United States Patent

Fairweather et al.

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[45] **Oct. 3, 1972**

[54] **APPARATUS FOR TREATING OR DIGGING INTO SURFACES AND CUTTING MEMBERS FOR THIS APPARATUS**

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[73] Assignee: **Errut Products Limited,** London, England

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **299/39,** 173/99, 299/85

[51] **Int. Cl.**.....**E01c 23/09**

[58] **Field of Search** 299/39, 85, 86, 37; 173/98, 173/99

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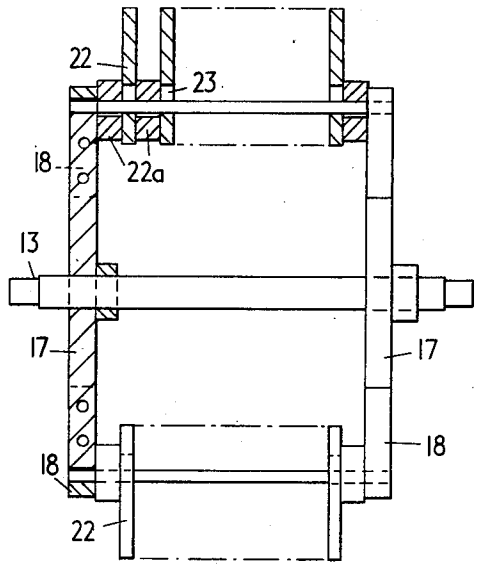
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Primary Examiner—Ernest R. Purser
Attorney—Irving M. Weiner

[57] **ABSTRACT**

Apparatus for planing or cutting a surface of hard material including a plurality of support rods mounted between two support members and extending parallel to each other, each support shaft carrying a plurality of cutting members or tines rotatably mounted thereon through elongated aperatures and moving means for rotating the support members in an orbital path so that, after impact with the surface of material, the cutting members can be returned to a position approximately along the radial component extending outwardly from the orbital path before the next succeeding impact of that cutting member.

13 Claims, 23 Drawing Figures



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SHEET 1 OF 7

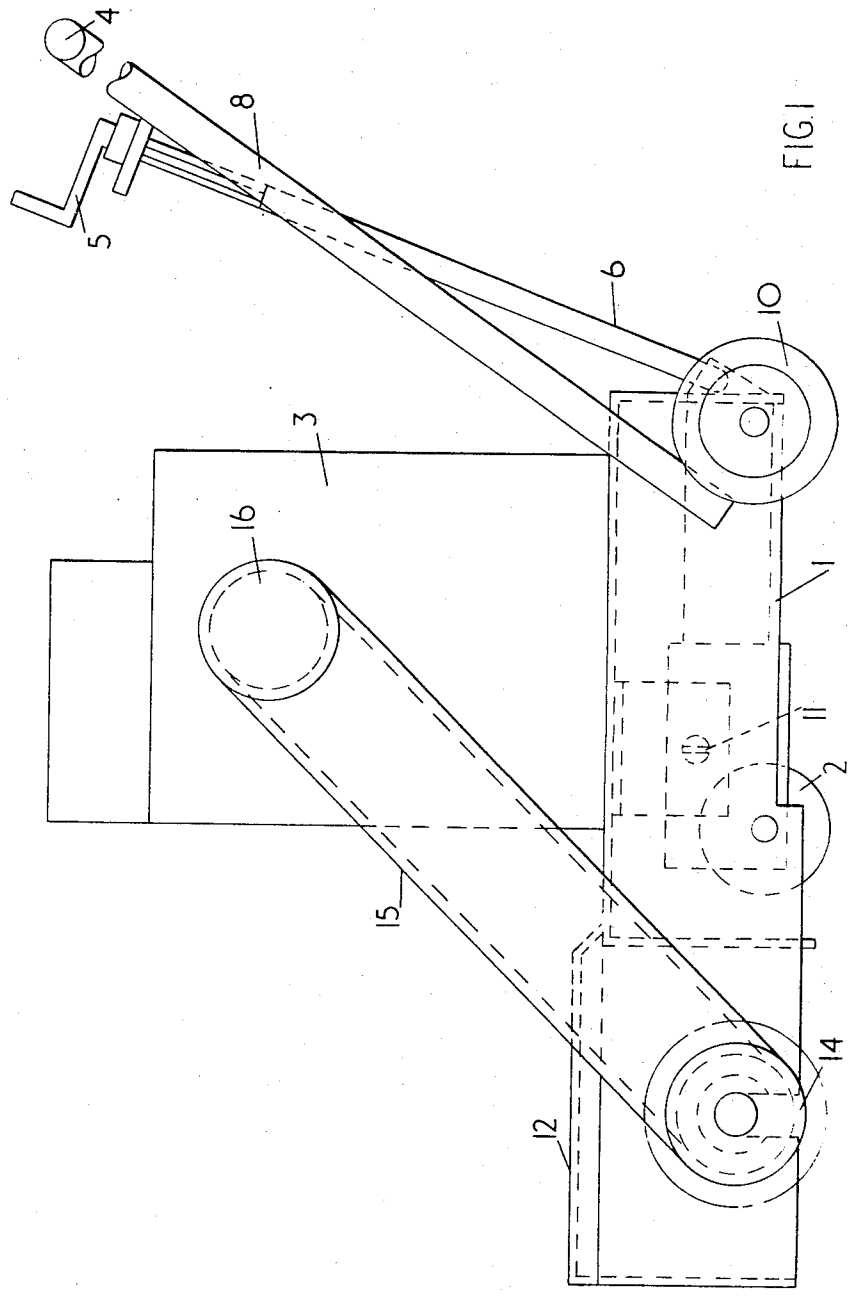


FIG. 1

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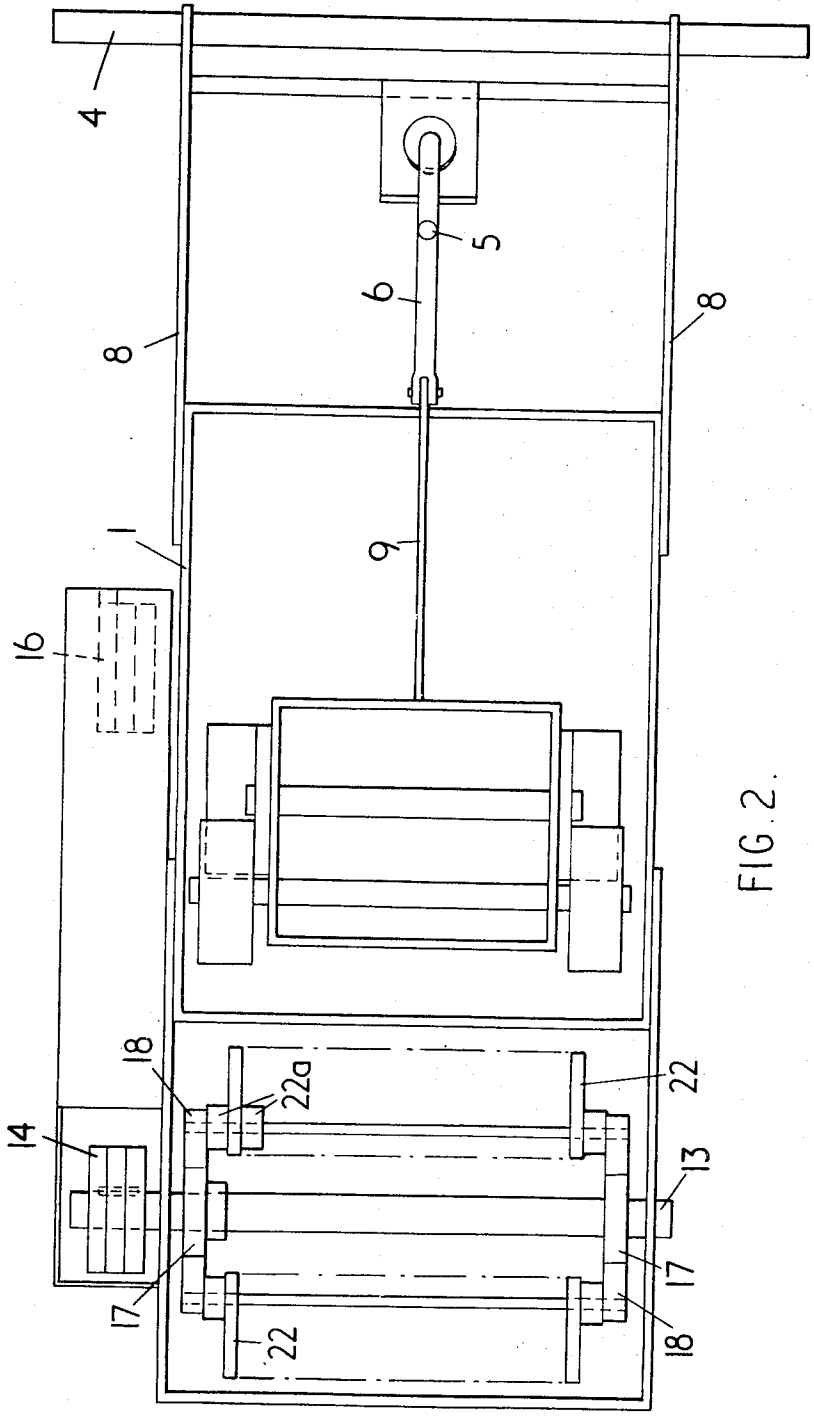


FIG. 2.

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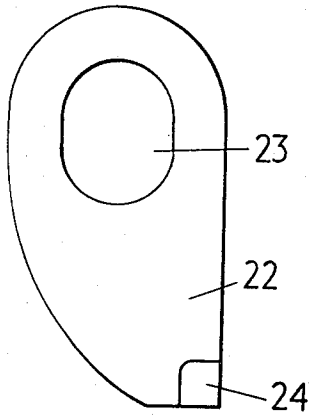


FIG. 3a

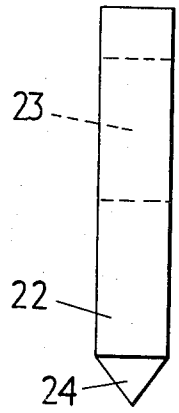


FIG. 3b

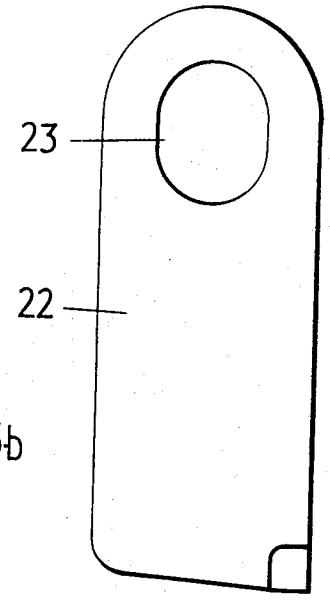


FIG. 4a

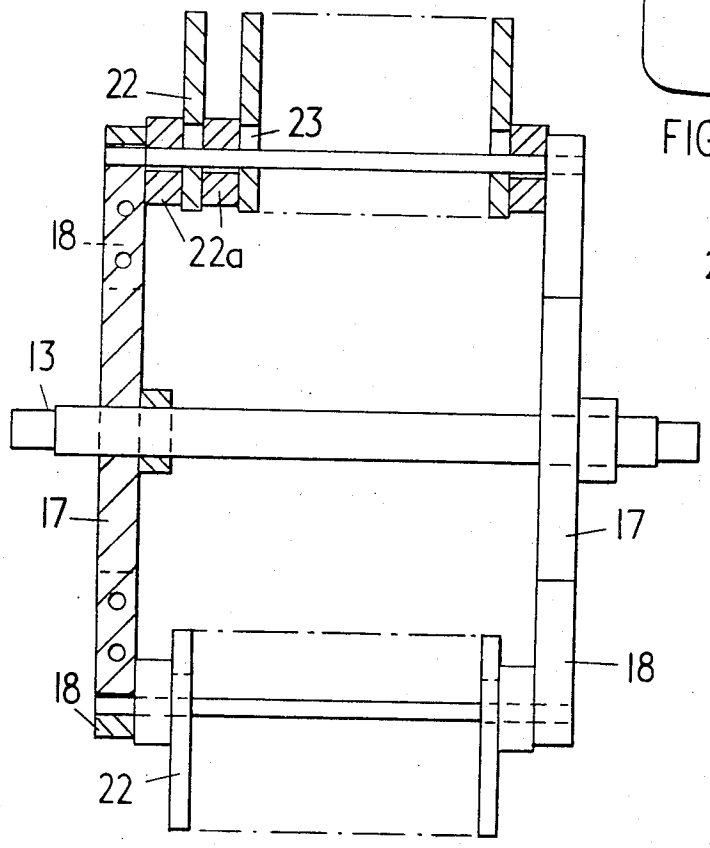


FIG. 5.

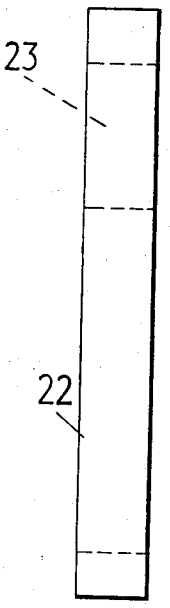


FIG. 4b.

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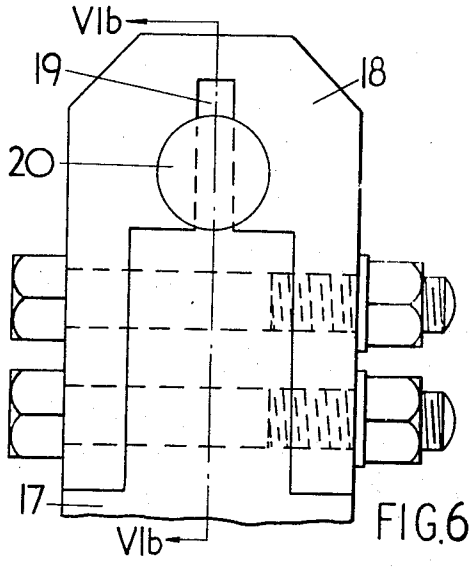


FIG. 6a.

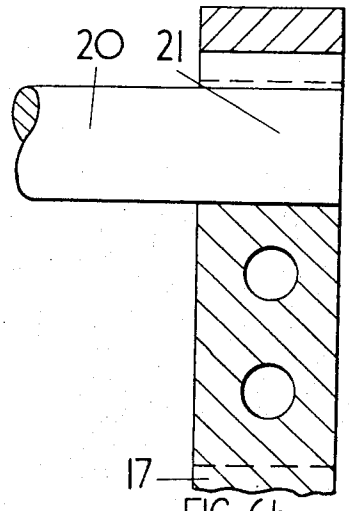


FIG. 6b.

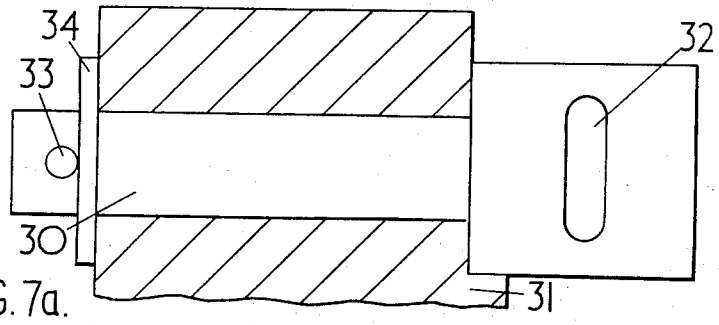
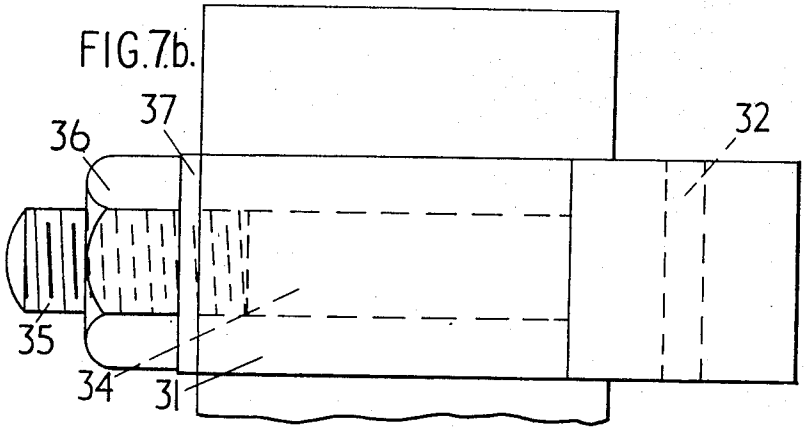


FIG. 7a.

FIG. 7b.



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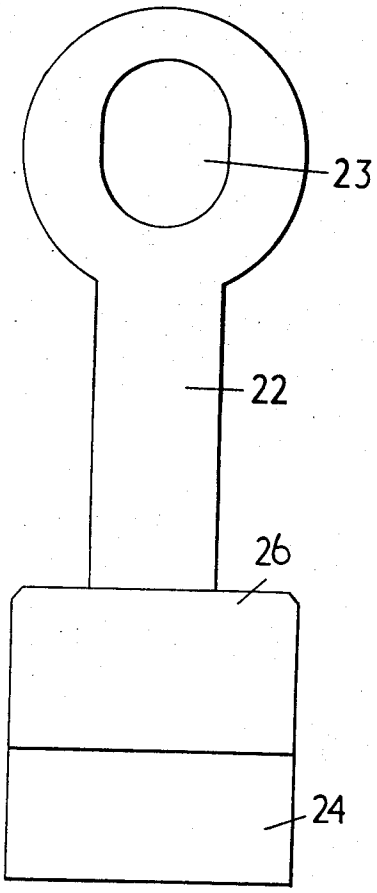


FIG 8a

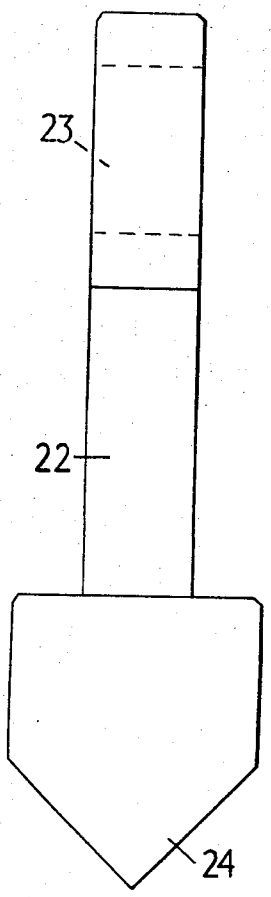


FIG 8b

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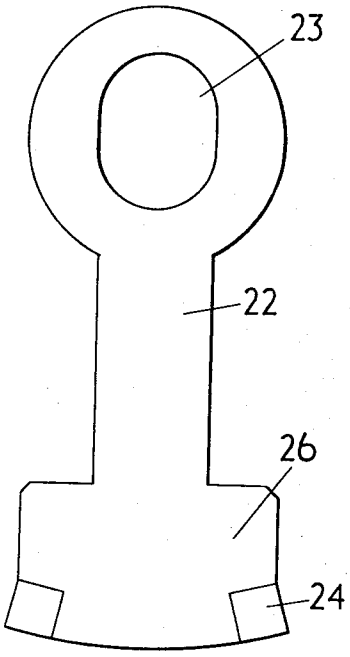


FIG. 9a.

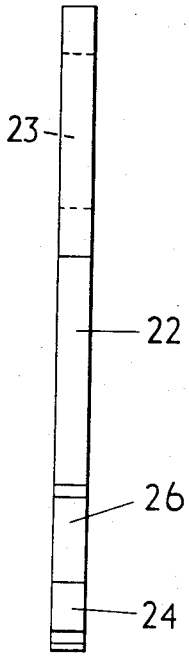


FIG. 9b.

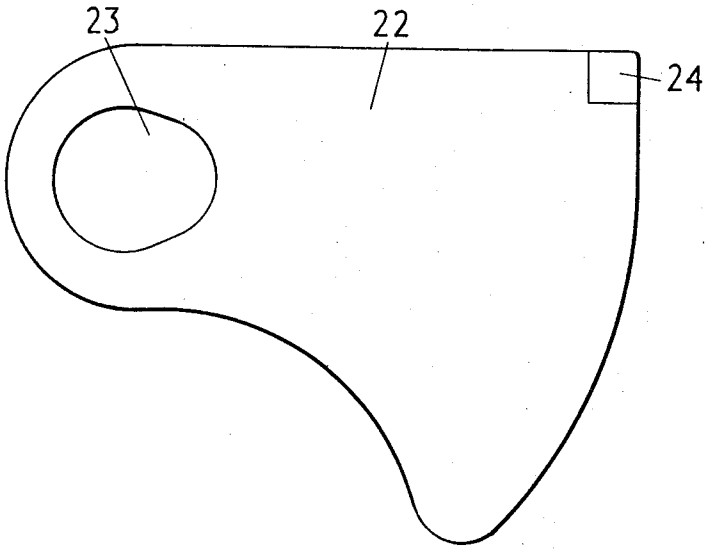


FIG. 10a.

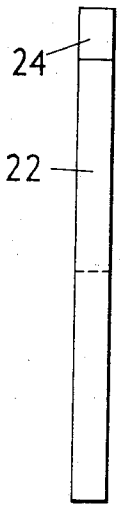


FIG. 10b.

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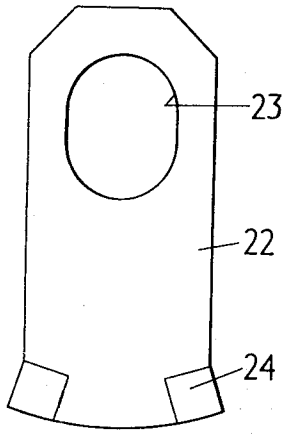


FIG. 11a.

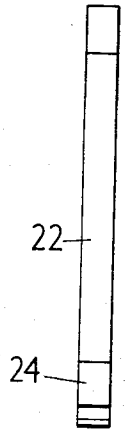


FIG. 11b.

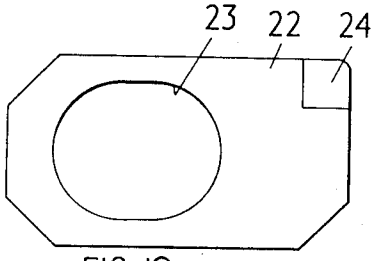


FIG. 12a.

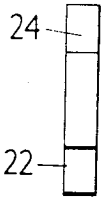


FIG. 12b.

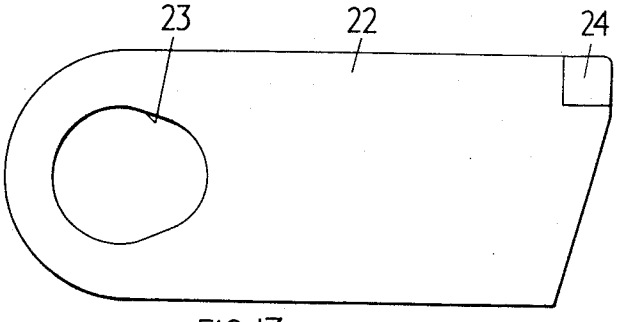


FIG. 13a.

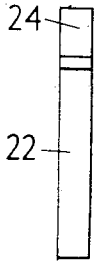


FIG. 13b.

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APPARATUS FOR TREATING OR DIGGING INTO SURFACES AND CUTTING MEMBERS FOR THIS APPARATUS

This invention relates to apparatus for treating or digging into material, for example for cutting grooves in bricks or the like and cutting members for this apparatus.

One useful example of this apparatus is a scarifying apparatus for planing down or otherwise dressing a man-made surface such as a concrete, asphalt, bitumen, brick or tile surface such as a floor, ceiling or wall, roads, runways or other large area and digging a channel in such a surface or digging down the whole area. Another example is apparatus for scabbling steel surfaces. Another useful example is apparatus for the comminution of natural rock, for example coal in a coal cutting machine. Another possible use is apparatus for cutting trees, bush clearing or even grass cutting or digging soil.

It is already known to provide hard metal tipped cutting or impacting hammers which have a number of annular ring-shaped cutting abrasive wheels on a support shaft in a freely rotatable manner and which arrange for the shaft to be moved in an orbital path around an axis parallel to the shaft so that the cutting wheels strike the surface to be planed and proceed to grind the surface whilst, at the same time, the tools are rotated around the support shaft. The cutting wheel has a number of radially extending projections to strike and cut into the hard surface. These cutting wheels have the disadvantages that the wheels wear out too quickly and also the planing down action is not fast enough. It is possible for all these apparatus to be powered by a petrol or diesel engine, a pneumatic motor or an electric battery or the electric mains supply.

From one aspect the invention consists in apparatus for treating surfaces comprising a plurality of support members, a plurality of cutting members rotatably mounted on each support member, each cutting member being so shaped that its center of gravity is spaced from the support member by a predetermined distance, support means for supporting the plurality of support members in parallel relation and moving means for moving the support means so that the cutting members are moved in an orbital path and at such a speed that, after impact with the surface of the material, the center of gravity of the cutting members can be returned to a position along the radial component extending outwardly from the orbital path perpendicular to the direction of movement of the cutting member before the next succeeding impact of that cutting member with the surface of the material.

Preferably the machine includes securement means for securing the support shaft to the support means, this securement means including a receiving member connected to the support means and arranged to provide a slot to receive one end of the associated shaft.

The receiving member may have a stem portion extending through an aperture in the support means and a head portion having a slot to receive the end of the support shaft.

The machine is particularly useful for cutting grooves or channels in concrete walls and floors.

The invention also includes a cutting member or tine which has an integral cutting tip and connecting means for connecting the cutting member to support means,

the connecting means being such as to permit movement of the cutting member having a radial component with respect to an orbital path of the support member after impact, the center of gravity of the cutting member being spaced from the support means.

The cutting member is preferably a straight bar of steel as connection means with an integral tungsten carbide tip or simply a high speed steel providing its own tip. The tip may be secured by brazing and its mounting improved by having a spigot receivable in a recess in the cutting member. The cutting member may have more than one cutting tip, possibly a second for use after the first has become worn situated at a corner adjacent the first and remote from the connecting means. The connection means may be an elongated aperture for receiving the support means therethrough or spigots projecting therefrom and receivable in a slot in the support means so as to permit the necessary movement of the cutting member. Alternatively the cutting member may simply comprise a hard cutting material tip mounted on a flexible connection or support member, for example a steel wire or chain, which can be made fast to an additional support means. Such a flexible connecting member permits the necessary movement of the cutting member. The center of gravity of the cutting member should lie on an arc as near the point of cutting as possible.

The radial movement of the cutting member after impact is its most important feature. It prevents dragging of the cutting member across the cut surface after impact and thus saves energy. Bar cutting members with non-flexible connection means are preferably dressed off by grinding at the corner next to the cutting point and remote from the connection or connecting means. This also saves energy by preventing dragging. After impact the cutting member rides up with respect to the support member and so saves energy and prevents damage to its mounting.

The center of gravity of the cutting member may in general be spaced from the support means by from one-half to 12 inches, preferably from 1⅛ to 4⅜ inches. An elongated aperture or spigot should in general have a minimum diameter 1.05 times that of the shaft or slot with which it is to engage. The ratio of the major to the minor diameter of such an elongated aperture or slot should be at least 1.25. The cutting angles of the cutting member may be from −10° to +25° on the front clearance and from +2° to +15° on the top clearance. A cutting tip end which is spherical or fully radiused in side view can be used, a radius of three-eighths inch being suitable. Such a tip need never be re-ground; the full volume of the tip can be used up and then the cutting member thrown away. Alternatively a pointed tip may be used.

These cutting members may advantageously be used in machines for continuous tunnelling; ripping; dinting; concrete planing, sawing or grooving; wall chasing; anti-skid surfacing; coal cutting; asphalt planing; suitably modified where necessary, in addition to the other kinds of machine mentioned above. Cutting tip speeds of up to 150 feet per second have satisfactorily been used on tines up to 6 inches long with high efficiency, in terms of cubic yards of rock cut per gram of hard cutting material of the tip used up. The higher the impact speed the better. Speeds lower than that at

which centrifugal force is such that the cutting members do not return to an approximately radial or cutting position before the next impact cannot be used. The force on the cutting members is generally such that they tend to roll rather than slide on their support means as is shown by the wear patterns. As many cutting members as possible should be used in any particular circumstances. For anti-skid grooving or sawing the cutting members should be accurately guided in a radial plane so as to minimize lateral movement and produce sharp-edged cuts.

An example is shown in the accompanying drawings in which:

FIG. 1 is a side view of a machine suitable for cutting slots or grinding surfaces;

FIG. 2 is a plan of FIG. 1;

FIGS. 3*a* and 3*b* show a tine in side view and end view respectively;

FIGS. 4*a* and 4*b* show another tine in side view and end view respectively;

FIG. 5 is a section through the drum of the surface treating machine;

FIG. 6*a* is an enlarged view of a part of FIG. 5;

FIG. 6*b* is a section on the line VI*b*—VI*b* of FIG. 6*a* without bolts, nuts or washers;

FIGS. 7*a* and 7*b* show parts of two modified versions of a part of the machine, namely two further end caps; and

FIGS. 8*a* and 8*b* to 13*a* and 13*b* show further forms of tine in side view and end view respectively.

In FIG. 1 and FIG. 2 there is shown a floor treating machine suitable for planing down a floor surface by say 2 or 3 or, if required, it could cut out a channel of up to say 4 to 6 inches. The machine has a basic frame 1 or carriage supported on wheels 2 and arranged to carry a power source within the container 3 and having a guide handle 4 for the operator to guide the machine over the floor during operation. An adjusting handle 5 is secured to an adjustment tubular rod 6 in screw-threaded connection with a cross-member to the two side arms 8 of the guide handle 4. The adjustment rod 6 is connected to a fork member 9 which carries the rear wheels 10 and is pivotally connected by pivot bolts 11 to the frame 1 so that rotation of adjusting handle 5 will make fork 9 pivot relative to frame 1 so that the cutting assembly located on the front of frame 1 will be raised or lowered relative to the floor which is to be treated.

This cutting assembly includes a cover frame 12 connected to the front end of frame 1 and carrying a main drive shaft 13 driven by pulleys 14 connected by an endless belt 15 to pulleys 16 driven by the power source in container 3. Shaft 13 carries spiders 17 (FIGS. 5 and 6) and each arm of the spiders 17 has an end cap 18 bolted to the end of the arm and defining a slot 19 extending radially outwardly from the main shaft 13.

A secondary or support shaft or rod 20 extends between each pair of corresponding arms of the spiders 17 and each end of the shaft 20 has a flat portion 21 (FIG. 6*b*) located within slot 19 to allow a little radial movement when the spider 17 rotates as main shaft 13 is rotated by the power source. This power source could be an electric battery. Alternatively the power source could be replaced by a mains supply. Each secondary or support shaft 20 which are equiangularly spaced around the shaft or axis 13, form of tines having a body 22 (FIGS. 3, 4 and 8 to 13) and spaced apart by precision spacers 22*a* so that the tines of different shafts 20 are aligned with each other. For many uses these spacers 22*a* are removed and the machine will then cut a wide groove equal to the combined width of the adjacent cutting members instead of a series of spaced grooves or slots. These tines can be packed together along the shaft 20 or spaced apart or in groups by removable spacing elements. Each body 22 has an aperture 23 to allow the tine to be freely rotatable around shaft 20 and also has a cutting tip 24 of tungsten carbide. In the tine of FIG. 4 the aperture 23 is elongated to allow movement of the tine radially relative to the shaft 20 so that upon impact, the tine can move radially inwardly to give an impact cutting effect. Instead of a point tip of tungsten carbide, the tip could be a rectangular block fitting into a corresponding shape in the tine body.

In FIG. 7*a* there is shown another form of end cap for the secondary support or cutter shaft including a bolt member 30 extending through another form of spider 31 and having a head portion defining a slot 32 to retain the flat end of the secondary support shaft for supporting the cutting members. The slot 32 allows some transverse displacement of the support shaft. The bolt member is held in position mounted on the spider 31 by a pin 33 resting against a washer 34 hard up against the spider 31.

In FIG. 7*b* the bolt member is viewed in plan showing the slot 32 in dotted lines and looking end-on down the spider to see the main shaft of the drum. However, a different securing means is shown in dotted lines since the bolt member has an axial slot 34 into which a bolt 35 screw fits and a nut 36 screw fits onto the bolt 35 and rests tightly against washer 37 resting against spider 31. These arrangements allow a narrow spider of only 1 inch thickness to be used.

There could be some marble or tiles put down in factories, or put up especially on office and other walls, the treatment of that surface, or grooving or channelling into the surface, could be achieved with this apparatus with any suitable modifications.

We wish to point out that, although in the example described, an electric power source was used, this machine could very suitably be used with petrol or diesel engines or pneumatic or hydraulic engines where the application of the machine makes these other engines more suitable.

We also wish to point out that the machine can be used to take off small amounts such as one-eighth inch or one-fourth inch from a surface as well as larger amounts.

It will be seen that this machine uses energy more efficiently than compressed air driven machines so that another form of the machine could be designed to be especially suitable for comminuting material and it is possible to use tines freely pivotally supported on a support shaft arranged to move in an orbital path. The tine is held by centrifugal force in an outwardly approximately radial direction due to its center of gravity being spaced from the support shaft and the support shaft being rotated sufficiently fast. In this radially outward position the tines strike the material, for example a rock or coal face, and by frequent and continual battering by these tines the rock can be cut into. Clearly some

of the constructional details of the machine would vary from the floor surface treating machine shown in the drawings.

A feature of the machine when used for comminuting material is that it can make available greater amounts of energy for comminuting and degrading rock or other materials than can the currently used machines, in particular those driven by compressed air. The present method of planing concrete to lower the surface is to use a scabbling machine which comprises a multiplicity of piston cylinder units. Typically there would be seven such units in a block, the pistons having a diameter of 1½ inches and a stroke during the operating stroke of 1¾ inches.

It will be appreciated that increasing the drum speed increases the available energy as the square of the ratio of the increase and increasing the tine weight gives a proportionate increase in energy available at the point of impact.

Also energy can be very much concentrated, not only by making a tine width of say one-fourth inch but also by having many tines in the same radial plane and so striking the same spot many times per revolution of the drum.

Also the machine is much more compact that the scabbler, in that the scabbler has seven or 11 pistons over a width of say 16 inches. In the case of tines the only restriction on the number of impacts per revolution is in the number of cutter shafts on the drum over the same width, whereas the scabbler needs space to accommodate each piston/cylinder unit in the block. Hence, within the same weight and working volume it is possible to accommodate many more energy producing units than with the compressed air driven machine.

Finally, there is no theoretical limit on either drum size or tine weight. A drum of say 60 inches in diameter having tines of say 10 lbs. weight could be used for cutting say, coal, and with a smaller energy input than the modern coal cutter machine, although in this case restriction of sideways tine movement would be essential.

The only restriction on the effectiveness of the tine is that the centrifugal force provided by drum rotation must be great enough to ensure that the tine is approximately radially disposed to the shaft center line immediately prior to impact. This requirement holds whatever the displacement of the tine during the comminution process.

This machine and cutting member could be used to cut into rocks and in extreme varied mining applications and several possible forms of the cutting member or tine are shown in each of FIGS. **8***a* and *b* to **13***a* and *b* in side view and end view respectively.

In FIG. **8** the body portion **22** has a stem connecting the aperture **23** to a wider and heavier portion **26** containing the cutting tip **24**. A similar form is shown in FIG. **9** but in this case two cutting tips **24** are shown provided on opposite sides of the same outer end of the tine so that, when one tip **24** has been used, the tine can be reversed and the other tip **24** can be used.

In FIG. **10** the body **22** is shaped to continuously widen towards the outer end containing the cutting tip **24** so as to provide the necessary weight for effective percussion action by the tine.

In FIG. **11** two tips **24** are provided on opposite sides of the outer end and the width of the tine around the aperture **23** is reduced by chamfering the shoulders of the inner end adjacent the aperture **23**.

In FIG. **12** only one tip **24** is provided and the remaining shoulder of the outer end has been chamfered like the two shoulders of the inner end. In FIG. **13** the aperture **23** is shaped to have a radius of 1.25D/2 on its inner side and 1.05D/2 on its outer side where D is the diameter of the support shaft to extend therethrough. The distance between the center of curvature of the inner and outer sides of this aperture **23** lies in the range 0.1D to 0.5D.

With these tines there can be a great improvement on the current machines not only for scabbling concrete but in many mining operations. Not only are compressors not required for treating man-made surfaces but the energy required is only that to rotate the drum and also to absorb the impact of each tine after it has struck the surface being worked.

It will be appreciated that the cutting members really achieve their effect by impact rather than literally cutting since they are allowed to recoil. This recoil can be up to 30°. The machine must be run at sufficient speed for the cutting members to regain their approximately radially extended position before the next impact.

It is often desired to provide a series of parallel grooves or slots on a surface, for example roads or runways and this machine can be used employing the precision spacer **22***a* between adjacent cutting members **22** on each support shaft **20** so that the cutting members of each shaft **20** are coplanar and thus produce a series of slots corresponding to the number of cutting members on a support shaft **20**. Thus the width of each slot corresponds with the thickness of the cutting members producing it. The spacers **22***a* must permit complete freedom of radial movement of the cutting members on their support shafts and then allow the desired movement of the cutting members back to their impact position. This is particularly useful to provide anti-skid and non-aquaplaning surfaces.

It is, in practice, very desirable to provide a strong safety cover to fit over the rotating drum when in use.

We claim:

1. A machine for treating a surface, comprising in combination:

a carriage carrying support means rigidly supporting a plurality of support rods extending in parallel relation and equiangularly spaced around a central axis;

drive means for rotating said support means so that said support rods move in a circular path around said central axis;

at least one cutting member for each support rod;

each cutting member being elongated in one direction towards an outer end;

a cutting tip portion adapted to cut into said surface and located at said outer end of said cutting member;

said cutting member having an elongated aperture elongated in the direction towards its outer end and adapted to receive one of said support rods so that said cutting member can rotate around said support rod and can move a predetermined distance radially relative to said support rod; and

the rotary speed of the moving means being such that, after impact with said surface, each cutting member freely pivots on its associated support rod to return substantially to its original position before the next succeeding impact of said cutting member with said surface.

2. A machine characterized in accordance with claim 1, wherein said support means includes at least a main body part, a securement member having an aperture for receiving an end portion of said support rod and connecting means for releasably connecting this securement member to said main body.

3. A machine characterized in accordance with claim 1, including:

a plurality of cutting members on each said support rod;

spacer means located between said cutting members;

and said spacer means being wider than the width of said cutting members and the arrangement of spacer means and cutting members on each support rod being identical so that the machine produces a number of parallel continuous slots in said surface.

4. A machine characterized in accordance with claim 3, wherein said support means includes at least a main body part, a securement member having an aperture for receiving an end portion of said support rod and connecting means for releasably connecting said securement member to said main body.

5. A cutting member comprising: an integral tungsten carbide cutting tip;

an elongated body;

said cutting tip being disposed at one end of said elongated body to cut into a surface to be treated;

means defining an elongated aperture extending in a direction generally toward said end having said cutting tip;

said means defining said elongated aperture being adapted to receive therethrough at least one support rod so that said cutting member may rotate around said support rod and move a predetermined distance radially relative to said support rod; and

the center of gravity of the cutting member being spaced from said support rod.

6. A cutting member as claimed in claim 5 which is of high speed steel providing its own tip.

7. A cutting member as claimed in claim 5 in which the tip has a spigot receivable in a recess in the cutting member.

8. A cutting member as claimed in claim 5 in which the tip is secured by brazing.

9. A cutting member as claimed in claim 5 which has two cutting tips.

10. A cutting member as claimed in claim 5 in which the center of gravity of the cutting member is spaced from the support means by from one-half to 12 inches.

11. A cutting member as claimed in claim 5 in which the center of gravity of the cutting member is spaced from the support means by from 1⅛ to 4⅜ inches.

12. A cutting member as claimed in claim 5 in which the cutting angles of the cutting member may be from −10° to +25° on the front clearance and from +2° to +15° on the top clearance.

13. A cutting member as claimed in claim 5 in which the cutting tip is spherical or fully radiused in side view.

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