United States Patent

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Clermont, France
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[73] Assignee Charbonnages De France
Paris, France
[32] Priority May 17, 1968
[33] France
[31] 152,304

[54] MACHINE FOR EXCAVATING GALLERIES
5 Claims, 16 Drawing Figs.

[52] U.S. Cl. 299/72, 299/15
[51] Int. Cl. E21c 25/62
[50] Field of Search 299/15, 72; 173/23

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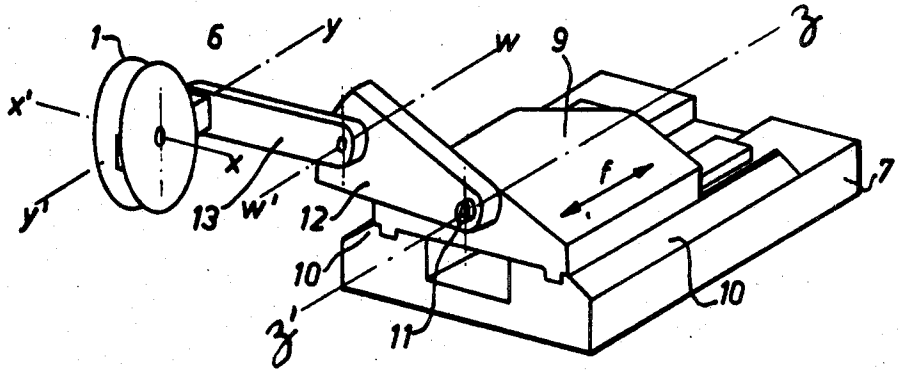
Primary Examiner—Ernest R. Purser
Attorney—Karl W. Flocks

ABSTRACT: A machine for excavating galleries or levels in mines by means of a cutting head which is arranged in such manner that it cuts out, in the wall to be mined, grooves in which the outlines on a vertical plane are parallel in pairs but always perpendicular to the flat wall and cut this latter along successive flat vertical surfaces.

The cutting head is consequently formed by two parallel discs provided with picks driven in rotation by a shaft at right angles to the axis of the gallery and carried by a disc-carrier head which is orientable with respect to a longitudinal axis parallel to the axis of the gallery.



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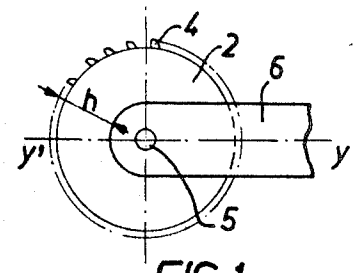

FIG.1

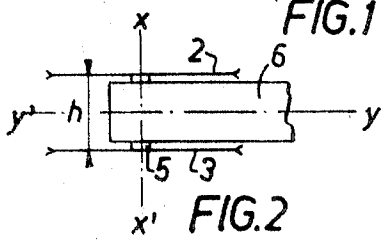

FIG.2

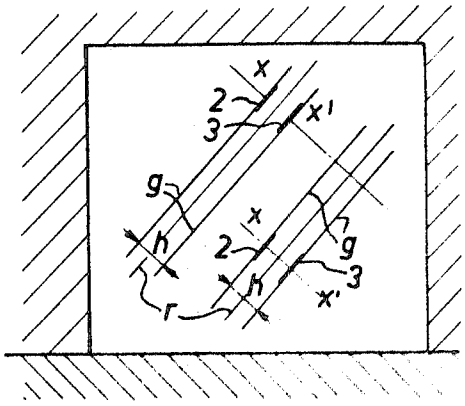

FIG.3

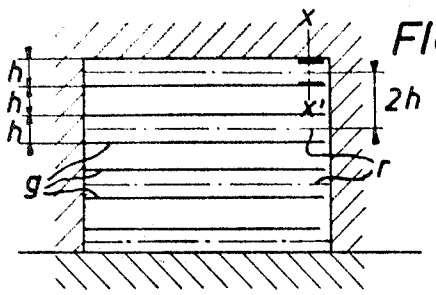

FIG.4

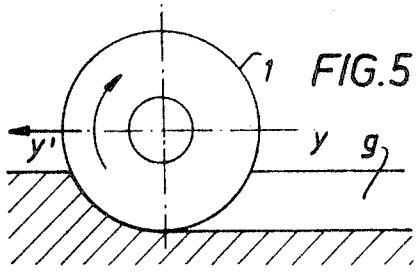

FIG.5

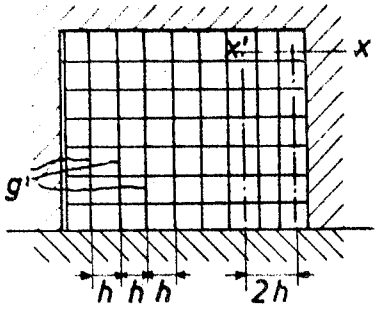

FIG.6

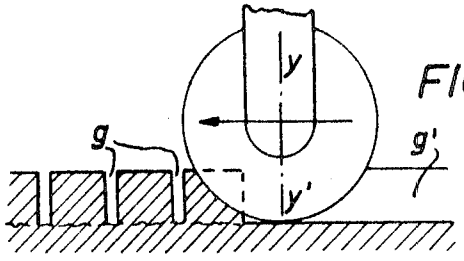

FIG.7

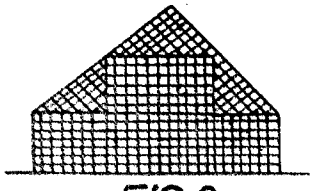

FIG.9

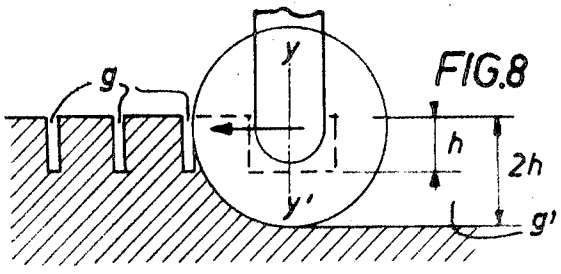

FIG.8

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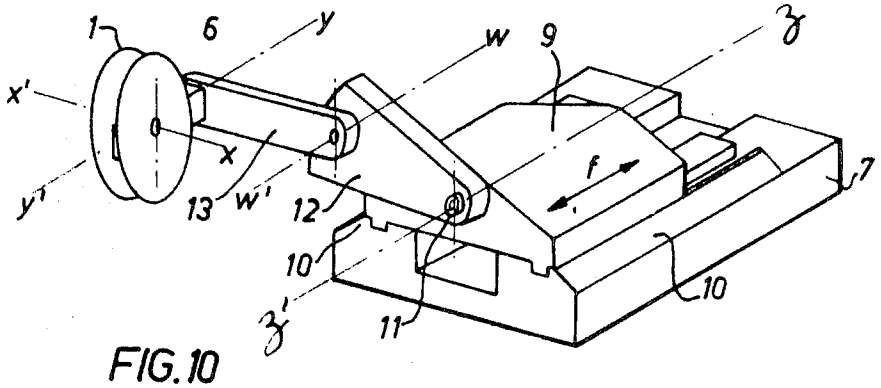


FIG. 10

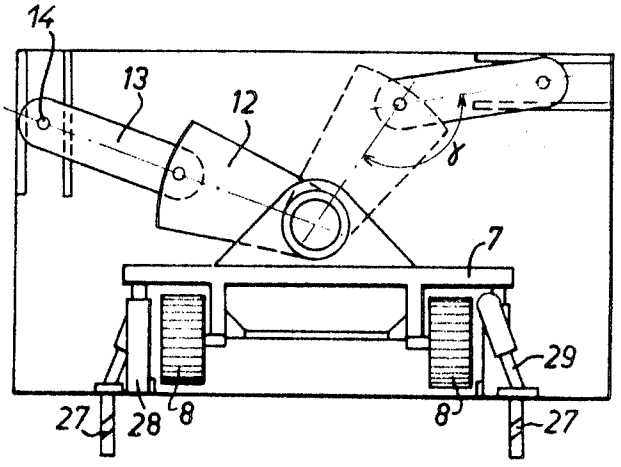


FIG. 13

FIG.11

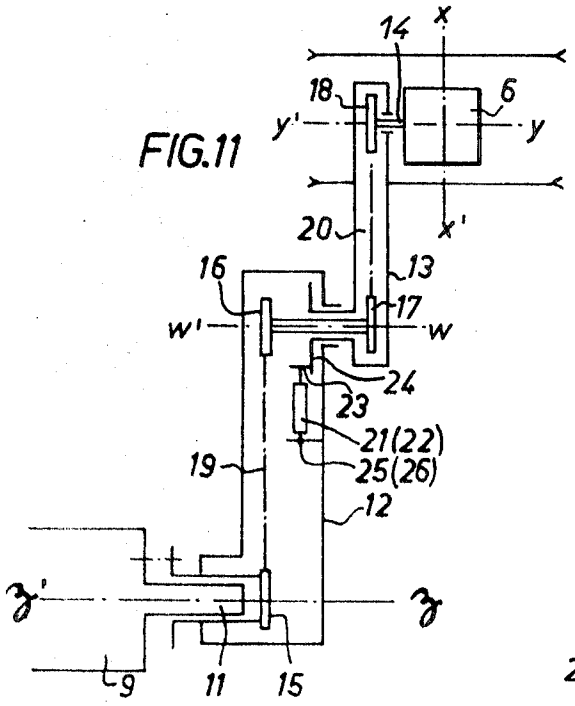
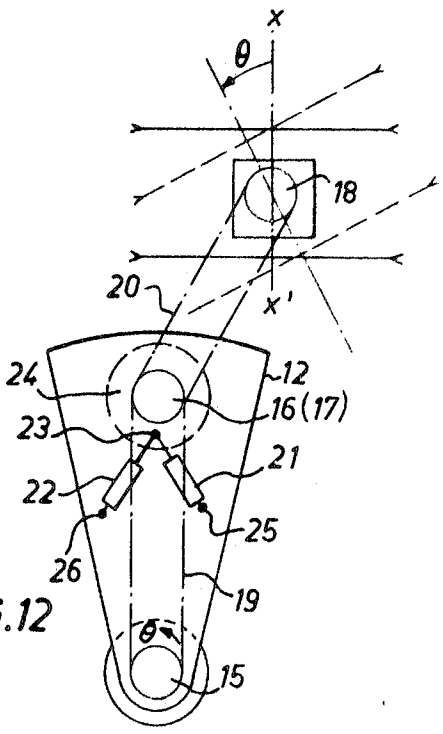

14
x
18
6
y'
y
20
x'
16
13
17
w'
w
24
23
21(22)
25(26)
19
12
z'
z
9
11
15

FIG.12


x
θ
18
20
x'
24
12
16(17)
23
21
22
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26
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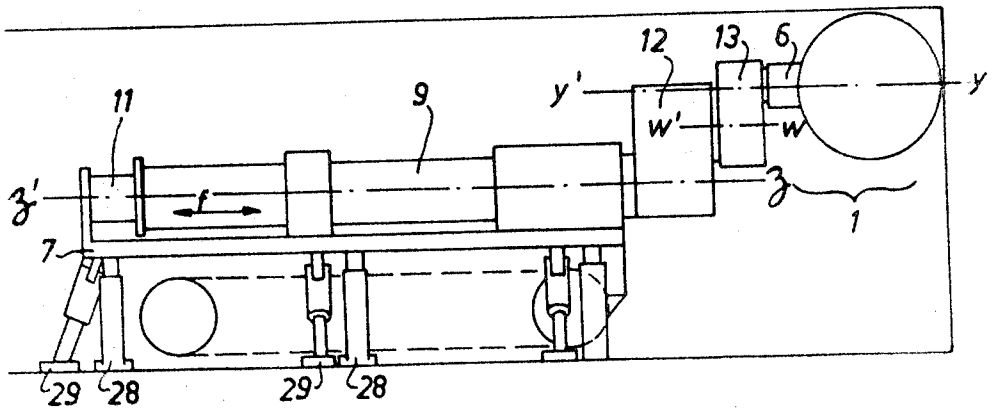
θ
15

FIG.14


12
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y
y'
11
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w'
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z'
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1
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29
28
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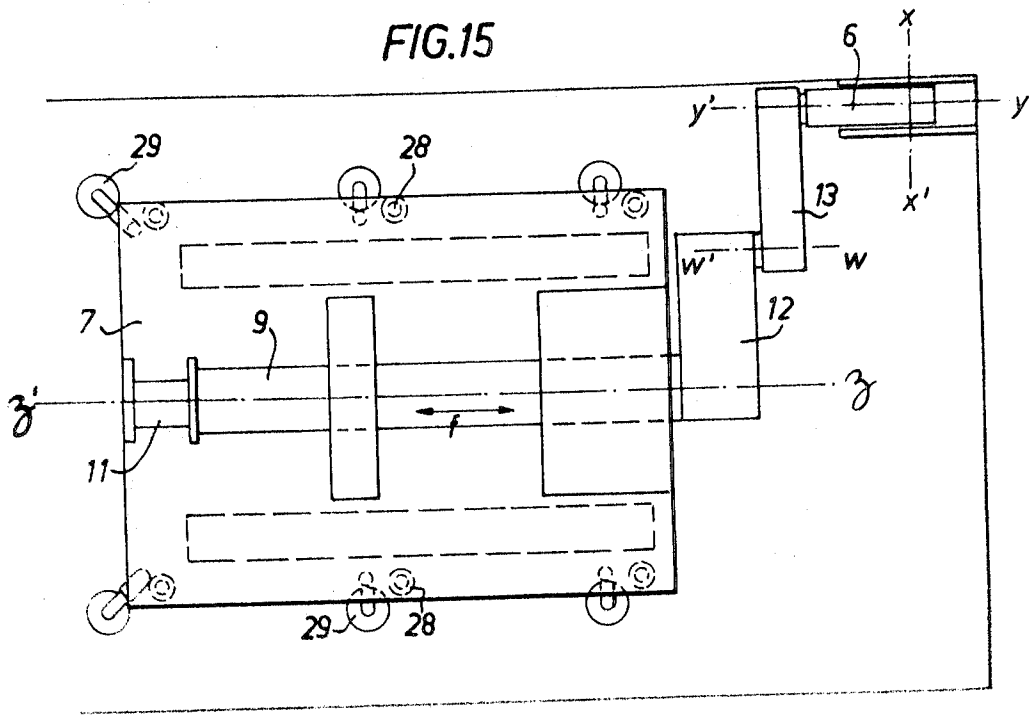
28

FIG.15


x
6
y'
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29
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w
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f
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MACHINE FOR EXCAVATING GALLERIES

The present invention has for its object a machine intended for excavating galleries or levels in mines of all types, by means of a rotating tool which works frontally on the end wall of the gallery to be excavated.

Machines of this type known at the present time are equipped with tools which break up with picks the entire volume to be cut during the course of one pass, which necessitates the provision of very large power.

The Applicant has found that in order to break up a certain volume with a minimum of ground effectively detached by the picks, it is only necessary to arrange the picks on the periphery of the rotating tool in groups of at least three picks, the points of which are separated from each other by a distance substantially equal to the width of one pick, the various groups of picks being separated by a distance which is at most equal to the height of the hollow space existing between each group of picks.

This principle is described in U.S. Pat. No. 3,325,219 filed by the present Applicant, which describes a cutting drum provided with picks distributed in the manner described above.

The machine according to the present invention utilizes a cutting head provided with picks distributed in the manner described above.

Furthermore, contrary to the machines at present known, in which the cutting tools work on the wall along divergent cuts and break it down following successive curved surfaces of a generally spheroidal form, the cutting head of the machine according to the invention is arranged in such manner that it cuts out, in the wall to be mined, grooves in which the outlines on a vertical plane are parallel in pairs but always perpendicular to the flat wall and cut this latter along successive flat vertical surfaces.

To this end, the machine according to the invention comprises, in combination:

- A cutting head formed by two parallel discs provided with picks driven in rotation by a shaft having a "transverse axis" at right angles to the axis of the gallery to be excavated, and carried by a disc-carrier head which is orientatable with respect to a "longitudinal axis" parallel to the axis of the gallery to be excavated, the distance between the discs being at most equal to the radial distance separating the points of the picks from the free extremity of the said disc-carrier head;
- Means for orientating the disc-carrier head in such manner that the above-mentioned transverse axis takes up a desired direction;
- Means for maintaining the direction of the transverse axis parallel to itself; and
- Means for causing the said longitudinal axis to describe planes parallel to the axis of the gallery and at right angles to the direction of the said transverse axis.

According to other characteristic features:

- The cutting head is carried by a part of the machine which is capable of sliding longitudinally with respect to the remainder of the machine;
- The machine is provided with means for immobilizing it, at least momentarily;
- The machine is provided with means for evacuating the products mined by the cutting head.

According to a preferred characteristic feature, the means for immobilizing the machine are constituted by:

- On the one hand a series of extensible jacks arranged between the machine and the ground;
- On the other hand, a series of retractable jacks connecting the machine to anchorage bolts fixed in the ground.

In accordance with one form of embodiment, the sliding portion of the machine is provided with a trunnion having its axis parallel to the axis of the gallery to be excavated, on which can pivot a first transverse arm at right angles to the axis of the trunnion, a second arm being articulated on the free extremity of the said first arm, the cutting head being carried by a shaft having its longitudinal axis parallel to the axis of the trunnion and located at the free extremity of the said second arm, the distance separating the longitudinal axis from the axis of the articulation being at least equal to the distance separating the articulation axis from the axis of the trunnion, reduced by the distance separating the two discs.

Following a preferred characteristic feature of this form of embodiment, the means for orientating the transverse axis of the cutting head and for keeping it parallel to itself, are constituted by:

- A driving pulley pivoted on the trunnion and capable of being locked with respect to the trunnion and free for rotation with respect to the first transverse arm;
- Two intermediate pulleys having their axis coincident with the axis of the articulation of the two transverse arms, coupled together for rotation and free for rotation with respect to the transverse arms;
- A driven pulley coupled for rotation to the cutting head, and free for rotation with respect to the second transverse arm; and
- Two synchronization chains, one winding on the driving pulley and on one of the intermediate pulleys, the other winding on the driven pulley and on the other intermediate pulley.

According to another preferred characteristic feature of the said form of embodiment, the means for causing the longitudinal axis to describe planes parallel to each other and perpendicular to the direction of the transverse axis are constituted:

- by two jacks, the bodies of each are each articulated on a fixed point of the first transverse arm, and the pistons of which are articulated on a wristpin carried by a plate having its axis coincident with the articulation axis of the two transverse arms and fast for rotation with the said second transverse arm; and
- means for causing the said first transverse arm to carry out a rotation, with respect to the trunnion which carries it, conjointly with that of the said plate.

The invention also relates to a method of cutting end sections of galleries to be excavated, the said method consisting:

- in a first state, of orientating the transverse axis of the cutting head along a first determined direction, then causing the longitudinal axis to describe a succession of planes parallel to each other and perpendicular to the direction of the transverse axis, and separated by a distance which is twice that which separates the two discs; and
- in a second state, of orientating the transverse axis along a second direction perpendicular to the said first direction, and then causing the longitudinal axis to describe a succession of planes parallel to each other and perpendicular to the second direction of the transverse axis, and separated by a distance which is twice the distance separating the two discs;
- the depth of cut during the course of the two stages being equal to the distance separating the two discs.

In an advantageous manner, the depth of cut during the course of the second stage is equal to twice the distance separating the two discs.

Other characteristic features and advantages of the present invention will be brought out in the description which follows below, reference being made to the accompanying diagrammatic drawings which are given purely by way of explanation and not any limitative sense. In these drawings:

FIG. 1 is a partial side view of the cutting head;

FIG. 2 is a view of the head looking from above;

FIG. 3 is a diagrammatic representation of the outlines left by the discs on the end of the gallery;

FIGS. 4 and 5 are explanatory diagrams of the method of working of the cutting head during the first stage of the method of mining according to the invention;

FIGS. 6 and 7 are explanatory diagrams of the method of working of the cutting head during the course of the second stage of the method of mining according to the invention;

FIG. 8 is an explanatory diagram similar to that of FIG. 7 of the preferred method of working of the cutting head during the course of the second stage of the method of cutting according to the invention;

FIG. 9 shows a method of notching the end of a gallery having a polygonal section of any kind;

FIG. 10 is an isometric perspective view of a form of construction of the machine according to the invention;

FIGS. 11 and 12 are two partial views, taken along two directions at right angles, of a part of the machine shown in FIG. 10; and

FIGS. 13, 14 and 15 represent a version according to the form of embodiment, shown respectively from the rear, from the side and from above.

FIGS. 1 and 2 respectively represent in diagrammatic longitudinal section and in plan view, the cutting head fitted on the machine according to the invention.

The cutting head, indicated by the general reference 1, is composed of two parallel discs 2 and 3, provided at their peripheries with cutting picks 4 and fast for rotation with a transverse shaft 5 having an axis X–X′ located at the extremity of a disc-carrying head 6, the shaft being driven in rotation about X–X′ by means (not shown) to which reference will be made later.

The disc-carrier head 6 is orientatable about an axis Y–Y′ parallel to the axis of the gallery to be cut and at right angles to X–X′. In FIGS. 1 and 2, the plane of symmetry of the cutting head contains the axis Y–Y′. As will be seen later, the axis Y–Y′ can be displaced with respect to the plane of symmetry of the cutting head, while remaining parallel to this latter.

According to a characteristic feature of the invention, the distance *h* separating two discs 2 and 3 is chosen to be at most equal to the distance separating the extremities of the picks 4 from the free extremity of the casing of the disc-carrier head 6.

The machine is is further characterized in that, for a given orientation of the axis X–X′ (see FIG. 3):

1. X–X′ remains parallel to itself;
2. and in that the axis Y–Y′ may be caused to be displaced parallel to itself in a series of planes parallel to each other and at right angles to the direction of the axis X–X′, these planes forming parallel rectilinear outlines on the wall to be cut (end wall of the gallery).

It follows that during the course of the displacement of the cutting head, and for a given orientation of the axis X–X′, the discs cut in the wall to be worked, pairs of parallel grooves *g* which are equidistant from each other by a value *h*.

The method of cutting according to the invention will not be described, assuming for the purpose of simplification that the section of the gallery to be excavated has a rectangular form (see FIGS. 4 and 5).

In a first stage, the orientation, vertical for example, of the axis X–X′ is first fixed (see FIG. 4). The cutting head being placed in a corner of the section of the wall to be cut, the discs are forced inwards to a depth which is almost equal to *h* so that the casing of the disc-carrier head is level with the wall to be cut (see FIG. 5). Then the axis Y–Y′ is caused to describe a series of parallel horizontal planes separated from each other by a distance substantially equal to 2 *h*. It follows that the discs 2 and 3 form a family of grooves *g* parallel to each other and equidistant by *h*.

In a second stage, the cutting head being again placed in one corner of the section of the wall to be cut, the orientation of the axis X–X′ is fixed perpendicular to the preceding position, that is to say horizontal in the case described, the discs taking up the position shown in FIG. 6. Then the axis Y–Y′, is caused to describe a series of vertical parallel planes separated from each other by a distance substantially equal to 2 *h*.

It follows that the discs, forced into the wall to be cut to a depth *h*, produce a family of vertical parallel grooves *g*′ which are equidistant by *h*. (See FIG. 7).

It can thus be seen that during the course of the second stage, and that as and when the grooves *g*′ are out, the wall to be worked is grooved to form a series of cubes held by one face (their base) which can easily be sheared off at their base, as described in the above-mentioned U.S. patent.

At the end of the second stage, the wall to be cut during the course of the next following pass has a substantially flat surface.

For the second stage, the following method of operation can advantageously be adopted:

In the hole left free by the first cube cut out and sheared off at its base, the disc-carrier head 6 is inserted until it is level with the bottom of the said hole (see FIG. 8). It follows that, when the axis Y–Y′ describes the vertical parallel planes:

a. The discs 2 and 3 cut vertical grooves *g*′ having a depth 2 *h* which is twice that of the horizontal grooves *g*′ cut by the discs during the course of the first stage;
b. The disc-carrier head bears laterally on the cubes thus cut out and causes them to be sheared off.

At the end of this second state, the wall to be cut during the course of the next following pass has the form of a substantially flat wall already cut by vertical grooves *g*′ having a depth *h*.

When the section of the gallery has a polygonal form of any kind (see FIG. 9 for example), it will always be possible to divide it into a number of rectangles which will be cup up, each remaining triangle being cut;

c. In the first place by forming a series of grooves parallel to one of the sides of the triangle;
d. In the second place by forming a series of grooves perpendicular to those preceding.

The machine which enables the method of cutting described above to be effected must therefore comprise:

1. Means for keeping the direction of the axis X–X′ parallel to a predetermined direction;
2. Means for causing the displacement of the axis Y–Y′ parallel to itself and following a series of planes parallel to each other and at right angles to the direction of the axis X–X′;
3. Means for forcing the discs into the wall to be cut;
4. Means for driving in rotation the shaft 5 which drives the discs and of course means for displacing the machine as and when the gallery is excavated, means for immobilizing the machine during the course of a cutting pass, and also means for evacuating the cut products.

According to a form of embodiment shown in FIGS. 10 to 15, the machine comprises the following parts:

A platform 7 which can be displaced by any known means, for example by means of caterpillar tracks 8, supports a frame 9 which can move longitudinally with respect to the platform 7. In FIG. 10, which is a diagrammatic view of the machine intended to show the relative movements of the parts of this form of construction of the machine according to the invention, the frame 9 slides along two longitudinal slides 10. The frame 9 is provided with a longitudinal trunnion 11 having an axis Z–Z′;

A first transverse arm 12, known in the text which follows as a coupling arm, is mounted free for rotation on the trunnion 11;

A second transverse arm 13, known in the text which follows as a supporting arm, is pivoted on the free extremity of the coupling arm by means of an articulation having an axis W–W′.

The disc-carrier head 6 of the cutting head 1 is coupled for rotation to a shaft 14 having its axis Y–Y′ parallel to the axis Z–Z′ and located at the free extremity of the supporting arm.

In this form of embodiment, the means for maintaining the direction of the axis X–X′ of the cutting head parallel to itself irrespective of the movements of rotation of the coupling arm with respect to the trunnion 11 and independently of the movements of rotation of the supporting arm 13 with respect to the coupling arm 12, are advantageously constituted by (see FIGS. 11 and 12):

A driving pulley 15 with an axis Z–Z', capable of rotating freely with respect to the coupling arm 12 but capable of receiving a movement of rotation with respect to the trunnion 11 and of being locked with respect to this latter;

Two intermediate pulleys 16 and 17 with an axis W–W', coupled to each other for rotation but free for rotation with respect to the coupling arm 12 and to the supporting arm 13;

A driven pulley 18 fast for rotation on the shaft 14 with its axis Y–Y' of the disc-carrier head 6, but free for rotation with respect to the supporting arm 13; and

Two synchronizing chains 19 and 20, of which one is wound on the pair of pulleys 15 and 16 and the other on the pair of pulleys 17 and 18.

By means of this set of pulleys and return chains:

1. The two arms 12 and 13 being held stationary with respect to each other and both with respect to the trunnion 11, if the driving pulley 15 is caused to rotate through an angle θit is found that successively:
   a. The chain 19 drives the pulley 16 and the pulley 17 in a movement of rotation having an angle θ, about the axis W–W';
   b. The chain 20 drives the pulley 18 and the axis X–X' in a movement of rotation through an angle θabout the axis Y–Y'.

As the axis Y–Y' and the arms 12 and 13 have not moved, the axis X–X' has rotated through an angle equal to the relative angle through which have turned, on the one hand the driving pulley 15 with respect to the axis of the coupling arm 12, and on the other hand the pulleys 16 and 17 with respect to the supporting arm 13. It follows that, if the driving pulley 15 is locked for rotation on trunnion 11:

2. As the angle of the axes of the arms 12 and 13 remains the same, any rotation through an angle of $\theta$of the coupling arm 12 with respect to the trunnion 11 is equivalent to a rotation through an angle $-\theta$ of the driving pulley 15 with respect to the axis of the coupling arm. The direction of the axis X–X' is therefore compelled to follow at the same time a rotation through an angle $+\theta$ due to the movement of the coupling arm 12 and a rotation through an angle $-\theta$ imposed by the driving pulley. The direction of the axis X–X' remains unchanged.
3. In a similar way, any rotation of the direction of the axis X–X' due to a rotation of the axis of the supporting arm 13 with respect to the coupling arm 12 held fixed, is compensated by a rotation through an equal and opposite angle imparted by the pulleys 16 and 17, fixed for rotation with respect to the axis of the coupling arm 12. In this case also, the direction of the axis X–X' remains unchanged.

It follows that for a given position of the driving pulley 15 on the trunnion 11, the axis X–X' remains parallel to itself, irrespective of the compound movements of the coupling arm 12 with respect to the trunnion 11 and of the supporting arm 13 with respect to the coupling arm 12.

The arm 12 and the arm 13 form a pair of scissors, the blades of which are at an angle γ, and in which the articulation of the axis W–W' can describe a circle, the center of which is the axis Z–Z' of the trunnion 11. It is known that in such an assembly it is possible to compel the free extremity of one of the arms to follow a straight line trajectory of any desired orientation, located inside a surface, the form and the extent of which depend on the relative dimensions of the arms, the extremity of the other arm being articulated on a point fixed in space.

In the form of construction of the machine described, it is only necessary to vary simultaneously and in an appropriate manner the orientation of the coupling shaft 12 and the value of the angle γ formed by the supporting arm 13 and the coupling arm 12, the axis X–X' remaining parallel to itself during the course of these simultaneous movements impressed on the arms 12 and 13.

In order to vary the value of the angle γ, use may advantageously be made of two jacks 21 and 22, the pistons of which have convergent directions and are articulated on a wristpin or crankpin 23 fixed on a plate 24 having an axis W–W' and fast for rotation with the supporting arm 13, the body of each of the jacks being articulated on a fixed point 25, 26 of the coupling shaft 12. The conjoint extension and retraction of the pistons of the jacks 21 and 22 drive the crankpin 23 and therefore the place 24 and the supporting arm 13, in a movement of rotation with respect to the coupling arm 12, the amplitude of this movement of rotation being controlled, either by a manual adjustment or by means of a copying device, in dependence on the amplitude of the movement of rotation of the coupling shaft 12, so that the free extremity of the supporting arm 13 describes the desired straight line trajectory.

During the course of this movement, the axis Y–Y' remaining parallel to itself and to the axis Z–Z', describes a plane parallel to the axis Z–Z' an perpendicular to the direction of the axis X–X'.

The machine shown in FIGS. 13 to 15 differs slightly from that shown in FIG. 10 in that the sliding portion of the machine has the form of a cylindrical beam 9 sliding along a shaft arranged behind the platform, the arm 12 being coupled to the beam 9 in translation in the direction *f* and for rotation about Z–Z'.

Furthermore, it is shown equipped with immobilizing means which are preferably constituted by:

Expandable anchoring bolts 27 forces into the ground all round the platform 7, by any appropriate means (not shown);

A series of extensible jacks or crutches 28 permitting the platform 7 to be raised and the caterpillar tracks to be lifted off the ground; and

Retractable jacks 29 which couple the platform 7 to the bolts 27.

The platform 7 is firmly secured to the ground by the conjoint operation of the crutches 28 and the jacks 29, acting in opposite directions.

The platform 7 being thus immobilized, it is only necessary to cause the frame 9 to move forward with respect to the platform so as to drive the cutting head into the wall to be cut.

It is clear that the dimensions of the parts of the machine are chosen in such manner that the cutting head sweeps over the whole section of the wall to be cut.

In particular, the distance separating the axis Y–Y' from the axis W–W' should not be less than the distance separating the axis W–W' from the axis Z–Z' reduced by the distance *h* separating the two discs. These two distances will preferably be equal.

In all the foregoing text, the means for driving the shaft 5 in rotation about the axis X–X' has not been described and shown.

These means, for any known type, must be compatible with the small dimensions of the disc-carrier head.

It is possible to drive the shaft 5:

either by a series of gears driven in rotation by a motor mounted on the machine;

or by a hydromechanical system comprising two hydraulic jacks and a dog-clutch engagement system or free wheel coupled in rotation to the shaft 5.

Also, the means for driving the coupling shaft 12 and the beam 9 of FIGS. 14 and 15 in rotation about Z–Z' have not been shown.

Similarly, the means for evacuating the broken cutting products have not been shown and described.

These may be of any type known per se, for example of the orientatable "lobster claw" type.

The advantages of the machine according to the invention are numerous.

First of all, the fact that only part of the volume to be cut has to be torn away makes it possible to excavate the gallery more rapidly, with an equal installed power.

Due to the fact that for its immobilization during the course of a pass, its weight is artificially increased by the operation of

the fixing jacks, it may be of very light design, which facilitates its movements of displacement.

Finally, it leaves the front clear, which thus permits the staying system to be put into position as close as possible to the front of the gallery without stopping the working of the cutting head.

I claim:

1. A machine for excavating galleries in mines of all kinds by means of a rotating tool cutting frontally into the wall of the end of the gallery to be excavated, comprising:

a cutting head constituted by two parallel discs, each provided with picks and driven by a shaft with a transverse axis at right angles to the axis of the gallery to be excavated;

the said driving shaft for the discs being carried by a disc-carrier head which is orientatable with respect to a longitudinal axis parallel to the said axis of the gallery to be excavated;

the distance comprised between said discs being at most equal to the radial distance between the points of said picks and the free extremity of said disc-carrier head;

means coupled to said disc-carrier head adapted to orientate said disc-carrier head and to bring said driving shaft with transverse axis into a predetermined direction;

means supporting said orientating means adapted to maintain said predetermined direction of the driving shaft with transverse axis parallel to itself;

means supporting said cutting head in a longitudinally sliding manner with respect to the remainder of said machine;

and means pivotally supported on said last mentioned supporting means adapted to cause longitudinal axis to describe planes parallel to said axis of the gallery to be excavated, and at right angles to said direction of said transverse axis.

2. A machine for excavating galleries as claimed in claim 1, and further comprising means for immobilizing said machine momentarily, said means being constituted, on the one hand by a series of extensible jacks disposed between the machine and the ground, and on the other hand by a series of retractable jacks coupling the machine to anchorage bolts in the ground.

3. A machine for excavating galleries as claimed in claim 1, in which said sliding means carrying the cutting head comprise: a trunnion having its axis parallel to said axis of the gallery to be excavated and on which is pivotally mounted a first transverse coupling arm perpendicular to the axis of said trunnion; a second transverse supporting arm mounted on an articulation axis at the free extremity of said first coupling arm, the cutting head being in turn carried by a shaft with its longitudinal axis parallel to said trunnion axis and located at the free extremity of said second supporting arm, the distance separating the longitudinal axis of said cutting arm from said articulation axis of the two transverse arms being at least equal to the distance separating said articulation axis from the axis of said trunnion, reduced by the distance between said two discs.

4. A machine for excavating galleries as claimed in claim 3, in which the means for orientating the transverse axis of the cutting head and for maintaining it parallel to itself are constituted by:

a driving pulley pivoting on said trunnion and adapted to be locked with respect to said trunnion and free for rotation with respect to said first transverse coupling arm;

two intermediate pulleys having an axis coincident with the articulation axis of the two transverse arms, coupled for rotation to each other and free for rotation with respect to said transverse arms;

a driven pulley coupled for rotation with said cutting head and free for rotation with respect to said second transverse supporting arm;

and two synchronizing chains; one winding on said driving pulley and on one of said intermediate pulleys, the other on said driven pulley and on the other intermediate pulley.

5. A machine for excavating galleries as claimed in claim 3, in which the means for causing said longitudinal axis to describe planes parallel to each other and perpendicular to the direction of the transverse axis are constituted by:

two jacks, the bodies of which are each articulated on a fixed point of the first transverse coupling arm, and the pistons of which are articulated on a crankpin carried by a plate having its axis coincident with the articulation axis of the two transverse arms and fast for rotation with the second transverse supporting arm;

and means for applying to said first transverse coupling arm a rotation with respect to the trunnion supporting said arm, said rotation being conjoint with that of said plate.