PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : B23D 63/14	A1	(11) International Publication Number: WO 92/19406
		(43) International Publication Date: 12 November 1992 (12.11.92)

(21) International Application Number: PCT/GB92/00833

(22) International Filing Date: 7 May 1992 (07.05.92)

(30) Priority data:
9109832.7 7 May 1991 (07.05.91) GB

(71)(72) Applicant and Inventor: ELLIS, Glynn, Arthur [GB/GB]; 55 Canal Street, Long Eaton, Nr. Nottingham NG10 4GA (GB).

(74) Agent: RUSSELL-RAYNER, Albert, Patrick; Russell-Rayner, Business Centre, Avenue One, Business Park, Letchworth Garden City, Hertfordshire SG6 2HB (GB).

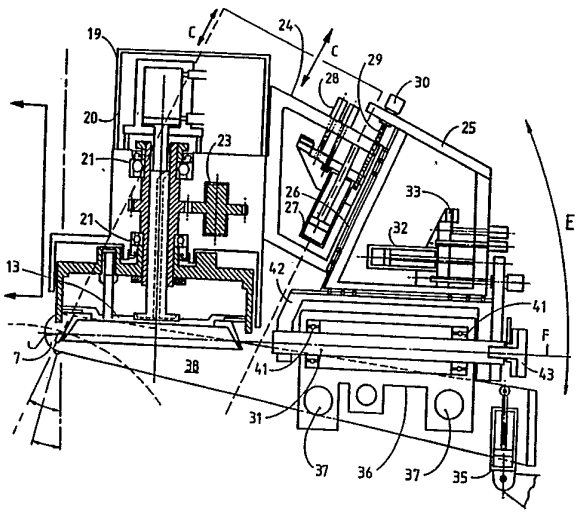
(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BG, BR, CA, CH, CH (European patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GB, GB (European patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC (European patent), MG, MW, NL, NL (European patent), NO, PL, RO, RU, SD, SE, SE (European patent), US.

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: SAW BLADE MACHINING SYSTEM

(57) Abstract

A machine for grinding the hard material tips (9) provided upon saw blades (6), characterised in that to one side of a vertical plane passing through a machining position (X) to which a tip (9) is set for the purpose of the machining of faces of the tip, means are provided for enabling the machining of the front (10) and top (11) faces of the tips and in that provision is made on the machine to the other side of said plane for mounting means for enabling the machining of the side faces and/or the machining of the steel relief groove in the blade and/or grooves, slots, in the top and front faces of the tips, the arrangement being such that all machining operations required on a tip may be performed without it being necessary to displace the tip being machined from the machining position to which it is set for the purposes of machining.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CS	Czechoslovakia
DE	Germany
DK	Denmark
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GN	Guinea
GR	Greece
HU	Hungary
IT	Italy
JP	Japan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
LI	Liechtenstein
LK	Sri Lanka
LU	Luxembourg
MC	Monaco
MG	Madagascar
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
NL	Netherlands
NO	Norway
PL	Poland
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SN	Senegal
SU	Soviet Union
TD	Chad
TG	Togo
US	United States of America

SAW BLADE MACHINING SYSTEM

FIELD OF THE INVENTION

This invention is concerned with machines and systems for producing saw blades having hard material tips.

BACKGROUND OF THE INVENTION

Commonly used materials for the hard material tips includes Tungsten carbide; Stellite etc.

It is a very well established practice to provide hard metal tips for circular and linear saw blades by mounting to the individual teeth of the blade tips which have been previously shaped so as generally to conform the the finally required shape to the tip.

In use the faces of the tips need to be accurately ground so as to produce a series of surfaces bevelled or otherwise which bear very carefully defined angular relationships one to the other.

In particular, the faces to be thus machined include the front face of the tip, i.e., that face which forms the leading face of the tip when a saw is in use; the top face of the tip which is the face most remote from the base of the tip and the two side faces.

In addition to the faces of the tip itself it is usually necessary to be able to machine the outermost peripheral part of the tooth itself this being commonly referred to as steel relief.

It will be understood by those skilled in the art that

the machining of the tip front face must be such as not to damage the tooth gullet. The machining of the front faces is itself a relatively complex matter since the face may be required to slope downwardly and rearwardly, may required to be bevelled, grooved, with bevelling etc., differing from tip to tip.

In addition, it is important that the machining of the side faces does not unnecessarly remove material from the side faces of the tooth.

The machining of the top face of a tooth effectively sets the location of the tip cutting edge, this being the line interface between the top face and the front face.

In relation to these two faces it is important to bear in mind that according to the specific requirements for a saw blade that the top faces can be machined so that the cutting edge is effectively parallel to the axis of the blade, or is inclined so that each end of the cuting edge is higher than the other. Furthermore, it is also possible that the inclination of the cutting edge of successive tips should be oppositely inclined with respect to each other.

In addition, either or both the top and front faces can be bevelled. This bevelling can provide two or three sections to a face, and may be symmetrical or asymmetrical as required.

Finally the machining of the side faces can involve dishing of these faces in such manner that the cutting edge ends appear to sweep outwards to distinct points.

From the forgoing it will be appreciated that the machining of the tips provided upon for example, a

circular saw blade is a very compliated process.

THE PRIOR ART

Many proposals have been made for the production of machines which are able to deal with the machining of various faces of the tips. However, with all of the known mahines it is necessary to provide separate machines to perform top face side face and front face grinding capability.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide a machine for the machining of the hard material tips provided upon saw blades which is capable of being utilised for the grinding of various combinations of machining operations on the fasces of the tips and the tooth itself.

STATEMENTS OF INVENTION

Broadly, according to a first aspect of the invention there is provided a grinding machine including means for enabling top face, front face and side face grinding of hard material tips provided upon the teeth of saw blades to be machined without it being necessary to displace the tip being machined from its initial position.

Preferably, the machine is based upon a modular concept in that at any one time at least three various forms of machine tool can be presented to tip to be machined.

In a preferred construction top face bevelling; front face bevelling can be effected on a tip whilst it is in the machining position for the machine.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention and to show how to carry the same into effect reference will now be made to the accompanying drawings in which:-

Figure 1 schematically illustrates a known form of grinding wheel when in its saw blade tooth tip front face grinding position;

Figure 2 illustrates schematically forces involved in machining a tooth tip front face with the grinding wheel of Figure 1;

Figure 3 is a sectional side view of a first embodiment of a machine incorporating the concepts of the invention and being particularly intended for the grinding of the front faces of saw blade tooth tips;

Figure 4 illustrates to an enlarged scale a detail of the machine of Figure 3;

Figure 5 is a fragmentary plan view to an enlarged scale of a detail of the apparatus of Figure 3:

Figure 6 is a fragmentary plan view of a further detail of the machine of Figure 3:

Figure 7 schematically illustrates the pivoting range of a grinding wheel head of the machine of Figure 3;

Figure 8 shematically illustrates detail of a tip height setting arrangement provided in the machine of Figure 3;

Figure 9 is a part sectional view of the machine of

Figure 3 and additonally incorporating means for effecting steel relief angle machining; quill grinding and top face slotting;

Figure 10 is a plan view of the right hand side of Figure 9;

Figure 11, schematically illustrates steel relief machining;

Figure 12, schematically illustrates slotting of a top face;

Figure 13, schematically illustrates front face grooving by a quill grinding wheel;

Figure 14 is a sectional view of embodiment of a machine incorporating the concepts of the invention and being particularly intended for the grinding of the front, top and side faces of saw blade tooth tips;

Figure 15 is an enlarged plan view of an arrangement for profiling the side faces of a tip;

Figure 16 is a transverse schematic view illustrating the profiling operation; and

Figures 17 to 22 each illustrate a possible profile that can be produced on a tip.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before considering the structure and operational functions of the machine of the present invention it is convenient to consider a major problem arising from the use of the commonly used disc like diamond tipped grinding wheels by referring to Figures 1 and 2. Thus, Figure 1 schematically illustrates a known form of diamond grinding wheel 1 including a main body 2 journalled for operational rotation on a drive arbor 3. The wheel 1 has an annular peripheral region 4 provided with a peripheral layer 5 of diamond grinding material.

In the Figure the wheel 1 is illustrated in its operational relationship to a saw blade 6 having teeth 7 and gullets 8, therebeing on each tooth 7 a hard material tip 9 with a front face 10 and top face 11.

Since the blade teeth 7 of present day saw blades 6 can have very small tooth pitches i.e., 8 millimetres, the tips 9 to be ground are relatively close to each other so that the separation therebetween is relatively small, leaving little clearance for the grinding wheel 1. Thus it is necessary for the peripheral region 3 of the grinding wheel to taper as indicated in Figure 2 so as to be able to enter the tooth gullets 8 of the saw blade 6 to machine a tip front face 10.

Hence the peripheral region 4 and the grinding material layer 5 are relatively thin in the axial direction of the grinding wheel 1, whereby the pressures arising from a grinding operation tend to distort the grinding wheel peripheral regions 4. The direction of the distortion is schematically indicated in Figure 3 which is a greatly enlarged fragmentary view of a tooth 7, a gullet 6, a tip

9, together with the grinding wheel peripheral region 4 and associated grinding material layer 5.

During the grinding operation the wheel 1 is moved downwardly in the direction of the arrow 'A', and in the course of such grinding, distorting forces are produced in the sense indicated by the arrow 'B' at the peripheral region 4 of the grinding wheel.

It is convenient to note that Figure 2 illustrates a partially ground front face 10 and that during grinding the layer 5 of grinding material wears away generally in the manner shown at 12.

To reduce the effect of these distorting forces upon a grinding wheel it is proposed in accordance with a first aspect of the present invention that the grinding wheel for the grinding of the front faces of the tips of saw blade teeth is of a dished/cup form as shown in Figures 3 and 4. This wheel can be regarded conveniently as a flaring cup wheel.

Figure 4 is a fragmentary view of a grinding wheel in dished/cup form in the course of grinding a front face 10 of a tip 9 on a tooth 7 of a saw blade 6 having gullets 8. As indicated in the Figure 4 a cup shaped grinding wheel 13 includes a central main body 9 having a central bore (not shown) for enabling mounting of the grinding wheel 13 to an arbor (not shown) and a conical wall 15 provided at its outer peripheral region 16 with a circuferential continuous strip material layer 17 of grinding material such as diamond grinding material. In practice it has been found that the conical wall can have a cone angle between 15 to 35 degrees of angle with approximately 25 degrees being a preferred value.

In use, the cup wheel 13 and the tip face 10 to be machined are so relatively positioned that during the tip face machining operation the grinding layer 17 is advanced in a direction 'C' running parallel to the required angle for the tip front face 10 being machined.

It will be noted from the Figure 4 that the conical cup formation ensures that the area/portion of the layer 17 (and of course the corresponding region of the conical wall periphery 16) that is in instantaneous contact with a tip face 10 does not distort (as would be the case with a flat grinding wheel 1) since the instantaneous contact portion/area is fully supported by the remainder of the cup formation of the wheel 13.

Turning now to Figure 3 this illustrates in cross section apparatus for mounting the cup wheel 13 of Figure 4, and for enabling the wheel 13 to undergo the operational displacements necessary to machine the front face of tooth tip to be ground.

The machine includes a main frame structure (not shown) providing an arbor 18 for mounting a circular saw blade 6 whose tips 9 are to be ground. The machine incorporates arrangements (not shown) for rotationally indexing the blade so as sucessively to bring the next tip 9 to be machined into a machining position. This machining position has been indicated by the letter 'X'. For the purposes of the following description this position can be regarded as an axis extending perpendicular to the plane of the sheet on which Figure 3 is drawn.

In practice, in order to be able to machine a tooth tip front face it is required that the mounting and control arrangements for the associated grinding wheel should enable the grinding wheel:-

(a) to advance and retract relative to a tip front face to be machined along the direction which forms the front face hook angle.

(b) to enable the angular set of the grinding wheel grinding surface to be varied according to the required hook angle of the front face;

(c) to be able to advance the grinding wheel from a rest position into the position in which it can make a face grinding pass to remove the requisite amount of tip face material, and to be able to retract the grinding wheel away from any possible contact with the machined front face during the return of the grinding wheel to its rest position.

(d) to enable full length and partial bevelling of the front faces of the tips.

In order to provide for the factors above mentioned the machine of Figure 3 can be conveniently regarded as comprising a number of sections/units each associated with a particular operational function and interconnected one with the other to enable what ever face grinding requirement needs to be effected.

A first of these units 19 forms the machine grinding head and incorporates the grinding wheel 13 and its associated rotational drive. The section thus includes a housing 20 mounting bearing arrangements 21 for rotatably mounting a shaft structure 22 carrying at its lower end the cup shape grinding wheel 13. The unit 19 incorporates drive means 23 for transmitting rotational drive to the shaft structure 22. The drive can be by electric motor; or which ever drive means considered appropriate such as,

for example, a hydraulic drive.

The unit 19 is carried by a support assembly 24 which can be regarded as providing a further one of said sections.

The support assembly 24 is in turn mounted to a further support assembly 25 by way of spaced parallel bearing guide ways schematically shown at 26 which enable precise relative displacements therebetween in such manner that relative slidable movements between the assemblies 24 and 25 is along the direction 'C', that is along the required face angle direction.

The structural inter-relationships between the grinding head 19 and the support assembly 24 are such that the displacement of the support assembly along the direction 'C' correspondingly moves the grinding wheel 13 in such manner that the layer 17 of the grinding wheel 13 is also moved along the direction 'C' that is along the required face angle direction.

The support assembly 24 is displaced relative to the support assembly 25 by means of a hydraulic cylinder/ram 27 controlled by a hydraulic system (not separately shown).

A stop arrangement 28 is provided for controlling the extent of the relative displacement between the assemblies 24 and 25. This stop arrangement 28 will be discussed in detail hereinafter. The initial setting of the assembly 24 with respect to the assembly 25 is settable by means of a precise ball screw type adjustment means 29 having an operating head 30. This positional setting, in practice, defines the limit of downward movement of the bracket assembly 24 relative to the assembly 25.

The setting is necessary to ensure that at the completion of a downwardly directed machining movement of the grinding wheel 13 the latter cannot touch a tooth gullet 8.

The support assembly 25 is positionally adjustably carried from a mounting unit 31 in such manner that the assembly 25 can be reciprocated, relative to the mounting unit 31 by means of a hydraulic system including a hydraulic cylinder/ram 32, along the direction of the arrow 'D'. A further adjustable stop arrangement 33 whose structure is similar to that of the arrangement 28 is provided for setting the limits of displacement of the assembly relative to the mounting unit 31. In so far as the movement of the grinding wheel 13 is concerned the displacement of the assembly 25 along the direction 'D' moves the grinding wheel head 19 and thus the wheel 13 towards the tip 9 so that the grinding layer 17 is advanced prior to the commencement of a machining movement to the required position relative to the next front face to be ground and which has by then been indexed to axis 'X', and to retract the wheel 13 sufficiently from the tip on completion of front face machining operation to prevent further contact between the layer 17 and the thus machined front face 10 on movement of the grinding wheel 13 upwardly.

The mounting unit 31 is carried by a yoke unit 34 which is pivotally mounted to the main frame of the machine in such manner that the pivotal axis thereof intersects the previously mentioned axis 'X', and such that the yoke unit 34 can be pivoted up or down under the control of a control means shown in the Figure 1 as a hydraulic cylinder/ram 35, the sense of pivotal movement of the yoke unit 34 is indicated by the arrow 'E'.

In practice, the construction of the yoke unit 34 is such that the angular positioning of the yoke unit 34 with respect to the machine frame determines the face angle to be machined on a tip.

The mounting unit 31 is intended to provide for two modes of movement of the support assembly 25, and thus the axis of rotation of the shaft 22 mounting the grinding wheel 13, with respect to the medial plane of a blade 6 whose tips are to be machined. The first mode involves pivoting the assembly 25 and thus the grinding head 19 whereby the rotational axis of the shaft is tiltable to either side of the vertical plane about an axis 'F.

The second involves a lateral displacement of the assembly 25 in the plane of the axis 'F', that is into and out from the plane of the paper on which the Figure 3 is drawn. This second movement mode has the effect of displacing the axis of rotation of the shaft 22 to either side of the medial plane of the blade 6, and thus the centre line of the associated teeth tips, thereby moving the grinding wheel to such position that the region of contact between the grinding layer 17 and the tip front face 10 is offsettable with respect to the medial plane of the blade 6, and thus the centre line of a tip front face 10. In practice, on grinding the front face when the grinding wheel is in such an offset position the front face can be bevelled at the side to which the grinding wheel 13 has been laterally displaced.

The mounting unit 31 includes a slide block 36 slidably engaged with two transverse members 37 forming part of the yoke 34 and engaging in the side rails 38 of the yoke 34.

The slide block 36 is positionally adjustable lengthwise of the members 37 by means of a hydraulic cylinder/ram 39 which is arranged to be able to displace the slide block to either side of the medial plane of the blade by presettable distances as is shown in Figure 5. A manual control 36A is provided for setting the central position of the slide block to take into account the thickness of a blade.

The manual control 36A can comprise a screw threaded arrangement so as to adjust the central position of the slide block 36 to take into account differing thicknesses of saw blades 6. This is shown in Figure 6.

When correctly set relative to the yoke 34 the central longitudinal plane of the slide block 36 coincides with the vertical plane containing the axis 'F'as is shown in Figure 6. Stop means (not shown) are provided for limiting displacement to either side of the central position of the slide block 36. The stop means setting range is such as to enable front face bevelling within a range of 5 to 25 degrees of arc.

An axially directed shaft 40 is supported from the slide block 36 by means of bearings 41. A support bracket 42 carrying the assembly 25 is secured to the shaft 40. The bracket 42 is lockable in the position in which the support assembly 25 effectively supports the head unit 19 in the position in which the axis of the shaft is vertical by an electromagnetic locking device 43. A hydraulic ram (not shown) is provided for pivoting the bracket 42 and thus the grinding head 19. The pivoting can be to either side of the central plane containing the axis 'F'. The tilting feature is shown in Figure 8. In this Figure 8 the extremes of the tilt positions for the head unit 19 are shown in dashed lines.

The extent of pivoting of the grinding head 19 to either side of this plane can be at any required angle up to forty five degrees of arc. It will be appreciated that control means (not shown) are provided for ensuring that the tilt of the grinding head is accurately repeatably settable to the required degree of tilt.

To effect grinding of a front face the ram 26 is operated to lower the grinding head to cause the wheel 13 and thus the layer 17 to make a grinding pass across the front face. At the end of the stroke, this being defined by the stop arrangement 28, the ram 32 operates to move the wheel 13 away from contact with the tip face 10 and the ram 26 is operated to lift the wheel 13 away from engagement between the teeth 7 of the blade 6 whereafter the indexing arrangement is caused to index the blade 6 to bring the next tip to be machined to the position 'X'.

It will be understood that the position of the axis 'X' does not change and can thus be regarded a prime reference position for the machine.

The Figure 3 also illustrates arrangements for enabling a further grinding wheel intended for the grinding of the top faces 11 of the tips 9 to undergo the displacements reguired to achieve requisite grinding of such top faces. Thus to enable machining of the top faces of the tips the head unit 19 is modified as to incorporate a second grinding wheel 50 which is coaxial with the cup wheel 13.

For the double grinding wheel construction the shaft 22 connects with the second grinding wheel 50 which essentially comprises a cylindical wall part 51 concentric with the axis of rotation of the shaft 22 and provided with a continuous layer 52 of grinding material

on its lowermost annular face 53. The shaft 22 in this embodiment has an axial through bore 54 within which is located a support shaft 55 for the cup grinding wheel 13 previously discussed. The shaft 55 of the cup wheel 13 is axially displaceable with respect to the shaft 22 so that the cup wheel 13 can be selectively positioned in a retracted position as is shown in Figure 9 in which the wheel 13 is totally shrouded by the cylindrical wall 51.

With this relative positioning the cylindrical grinding wheel 50 is in a position to effect a grinding operation upon the top faces of the tips on a blade whereas the grinding wheel 13 has been moved to a position in which it cannot contact the front face of any tip.

The upper end of the cup wheel shaft 55 connects with a piston 56 moveable in a cylinder 57 which is positionally fixed relative to the shaft 22.

The relative displacement of the cup wheel 13 with respect to the cylindrical wheel 50 is conveniently effected hydraulically by way of oil flow ports 58,59.

In order to prevent ingress of grinding detrius into the space beween the two grinding wheels 13 and 50 a wiper ring 60 closes off the space 61 defined between the two wheels 13 and 50. To prevent upward distortion of the wiper ring 60 when the cup wheel 13 is moved downwards into its operational position an air bleed path 62 is provided between a location upwardly of the shaft 22 and the space 61 between the two grinding wheels 13,50.

Rotational drive for the cup wheel 22 is derived via connection pins 63 (only one shown) engaging in complementary bores 64 in the main body 65 of the cylindrical wheel 50.

Downward movement of the cup wheel relative to the cylindrical wheel 50 into its operational position effectively automatically moves the cylindrical top face grinding wheel 50 to its inoperative position.

Retraction of the cup wheel 13 upwardly, to its rest position automatically brings the top face grinding wheel into its operational position.

In relation to the grinding of the top faces of a tip there is a frequent requirement that the top face height should vary from tip to tip. In the case of machines presently available only two tip heights are possible. In practice, this situtation does not satisfy present day requirements for a wider range of tip heights. In accordance with a further aspect of the invention the machine of the present invention affords the possiblility of arranging for as many heights as may thought useful, for example, from one to five different heights. In practice, the height variation is normally effected in such manner on sucessive teeth as effectively to form groups of teeth.

The variation of the heights is effected by the adjustable stop arrangement 28 provided upon the support assembly 24. This height adjustment arrangement 28 is such that in order to change the grinding height for a tip top faces, it is merely necessary to select the relevent one of a number of stops controlling the extent of downward movement of the support assembly 24 with respect to its support assembly 25.

When it is required to machine the tip top faces it is necessary to changeover the grinding wheels so that the wheel 50 beomes operational and also to alter the

inclination of the yoke unit 34 so that the axis of rotation of the grinding wheel 50 is inclined to the vertical at such angle that the lowermost face 66 of the annular layer 52 of grinding material is set to the required top face relief angle.

To effect this operation it is neessary to displace the grinding head unit in which at this point of time the cup wheel 13 is exposed for grinding to the left by the ram 32 sufficiently to ensure that on moving the support assembly 24, and thus the grinding head 19 and the cup wheel 13, upwardly to the top of its upward stroke relative to the support assembly 25 by operation of the ram 27 the wheel 13 cannot contact the previously ground front face 10. The cup wheel 13 is then retracted to the raised position shown in Figure 1 by suitable displacement of the piston 56 in its cylinder 57 so as effectively to expose the cylindrical wheel 50 as shown in Figure 5. In a variation of the control of the displacement of the wheel 13 relative to the wheel 50, the wheel 13 can be resiliently loaded towards its retracted position so that on release of the hydraulic ram pressure used to lower the wheel 13 into its operational position the latter automatically returns to the retracted position.

After the grinding wheel 13 has been raised relative to the grinding wheel 50 the latter is moved downwards by the ram 27 to the required position by operation of the ram 27 to lower the support assembly 24 relative to the support assembly 25 thereby to set the grinding material surface 66 to the height necessary to grind the tip height desired. It will be understood that the stop arrangement 28 will have been set to achieve the required result as will be discussed hereinafter.

The actual grinding of the top face 11 involves passage of the grinding wheel face 66 across the surface of the top face 11 and this is effected by displacement of the support assembly 25 with respect to the mounting 31 by operation of the ram 32 to move the assembly 25 and thus the grinding head 19 to the left in the direction 'D'.

If it is desired to bevel the top face 11 the grinding head will be tilted by the requisite angle of tilt as above disussed. A grinding pass of the wheel 50 will produce a bevel since the grinding wheel 50 will be brought into contact with a marginal edge region of the top face.

It will be appreciated that the extent of the grinding head tilt determines the extent of bevelling.

Referring now to Figure 8 this schmatically illustrates details of the stop arrangement 28.

This figure shows in outline the relative positions of the support assemblies 24 and 25 and very schematically one of the bearing guide ways 26.

The stop arrangement 28 includes a support plate or block 66 which is mounted for relative slidable movement with respect to the remainder of the assembly 24, by means of slide bearing units 67, therebeing one to each side of the block 66.

In practice, the upper surface 68 of the block is intended to provide a reference surface which is positionally settable with respect to the support assembly 25 by means of the ball screw type adjustment means 29 and its operating head 30. It will be noted

that rotation of the head 30 in a first sense will raise the block relative to the support assembly 25 whilst rotation in the opposite sense will lower the block 66 relative to the support assembly 25.

The ram rod 68 of the hydraulic cylinder/ram 27 is operationally connected between the support assemblies 24 and 25 and passes through the block 66 so that the block itself does not impede the movements of the cylinder/ram 27.

A series of rods 69,70,71, and 72 depends downwardly from the top of the support assembly 24 structure each rod is able to engage with clearance a corresponding bore 69A, 70A, 71A and 72A in the block 66. Each of the rods 69-72 is intended act as a stop pin. In order that the operative lengths of the rods can be selectively adjusted the rods are respectively provided with operating heads 69B,70B,71B, and 72B. whereby the rods can be shortened or increased in length according the required positions of the free ends 69C,70C,71C and 72C of the rods with respect to the remainder of the support assembly 24.

As so far described on downward movement of the support assembly 24 relative to the support assembly 25 has the effect of moving the free ends 69C,70C,71C, and 72C towards the bores 69A,70A,71A and 72A and ultimately into the bores to a depth depending upon the extent of downward movement of the support assembly 24.

If the entrance of the lower end of any one of the rods is prevented it follows that further downward movement of the support assembly is prevented.

It, therefore, follows that selective prevention of the rods from entering their associated bores gives, since as

stated the rods are of differing lengths, a range of positions at which downward movement of the support assembly 24 is prevented. If the lengths of the rods are related to the heights of tips to be ground and also the maximum depth allowed for a machining operation on a front face it will be apparent that the simple action of preventing rods from entering bores provides a multi-position stop arrangement. This concept of preventing the entry of rod ends into bores for the purposes of forming a movement stop funtion provides a further aspect of the invention.

The entry of the rod ends into the associated bores is prevented by positioning a stop plate 73 above the entrance to the associated bore. In the embodiment shown each bore/rod combination has associated therewith a plate 73 which is movable by a solenoid 74 from a retracted position (as shown in relation to rods 70,71 and 72) into a bore blocking position (as shown for the plate 73 associated with the bore 69)

Thus, whenever a plate 73 is positioned by its solenoid 74 over the entrance to its associated bore thereby preventing entry of the associated rod further downward movement of the support assembly 24 is prevented. Arrangements (not shown) are provided for stopping further ram pull-down whenever a rod 69,70,71 or 72 encounters a stop plate 73.

In a practial arrangement the rod 69 is associated with the highest tip setting; the rod 70 with a next highest tip setting; the rod 71 with the lowest tip height. Finally, the rod 72 is associated with limiting downward movemnt of the cup grinding wheel 13.

It will be understood that by providing more rods and

associated solenoid controlled blocking plates 73 further tip heights can be defined.

It will also be noted that adjustment of the operating head 30 simultaneously sets the reference level for all of the rods so that effectively all of the rods can be simultaneously moved so that various ranges of tip heights are possible.

If desired the above discussed height adjustment unit could be replaced by a stepper motor system and its associated electronic control equipment. However, it is considered that the above discussed mechanical height adjustment unit offers many advantages over a complex electronics control system for achieving the same effect.

It is important to note that a machine which is capable of machining saw blade teeth tips top and front faces bevelled and not bevelled has been dislosed which is of such construction that all the requisite grinding wheels and their associated support and operational movement producing arrangements have been located to the right hand side (as seen in the Figures) of the vertical plane containing the above defined reference axis 'X'.

In practice, this represents a radical departure from the structural arrangements and operational requirements of saw blade tip grinding machine presently known since all of these known machines involve the swinging of massive and weighty grinding heads from the front to the rear of a tip being machined in order to merely to achieve front and top face machining capability on the same machine.

Because of this basic sturctural requirement of the known machines it has hitherto been impossible to provide on the same machine additional grinding facilities such as

for side face grinding, and the so-called steel relief grinding etc.

Thus, in accordance with a further aspect of the present invention there is provided a machine which can simultaneously incorporate grinding wheels for effecting at least top face/front face machining or both top and front face machining together with other tip face machining facilities such as side face, steel relief, face profiling, etc., for a single indexing of a tooth to the machining position.

Referring now to Figure 9 this illustrates a machine of the present invention when incoporating facilities for carrying out steel relief grinding.

In practice, a problem arises in the use of diamond wheels for grinding hard material tips mounted to the teeth of a steel blade in that a diamond wheel which is suitable for the machining of very hard material is not suitable for the machining of steel since the grinding speeds for steel are much less than those for hard materials such as Tungsten carbide and since the use of incorrect speeds rapidly damages the diamond wheels. Thus, it is of importance particularly in the resharpening of tipped saw blades to ensure that during any grinding or regrinding the steel of the tooth cannot be contacted by the diamond wheel provided for the tips grinding.

In order to overcome this difficulty it is usual to mount the saw blade to a second machine to carry out the required steel relief grinding operation. As will be clear this involves time consuming transfer of the blade from one machine to another together with problems in resetting the partially machined blade to a correct

machining position for further machining operations.

In disussing the machine of Figure 9 those parts thereof whih have been previously considered will be identified by the same reference numerals.

The machine of Figure 10 is provided with a second pivotally mounted yoke unit 80, whose pivotal axis coincides with that of the yoke 34.

The yoke is angularly displaced by a ram unit 81. A motor unit 82 for a steel relief grinding wheel 83 is mounted to a support platform 84 by way of a column 85 which allows the motor unit and thus the wheel to be pivoted about an axis 85 by a further ram unit 86.

The platform is displaceable in a direction lengthwise of the yoke 80 by means of a ram unit 87 so that the wheel can be moved towards and away from the tip grinding position axis 'X'. The platform and associated ram unit are transversely displaceable relative to the yoke 80 in a manner similar to the displacement of the slide block 36 of the mounting unit 31 for the support assembly 25 and for generally similar purposes i.e., bevelling in relation to the positioning of the grinding wheel 83 with respect to the blade tooth.

A cam and associated follower arrangement 88 is provided for lifting and lowering the grinding wheel 83 according to the required profiling for the steel relief grinding operation.

It will be understood that during the machining of the tip top and front faces the steel relief grinding wheel 83 will have been displaced by the ram 87 to a retracted position in which it cannot impede the top and front face

machining operations.

It will be understood that during the movement of the wheel 83 to its retracted setting the wheel has to be lifted upwards to clear the next tooth to be machined. This can be effected by suitable profiling of the cam arrangement 88 and/or by the provision of a ram unit (not shown).

To carry out a steel relief grinding operation the front and top face grinding head 19 is moved to its raised position and the relief grinding wheel is advanced by the ram 87 towards the grinding position. The yoke 80 having been previously set to the angle necessary to set the grinding wheel 83 to the required relief angle.

The ram 87 is then actuated to cause the blade 83 to perform, under the control of the cam arrangement 88, the required movements of the wheel 83 along the steel surface to be ground.

Figure 11 very schematially illustrates the steel relief operation.

It is to be noted that by replacing a steel relief grinding wheel with a suitably dimensioned diamond wheel the tips top could be cross grooved.

If it is required to provide the machine as so far discussed with the facility of being able to groove or profile the top or front faces of a tip in the manner shown in Figure 12 a so-called quill type grinding wheel can be provided.

As is indicated in Figure 12 the quill type grinding wheel 90 is mounted to the steel relief grinding wheel

assembly. In the embodiment of Figure 9 the steel relief grinding assembly is rotatably mounted so that changeover between use of the steel relief wheel 83 and the quill 90 is in the manner similar to the operation a turret tool changer construction such as is used on lathes to enable easy tool changerover.

The drive for the quill grinding wheel can be pneumatic or electric as considered convenient.

Figure 9 schematially illustrates that the turret like feature enables positional setting of the wheel 83 for bevelling purposes, and for centralising the quill 90 with respect to a tip to be machined by the quill 90.

It is important to note that with the quill wheel assembly as proposed it is possible to quill grind the top and front faces of a tip whilst the tip is in the same indexed position, and also whilst it is in the same position involved with the top face and front face machining operations. In other words the proposals of the invention eliminate the need for separate machines and the problems associated with the use of separate machines.

Referring now to Figure 14 this also illustrates a machine of the invention incorporating tip side face grinding capability. In the embodiment of Figure 14 a side grinder assembly 95 is mounted to the second yoke 80.

As before those parts of the machine which have been previously mentioned will receive the same reference numerals and will not be further discussed.

The side grinder assembly 95 incorporates two similar

grinding wheels 96 (only one being shown) locatable one to each side of the tip to be machined. The wheels 96 are mutually relatively positioned and set so that both faces can be machined at the same time.

As may be seen from Figures 14 and 15 these side grinding wheels 96 are rotatably mounted on drive shafts 97 depending from support plates 98 pivotally mounted via pivot bearings 99 to a plate 100 which in turn is connected by way of a ram unit 101 to a support frame 102 which is itself pivotally mounted to the yoke 80 for pivotal displacement about a pivot axis 102A. The support frame is of such construction as to permit the plate to be displaceable linearly to and from the pivot axis by way of slide bearings 103.

The mounting of the side grinder assembly is thus such that it is so pivotally mounted to the yoke 80 for pivotal movement about the axis 102A that the side grinding assembly 95 can be pivoted between an operational position as shown in Figure 14 and a retracted position (not shown) in which the wheels 96 are moved away from the grinding position to permit for example, top and front face grinding by the grinding head unit 19.

Each support plate 98 mounts on the upper side thereof a drive motor 104 having an output shaft 105 projecting to the underside of the support plate and mounting a belt drive pulley 106. The pulley is drivingly coupled via a belt 107 with a belt drive pulley 108 provided upon the grinding wheel shaft.

Thus rotation of the motor drive shaft drives the grinding wheels 96.

As may be seen from Figures 15 and 16 the two support plates are resiliently loaded by a spring loaded hydraulic cylinder 109 in such manner that the support plates are biassed to the position in which the grinding wheels do not contact the tip 9 to be ground.

Application of hydraluic fluid to the cylinder 109 pivots the support plates 98 and thus the grinding wheels 96 into operational contact with the side faces of a tip 9 located therebetween.

As has been mentioned the tip side face grinding action involves displacement of the grinding wheels radially of the tips.

A tip grinding shape profile attachment 110 is mounted from the support plates 98 this attachment 110 essentially comprises means for supporting a profile former 111 for the tip shape required, and associated profile cam follower 112 operationally coupled to the associated support plate whereby on moving the grinding wheels 96 radially of the tip 9 will cause the cam followers 112 to follow the form of the profile former 111 and in so doing produce complementary displacements of the grinding wheels towards and away from the medial plane of the blade and thus the tip in such manner that the forms of the side faces ground on the tip will replicate the shape of the profile form.

A further important advantage of providing a single machine to enable multi-face grinding is that it is ensures that all of the faces ground are correctly oriented one with the other.

It will be understood that since the side grinder of the present invention involves a profile former that the side faces of the tips can be machined to provide what ever shape required.

Figures 17 to 22 respectively illustrate various profiles to which the side faces of the tips can be ground using the side face grinding facilities of the apparatus of the present invention.

The provision of the quill, slotting wheel, steel relief wheel, side grinding wheels and the profiling facility effectively provides together with the top face and front face grinding capability of the grinding head 19 a multi-machine capability affording many possible tip machining combinations of grinding capabilities hitherto only been available by using several several separate machines.

Examples of such combinations are:-

(a) Quill plus top and front face grinding:

(b) Steel relief plus top and front face grinding:

(c) Slotting, bevelling, front and side face grinding:

(d) Top, front and side face grinding:

From the forgoing it will be apparant that many other combinations are possible with a single machine incorporating the concepts of the invention as compared with the present day need to use separate machines as would at present be required.

CLAIMS

1. A machine for grinding the hard material tips provided upon saw blades, characterised by enabling provision upon the same machine facilities for enabling the front face, top face and the side faces of the tips to be machined without it being necessary to displace the tip being machined from a machining position to which the tip is set for the purpose of it being machined.

2 A machine for grinding the hard material tips provided upon saw blades, characterised in that to one side of a vertical plane passing through a machining position to which a tip is set for the purpose of the machining of faces of the tip, means are provided for enabling the machining of the front and top faces of the tips and in that provision is made on the machine to the other side of said plane for mounting means for enabling the machining of the side faces and/or the machining of the steel relief groove in the blade and/or grooves, slots, in the top and front faces of the tips, the arrangement being such that all machining operations required on a tip may be performed without it being necessary to displace the tip being machined from the machining position to which it is set for the purposes of machining.

3. A machine as claimed in claim 1 or 2, and characterised in that suppport means are provided for so mounting means for machining tip front faces that the tip face machining tool carried by the mounting means can be selectively set to the produce a required hook angle for the front face.

4. A machine as claimed in claim 3, and characterised

in that the mounting means is positionally adjustable lengthwise of the front face and an angle corresponding to a required hook angle.

5. A machine as claimed in claim 3 or 4, and characterised in that the support means is pivotally mounted for pivotal movement about a reference axis defined by said machining position, and in that the angle of tilt of the support means with respect to a horizontal plane including said axis is utilised to set the position of the mounting means to such inclination that the a tip front face can be machined to a requisite hook angle.

6. A machine as claimed in claim 5 and characterised in that the mounting means for the machine tool for machining the tip front faces is adapted also to mount a machine tool for machining the top faces of the tips; the arrangement being such that the two tools carried by the mounting means can be interchangeably moved between a rest or retracted position and an tip machining position;

7. A machine as claimed in claim 6, and characterised in that the tools for the top face and front face machining are mounted for concentric rotation about a common axis.

8. A machine as claimed in claim 6 or 7, and characterised in that the front face machining tool comprises a cone formation grinding wheel whose machining face is on the conical surface thereof, in that the top face machining tool comprises a cylindrical cup wheel providing an annular grinding surface whose axis of rotation is coaxial with that of the cone wheel, and in that means are provided for enabling at any one time one or the other of the tools to be enageable with a tip.

9. A machine as claimed in claim 5,6,7 or 8, and characterised in that means are provided for enabling selective adjustment of the position of the top face machining tool respect to its support means so as to enable seclective adjustment of tip heights with respect to a body of the blade.

10. A machine as claimed in claim 5,6,7,8 or 9, and characterised in that the mounting means for the top face and front face machining tools enables selective bevelling of these faces.

11. A machine as claimed in claim 10, and characterised in that the support means for the mounting means includes a yoke member which is pivotable, about an first horizontal axis intersecting said machining position for the purposes of enabling selective adjustment of the hook angle, and tiltable about a further axis transverse to said first axis to enable bevelling of the top faces and rotatable about a vertical axis to enable front face bevelling.

12. A machine as claimed in claim 11, and characterised in that the mounting means is bodilly displaceable lengthwise of the yoke member.

13. A machine as claimed in claim 2, and charcterised in that the means for mounting machine tools on said toher side includes is pivotally mounted for pivotal movement about asaid reference axis defined by said machining position, and in that the angle of tilt of the support means with respect to a horizontal plane including said axis is utilised to set the position of the mounting means to such inclination that the a tip face can be machined to a requisite angle.

14. A machine as claimed in claim 13, and charcterised in that a toll ofr effecting the side grinding of the faces of the tip is mountable to tp said support makes on said other side.

15 A machine as claimed in claim 13 or 14, and characterised in that the support means for the mounting means at said other side includes a yoke member which is pivotable, about an first horizontal axis intersecting said machining position for the purposes of enabling selective adjustment of the face grinding angles.

16. A machine as claimed in claim 14, and characterised in that the side face grinding arrangements include a profiling attachment.

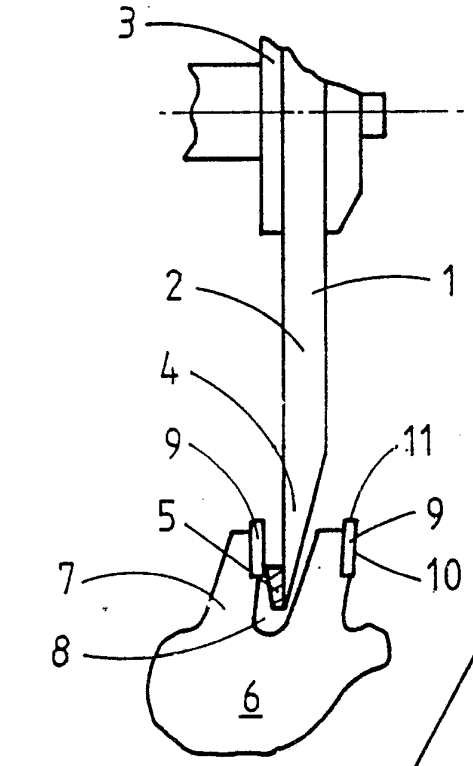


FIG 1

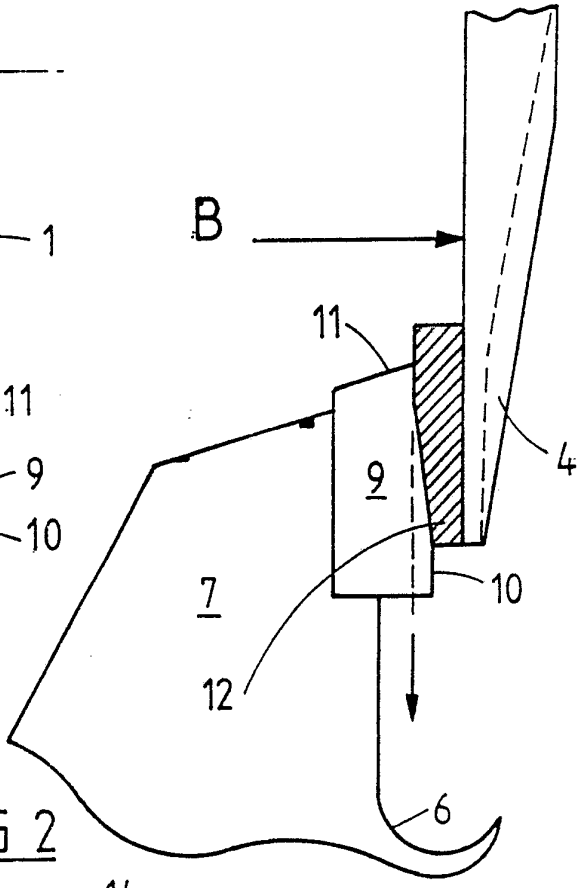


FIG 2

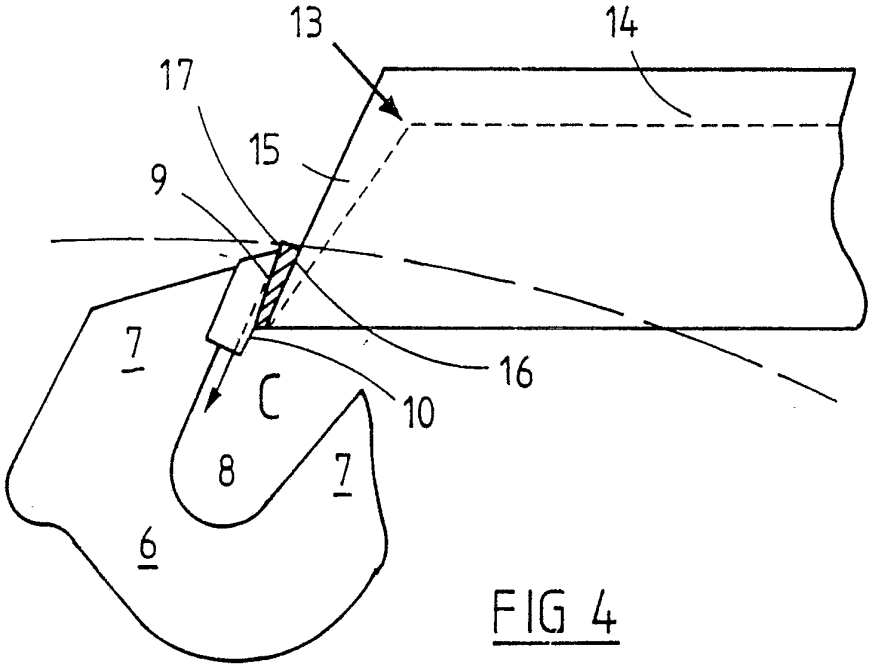


FIG 4

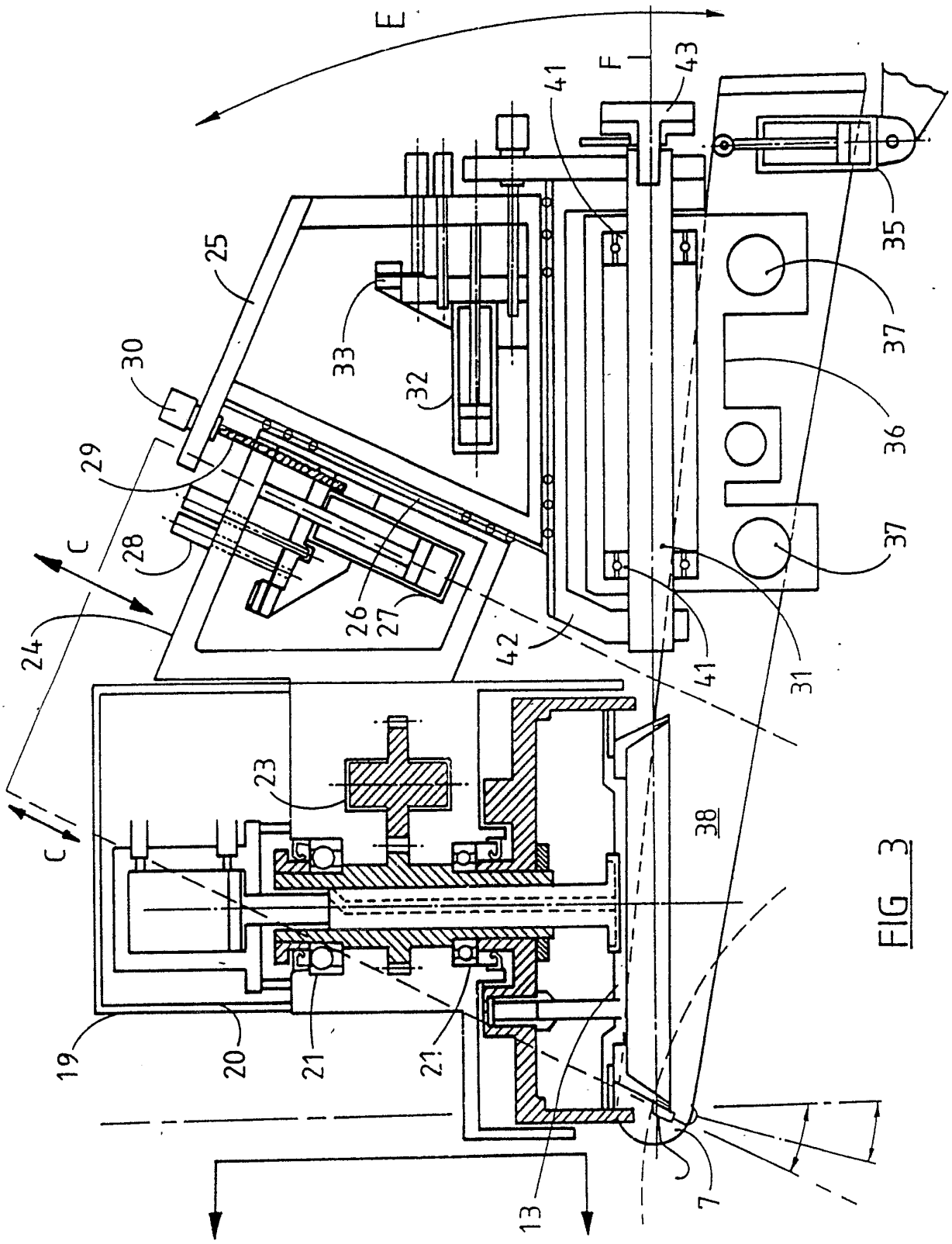

E
F
41
43
35
25
33
32
37
30
36
29
C
28
37
26
27
24
42
41
31
23
38
C
19
20
21
21
13
7

FIG 3

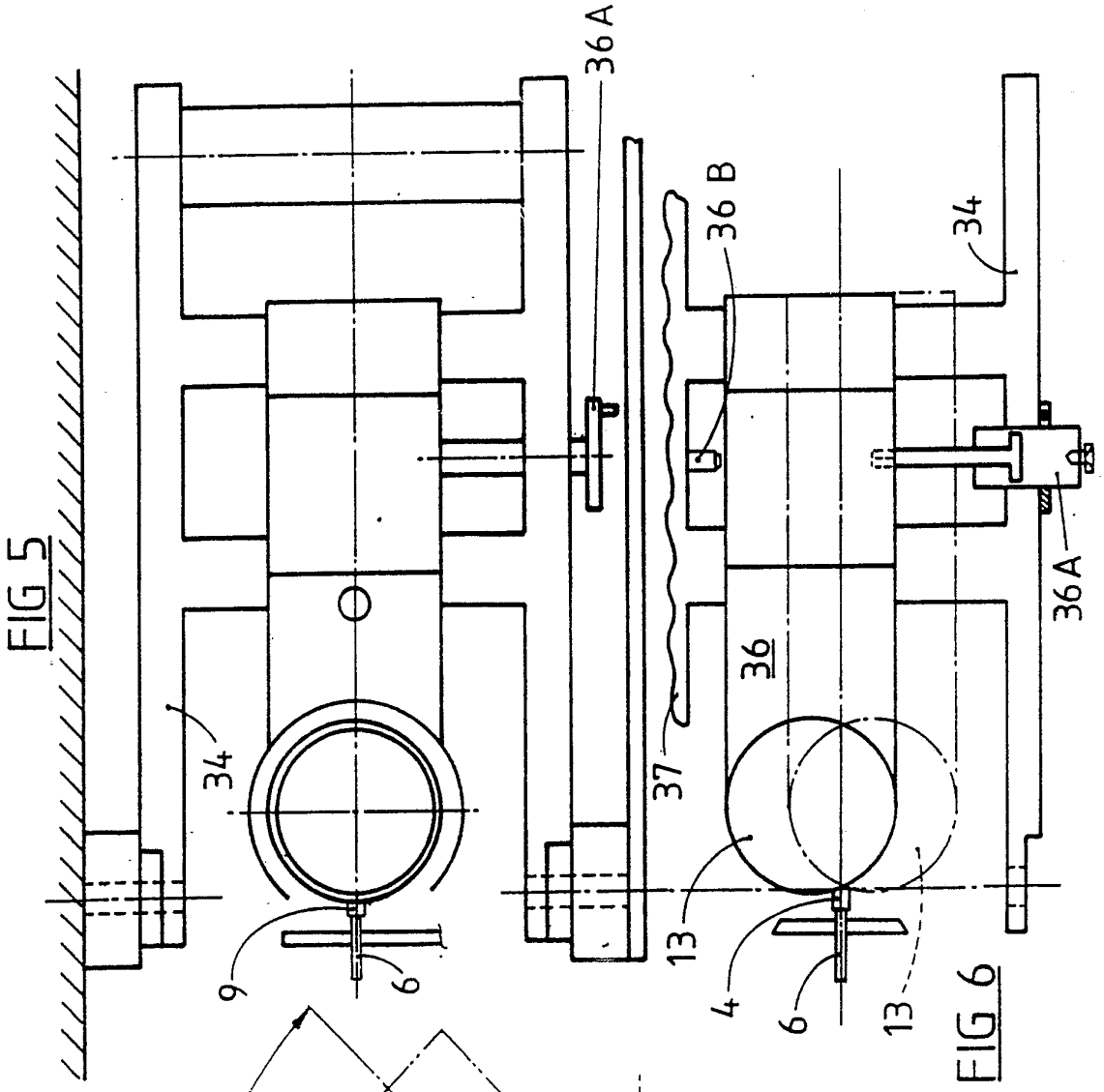


FIG 5

FIG 6

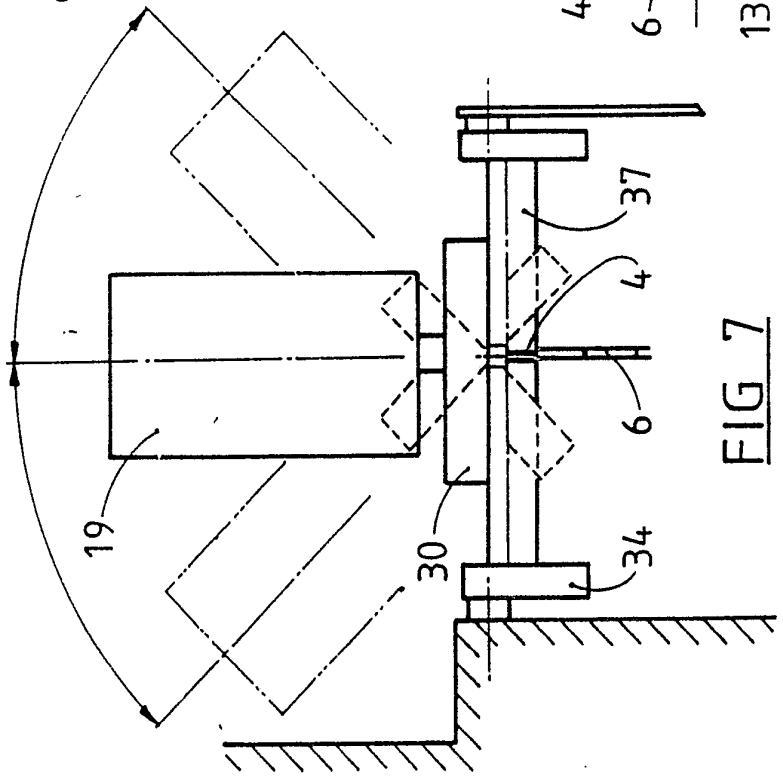


FIG 7

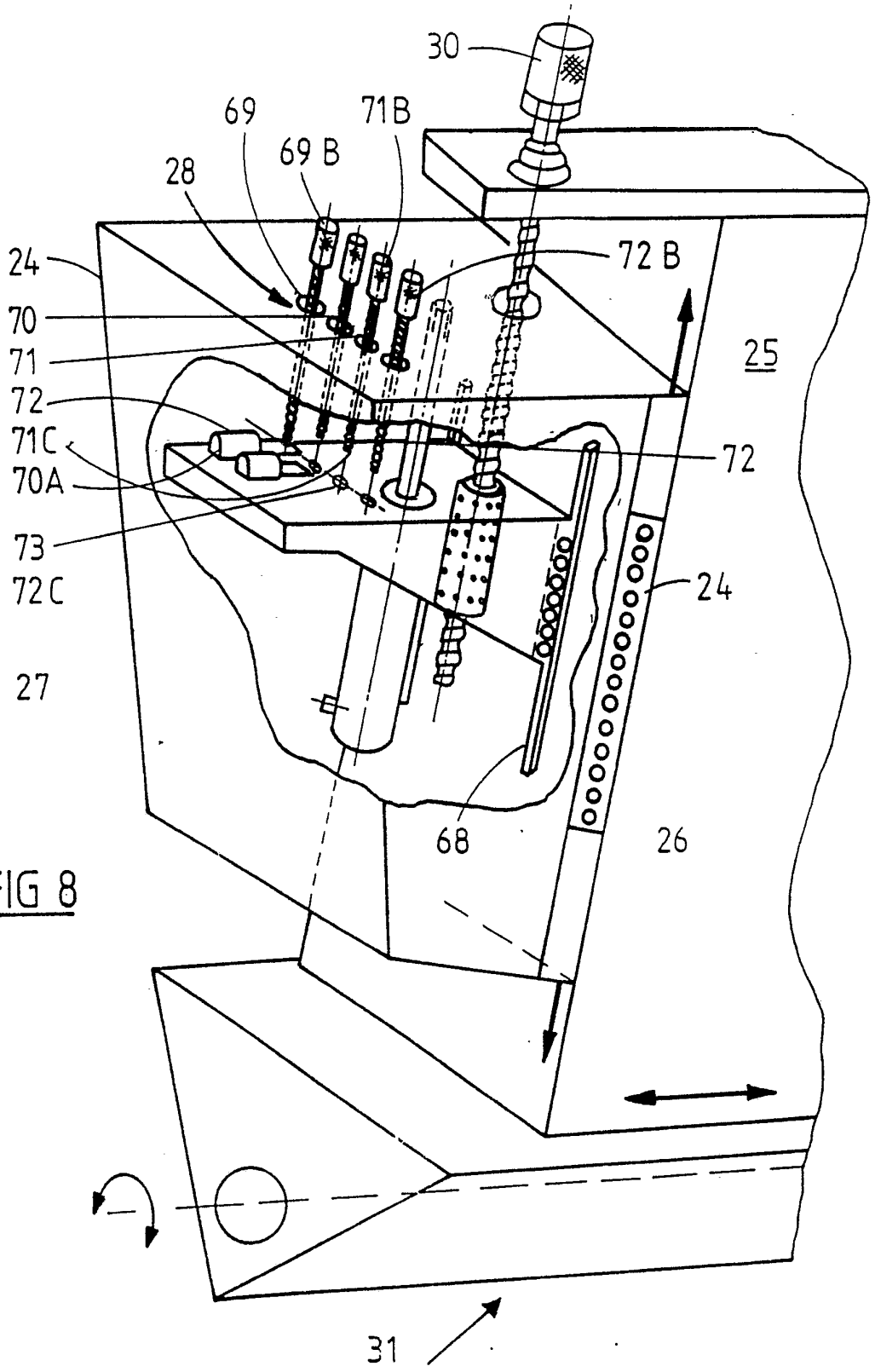


FIG 8

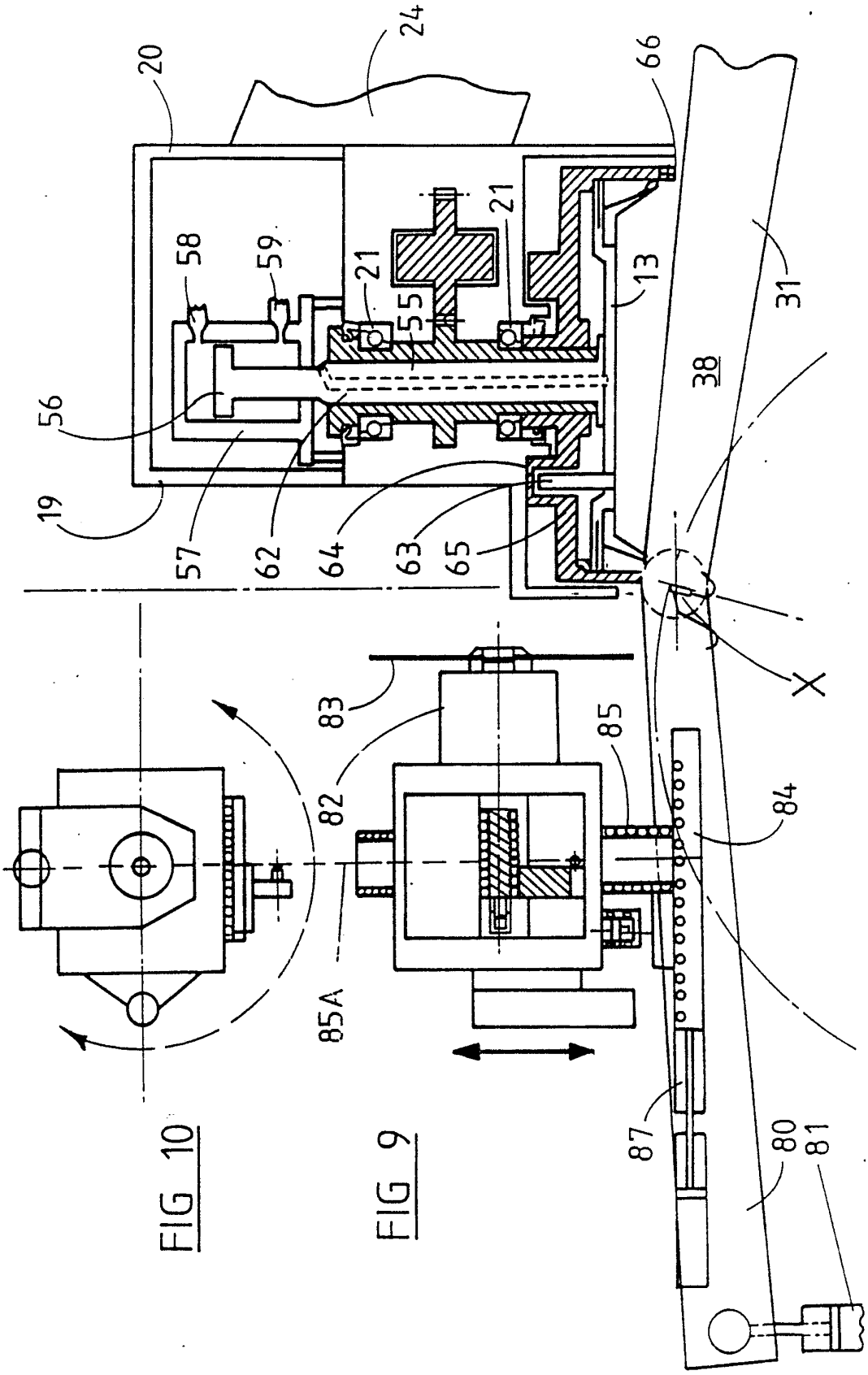

24
20
66
58
59
21
21
55
13
31
38
56
19
57
62
64
63
65
X
83
85
82
84
85A
87
80
81

FIG 10

FIG 9

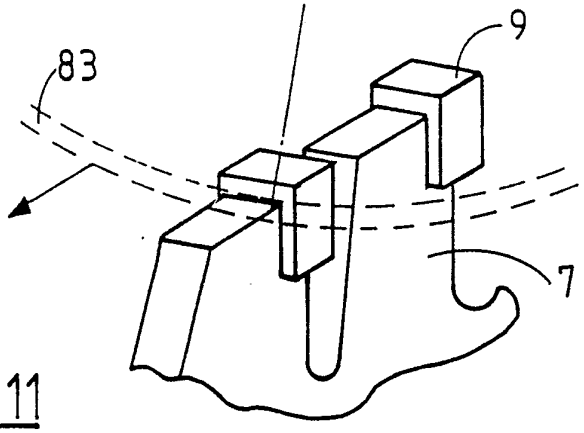


FIG 11

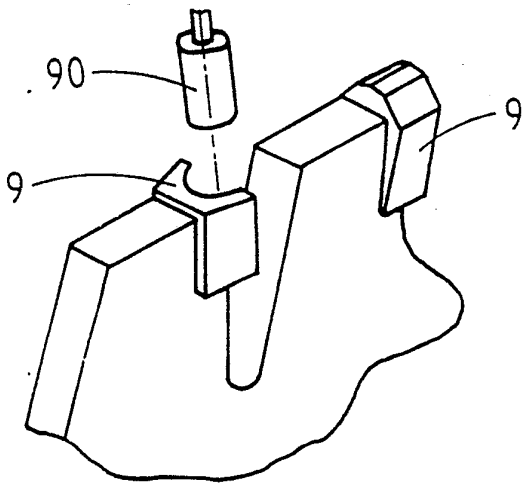


FIG 12

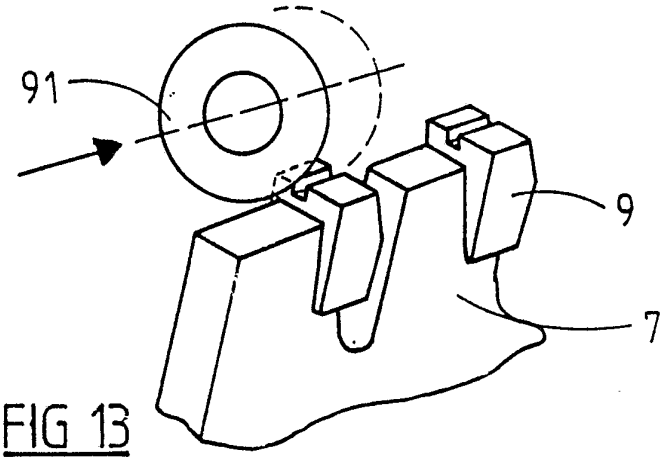


FIG 13

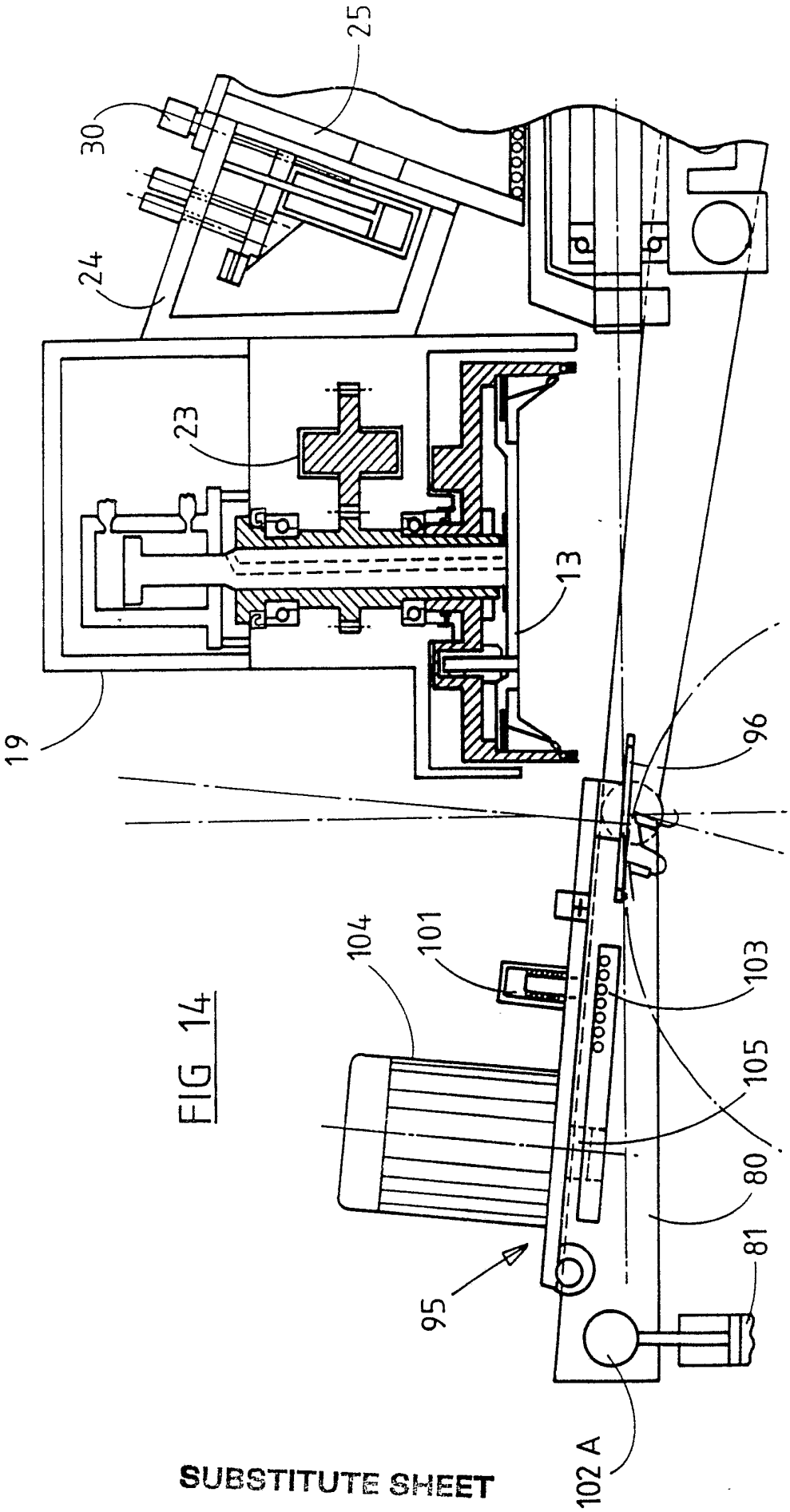


FIG 14

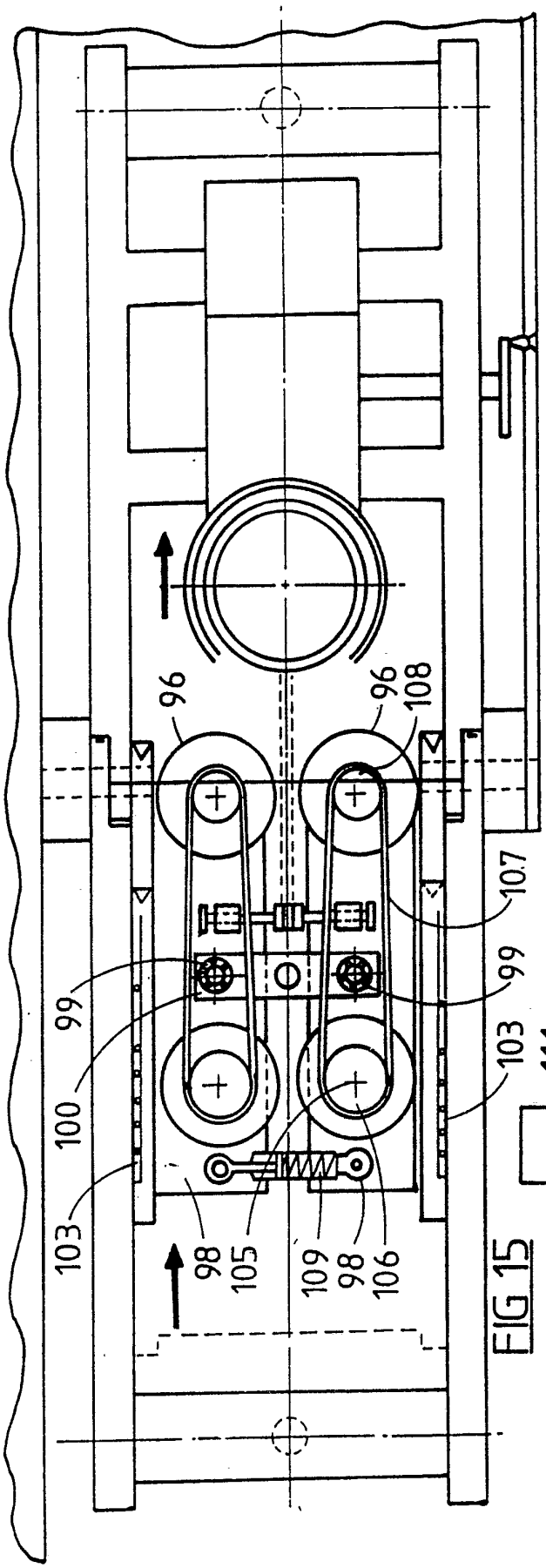


FIG 15

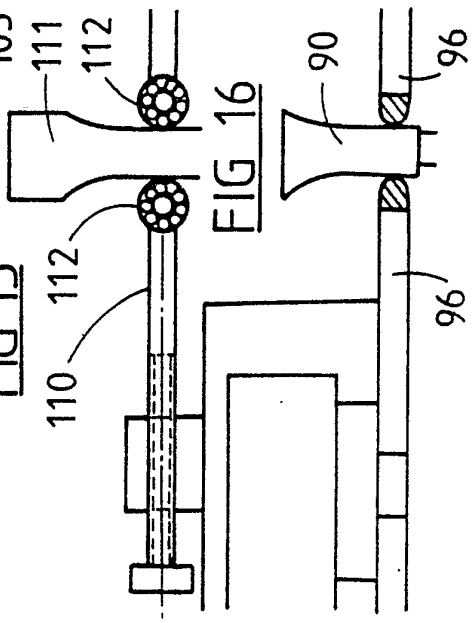


FIG 16

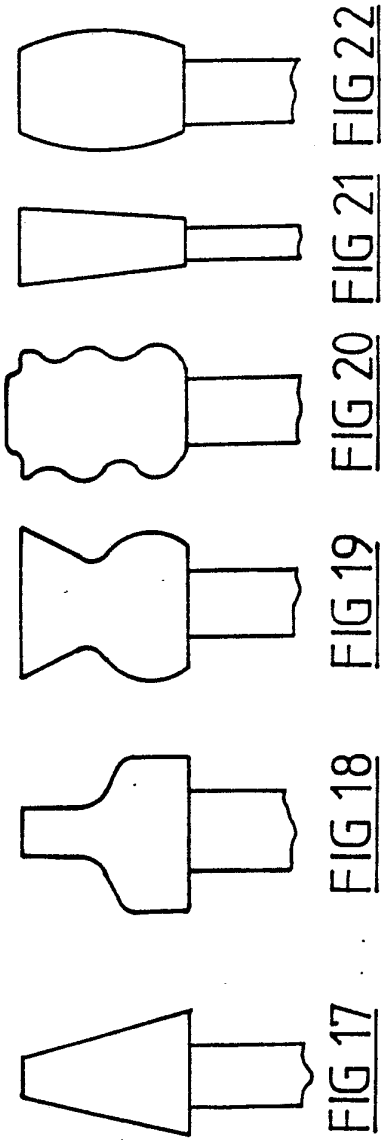


FIG 17 FIG 18 FIG 19 FIG 20 FIG 21 FIG 22

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 92/00833

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B23D63/14

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B23D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	EP,A,0 202 115 (WIDMANN GMBH) 20 November 1986 see page 4, line 7 - page 6, line 2 see page 14, line 14 - page 18, line 4; figures 1-10	1
Y	---	2-6,9-12
Y	US,A,3 304 810 (CECIL ENGLISH) 21 February 1967 see figure 1	2-6,9-12

A	US,A,3 616 711 (BRYON G. DAGGETT) 2 November 1971 see figure 2C	8

X	US,A,3 279 282 (HARLAN W. GILL) 18 October 1966 see column 6, line 64 - column 7, line 64; figures 1-8	1

° Special categories of cited documents :[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
24 AUGUST 1992	24. 09. 92
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	GERARD O.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9200833 SA 59102

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 24/08/92
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0202115	20-11-86	DE-A- 3684171	16-04-92
		US-A- 4754667	05-07-88
US-A-3304810		None	
US-A-3616711	02-11-71	None	
US-A-3279282		None	