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(54) A grading machine.

(57) A grading machine for grading articles by size, eg fruit and vegetables such as apples, tomatoes and potatoes, comprising: a grading tray (1) provided with at least one elongate opening (3) which increases in width from one end to the other; resilient mountings (5) supporting the grading tray (1) in a manner which allows it to be oscillated; and one or more pneumatic pistons (6) arranged to oscillate the grading tray (1). The oscillation being such as to lift and move the grading tray (1) forward during each cycle, the angle of the forward movement with the horizontal and the amplitude and frequency of the oscillation being such as to cause articles on the grading tray (1) to move from the narrow end of the opening (3) towards the wide end until they reach a position where they are able to pass through the opening (3) whereupon they are directed by an off-take tray (9) into containers (10).

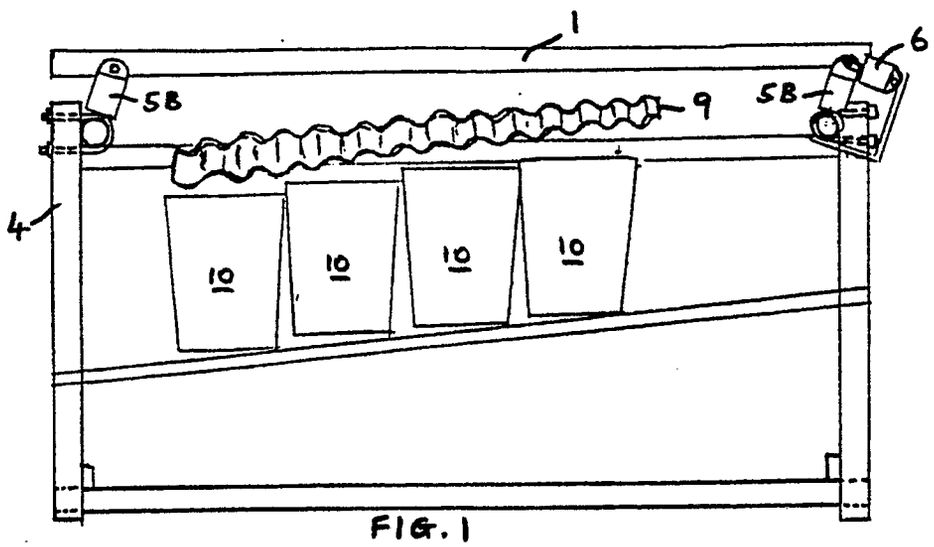

FIG. 1

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This invention relates to a grading machine and more particularly to a machine for grading articles such as fruit and vegetables.

Grading was originally carried out by shaking material in hand held sieves, with grids of the appropriate size. This process has been subsequently mechanised, the sieves being shaken mechanically with sieves of increasing aperture size being arranged in series. The material is passed over the sieves so that the smaller size articles fall through apertures in the earlier sieves and the larger size material passes on to the next size sieve. The sieves are formed by steel wires crossing to make rectangular grids and the series of increasing size grids are arranged on a downward slope, so that gravity moves the material from one sieve to the next. Various forms of paddle and rotary brush have also been used to help move the material. A further development is the use of mechanical jigging, to help material to pass through the sieve aperture and this led to jigging conveyers which give forward motion to the material by means of oscillatory movement.

Difficulty is experienced with all these types of grader firstly with damage to the material from the mechanical means used to push the material forward and secondly with material sticking in the rectangular apertures and being jammed by subsequent material passing over it. Such jammed and damaged material tends to rot, and infect other material.

This invention seeks to reduce the possibility of material being subjected to mechanical pressure and damaged, and to minimise the possibilities for the material to become jammed at any point.

According to the invention there is provided a grading machine for grading articles by size, including articles of a substantially spherical shape such as fruit, comprising: grading means provided with at least one elongate opening which increases in width from one end to the other; support means supporting the grading means in a manner which allows it to be oscillated; and oscillatory means for oscillating the grading means so as to lift and move the grading means forward during each oscillation, the arrangement of the oscillatory means and the support means being such that, in use, the angle of the forward movement with the horizontal and the amplitude and frequency of the oscillation is such as to cause articles positioned on the grading means to move from the narrow end of the said opening towards the wide end thereof until they reach a position where they are able to pass through the opening.

Preferred features of the invention will be apparent from the following description and the subsidiary claims of the specification.

The invention will now be further described merely by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a side view of an embodiment of a grading machine according to the invention;

Figure 2 is a plan view of the grading machine shown in Figure 1;

Figure 3 is an end view of the grading machine shown in Figure 1;

Figure 4 is a more detailed side view of oscillatory means which may be used in a grading machine such as that shown in Figure 1 (but shown in the opposite orientation);

Figure 5 is a side view of an alternative arrangement of oscillatory means to that shown in Figure 4;

Figure 6 is a side view of the grading machine shown in Figure together with collection apparatus for collecting articles graded by the machine;

Figure 7 is a plan view of the grading machine and collection apparatus shown in Figure 6; and

Figure 8 is an end view of the grading machine and collection apparatus shown in Figure 6.

The illustrated grading machine involves two main principles:

1. Oscillatory conveying, in which material is moved with no mechanical pushing or pressure. The material being handled is not therefore subject to compression or any mechanical pressure and hence suffers no damage.

2. Size grading by means of at least one elongated opening which increase in width from a narrow end to a wide end. The grading aperture does not therefore present any obstruction to forward motion of the material unlike a conventional sieve in which each aperture presents a potential obstacle on which an article can become stuck as material is moved across the sieve.

The combined use of these two principles provides forward movement without damaging the material and an obstruction-free method of grading which avoids sticking and jamming of the material.

The machine shown in the drawings comprises a grading tray which is provided with a plurality of channels 2 in the base of which is, formed an elongated aperture 3 whose width increases continuously from one end of the channel 2 to the other. The grading tray 1 may be formed from a corrugated sheet of Darvic (ICI trade name), a non-toxic, plastics material specially designed for use in food handling which is resistant to vegetable and fatty acids and other contaminating materials associated with food products. Sheets of this material can be used although it can be difficult to form the corrugations therein without cracking. The preferred material is thus a laminate comprising galvanised metal sheets coated with a thin film of Darvic as

this can be formed to the required shape much more easily.

The channels 2 are conveniently about 6 inches (15.2cm) wide, 3 inches (7.6cm) deep and 6 feet (1.8m) long. The apertures 3 formed in the channels vary in width from about 1/4 inch (0.64cm) at the narrow end to 6 inches (15.2cm) at the wide end. The width of the apertures 3 thus increase by about 1 inch (2.5cm) for every foot (30.5cm) along the channel. These dimensions can, of course, be altered depending on the particular operation and the size of the articles to be graded. As shown, the grading tray 1 conveniently comprises four parallel channels. Other arrangements are, however, possible.

In an alternative arrangement, the grading tray may be provided with other means defining at least one elongate aperture whose width gradually increases. One possible arrangement is to use pairs of diverging bars which define such an aperture between them with baffles or other guide means for preventing material falling between adjacent pairs of bars.

The grading tray 1 is mounted on the grading machine in a substantially horizontal position. As shown in Figure 4, it may be supported on a frame 4 of the machine by means of metalastic, rubber bobbins 5A similar to those often used for vehicle exhaust mountings (see Figure 4). The bobbins 5A are set at an angle of between 10 and 30 degrees, eg 27.5 degrees, to the vertical for reasons which will become clear from the description below.

The grading tray 1 is arranged to be oscillated by means of two pneumatic cylinders 6 which are shown in more detail in Figure 4 and Figure 5. Each of the cylinders 6 is mounted at a corner of the grading tray 1 at the end nearest to the narrow ends of the apertures 3. The cylinders 6 are mounted so their thrust rods 7 make an angle of approximately 27.5 degrees to the horizontal as shown in Figure 4. The cylinders 6 are secured to the frame 4 by means of substantial rubber washers 16A which allow for the angular change required for the movement of the grading tray 1. The ends of the thrust rods 7 are similarly secured to the grading tray 1 using rubber washers 16A to allow for the required angular movement. Such an arrangement avoids the use of mechanical articulation which, with the frequency of oscillation involved, would present lubrication problems.

An alternative mounting arrangement which allows the angle of the bobbins supporting the grading tray 1 to be varied is shown in Figure 5. This alternative has been developed to accommodate rubber bobbins 5B with higher elasticity, ie more flexible (less resistance to deflection), than those used in the arrangement shown in Figure 4. In the arrangement shown in Figure 5, the angle of the bobbin 5B to the vertical can be varied through a very wide range, which ensures that variations in the elasticity of the bobbins 5B can be therefore compensated for by adjustment of the angle to ensure the required oscillatory movement is generated. The required angle depends on the elasticity of the material from which the bobbins 5B are formed. The rubber bobbins 5B are bolted at the lower end to tubular cross-members 11, which are attached to the legs of the main frame 4 by U-bolts 12. After slackening, the U-bolts 12, the tubular cross-members 11 can be rotated, to set the bobbins 5B at whatever angle is required. The pneumatic drive cylinders 6 are attached to brackets 13 that rotate with the tubular cross-members 11 so that a constant angle (approximately 90 degrees) is maintained between the pneumatic thrust rod 7, and the axis of the bobbins 5B. In this arrangement, it is not possible to use rubber washers to provide for the required articulation of the cylinders 6 or the top end of the bobbin 5B to the grading tray 1. Instead, the bases of the cylinders 6 are attached by trunnions and pins 14 to their locating brackets 13, and the end of the thrust rod 7 is fitted with a clevis 15, attached by a pin to the top end of the rubber bobbins 5B and to the grading tray 1.

In a further alternative, the grading tray 1 maybe arranged to be oscillated by means of a single pneumatic cylinder 6 mounted on the centre line of the machine and providing thrust to a cross member of the grading tray 1. It would also be possible to use one or more double-acting pneumatic cylinders to oscillate the grading tray 1.

The pneumatic cylinders 6 are arranged to move the grading tray 1 in a trajectory corresponding to the arc of a 3 inch (7.6 cm diameter) circle whose chord is inclined to the horizontal so as to provide a forward movement of substantially 3/4 inch (1.9 cm) and a total rise throughout the trajectory of substantially 3/8" (0.95cm).

The amount the grading tray 1 is lifted during the trajectory is preferably between 1/4 inch and 1/2 inch (0.64 and 1.27 cm) and the forward movement between 1/2 and 1 inch (1.27 and 2.54 cm), with the ratio between the two being substantially 1:2.

The cylinders 6 and rubber bobbins 5 are set at appropriate angles to enable the required trajectory to be achieved. The resilience of the mounting may also be arranged to provide a degree of harmonic resonance, thereby reducing the energy needed for the operation or the machine.

The optimum frequency of oscillation required for material such as apples and potatoes is found to be about 300-320 cycles per minute. Lower frequencies fail to achieve the required forward movement, and higher frequencies tend to produce bouncing of material, and often reduced speed of

forward travel.

The frequency of oscillation is controlled by feeding pneumatic pressure to the cylinders 6 from a compressor and air storage vessel (not shown), eg by a control valve positioned on the side of the machine. The control valve is actuated by a fluid logic system and allows the frequency of oscillation to be varied pneumatically, between fairly small limits, eg. from 280 cycles per minute to 350 cycles per minute. The pneumatic pressure required is between 60 and 100 psi. (400-700 KN/m^2) and the air consumption is between 1.5 and 2.6cu.ft. (40-70 litres) per minute. Compressed air may be provided by a small compressor provided with the machine or, if compressed air is already available on site, this can be used instead. Control of the oscillation can thus be entirely pneumatic without the need for any electrical equipment.

The combination of pneumatic thrust and suspension of the the grading tray 1 on rubber mountings provides a very simple and reliable mechanical arrangement for oscillating the grading tray.

Below the grading tray 1, an off-take tray 9 is provided. In its simplest form, this is mounted to slope downward, across the line of travel of the grader, so that material on it rolls or slides towards the side of the machine, where containers 10 are positioned to collect the graded material (see figures 1 and 2). The off-take tray 9 is corrugated, with the corrugations running at right angles to the line of travel of material along the grading tray 1. The corrugations prevent graded material from spreading sideways, and hence mixing with material of other sizes, and guide the graded material to the containers 10 at collecting points along the side of the machine.

The corrugations of the off-take tray 9 amay be about 3 inches (7.6cm) wide and feed into containers about 12 inches wide (30.5cm), possibly with the assistance of a funnel (not shown). Each container thus collects material from three or four of the corrugations.

As well as sloping to one side, the off-take tray 9 slopes down from the input end of the machine towards its far end as shown in Figure 1. This slope is provided in order to keep the distance the material falls from the grading tray 1 to the take-off tray 9 to the minimum, ie to no more than the diameter of the graded material plus about half an inch (1.27 cm) for clearance. This limits bruising and damaging of the material being graded.

In another arrangement (not shown) the take-off tray 9 is not inclined transversely towards the collecting stations, but is mounted so that it can be oscillated in a direction at right angles to the direction of travel of material through the grader so as to move the graded material towards the collecting stations at the side of the machine. The frequency of oscillation of the off-take tray 9 may be controlled to be the same as that of the grading tray 1 by the same fluid logic controller. In the simplest form of the machine, bins, buckets, sacks or bags 10 are located alongside the machine, at collecting stations, at the edge of the take-off tray 9 as shown in Figure 1 and 2. They can be positioned to catch material at the points where the sizes required are coming out. A marked bar (not shown) running along the side of the machine, above the collecting stations, indicates the graded sizes to be found at any given point along the off-take side.

Instead of having corrugations, the take-off tray 1 may simply be provided with separator plates or any other means extending across the take-off tray and which effectively define chutes for directing material falling onto the tray 1 at different points towards the containers 10 positioned at the side of the machine. The position of the separator plates along the length of the machine may be varied to provide an adjustment of the sizes of material collected.

In operation, material is fed onto the end of the grading tray 1 nearest the narrow ends of the apertures 3 and travels along the channels 2 as the tray 1 is oscillated. The material passes along the channels from the narrow ends of the apertures 3 towards the wide ends thereof until it reaches a position where the width of the aperture 3 just exceeds the size of the article so that the article falls through the aperturue 3 onto the take-off tray 9 where it is directed by corrugations or separator plates into the appropriate container 10.

Agricultural produce does not generally have an exact geometrical shape, or consistent dimensions. No fruit or vegetable is truly circular in cross section and most products vary widely from generally spherical shape, having a long axis, and a short axis. Carrots and cucumbers are classic examples, with exaggerated long axes. The grading machine will tend to orient material placed on the grading tray 1 so that it travels in the direction of its long axis. It will then be graded by the size of its diameter. If the cross section is not a true circle, the grading may be by the largest cross sectional dimensions or by smaller one. The grading machine has been found to be accurate to about 1/8" (0.32cm) if used on marbles or billiard balls. It can be set to achieve even closer accuracy than this but cannot eliminate inherent irregularities in cross-sectional dimensions of individual articles.

The continuously enlarging apertures 3 allow any size or range of sizes, between the width of the aperture 3 at the start, and the width at the far end, to be achieved without any change of setting. Previous equipment required the removal of sieves of one grid size, and then replacement by others of a different size if a change of size was required.

With the grading machine described above, all that is needed for such a change of selection of graded size is to move the containers 10 along so they collect articles of the required range of sizes passing through the apertures 3 at different points. Alternatively, as mentioned above, the position of the separator plates on the grading tray may be varied to adjust the size of material collected. The side of the machine may be provided with a marked bar along the side of the off-take tray 9 to indicate the points at which specific grade sizes will be found to be coming off.

Various feed arrangements may be used to feed material to be graded onto the grading tray 1. A first arrangement suitable for use with soft fruit and vegetables, which are easily damaged, is to use several deep trough oscillatory conveyors (not shown) arranged in series to feed material onto the grading tray 1. These conveyors comprise troughs which are oscillated in a similar manner to the grading tray 1 to feed material towards the grading machine.

If the material needs to be washed, this can be achieved by using one of the deep trough conveyors as a washing station (not shown). In this case, the conveyor is constructed from a series of parallel stainless steel rods about 1/4 inch (0.64cm) apart. High pressure water sprays are mounted alongside, below, and above this conveyor, and directed onto the material placed therein. If it is required to conserve the soil and other material washed off the produce, a galvanised sheet steel trough can be mounted to oscillate, immediately below the washing conveyor, to collect the soil, and to allow the water to overspill to drainage points.

In an alternative arrangement suitable for bulk feeding of harder, less sensitive material, a large vertical gravity-fed hopper (not shown), with an inclined chute at its base may be used to direct the material onto the grading tray 1. The delivery of material onto the grading tray 1 is controlled by an intermittently rotated spider which prevents all the material on the hopper arriving at the grader at the same time.

The take-off arrangements can also be developed to operate automatically so that a full load can be graded without the need for an operator to stop the machine and remove the containers 10 by hand once they are full (see Figure 6-8). In this development the bags, sacks, or containers 10 in which the graded material is to be collected, are carried on trays 17 suspended from simple overhead conveyor tracks 18. The tracks 18 are inclined so that the trays 17 will move along them by gravity. Each tray 17 is stopped, and held at a respective collecting station by stop pegs (not shown). When any given container io is full, a load sensitive switch 19 (which may be electrical or pneumatic) releases the stop pegs so allowing the tray 17 to roll by gravity to its final unloading point. The next empty container 10 on the track 18 then moves to the collecting station by gravity. While the containers are being changed, the load sensitive switch stops the oscillation of the take-off tray 9 to prevent spillage of material. It is convenient to arrange four parallel conveyor tracks allowing for the collection of four graded sizes as shown in Figures 6 and 7. Tubular frames 20 are provided to support the weight of the conveyor tracks 18.

With these automatic feed and collection arrangements, the grading machine can be left to run all day without adjustment once it has been set up to collect the required sizes of material.

It will be seen that each of the components of the machine is designed to minimise the possibility of articles becoming jammed or being damaged. The use of oscillatory motion and elongated grading apertures as described greatly facilitates this aim. At the same time, the machine is based on simple, inexpensive components so providing a considerable cost advantage over graders employing more complex methods of grading.

The design of the machine also lends itself to use of hygienic materials such as the laminated plastic material Darvic mentioned above. Conventional graders employing belt conveyors or slat conveyors would be difficult to manufacture from such material.

Claims

1. A grading machine for grading articles by size, including articles of a substantially spherical shape such as fruit, comprising: grading means (1) provided with at least one elongate opening (3) which increases in width from one end to the other; support means (5) supporting the grading means in a manner which allows it to be oscillated; and oscillatory means (6) for oscillating the grading means (1) so as to lift and move the grading means (1) forward during each oscillation, the arrangement of the oscillatory means (6) and the support means (5) being such that, in use, the angle of the forward movement with the horizontal and the amplitude and frequency of the oscillation is such as to cause articles positioned on the grading means (1) to move from the narrow end of the said opening (3) towards the wide end thereof until they reach a position where they are able to pass through the opening (3).

2. A grading machine as claimed in claim 1 in which the oscillating means comprises one or more pneumatic cylinders (6) connected to oscillate the grading means (1).

3. A grading machine as claimed in claim 1 or 2 in

which the grading means (1) is supported by resilient mountings (5) which are sufficiently flexible to permit oscillation of the grading means (1) by the oscillating means (6).

4. A grading machine as claimed in any preceding claim arranged such that the oscillatory movement of the grading means (1) comprises forward movement at an angle to the horizontal of between 10 and 30 degrees, and preferably substantially 27.5 degrees.

5. A grading machine as claimed in claim 4 arranged such that the oscillatory movement of the grading means (1) comprises lifting the grading means (1) by between 1/4 and 1/2 inch (0.64 and 1.27 cm), and preferably by substantially 3/8 inch (0.95 cm), and moving it forward by between 1/2 and 1 inch (1.27 and 2.54 cm), and preferably by substantially 3/4 inch (1.9 cm), the ratio between the lifting and forward movement being substantially 1:2.

6. A grading machine as claimed in any preceding claim in which the oscillatory means (6) is arranged to oscillate the grading means (1) at between 280 and 350 cycles per minute, and preferably between 300 and 320 cycles per minute.

7. A grading machine as claimed in any preceding claim in which the grading means (1) comprises at least one channel (2) with the said aperture (3) formed in its base.

8. A grading machine as claimed in claim 7 in which the grading means comprises a corrugated sheet (1) made up of a plurality of such channels (2).

9. A grading machine as claimed in any preceding claim having collection means (9) comprising a plurality of channels positioned to collect articles falling through the said aperture (3) and for leading the articles to respective containers (10).

10. A grading machine as claimed in claim 9 in which each of the said plurality of channels is positioned to minimise the distance articles fall from the aperture (3) to the respective channel.

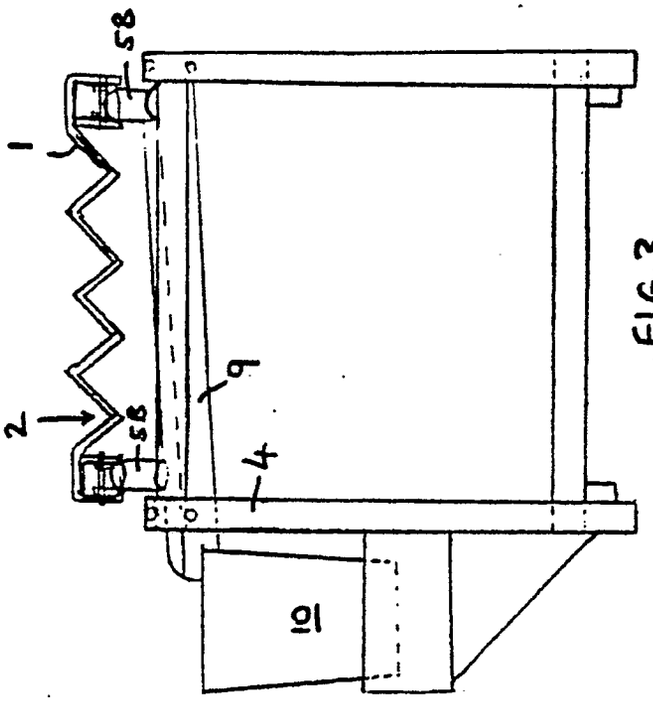


FIG.3

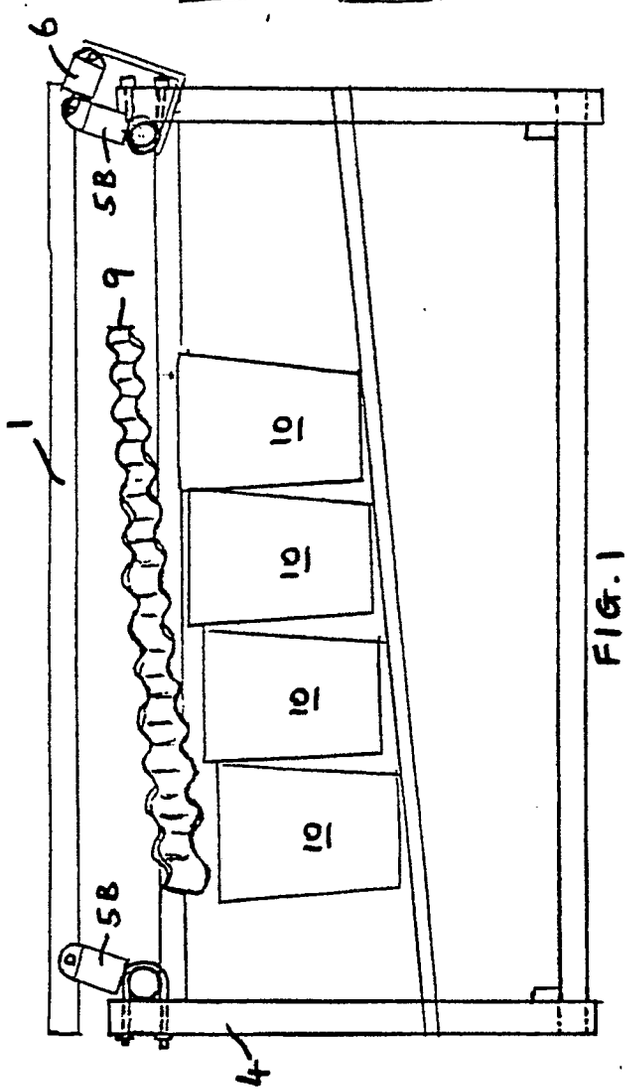


FIG.1

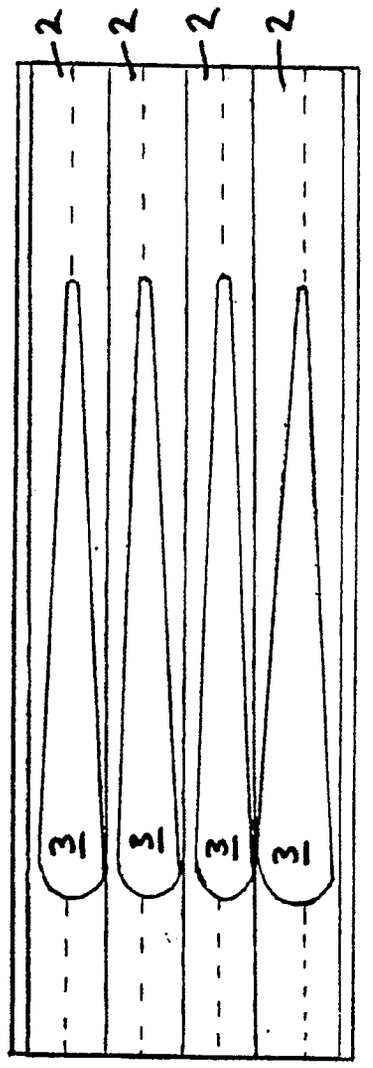


FIG.2.

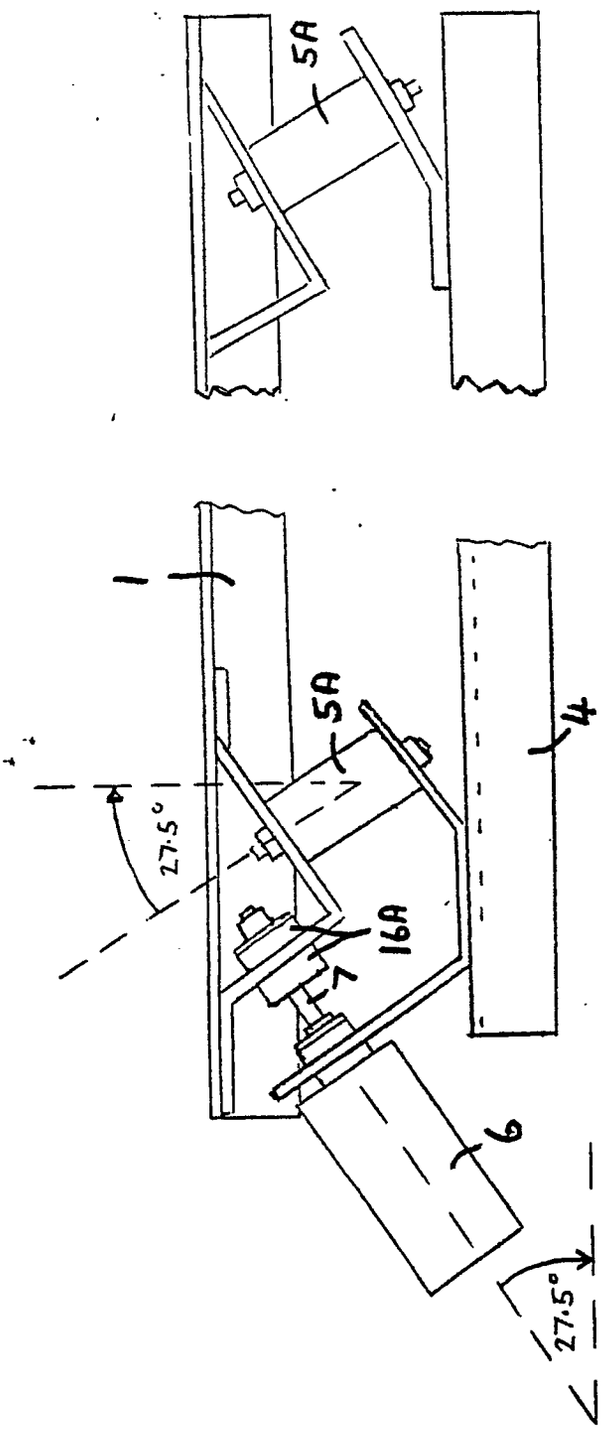


FIG.4.

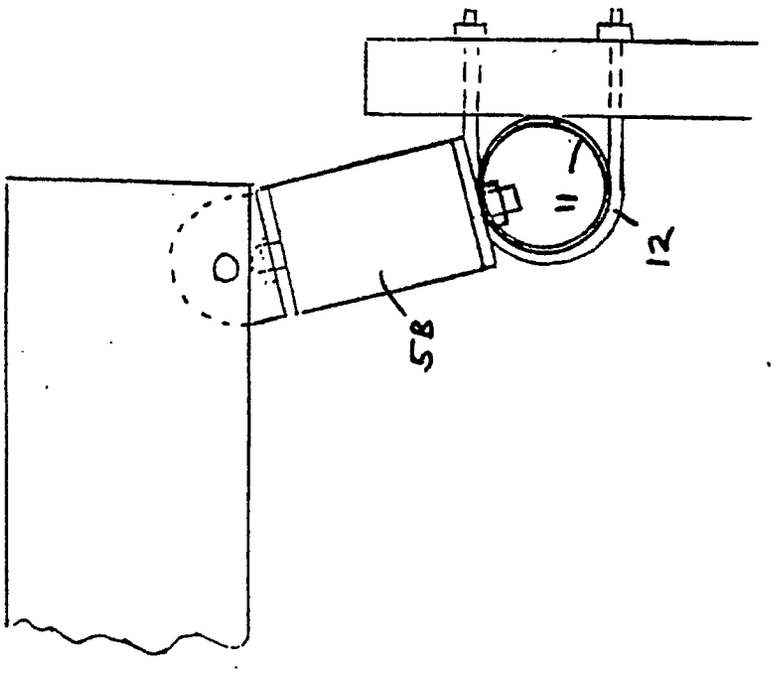
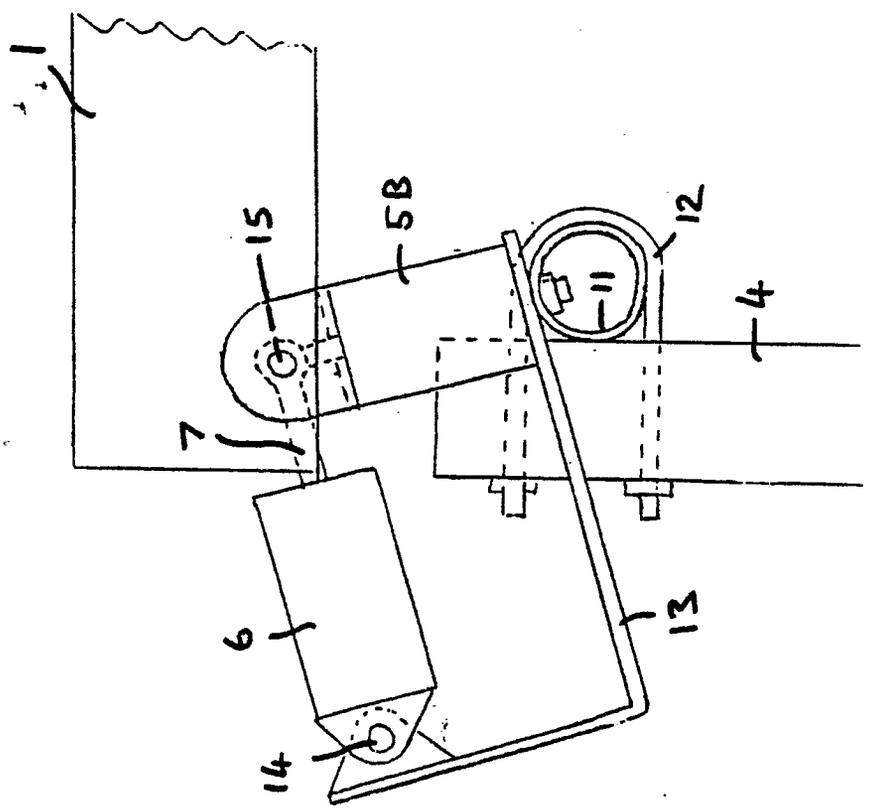


FIG.5.



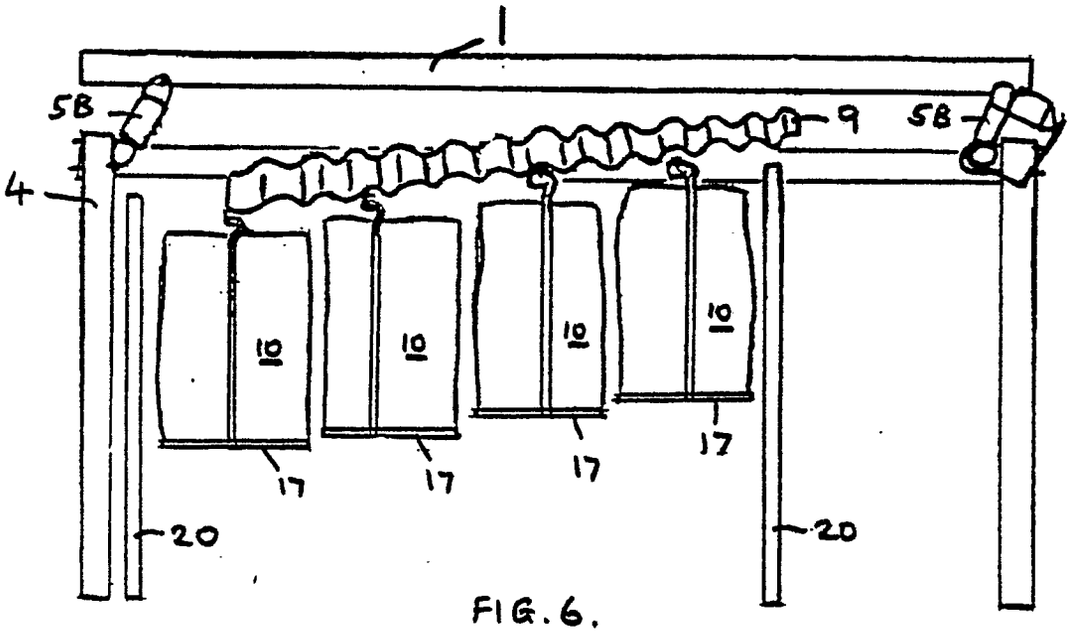

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FIG.6.

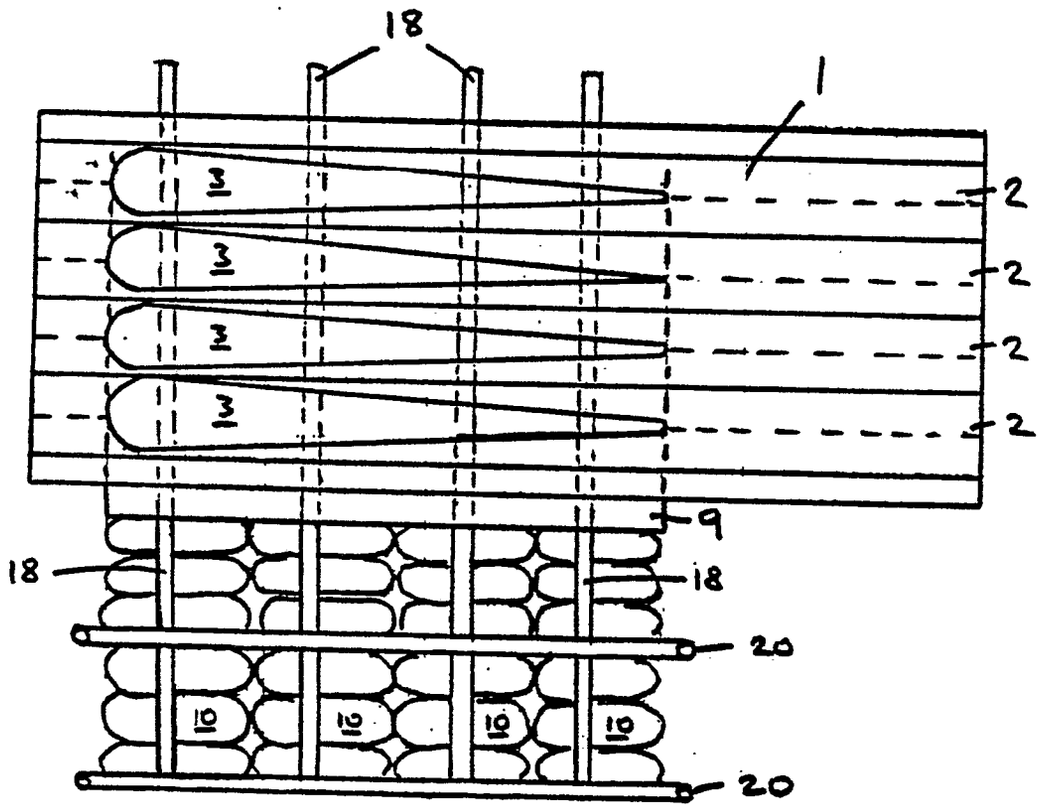
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FIG.7.

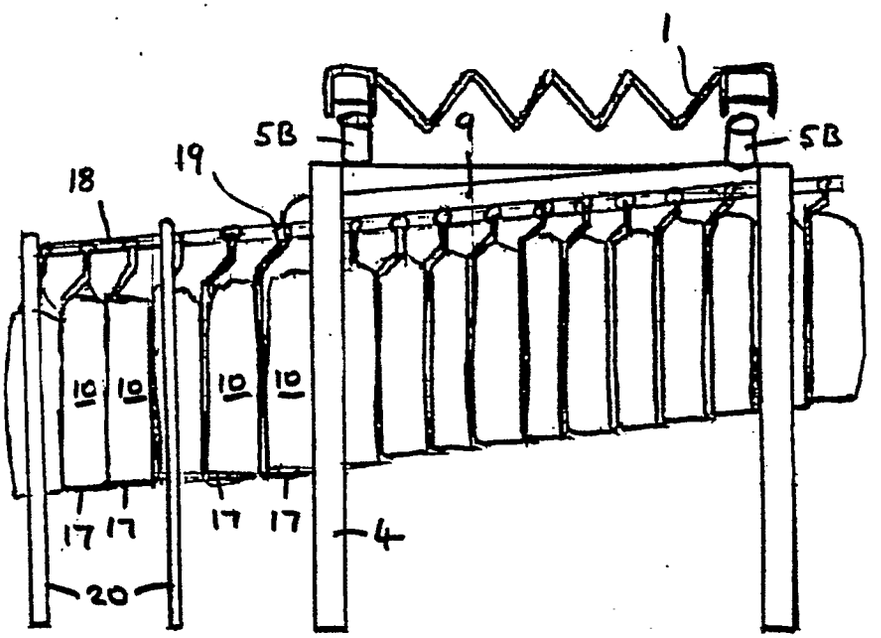

FIG. 8

European Patent Office

EUROPEAN SEARCH REPORT

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 90307031.6

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl⁵)
A	DD - A1 - 239 957 (VEB SAAT- UND PFLANZGUT HALLE) * Abstract, fig. 1 *	1	B 07 B 1/30 B 07 B 13/07
A	FR - A - 2 467 025 (BRUBST ANDRE) * Claim 1,2; fig. 1,2 *	1	
A	GB - A - 2 174 666 (BACKUS SORMAC BV) * Abstract; fig. 1,2 *	1	
A	AT - B - 385 213 (LICENTIA PATENT-VERWALTUNGS-GMBH) * Abstract; fig. 1,3 *	1	

TECHNICAL FIELDS SEARCHED (Int Cl⁵)

B 07 B 1/00
B 07 B 13/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	28-09-1990	BRUS

CATEGORY OF CITED DOCUMENTS

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

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

& : member of the same patent family, corresponding document

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