Sept. 13, 1966 P. A. CLARK ET AL 3,272,312

COOLING BEDS

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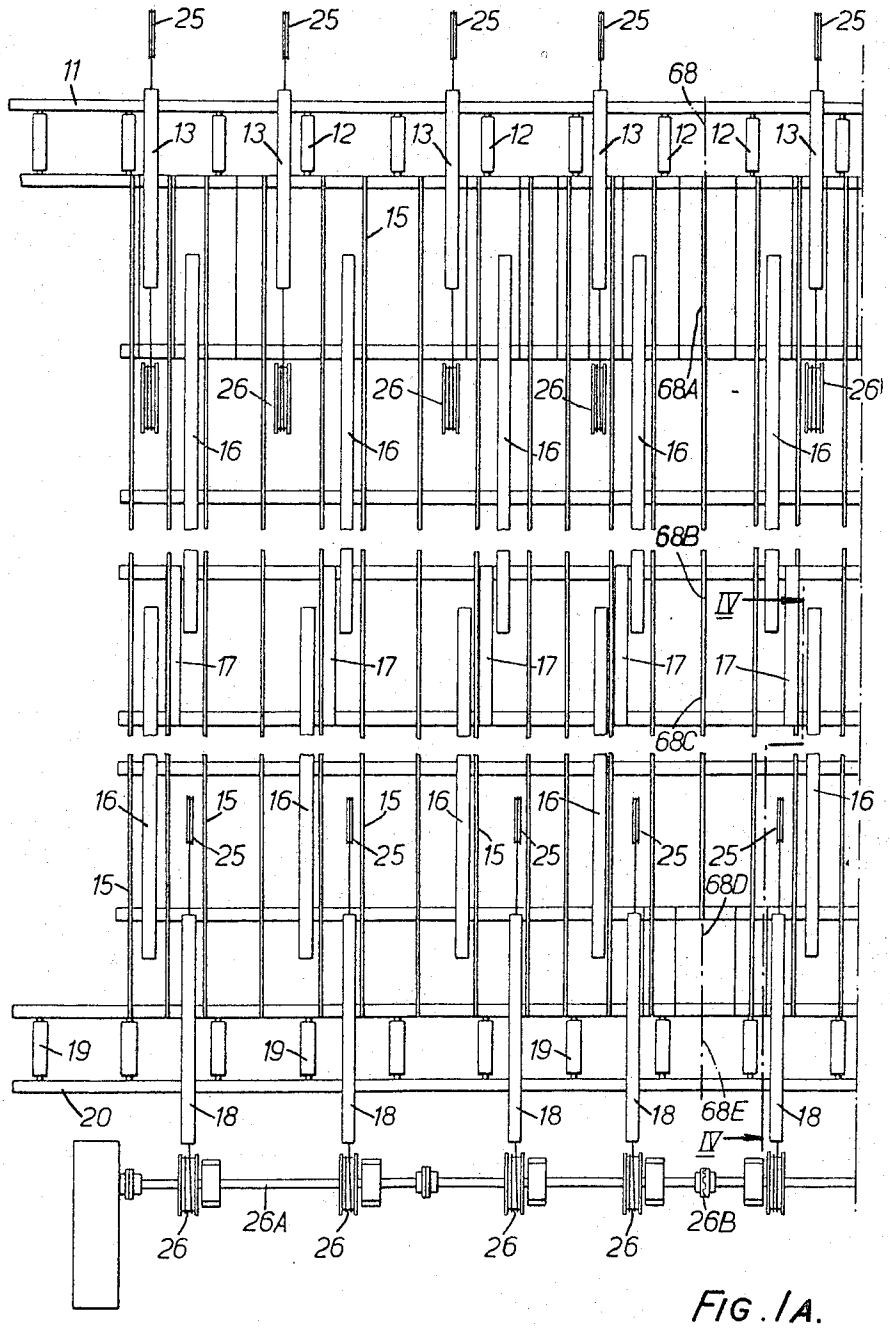


FIG. 1A.

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COOLING BEDS

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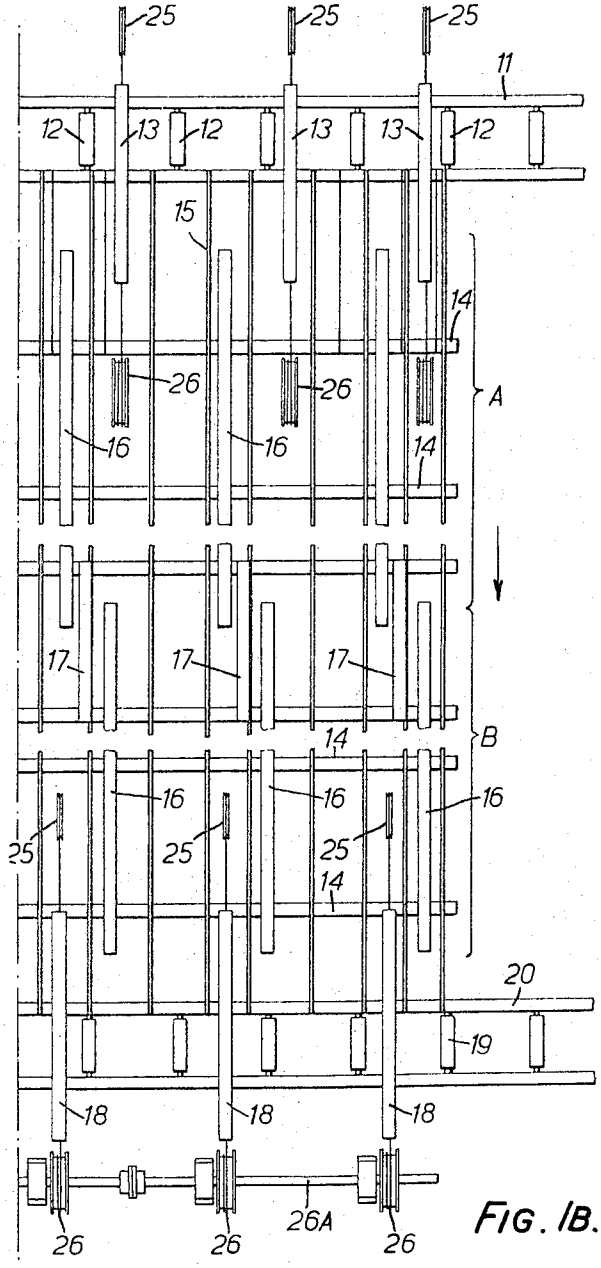


FIG. 1B.

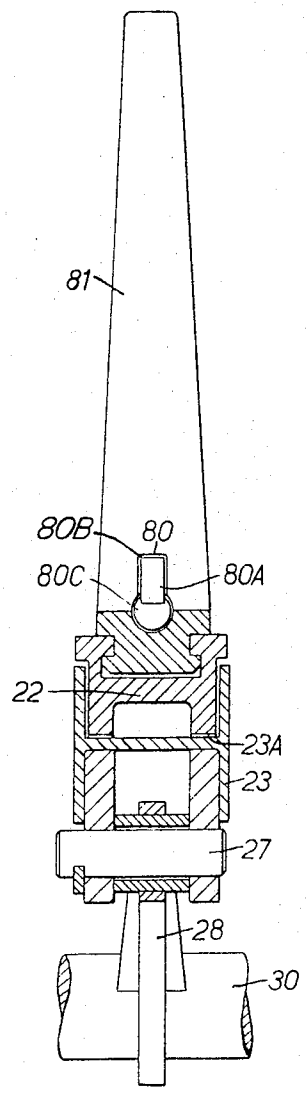


FIG. 6.

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COOLING BEDS

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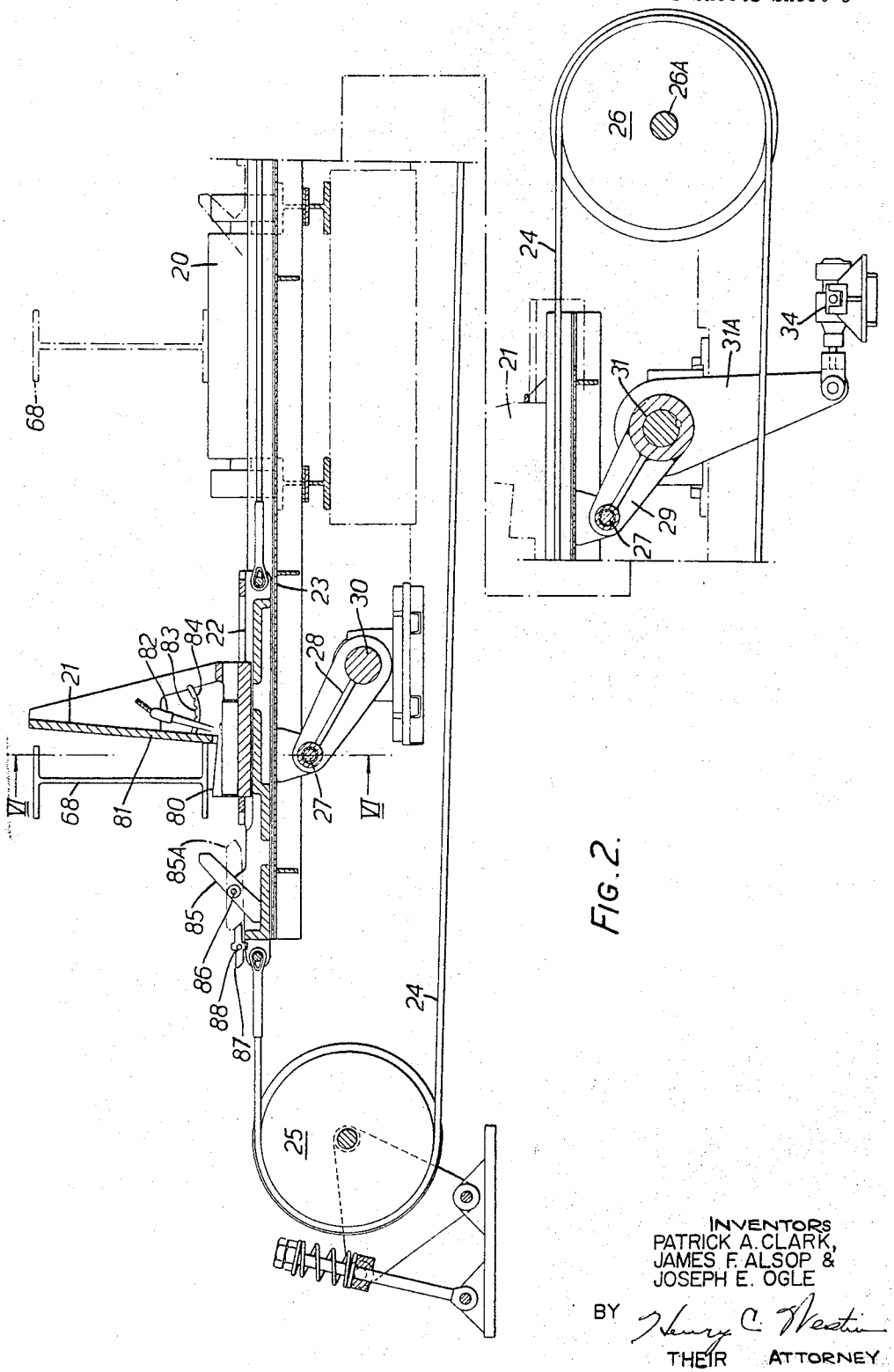


FIG. 2.

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COOLING BEDS

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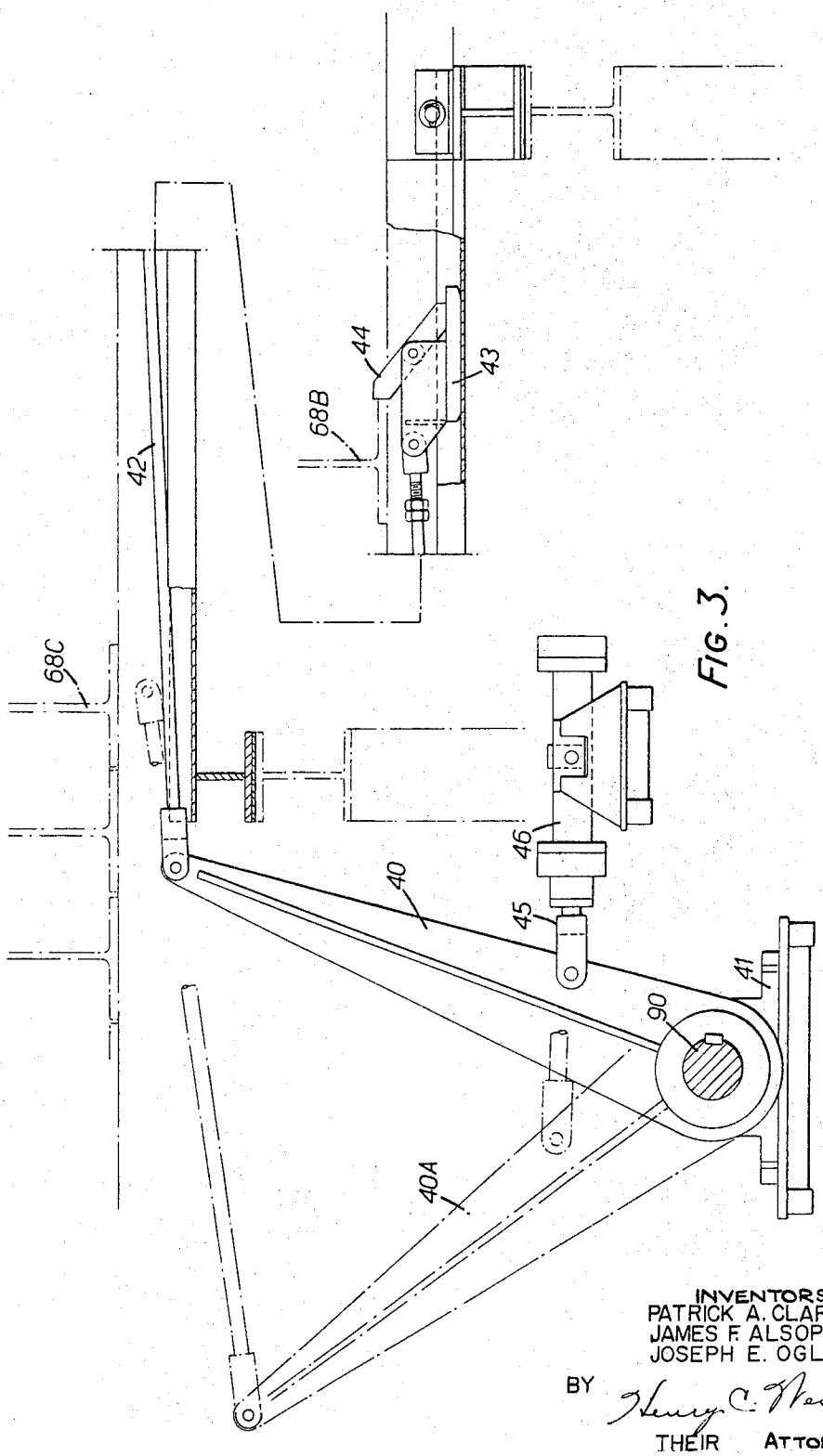


FIG. 3.

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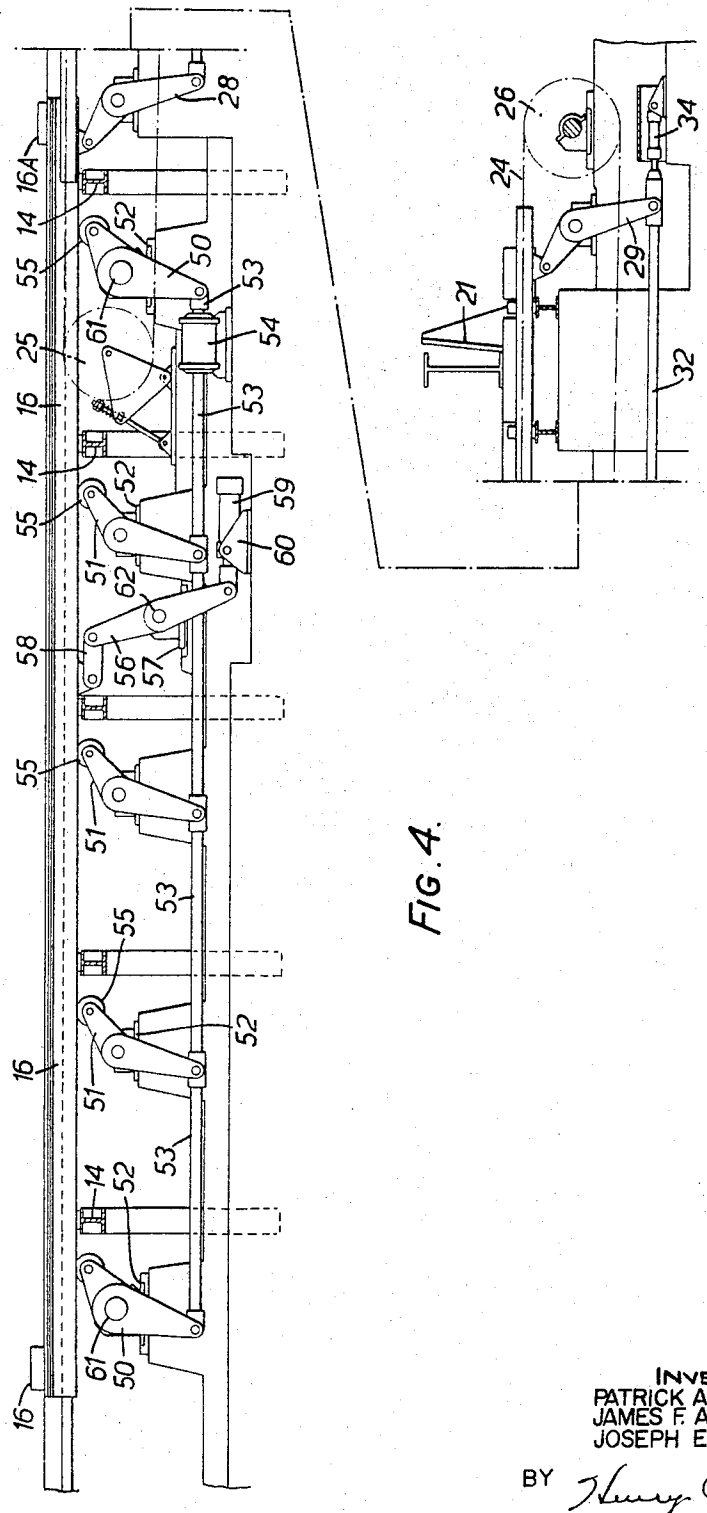


FIG. 4.

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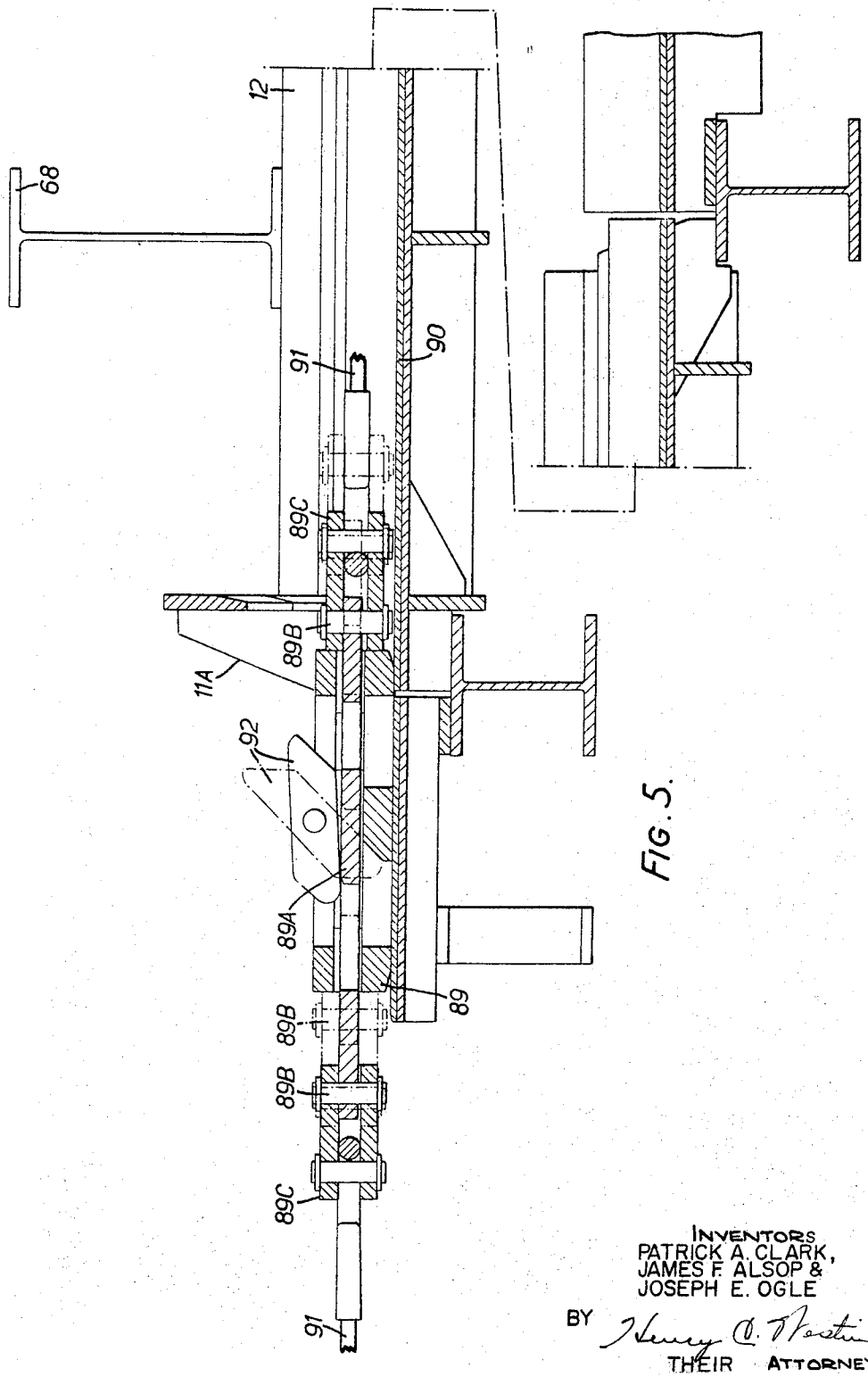


FIG. 5.

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United States Patent Office 3,272,312
Patented Sept. 13, 1966

3,272,312

COOLING BEDS

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12 Claims. (Cl. 198—34)

This invention relates to a method of and apparatus for controlling the cooling rate of and handling hot elongate objects.

When the hot-rolled products of a rolling mill leave the mill, provision has to be made for the products to cool. If the products have complicated cross-sections of which some parts are of heavier gauge material than others, or there are parts extending away from the general body of the product, it is essential to control the rate of cooling of all parts of the product to a rate substantially equal to that of the part cooled most slowly. This is in order to avoid stresses being set up in the product due to temperature gradients which occur within the product during the cooling process. Even when the products are of simple cross-section, it is sometimes necessary to control the cooling rate, due to the substantial mass of the product.

At the same time it is necessary to keep the mill products moving, to make room for further products coming from the mill, so that the arrangements made for controlled cooling do not form a bottleneck in the mill processing line.

With some products it is also necessary to subject them to one cooling rate over a first temperature range, and to a different cooling rate over a second temperature range.

A further problem occurring in the handling of elongate hot rolled products on a cooling bed, is that the product may be bent so that its horizontal axis is curved in a horizontal plane. Therefore, when the product is engaged by a series of supports which are spaced apart along its horizontal axis, arrangement must be made for the various supports to take up differing positions in the horizontal plane, in order that each support may fully engage the product in spite of the fact that it is bent.

In one aspect the present invention provides a method of controlling the cooling rate of hot elongate objects which comprises moving objects through a first cooling location in a first spatial relationship to one another and moving the objects through a second cooling location in a different spatial relationship to one another.

In another aspect the invention provides a method of controlling the cooling rate of hot elongate objects, which comprises transferring objects successively to a first cooling table, moving the objects over the table in a first spatial relationship to one another, transferring objects successively from the first table to a second cooling table, moving the objects over the second table in a second spatial relationship to one another, and transferring objects successively from the second cooling table.

In another aspect the invention provides a cooling table for supporting a plurality of elongate objects and moving them substantially normal to their major axes, comprising a plurality of fixed supports spaced apart from one another in a first direction, a plurality of movable supports located between the fixed supports and normally having their upper surfaces no higher than the upper surfaces of the fixed supports, lifting means for raising together the movable supports to a raised position in which their upper surfaces are above the upper surfaces of the fixed supports, and separate means for moving the movable supports together, while in their raised position, through a predetermined distance in a second direction substantially normal to the first direction.

Preferably apparatus is provided comprising two such cooling tables having different predetermined distances and transfer means for successively transferring objects from one table to the other.

The transfer means are arranged to effect transfer of the foremost object in the group on the first cooling table to the second cooling table. The transfer means may be arranged so that the position at which the product is deposited upon the second cooling table is variable. Preferably, means provided for the transfer of the objects from an approach conveyor to the first cooling table are also arranged so that the position at which an object is deposited on the first cooling table is variable.

When the individual objects in a group are in a first spatial relationship, for example six inches apart, it is necessary for the movable support surfaces to traverse the group a distance equal to the dimension of the object in the direction of progression plus the six inches spacing between the objects. Thus, in order that the means for traversing the movable surfaces may be able to handle groups of objects of which the sum of the dimension of the object in the direction of progression and the distance between one object and the next in the group, differs from that of other groups, the means for traversing the movable support surfaces should be arranged so that the dimension of the traversing movement is variable.

In yet another aspect the invention provides apparatus for moving an elongate object laterally with respect to its major axis, comprising a plurality of supports spaced apart in a first direction, each support having a substantially vertical surface for engaging the object, means for raising the supports together, and means for moving the supports together in a second direction substantially normal to the first direction, the position of at least the substantially vertical surfaces of each support being adjustable relative to the other supports in the second direction.

The dimension, in a direction parallel to the line of movement, of the substantially horizontal surface of the said support may be adjustable in order to accommodate objects having different dimensions in that direction, or in order to accommodate either one or more of the said objects upon the said surface.

The following description relates to the accompanying diagrammatic drawing which show, by way of example, cooling beds and associated equipment for a beam mill.

Of the drawings:

FIGURE 1 is a plan view of a cooling bed having two sections, A and B, and showing the general layout of the apparatus,

FIGURE 2 is an enlarged view of a pull-off transfer mechanism with some parts shown in section,

FIGURE 3 is an enlarged view of a centre transfer mechanism,

FIGURE 4 is an enlarged view of a cross-section on the line IV—IV in FIGURE 1;

FIGURE 5 is an enlarged view of a pull-on transfer mechanism, and

FIGURE 6 is a section on the line VI—VI in FIGURE 2.

The apparatus shown in FIGURE 1 comprises an approach roller table **11**, between rollers **12** of which are arranged pull-on transfer mechanisms **13**. Each of two sections A and B of the cooling bed include fixed, transverse supports **14** upon which are arranged a series of fixed, longitudinal support skids **15**.

Between the fixed supports skids **15** there are arranged walking beams **16**. Between the sections A and B of the cooling bed and between the walking beams **16**, centre transfer mechanisms **17** are provided. At the delivery

end of section B of the cooling bed pull-off transfer mechanisms **18** are arranged between the rollers **19** of a delivery roller table **20**.

In FIGURES 2 and 6 a pull-off transfer mechanism **18** is shown comprising a chair **21** which is slidably mounted on a frame **22** which itself is slidably supported in a channel **23A** of a track **23**. The frame **22** is connected to a rope **24** which passes over a tension pulley **25** and a driving drum **26**. The driving drum **26** is carried on a shaft **26A** which extends to connect all the drums **26**, as shown in FIGURE 1. The track **23** is pivotally connected by pins **27** to a lever **28** and the upper arm **29** of a crank. The lever and the crank are pivotally secured to the foundation structure by shafts **30** and **31**. The other arm **31A** of the crank is pivotally secured to the rams of a hydraulic cylinder **34**. The hydraulic cylinder **34** is pivotally secured to the foundation structure.

The chair **21** is provided with a substantially horizontal surface **80** and a substantially vertical surface **81**, which together, provide a support for the rolled beams being moved. A lever **82** pivotally carried by the chair **21** and having a well-known constructed releasable spring-biased pawl, not shown, which engages with one of the slots **83** in a quadrant **84**, projects into a recess **80D** formed in the member having the support surface **80**, to thereby engage the member to urge it horizontally wherein adjustment of the lever moves the horizontal surface **80** to the right (in FIGURE 2) to vary the degree of extension of the support surface **80** to the left of the vertical surface **81**.

FIGURE 6 shows how the substantially horizontal surface **80** is provided on a member **80A**, and this member is arranged to be slidable in a channel **80B** in a member **80C**. This arrangement allows the chair to be adjusted to accommodate beams of different flange widths, or one or more beams of a given flange width.

The frame **22** carries a two-armed latch **85** which is pivoted at **86** and a further two-armed latch **87**, pivoted at **88**. The latches are arranged so that the latch **85** may be retained in the horizontal position (**85A** shown in chain dotted line), by the latch **87**, or, by manually rotating the latch **87** in a counter-clockwise direction, it may be released to take up the position shown in full line.

The shaft **31** extends to operate all the pull-off transfer mechanisms shown in FIGURE 1.

In FIGURE 3 a centre transfer mechanism **17** is shown comprising an arm **40** pivotally secured at one end to the foundation structure by a bearing **41**, and at the other end to a connecting link **42** which itself is pivotally secured to an extension of a skid **43**. The skid **43** pivotally supports a latch **44**. A ram **45** of an hydraulic cylinder **46** is pivotally connected to the arm **40**, and the cylinder **46** is pivotally connected to the foundation structure. The centre transfer mechanisms shown in FIGURE 1 are interconnected mechanically, by being keyed to the shaft **90** which extends to operate each centre transfer mechanism.

In FIGURE 4 the walking beam mechanism shown comprises end elevating cranks **50** and intermediate elevating cranks **51**, each of which are pivoted to the foundation structure by supporting bearings **52**. The lower arms of the cranks **50** and **51** are each pivotally connected to a connecting link **53** which is pivotally secured to the ram of an hydraulic cylinder **54**. The upper arms of the cranks carry rollers **55** which contact the undersurface of the walking beam **16**.

A walking beam traverse lever **56** is pivotally supported to the foundations by a bearing **57**, the upper end of the lever **56** being connected by a pivoted link **58** to a bracket extending downwardly from the walking beam **16**. The lower end of the lever **56** is pivoted to the ram of an hydraulic cylinder **59**, which itself is pivoted to the foundation structure by a bracket **60**. The end cranks **50** in each of the sections A and B of the cooling bed are

interconnected by means of shafts **61**. The levers **56** are similarly interconnected by shafts **62**.

When the walking beams **16** are traversed, it is desirable that they are decelerated to the stationary position smoothly, in order to avoid the possibility of a sudden deceleration causing the rolled beam **68** to fall from the upright position. To this end, during the forward traversing stroke, the liquid exhausting from the cylinders of the rams **59** passes via ports in the walls of the cylinders, and the forward stroke is terminated by the pistons completely obturating the ports. It will be appreciated that the deceleration may be made more gradual by varying the shape of the ports in the cylinder walls. When it is desired to vary the length of traverse of the walking beam, adjustment is always made to the position of the walking beams at the beginning of the traversing stroke. In this way, termination of the forward stroke always occurs when the pistons completely obturate the said ports, so that smooth deceleration of the walking beams, referred to above, is always achieved.

The walking beams **16** are guided in their vertical plane of operation by lateral guides **16A**.

In FIGURE 5 a pull-on transfer mechanism **13** is shown, comprising skid **89** slidably supported on a guide **90** and driven by a rope **91**. The skid **89** houses a slider plate **89A** which is slidably arranged within the skid, and which is connected at each end to the rope **91** by pins **89B** engaging in eyes in the slider plate and in fork-ends **89C** attached to the rope **91**. The skid **89** pivotally supports a latch **92**, and the arrangement is such that with the slider plate **89A** in the position shown in full line in the drawing, the latch **92** is held in the horizontal position shown in full line. When the rope drive mechanism is actuated to move the skid **89** to the right in the drawing, the slider plate alone is first moved to the right until the lefthand fork-end contacts the skid **89**. By this time, the latch **92** will have moved to the position shown in chain line, and be ready to engage the rolled beam **68**. Further actuation of the rope mechanism is then effective to traverse the skid **89** to the right, and so slide the rolled beams **68** off the roller table onto the fixed support skids **15**. The rope **91** extends over a tension pulley and a driving drum (neither of which is shown) in the manner of the pull-off transfer mechanism shown in FIGURE 2. The driving drums of all the pull-on transfer mechanisms are also carried on a common drive shaft.

A series of curb plates **11A** (FIGURE 5) are provided on the roller table **11**, and the pull-on mechanisms shown in this figure are located between these curb plates.

In operation, a rolled beam **68** arrives on the approach roller table **11**, and the pull-on mechanisms (FIGURE 5) are operated by means of the ropes **91** driven by the drums **26**, so that the latches **92** engage the flanges of the rolled beam and slide the beam laterally into the required position **68A** (FIGURE 1) on section A of the cooling bed. The pull-on mechanisms are then operated to return the skids **89** to the position shown in the drawing, and are ready to repeat the operation on the arrival of the next rolled beam on the roller table **11**.

The walking beams **16** (FIGURES 1 and 4) are then elevated by actuation of the hydraulic cylinder **54**, to a height at which they support the rolled beam **68**. The beams **16** are then traversed by actuation of the hydraulic cylinder **59** and the amount of traverse is equal to the dimension of the flange of the rolled beam in the direction of progression plus the desired distance between the rolled beams in the group. The beams **16** are then lowered so that the rolled beam **68** is deposited on the fixed skids **15**. The beams **16** are then traversed to the position shown in FIGURE 4 and are ready to repeat the operation.

The sequence of operation as described in the previous two paragraphs is then repeated until the section A of the bed supports a group of rolled beams extending to the centre transfer mechanism **17**.

The rams 46 (FIGURE 3) of the centre transfer mechanisms are then actuated to move the levers 40 to the positions 40A, so that the latches 44 slide a beam from position 68B on section A of the cooling bed to the position 68C on section B of the cooling bed. The rams are then actuated to return the levers from position 40A to position 40 so that the latches 44 are in position to transfer the next beam.

The walking beams in section B of the cooling bed are then operated, in the manner described with reference to section A, to traverse the rolled beam the desired distance along the bed. In the embodiment described the rolled beams are arranged on section B without any spacing between them, so that the traverse of the walking beams in this section of the bed will be equal to the dimension of the flange of the beams in the direction of progression. The operation of the various mechanisms described continues in the manner stated, and when the foremost rolled beam in the group on section B arrives at the position 68D, the pull-off mechanisms 18 (FIGURE 2) are operated to transfer a rolled beam from position 68D on the cooling bed to position 68E on the delivery roller table 20.

The operation of the pull-off mechanisms 18 is as follows. The latches 85 and 87 are both secured in their inoperative horizontal positions. The driving drums 26 are operated to slide the frames 22 to the left and into the position shown in the drawing, so that the substantially vertical surface 81 contacts the lower flange of the beam 68. Should the beam 68 be bent so that its longest axis is curved in a horizontal plane, as sometimes occurs, the arrangement of each chair to be slidable on its supporting frame 22, allows the chair first contacting the beam to remain stationary on its frame, while the frames are further traversed until each chair is in contact with the beam.

The hydraulic ram 34 is then operated to elevate the the tracks 23, so that the beam 68 is contacted by the highest point of the surface 80, causing the beam to tilt to the right (in the drawing) until it is supported by the surfaces 80 and 81 of the chairs 21. The arrangement of the surfaces 80 at a slight inclination to the horizontal, and of the surfaces 81 at a slight inclination to the vertical, conveniently causes the rolled beam 68 to be tilted to sit more stably in the chairs 21.

The drums 26 are operated to traverse the frames 22 and to bring the rolled beam 68 in position over the roller table 20, when the ram 34 is operated to lower the tracks 23, and so the beam 68, onto the roller table 20. The drums 26 are then again operated to traverse the frames and the chair to the extreme right position, as shown in chain line, where the chairs contact abutment means so that all the chairs are returned to the extreme left position on their frames, in preparation for the next cycle of operation.

Once on the roller table 20 the beams are then conveyed to store or for further finishing processes.

The arrangement of chairs, frames and skid elevating mechanism described, enables one or more rolled beams (depending on the position of the surface 80 and the dimensions of the flanges of the beam) to be taken from a group of beams arranged on section B of the bed without any spacing between them. When the beams are arranged on section B with sufficient spacing between them, they can be transferred to the roller table 20 by the latch 85. For this operation the latch 87 is manually rotated in a counter-clockwise direction (in the drawing) until the latch 85 can fall to the position shown in full line (FIGURE 2), after which the latch 87 is returned to the horizontal position. The dimensions and arrangement of the latches are such that, when the frame 22 is being traversed from the position shown in chain line to the position shown in full line in the drawing, contact of the upper surface of the latch 85 with the lower flange of the beam 68, causes the latch to be depressed and allows it to pass under the beam, but does not depress it sufficiently to allow the latch 87 to retain it in the horizontal position. It will be understood that it is not necessary to elevate the tracks 23 for any part of this operation.

It will be seen that a measure of control over the cooling rate of the beams is achieved by arranging and maintaining their juxtaposition for a desired period of time, and in apparatus according to the invention this is achieved whilst the beams are being progressively transferred to a despatch point. In this way the arrangement for controlled cooling of the mill products does not form a bottleneck in the mill processing line.

An alternative arrangement in place of the centre transfer mechanism shown in FIGURE 3 may comprise latches, similar to the latches 44 on the centre transfer mechanism, pivotally secured to the ends of the walking beams 16 of section B of the bed. In this case, transfer of the rolled beams from section A to section B is effected by traversing the walking beams 16 rearwardly until the latches engage the lower trailing flange of the beam, and then traversing the walking beams 16 forwardly, to slide the rolled beam from section A to section B. It will be appreciated that the walking beams 16 are not elevated whilst performing this centre transfer operation.

It will be understood that the beams 68 can be deposited on either section of the bed with any desired spacing between them, within the limits of the degree of traverse of the pull-on and centre transfer mechanisms. Thus in contradistinction to the described embodiment the beams may be placed with no spacing between them in section A of the bed, and spaced apart in section B of the bed. In this case, the juxtaposition of the sections A and B of the bed is arranged so as to permit the use of a pull-off mechanism 18 as shown in FIGURE 2, in place of the centre transfer mechanism 19, and a roller table such as 20, FIGURE 1, is provided to convey the rolled products to a position where it can be transferred to section B of the bed by a pull-on mechanism such as 13 shown in FIGURE 5.

It will also be understood, that when beams having a relatively narrow flange width are being produced, more than one beam may be transferred by the mechanisms 13, 17 and 18 in one operation.

In practice, the chair 21 may be provided with wheels which run on the frame 22, thus reducing the coefficient of friction between these parts and reducing the effect of scale on their relative movement. In this way when relatively light beams are being handled, the chairs will move readily to accommodate bent beams without tending to tip the beams.

Each of the operating shafts connecting the pull-on mechanism 13, the walking beams 16, the centre transfer mechanisms 17, and the pull-off mechanisms 18, may be provided with a disengageable coupling as indicated at 26B in FIGURE 1. With this arrangement, the left hand and right hand halves of the cooling bed can be operated either, independently to deal with two streams of short beams, or together to deal with one stream of long beams.

In accordance with the provisions of the patent statutes, we have explained the principle and operation of our invention and have illustrated and described what we consider to represent the best embodiment thereof. However, we desire to have it understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. Apparatus for effecting controlled cooling of hot objects, said apparatus comprising two adjacent cooling tables forming first and second sections of a cooling bed, first transfer means for positioning successive objects to be cooled on the first section table, second transfer means for transferring said objects from said first section table to the second section table and first and second conveying means associated respectively with said first and second tables and arranged to move said objects across said

tables, said first transfer means being adjustable in operation to position successive objects at different positions on said first table so that said objects are conveyed by said first conveying means across said first table with a selectively variable and substantially equal first spacing, and said second transfer means being adjustable in operation to transfer said objects to said second table with a selectively variable and substantially equal second desired spacing differing from said first selectively variable and substantially equal spacing so that said objects are conveyed across said second table by said second conveying means with said second spacing.

2. Apparatus according to claim 1 wherein at least one of said first and second cooling tables comprises a plurality of fixed supports spaced apart from one another in a first direction, a plurality of movable supports located between the fixed supports and normally having their upper surfaces no higher than the upper surfaces of the fixed supports, lifting means for raising together the movable supports to a raised position in which their upper surfaces are above the surfaces of the fixed supports, and separate means for moving the movable supports together, while in their raised position, through a predetermined distance in a second direction substantially normal to the first direction.

3. Apparatus according to claim 2 including means for decelerating the movable supports slowly as they approach the end of their movement in the second direction.

4. Apparatus according to claim 2 wherein both said cooling tables are of the same form but the respective means for moving the supports of the tables through a predetermined distance are arranged to move the supports of one of said tables through a distance which is different from that through which the supports of the other table are moved.

5. Apparatus for effecting controlled cooling of hot objects, said apparatus comprising two adjacent cooling tables forming first and second sections of a cooling bed, first transfer means for positioning successive objects to be cooled on the first section table, said first transfer means comprises a roller table arranged to transfer objects to said first section table, a plurality of abutment members normally extending no higher than the upper surfaces of the rollers of the roller table, means for raising the abutment members together to a position above the upper surfaces of the rollers for engagement with an elongate object, means for moving the abutment members together through a predetermined distance in the second direction, and means for lowering the abutment members together before returning them to their original position, second transfer means for transferring said objects from said first section table to the second section table and first and second conveying means associated respectively with said first and second tables and arranged to move said objects across said tables, said first transfer means being adjustable in operation to position successive objects at different positions on said first table so that said objects are conveyed by said first conveying means across said first table with a selectable desired first spacing, and said second transfer means being adjustable in operation to transfer said objects to said second table with a selectable second desired spacing differing from said first spacing so that said objects are conveyed across said second table by said second conveying means with said second spacing.

6. Apparatus according to claim 5 in which the abutment members are located between the rollers of the roller table.

7. Apparatus according to claim 5 wherein the means for moving the abutment members is adjustable in operation to vary the distance through which said abutment members are moved.

8. Apparatus for effecting controlled cooling of hot objects, said apparatus comprising two adjacent cooling tables forming first and second sections of a cooling bed, first transfer means for positioning successive objects to be cooled on the first section table, second transfer means for transferring said objects from said first section table to the second section table and first and second conveying means associated respectively with said first and second tables and arranged to move said objects across said tables, said second section table has associated with it unloading means which comprises a plurality of spaced-apart supports, each having a substantially horizontal surface and a substantially vertical surface for engaging an object, means for lifting the supports together to a raised position in which the substantially horizontal surfaces are above the upper surface of the fixed supports of the second cooling table, and means for moving the supports together, while in the raised position, through a predetermined distance in the second direction, said first transfer means being adjustable in operation to position successive objects at different positions on said first table so that said objects are conveyed by said first conveying means across said first table with a selectable desired first spacing, and said second transfer means being adjustable in operation to transfer said objects to said second table with a selectable second desired spacing differing from said first spacing so that said objects are conveyed across said second table by said second conveying means with said second spacing.

9. Apparatus according to claim 8 in which the position of at least the substantially vertical surface of each support is adjustable relative to the other supports in the second direction.

10. Apparatus according to claim 8 in which each support is mounted on a frame for movement relative to the frame parallel to the second direction, and the frames are mounted for movement together in the second direction on vertically movable tracks.

11. Apparatus according to claim 10 including means for causing relative movement between the substantially horizontal and vertical surfaces of each support.

12. Apparatus according to claim 8 in which the substantially horizontal surface of each support is inclined slightly downwardly towards its substantially vertical surface, and the substantially vertical surface is normal to the substantially horizontal surface.

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