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FORM 1

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21 JUL 1987
Sydney

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

APPLICATION FOR A STANDARD PATENT

I Mesac Corporation, of Taiyo Building, 12-1 Kabuto-cho, Nihonbashi, Chuo-ku, Tokyo, JAPAN, Toyo Flocking Co., Ltd., of 1-680 Sukedo, Ashikaga-Shi, Tochigi-ken, JAPAN, hereby apply for the grant of a standard patent for an invention entitled:

Electrostatic flocking apparatus

which is described in the accompanying complete specification.

Details of basic application(s):-

Basic Applic. No:	Country:	Application Date:
177465/86	JAPAN	28 July 1986
208032/86	JAPAN	5 September 1986

The address for service is:-

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DATED this TWENTY FIRST day of JULY 1987

Mesac Corporation, Toyo Flocking Co., Ltd.

By: W. J. Anderson

Registered Patent Attorney

TO: THE COMMISSIONER OF PATENTS
OUR REF: 31773
S&F CODE: 61790

5845/2

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 26.10.90

SPRUSON & FERGUSON

COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

In support of the Convention Application made for a patent for an invention entitled:

Electrostatic Flocking Apparatus

I/We, Satonobu Yoshikawa and Tomoji Haranoya
[full name of declarant(s)]

of 5-12, Nihonbashi 3-chome, Chuo-ku, Tokyo, Japan and
[full address of declarant(s) - not post office box]
1-680 Sukedo, Ashikaga-shi, Tochigi-ken, Japan

do solemnly and sincerely declare as follows:-

1. We are authorised by
Mesac Corporation and
Toyo Flocking Co., Ltd.

the applicants for the patent to make this declaration on their behalf.

2. The basic applications as defined by Section 141 of the Act were made
in JAPAN
on 28 July 1986
by Mesac Corporation.
and on 5 September 1986 by Mesac Corporation and Toyo Flocking Co., Ltd.

3. MASAAKI ABE, TOMOJI HARANOYA and TOSHIO MOTEGI

of 2 - 1256 Ohwada-machi, Ohmiya-shi, Saitama-ken, Japan; Keno Elemental Heights 306, 462 Yamon-cho, Asikaga-shi, Tochigi-ken, Japan and Yokodai House 205, 2 - 4003 - 2 Honjyo, Ashikaga-shi, Tochigi-ken Japan

are the actual inventors of the invention and the facts upon which the applicants are entitled to make the application are as follows.

The applicants are the assignees of the invention from the actual inventor.

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention(s) the subject of the application.

DECLARED at TOKYO this 1st day of July, 1987

Tomoji Haranoya
Signature of Declarant

TO: THE COMMISSIONER OF PATENTS
AUSTRALIA

Satonobu Yoshikawa

KLN:0004W

Spruson & Ferguson

AUSTRALIA CONVENTION STANDARD & PETTY PATENT DECLARATION SFP4

COMMONWEALTH OF AUSTRALIA

THE PATENTS ACT 1952

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

In support of the Convention Application made for a patent for an invention entitled:

Title of Invention: Electrostatic flocking apparatus

Full name(s) and address(es) of Declarant(s): I/We Satonobu Yoshikawa and Tomoji Haranoya care of Mesac Corporation, Taiyo Bldg, 12-1 Kabuto-cho, Nihonbashi, Chuo-ku, Tokyo and Toyo Flocking Co., Ltd. 1-680 Sukedo, of Ashikaga-shi, Tochigi-ken both in Japan respectively

do solemnly and sincerely declare as follows:–

Full name(s) of Applicant(s):

1. ~~I am/We are the applicant(s) for the patent~~

(or, in the case of an application by a body corporate)

1. ~~I am~~/We are authorised by Mesac Corporation and Toyo Flocking Co., Ltd. the applicant(s) for the patent to make this declaration on ~~its~~/their behalf.

2. The basic application(s) as defined by Section 141 of the Act ~~was~~/were made

Basic Country(ies): in JAPAN

Priority Date(s): on 28 July 1986

Basic Applicant(s): by Mesac Corporation

and on 5 September 1986 by Mesac Corporation and Toyo Flocking Co., Ltd.

3. ~~I am/We are the actual inventor(s) of the invention referred to in the basic application(s)~~

(or where a person other than the inventor is the applicant)

Full name(s) and address(es) of inventor(s):

3. MASAAKI ABE, TOMOJI HARANOYA and TOSHIO MOTEGI

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~~is~~/are the actual inventor(s) of the invention and the facts upon which the applicant(s) is/are entitled to make the application are as follows:

Set out how Applicant(s) derive title from actual inventor(s) e.g. The Applicant(s) is/are the assignee(s) of the invention from the inventor(s):

Agreement of 1 July, 1987, by which inventions of the inventors relevant to business of the Applicants were deemed to be the property of the Applicants.

4. The basic application(s) referred to in paragraph 2 of this Declaration ~~was~~/were the first application(s) made in a Convention country in respect of the invention(s) the subject of the application.

Declared at Tokyo this 1st day of July, 1987

TOYO FLOCKING CO., Ltd.
Tomoji Haranoya.
Mesac Corp.
Satonobu Yoshikawa.

Signature of Declarant(s)

SFP4 To: The Commissioner of Patents 11/81

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(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 605776

(54) Title
ELECTROSTATIC FLOCKING APPARATUS

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(56) Prior Art Documents
AU 26000/77 B05B, B05C

(57) Claim

1. An electrostatic flocking apparatus comprising:

a flocking chamber;

flock support means disposed at the bottom of said flocking chamber for supporting flock within said flocking chamber,

said flock support means comprising a box, a perforated board or mesh screen defining an upper surface of the box for supporting flock, and vibratory or rocking means operatively connected to said box for vibrating or rocking said box to separate mass or masses of flock supported on the upper surface of said box into discrete fibers;

an air blow producing means for forcing a stream of air upwardly through said upper surface of said box that blows the discrete fibers supported on said upper surface upwardly in said flocking chamber;

filter means disposed at an upper portion of said flocking

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chamber for allowing the stream of air to discharge therethrough and for preventing the fibers blown by the stream of air from discharging therethrough;

a first electrode disposed between the upper surface of said box and said filter means;

a second electrode disposed between said first electrode and the upper surface of said box;

a third electrode disposed between said second electrode and the upper surface of said box for polarizing the discrete fibers as they are blown upwardly in said flocking chamber by the stream of air;

three power source means electrically connected to said first, second and third electrodes, respectively for impressing respective voltages on said electrodes,

the power source means of at least one of said first and said second electrodes including a polarity changeover means for changing the polarity of the voltage of the electrode to which said power source means including the polarity changeover means is electrically connected; and

workpiece support means within said flocking chamber for supporting a workpiece to be flocked between said first and said second electrodes.

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FORM 10

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

COMPLETE SPECIFICATION

(ORIGINAL)

This document contains the amendments made under Section 49 and is correct for printing

FOR OFFICE USE:

Class Int Class

Complete Specification Lodged:
Accepted:
Published:

Priority:

Related Art:

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Complete Specification for the invention entitled:

Electrostatic flocking apparatus

The following statement is a full description of this invention, including the best method of performing it known to me/us

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ABSTRACT OF THE DISCLOSURE

There is provided an electrostatic flocking apparatus which comprises a flocking chamber, an air flow producing means for supplying and discharging air into and out of said flocking chamber, a filter means for allowing the air out of the flocking chamber, but preventing the fibers from discharging out of the chamber, an air box at the bottom of the flocking chamber and having a perforated board or wire mesh, an electrode means, power sources electrically connected to the electrode means, a support means for supporting the work and a conveying means for conveying the work into and out of the flocking chamber.

ELECTROSTATIC FLOCKING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to an electrostatic flocking apparatus which is adapted to flock fibers on one or more surfaces of a work.

Prior Art

A variety of electrostatic flocking apparatus have been proposed and practically employed. One of the prior art electrostatic flocking apparatus generally comprises an electrode or electrodes to which a high DC voltage is applied by a high DC generator, a box for holding fibers in the form of fine particles to be flocked on a work and a means disposed in opposition to the electrode or electrodes for maintaining the fibers in their grounded condition.

In order to electrostatically flock the fibers on the work by use of the prior art electrostatic flocking apparatus referred to above, a work having a wet adhesive applied on at least one surface thereof is held by a holding means and a high DC voltage is applied to the electrode or electrodes by a high DC voltage generator.

By the application of the voltage to the electrode or electrodes, an electric field is produced between the work and electrode or electrodes and the lines of electric

force in the electric field are orientated or directed to the work. The fibers held within the box are charged in the directions of the lines of electric force whereby the fibers are caused to fly towards the work. Since the work has the adhesive applied on at least one surface thereof, the charged fibers pierce the adhesive on the work to provide a flocked product. The flocked product is then subjected to a dry step to dry the wet adhesive to provide a final flocked product.

However, the above-mentioned electrostatic flocking apparatus presents some problems.

The first problem is that when the charged fibers mix with the non-charged fibers held in the box which is disposed within the filtering chamber, the charged fibers tend to attract some of the non-charged fibers surrounding the charged fibers resulting in the formation of a mass or masses of fibers which would not fly easily. Even if the mass or masses of fibers fly, the fibers will be flocked unevenly on the work resulting in a reject having an unevenly flocked surface or surfaces.

The second problem is that when the fibers fly in low density in the flocking chamber, the fibers may be sparsely flocked on the work.

The third problem is that since the electrostatic flocking is performed by the utilization of the electric

field phenomenon produced between the electrode or electrodes and work as mentioned hereinabove, when the work has a smooth surface or surfaces the lines of electric forces produced by the electrode or electrodes are uniformly distributed on the work surface or surfaces, but when the work has concaves and convexes on the surface or surfaces thereof and especially, a hollow or hollows as found in a so-called deeply drawn moulding, the lines of electric force will not be uniformly distributed on the work surface or surfaces. Thus, it has been considered that fine flocking can not be conducted on such a work. In order to finely flock fibers on such a work, it was necessary to employ a special electrode or electrodes adapted to produce lines of electric force which conform with the surface configuration of the work as one example.

In addition to the above-mentioned problems with respect to performance, the prior art electrostatic flocking apparatus presents a problem with respect to conveyance of the work.

That is, in the electrostatic flocking, in order to flock fibers in a predetermined density, it is necesssary to cause the work to dwell in the electric field within the flocking chamber for a predetermined time period. Thus, in order to efficiently treat a number of works in succession, it is necessary to convey the works in

succession into the flocking chamber to be flocked fibers thereon and convey the treated or flocked works out of the flocking chamber in succession after the completion of the flocking operation on the works to thereby enhance the operation efficiency of the apparatus.

With the aim to enhance the operation efficiency of the flocking apparatus in electrostatically flocking fibers on a number of works in succession, the conveying mechanism of the prior art flocking apparatus comprises a conveying means in the form of a conveyer or the like which extends from the setting position in which the work is set on a support platform through the flocking chamber to the discharge position in which the flocked work is discharged out of the system.

The conveying means is so designed that the work conveyed from the setting into the flocking chamber is caused to dwell in the flocking chamber for a predetermined time period to be flocked fibers thereon and then conveyed out of the flocking chamber.

However, although the prior art conveying mechanism enhances the operation efficiency of the electrostatic flocking apparatus by conveying the works in succession into and out of the flocking apparatus, since the setting position of the work and the processed work discharge position are separate positions with the flocking chamber

interposed therebetween, the flocking apparatus occupies a relatively large space for installation thereof.

And since the flocking chamber is provided with the openings in the opposite said walls thereof, a relatively large portion of the fibers filling the flocking chamber tend to disperse out of the chamber through the openings into the environment surrounding the flocking chamber.

Furthermore, when the conveyer is provided within the flocking chamber, it is very difficult to clean the lower run of the conveyer positioned below the work and/or work support platform. Thus, there is the possibility that replacement of the fibers by different fibers is troublesome and/or a portion of the fibers employed in the previous step tend to adhere to a portion of the flocking chamber and mix with the latter fibers to be employed in the succeeding step resulting in the production of a reject.

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SUMMARY OF THE INVENTION

It is an object of the present invention to substantially ameliorate at least some of the disadvantages of the prior art.

Accordingly, an electrostatic flocking apparatus is provided. The apparatus comprises a flocking chamber and flock support means disposed at the bottom of the chamber for supporting flock within the flocking chamber. The flock support means comprises a box, a perforated board or a mesh screen defining an upper surface of the box for supporting flock and vibratory or rocking means operatively connected to the box for vibrating or rocking the box to separate a mass or masses of flock

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supported on the upper surface of the box into discrete fibers. An air blow producing means is also provided for forcing a stream of air upwardly through said upper surface of said box and blowing the discrete fibers supported on said upper surface upwardly in the flocking chamber. A filter means is disposed at an upper portion of said flocking chamber for allowing the stream of air to discharge therethrough and for preventing the fiber blown by the stream of air from discharging therethrough. A first electrode is disposed between the upper surface of the box and the filter means. A second electrode

is disposed between the first electrode and the upper surface of the box. A third electrode is disposed between the second electrode and the upper surface of the box for polarising the discrete fibers as they are blown upwardly in the flocking chamber by the stream of air. Three power source means are electrically connected to the first, second and third electrodes. The power source means of at least one of the first and second electrodes includes a polarity changeover means for changing the polarity of the voltage of the electrodes to which the power source means including the polarity changeover means is electrically

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connected. A workpiece support means within the flocking chamber supports a workpiece to be flocked between the first and second electrodes.

The above and other objects and attendant advantages of the present invention will be more readily apparent to those skilled in the art from a reading of the following detailed description in conjunction with the accompanying drawings which show one embodiment of the invention for illustration purpose only, but not for limiting the scope of the same in any way.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a vertically sectional schematic view of one embodiment of the electrostatic flocking apparatus according to the present invention;

Fig. 2 is a side elevational view of the flocking apparatus shown in Fig. 1 with a portion thereof cut away;

Fig. 3 is a perspective view on an enlarged scale of an electrode means in the flocking apparatus shown in Fig. 2;

Fig. 4A is a plan view on an enlarged scale of the

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truck employed in the flocking apparatus shown in Fig. 1;

Fig. 4B is a fragmentary vertically sectional view on an enlarged scale taken along the line Y-Y in Fig. 4A;

Fig. 5 is a time chart showing one mode for controlling the three electrodes of the electrode means shown in Fig. 3;

Fig. 6A is a view showing one condition of lines of electric force in the electric field produced between the intermediate and uppermost electrodes in the electrode means shown in Fig. 3;

Fig. 6B is a view showing another condition of lines of electric forces in the electric field produced between the intermediate and lowermost electrodes in the electrode means shown in Fig. 3.

PREFERRED EMBODIMENT OF THE INVENTION

The present invention will be now described referring to the accompanying drawings which show one preferred embodiment of the present invention for illustration purpose only, but not for limiting the scope of the same in any way.

Figs. 1 to 4 inclusive show the preferred embodiment of the electrostatic flocking apparatus according to the present invention. Reference numeral 11 denotes a flocking chamber wherein fibers are to be flocked on a work and which includes a vibratory air box 39 formed at

the bottom of the chamber and having a perforated top board or wire mesh 40 which is preferably formed of conductive material and which forms the inner bottom of the flocking chamber on which the fibers 12 are deposited.

A shock abosorber 11a formed of resilient material connects between the lower end of the flocking chamber 11 and the upper end of the air box 39 to absorb the vibratory movement of the vibratory air box.

Suitably disposed above the perforated top board 40 within the flocking chamber 11 are three vertically spaced uppermost, intermediate and lowermost electrodes 41, 42 and 43, which extend horizontally. Grounded rails 18 are interposed between the uppermost and intermediate electrodes 41, 42 and extend in a level in parallel and spaced relationship to each other and the electrodes. A filter 54 is stretched across an upper portion of the interior of the flocking chamber 11 and an air blower 53 is disposed on the top of the chamber. An opening 15 is formed in only one side wall of the flocking chamber 11 and has a shutter 14. A work 13 is conveyed by a suitable means of which description will be made hereinafter into and out of the flocking chamber 11 through the opening 15. An air flow means is provided in cooperation with the opening 15. The air flow means is adapted to recycle the exhaust air from the top of the flocking chamber 11 to the

air box 39. Provided adjacent to the opening 15 are an air curtain mechanism 87 which utilizes the air from the air flow means and an air jet mechanism 92.

The perforated board or wire mesh 40 is formed of conductive material and grounded.

A truck 17 formed of conductive material and having the work 13 secured thereto by means of a conductive jig or jigs is guided along the rails 18. Thus, the work 13 is maintained in the grounded condition. The work 13 has an adhesive applied on at least one surface thereof. With the work 13 maintained in the grounded condition, the electrostatic flocking apparatus is in its operative condition. When the electrostatic flocking apparatus operates, the air box 39 at the bottom of the flocking chamber 11 is vibrated or rocked by a crank mechanism 38 and simultaneously, air is blown into the air box 39. The air blown into the air box 39 is forced to pass upwardly through the apertures in the perforated board or wire mesh 40 which forms the inner bottom of the flocking chamber 11 and on which the fibers 12 are deposited into the interior of the flocking chamber 11. The vibratory or rocking motion of the air box 39 and the flow of air passing through the perforated board 40 dislodge the fibers 12 upwardly from the board and blow the fibers upwardly within the flocking chamber 11 in uniform dispersion.

A high DC voltage (negative, for example) is applied to the intermediate electrode 42 by a high DC voltage generator 48 via an insulator (not shown).

Furthermore, a high DC voltage (positive, for example) is applied to the uppermost electrode 41 by DC voltage generators 45, 46, 47 via an insulator (not shown).

Thus, the fibers 12 caused to fly upwardly within the flocking chamber 11 are polarized under the action of the electric field produced by the lowermost electrode 43 and attracted to the electrode 43. Furthermore, the fibers 12 are charged by the lowermost electrode 41 and then enter the electric field produced by the intermediate electrode 42 whereupon the fibers are attracted to the intermediate electrode and fly upwardly within the flocking chamber 11. That is, the fibers 12 fly in the flocking chamber 11 in high density by the above-mentioned phenomenon. This provides the condition as described in the preamble of this application.

The flying condition when the fibers 12 flying within the flocking chamber 11 enter the electric field produced between the intermediate and lowermost electrodes 42, 43 will now be described. When the fibers 12 flying in the abovementioned condition pass by the intermediate electrode 42, the fibers are charged by the intermediate

electrode and fly towards the uppermost electrode 41 by the lines of electric force of the electric field produced between the intermediate and lowermost electrodes 42, 43. The work 13 is disposed in the grounded condition between the intermediate and uppermost electrodes. If the undersurface of the work 13 has an adhesive applied thereon, the fibers 12 pierce the adhesive by the electric field produced between the intermediate electrode 42 and work 13. Thus, the fibers are flocked on the undersurface of the work 13. Fibers which have not pierced the work undersurface are attracted towards the uppermost electrode 41 to be charged by the electrode. The charged fibers 12 are dispersed under the influence of the repulsive force from the electrode 41. As the fibers 12 pass by the uppermost electrode 41, the fibers are charged by the electrode 41, and the fibers fly in high density between the uppermost electrode 41 and the ceiling of the flocking chamber 11.

The behaviour of the fibers flying in dispersion will now be described in brief. When the fibers 12 are disposed adjacent to the lowermost electrode 43, since the fibers are charged with the same polarity as that of the uppermost electrode 41, the fibers tend to move away from the electrode 41 by the repulsive force acting between the fibers 12 and electrode 41.

When the fibers fly towards the intermediate electrode 42, the fibers fly while being attracted towards the intermediate electrode 42. Since the work 13 is disposed in the grounded condition between the intermediate and uppermost electrodes 42, 41, the fibers 12 flying while being attracted towards the electrode 42 strike against the upper surface of the work 13. Thus, if the upper surface of the work 13 has an adhesive applied thereon, the fibers will pierce the work upper surface to thereby perform flocking thereon. Fibers which have not striked against the work, are attracted towards the intermediate electrode 42 whereby the fibers are charged with the same polarity as that of the intermediate electrode 42. Thus, the fibers 12 can fly towards the uppermost and lowermost electrodes 41, 43. The fibers flying towards the uppermost electrode 41 are attracted by the electrode and the fibers flying towards the lowermost electrode 43 are attracted towards the electrode. Some of the fibers which have passed by the lowermost electrode 41 drop onto the bottom of the flocking chamber 11. The fibers which have dropped on the bottom of the flocking chamber 11 are repeatedly blown upwardly and fly as described in the preamble of this application. Thus, the flocking of the fibers on the work is performed while the fibers are flying in high density.

Next, the flying condition of the fibers when the intermediate and uppermost electrodes are imperated with the same polarity.

As described hereinabove, the fibers 12 deposited on the bottom of the flocking chamber 11 are caused to fly upwardly by the blowing-up action of air and the electric field produced between the uppermost and lowermost electrodes 41, 43. When the fibers 12 enter the electric field produced between the intermediate and uppermost electrodes 42, 41, since the two electrodes have the same polarity, the repulsive force acts between the electrodes to cause the fibers to fly in the direction of the lines of electric force of the electric field. Thus, if the side faces of the work 13 have adhesive applied thereon, the side faces of the work are flocked. And the fibers strike against the electrodes, pass by the electrodes or fly in the vicinity of the electrodes and the fibers always fly in various directions under the electric field phenomenon producing the electrodes in high density within the flocking chamber as described hereinabove.

In the flocking apparatus described hereinabove illustrated in the drawings, by imparting the adjacent electrodes with the same polarity or opposite polarities and/or varying voltage to be applied to the electrodes, the directions of the electric field to be established

between adjacent electrodes, of the electric field to be established between a particular electrode and the work and of lines of electric force providing the electric fields can be varied. Thus, an electric field optimum for flocking fibers to the surface configuration of the work can be established even when the work has an irregular surface configuration which is referred to as a deeply drawn moulding or is a ring. And if the electrodes and work can be moved by known means, the above-mentioned phenomena can be more conspicuously developed.

While the fibers 12 are being flocked on the work 13 within the flocking chamber 11, the fibers fly in high density due to the air blowing and electric field establishment phenomena.

The air is normally caused to discharge from the flocking chamber 11 by the air blower.

Thus, the fibers 12 flying in the flocking chamber in the manner as described hereinabove are concentrated at the exhaust port together with the blown-in air. However, since the filter 54 adapted to exhaust only the air and prevent the flying fibers from passing therethrough is stretched across the upper portion of the flocking chamber 11, the fibers are arrested by the filter. Thus, the fibers are prevented from being carried away to the exterior of the flocking chamber 11 by the exhausting air.

Furthermore, in order to prevent the clogging of the filter 54 with the fibers, an air nozzel 56 is provided adjacent to the filter 54. The fibers 12 arrested by the filter 54 are blown off the filter by air sprayed from the nozzle 56 to thereby prevent the clogging of the filter 54 with the fibers.

Since the fibers 12 have passed through the electric field while flying within the flocking chamber 11, the fibers have been electrically charged. When the charged fibers drop onto the non-charged fibers deposited on the perforated board or wire mesh 40, the charged fibers tend to electrically attract the non-charged fibers positioned at and about the drop point to form masses of fibers. However, as mentioned hereinabove, the vibratory movement of the perforated board 40 caused by the vibration of the air box 39 and the air forced to pass through the apertures in the perforated board 40 break the masses into discrete fibers which are then caused to fly within the flocking chamber as mentioned hereinabove.

The electrodes 41, 42, 43 have a simple configuration and arrangement, that is, the electrodes 41, 42, 43 comprise respective frameworks 41a, 42a, 43a and a plurality of wires 41b, 42b, 43b stretched in parallel and spaced relationship across the interior of the respective frameworks, respectively.

With the above-mentioned construction and arrange-ment of the components of the flocking apparatus according to the present invention, when the electrodes 41, 42, 43 are energized by current supplied by their respectively associated power sources or high voltage generators and apply a high voltage to their respective wires 41b, 42b, 43b via the respective frame members 41a, 42a, 43a, a strong discharge occurs between the adjacent electrodes through the wires to provide lines of high electric force.

As more clearly shown in Fig. 2, a lifter 16 is provided in opposition to the opening 15 and the work 13 is held on the truck 17 by means of a suitable jig or jigs (not shown). The truck 17 is adapted to move from a position on the lifter 16 into the flocking chamber 11 and from the flocking chamber onto the position on the lifter through the opening 15 in the flocking chamber 11. Two horizontal rails 18 are laid in parallel and spaced relationship within the flocking chamber 11 by suitable means (not shown) and the truck 17 is guided along the rails. The guide rails 18 are grounded and thus, the work 13 on the truck 17 is also grounded. As more clearly shown in Figs. 4A, 4B, the truck 17 comprises a rectangular frame member 19, rollers 20 rotatably mounted at the opposite ends of the frame member 19 and adapted to roll on the guide rails 18, projections 21 extending

upwardly from the frame member 19 adjacent to the rollers 20 for securing the work 13 and an endless chain 22 extending along one end of the frame member 19 and trained about sprockets 23 to be rotated thereby as the sprockets 23 rotate whereby the truck 17 is guided along the rails 18 to be moved into and out of the flocking chamber 11. The truck 17 is also provided with a bar 24 for transmitting vibratory driving force from a vibrator of which description will be made hereinafter.

The sprockets 23 are rotated by a reversible motor 28 through a chain 25, a sprocket 26 and a chain 27 which are provided outside of the flocking chamber 11. Reference numeral 29 denotes a vibration motor which reversibly rotates a sprocket 32 through a chain 31 and vibratory force from the vibration motor 29 is transmitted through the shaft of the sprocket 32 to the interior of the flocking chamber 11 wherein a suitable table means (not shown) is adapted to engage the above-mentioned bar 24 so as to vibrate the truck 17.

Also provided outside of the flocking chamber 11 is a motor 33 as a drive means which vibrates the above-mentioned air box 39.

In the illustrated embodiment, an air flow producing means for supplying and exhausting air into and out of the flocking chamber 11 comprises a means adapted to recycle

the air exhausted from the flocking chamber 11 through a recycle line 68 back into the flocking chamber 11. The blower 53 and a moisturizing box 49 are provided in the recycle line 68. The blower 53 sucks in the air from the flocking chamber 11 which has passed through the filter 54 and has been constricted through a damper 55 and pumps the air into the moisturizing box 49.

The air is moisturized by a moisturizer 50 in the moisturizing box 49 and fed into the air box 39 after the humidity of the air has been controlled to a value by an eliminator 52 in accordance with a signal from a humidity sensor 51. The moisturization of the air is to maintain the moisture within the flocking box 11 at an optimum value for electrostatic deposition in a standard atmosphere, but the resistance value of the fibers may vary depending upon the relative humidity of the air. In this case, the fibers having the varied resistance value can not be satisfactorily flocked. To cope with the difficulty, it may be considered to moisturize the flocking chamber, but according to the present invention, the fibers deposited on the perforated board 40 are moisturized before the fibers fly upwardly within the flocking chamber 11 so that the fibers are maintained in a good condition. That is, when the interior of the flocking chamber 11 is dry, the fibers are weakly charged

and fly weakly. Thus, the fibers tend to pierce the adhesive layer on the work by a shallow depth and sparsely. Thus, according to the present invention, it is contemplated that the fibers are strongly charged and caused to fly positively whereby the fibers pierce the adhesive layer by an optimum depth and in an optimum density.

The lifter 16 is provided with work holding means 57a, 57b disposed in two different levels and the holding means 57a, 57b are formed within the travelling framework 58 of the lifter 16. The travelling framework 58 is supported by guide rods 59, 59 for vertical movement and operatively connected to the rod 61 of a cylinder 60. Thus, as the cylinder 60 is operated for upward and downward stroke movements, the travelling framework 58 moves upwardly and downwardly. The work holding means 57a, 57b each support the truck 17 and are provided with sprockets 62a, 62b, respectively, for driving the above-mentioned chain 22 on the truck 17. Drive force is transmitted from a truck drive means on the flocking chamber 11 to the sprockets 62a, 62b via chains 63a, 63b, a sprocket 64, a chain 65, a sprocket 66 and a chain 67.

Now, the operation of the embodiment will be described. In operation, the fibers 12 deposited on the perforated board 40 of the vibratory air box 39 at the

bottom of the flocking chamber 11 shown in Fig. 1 are blown upwardly and caused to fly within the flocking chamber by the air passing through the apertures in the perforated board 40. With the fibers flying within the flocking chamber 11, when a high DC positive voltage, for example, is applied to the lowermost electrode 43 and a high DC negative voltage, for example, is applied to the intermediate electrode 42, the flying fibers 12 are polarized and further urged upwardly within the flocking chamber 11 under the influence of the electric field produced between the two electrodes 42, 43. On the other hand, the fibers 12 deposited on the perforated board 40 of the vibratory air box 39 are finely dispersed upwardly by the rocking or vibratory movement of the box and board by the crank mechanism 38 and the air flow passing through the apertures in the perforated board. And the flying fibers charged in the electric field within the flocking chamber 11 drop onto the non-charged fibers 12 deposited on the perforated board 40 and mix with non-charged fibers to charge the latter resulting in the formation of masses of fibers by the attraction pheonomena. However, the masses are broken into discrete fibers by the rocking and vibratory movement of the vibratory air box 39 and the air flow passing through the apertures in the perforated board 40 to be blown upwardly.

When two adjacent electrodes are polarized with the same polarity, the direction of lines of force in the electric field produced between the two electrodes is different from the direction of lines of force in the electric field produced between the two adjacent electrodes are polarized with opposite polarities. And it is also possible to vary the direction of lines of force in the electric field to be produced between the two adjacent electrodes by varying the value of voltage to be applied to the two adjacent electrodes. Furthermore, when time factors are involved, a variety of electric fields can be produced. By the utilization of the phenomena, fibers can be uniformly flocked on the uneven surfaces of three-dimensional articles which are called as deeply drawn mouldings.

Turning now to Fig. 5 which is a time chart showing one control mode of electrodes in this Figure, A shows the initial fiber filling condition in the flocking chamber 11 wherein the fibers 12 caused to fly upwardly by the air flow are further urged upwardly by the electric field produced between the lowermost electrode 43 to which positive voltage is applied and the intermediate electrode 42 to which negative voltage is applied and that produced between the uppermost electrode 41 to which positive voltage is applied and the intermediate electrode 42 and especially, by the electric field between the lowermost

and intermediate electrodes 43, 42, and thus, the fibers fly in high density. This forms the environment in the flocking chamber as mentioned hereinabove in the preamble of this application. In this Figure, B and C show the instances in which the electrodes 41, 42 are imparted with the same polarity and opposite polarities, respectively and these modes are alternated by a suitable number of times. When electrodes 41, 42 have the opposite polarities, the lines of electric force produced are as shown by 70a in Fig. 6A and the fibers 12 are orientated and flow in the direction along these lines of electric force. Thus, the fibers 12 are predominantly flocked on one surface of the work 13 to be flocked disposed between the electrodes 41, 42. When the electrodes 41, 42 have the same polarity, repulsive force acts between the two electrodes and the lines of the electric force will be as shown by 70b in Fig. 6B. Thus, the fibers 12 fly in the direction along the lines 70b of electric force and the fibers are predominantly flocked on the side and end faces (as well as the hollow or hollows in the surface or surfaces) of the work 13. By alternating the same polarity and opposite polarity modes of the electrodes by a number of times, the fibers can be uniformly flocked on the whole area of the work 13 even if the work is a deeply drawn moulding having extreme conspicuous concaves and

convexes.

Next, the operation for conveying the work 13 into and out of the flocking chamber 11 will be described referring to Fig. 2. First of all, the work 13 is held on the truck 17 which is disposed on either one of the holding means 57a, 57b. The shutter 14 normally held in the closed position is then opened and the lifter 16 is raised to align the truck 17 on which the work 13 is set on the rails 18. Then, the truck 17 is moved through the opening 15 until the truck rides on the rails 18. The conveying operation is carried out by rotating the sprockets 62a, 62b, 23 and accordingly, the chain 22 on the truck 17 trained about these sprockets. When the truck 17 has been properly positioned on the rails 18, the shutter 14 is closed. Since the chain 22 is provided on the truck 17, only the rails 18 for guiding the truck 17 and the sprockets 23 are required as means for conveying the work within the flocking chamber 11. Thus, it is only necessary to provide a quite simple mechanism within the flocking chamber 11 and when the fibers are replaced by new ones, the fibers previously filled within the flocking chamber can be easily and perfectly purged out of the flocking chamber.

The work 13 disposed between the electrodes 41, 42 is flocked the fibers thereon by the electrostatic

flocking as mentioned hereinabove, but during the electrostatic flocking, the truck 17 having the work held thereon is set on the other holding means 57a or 57b. At the completion of the flocking on the first work 13, the sprockets 23 are rotated in the direction opposite to that in which the sprockets have been rotated when the truck has been conveyed into the flocking chamber 11 and the shutter 14 is opened again and the truck 17 is moved back onto the holding means 57b or 57a.

Thereafter, the lifter 16 is further raised to position the holding means 57a or 57b on which the processed or flocked work 13 is set to a level above the rails 18 and position the other holding means 57a or 57b to thereby align the truck 17 on the other holding means with the rails 18. The truck 17 is then conveyed through the opening 15 onto the rails 18 for carrying out the flocking operation on the next work 13 in the same manner as performed on the first work 13.

Basically, by repeating the above-mentioned procedure, the successive works 13 are in succession electrostatically flocked the fibers thereon. The conveying of the work 13 into and out of the flocking chamber 11 can be automatically and effectively carried out.

Since the lifter 16 which is adapted to deliver the work 13 into the flocking chamber 11 and receive the work

from the flocking chamber is provided adjacent to only one side of the flocking chamber 11 and the holding means 57a, 57b are disposed in different levels, the space required for the conveying mechanism is less than that for the conveying mechanism in the prior art electrostatic flocking apparatus. And since the conveying of the work 13 into and out of the flocking chamber 11 is performed through the sole opening 15, the area of the opening 15 may be made small so that the possibility of escaping of the fibers from the interior of the flocking chamber 11 can be minimized accordingly.

In the illustrated embodiment, although the work holding means are disposed in two different levels, the holding means may be disposed in three or more different levels within the scope of the present invention. And the arrangement of the electrodes is also not limited to that shown in the illustrated embodiment. The polarity arrangement of the electromagnets may be also reversed from that described hereinabove. Even when the polarity arrangement is reversed, when the adjacent electrodes are polarized with the opposite polarities, attraction force or repulsive force may act between the adjacent electrodes.

As clear from the foregoing description on the preferred embodiment, according to the electrostatic

flocking apparatus of the invention, the fibers will not aggregate into a mass or masses and thus, although the fibers fly in tuft within the flocking chamber, the fibers will not be flocked on the work in tuft, but flocked uniformly on the work. Even when the work has convexes and concaves thereon, the fibers can be uniformly flocked on the work by controlling voltage to be applied to the electrodes.

And since the opening is provided in only one side of the flocking chamber, the lifter including the work holding means disposed in at least two different levels is provided in opposition to the opening and the work is transferred between the holding means and opening, the space required for the work conveying mechanism can be minimized and thus, the whole apparatus can be made compact.

The provision of the sole opening in the filtering chamber can minimize the dispersion amount of the fibers into the environment surrounding the filtering chamber and the cleaning of the interior of the filtering chamber can be easily performed whereby the fibers can be easily replaced by new fibers. The provision of the sole opening in the filtering chamber makes it easy to control the moisture within the filtering chamber.

Furthermore, the mechanism for conveying the work

into and out of the filtering chamber comprises simple rails which require a minimum space within the filtering chamber and cleaning of the interior of the filtering chamber can be simply and perfectly performed without being impeded by the rails.

While only one specific embodiment of the invention has been shown and described in detail, it will be understood that the same is for illustration purpose only and not to be taken as a definition of the invention, reference being had for this purpose to the appended claims.

The claims defining the invention are as follows:

1. An electrostatic flocking apparatus comprising:

a flocking chamber;

flock support means disposed at the bottom of said flocking chamber for supporting flock within said flocking chamber,

said flock support means comprising a box, a perforated board or mesh screen defining an upper surface of the box for supporting flock, and vibratory or rocking means operatively connected to said box for vibrating or rocking said box to separate mass or masses of flock supported on the upper surface of said box into discrete fibers;

an air blow producing means for forcing a stream of air upwardly through said upper surface of said box that blows the discrete fibers supported on said upper surface upwardly in said flocking chamber;

filter means disposed at an upper portion of said flocking chamber for allowing the stream of air to discharge therethrough and for preventing the fibers blown by the stream of air from discharging therethrough;

a first electrode disposed between the upper surface of said box and said filter means;

a second electrode disposed between said first electrode and the upper surface of said box;

a third electrode disposed between said second electrode and the upper surface of said box for polarizing the discrete fibers as they are blown upwardly in said flocking chamber by the stream of air;

three power source means electrically connected to said first, second and third electrodes, respectively for impressing respective voltages on said electrodes,

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the power source means of at least one of said first and said second electrodes including a polarity changeover means for changing the polarity of the voltage of the electrode to which said power source means including the polarity changeover means is electrically connected; and

workpiece support means within said flocking chamber for supporting a workpiece to be flocked between said first and said second electrodes.

2. An electrostatic flocking apparatus as claimed in claim 1, and further comprising conveyor means for conveying a workpiece between a setting position outside of said flocking chamber and a working position in said flocking chamber at which working position the workpiece is supported by said workpiece support means.

3. An electrostatic flocking apparatus as claimed in claim 1, wherein the power source means of at least one of said first and said second electrodes includes voltage varying means for varying the amplitude of the voltage of the electrode to which said power source means including the voltage varying means is electrically connected.

4. An electrostatic flocking apparatus as claimed in claim 1, wherein said workpiece support means comprises a truck for directly supporting a workpiece, and rails for slidably supporting and guiding said truck.

5. An electrostatic flocking apparatus a claimed in claim 2, wherein said flocking chamber comprises a sidewall having an aperture extending therethrough, and said workpiece support means is movable by said conveyor means through said aperture between the setting and the working positions.

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6. An electrostatic flocking apparatus as claimed in claim 5, wherein said workpiece support means includes a truck, said conveyor means includes means for engaging said truck to move said truck through said aperture between the setting and working positions, and further comprising an air blow mechanism disposed in said aperture for blowing fibers off of said truck as said truck is move through said aperture.

7. An electrostatic flocking apparatus as claimed in claim 5, and further comprising a lifter disposed adjacent said aperture and including a workpiece holder disposed at two different levels,

each said workpiece holder supporting a portion of said conveying means, and

said lifter being vertically movable to move each said portion of the conveying means vertically.

8. An electrostatic flocking apparatus substantially as hereinbefore described with reference to the drawings.

DATED this EIGHTEENTH day of OCTOBER 1990

Mesac Corporation

Toyo Flocking Co., Ltd

Patent Attorneys for the Applicants

SPRUSON & FERGUSON

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FIG. 1

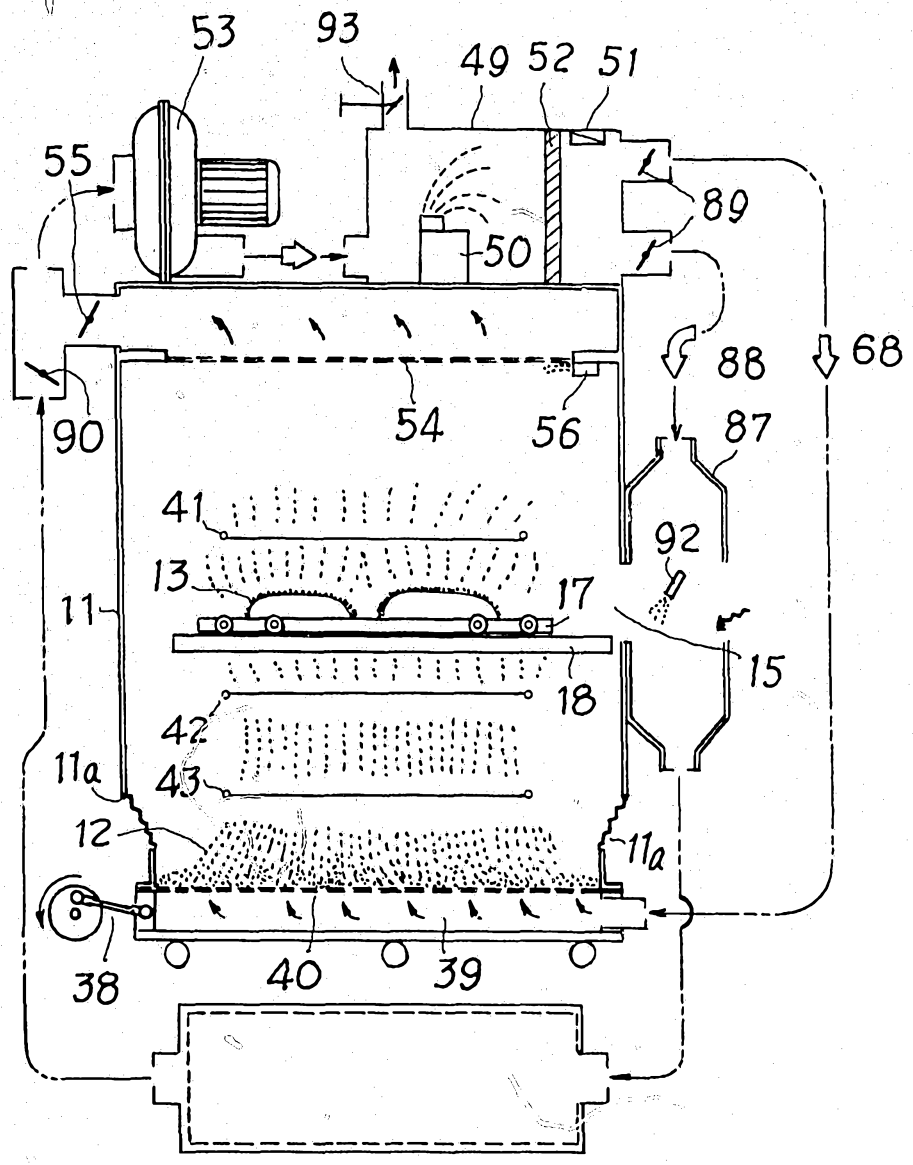
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FIG. 2

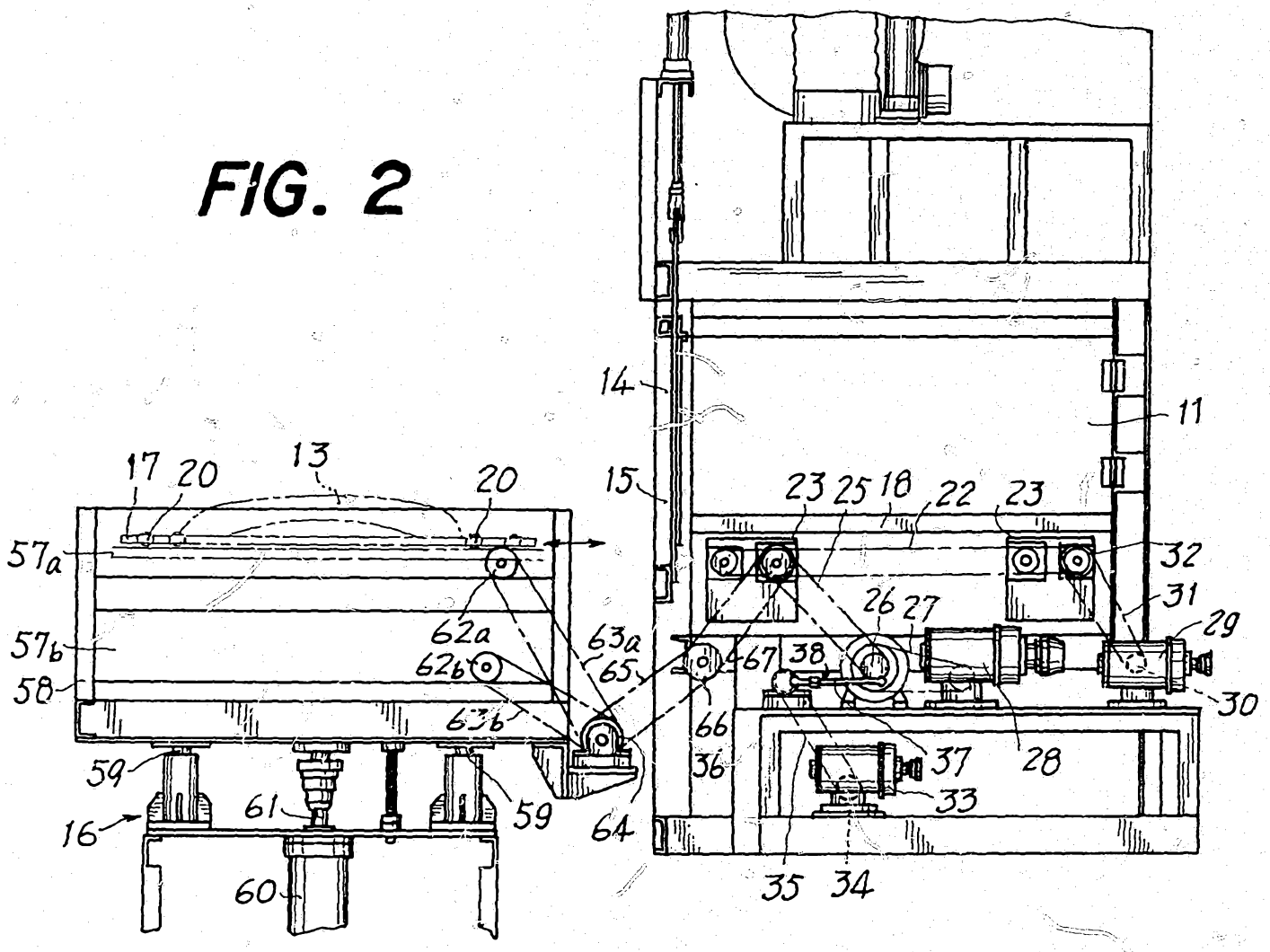
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FIG. 4A

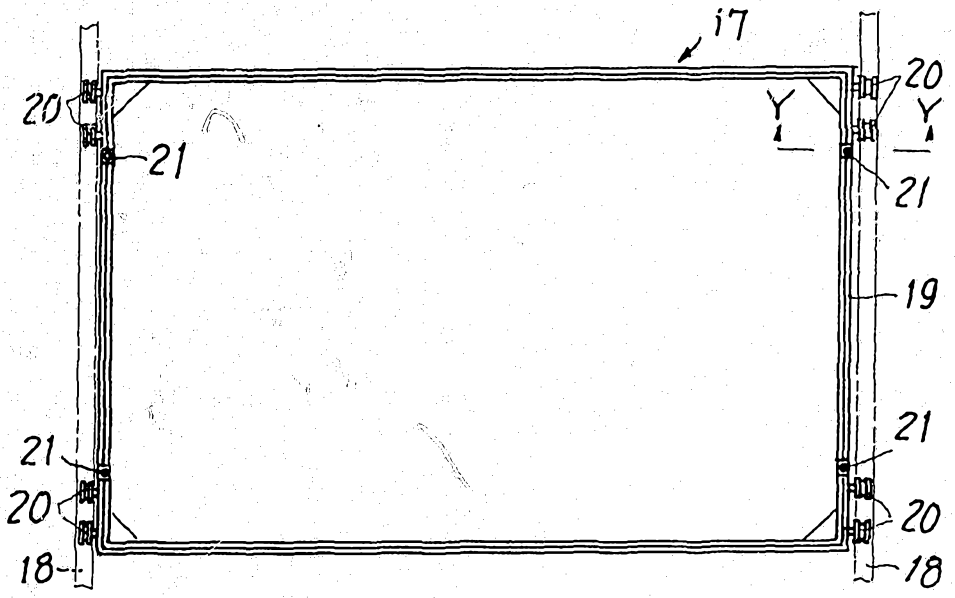

FIG. 4B

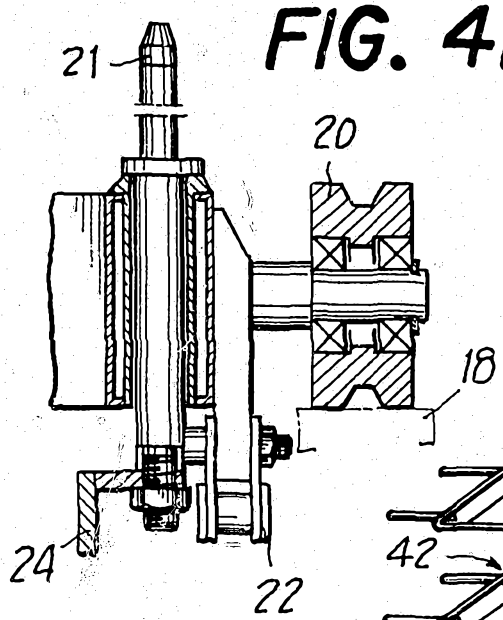

FIG. 3

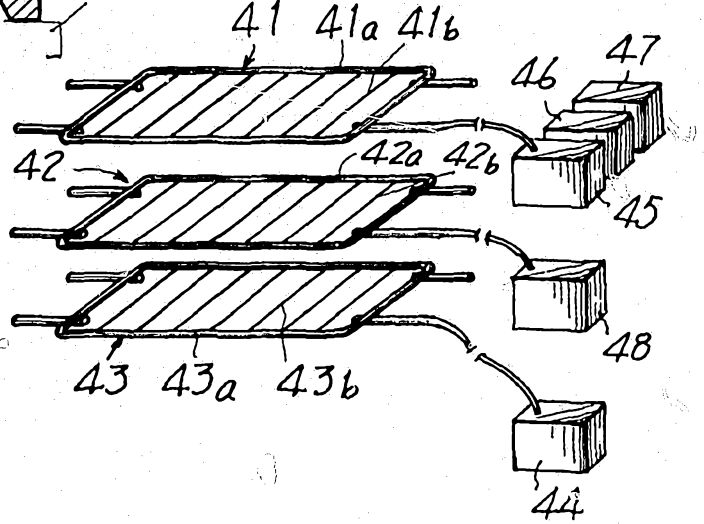

FIG. 5

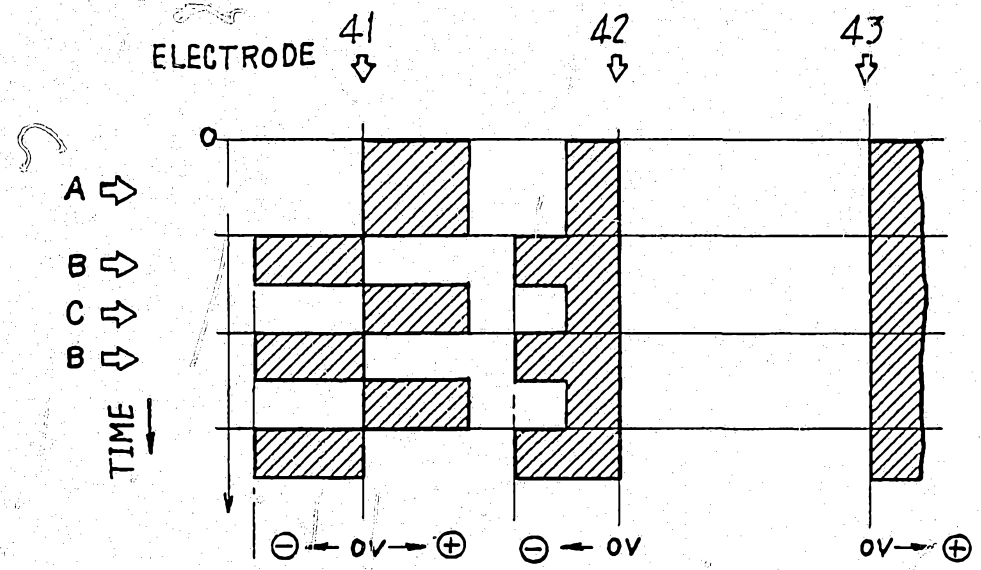

FIG. 6A

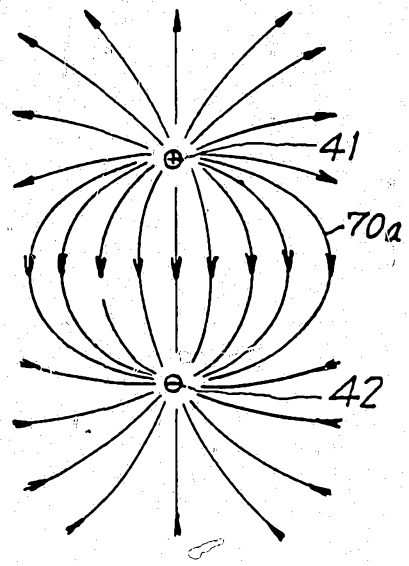

FIG. 6B