so that an improved mass balance and impact reaction balance will be obtained.

The housing 12 bears on the tunnel face by means of a sliding stop 22 and is urged against the tunnel face by a pneumatic or hydraulic piston drive 23 against the force of a spring 24. The piston drive itself bears on a fixed machine frame or the like, which is not shown in detail. When that cylinder space of the piston drive 23 which faces the housing 12 is relieved of pressure fluid, the spring 24 lifts the housing 12 from the tunnel face. The piston drive 23 may be supplied with the working fluid of the hammer shaft motor 14, which may be of hydraulic or pneumatic type. In this case, the hammer device will be automatically lifted from the tunnel face when the operation is interrupted and will be urged against the tunnel face during boring. The sliding stop 22 determines the correct distance of the hammer shaft 13 from the tunnel face. This stop may be replaced by rollers and, if desired, may be adjustable.

During the rotation of the hammer shaft 13, the striking weights 16 are urged outwardly by the centrifugal force within the range of pivotal movement determined by the hook extension 18 and the nose 19 or by the slots 21 and the shafts 20 and are thus caused to strike upon the tunnel face. The hammer face formed by the periphery of the striking weights 16 may be smooth, as is shown in FIGS. 5 and 7. FIGS. 8 and 12 show various embodiments in which the periphery of the striking weights 16 is provided with extensions 25 having a wedge- or knife-shaped profile. The ridge of these extensions may be serrated (FIGS. 8 and 9). The striking weights consist of a wear-resisting material. The hammer face and the extensions 25 may be reinforced and armored in any suitable manner.

In those areas of the tunnel face where such a directly acting hammer device cannot be accommodated, e.g., in the central zone, a device according to FIGS. 13 and 14 is used. In this case, the hammer shaft 13 and the striking weights 16 are spaced from the tunnel face, where they can be accommodated. To transmit the striking action to the face zone, rod-shaped chisels 26 are provided, which have a platelike head 27 which receives the impact energy and which are also provided with return springs 28. Stops, not shown, ensure that the chisels 26 are correctly positioned when inoperative. Like the striking weights 16 of the directly acting hammer device, the chisel ends 29 are blunt, wedge-shaped, cutting edge-shaped or of similar shape. They may be provided with special striking heads 30. 5 and 8 are again the inserted-tooth cutter and its transmission housing, respectively.

It is obvious that the striking device shown in FIGS. 13 and 14 may be used alone as a hammer device for other purposes, e.g., as a rock-drilling hammer, the hammer shaft being driven by a motor 14 disposed immediately beside the shaft, e.g., by an electric motor, or from a remote position by means of a flexible shaft.

If the inclination of the cutting discs gives a concave shape to the tunnel face, the striking weights disposed in pairs one beside the other have different diameters so that the striking weights are correctly spaced from the face portion to be acted upon by them.

What I claim is:

1. Apparatus for boring holes in rock comprising:
(a) a carrier;
(b) means for feeding said carrier in a predetermined direction;
(c) striking tool means carried by said carrier and operable in an operative position of the apparatus to deliver successive impacts to successive incremental rock surface portions to loosen the rock adjacent thereto; and
(d) cutting tool means carried by said carrier, spaced from said striking tool means in a direction opposite to said predetermined direction, and operable in said operative position of the apparatus to act on each of said surface portions after such impact has been delivered thereto, said striking tool means including
(1) a rotatable hammer shaft having an axis arranged to extend substantially parallel to a rock surface to be acted upon,
(2) striking weights mounted on said shaft for radial outward movement under the action of centrifugal forces when said shaft rotates about said axis,
(3) motor means for rotating said shaft about said axis, and
(4) stop means for limiting said outward movement of said weights.

2. Apparatus as set forth in claim 1, wherein said striking tool means further include chisel rods movably mounted on said carrier and arranged to be acted upon by said striking weights and adapted to act directly on said rock surface in said operative position.

3. Apparatus as set forth in claim 1, wherein said striking tool means further include a plurality of axially spaced discs fixed to said hammer shaft and a plurality of pivot pins fastened to said discs, and pairs of said striking weights in diametrically opposite positions are disposed between adjacent ones of said discs and pivoted thereto on said plurality of pivot pins, said pins having respective axes spacedly parallel to the axis of said hammer shaft.

4. Apparatus as set forth in claim 2, in which each of said striking weights is formed with a slot and in which said stop means comprise two eccentric shafts mounted on said discs and extending parallel to said hammer shaft and through said slots.

5. Apparatus as set forth in claim 2, in which said striking weights have hook-shaped extensions and said hammer shaft is formed with recesses defining noses which constitute said stop means and are engageable by said extensions.

6. Apparatus as set forth in claim 2, in which said striking tool means comprise at least three of said discs and four of said pivot pins, said pins being fixed to said discs and evenly radially spaced from the axis of said hammer shaft and spaced 90° apart relative to the last-mentioned axis, each of said pairs of striking weights being pivoted to two diametrically opposite ones of said

four pins and formed with slots receiving said stop means, which are constituted by the remaining two of said four pins, two of said striking weights being axially juxtaposed and pivoted on shafts angularly offset by 90° relative to the axis of said hammer shaft.

7. Apparatus as set forth in claim 1, wherein said carrier includes a housing, said hammer shaft is rotatably mounted in said housing which carries said motor means and which is pivoted to another portion of said carrier for movement about an axis extending substantially parallel to said hammer shaft, said housing having an open

side adapted to face said rock surface in said operative position.

References Cited by the Examiner

UNITED STATES PATENTS

1,083,666	1/1914	Cook	174—415
1,185,797	6/1916	Hodgson	175—319 X
2,758,825	8/1956	Wohlmeyer	175—106 X

CHARLES E. O'CONNELL, *Primary Examiner.*

N. C. BYERS, *Assistant Examiner.*