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(54) **screen printing machine having a material conveyor.**

(57) A screen printing machine hving a material conveyor driven by a power source, such that it is able to convey the material (3) to and to come to a halt at a printing position, in which print corresponding to the pattern on a stencil may be applied to the material, in addition to which the material conveyor is so affected by the power source that the material conveyor is driven at a high speed which, before the printing position for the material is reached, is reduced to a low speed so that the material is slowly advanced to its printing position. The front edge (3c') or similar of the material is capable of being sensed as it assumes a pre-determined position by means of a registration device (20,22) which does not touch the material, so that the material may be caused to stop by activation of the registration device.

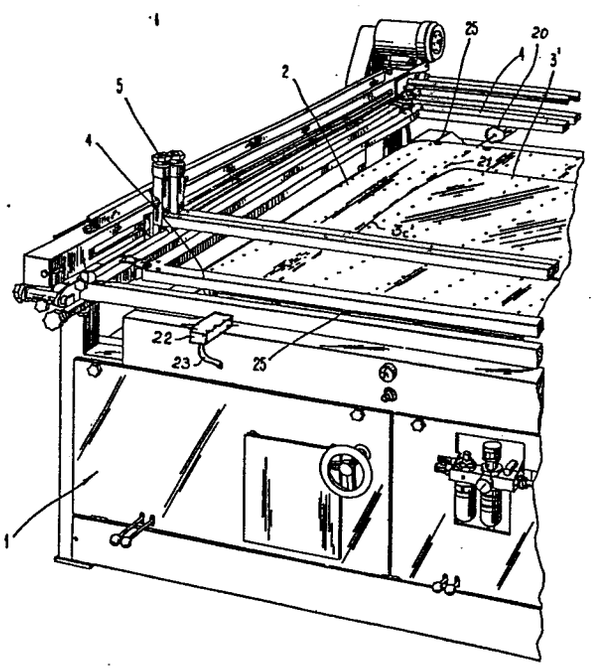

Fig. 2

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TITLE OF THE INVENTION: Screen printing machine having a material conveyor.

TECHNICAL FIELD

The present invention relates to a screen printing machine, and in particular to a screen printing machine of a kind which utilizes a material conveyor. The present invention is particularly appropriate to a screen printing machine in which an endless conveyor belt is used as the material conveyor. The conveyor belt is driven for this purpose by a power source, usually in the form of a d.c. motor, of such a kind that it is able to cause the conveyor belt to stop in a first position for the registration of a material to be printed which is resting on the belt, and then to convey the material to a printing position. In this printing position, print corresponding to the pattern on a stencil shall be applied to the material.

It is usual for the conveyor belt to be supported on and to be advanced over a supporting surface positioned beneath the conveyor belt, thereby causing the conveyor belt to rest on a flat supporting surface, both in the registration position of the material and in the printing position of the material, i.e. the position in which print is applied to the material.

DESCRIPTION OF THE PRIOR ART.

Previously disclosed is a number of different screen printing machines of the kind indicated above, utilizing an

endless conveyor belt as the material conveyor, and as an example of the prior art reference may be made to Swedish Patent Specification 383 487 which describes a rotary printing machine for strip-like material, in particular woven material, said machine including an endless belt driven by a driving pulley and mechanical transmission organs for a number of printing cylinders. The machine also has a synchronization device for synchronizing the movement of the supporting belt with the movement of the printing cyclinder whilst the machine is in use. Also described are organs for lifting the printing cylinders from the supporting belt.

The synchronization device described includes a rotating impulse generator which is driven by a sensor wheel in contact with the supporting belt. This is intended to produce impulses corresponding to the linear speed of the supporting belt. An amplifier and a pulse transformer for amplifying and transforming the impulses produced by the impulse generator are used for driving a stepping motor and a four-way control valve for regulating a flow of oil. This flow of oil shall be proportional to the movement of a screw and this is driven by the stepping motor via a reduction gear.

The description of the prior art must also include a screen printing machine having an endless conveyor belt as the material conveyor, said conveyor belt being driven by a power source so that it is able to come to a halt in a first position for the registration of the material intended for printing, and is then able to convey the material to and to come to a halt at a printing position in which print corresponding to the pattern on a stencil is applied to the material. In this machine the movement of the conveyor belt is sensed, before the material is moved from the registration position to the printing position, by means of a movement-sensing device having a resolution of 0.5 mm. This device is connected to a counter which, at a pre-determined setting corresponding to the total distance covered by the conveyor belt between the first position and the second position, will generate an activating signal which will

cause the power source to bring the conveyor belt to a halt, when the material will then adopt the second position.

A screen printing machine of the type indicated above is described in greater detail in Swedish Patent Application 79 01808-1.

DESCRIPTION OF THE PRESENT INVENTION.

TECHNICAL PROBLEM.

A screen printing machine having an endless conveyor belt as the material conveyor and in which said conveyor belt is driven by a power source designed in such a way as to be capable of bringing the belt to a halt in a first position for the purpose of registering the material to be printed, and of then conveying the material to a printing position for the purpose of causing the material to come to a halt in the printing position, and capable when in said printing position of applying to the material accurate print corresponding to the pattern on a stencil, presents a highly specific problem.

The nature of this problem is such that, once the material has been registered in the registration position on the conveyor belt, the material must then be capable of being advanced by the conveyor belt to the printing position and of being brought to a halt there, without the need for further mechanical registration or registration involving contact with the material, in the exact printing position. It may be stated here that the distance over which the material must be transported between the registration position and the printing position may vary, but that it is not unusual for said transport distance to exceed 10 metres, in which case steps must be taken to ensure that the material will adopt the correct printing position to an accuracy of less than 0.5 mm, and preferably 0.1 mm or below, so that the pattern on the stencil shall be capable of being transferred as precisely as possible to the material and of being related exactly to the material. The problem is made all the more difficult by the fact that the movement of the material from the registration position to the printing position must take place very rapidly.

The first problem referred to above has been found to be attributable principally to the fact that the conveyor belt must be provided with a join. It has been found to be practically impossible to make this join of identical uniformity to the rest of the conveyor belt. The endless conveyor belt must pass over a number of drive rollers, idler rollers and link rollers, and the deflection of the belt occurs to all intents and purposes only in a single direction. As the join passes over these rollers, the radius of the belt will vary depending on whether it is the uniform belt or the join in the belt which is passing over the roller. This is particularly true of the drive rollers and the idler rollers.

It has been found that the drive rollers and idler rollers in particular may exhibit diameters which differ considerably, being of the order of magnitude of 200 mm, and this naturally means that even a small difference in the radius of the conveyor belt will cause it to produce a considerable registration error in the printing position if the distance covered by the belt between the registration position and the printing position is measured by previously disclosed methods. This is the case, of course, when the distance covered by the conveyor belt is measured by the drive rollers or the idler rollers. If the variation in the diameter is assumed to be of the order of magnitude of 0.1 mm, then the conveyor belt will produce a registration error of the order of magnitude of 0.3 mm for each roller having a contact arc of 180°.

A problem exists, therefore, in connection with screen printing machines of the kind indicated above in the registration of the material in the printing position, concerning the measurement of the movement of the conveyor belt, since said printing position is dependent on two different parameters, one being that the conveyor belt must cover a precise distance between the registration position of the material and the printing position of the material, said distance needing to be capable of being measured very accurately and equally between the different material conveyors, and the other being that the

conveyor belt must exactly follow the centre-line of the conveyor belt in the direction of transport for each instance of material being transported from the registration position to the printing position. The latter problem may be regarded as actually having already been solved.

As far as concerns the problem of being able precisely to register a thin material, in particular thin and brittle material, in the registration position, it has been found, in experiments into the registration of very thin sheets of glass, that the registration devices actually caused the glass material itself to crack as they came into contact with the edge of the sheet of glass. It is thus very difficult to succeed in causing the sheet of glass to move along the conveyor belt because of the adhesion or friction which is present between the belt and the sheet of glass.

In summary, difficulties have been encountered in precisely determining the printing position by the mechanical and electronic measurement of the movement of the conveyor belt.

SOLUTION.

The problems described above may be solved by a screen printing machine having a material conveyor driven by a power source so that it will be able to convey the material to and to come to a halt at a printing position in which print corresponding to the pattern on a stencil may be applied to the material, in addition to which the material conveyor is so affected by the power source that the material conveyor is driven at a high speed which, before the printing material for the material is reached, is reduced to a low speed so that the material is slowly advanced to its printing position. The invention proposes that the front edge of the material be capable of being sensed as it assumes a pre-determined position by means of a registration device which does not touch the material, and that the material conveyor be so arranged as to come to a halt as the result of the activation of the registration device.

The transport of the material from the registration position to the printing position takes place as rapid acceleration, as a constant or essentially constant rate of advance and as rapid retardation, and the final registration takes place at a very low rate of advance.

The present invention proposes that an organ for sensing and registering the front edge of a sheet of material may be executed in the form of a laser beam which, by its reflection from the edge of the material or in some similar fashion, will immediately cause the power source to halt the transport of the material.

ADVANTAGES.

The advantages which may be regarded as being associated with the present invention are that the distance over which the conveyor belt advances between the registration position for the material and the printing position for the material is achieved by, amongst other things, the sensing of the front edge of the material as this moves into the printing position.

What may be regarded as the characteristic features of a device in accordance with the present invention are indicated in the first characterizing part of the following Patent Claim.

BRIEF DESCRIPTION OF THE DRAWINGS.

A preferred embodiment of the invention exhibiting the significant characteristic features of the present invention is described below in greater detail with reference to the attached drawings, in which:

Figure 1 shows a perspective view of a screen printing machine with a first sheet of material occupying the registration position;

Figure 2 shows the screen printing machine in accordance with Figure 1, in which a second sheet of material has moved into the position intended for printing;

Figure 3 shows in great simplification details of the control system used to define the distance covered by the material between the registration position and the printing position;

Figure 4 shows an arrangement for the control of a cam capable of being driven by the power source; and

Figure 5 shows a graph of the rate of advance in relation to time for the conveyor belt as it moves when transporting a sheet of material from the registration position to the printing position.

DESCRIPTION OF THE PREFERRED EMBODIMENT.

Although certain constituent parts of the preferred embodiment are not directly dependent on the embodiment shown in the attached drawing, the various characteristic features of the invention will nevertheless be described in greater detail in relation to a screen printing machine equipped with an endless conveyor belt serving as a supporting surface for the material to be printed.

Thus the screen printing machine itself shown in Figure 1 has been given the general reference designation 1 , and a specialist in this field will immediately appreciate the general operating principle of a screen printing machine of the nature indicated above, for which reason the following specification will restrict itself only to those component parts of the machine which are essential to the appreciation of the significant

characteristic features of the present invention. The endless conveyor belt used as a supporting surface has been given the reference designation 2 , and this conveyor belt is also used as the material conveyor. On the conveyor belt 2 rests a first sheet of material 3 in the form of a thin sheet of glass, said sheet of glass requiring to be registered, i.e. to be advanced to a precise position in relation to the frame 1' of the screen printing machine.

The conveyor belt 2 is driven by a power source not shown in Figure 1, in the form of a d.c. motor. This d.c. motor is controlled by a four-quadrant thyristor controller in such a way that it is able to stop the conveyor belt in a first position, for the purpose of registering the material 3 intended for printing in the position shown in Figure 1, and is then able to transport the material 3 , resting on the conveyor belt 2 , to the printing position, in which a second sheet of material is shown having the reference designation 3' . In the printing position, print corresponding to the pattern on a stencil is applied to the material. The stencil is not shown in the Figure for reasons of clarity, although it may be stated that the stencil is clamped in a frame 4 in a previously disclosed manner. By means of a scraper arrangement 5 ink placed on the upper surface of the stencil is forced through holes formed in the stencil, and in this way a printed image is applied to the material 3' in the position intended for printing.

It will now be apparent, since the stencil 4 is held in a fixed position in relation to the frame of the screen printing machine, that the position of the material 3' is extremely important if the printed images are to be in a precise relationship to each other, for which reason it is also important for the distance covered between the position of the material 3 shown in Figure 1 and the position of the material 3' shown in Figure 2 to be capable of being measured precisely (with an accuracy of a few tenths of a millimetre).

The material 3 in the first registration position in accordance with Figure 1 is capable of being influenced by a

flow of air directed from below, said flow of air permitting reduced friction between the material and its supporting surface in the form of the conveyor belt 2 . This facilitates the movement of the material 3 by the registration organ 6 for the front edge of the material 3a and the registration organ 7 for the lateral edge of the material 3b . Registration organs 8, 9 for the front edge of the material 3c are also provided. The material 3 can now be moved by the registration organs 6, 7, 8 and 9 into the exact registration position in the presence of only negligible friction between the material 3 and the conveyor belt 2 . The extent of the frictional force which must exist between the material 3 and the conveyor belt 2 in order to achieve good registration is determined in practice from one material to the next by increasing or reducing the level of the flow of air beneath the material.

The material 3 must, after having been registered by the organs 6, 7, 8 and 9 , be subjected to increased friction against the supporting component or the conveyor belt 2 , and this may be achieved through the effect of low pressure applied from below. This low pressure, or some other similar negative pressure, is effective for the whole of the distance covered by the material 3 to the printing position in Figure 2 and also during the printing phase itself.

As already mentioned above, the supporting surface for the material consists of the endless conveyor belt 2 . This belt should be specially treated so as to eliminate all variations in thickness to the greatest possible extent.

Beneath the conveyor belt 2 is situated a supporting surface or a so-called pressure table, said pressure table being divided up into sections. The conveyor belt 2 thus runs over the entire pressure table. The pressure table is provided with a number of holes, at the same time as the conveyor belt also has a number of holes.

The pressure table is divided up into a number of sections, whereby each section is connected to a tube. A first tube interacts with a hose 10a , a second tube interacts with a hose

11a , and a third tube interacts with a hose 12a . Each and every one of these hoses 10a, 11a and 12a runs to a valve not shown here.

The transport of the material to the registration position in accordance with Figure 1 may take place as rapid acceleration, as a constant or essentially constant rate of advance and as rapid deceleration, and finally as a very low rate of advance. During the slow rate of advance lateral registration organs 6 and 7 are activated for the purpose of registering the lateral edges 3a and 3b of the material whilst the front edge of the material is in contact with the front registration organs 8 and 9 , which causes the material to be registered before the conveyor belt 2 stops, which means that the conveyor belt slides beneath the material 3 . The registration devices 8 and 9 for the front edge of the material 3c are able to fold out of the way against a spring, thereby absorbing the kinetic energy stored in the material 3 when it is moved into the registration position by a conveyor not shown in the Figure.

A prerequisite for the precise registration of the material in the printing position in accordance with Figure 2 is that the conveyor belt 2 must have a direction of movement which coincides exactly with the centre-line of the conveyor belt, i.e. the belt must not be permitted to have any lateral displacement.

For this purpose the edge surface 2a of the conveyor belt 2 is equipped with a number of control organs 25 . These control organs are positioned at equal distances along the conveyor belt 2 and are so arranged as to be controlled by a number of guides in a fixed relationship to the frame 1' of the screen printing machine.

As far as concerns the measurement and the exact measurement to within small tolerances of the distance covered by the material between the registration position in accordance with Figure 1 and the printing position in accordance with Figure 2, the preferred embodiment proposes that the movement of the conveyor belt 2 be sensed by a movement-sensing organ 40 . This organ 40 must interact with the belt 2 at some point between the registration position of the material (Fig. 1) and the printing position

(Fig. 2). This organ consists of an "optical shaft encoder", i.e. a device which generates a coded signal by optical means. The device may be of the kind sold by "Data Technology Inc.", Mass., USA under the model designation OM25, which is designed to generate 2500 impulses per revolution. What is then required is to connect to the shaft 41 a wheel 42 with a toothed or fluted periphery 42 a , with the diameter of the wheel 42 being selected so as to produce in the line 43 one impulse for every small section of length. In the present case the diameter of the wheel has been selected so that each pulse represents a distance of 0.1 mm covered by the track. The line 43 is connected to a counter 44 of the type "Electronic Digital Present Counter" manufactured by (NLS) Non Linear System Corp., Calif., USA under the model number PR-S. The wheel 42 is in contact with the conveyor belt 2 and in this way is able to measure the distance covered by the belt and the material between the position shown in Figure 1 and the position shown in Figure 2. The line 43 is connected to the electronic counter 44 , which counts every small section of length.

A pre-determined value may be set on this counter, and the set value must then be less than the distance covered by the conveyor belt 2 between the first position shown in Figure 1 and the second position shown in Figure 2, and when the set value on the counter is reached an activating signal shall be generated at that point via a line 45 . This activating signal shall influence the power source, in the form of a d.c. motor 46 , and shall cause the driving motor and the conveyor belt 2 to slow down so that the material 3' is slowly advanced towards the second position in accordance with Figure 2.

As has already been mentioned, the transport of the material 3 from the registration position in Figure 1 to the printing position in Figure 2 shall take place as a rapid acceleration "a" , as a constant or essentially constant rate of advance "b" , and as a rapid retardation "c" , and finally as a very slow rate of advance "d" in Figure 5.

A connecting organ 47 in the form of a four-quadrant

thyristor controller, as produced by GME-system AB, Stockholm, Sweden, under the model designation TRDB-5, controls the power source during the rapid acceleration, the constant or essentially constant rate of advance, and under the rapid retardation and the low rate of advance. This four-quadrant thyristor controller is able via a sinusoidal oscillation to drive a d.c. motor in either of two directions.

The counter 44 is so arranged that it will, via the signal on the line 45 , control the thyristor controller and the power source 46 as far as the low rate of advance, and as soon as the pre-determined value has been reached on the counter 44 the control function will be assumed by a registration organ which does not touch the material and which will be described later.

If the distance to be covered is assumed to be 1.26 metres, then the use of a setting of 12400 is recommended on the counter.

At the start of the belt 2 in the position in accordance with Figure 1, counting of the impulses will begin. The material 3' is caused to come to a halt, when the front edge of the material will assume a pre-determined position as the result of the front edge reaching a registration organ which does not touch the material.

This organ which senses and registers the front edge 3c' of the material comprises a laser device 20 producing a laser beam 21 aimed at a receiver 22 intended for the laser beam. The laser beam 21 constitutes the registration line for the part at the front edge 3c' of the material 3' .

The laser device 20 could be one of the argon lasers sold by "Spectra Physics, California, USA", under the model designation "171-03".

As soon as the part 3c' of the edge of the material breaks the beam 21 a signal will be generated in the line 23 connected to the control organ 47 , said signal causing the drive motor 46 to stop.

The laser beam could also be so arranged as to be reflected by the part 3c' of the edge of the material.

The idea of invention also includes contactless registration against registration marks or registration holes in the material.

By means of a switch not shown in the Figures the power source 46 is activated so as to drive a wheel 46a , which in a previously disclosed manner is connected to the conveyor belt 2 . This interaction is not shown in the attached drawings for reasons of clarity. The power source 46 is influenced for the rapid acceleration and for the essentially constant rate of advance, and as soon as the wheel 46a has turned for the transport distance "e" in Figure 5 a switch 48 is activated, the effect of which is fed into the control device 47 via a line 49 . This causes the rapid retardation to be engaged, and during the transport period "f" the coupling organ 44 assumes control of the power source 46 in the manner described above, and the stop signal is generated via the line 23 .

At the same time it should also be noted that at the point in time "f" will be activated a hydraulic cylinder piston arrangement 50 , which is brought into interaction with a stop heel 51 on a cam wheel 52 . The cam wheel 52 is connected via a friction coupling to the wheel 46a , which means that the cam wheel 52 does not follow the rotation of the wheel 46a from the time "f" to the time "g" . The precise registration of the material in the position in accordance with Figure 2 shall occur between these times. This embodiment is preferred because it will cause the printing machine to halt in the same position in each cycle, so that the acceleration, the constant rate of advance and the rapid retardation will occur in such a sequence and for such periods that the material will be able to adopt the precise position for printing during the slow rate of advance.

The arrangement of the cam wheel 52 makes it possible, however, to achieve very rapid material transport until the material reaches a position immediately ahead of the registration position, and enables this to be repeated time after time.

Although the above specification proposes a counter for determining the transport distance of the material before the slow rate of advance is engaged, allowance should be made for the fact that other means may also be proposed. Thus, a laser beam could be used to sense the presence of the material at a certain distance

before the registration position for printing, and thus to re-engage the power source to provide the slow rate of advance.

The invention is not, of course, restricted to the embodiments indicated above by way of example, but may undergo modifications within the context of the following Patent Claims.

PATENT CLAIMS

1. A screen printing machine having a material conveyor driven by a power source in such a way that it is able to convey the material to and to come to a halt at a printing position, in which print corresponding to the pattern on a stencil may be applied to the material, in addition to which the material conveyor is so affected by the power source that the material conveyor is driven at a high speed which, before the printing position for the material is reached, is reduced to a low speed so that the material is slowly advanced to its printing position, c h a r a c t e r i z e d in that the front edge or similar of the material is capable of being sensed as it assumes a pre-determined position by means of a registration device which does not touch the material, and in that the material conveyor is so arranged as to be caused to stop by the activation of the registration device.

2. A screen printing machine in accordance with Patent Claim 1, c h a r a c t e r i z e d in that the movement of the conveyor belt, before the material is moved into the position intended for printing, is sensed by a movement-sensing device, in that said device is connected to a counter or similar arrangement which, at a pre-determined point before the end of the distance covered by the conveyor belt between one position and a second position, will generate an activating signal, and in that said activating signal will cause the power source to slow down the conveyor belt, after which the material is advanced slowly towards the position intended for printing and is brought to a halt once the front edge of the material assumes a pre-determined position as the result of the front edge or similar reaching a registration device which does not touch the material.

3. A screen printing machine in accordance with Patent Claim 1 or 2, c h a r a c t e r i z e d in that the transport of the material from one registration position to the printing position

takes place as rapid acceleration, as a constant or essentially constant rate of advance, as rapid deceleration and finally as a very low rate of advance.

4. A screen printing machine in accordance with Patent Claim 1, 2 or 3, c h a r a c t e r i z e d in that a registration device which senses the front edge of the material is in the form of a laser beam.

5. A screen printing machine in accordance with Patent Claim 2, 3 or 4, c h a r a c t e r i z e d in that the device for sensing movement is so arranged as to control the power source and in that the rapid retardation between the movements at very low speed is so arranged as to come to a halt as the result of the interruption of the laser beam and/or its reflection from the edge of the material or similar.

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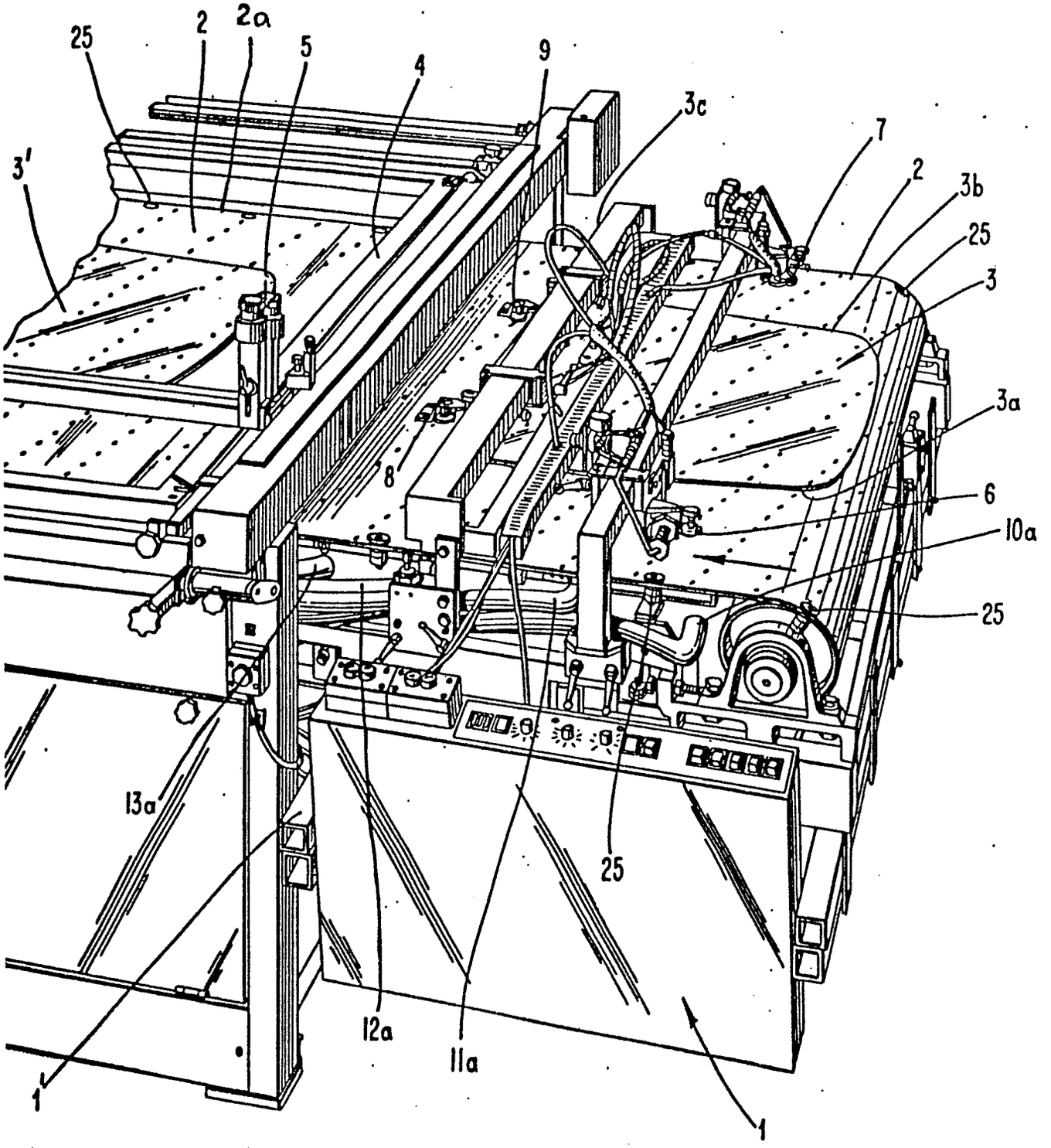

Fig. 1

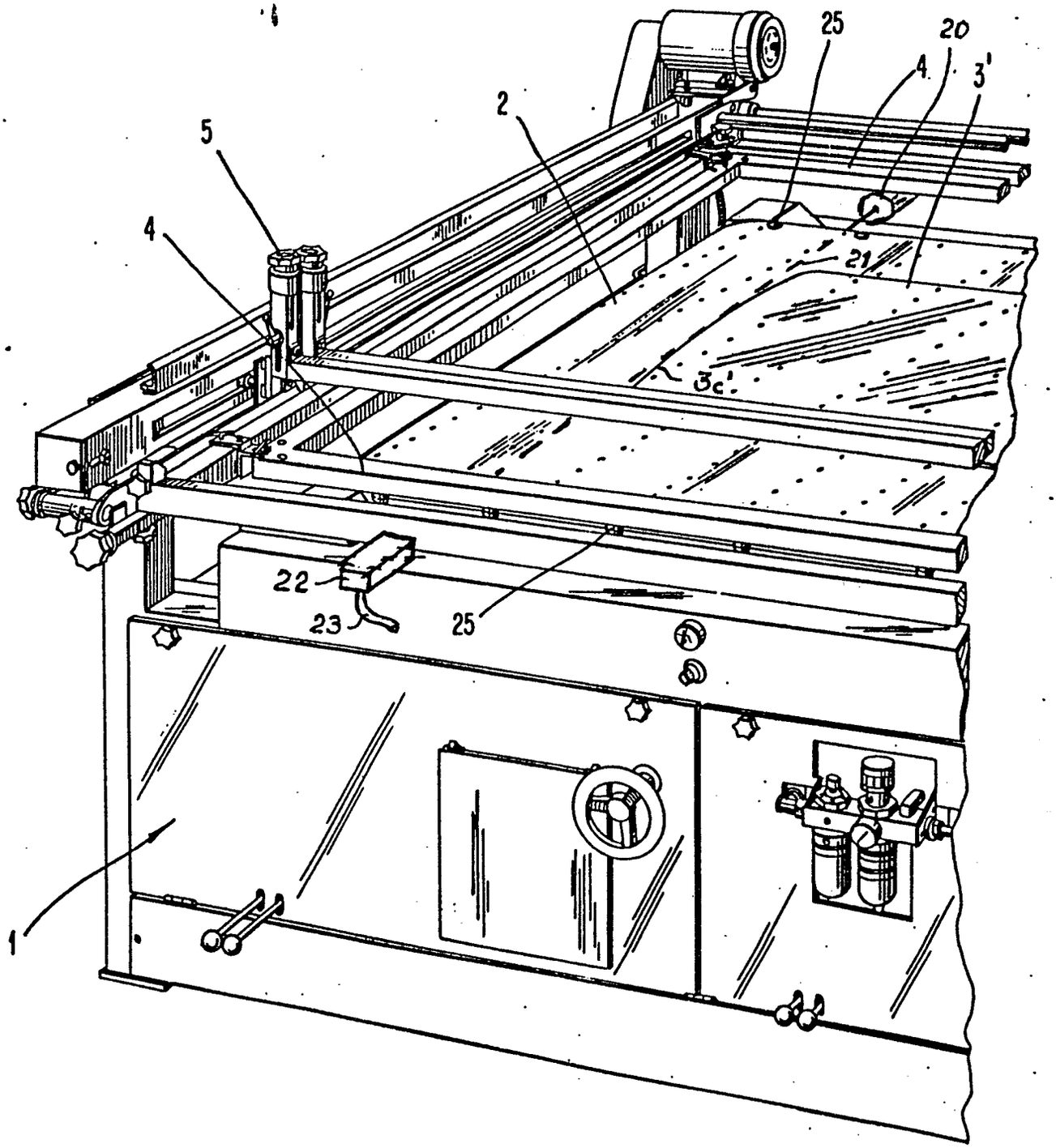

Fig. 2

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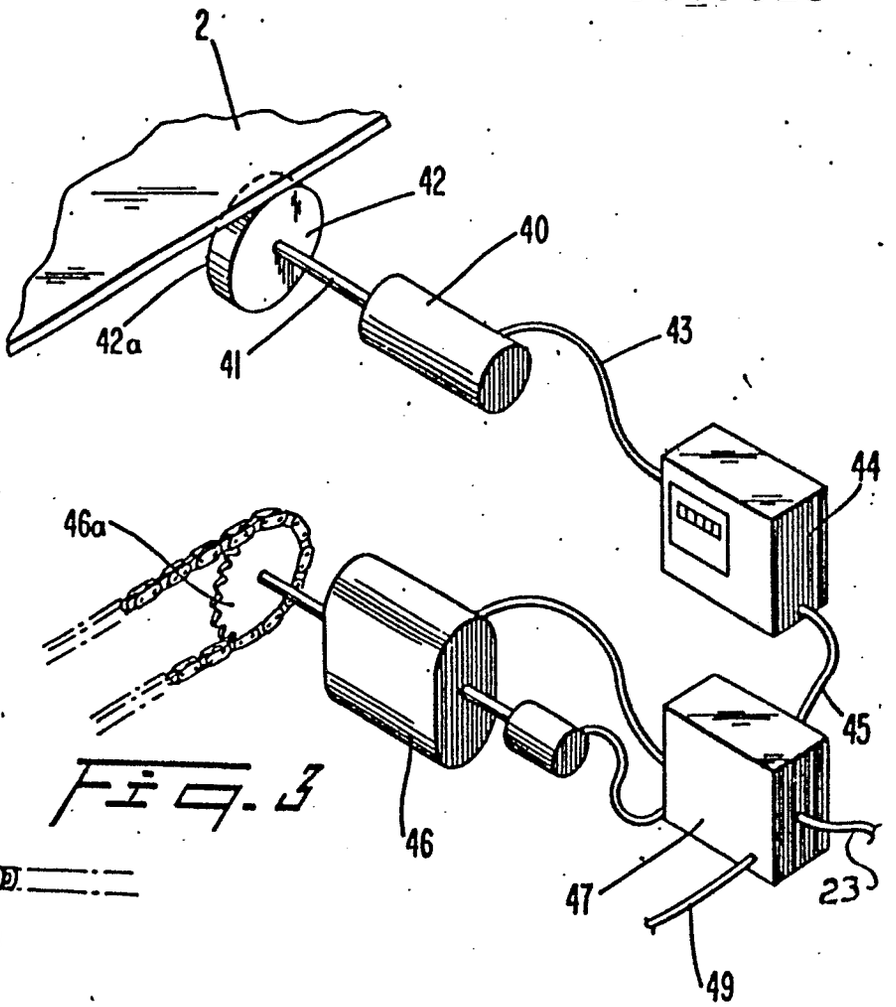


Fig. 4

Fig. 3

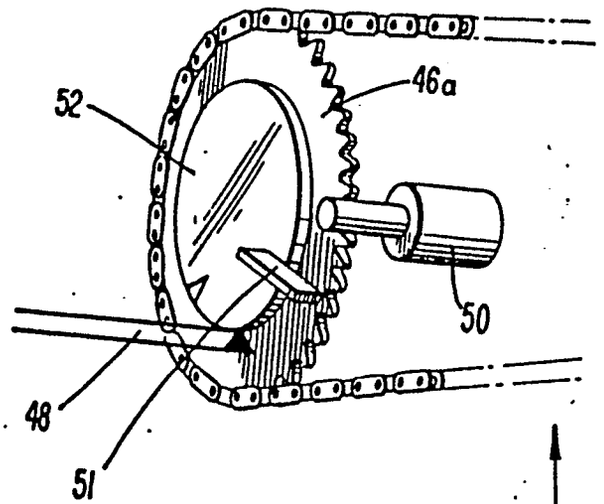
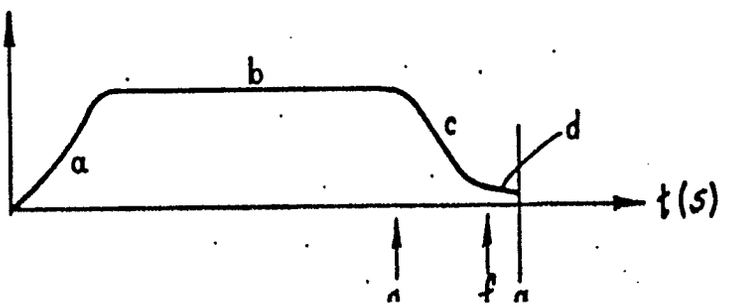


Fig. 5



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EUROPEAN SEARCH REPORT

0097629
Application number

EP 83 85 0139

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)
Y	GB-A-2 045 728 (ON APPLICANTS' NAME) * Page 5, line 31 - page 6, line 30; figures 1,2,8-10 *	1-3	B 41 F 15/08
Y	US-A-3 190 518 (AMERICAN SAINT GOBAIN) * Column 6, lines 22-51; figures 4,8,12-15,19a *	1	
A	US-A-3 949 864 (MONTSANT)		
A	GB-A- 838 187 (SIEMENS)		

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

B 41 F
B 65 H
B 65 G
C 03 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26-08-1983	LONCKE J.W.

CATEGORY OF CITED DOCUMENTS

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