Nov. 2, 1965 H. A. BOTTENHORN 3,215,420

ANNEALING AND/OR COOLING OF ELONGATED MATERIAL

Filed Nov. 20, 1961 5 Sheets-Sheet 1

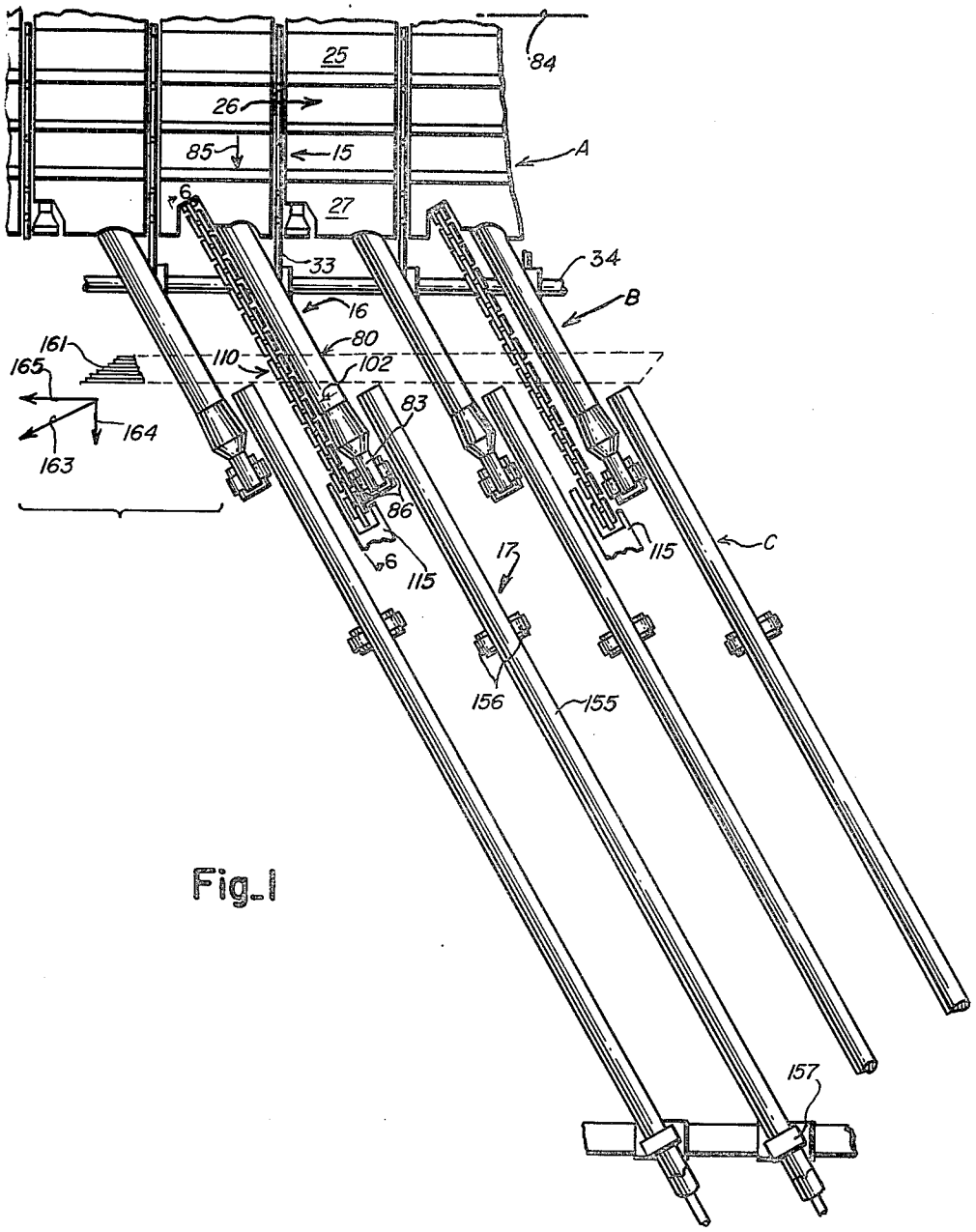


Fig_1

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ANNEALING AND/OR COOLING OF ELONGATED MATERIAL

Filed Nov. 20, 1961 5 Sheets-Sheet 2

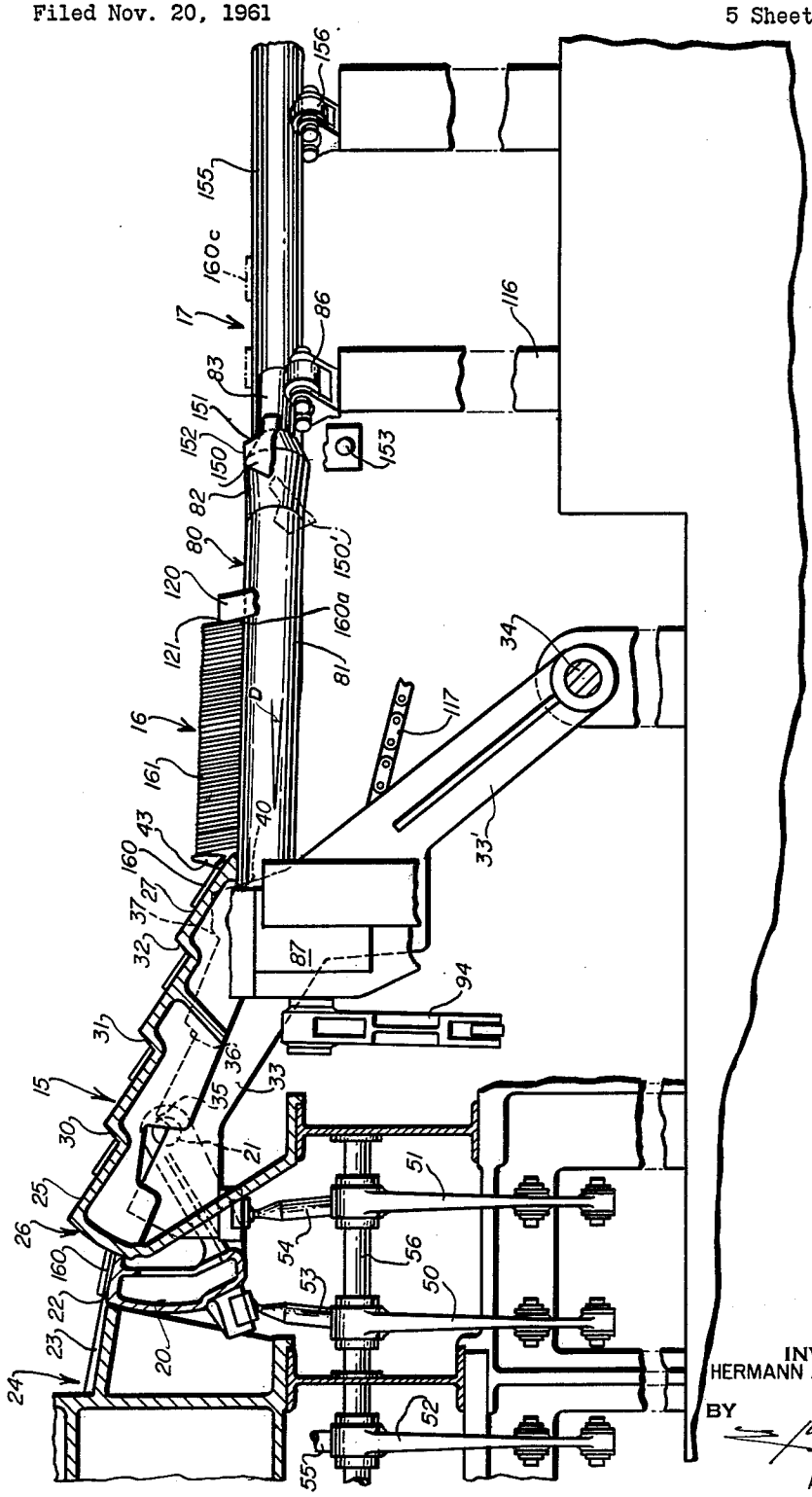


Fig_2

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ANNEALING AND/OR COOLING OF ELONGATED MATERIAL

Filed Nov. 20, 1961 5 Sheets-Sheet 3

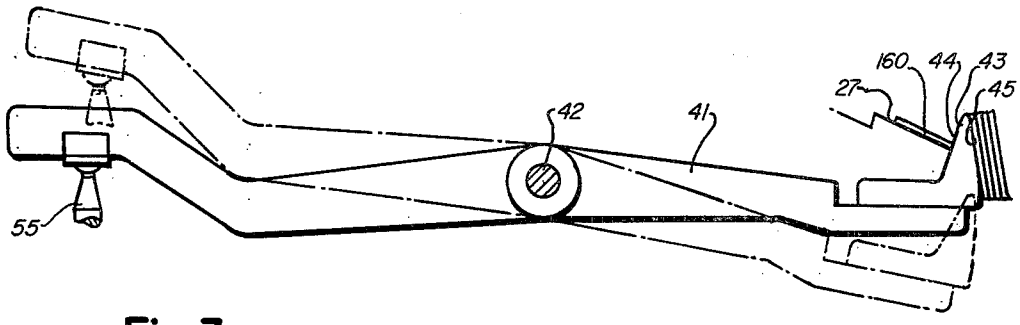


Fig_3

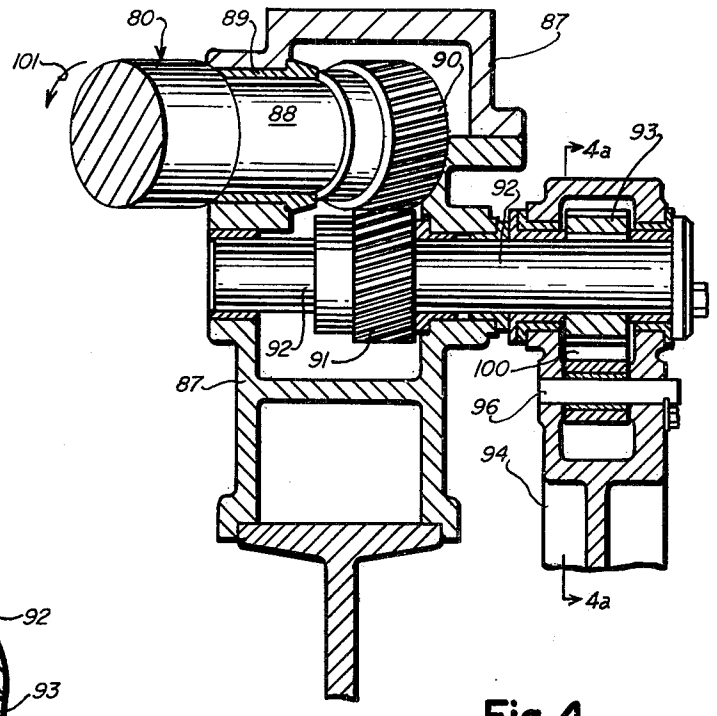


Fig_4

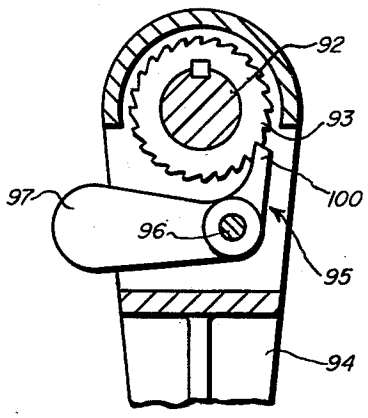


Fig_4a

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ANNEALING AND/OR COOLING OF ELONGATED MATERIAL

Filed Nov. 20, 1961 5 Sheets-Sheet 4

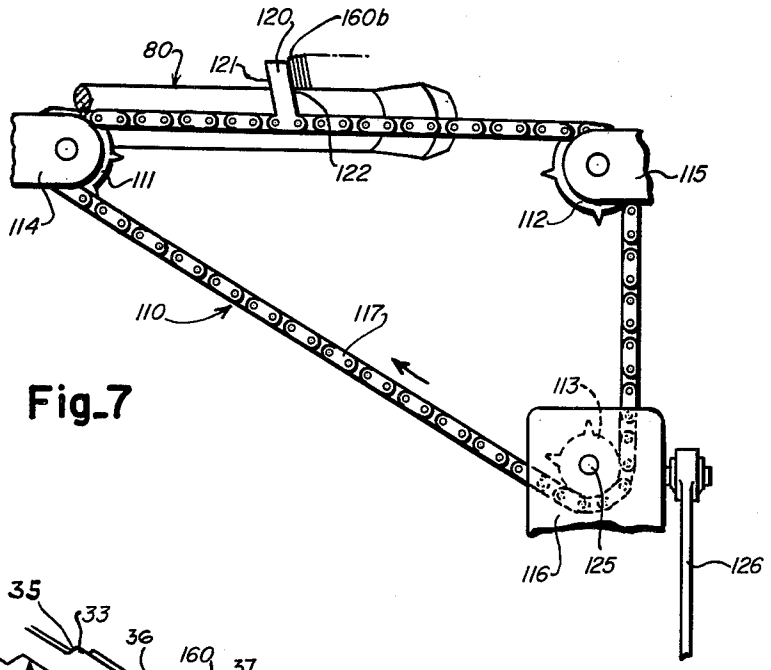


Fig_7

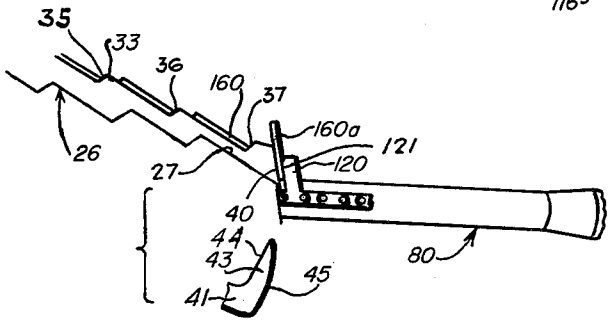


Fig_5

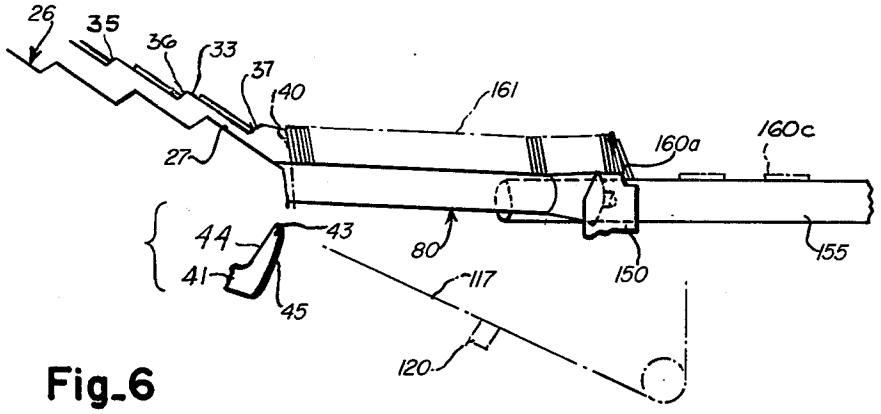


Fig_6

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ANNEALING AND/OR COOLING OF ELONGATED MATERIAL

Filed Nov. 20, 1961 5 Sheets-Sheet 5

Fig_8

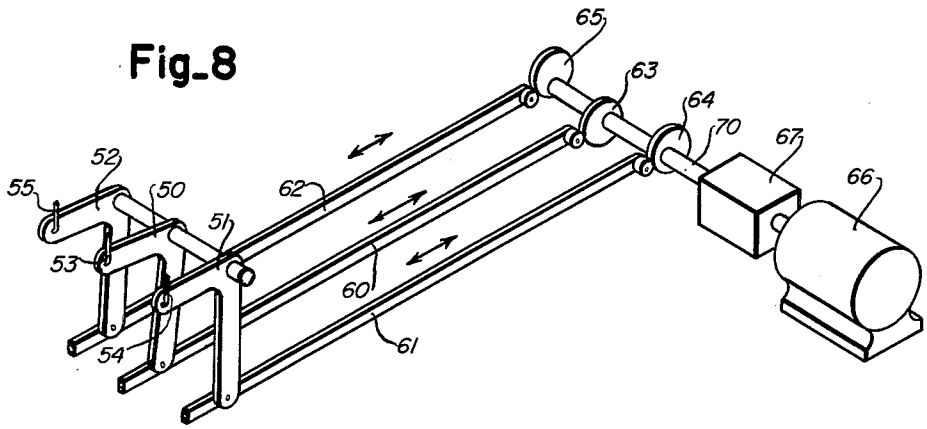
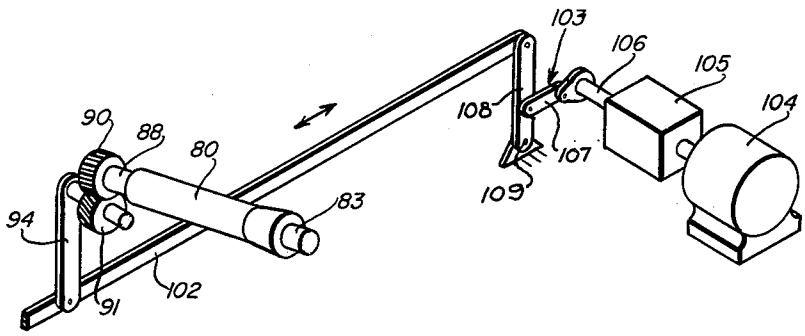


Fig_9



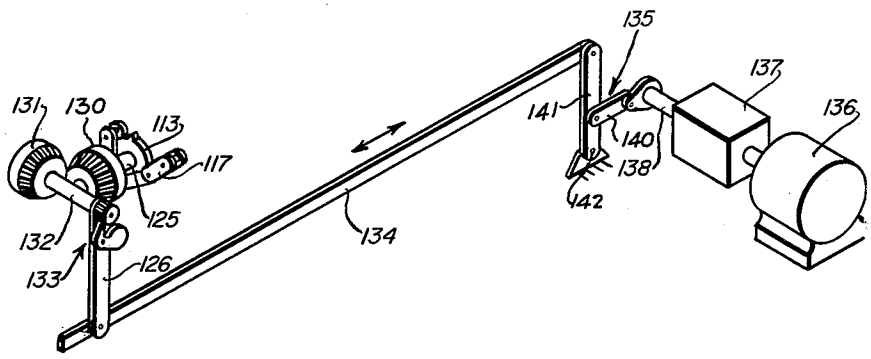


Fig_10

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United States Patent Office

3,215,420

Patented Nov. 2, 1965

3,215,420

ANNEALING AND/OR COOLING OF ELONGATED MATERIAL

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Filed Nov. 20, 1961, Ser. No. 153,527

15 Claims. (Cl. 266—5)

This invention relates to an improved work handling method and apparatus, and more particularly to a novel method and apparatus for the stacking, supporting, moving and dispensing of heated material during a continuous pack annealing and/or cooling operation. The workpieces to be treated are normally of an elongated shape having a longitudinal axis and are frequently in the form of flats or strips of relatively thin material such as spring steel.

When carrying out conventional pack annealing operations, workpieces are successively delivered to and stacked on edge on a work supporting means to form a pack and are thereafter retained and sidewise or laterally moved on said supporting means as a group during the annealing operation. As each new workpiece is added to the trailing end of the work pack formed, the annealed workpiece at the leading end of the pack is separated from the immediately following workpieces and is dispensed onto a final or main cooling bed. In conventional type systems, certain difficulties have been encountered which tend to reduce the speed and/or efficiency at which the pack annealing operation may be carried out. For example, where the pack supporting means comprises the usual type of straight rails or racks, the later continually engage substantially the same points on the lower side of the laterally moving work pack. This operational condition will give rise to localized increases in the rate of heat loss from the stacked workpieces and the resultant cold spots in the work pack can adversely affect the uniformity of the physical properties desired in the annealed material.

Other difficulties have been encountered when the last workpiece to be processed has been delivered to the work supporting means and the residual pack must continue to be progressively fed so that the terminal workpieces are treated in the same manner as the preceding workpieces. Here special apparatus and/or manual manipulative techniques have been used to handle the residual pack; however, these solutions have in many cases caused inherent delays in the overall operations or have been inefficient in the proper dispensing of the workpieces of the said residual pack onto the main or final cooling bed.

Further, the various devices previously used for maintaining and feeding the workpieces in stacked condition and for progressively separating the leading workpieces from the rest of the pack have not always been sufficiently flexible or efficient in use so as to properly accommodate all the various types of workpieces or operating conditions that may occur.

One object of the instant invention is to provide a simple, efficient method and apparatus for movably supporting a plurality of workpieces during a pack annealing operation, whereby the incidence of cold spots at the support points of the pack is substantially eliminated.

Another object of the invention is to provide a simple and efficient means for movably supporting a stacked group of workpieces during a pack annealing operation,

whereby substantially no sliding friction takes place between the moving pack and the pack supporting means.

A different object of the invention is to provide an improved method and apparatus for progressively feeding a stacked group of workpieces through a pack annealing station by applying a frictional feeding force to the lower edge of each of the workpieces in said pack.

An additional object of the invention is to provide a very simple and efficient arrangement for retaining the workpieces in a proper stacked condition when the work pack is initially being built up and also during the last stage of the operation when the residual pack is being progressively depleted.

A further object of the invention is to provide a novel method and apparatus for progressively separating the workpieces at the leading end of a work pack and for serially dispensing the same onto a final or main cooling bed.

A still further object of the invention is to provide simple means for operating a cooling bed selectively with or without a pack annealing step.

It is also an object of the invention to provide a workpiece supporting and advancing means for performing a pack annealing operation with the axes of the means being disposed at an angle to the longitudinal direction of the workpieces as oriented on said means.

It is another object of the invention to provide a novel workpiece supporting and advancing means for performing a pack annealing operation with the axes of said means being disposed at an angle to the general direction in which the workpieces are successively delivered to said supporting and advancing means.

It is a different object of the invention to provide an improved cooling bed arrangement having two serially arranged sets of angularly disposed and rotatably mounted workpiece supporting members which successively receive, support and advance the workpieces to be treated.

It is an additional object of the invention to provide a novel arrangement of rolls for supporting and displacing a plurality of stacked workpieces during a pack annealing operation, said rolls having parallel axes which are disposed at an acute angle with respect to the longitudinal axis of each workpiece, and which may also be disposed at a small angle with respect to a horizontal plane.

It is a further object of the invention to provide a novel supporting and advancing means for workpieces that are being pack annealed, said means including a set of rolls, each of which has a cylindrical and a frusto-conical work engaging portion.

It is a still further object of the invention to provide a novel pack retaining dog means which has a unidirectional circuital movement and which is capable of partaking of incremental feeding steps while selectively located at either the leading or the trailing end of a pack of workpieces; said dog means also being movable to a predetermined point in its circuital path where it is out of the operative path of the advancing workpieces.

Other objects and advantages of this invention will be readily apparent as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a fragmentary plan view generally illustrating the overall organization of the instant apparatus;

FIG. 2 is an enlarged, side elevational view in partial section and shows one of a plurality of the angularly dis-

posed pack supporting rolls at the pack annealing station and also illustrates apparatus for successively conveying workpieces to and from the pack annealing station;

FIG. 3 is an enlarged, side elevational view illustrating the construction and operation of a pack retaining arm;

FIG. 4 is an enlarged, vertical sectional view showing the housing, support and drive apparatus for one of the work pack supporting rolls, this view being taken from the right as seen in FIG. 1;

FIG. 4*a* is a fragmentary, side elevational view taken along section line 4*a*—4*a* of FIG. 4 and shows a ratchet type drive connection for the pack supporting roll;

FIGS. 5 and 6 are diagrammatic sketches illustrating the instant steps of progressively stacking, supporting, advancing and separating the workpieces at the pack annealing station;

FIG. 7 is a side elevational view similar in principle to the diagrams of FIGS. 5 and 6, but illustrating a final stage of the pack annealing operation and showing details of the chain drive for a movable pack engaging dog.

FIG. 8 is a diagrammatic sketch illustrating an exemplary power actuating means for the workpiece conveying and delivering apparatus of FIGS. 1–3;

FIG. 9 is a diagrammatic sketch illustrating an exemplary power actuating means for the pack supporting roll ratchet drive means of FIGS. 4 and 4*a*;

FIG. 10 is a diagrammatic sketch illustrating an exemplary power actuating means for the dog chain drive means of FIGS. 5 to 7.

Unless otherwise indicated, it may be assumed that the various parts of the apparatus shown and/or described are constructed, mounted and operated in a suitable manner well understood in the art.

Referring to the general plan view of FIG. 1, a portion of a work handling and cooling bed arrangement is shown having three main, serially arranged sections or stations A, B and C through which the elongated workpieces are progressively moved. The first station A generally comprises conveying apparatus for successively delivering heated elongated material to the second or continuous pack annealing station B. The apparatus for this second section generally comprises a plurality of angularly disposed members or skew rolls, and related equipment, which support and advance a plurality of stacked workpieces that make up a work pack to be annealed. The third or final cooling bed station C of the instant apparatus is adapted to receive and carry away material from the second or pack annealing station B and generally comprises a second set of angularly disposed work supporting members or skew rolls. The instant invention is primarily concerned with novel aspects of the pack annealing station B per se and also its combination with the other stations of the apparatus. Except at points hereinafter specifically indicated the construction and operation of the apparatus defining the workpiece delivering station A may be more or less conventional to the extent of producing the hereinafter described general work transporting functions desired.

Each of the stations A, B and C of the apparatus of FIG. 1 comprises a plurality of similar units, but it will suffice for the purposes of the present disclosure to discuss only one unit of each of said stations, and the interrelated cooperation therebetween, it being understood that the various other units are constructed, and simultaneously cooperate, in a similar manner. The respective specific units of the apparatus of FIG. 1 which will be described here will be the workpiece conveying unit **15**, the angularly disposed pack annealing unit **16**, and the angularly disposed final cooling bed unit **17**. The units **15**, **16** and **17** form a set substantially in parallel with adjacent similar sets arranged at both sides thereof as shown in FIG. 1. In practice, there may be as many as 170 parallel sets and the apparatus may extend in the direction of axis **84**, FIG. 1, through a distance on the order of 350 feet for treating material of a suitable length.

Referring now to FIG. 2 which shows the units **15** to **17** in a sectional side elevation, the work conveying unit **15** comprises an elevator **20** which is pivotally mounted at **21** on a suitable machine base and which is provided with a flat uper work engaging surface **22**. When the elevator is in its lower or counterclockwise position shown in FIG. 2, the surface **22** is substantially parallel to and just below the adjacent laterally inclined upper edges of tapered rolls **23** of a run-in table **24**. When elevator **20** is in its upper or clockwise position, the surface **22** is substantially coextensive with the initial inclined surface **25** of an adjacent stationary, work supporting rack or stepped platform **26** which has a final inclined surface **27** at its remote end. Rack **26** is fixedly mounted on the machine base and formed with a downwardly staggered set of work arresting shoulders **30**, **31** and **32**. Cooperating with the stationary rack or platform **26** is a movable rack **33** which by means of its downwardly extending arm **33'** is pivotally mounted as at **34** on the machine base and is also provided with a set of downwardly staggered work arresting shoulders **35**, **36** and **37**, compare FIGS. 5 and 6. The shoulders **35** to **37** of the movable rack are offset from the respectively associated stationary rack shoulders **30** to **32** and operationally cooperate with the latter to form an inclined, linear escapement for gravitationally advancing the material. The movable rack **33** is formed with a steeply inclined work erecting shoulder **40** which is located near the lowermost work arresting shoulder **37**.

Cooperating with the above described rack means is a stack retaining arm **41**, FIG. 3, which is pivotally mounted as at **42** on the machine base and is disposed in back of and parallel to the movable rack **33**. The forward or right hand end of the stack retaining arm **41**, as viewed in FIG. 3, is provided with an upstanding detent finger **43**, FIGS. 2 and 3, which is formed with a workpiece arresting rearward edge **44** and a curved forward pack engaging edge **45** that has a center of curvature located at the pivot axis of stack retaining arm **41**. Solid lines of FIG. 3 denote the normal counterclockwise or pack retaining position for arm **41**, while broken lines thereof indicate the clockwise or inoperative position for the pack retaining arm.

The elevator **20**, the movable rack **33** and the pack retaining arm **41** are adapted to be actuated in timed relation and for this purpose are respectively articulately connected to three bell cranks **50**, **51** and **52**, FIGS. 2 and 8, by means of connecting rods **53**, **54** and **55**. The bell cranks **50** to **52** are rotatably mounted on a shaft **56** which is suitably supported on the machine base and are respectively articulately connected to three cam follower actuator rods **60**, **61** and **62** diagrammatically illustrated in FIG. 8. These cam follower rods are respectively adapted to be reciprocated by eccentric cams **63**, **64** and **65** that are rotatably driven by means of a motor **66**, a speed reducing means **67** and a shaft **70**. Due to the action of gravity, the bell cranks **50** to **52** tend to turn in counterclockwise direction, FIG. 8, and thus will bias follower rods **60** to **62** to operatively engage the associated cams. As will be apparent, when the motor **66** is energized the elevator **20**, the movable rack **33** and the pack retaining arm **41** may be oscillated in predetermined timed relation to produce desired sequential work delivering operations which will later be described.

Cooperating with the work delivery unit **15** is a pack annealing unit **16**, FIG. 2, which comprises a rotatably mounted work pack supporting roll **80**, FIGS. 1 and 2, having a cylindrical portion **81**, a coaxially enlarging frusto-conical portion **82** and an outer bearing neck portion **83**. The axis of the pack supporting roll **80** is disposed at an acute angle such as an angle of 60° with respect to the longitudinal axis **84**, FIG. 1, of the run-in table **24**, FIG. 2, and at the complementary angle with respect to the direction **85**, FIG. 1, in which elongated workpieces are laterally or sidewise delivered to the pack annealing station. It will be clear that the axis of roll

80 is also in an angular position with respect to the longitudinal or axial direction of the elongated workpieces as placed on the skew roll 80 by the unit 15 and as oriented thereon.

The bearing neck end 83 of roll 80 is supported in a position slightly lower than that of the other end of the roll, which results in the roll axis being inclined slightly downwardly from the horizontal by a small angle D as illustrated in FIG. 2. The angle D is preferably less than one half of the apex angle of the cone defining the said frusto-conical roll portion 82 so that there is still a slight upward slant, FIG. 2, to the top edge of the frusto-conical portion 82 of the mounted roll 80. In one arrangement that has been successfully tested, angle D has been given a value of 1.5 degrees.

Neck portion 83 of roll 80 is journalled on a cooperating pair of rotatable bearing members 86, FIGS. 1 and 2, that are suitably supported on the machine base while the other end of the pack supporting roll is rotatably mounted in a base-supported bearing housing 87 which will now be described in connection with the sectional view of FIG. 4. Reduced end 88 of the pack supporting roll 80 is journalled in the bushing bearing 89 and has secured thereto a helical gear 90 which meshes with another helical gear 91. Gear 91 is secured to a shaft 92 which is rotatably mounted in the housing 87 and which has an extended end on which is fixed a ratchet wheel 93. Rotatably mounted on said extended end of shaft 92 is a lever 94 having a ratchet pawl 95, FIG. 4a, pivotally mounted thereon by means of a suitable pin 96. The horizontally extending counterweight portion 97 of the pawl is adapted by the action of gravity to bias the pawl tooth 100 into operative engagement with the teeth of the ratchet wheel 93. As will be apparent, the pawl 95 and the ratchet wheel 93 cooperatively define a one-way drive connection between the actuating lever 94 and the work pack supporting roll 80. Lever 94 may be power-operated by any suitable means such as those diagrammatically illustrated in FIG. 9. Here the lever 94 is articulately connected to a rod 102 which is adapted to be cyclically reciprocated by a crank mechanism 103 that is driven by a motor 104 through a speed reducing means 105 and a shaft 106. Mechanism 103 includes an intermediate link 107 and a guide link 108 pivotally mounted on the base at 109. When the motor 104 is energized, rod 102 will be reciprocated so as to incrementally and unidirectionally rotate the said angularly disposed pack supporting roll 80 through successive angular distances determined by the magnitude of the arcuate strokes of lever 94; the operative direction of the rotation of roll 80 always being that indicated by arrow 101 of FIG. 4 and arrow 102 of FIG. 1.

As shown in FIG. 1 a chain drive mechanism 110 is provided for cooperation with the pack supporting roll 80; this mechanism also being illustrated in the side view of FIG. 7. Three coplanar sprocket wheels 111, 112 and 113 are rotatably mounted in three fixed, base-supported housings 114, 115 and 116, respectively, the plane of said sprocket wheels being substantially parallel to a vertical plane through the axis of the adjacent roll 80. An endless flexible chain 117 is operatively reeved around said sprocket wheels and has secured thereto a pack engaging dog 120 that is formed with inclined trailing and leading edges 121 and 122, respectively. When the dog is moving from sprocket wheel 111 to sprocket wheel 112, the upper end thereof will project well above the upper edge of the pack supporting roll 80 as illustrated in FIG. 7.

The chain 117 is adapted to be driven by the sprocket wheel 113 which is secured to a base-supported shaft 125; the latter being adapted to be incrementally rotatably indexed by a lever 126, FIG. 7, through a suitable ratchet and gear means that may be similar in nature to that just described in connection with FIGS. 4, 4a and 9. Such a means is diagrammatically illustrated in FIG. 10 and may comprise a bevel gear 130 which is secured to shaft 125 and which meshes with another bevel gear 131 secured to a shaft 132. Lever 126 is rotatably mounted on shaft 132 and is operatively connected thereto by a ratchet mechanism 133 similar to that of FIGS. 4 and 4a, whereby an oscillatory actuation of lever 126 will produce an intermittent, unidirectional rotational indexing of the sprocket wheel 113. Lever 126 is articulately connected to a rod 134 which is adapted to be reciprocated by a crank mechanism 135 that is driven by a motor 136 through a speed reducing means 137 and a shaft 138. Mechanism 135 includes an intermediate link 140 and a guide link 141 pivotally mounted on the base at 142. When the motor 136 is energized, rod 134 will be reciprocated so as to incrementally advance the respective chain 117 and thus impart a step by step circuital or orbital movement to the dog 120; this circuital movement always occurring in a generally clockwise direction as seen in FIG. 7. The movement is circuital in that the dog travels along a closed or endless path around the area encompassed by the chain 117. The frequency of the intermittent energization of motor 136 may be varied in accordance with the speed desired for the step by step advance of the work engaging dog 120.

Mounted adjacent to and for cooperation with the frusto-conical portion 82 of roll 80 is a workpiece dispenser or control dog 150, FIG. 2, having a forward, downwardly inclined or tapered edge or face 151 and an upper flat edge or face 152 which is normally disposed laterally of and at the same level as, or just below, the highest point on the frusto-conical roll portion 82, the inclined edge 151 forming an extension of the flat edge 152. Dispenser 150 is secured to a rotatable base-supported shaft 153 and may be pivoted from its normal operative position shown by the solid lines in FIG. 2 to an inoperative position shown by the broken lines 150'. It should be noted that a workpiece dispenser such as 150 will be secured to the common elongated shaft 153 at points between every second or third pack supporting roll, these dispensers being accurately mutually aligned so that their top edges and forward, inclined edges, such as 151 and 152, are respectively substantially coplanar. In this way the various portions of a laterally moving workpiece may ride off the dispensers at substantially the same time.

The unit 17 of the main or final cooling station C of the instant apparatus is adapted to receive workpieces from the pack annealing station and comprises an elongated cylindrical, angularly disposed workpiece supporting and transporting roll 155, FIGS. 1, 2 and 6, having an axis that extends substantially parallel to the vertical plane that includes the axis of the associated pack supporting roll 80. As illustrated, roll 155 is normally substantially longer than roll 80 to provide for sufficient cooling of the workpieces while they travel on roll 155. The inner end portion of the skew roll 155 is positioned just below the highest portion of the tapered dispenser edge 151 when the latter is in the full line position of FIG. 2. At a certain distance from its inner end and from the dispenser 150, roll 155 is journalled on a cooperating pair of rotatable bearing members 156 that are suitably supported on the machine base, while the outer end of roll 155 is rotatably mounted in a suitable base-supported housing 157, FIG. 1. Roll 155 is incrementally rotatably indexed by means of ratchet and gear drive connections that are similar to those described above for the pack supporting roll means 80. The axes of the individual rolls 155 are disposed substantially in a common plane.

A description of the operation of the above described apparatus will now be made with particular reference to the structure-defining FIGS. 1 and 2, and also to FIGS. 5 to 7 which illustrate the instant steps as carried out by said apparatus. The interrelated timing of the energization of the motors 66, 104 and 136 of FIGS. 8 to 10 and the resultant power actuations of the respective drive

linkages associated therewith will be indicated by the sequential action of the various driven parts as is hereinafter described.

After the work has been rolled and moved onto the run-in table **24**, FIG. 2, it is severed and each successive elongated workpiece **160** laterally or sidewise slides onto the upper surface **22** of the lowered elevator **20**. The elevator is then swung to its upper position wherein the workpiece is free to laterally slide under the action of gravity to the first shoulder **30** of the stationary rack or stepped platform **26**. The movable rack **33** is then swung from a lower to an upper position and in the course of this upward movement picks up the workpiece from the stationary platform shoulder **30** and allows it to slide sidewise under the action of gravity to the shoulder **35** of the movable rack. Rack **33** is thereafter lowered and the workpiece is transferred back to the stationary, stepped platform where it is now free to slide sidewise to the next shoulder **31**. As the movable rack is thus cyclically oscillated, the workpiece successively escapes from the various rack shoulders and is gravitationally advanced step by step to the lowermost inclined surface **27**, FIG. 2, of the stationary platform **26** where it finally is arrested by the rearward edge **44**, FIG. 3, of finger **43**. As the movable rack **33** starts its next upward stroke, finger **43** of the pack retaining arm **41** is swung from its upper position to its lower dotted line position, FIG. 3, whereby the steeply inclined forward, work erecting shoulder **40**, FIG. 2, of the movable rack may intercept and swing the workpiece in a general clockwise direction off the platform surface **27** to a vertical or slightly inclined on-edge position either as the first member **160***a*, FIG. 5, of a new pack or, FIG. 6, as a member to be added at the rear of a work pack **161** being formed at the pack annealing station. Each time the movable rack **33** is moved downwardly, the pack retaining arm **41** is pivoted back to its normal solid line position of FIG. 3 so that the forward curved edge **45** of finger **43** re-engages the trailing end of the work pack and holds the workpieces of the latter in proper stacked condition as illustrated in FIGS. 2 and 3. In this manner a series of workpieces may be successively intermittently sidewise advanced and successively delivered in a predetermined on-edge, erect or upright stacking position to the angularly disposed set of coplanar pack supporting rolls **80**.

Before the first workpiece **160***a*, FIG. 5, of a production run or program is delivered to the pack annealing station by the movable rack **33**, the chain **117** is first moved by the means described so that the inclined rearward edge **121** of dog **120** is positioned just in front of the first workpiece when deposited on roll **80**. In this way this first workpiece will be prevented from sliding or falling forwardly from its proper on-edge or upright condition on the pack supporting rolls. It will be clear that when the movable rack **33** is lowered and the erecting edge **40** thereof moves away from the rear of the first workpiece, the finger **43** will swing to its upper pack retaining position shown by the solid lines of FIG. 3 so that the rear side as well as the front side of the workpiece **160***a* will then be laterally supported and thus the workpiece will be prevented from falling over in either direction from its proper upright condition on the pack supporting rolls. As each successive workpiece is thereafter serially added to the work pack **161**, each associated workpiece erecting movement of the inclined rack edge **40** would tend to apply a positive endwise feeding force to the work pack if the latter had remained in its position; but before the new workpiece arrives, the rolls **80** will have moved the pack in the manner described later and to an extent such that proper space for the new workpiece is readily available. The movable rack need normally merely add the new piece to the pack. During each erecting movement of rack edge **40**, the chain **117** is likewise simultaneously incrementally advanced in the manner described and by an amount corresponding to the thickness of each workpiece added. Thus the pack retaining dog **120** is intermittently stepped along to the right, FIG. 2, in timed relation to the movement of rack **33** and by amounts appropriate to make room for successive workpieces that are added to the progressively enlarging work pack. This is continued during the initial pack build-up so that the workpieces will remain in their proper stacked condition.

It should be noted that the retaining arm **41** and dog **120** are effective to arrange as well as retain the workpieces in stacked relation while on the pack supporting rolls **80**. The erecting shoulder or edge **40** merely delivers the workpieces in an on-edge position to rolls **80**, and no stack is formed if in particular the dog **120** is not initially in the FIG. 5 position.

As indicated hereinbefore, during the described feeding and erecting action of the movable rack edge **40** and the movement of dog **120**, the pack supporting rolls **80** are also simultaneously rotatably indexed by the means set forth in order to minimize any retarding friction between the pack supporting rolls and the lower edges of the workpieces of work pack **161**, and in order to have said pack supporting rolls exert a frictional driving force to the lower side of the work pack for feeding the latter through the pack annealing station. This frictional driving action will be maintained throughout each incremental movement of the workpieces in the pack by properly adjusting the effective length of each incremental rotational movement of the pack supporting rolls.

At the left side in FIG. 1 the arrow **163** diagrammatically denotes the direction and effective peripheral length of one incremental indexing movement of the cylindrical portion of a pack supporting roll. The effective length of this movement is selected so that the lateral component **164** thereof is at least equal to, or slightly exceeds, the thickness of each workpiece added to the pack **161**, the component **165** acting to simultaneously advance the workpieces in a direction along their longitudinal axes. In this way, due to the angular or skew disposition of the pack supporting rolls such as **80** the work pack will intermittently move as a whole in the direction of the arrow **163**, FIG. 1, that is, approximately at right angles to the axial direction of rolls **80**; and in doing so the points of contact between the respective pack supporting rolls and the lower edges of the stacked workpieces defining the pack **161** will continually change. This action will prevent the occurrence of "cold spots," i.e., any sustained localized increase in the rate of cooling of the work pack that might adversely affect the annealing of the workpieces as they slowly cool during their passage through the pack annealing station. Thus, the dissipation of heat along the lower edges of the workpieces will be substantially equalized.

As the work pack gradually builds up, the dog **120** and the leading workpiece **160***a*, FIG. 2, move towards the frusto-conical portions of the pack annealing rolls. When a position such as shown in FIG. 2 has been reached or passed and thus the pack **161** is of a substantial size, the pack will no longer require the forward lateral support afforded by the dog **120**. The latter may then be rapidly advanced to an inoperative position out of the path of travel of the work pack as is diagrammatically illustrated in FIG. 6; this rapid advancement being produced by a relatively high frequency of energization of the motor **136**. When the leading workpiece **160***a* engages the frusto-conical portions of the pack supporting rolls, the lower edge of this workpiece will be sidewise accelerated and silghtly elevated with respect to the next following workpiece as is illustrated in FIG. 6. This results in a separating action and is achieved because the peripheral surfaces of the enlarged frusto-conical roll portions are moving faster than the peripheral surfaces of the smaller cylindrical roll portions and are thus able to laterally speed up the lower contacting edge of workpiece **160***a*

and separate the latter from the following workpiece. The leading workpiece **160***a* after being separated from the rest of the pack will finally ride over the conical ends of the pack supporting rolls and slide down the aligned forward tapered faces of the work dispensers **150** onto the long coplanar work-receiving rolls, such as **155**, of the final cooling bed station where as indicated in broken lines at **160***c* in FIGS. 2 and 6 they are progressively transported to another operational station.

During most of the production program there will continually be a full complement of workpieces on the pack supporting rolls, except when the last workpiece **160***b* of a lot is gradually advanced over the rolls **80**, FIG. 7. At the time when the last workpiece is delivered to the trailing end of the pack prior to the FIG. 7 position, chain **116** is actuated in a general clockwise direction to move dog **120** from its inoperative position shown in FIG. 6 towards and over sprocket wheel **111**. When the rack means **33** has added the last workpiece to the pack and the latter is engaged by the retaining arms **41**, the inclined leading edge **122** of dog **120** is brought, between arms **41**, into lateral supporting engagement with the rearward side of the last workpiece. Thereafter, the dog **120** is incrementally advanced by actuating the motor **136** so that it will move along with the trailing end of the pack as illustrated in FIG. 7 and will replace the supporting action of retaining arms **41** which are no longer in contact with the last workpiece **160***b*. The intermittent frictional feeding force imparted to the lower side of the work pack by the pack supporting rolls will continue until the last workpiece **160***b* is dispensed onto the main cooling bed station C. In this way the workpieces which make up the residual pack will be subject to the same length of annealing period and to the same conditions as apply to all the preceding workpieces; there being no need here for any manual manipulation or special apparatus in order to process the last few workpieces.

If the next production program requires no pack annealing operation, the chain drive dogs such as **120** and the work dispensers such as **150** are moved to their inoperative position, respectively illustrated in FIGS. 2 and 6, and the rolls such as **80** then serve merely as a supporting and advancing means for spaced successive workpieces. As may be readily appreciated, very little adjustment is required with the elements **120** and **150** being selectively operable to quickly condition the unit **16** to afford either a pack annealing function or merely a simple work supporting and advancing function.

It should be understood that the foregoing disclosure relates to only one preferred embodiment of the invention and that it is intended to cover any changes and modifications which do not constitute departures from the spirit and scope of the invention as defined in the appended claims.

What I claim is:

1. In a cooling and annealing bed for handling heated elongated workpieces and advancing said workpieces along a predetermined path,

(a) a first set of spaced elongated members for successively receiving and supporting said workpieces in a predetermined orientation, each of the members in said first set being arranged at an angle with respect to the longitudinal direction of the elongated workpieces as received thereon and to said predetermined path,

(b) means selectively operable for arranging and retaining said workpieces in stacked relationship while on the members of said first set, and

(c) a second set of spaced elongated members for successively receiving workpieces from said first set and supporting the workpieces received, each of the members in said second set being likewise arranged at an angle with respect to the longitudinal direction of the elongated workpieces in said predetermined orientation thereof and to said predetermined path,

whereby the point of contact between the advancing workpieces and said spaced elongated members will continually change such that heat dissipation along the length of said workpieces will be substantially equalized.

2. Apparatus as defined by claim **1**, wherein the workpiece supporting members of said first set comprise a plurality of rotatably mounted rolls having axes that are disposed substantially in a common plane.

3. Apparatus as defined by claim **2**, wherein the workpiece supporting members of said second set likewise comprise a plurality of rotatably mounted rolls having axes disposed substantially in a common plane, the rolls of the second set being longer than the rolls of the first set.

4. Continuous pack annealing and cooling apparatus for handling a series of heated elongated workpieces, comprising

(a) conveying means for delivering said workpieces sidewise to a pack annealing station,

(b) a set of spaced, rotatably mounted rolls arranged to receive and support said workpieces for progressive movement through said pack annealing station, said rolls having substantially parallel axes disposed at an acute angle with respect to the sidewise direction in which said workpieces are delivered to the pack annealing station, each of said rolls including a cylindrical, work engaging portion,

(c) means for arranging and retaining said workpieces in stacked relation while on said rolls,

(d) actuating means connected to drive said rolls for applying incremental feeding forces to the bottom portions of workpieces stacked on said rolls and for thereby progressively displacing said workpieces through said pack annealing station in a predetermined direction at an angle to said parallel axes of the rolls, whereby the point of contact between the advancing workpieces and said rolls will continually change so as to substantially equalize heat dissipation along the length of the latter,

(e) a terminal frusto-conical, work engaging portion on each roll adjacent and coaxial with said cylindrical portion thereof and positioned remote from said conveying means for separating successive leading workpieces from said pack, and

(f) a cooling bed means for receiving said successively separated leading workpieces of said pack and for transporting the same away from said pack annealing station.

5. Apparatus as defined by claim **4**, wherein the axes of said rolls are disposed at an angle with respect to a horizontal plane, said angle being smaller than one half of the apex angle of each frusto-conical roll portion.

6. Pack annealing and cooling apparatus for handling a series of heated elongated work pieces comprising conveying means for delivering work pieces to a pack annealing station, a set of parallel, spaced, elongated, work piece supporting members receiving and supporting work pieces for progressive movement through said pack annealing station, the longitudinal axes of said members being oblique to the longitudinal axes of the elongated work pieces as received by said members, means for retaining the work pieces in stacked relation while on said members, actuating means for applying unidirectional incremental feeding forces to said work pieces for progressively displacing the latter through said pack annealing stations in predetermined direction to said longitudinal axes of said members, whereby contact between the moving work pieces and said members will continually change so as to substantially equalize heat dissipation along the length of the work pieces, means for separating successive leading work pieces from the pack, and a cooling bed means for receiving said successively sepa-

rated leading work pieces of said pack and for transporting the same away from said pack annealing station.

7. Apparatus as defined by claim 6, wherein the work arranging and retaining means include

(a) dog members mounted for unidirectional circuital movement, and

(b) mechanism for first locating said dog members at the leading end of the stacked group of workpieces on said supporting members so as to laterally support said workpieces in stacked condition while the stack is built up, then locating said dog members at an inoperative position substantially until the last workpiece of said series has been delivered and thus a residual stack portion is formed on said supporting members, and finally locating said dog members at the trailing end of the residual stack portion while the latter is moved over said supporting members.

8. Pack annealing apparatus of the character described, comprising

(a) a conveying assembly for sequentially delivering a series of elongated workpieces to the pack annealing station in a predetermined disposition,

(b) a plurality of rotatably mounted pack supporting rolls adapted to successively receive workpieces from said conveying assembly and to support said workpieces for progressive movement through said station, the axes of said pack supporting rolls being substantially mutually parallel and each axis being disposed at an acute angle with respect to the longitudinal direction of the workpieces in said predetermined disposition,

(c) mechanism for incrementally rotating said pack supporting rolls so as to apply an incremental frictional feeding force to the bottom of the stacked group of workpieces supported on said rolls, whereby said workpieces will be advanced in a direction at an angle to said axes of the rolls and contact between the advancing workpieces and said rolls will occur at varying areas along the length of said workpieces so as to substantially equalize heat dissipation along the length of the latter,

(d) power means for actuating said roll rotating mechanism in timed relation to the operation of said conveying assembly, and

(e) means for successively receiving individual workpieces from said pack annealing station and for moving said individual workpieces away from said station.

9. Apparatus as defined by claim 8, in which said mechanism for rotating the pack supporting rolls includes ratchet means.

10. Apparatus as defined by claim 8, wherein

(a) the work conveying assembly includes erecting means operable to place a workpiece of said series in an on-edge position on said pack supporting rolls and add succeeding workpieces in like position thereto, said erecting means being operated simultaneously with the actuation of the roll rotating mechanism,

(b) movable retaining means being provided operable to temporarily engage each workpiece placed on edge so as to support it at its trailing side, said retaining means being in engagement with the work while said roll rotating mechanism is at rest.

11. Apparatus as defined by claim 8, comprising

(a) dog means mounted for unidirectional circuital movement adjacent to said rolls and being locatable selectively at the leading end and trailing end of the work pack supported on said rolls so as to retain the pack workpieces in proper stacked condition,

(b) mechanism for incrementally advancing said dog means, and

(c) power means operable in timed relation to the incremental rotation of said pack supporting rolls for incrementally actuating said dog advancing mechanism.

12. In pack annealing apparatus for handling a series of heated elongated workpieces stacked on edge,

(a) a plurality of rolls for receiving the workpieces in a predetermined stacked disposition and supporting said workpieces during pack annealing, said rolls having substantially parallel axes which are arranged at an acute angle with respect to the longitudinal direction of said workpieces as disposed on the rolls,

(b) each of said rolls having a cylindrical work engaging portion and an enlarged coaxial frusto-conical work engaging end portion, the latter roll portion serving to progressively accelerate the lower edges of the leading workpieces of the pack whereby said leading workpieces are serially separated from the pack and are sequentially dealt bottom first off the frusto-conical ends of said rolls, and

(c) drive means for rotating said pack supporting rolls, whereby contact between the work pieces and said members will continually change so as to substantially equalize heat dissipation along the length of the work pieces.

13. Apparatus as defined by claim 12, including

(a) a plurality of dispenser members mounted adjacent some of said rolls for cooperation with the frusto-conical portions thereof and movable to operative and inoperative positions,

(b) an upper, substantially flat face on each dispenser member disposed when in operative position approximately at the level of the highest portion of the related frusto-conical roll portion for receiving workpieces therefrom, and

(c) a downwardly inclined face on each dispenser member forming an extension of said substantially flat face for causing said workpieces to slide away from said frusto-conical roll portion.

14. In pack annealing apparatus for handling a series of heated elongated workpieces,

(a) a plurality of elongated supporting members for receiving said workpieces and supporting the latter for progressive movement in stacked relationship during pack annealing, and

(b) at least one abutment mechanism engaging an end workpiece of the pack for retaining the workpieces in stacked relationship on said supporting members while said workpieces are progressively moved over said members; said abutment mechanism including

(i) a flexible chain disposed in a plane which is substantially parallel to the longitudinal direction of a related one of said supporting members,

(ii) a set of sprocket wheels for mounting and driving said chain,

(iii) a dog secured to said chain for unidirectional circuital movement and operable during a portion of its movement to project above the the upper edge of said related one of the workpiece supporting members so as to be capable of engaging and laterally supporting one end of the work pack, and

(iv) drive means for unidirectionally actuating at least one of said sprocket wheels.

15. Apparatus for handling a series of heated elongated work pieces during the pack annealing and cooling of the work pieces comprising a pack annealing station, a set of spaced rollers at said station having parallel axes, conveying means for moving at least one work piece at a time to said rollers in a manner so that the longitudinal axis of each work piece is positioned at an oblique angle with respect to the axes of said rollers, means for moving said work pieces as a pack in a single direction through said station so that the points of contact between the work pieces in said pack and said rollers will continually change to substantially equalize heat dissipation, actuating means for coordinating said moving means and said conveying means as a function of the

thickness of the work pieces, retaining means for holding said work pieces in a pack, means for separating successive leading work pieces from said pack, and a cooling bed having rollers for receiving the separated work pieces.

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