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(12) # EUROPEAN PATENT APPLICATION

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(71) Applicant: JAMES NEILL HOLDINGS LIMITED
Napier Street
Sheffield S11 8HB(GB)

(72) Inventor: Bentley, Allen Edward
Whitelow House Farm Whitelow Lane
Dore Sheffield, S17 3AG(GB)

(74) Representative: Houghton, David et al,
Hulse & Co. Cavendish Buildings West Street
Sheffield, S1 1ZZ(GB)

(54) **Metal strip.**

(57) The invention relates to metal strip and particularly to bi-metallic strip. The advantages of bi-metallic strip where each metal has characteristics to serve its intended function are well known but the production of such strip has, hitherto, required high capital costs and has predominently involved the welding together of the two metals by electron beam welding equipment or the like. Such techniques require high standards of cleanliness and frequently the welded composite strip requires subsequent mechanical finishing to form a smooth surface but even so the weld line cannot be visually eliminated. The object of the invention is to provide a bi-metallic strip which avoids the above disadvantages, which objective is met by a metal strip comprising two or more metals each in discrete longitudinal stripes with a longitudinal joint between adjacent stripes, said metals initially being in powder form and the powders simultaneously compacted to form a composite metal strip (6).

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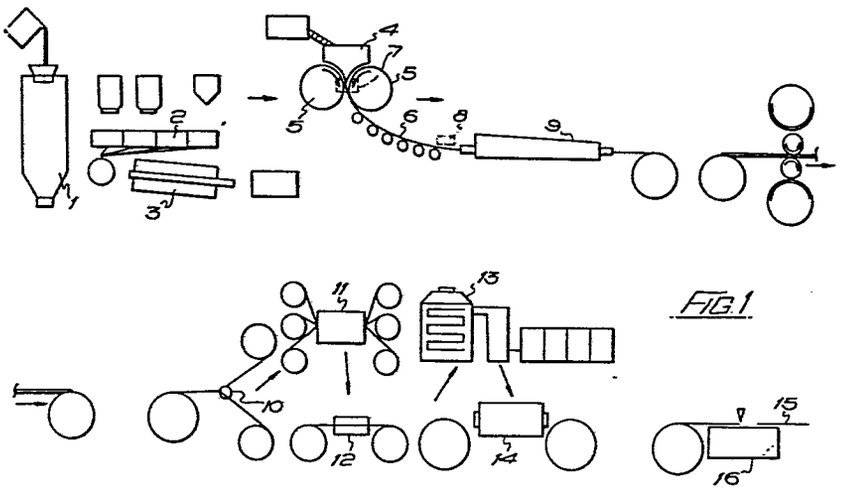

FIG.1

METAL STRIP

This invention relates to metal strip and is particularly concerned with metal strip that is formed from at least two metals so that a variety of different mechanical and/or metallurgical properties can be provided across the width of the strip.

Thus, in the production of, e.g., saw blades, it would be highly advantageous to produce a bi-metallic strip with one metal running full length of one side of the blade and suited to requirements of the saw teeth, and a second metal running full length of the other side and suited to the requirements of the body of the saw blade. Attempts have been made hitherto to weld longitudinally two strips of appropriate metals. However this requires high capital cost electron beam welding equipment or the like, and such techniques require high standards of cleanliness before an effective weld can be formed. Also, it is frequently the case that the welded blade requires subsequent mechanical finishing to form a smooth surface, but even when finely ground there can still be faults in the weld area which would reduce the value of the finished blade, and the weld line cannot be visually eliminated even when

it does not contain a fault. In addition, it is only practical to produce a single width with a longitudinal weld making the production of, e.g., saw blades by this technique slow and uneconomic.

The object of the present invention is to provide strip material formed by two or more metals that avoids the disadvantages of the welding technique.

According to the present invention, a metal strip comprises two or more metals each in discrete longitudinal stripes with a longitudinal joint between adjacent stripes, said metals initially being in powder form and the powders simultaneously compacted to form a composite metal strip.

Thus, two metal powders can be compacted to form a bi-metallic strip, but it is preferred to provide first and second metals in alternation across the width of the strip so that after compaction and appropriate processing, the multi-stripe strip can be severed longitudinally to produce bi-metallic strips and laterally into discrete lengths such as would be required, e.g., for hacksaw blade production.

The invention in its first aspect, therefore provides an efficient technique for producing metal strips of two or more metals more

efficiently and economically than known welding techniques, allowing for continuous production, and with a longitudinal joint between the adjacent metal stripes that is not discernable and requires no separate machining.

Obviously, the metals chosen for joining together in longitudinal stripes must be suited to the required properties of the finished strip, and must also be reasonably compatible because of the unavoidable simultaneous further processing, rolling and heat treatment, that the compacted strip would normally be subjected to in the creation of a finished product. For example, in the production of hacksaw blades, the teeth can with advantage be formed from high speed steel such as M2 and the backing material tougher steel such as EN31. Thus, M2 and EN31 powder can first be compacted into a striped strip, and then passed through a tube sinter furnace to further the densification by partial or total sintering. The strip can then be cold-rolled to its final thickness and subsequently severed into bi-metallic lengths with an edge formed from M2 and from which the teeth are formed, and the other edge formed from EN31. To ease mechanical working, the respective powders can be of low carbon or even

carbon free, and the finished bi-metallic hacksaw blade finally re-carburised to provide the mechanical properties required.

Because two or more different metal powders are being simultaneously compacted, and each powder has a different flow characteristic, it is important that effective control is provided over the flow of powders to the compaction equipment.

Therefore, according to a second aspect of the invention, a hopper is provided, divided internally into a number of compartments, each compartment having a separately adjustable gate valve. The gate valves may be manually adjustable, but it is preferred to provide for automatic and continuous adjustment. Thus, each gate valve may be operated by a hydraulic actuator, which can be controlled in accordance with the density distribution of the compacted strip. For optimum control, a full feed-back circuit can be employed, with density readings obtained, e.g., by a radio isotope gauge. The geometry of the hopper is also important. Thus it is highly advantageous for the divided outlet from the hopper to protrude into the roll bite area between a pair of compacting rolls, and for the outlet to be so shaped as to lie in close proximity to the rolls. With advantage, the

interior of the hopper can be coated with a low friction material, and the hopper can be subjected to high frequency, low amplitude vibrations to improve the feed of materials past the gate valves and to the compacting rolls.

When working with materials that are likely to work harden during processing after a roll compaction/sintering stage, it becomes necessary to ensure good compaction across the full width of the strip, it being highly advisable to maintain a density variation of less than 5%. To achieve this, side compaction mechanism needs to be provided to either side of the compacting rolls. Thus, a two-part belt comprising a linked support belt and a flat facing belt can be provided to either side of the compacting rolls, with the belts moving at the same speed as the passage of powder material through the compacting rolls, whereby to provide full support and compaction of the side edges of the strip material.

One embodiment of the invention will now be described with reference to the accompanying drawings, in which :-

Figure 1 is a block diagram illustrating a process route in the production of a hacksaw blade according to the invention;

Figure 2 is a part-sectional perspective view of the powder hopper of Figure 1; and

Fgure 3 is a diagrammatic representation of a means of effecting side compaction of the powder passing between the rolls of Figure 1.

As is illustrated in Figure 1, powder, first formed by melting an appropriate metal alloy in a furnace 1, from which a carbon free de-watered, dried, atomised powder is produced, is passed through a blender 2 and then an annealing furnace 3. Two such powders are formed, e.g., EN31 to form the backing and M2 to form the cutting edge of a hacksaw blade, the EN31 powder being placed in two outer compartments of a hopper 4 and the M2 powder in a central compartment as will be described later in conjunction with Figure 2.

From the hopper 4, the powders are fed between two counter rotating rolls 5, where the powders are compacted to form a strip 6 having three longitudinal stripes, two outer stripes of EN31 powder and a centre stripe of M2 powder. For consistancy of density across the full width of the composite strip, side compaction is effected by means 7 at the nip of the rolls, as will be described in detail with respect to Figure 3. The major parameters of compaction, i.e., roll gap,

strip speed, powder feed and strip density can be controlled automatically by providing a detection head 8 for the strip emerging from the rolls, to provide information for a microprocessor which is utilised to adjust the compaction parameters and maintain the strip in the optimum condition required.

The strip emerging from the rolls is sintered in a hydrogen furnace 9 in conventional manner, following which the strip is cold rolled to finish gauge. The strip is then slit, by appropriate slitting means 10, mid point of the central, M2 metal stripe, and the two resulting strips, having an EN31 metal backing and an M2 metal cutting edge on which the teeth are milled in a milling machine 11. The teeth are then set and the usual fixing holes punched at a punching and setting station 12.

Following this each strip is subjected to recarburisation and diffusion in a furnace 13 such as is described in British Patent No. 2015580 and the recarburised strip conventionally solution heat treated in a furnace 14, following which the strip is severed into discrete lengths 15 at a severing station 16, to form hacksaw blades.

Apart from the final severing into discrete

lengths, the production of the composite strip, and its subsequent heat and other treatments are effected continuously, thereby reducing the overall costs of the production of bi-metallic blades, with the other advantages over conventional bimetallic blades referred to previously.

As is shown particularly by Figure 2, it is preferred to construct the hopper 4 such that the outlet from the hopper is as close to the nip of the rolls 5 as practical conditions will allow. Thus, the lower end of each side 16 of the hopper is arcuately formed to accomodate the upper part of the respective roll. The hopper 4 is sub-divided internally by two parallel plates 17, which co-operate with the hopper outer plates 18 to form three compartments 19. The ends of the operative parts of the hopper compartments are formed by adjustable fingers 20, which fingers can be adjusted both vertically and in respect of angular disposition, such that the outlet opening from a compartment formed between the lower ends of the respective fingers can be pre-set, or controlled and adjusted as required by adjustment mechanism (not shown) under the control of the microprocessor referred to earlier.

One means of effecting side compaction of

the strip is illustrated in Figure 3. Thus, two endless belts 21, 22 can be provided, to each side of the rolls, one, 21, a smooth surfaced belt and the other, 22, a heavy duty support belt, with both held adjacent to a respective side of the nip of the rolls. Each belt is driven at a linear speed equal to the peripheral speed of the rolls to reduce to a miniminal degree any friction between the belts 21 and the rolls. As powder passes through the nip of the rolls, any sideways spread of the powder is prevented by the belts 21, 22, with the effect that a substantially uniform density of strip across its full width is provided.

CLAIMS

1. A metal strip characterised by two or more metals each in discrete longitudinal stripes with a longitudinal joint between adjacent stripes, said metals initially being in powder form and the powders simultaneously compacted to form a composite metal strip.

2. A metal strip as in Claim 1 characterised by the provision of first and second metals in alternation across the width of the strip so that after compaction and appropriate processing, the multi-stripe strip can be severed longitudinally to produce bi-metallic strips and laterally into discrete lengths.

3. A metal strip as in Claim 1 or Claim 2, characterised in that the metals chosen for joining together in longitudinal stripes are suited to the required properties of the finished strip, and are reasonably compatible because of the unavoidable simultaneous further processing, rolling and heat treatment, that the compacted strip would normally be subjected to in the creation of a finished product.

4. A metal strip as in Claim 3 for the production of hacksaw blades characterised in that one metal is a high speed steel and the other metal

is a tougher steel.

5. A metal strip as in any of Claims 1 to 4 characterised in that each metal powder is of low carbon or is carbon free, for ease of mechanical working and the finished product finally re-carburised to provide the mechanical properties required.

6. A method for the production of a metal strip as in Claim 1 characterised in that first and second metal powders are first compacted into a striped strip and the striped strip then passed through a tube sinter furnace to further the densification of the strip by partial or total sintering, the strip then being cold rolled into its final thickness and severed into bi-metallic lengths with one edge formed from one metal powder and the other edge formed from the other metal powder.

7. A method as in Claim 6 characterised in that each powder is initially of low carbon or is carbon free, and the strip with said powders alternating across its width is, after being severed into bi-metallic lengths, finally re-carburised to provide the mechanical properties required.

8. A method as in Claim 6 or Claim 7 for

the production of a hacksaw blade characterised in that one powder is of high speed steel and the other powder is a tougher steel, hacksaw teeth being cut on to the edge formed by the high speed steel and said teeth being set prior to the re-carburisation treatment.

9. A hopper for use in the process of Claim 6 and for the accurate dispensing of two or more powders having different flow characteristics at the required rate to compaction means for the powders characterised in that the hopper is divided internally into a number of compartments, each compartment having a separately adjustable gate valve capable of manual or automatic adjustment.

10. Equipment for the production of a strip as in Claim 1 characterised in that compaction mechanism is provided in the form of opposed rolls, and said compaction mechanism is provided to either side of the compacting rolls to ensure even compaction across the full width of the strip.

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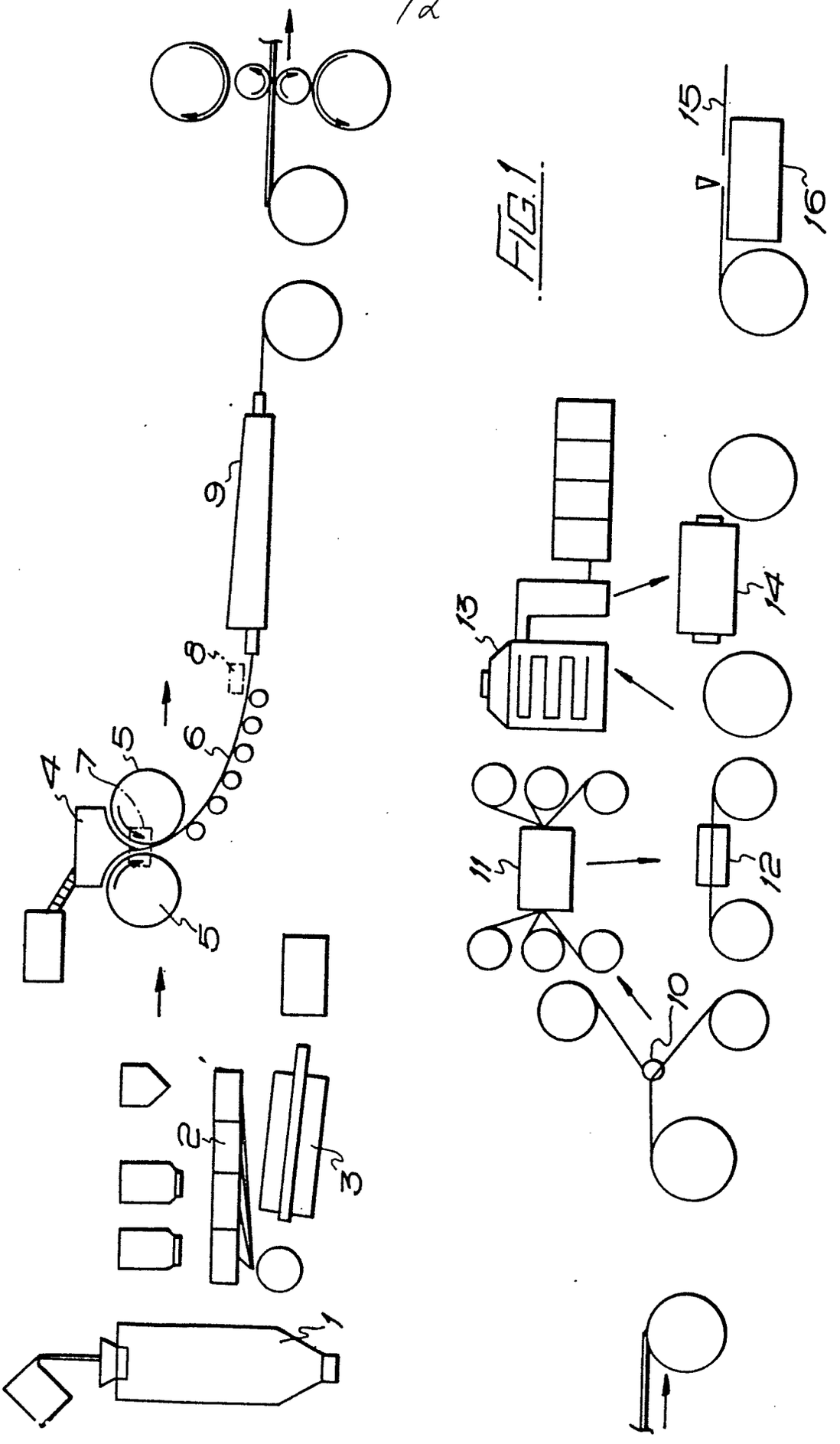

FIG.1

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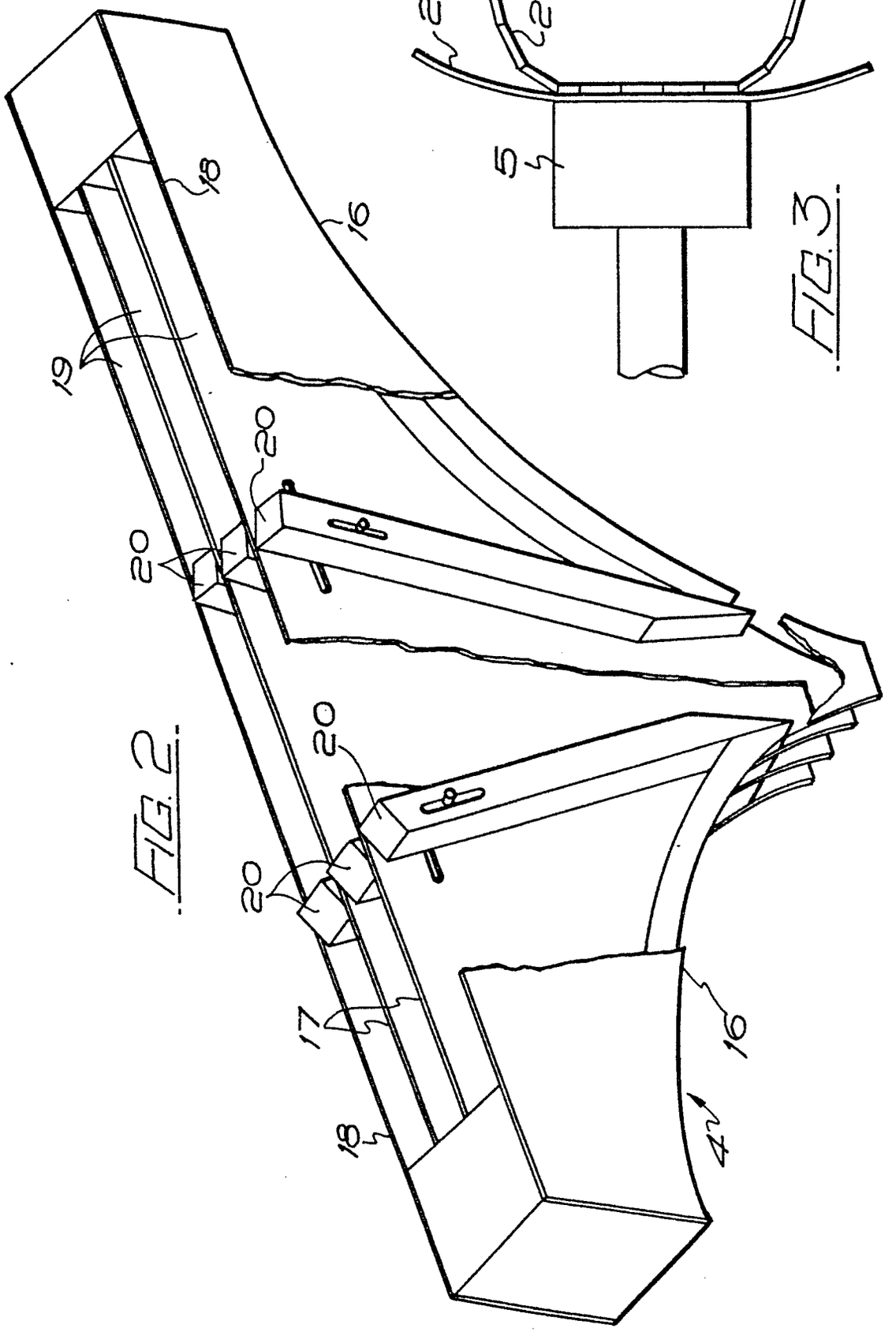

FIG. 2.

FIG. 3.

European Patent Office

EUROPEAN SEARCH REPORT

0078147

Application number

EP 82 30 5576

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X,Y	GB-A-1 414 413 (CONTOUR SAWS INC.) * claims 1,4,8,11,17 *	1-10	B 22 F 7/02 B 22 F 3/18
Y	GB-A-2 038 882 (DAVY-LOEWY LTD.) * claims 1,3 *	5,7	
Y	US-A-3 411 197 (G.I. AXENOV et al.) * column 2, lines 41-55 *	9	
Y	US-A-3 146 099 (J.D. TEJA) * column 4, lines 38-46 *	9	
Y	US-A-4 231 729 (J.H. TUNDERMANN et al.) * claim 1 *	10	TECHNICAL FIELDS SEARCHED (Int. Cl. ³) B 22 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24-01-1983	SCHRUERS H.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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