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(54) A method and equipment for detecting the profile of an item of footwear during manufacture.

(57) The method described provides for the footwear to be struck by light beams from two sides thereof, for a plurality of points on the edge of the shadow projected by the footwear to be detected on respective opposite sides, and for the profile of the footwear in the plane of the sole to be derived from the positions of the points detected and from the geometrical characteristics of the light beams. Equipment for obtaining the profile of footwear automatically during manufacture with the use of this method is described, and comprises means for causing the footwear to pass through a detection plane, and two photoelectric devices (16, 19) disposed in the detection plane and constituted by light emitters (16a, 16b, 19a, 19b) and light receivers (16c, 19c) which are switched on and scanned in succession. These devices define pairs of straight lines (t1, t2) which are tangential to the footwear and each of which passes through an emitter which is switched on and through a receiver. The intersections of the pairs of straight lines, in association with the position of the footwear along its line of advance, define the profile of the footwear.

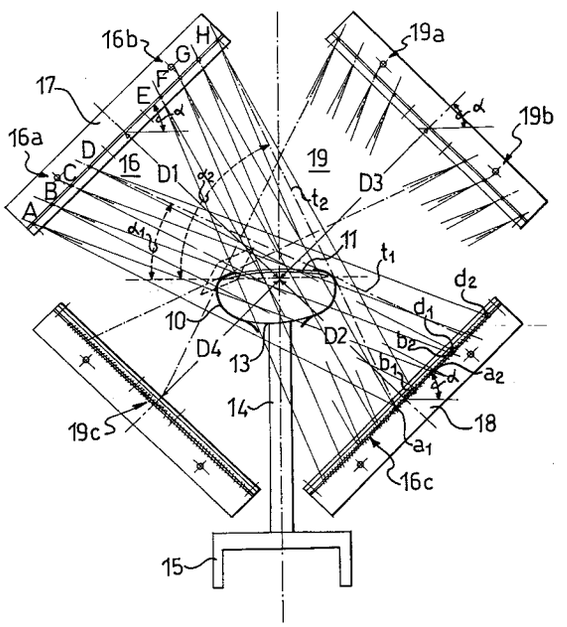

FIG.1

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The present invention relates to equipment for the automated mass-production of footwear and, more particularly, to a method and equipment for detecting the profile of an item of footwear in the plane of the sole during manufacture.

An industrial footwear-production cycle provides for various steps which are carried out in succession and which require the tools of the respective machines to move along the same path. For example, two steps of this type are the roughing of the edge of the upper which has been folded and glued to an internal support sole known as an insole board, and the deposition of adhesive on the roughened surface for the subsequent application of a sole thereto. As is known, in the footwear industry, a step, the object of which is to roughen the surface of the leather of the upper in order to prepare it for gluing, is called roughing.

In order to carry out the roughing, the semi-finished product, fitted on a suitable last fixed to a movable support, is brought beneath a roughing machine and is processed by the roughing tool which is guided along the profile of the footwear in the plane of the sole, that is, along the "false edge" which divides the surface of the upper which, upon completion of the processing, will remain in view, from its folded edge which is glued to the insole board and to which the sole will be applied.

During the next step of the process, the semi-finished product is brought, on its last, under an adhesive-dispensing machine which applies a layer of adhesive to the roughed edge of the upper, that is, to the surface to which the sole is to be glued, by means of a movable dispenser which follows a path substantially identical to that of the roughing tool.

Other steps which may be carried out by a tool which is guided along the same path are pre-roughing in order to remove residues of the process in which the upper is glued to the insole board, and brushing, which may be carried out after each step, such as roughing, which is accompanied by the formation of particles and dust.

The use of machines which can be programmed so that the tool follows the desired path in order to carry out these processes along the profile of the footwear automatically is known. The programming may be of the analog type, when the path is determined by means of a template having the shape and dimensions of the footwear to be manufactured, or of the digital type, when the path is determined by an electronic control unit into which the geometrical characteristics of the footwear being processed are introduced in digital form. In both cases, the programming requires a specific step which has to be carried out before manufacture and which is repeated each time there is a change in the model or the size of the footwear to be produced. In any case, before processing along the programmed path is started, it is essential to position the item to be processed with maximum precision.

The object of the present invention is to propose a method and equipment for automatically detecting the profile of an item of footwear during manufacture, without the need for preliminary programming steps.

According to the invention, this object is achieved by a method which provides for the footwear to be struck by light beams from two sides thereof, for a plurality of points on the edge of the shadow projected by the footwear to be detected, and for a plurality of points on the profile of the footwear in the plane of the sole to be derived from the positions of the points detected and from the geometrical characteristics of the light beams. According to the invention, the method is put into practice by equipment such as that defined in the second claim following the present description.

The invention will be understood further from the following description of an embodiment of equipment which incorporates the principles thereof, with reference to the appended drawings, in which:

Figure 1 shows schematically and in section the devices for the optical detection of footwear-profiles of equipment according to the invention,

Figure 2 is a functional block diagram of the equipment according to the invention, and

Figures 3 and 4 show two portions of the diagram of Figure 2 in detail.

Figure 1 shows a shoe during a manufacturing step in which it is constituted substantially by an upper 10 glued to an insole board 11. The semi-finished product is fitted on a last 13 fixed to a column 14 mounted on a carriage 15. The carriage can be moved along a predetermined path, not shown, in order for the shoe to undergo various processes at suitable stations arranged along the path. Equipment which moves the carriage along a path, particularly for the roughing of the edge of the upper and for the application of adhesive thereto, and in which the present invention can be used advantageously, is described in European patent application No. 92830152.2 filed by the Applicant on 27th March 1992.

According to the invention, the shoe mounted on the last is moved along the line of its longitudinal axis at a predetermined constant speed. Photoelectric devices fordetecting the profile of the shoe are mounted in a plane which is perpendicular to this line, and which may be defined as the detection plane. More precisely, as can be seen in Figure 1, a first device, generally indicated 16, comprises first and second sets 16a and 16b of

light emitters, for example, LED diodes mounted in alignment on a common support element in the form of a bar 17, and a series of light receivers 16c, for example, phototransistors, also mounted in alignment on a common support element in the form of a bar 18. The emitters of the first set 16a, of which there are four in this embodiment of the invention, indicated A, B, C, D in the drawing, and those of the second set 16b, of which there are also four, indicated E, F, G, H, are functionally associated, as will be explained below, with the receivers 16c of which there are 72 in this embodiment. As can be seen, the emitters and receivers are disposed facing each other in parallel lines. The lines are spaced from the longitudinal axis of the shoe by distances D1 and D2, respectively, and are inclined at an acute angle alpha to the plane of the sole, that is to the plane generally defined by the insole board 11. A second device, indicated 19 and just like the first, is constituted by first and second sets of light emitters 19a and 19b and a series of light receivers 19c disposed facing each other in parallel lines spaced from the longitudinal axis of the shoe by distances D3 and D4, and perpendicular to the parallel lines defined by the emitters and receivers of the first device 16.

The emitters of the first and second sets of each device are switched on individually in rapid succession, each for a predetermined period of time, so that the shoe is struck by light beams coming from various points. The periods of time for which the emitters are switched on are much shorter than the time taken by the shoe to pass through the detection plane, so that the shoe may be considered to be substantially stationary during the determination of a point on its profile. For example, the speed of advance of the carriage may be 20 cm/s and the time for switching on the sixteen emitters may be 0.5 ms.

The switching-on is controlled by circuits of known type, indicated by a block 20 in Figure 2, piloted by a central processing and control unit, indicated CPU, by means of a data transmission bus indicated BUS-D.

In each of the two devices 16 and 19, a predetermined plurality (15 in the embodiment shown) of receivers is associated with each emitter. These receivers are included in a portion of the series of aligned receivers which, with the associated emitter, defines a triangle which may be indicated as the light beam emitted by the emitter in question. The emitters and receivers are associated in a manner such that each portion of the series of receivers and the respective associated emitter are in substantially diametrally opposed positions with respect to the longitudinal axis of the shoe, that is, such that the light beams produced by the emitters of each set can strike the shoe at least along the whole of its right-hand half-profile or of its left-hand half-profile, when it passes through the detection plane. In practice, the arrangement is that shown in Figure 1.

The states (illuminated or not illuminated) of the detectors are scanned in succession by scanning circuits of known type, generally indicated 21. This step is coordinated by a synchronizing circuit 22 controlled by the unit CPU by means of a signal-transmission bus indicated BUS-C and an address-transmission bus, indicated BUS-I. The synchronizing circuit 22 is also connected to the switching circuits 20 so that the whole set of 15 receivers associated with a given emitter is scanned within the period of time in which the emitter is switched on. The connections between the circuit 22 and the blocks 20 and 21 are indicated by two bus connectors indicated CTR-EM and CTR-SC, respectively. It should be noted that, in this embodiment, some of the receivers are associated with two adjacent emitters; clearly, however, it is also possible to have a series of receivers associated with each individual emitter independently.

The signals output from the receiver-scanning circuit block 21 are sent to the central unit CPU in order to be interpreted in relation to the switching-on commands supplied to the emitters by means of the emitter-switching circuit block 20 and to the data regarding the position of the carriage supporting the shoe during the scanning step. These latter data, which come from a suitable position-transducing system of known type, are supplied to the CPU continuously at its input indicated D-POS.

More particularly, if it is assumed that both the switching-on of the emitters and the scanning of the receivers take place from left to right looking at the drawing, and if, for the moment, consideration of the operation of the equipment is limited to the emitters A, B, C, D of the first set 16a of the device 16, for a series of 15 receivers associated with a given emitter which is switched on, the following four situations may arise:

- all the receivers are illuminated, that is, the light beam delimited by the triangle defined by the emitter which is switched on and by the receivers associated therewith is not intercepted by the shoe passing through the detection plane,
- at least one of the receivers is illuminated and is followed by at least one illuminated receiver, that is, the beam is partially intercepted by the left-hand portion of the shoe (this is the case of the beam defined by the triangle A, a1, a2 in Figure 1),
- none of the receivers is illuminated (this is the case, for example of the beam delimitated by the triangle B, b1, b2 in the drawing),

- at least one of the receivers is not illuminated and is followed by at least one illuminated receiver, that is, the beam is partially intercepted by the right-hand portion of the shoe (this is the case of the beam defined by the triangle D, d1, d2 in the drawing).

The central unit CPU is structured and programmed so as to take into consideration only the last of the situations described above. In practice, that is, it identifies the emitter and the first of the receivers which is illuminated after a series of non-illuminated receivers and thus identifies a straight line, which is indicated t1 in the drawing and is tangential to the right-hand edge of the shoe.

When the system is being set up, on the other hand, data identifying the positions of the emitters and of the receivers relative to a predetermined system of co-ordinates are input into a memory in the central unit CPU at an input indicated D-IN in Figure 2 and the tangent is thus identified precisely in the central unit CPU from the co-ordinates of the emitter and of the receiver.

The second set 16b of emitters E, F, G, H of the first device 16 and the receivers associated therewith at any particular time operate exactly as described above with reference to the emitters A, B, C, D so that, after all the emitters of the device 16 have been switched on, the central CPU finally identifies two straight lines t1 and t2, which are tangential to the right-hand portion of the shoe. The point of intersection of these two straight lines is determined by a simple calculation in the unit CPU and that point is stored, in association with the datum of the position of the shoe along its line of advance, as a point on the profile of the shoe, in a memory which may be defined as the profile memory M-PROF, within the unit CPU.

As can easily be observed by means of simple geometrical considerations, the precision with which the profile is detected depends on various parameters such as the number and widths of the light beams, the inclination of the beams to the plane of the sole, the relative orientations of the two sets of emitters of the same device and the distances of the emitters and the receivers from the shoe. Practical tests have shown that optimal results are obtained with four emitters per set, spaced about 2 cm apart, with the emitters on a line which is inclined to the plane of the sole so that the angles alpha 1 and alpha 2 between the straight lines t1 and t2, respectively, and the plane of the sole are about 30o and 70o, respectively, at a distance D1 of about 15cm from the longitudinal axis of the shoe, with the centres of the two sets of emitters spaced about 13 cm apart and with the receivers aligned at a distance D2 of about 13cm from the longitudinal axis of the shoe and spaced evenly along a support rod 18 of about 20 cm, substantially identical to the support rod 17 for the emitters. This is all substantially as shown in Figure 1.

Clearly, however, the relative arrangement of the emitters, the receivers and the shoe may vary within wide limits from that described, according to the optical and structural characteristics of the various components.

In a practical embodiment, as shown in Fig. 3, the emitter-switching circuit block 20 comprises a plurality of bistable circuits F/F, of which the inputs D receive data from the unit CPU on the bus BUS-D and the control inputs CP are activated by the synchronizing circuit 22, by means of the connector CTR-EM. The outputs Q of the bistables F/F pilot the emitters of the devices 16 and 19, which are shown as LEDs in the drawing, by means of respective power components TR, for example MOSFET or BJT power transistors. As shown in Fig. 4, the scanning-circuit block 21, which is combined with a series of receivers of the devices 16 and 19 in the form of phototransistors, comprises, for each phototransistor, a comparator CMP which compares the output of the phototransistor with a reference voltage VREF and produces a signal which is at a high or low level according to whether the input voltage is greater than or less than the reference voltage, respectively; the outputs of the comparators are connected to the inputs IN of a multiplexer MTP which is piloted by the scanning-control signals CTR-SC emitted by the synchronising circuit 22 and supplies the data resulting from the scanning to the unit CPU on the data bus BUS-D.

The second device, indicted 19, operates in exactly the same way as described above with reference to the device 16 and detects the profile of the left-hand portion of the shoe.

The profile of the shoe is thus detected point by point, one point per side for each complete scanning of the two detection devices the shadow projected by the shoe being analyzed, in practice, as the carriage with the shoe gradually passes through the detection plane. The data thus obtained, indicated D-PROF in Figure 2, are used to control the advance and the positions of the tools of the machines which perform the various operations on the shoe.

The equipment according to the invention has been found extremely advantageous in comparison with known equipment, since it detects the profile of the footwear whilst it is moving along the processing path, before processing starts or even as the footwear passes between two successive steps, without any intervention by the operator even when there are changes in the sizes and models of the footwear manufactured. Clearly, with the equipment of the invention, accurate positioning of the foot-

wear to be processed is not necessary.

Although only one embodiment of the invention has been described and illustrated, clearly, many variants and modifications are possible within the scope of the same inventive concept. For example, the detection plane need not be perpendicular to the line along which the footwear advances, the devices for detecting the two half-profiles need not be in the same plane (in this case, their relative positions would naturally have to be input into the central unit CPU, together with a suitable correction program), and the sequence in which the emitters are switched on and the receivers are scanned could take place in the opposite direction to that described. Moreover, it should be noted that it is not essential for the detector devices 16 and 19 to remain active throughout the period during which the footwear is passing through the detection plane; in fact, it may be appropriate to de-activate them during the passage of regions of the footwear the profiles of which are not well defined, such as in the inner, arcuate portion of the footwear, and to generate a series of points which enable the profile detected to be completed by suitable programming of the unit CPU on the basis of standard profile shapes.

Claims

1. A method of detecting the profile of an item of footwear in the plane of the sole during manufacture, characterized in that it provides for the following steps:

striking the footwear with first and second sets of light beams from first and second sides of the footwear, respectively,

detecting a plurality of points on the edge of the shadow projected by the footwear on respective sides opposite the first and second sides, and

deriving points on the profile of the footwear in the plane of the sole from the positions of the points detected and from the geometrical characteristics of the light beams.

2. Equipment for detecting the profile of an item of footwear (10, 11) in the plane of the sole during manufacture, characterized in that it comprises:

- translation means for moving the footwear in a direction in which its longitudinal axis is transverse a detection plane,
- position transducer means for detecting the position of the footwear relative to a predetermined reference point,
- first (16) and second (19) devices for detecting the right-hand and left-hand half-profiles, respectively, point by point, each of the devices comprising first (16a, 19a) and second (16b, 19b) sets of light emitters (A-H) and a series of light receivers (16c, 19c) disposed facing the emitters of the first (16a, 19a) and second (16b, 19b) sets of emitters on opposite sides of the footwear,
- means (20) for switching the emitters on in succession for predetermined periods of time,
- means (21) for associating predetermined pluralities of receivers of the series with the emitters which are switched on at any particular time, in order to detect the illuminated or non-illuminated states of the receivers of the plurality of receivers in succession and to generate a signal when the states of two adjacent receivers are different, and
- processing and storage means (CPU) for associating the signal with the positions of the emitter and of the receiver which have caused it to be generated, identifying the straight line which passes through that emitter and that receiver, calculating the point of intersection of the two straight lines (t1, t2) identified by the switching-on of one emitter of the first set of emitters and one emitter of the second set of emitters, respectively, and storing the point of intersection, in association with the position of the footwear detected by the transducer means, as a point on the profile of the footwear.

3. Equipment according to Claim 2, characterized in that the detection plane is perpendicular to the longitudinal axis of the footwear.

4. Equipment according to Claim 2 or Claim 3, characterized in that each of the plurality of detectors and the respective associated emitter are disposed substantially in diametrally opposed positions with respect to the longitudinal axis of the footwear.

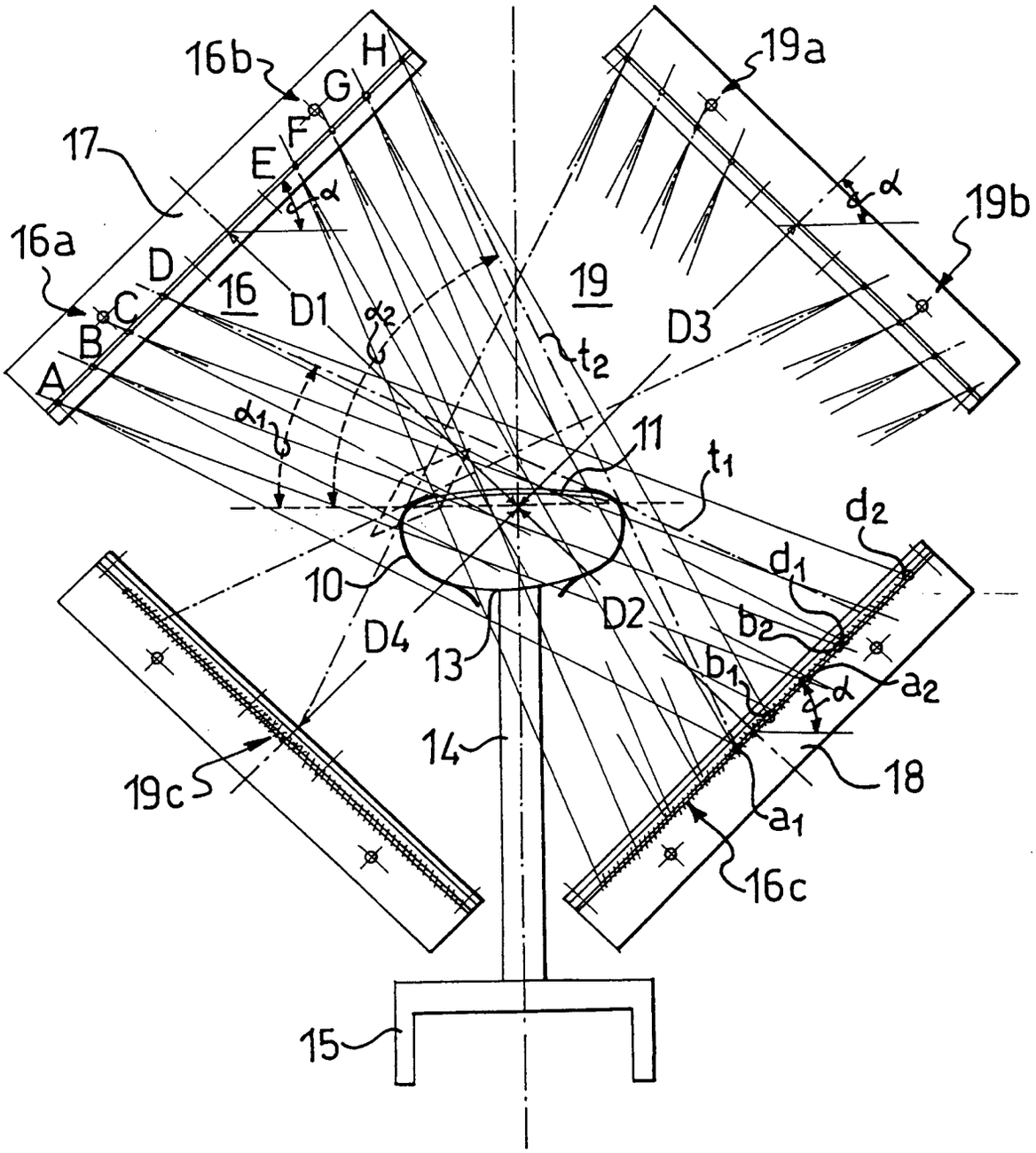
5. Equipment according to Claim 2, Claim 3, or Claim 4, characterized in that it comprises means (22) for causing the emitter-switching means (20) and the means (21) for detecting the state of the receivers to operate in synchronism with the translation means so as to detect a point on the right-hand half-profile and a point on the left-hand half-profile when the footwear is in a predetermined position.

6. Equipment according to any one of Claims 2 to 5, characterized in that the translation means

can move the footwear at a predetermined constant speed.

7. Equipment according to any one of Claims 2 to 6, characterized in that, for each of the two devices (16, 19) the emitters of the first (16a, 19a) and second (16b, 19b) sets are aligned on a first support element (17) and the receivers (16c, 19c) of the respective series of receivers are aligned on a second support element (18).

8. Equipment according to any one of Claims 2 to 7, characterised in that the first (16) and second (19) devices are disposed in the same plane.


16b
H
G
F
E
17
α
16a
D
C
B
A
16
D1
α2
19
t2
D3
19a
19b
α1
11
t1
d2
d1
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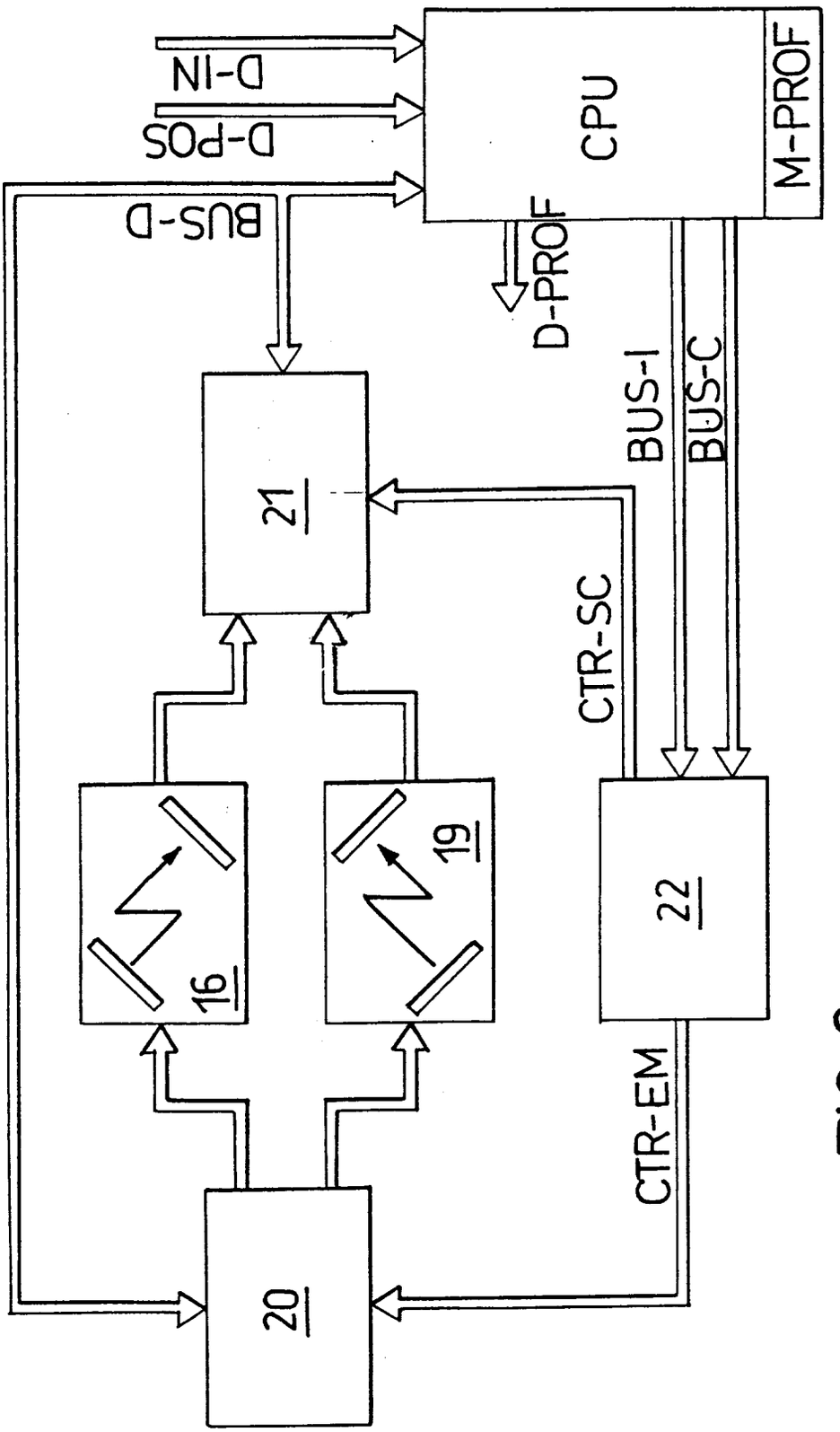
13
D2
b2
b1
a2
α
14
18
19c
a1
16c
15

FIG.1


D-IN
D-POS
BUS-D
CPU
M-PROF
D-PROF
BUS-I
BUS-C
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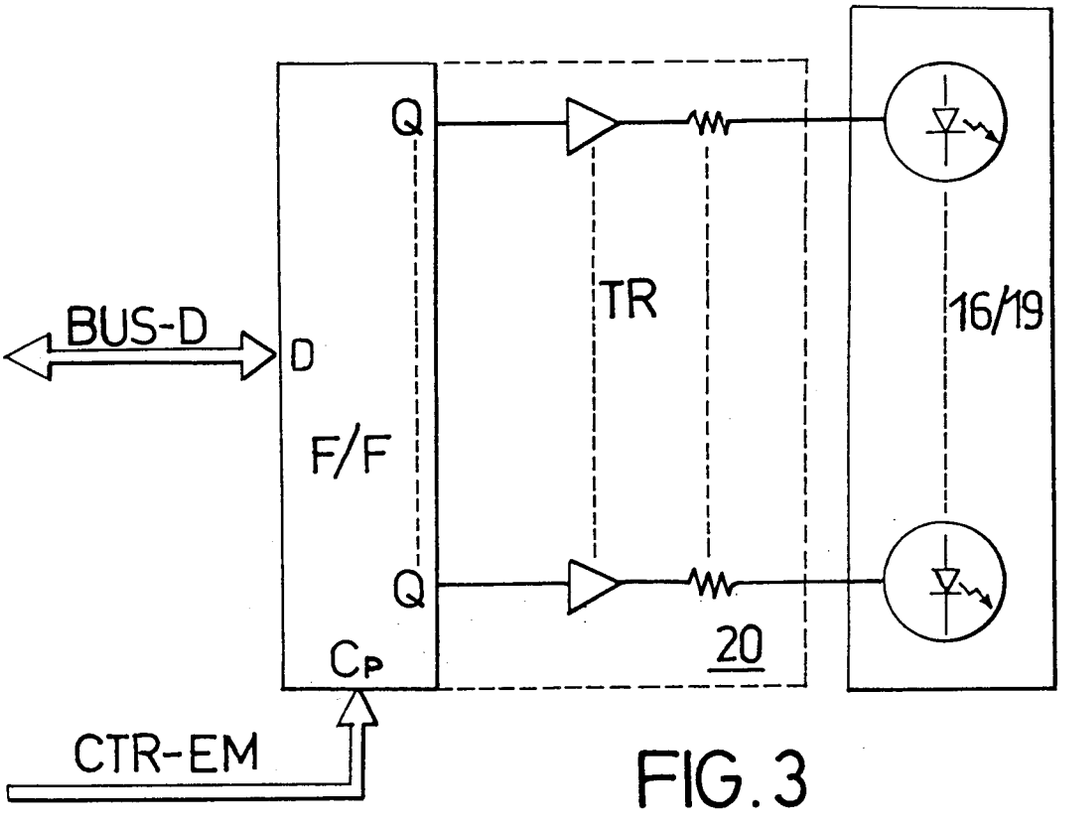
CTR-SC
16
19
22
CTR-EM
20

FIG.2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TR
16/19
BUS-D
D
F/F
Q
20
CP
CTR-EM

FIG.3

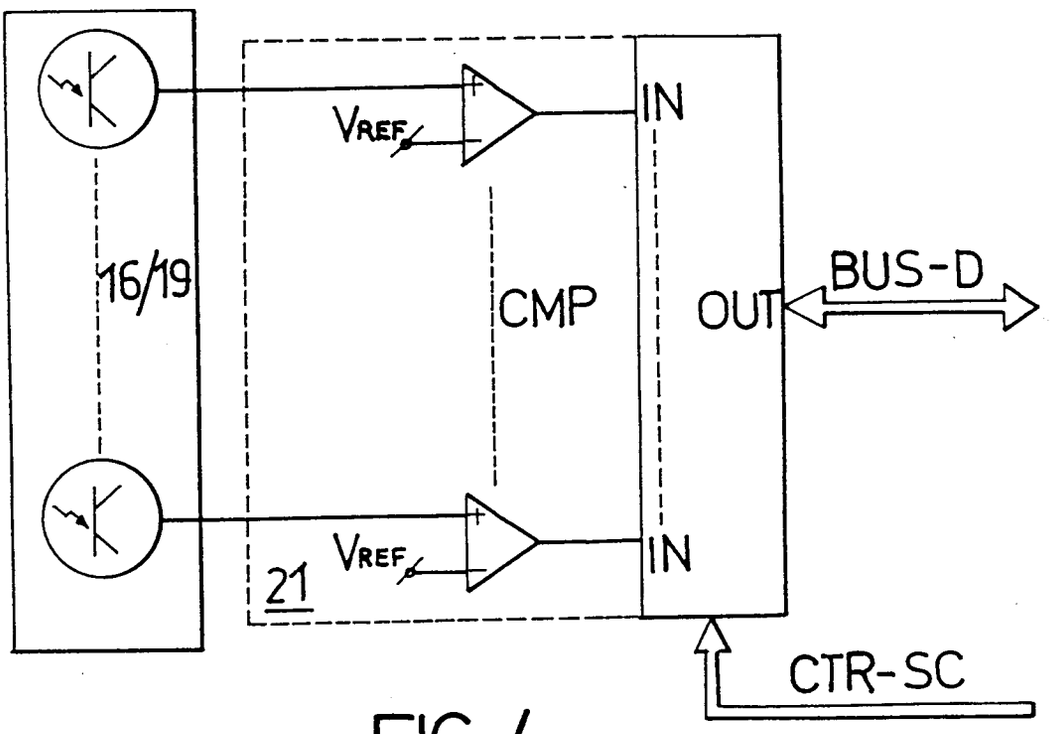
VREF
IN
16/19
CMP
OUT
BUS-D
VREF
IN
21
CTR-SC

FIG.4

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EUROPEAN SEARCH REPORT

Application Number
EP 93 20 3022

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.5)
Y	EP-A-0 512 773 (BRITISH UNITED SHOE MACHINERY LTD.) * page 3, line 2 - line 21; claims; figure 1 * ---	1-8	A43D119/00
Y	NL-A-9 002 167 (HELSY ZALTBOMMEL BV) * page 3, line 18 - line 21 * * page 4, line 8 - line 24; figures * & DATABASE WPI Week 9221, Derwent Publications Ltd., London, GB; AN 92-173304 & NL-A-9 002 167 (HELSY ZALTBOMMEL BV) 6 May 1992 * abstract * ---	1-8	
A	DE-C-40 20 358 (KLÖCKNER FERROMATIK DESMA GMBH) ---		
A	GB-A-2 240 623 (N. STARSMORE) -----		

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

A43D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 December 1993	Soederberg, J

CATEGORY OF CITED DOCUMENTS

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