Nov. 5, 1935. E. W. MIKAELSON ET AL 2,019,576

APPARATUS FOR PACK ANNEALING

Filed Oct. 4, 1933 4 Sheets-Sheet 1

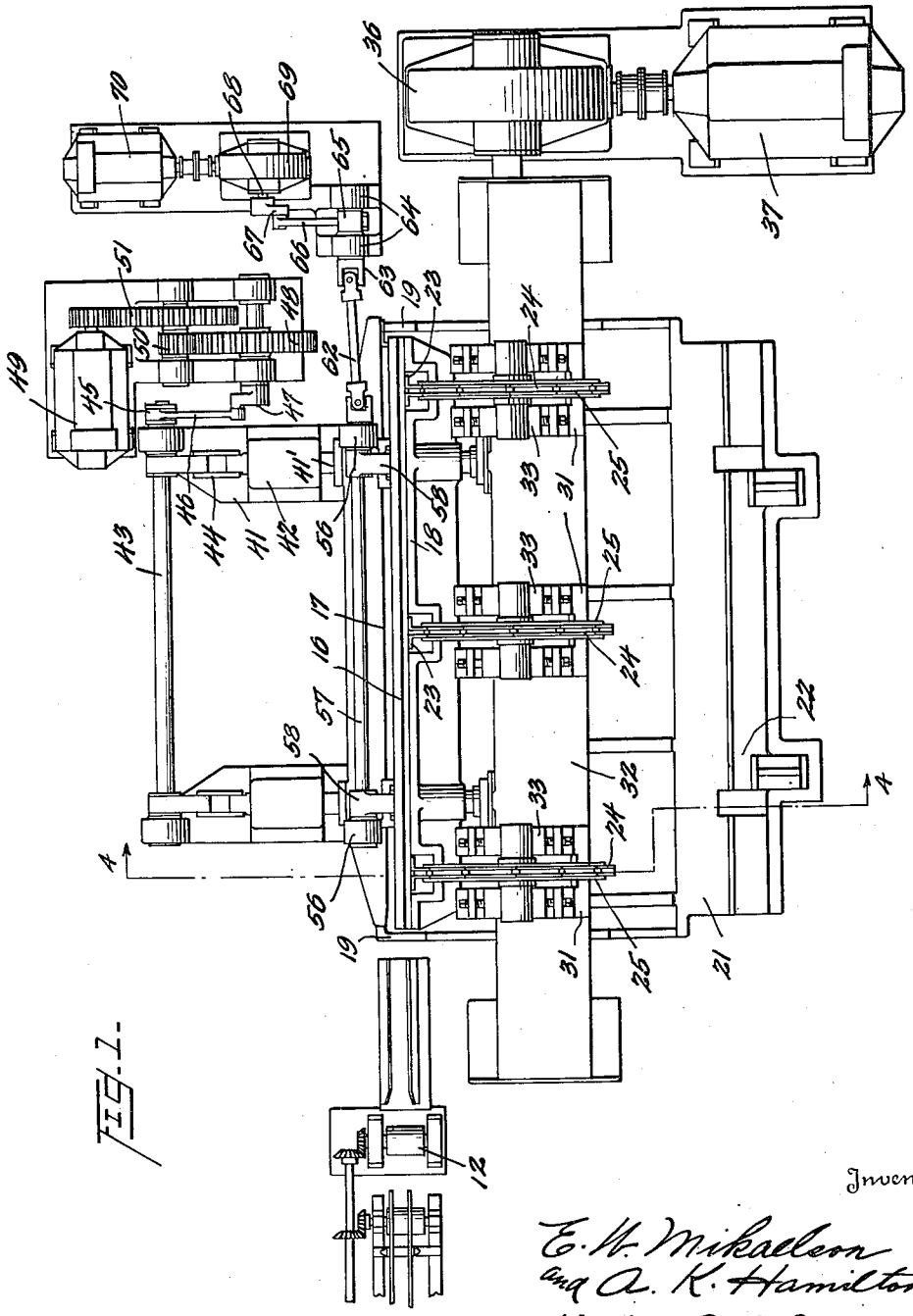


FIG. 1.

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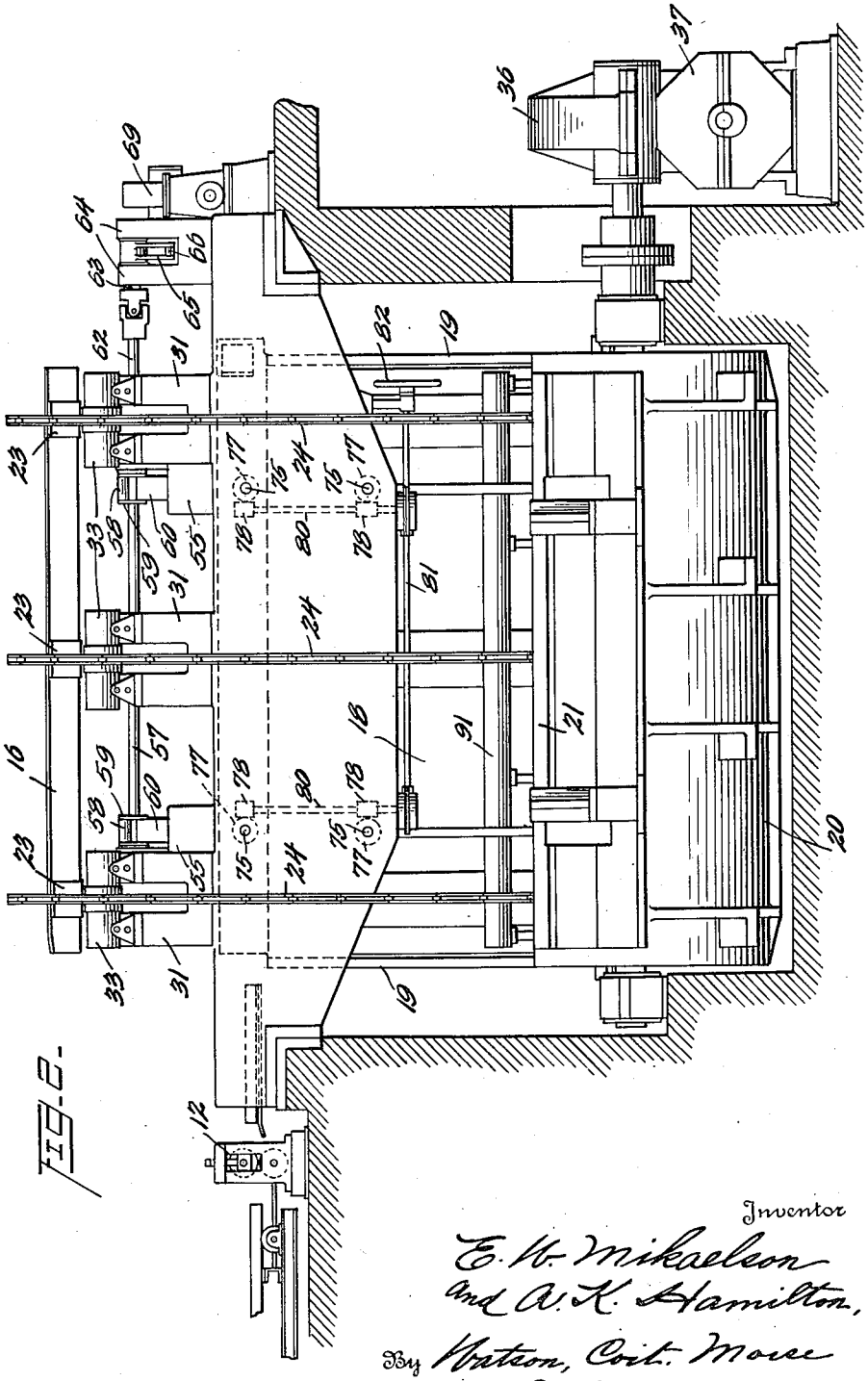



FIG. 2.

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FIG. 4.

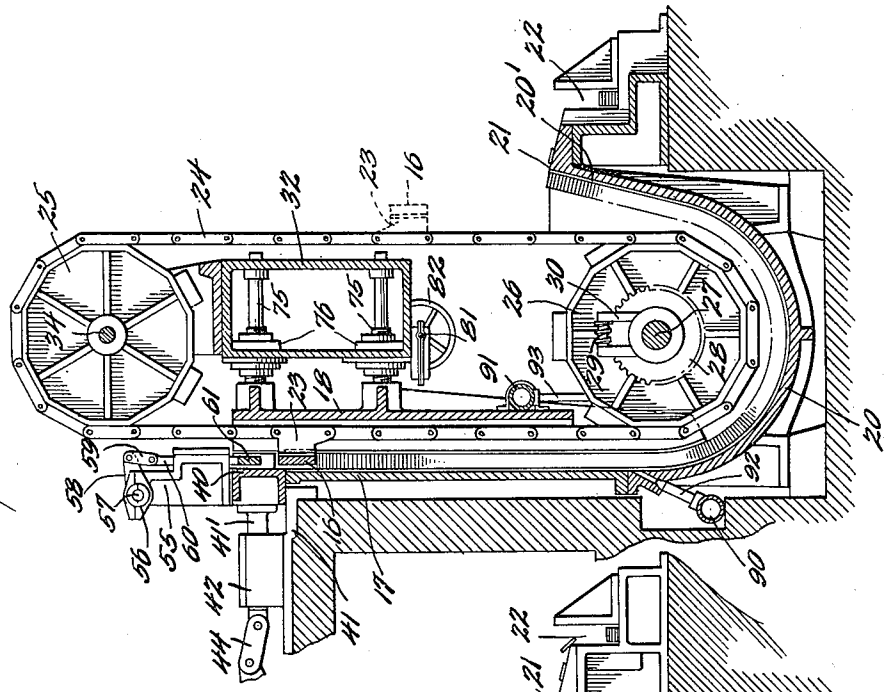
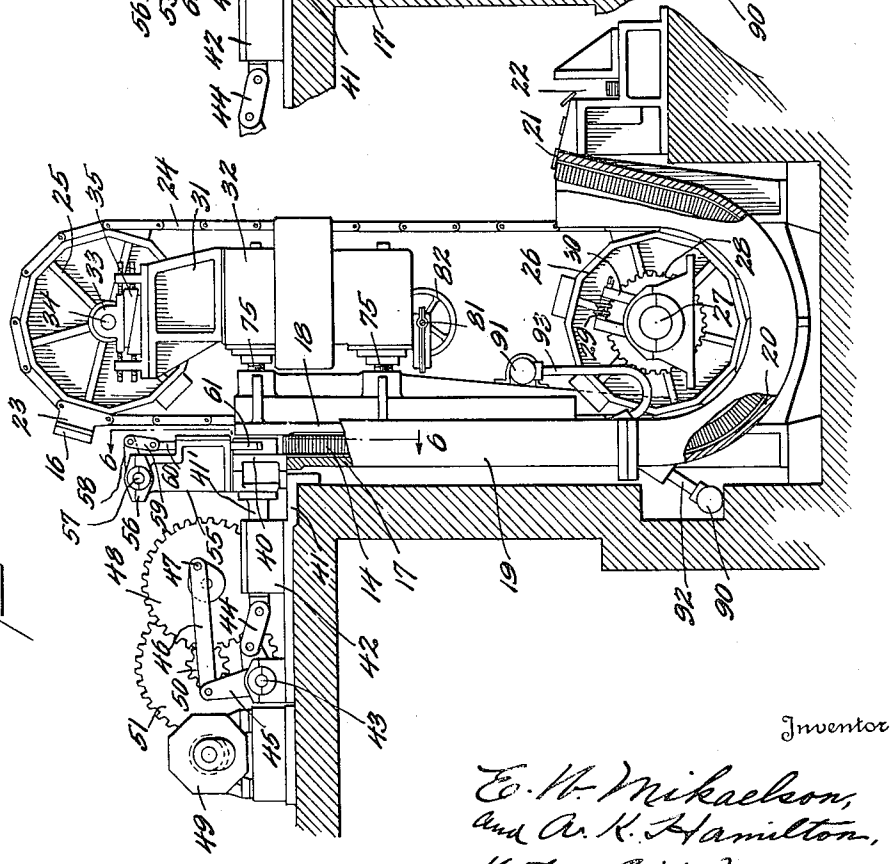


FIG. 3.



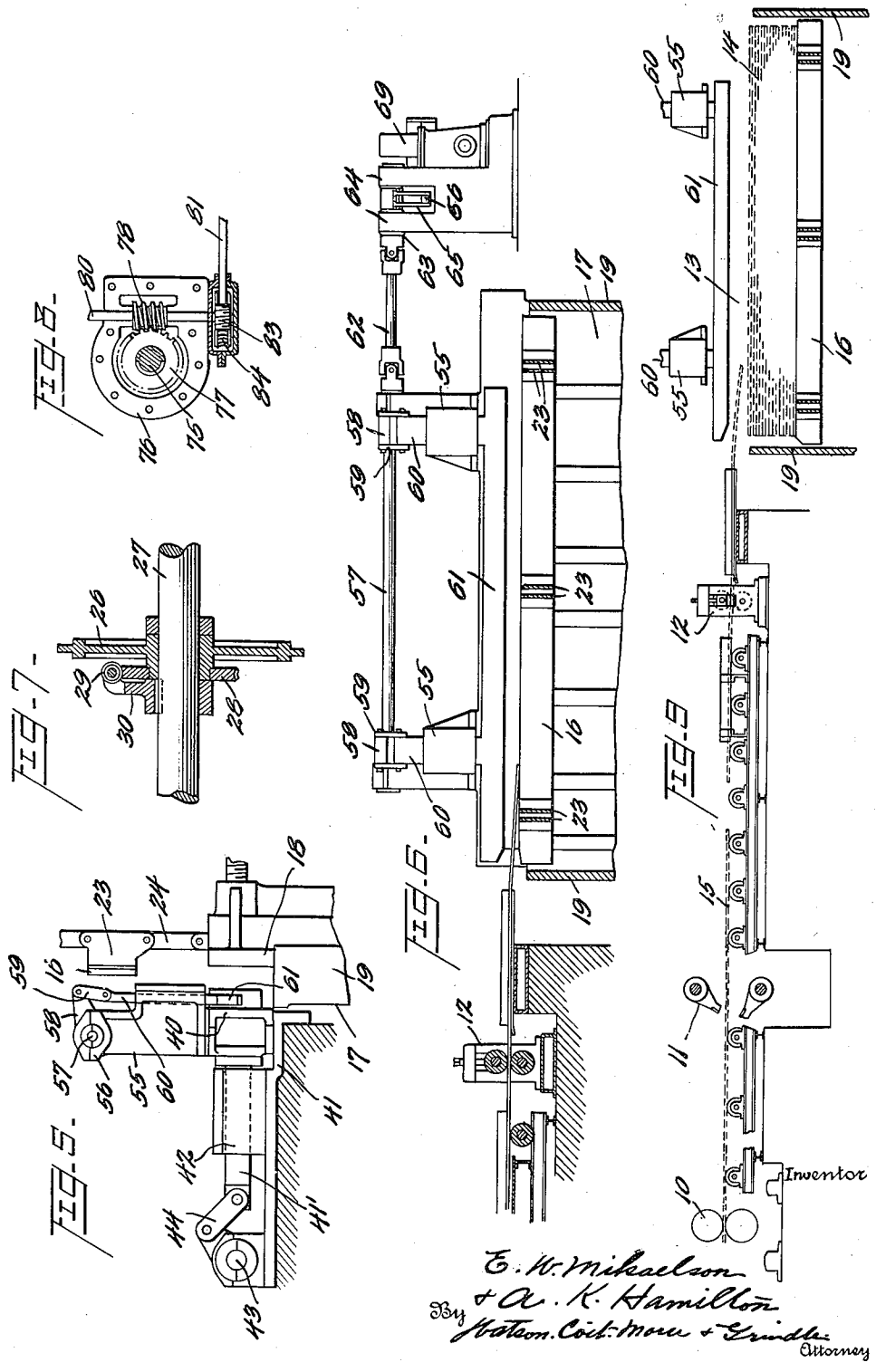
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APPARATUS FOR PACK ANNEALING

Filed Oct. 4, 1933 4 Sheets-Sheet 4



Patented Nov. 5, 1935 2,019,576

# UNITED STATES PATENT OFFICE

2,019,576

## APPARATUS FOR PACK ANNEALING

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Application October 4, 1933, Serial No. 692,199

21 Claims. (Cl. 80—42)

The present invention relates to methods of and apparatus for pack annealing.

Various types of machines for and methods of continuously and automatically pack annealing the relatively long and highly heated bars freshly fabricated by rolling mills have heretofore been designed or suggested. As such bars come successively from the mill, they are quite hot and it has been found to be desirable that they be relatively slowly cooled, or annealed, in order that the proper grain structure of the steel be obtained, this annealing process being particularly helpful in the case of bars fabricated of steels having certain percentages of carbon and alloying materials. To obtain the desired grain structure in the steel, it is necessary to prevent the bars from cooling too rapidly until they have passed below a certain critical temperature. A convenient and economical method of effecting this slow annealing, which method is now commonly practiced, is to form a "pack" of bars, i. e., a group of bars, coextensive in length and arranged in parallel relationship, each bar being in close contact with the bars on opposite sides thereof. The number of bars in the pack is maintained substantially constant, heated bars being added to one side of the pack as cooled and annealed bars are withdrawn from the opposite side. Each bar passes through the pack, therefore, in contact with adjacent bars having substantially the same temperatures, its rate of cooling being thereby greatly lessened as compared with the rate of cooling of a bar exposed on all sides to the atmospheres.

A further advantage of this process resides in the fact that the formation of scale on the surfaces of the bars is largely prevented. A large proportion of the bars subjected to pack annealing operations are of the type known as "spring flats" and are of rectangular cross-section, relatively thin but of considerable width. Bars of this nature are incapable of standing on edge without receiving lateral support, and hence special apparatus is generally necessary for turning and erecting the bars as they are successively received from the rolling mill and placing them on edge and in pack formation upon a support or cooling bed, other apparatus being associated with the bed to support the bars during the formation of the pack. Pack annealing apparatus of this type is generally large, cumbersome, and expensive, involving the use of a cooling bed which occupies a large area and is comparatively costly.

While the present invention contemplates pack annealing apparatus which may be utilized in the pack annealing of bars of various shapes and cross-sections, it is particularly useful in connection with the pack annealing of bars of rectangular cross-section such as the "spring flats" just referred to. The "pack", in accordance with the present invention, is formed in a simple manner and without the aid of mechanism for turning and erecting the bars upon a supporting bed, the bars being added to the pack as they are received from the delivery mechanism which conveys them from the rolling mill and shear, i. e., with the flat sides of the bars horizontally disposed. In order that this may be done, the invention contemplates that the bars shall be successively added to a pack which is vertically disposed, the heated bars being added to the top of the pack and the cooled bars being removed successively from the bottom. By disposing the pack vertically, a great deal of floor space in a fabricating mill is saved and numerous further advantages realized. Thus, for instance, the invention contemplates a novel and improved means for straightening the bars edgewise as they are received from the mill, and furthermore the weight of that portion of the pack which is superposed upon any given bar causes the same to be very effectively straightened in a direction normal to its flat sides.

The invention also contemplates the provision of means for aiding or assisting in the cooling of the bars where necessary, means being provided for delivering against the opposite sides of the pack blasts of cooling gases, which may be air or other gases. A very precise control of the cooling time of the bars passing through the pack may therefore be effected, which is highly advantageous in the case of bars of certain chemical compositions. The machine is of such character that it may be conveniently mounted if desired for movement or adjustment in a direction transverse to the pack in order that its pack supporting guideway or chamber may be exactly aligned with that portion of the rolls of a rolling mill which is at the time being effective in rolling the bars. In this way the pack may be located at all times in exact alignment with the effective portions of the rolls and the bars delivered to the pack without departure from an exact rectilinear course.

Other features and advantages of the invention will become apparent to one skilled in the art. Naturally in adapting the invention for use in various plants and for the pack annealing of bars of different sections, numerous changes in

the design and arrangement of the component elements of the invention may be made. That embodiment of the invention which is herein set forth is therefore given by way of example only.

In the drawings:

Figure 1 is a top plan view of the novel pack annealing apparatus;

Figure 2 is a side elevation of the same;

Figure 3 is an end elevation partially broken away;

Figure 4 is a section on line 4—4 of Figure 1;

Figure 5 is a view of a portion of the apparatus, as seen in Figure 3, several movable parts thereof, however, being shown in different positions;

Figure 6 is a section on line 6—6 of Figure 3;

Figures 7 and 8 are views of details; and

Figure 9 is a diagrammatic view showing a preferred arrangement of the pack annealing apparatus in alignment with the rolling mill, flying shear, and feed rollers.

By referring first to Figure 9, which is a rather diagrammatic view, the relative arrangement of rolling mill, shears, conveyor tables, feed rollers, and pack annealing mechanism may be discerned. The last stand of rolls of a rolling mill which may have a plurality of stands is indicated at 10, a flying shear at 11, feed rollers at 12, and the pack annealing mechanism at 13, a partially formed pack of bars being indicated at 14. Pack 14 is in exact alignment with bar 15 as it issues from the rolling mill 10 so that this bar, after being cut into sections by the shear 11, passes into the annealing apparatus without lateral deflection of any kind. It is severed into shorter blanks of the desired length by the shear 11 which is controlled so as to operate at the speed of the rolling mill and hence so as not to tear or bend the blank. The severed blanks are successively picked up by the feed rollers 12, which are so operated as to increase the linear speed of each blank thus engaged to make certain that each blank is positioned in the pack 14 before the succeeding blank reaches the annealing apparatus. A vertically movable bar engaging element 16 is lowered as the number of bars in the pack increases, the top of the pack being kept, substantially, in the same horizontal plane. As will be hereinafter more fully explained, this process of feeding bars and lowering element 16 is continued until the pack is fully formed, and thereafter other mechanism is employed to positively advance the pack and effect the discharge of cooled bars from the remote end.

Referring now to Figure 3, the ends of the bars comprising pack 14 may be observed, a portion of the pack supporting mechanism being broken away. This pack supporting mechanism comprises principally spaced parallel side walls, a fixed side wall being indicated at 17 and an adjustable side wall at 18, these side walls being disposed in parallel relationship and their mutually facing surfaces being provided with ribs to engage the edges of the bars comprising the pack to adequately support these bars without at the same time having such extensive contact therewith as to rapidly withdraw heat by conduction and hence cause cold spots on the bars. The fixed side wall 17 is provided with end flanges 19, which are vertically disposed and comprise end walls for the pack supporting guideway, the side walls 17 and 18 and the end walls 19 being of heat retaining nature so that the pack may be said to be positioned, when it has been formed, in a heat retaining chamber open at its top and bottom.

To the bottom of fixed side walls 17 is secured a cylindrical member 20, the cylindrical inner surface of this member comprising a curved continuation of the flat vertical inner surface of the fixed side wall 17 and being likewise provided with ribs for slidably supporting the bars which together comprise the pack. When the machine is in operation and contains its full complement of bars, it includes not only the vertical column of bars between the vertically extending walls 17 and 18, and between which walls the pack annealing operation is substantially completed, but also includes the very considerable number of bars resting against the cylindrical inner surface 20, the end of this group of bars being located, as shown in Figures 3 and 4, at the level of the upper end of inclined surface 21. In the operation of the machine, the vertical pack moves downwardly through the chamber defined by walls 17 and 18 and thence around the cylindrical surface of member 20 and upwardly to the delivery point adjacent surface 21. As will be seen, the cylindrical surface of member 20 finally merges with a surface 20' tangential thereto, somewhat below surface 21. As fresh bars are added to the top of the vertical guideway, cooled bars slide successively onto the inclined surface 21 and thence laterally into the receiving notch 22 from whence they may be removed from time to time in groups by a crane or the like. In order that this lateral sliding of bars may freely proceed, the inclination of surface 20' is made such that bars projecting above surface 21 will slide laterally, and surface 21 is disposed at such an angle that any bar passing on to it will continue its sliding movement until it drops into the receiving notch.

The bar engaging element 16 previously referred to is intended to perform a double function. It assists in the initial formation of a pack by supporting the bar first delivered at or about the elevation of the upper end of the fixed side wall 17, thereafter supporting all bars subsequently superposed upon the initial bar until the pack is fully formed, element 16 being intermittently lowered as the pack increases in height and functioning to support the pack until the pack is supported by that portion of the column of bars which lies within member 20. It will be appreciated that the bars engaging member 20 will be frictionally retarded thereby and furthermore that the weight of the bars in the inclined column and which rest against surface 20' partially counterbalances the weight of the column of bars within the pack annealing section. The parts are so designed that the weight of the vertical pack of bars in the pack annealing chamber is insufficient to overcome the weight and frictional resistance of the bars within the lower section 20 so that the pack, when fully formed, will not advance unless pressure is exerted upon its top. This intermittent pressure to advance the pack is provided by a pusher mechanism hereinafter to be described.

The bar engaging element 16 is supported upon brackets 23, three in number, which brackets are in turn secured respectively to endless chains 24 supported upon sprocket wheels 25 and 26 mounted to rotate about spaced parallel axes. The lower sprockets 26 are loosely mounted upon drive shaft 27, but each sprocket is connected to the shaft through a worm and worm wheel by means of which its angular relationship to the

shaft may be varied as desired. Thus, as may be seen in Figure 7, upon the hub of each sprocket is mounted a worm wheel 28, the teeth of which mesh with those of a worm 29 rotatably mounted upon a bracket 30, the hub of which bracket is keyed to shaft 27. The provision of means for effecting relative adjustment of the three sprockets 26 is made in order that the chains may be so adjusted that the bar engaging element 16 may be maintained horizontal at all times regardless of wear in the links of the chain. The chains 24 and brackets 23 move through vertical recesses or slots in the adjustable side wall 18 of the pack annealing chamber, only the element 16 passing through this chamber.

The upper sprockets 25 are rotatably mounted respectively upon sprocket pedestals 31 which are in turn supported upon a transversely extending beam 32, the ends of which are mounted upon a suitable framework or upon foundations such as indicated in Figure 2. Intermediate pedestals 31 and the bearings 33 for the upper sprocket supporting shafts 34 are positioned, respectively, pairs of adjusting wedges 35. By advancing these wedges toward each other, the upper sprockets may be lifted and hence any looseness in the chains eliminated. Suitable means, of course, is provided for adjusting the wedges and maintaining them rigidly in adjusted position. The right-hand end of drive shaft 27 is connected, through reducing gearing 36, to a motor 37 provided with the usual control means for starting and stopping.

During the formation of a pack, the motor 37 is intermittently energized to effect the intermittent lowering of the bar engaging element 16, as has previously been explained, and after the pack has been fully formed, element 16 is moved to inoperative position as indicated in dotted lines in Figure 4. At the conclusion of a pack annealing operation, i. e., after the rolling mill has ceased to supply fresh bars, the element 16 may be employed to clear the apparatus of the entire pack which it contains, being brought down upon the uppermost bar of the pack, after the pushing and straightening mechanism hereinafter to be described has been retracted (see Figure 5) and its movement then continued through the pack annealing chamber and past pack retarding member 20 until all of the bars of the pack have been delivered over the surface 21 and the machine entirely cleared.

A straightening head is indicated at 40, member 40 being coextensive in length with the pack-annealing chamber and being slidably supported upon a plate 41. By means of this straightening head, a bar or a group of bars freshly deposited upon the top of the pack may be straightened, this bar or group of bars being subjected to horizontal pressure between the head 40 and the opposed parallel flat surface of the upper portion of the adjustable side wall 18 of the chamber. The means for advancing and retracting the pressure head 40 includes two spaced rods 41' slidably mounted in pedestals 42, the outer ends of these rods being connected respectively to a rock shaft 43 by toggle arms 44. Rock shaft 43 may be intermittently rocked through mechanism which comprises rocker arm 45 fixed on shaft 43, link 46 connecting the outer end of this rocker arms to a pivot pin 47 mounted eccentrically upon a gear wheel 48, which gear wheel is in turn operatively connected to a motor 49 through a pinion 50 and gear 51. Motor 49 is, of course, provided with suitable controls by means of which it can be energized and de-energized as desired.

The pusher mechanism for downwardly acting upon the uppermost bar of the pack and hence intermittently advancing the same is rigidly supported upon the top of the plunger member 40 and includes spaced supporting pedestals 55, each having thereon a bearing 56 to support rock shaft 57. Fixed on rock shaft 57 are arms 58 connected by links 59 to plungers 60 slidably fitting within vertically disposed apertures within pedestals 55 and having rigidly secured to their lower ends the horizontally disposed pusher head 61. To one end of rock shaft 57 is connected a spindle 62, which spindle is in turn operatively connected to a rock shaft 63 mounted in bearings 64. Rock shaft 63 is provided with an arm 65 intermediate bearings 64, the outer end of which is in turn connected by a link 66 with the end of a crank arm 67 mounted upon a shaft 68. Shaft 68 may be rotated, through reduction gearing 69, by a motor 70. Motor 70 may be intermittently energized as desired by the operator to effect vertical reciprocation of the pusher head 61. Spindle 62 is flexibly connected to shafts 57 and 63 so that the drive between these shafts is not interrupted due to movements of shaft 57 relatively to shaft 63, shaft 57 being, of course, movable transversely of the apparatus as straightening head 40 is moved.

In order that the apparatus may be adjusted from time to time to accommodate bars of different widths, side wall 18 of the pack annealing chamber is supported so that it may be moved relatively to side wall 17 while at all times maintaining parallel relationship therewith. In order that this adjustment may be accomplished, side wall 18 is mounted upon four or more threaded supporting and adjusting screws indicated at 75, these screws being disposed horizontally and in parallel relationship and extending through casings 76 rigidly mounted upon supporting beam 32. Within each casing 76 is positioned a worm wheel 77, which worm wheels respectively encircle the associated adjusting screws 75 and are interiorly threaded to engage the threads of the adjusting screws. The outer teeth of each worm wheel mesh with the teeth of a worm 78, by the rotation of which the associated worm wheel 77 may be rotated, and hence the adjusting screw 75 upon which it is mounted is given a horizontal adjustment in one direction or the other, depending upon the direction of rotation of the worm 78. It will be appreciated that each of the worm wheels 77 is confined by its casing 76 against movement relatively to the supporting frame 32 and axially of adjusting screw 75.

It is necessary of course that, in effecting any adjustment of member 18, the adjusting screws be operated simultaneously and through equal angles to insure that side wall 18 at all times maintains parallel relationship to fixed side wall 17. To insure simultaneous operation of worms 78, two of these worms are fixed on each of two parallel shafts 80, which shafts are adapted to be simultaneously and equally rotated through a driving connection with horizontal shaft 81 upon one end of which the adjusting hand wheel 82 is fixed. Each of these driving connections includes a worm 83 fixed on shaft 81, the teeth of which mesh with those of a worm wheel 84 fixed on the end of the associated shaft 80. As a result of this gearing, the operator is enabled, by rotating the hand wheel 82 through the desired angle, to simultaneously and equally adjust the positions of threaded rod 75 relatively

to the supporting beam 32 and hence effect very precise adjustment of the adjustable side wall 18 of the annealing chamber.

In certain instances it is desirable to subject the descending pack of bars in the annealing chamber to the action of gaseous blasts and, for the purpose of accomplishing this object, the gas conducting and delivering mechanism shown most clearly in Figures 3 and 4 is provided. Headers or manifolds for conducting cooling gases are indicated at 90 and 91 respectively, these headers being positioned on opposite sides of the annealing chamber and being adapted to receive gas, either air or any other gas, under pressure from any suitable source of supply and to conduct this gas to branch or distributing pipes 92 and 93. Each of these branch or distributing pipes discharges into a duct which extends entirely through the adjacent wall of the annealing chamber so that the gas passing therethrough will be delivered against the adjacent side of the pack contained within such chamber. Suitable valves, of course, are provided for controlling the flow of gas. In many instances it will be unnecessary, and in fact undesirable, to deliver cooling gas in this manner against the opposite sides of the pack, but in certain instances, depending upon the mass and chemical compositions of the individual bars, it may be highly desirable to effect this added cooling. The positions of the discharge ducts may, of course, be varied as desired.

From the foregoing description it is believed that the manner of operation of the mechanism just described will be entirely apparent. As has already been pointed out, the design and arrangement of the component elements of the invention may be considerably varied in adapting the same to different steel plants. The entire mechanism may be mounted upon its supporting base in such manner that it may be moved or adjusted in a direction normal to the annealing chamber as has been previously explained. This supporting means may include suitable rails or trackways, anti-friction means, and holding-down devices which it is not necessary to illustrate. By applying jets of cooling gas to both sides of the vertical pack, lateral warping of the bars due to unequal cooling of the sides of the pack is avoided.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. Apparatus for pack annealing comprising means defining a guideway for laterally supporting a pack of superposed bars which tends to move downwardly under the influence of gravity, and means at the lower end of said guideway, and onto which the pack may advance, for frictionally retarding movement of the portion of the pack thereon and hence causing this portion of the pack to yieldably support the superposed portion of the pack guided by said guideway, said means opposing forward movement of the pack by frictional forces only.

2. Apparatus for pack annealing comprising means defining a guideway for laterally supporting a pack of superposed bars which tends to move downwardly under the influence of gravity, and means at the lower end of said guideway, and onto which the pack may advance, for frictionally retarding movement of the portion of the pack thereon and hence causing this portion of the pack to yieldably support the superposed portion of the pack guided by said guideway, said means also guiding the pack to a point of discharge and there permitting the successive free discharge of bars from the discharge end of the pack as fresh bars are added to the other end.

3. Apparatus for pack annealing comprising a chamber having parallel vertically disposed side supports adapted to laterally confine between them a pack of superposed bars, means for introducing bars into the space between said supports at the top thereof, and means for supporting a pack of superposed bars within said space which permits discharge of cooled bars from the bottom of the pack as heated bars are added to the top thereof.

4. Apparatus for pack annealing comprising a chamber having parallel vertically disposed side walls adapted to laterally confine between them a pack of superposed bars, said chamber having likewise parallel end walls and the side and end walls constituting heat retaining walls, means for introducing heated bars into said chamber through its open top, and means for supporting a pack of bars within said chamber and permitting discharge of cooled bars from the bottom of the pack as heated bars are added to the top thereof.

5. Apparatus for pack annealing comprising means defining a vertically extending guideway, means defining a second guideway communicating with the bottom of the first guideway and forming a laterally curved extension of said first guideway into which the bars may move in pack formation, the top of the vertical guideway being open for the introduction of bars, and the free open end of the second guideway being an open discharge port therefor.

6. Apparatus for pack annealing comprising means defining a vertically extending guideway for bars and whereby bars introduced thereinto are maintained in superposed relationship, a second guideway communicating with the bottom of the first guideway and forming an extension of said first guideway into which the bars may move in pack formation, said second guideway being curved and its terminal portion being upwardly directed, the top of the vertical guideway being open for the introduction of bars and the free open end of the extension being a point of discharge therefor.

7. Apparatus for pack annealing comprising means defining a vertically extending guideway, means at the bottom of said guideway for yieldably supporting a pack of bars maintained in superposed relationship by said guideway, means for feeding heated bars into the top of said guideway, and means for pressing downwardly said pack of bars.

8. Apparatus for pack annealing comprising means defining a vertically extending guideway, means at the bottom of said guideway for supporting a pack of bars maintained in superposed relationship by said guideway, means for feeding heated bars into the top of said guideway, and intermittently operable means for acting upon the uppermost bar of the pack to press the pack downwardly.

9. Apparatus for pack annealing comprising means defining a vertically extending guideway, means at the bottom of said guideway for frictionally engaging bars issuing from said guideway and thereby frictionally supporting a pack of superposed bars within said guideway, and means for acting upon the top of said pack to overcome the frictional resistance of said means and thereby effect advancement of the pack.

10. The combination set forth in claim 8 in which the last mentioned means comprises an intermittently operating pusher member.

11. Apparatus for pack annealing comprising means for guiding a plurality of superposed bars in pack formation, second means at the discharge end of said first means for laterally deflecting a pack passing onto the same from said first means, without breaking the pack, said means frictionally opposing movement of the portion of the pack contacting therewith whereby movement of the entire pack is retarded, and mechanism at the other end of said first mentioned means for intermittently acting on the pack and advancing the same against the frictional resistance of said second means, said second means also guiding the pack to a point of discharge for individual bars.

12. Apparatus for pack annealing comprising means defining a vertically extending guideway, a bar supporting member in said guideway, means for introducing bars into the top of said guideway to be supported in vertical pack relationship by said member, and means for lowering said member as the pack increases in volume.

13. The combination set forth in claim 12 in which said last mentioned means may be operated to bring said member to bear upon the upper end of said pack and to cause the same to discharge the pack and clear the apparatus of bars.

14. Apparatus for pack annealing comprising means defining a vertically extending guideway, second means at the bottom of the guideway for frictionally engaging bars issuing from said guideway and thereby frictionally supporting a pack of superposed bars within said guideway, means for feeding bars into the top of said guideway, and a bar supporting member movably supported within said guideway and upon which the pack is initially formed, said member being adapted to be gradually lowered as the pack increases in height and to become ineffective when said second means becomes effective.

15. The combination set forth in claim 14 in which a pusher mechanism at the top of said guideway is provided for advancing the pack when the said second means becomes effective.

16. Apparatus for pack annealing including pack supporting and guiding means, pack retarding means which becomes effective when the pack is fully formed and which permits the free discharge of bars successively from the end of the pack, and pack advancing means for advancing the full pack, after formation, against the resistance of said retarding means.

17. Apparatus for pack annealing comprising means for supporting bars in pack formation, a bar engaging element, and means for moving said element in a path fixed relatively to said means so as to either movably support the foremost bar of a pack during the formation of a pack or to engage the rearmost bar to advance the entire pack and clear the apparatus.

18. Apparatus for pack annealing comprising means for supporting bars in pack formation, a pack forming and pack clearing element, and means for moving said element to movably support the foremost bar of a pack during the formation of a pack or to engage the rearmost bar of a completed pack to advance the entire pack and clear the apparatus.

19. Apparatus for pack annealing comprising means for supporting bars in the form of a vertically disposed pack, means for feeding bars to the top of the pack, means for pushing the pack downwardly as fresh bars are added, means for permitting the escape of bars from the bottom of the pack as the pack is advanced, and mechanism in addition to said pushing means for advancing the entire pack and clearing the apparatus.

20. Apparatus for pack annealing comprising means for supporting bars in pack formation, means for advancing the pack, and stationary means for subjecting the pack to a cooling blast of a fluid to accelerate the cooling thereof at a predetermined point in the travel of the pack and as the pack moves past said means.

21. Apparatus for pack annealing comprising a vertically extending guideway for laterally supporting a vertical pack of bars, means for feeding bars to the top of the pack, and means for subjecting the uppermost bar of the pack, while in position upon the pack, to pressure directed transversely of the pack to straighten the same.

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