United States Patent [19]

White

[11] **3,871,288**

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[54] **AUTOMATIC BAR HANDLING SYSTEM**

[75] Inventor: **Frank F. White,** Mentor, Ohio

[73] Assignee: **Automation Development Corporation,** Mentor, Ohio

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[52] **U.S. Cl.** ..... **100/2,** 100/4, 100/7, 100/26, 100/212, 83/158, 214/6 H

[51] **Int. Cl.** **B65b 13/04**

[58] **Field of Search** ..... 100/2, 3, 4, 7, 26; 83/158; 214/6 D, 6 H

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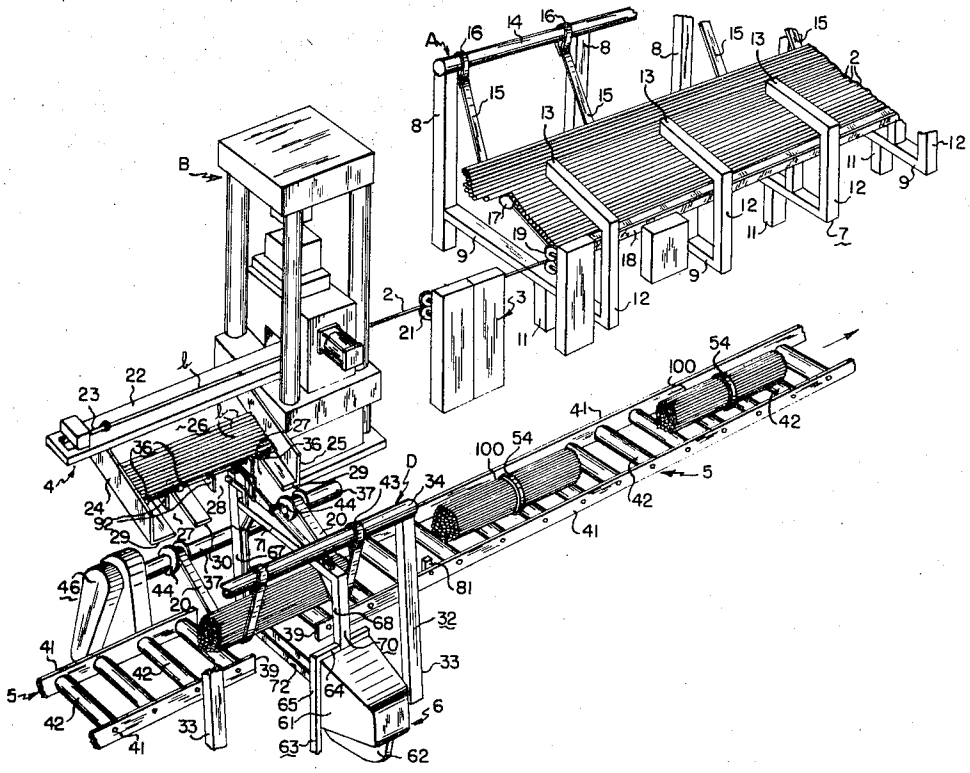
Primary Examiner—Billy J. Wilhite

Attorney, Agent, or Firm—Bosworth, Sessions & McCoy

[57] **ABSTRACT**

A bar handling system is provided wherein bars or tubes from a bundle are automatically unscrambled, fed through a shear or other machine to a discharge ramp, fed from the ramp in increments one or several at a time, and automatically strapped in bundles containing a predetermined number of bars. A unique bundler is provided at the end of the discharge ramp having spaced slings which catch and slowly lower a bundle of bars onto a roller conveyor and having a strapping machine with a strap guide or chute which extends around the bundle and is specially constructed to permit lateral feed of the bars from the discharge ramp to the slings of the bundler.

24 Claims, 6 Drawing Figures



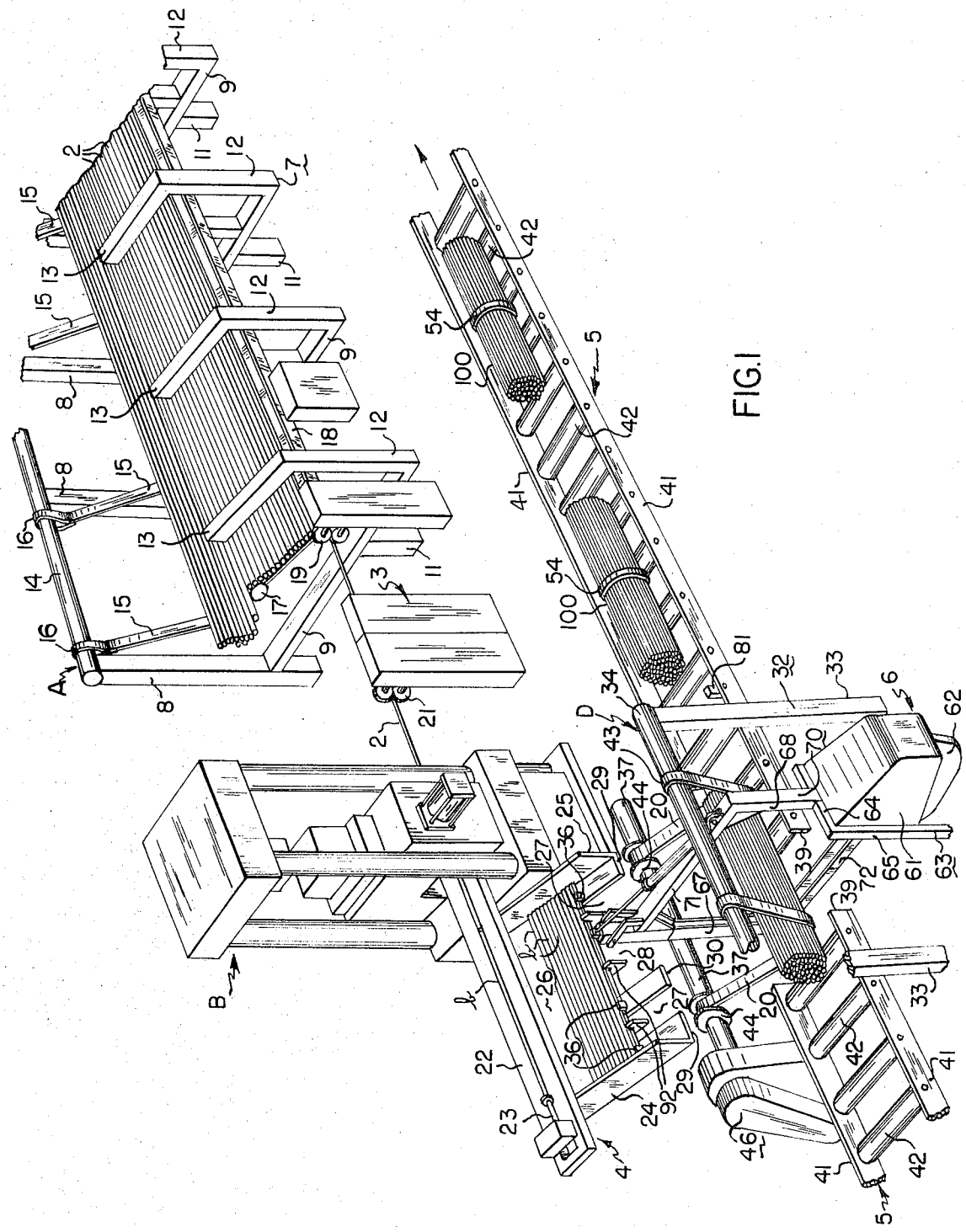


FIG.1

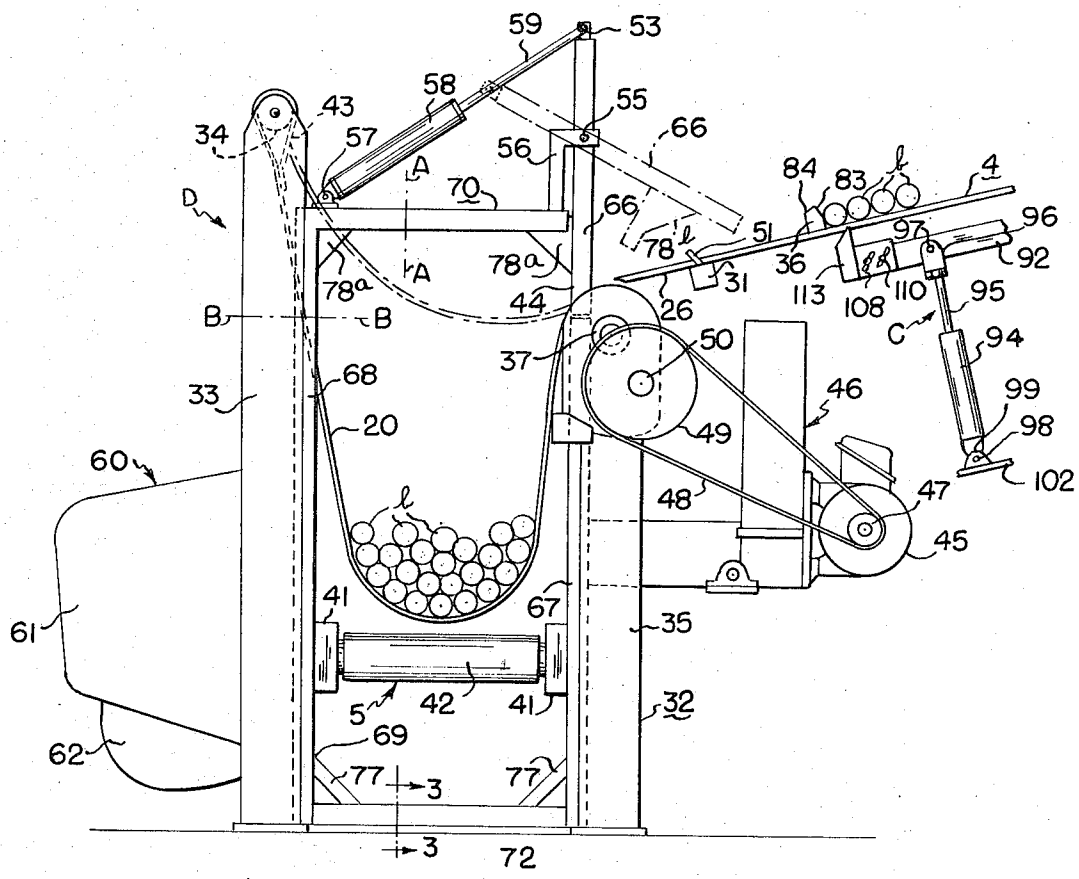


FIG. 2

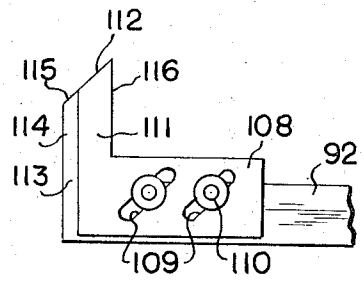


FIG. 4

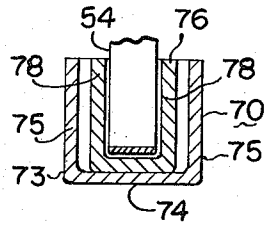


FIG. 3

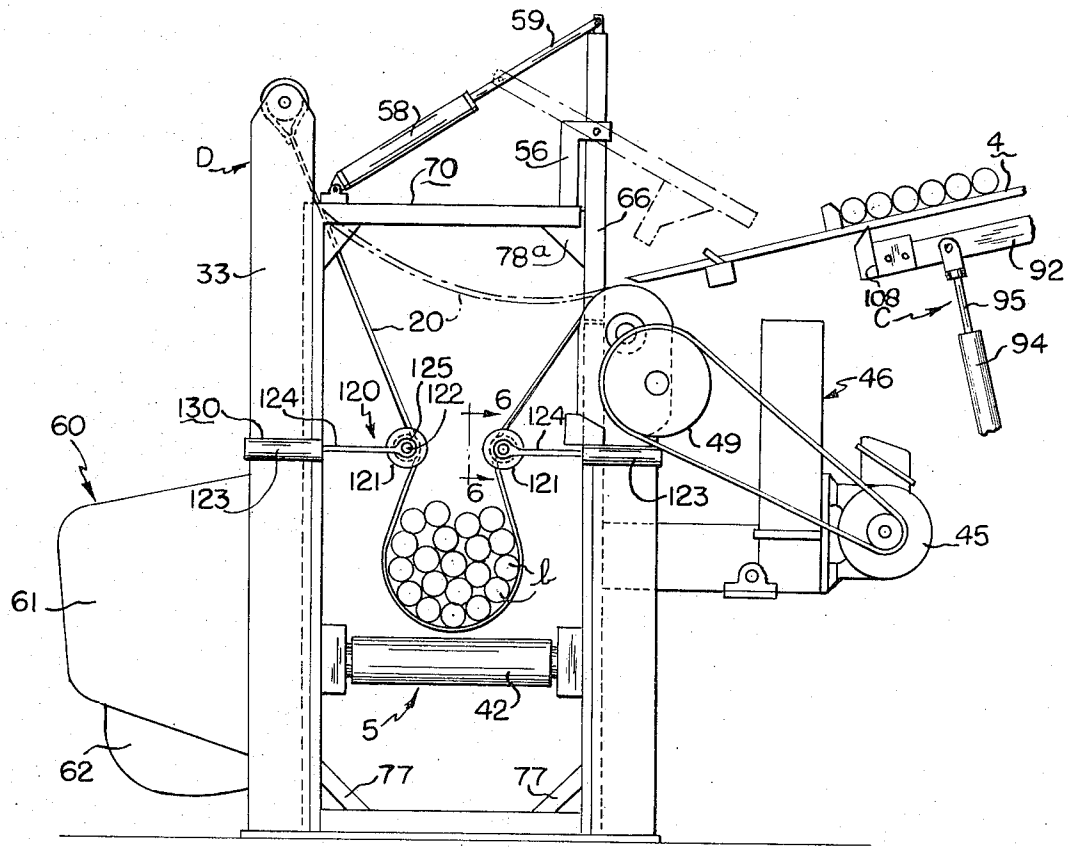

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D
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56
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FIG. 5

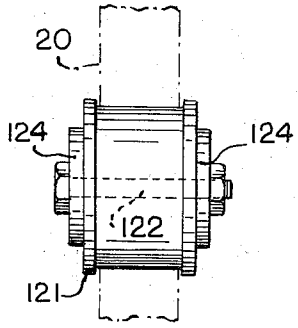

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FIG. 6

AUTOMATIC BAR HANDLING SYSTEM

This invention relates to automatic bar systems for shears, lathes, saws, grinders, metalworking machines and the like and more particularly to a bar handling system which minimizes the cost of handling and strapping bars and tubes discharged from such machines.

Prior to this invention, bar handling systems have been used extensively in connection with metal cutting or metalworking machines to feed long metal bars automatically to the machine. At the discharge side of the machine, various methods were employed to remove the finished bars or workpieces, and, in some instances, the finished bars were tied or strapped in bundles; however, such bundling operations were inefficient and usually required manual labor. A more efficient automatic system for handling the discharged bars has been needed for many years but, up to the time of the present invention, simple inexpensive equipment has not been available for this purpose.

The present invention involves the discovery of a unique system wherein discharged bars can be collected, bundled, strapped and removed at much less cost than was previously considered possible. The novel apparatus includes a bundler at the end of the discharge ramp with spaced slings for receiving the discharged bars from the ramp and for gradually lowering them toward a roller conveyor while forming a bundle and an automatic strapping machine having a strap guide specially constructed to permit lateral feed of the bars from the discharge ramp to the bundle. Each strapped bundle may be removed quickly by lowering the slings between the rollers of the roller conveyor.

In accordance with this invention, the strap guide of the automatic strapping machine has a movable portion in the path of movement of the bars leaving the discharge ramp, which portion may be moved out of said path during forming of the bundle. Such portion may be swung out of such path automatically by the piston of a pneumatic cylinder or fluid motor at the proper time during each cycle and may be returned to the normal position during the strapping operation.

Electrical equipment is provided to count the number of bars in each bundle and to control the sequence of operation so that the bars are escaped one or two at a time from the discharge ramp to the slings while the strap guide is open, the feed of bars is temporarily stopped and the strap guide is closed after a predetermined number of bars are in the bundle, and the bar feed is not resumed until the strapping operation is completed.

An object of the invention is to provide a fully automatic bar handling system which reduces handling costs to a minimum while at the same time minimizing damage to the workpieces.

Another object of the invention is to provide a simple inexpensive process and apparatus for automatically bundling bars or tubes discharged from a metalworking machine.

Another object of the invention is to provide a bundling apparatus for long bars and tubes having sling means to assist in shaping the bundle before it is strapped.

These and other objects, uses and advantages of the invention will become apparent to those skilled in the art from the following drawings, description and claims.

In the drawings:

FIG. 1 is a perspective view on a reduced scale showing the bar handling system of this invention as applied to a shearing machine;

FIG. 2 is a fragmentary transverse elevational view of the apparatus of FIG. 1;

FIG. 3 is a fragmentary vertical sectional view taken on the line 3—3 of FIG. 2 and on a larger scale;

FIG. 4 is a fragmentary elevational view showing a portion of the escapement mechanism of FIG. 2 on a larger scale;

FIG. 5 is a transverse elevational view similar to FIG. 2 showing the apparatus of FIG. 1 modified to include power-actuated sling-engaging rollers for shaping the bundle; and

FIG. 6 is a fragmentary view of one of the sling-engaging rollers showing its position relative to its assocaited sling.

Referring more particularly to the drawings, in which like parts are identified by the same numerals throughout the several views, FIG. 1 illustrates a bar handling system according to this invention wherein long metal bars 2 are fed from a bundle loader-unscrambler A to a pinch-roll feeder 3 and then to a shear or cut-off machine B. The cut bars b are fed from the machine to a downwardly inclined discharge ramp 4 having an escapement mechanism C for forming a row of parallel bars on the ramp and for feeding the bars from the row one at a time to a bundler D wherein the bars are strapped in bundles by an automatic strapping machine 6 and lowered onto a roller conveyor 5.

The unscrambler A is constructed substantially as disclosed in my U.S. Pat. No. 3,506,142 and in my allowed U.S. application Ser. No. 198,919, filed Nov. 15, 1971, which are incorporated by reference and made a part of this specification. The unscrambler A has a rigid frame 7 with a series of aligned vertical standards 8, a series of aligned horizontal beams 9 rigidly connected to the standards, a series of aligned vertical legs 11 supporting said beams, a series of aligned vertical members 12, and a series of inclined cantilever beams 8 overhanging the inclined storage ramp and spaced a short distance therefrom to form a single row of parallel bars 2 on the ramp. Means may be provided for escaping the bars one at a time from the storage ramp to the feed trough 18.

A long horizontal beam 14 is welded to the top ends of the standards 8 to provide a support for a series of wire mesh slings 15. The looped end portions 16 of the slings are slidably mounted on the beam 14 to permit adjustment. The slings are maintained in axial alignment and are periodically raised and lowered in unison by circular sling support wheels carried on a common shaft near the upper entrance side of the storage ramp as disclosed in more detail in said U.S. Pat. No. 3,506,142, whereby the bars in the bundle are oriented and the desired unscrambling is effected. In the unscrambler A shown herein, each wheel 17 is a circular drum with an axial length to accommodate the flat wire mesh sling. Such wheel could be a drum of the type shown in U.S. Pat. No. 3,604,563 or could be a sprocket as shown in my U.S. Pat. No. 3,506,142 if the sling 15 were a chain.

A trough, feed table, or conveyor means is provided at the discharge side of the storage ramp to feed bars one or two at a time from the unit A to the cut-off machine B. As herein shown, the conveyor means includes a feed trough 18 and a pair of motor-driven pinch rolls

19 which deliver one bar 2 to the pinch roll feeder 3. The latter has at least one pair of motor-driven pinch rolls 21 for feeding the bar 2 to the machine B. As shown, only one bar enters the machine B at one time, but it will be understood that the equipment could easily be modified to supply two parallel bars.

The machine B has a flat horizontal table 22 of uniform width which extends rearwardly to support the bar or tube being cut by the shear. A conventional length gage 23 is mounted on the table in axial alignment with the bar for engaging the end of the bar. In operation the bar 2 is fed forward through the shear die against the length gage 23 to actuate the shear. The sheared bars b are then caused to move from the table 22 to the inclined discharge ramp 4, which is rigidly mounted on the table 22 and/or on the frame of machine B.

As herein shown, the discharge ramp 4 has a pair of flat parallel vertical side flanges 24 and 25 extending upwardly from a flat rectangular bottom wall 26, which is cut to provide slots 27 and 28 at the discharge end to receive the arms 92 of the escapement mechanism C and the swinging portion 66 of the bundler D described hereinafter. A series of longitudinally aligned stops 36 are rigidly mounted on the remaining portions 29 and 30 of the wall 26 in the path of movement of the bars *b* rolling down the inclined ramp surface at 26. The stops cause the bars to accumulate in a row parallel to the direction of feed of bars 2 to the shear B as shown in FIG. 1. In the apparatus shown, a pair of the stops 36 are located on the outer side portions 29 of the ramp 4 and another pair of said stops are located on the narrow projecting portions 30 of the ramp.

Various means may be employed to control the movement of the bars *b* from the bottom wall 26 of the discharge ramp to the slings 20 of the bundling machine D. Such means is preferably an escapement means which feeds the bars incrementally one or several at a time from the ramp to the slings. The escapement means may be of the general type disclosed in U.S. Pat. No. 3,306,472 or in my U.S. Pat. Nos. 3,480,159; 3,493,125; 3,506,142; 3,630,069; and 3,655,067.

As herein shown, the machine of this invention is provided with an escapement mechanism C corresponding to the escapement mechanism C of my U.S. Pat. No. 3,587,822, granted June 28, 1971, and including a plurality of aligned stops 36 rigidly mounted on the discharge ramp and a series of aligned escapement arms 92 having escapement members 108 which engage the lowermost bar on the ramp to lift it over the stops 36 and push it toward the bundler D. The arms 92 are rigidly connected to a common horizontal escapement arm shaft (not shown) to swing in unison about the horizontal axis of that shaft from a lower retracted position wherein the escapement members 108 are below the discharge ramp to an upper advanced position wherein the uppermost portions thereof at 112 project above the ramp and/or above the stops 36.

The escapement mechanism C feeds the bars *b* one at a time from the discharge ramp to the bundler D, the ramaining bars on the ramp being held against movement by the stops 36, which are in longitudinal alignment. Each stop 36 is constructed according to U.S. Pat. No. 3,587,822 and has a steeply inclined bar-engaging surface 83, suitable for engaging large and medium diameter bars, and a flat inclined upper surface 84.

The escapement arms 92 are all swung in unison about the horizontal axis of the escapement arm shaft (not shown) by a pneumatic or hydraulic cylinder 94 having a piston rod 95 pivotally connected to one of the arms. A bifurcated connecting member 96 is mounted on a horizontal pivot pin 97 which extends through the arm 92. At the opposite end of the cylinder there is a similar pivotal connection including a mounting bracket 99 rigidly mounted in a fixed stationary position on a support member 102 of the machine frame. A pivot pin 98 extends through the bracket 99 to provide a pivotal connection to the lower portion of the cylinder 94.

Each arm 92 has adjustable means for supporting an escapement member 108 having a triangular upwardly projecting portion 111 for engaging a bar *b* to lift it over the stops 36. Each member 108 has two parallel inclined slots 109 and two clamping screws 110 which screw into the arm 92. The flat inclined upper surface 112 of portion 111 is parallel to the slots 109. An auxiliary escapement member 113 is provided at the end of each arm 92 and has a triangular upper end portion 114 with a flat inclined upper surface 115 located substantially in the same plane as the upper surfaces 112 of the several members 108. The portions 111 and 114 function to permit operation with bars b of small and large diameters. The escapement operation is as disclosed in said U.S. Pat. No. 3,587,822, which is incorporated herein by reference. The numerals used herein to identify parts of the escapement mechanism C correspond to those used in that patent. It will also be understood that the escapement mechanism C may be employed on the unit A to deliver bars to the feed trough.

Each time the cylinder 94 is actuated to raise the escapement arms 92, the inclined surfaces 112 move against the lowermost bar *b* of the row at the stops 36 to lift the bar out of the row and push it upwardly and outwardly over the stop while the flat rear surface 116 of the portion 111 holds the next adjacent bar of the row against movement. As will be apparent from the drawings, the slots 109 permit the members 108 to be adjusted for bars *b* of different diameters so that the arms 92 will function properly with both small and large diameter bars.

In the preferred process according to this invention the cylinder 94 is actuated repeatedly at regular intervals to cause the bars *b* to be fed one at a time to the slings 20 at a suitable rate, such as one or two per second, greater than the average rate of discharge of the cut bars *b* from the shear B. After the number of bars transferred to the slings 20 is such as to provide a bundle of a predetermined size or weight, the feeding of bars is stopped temporarily to permit strapping of the bundle. In the preferred process this is determined by counting the number of bars fed to the slings 20, stopping operation of the cylinder 94 and initiating the strapping operation after a predetermined number of bars are on the slings. The method may be carried on automatically by a suitable electrical apparatus having the usual counters and limit switches or in other ways.

As shown in FIGS. 1 and 2, the bars *b* roll down the ramp 4 directly to the slings 20 of a bundle banding apparatus D somewhat similar to the unscrambler A described above. The apparatus D has a rigid frame 32 which may be somewhat similar to the frame 7 and

which supports the slings **20** in a similar manner. At one side, the frame **32** has a plurality of aligned vertical standards **33** which support a horizontal rod **34** similar to rod **14.** At the opposite side, the frame has a plurality of aligned vertical legs **35** supporting a main shaft **37** which is journaled for rotation about a horizontal axis parallel to tube **34** and to the bars *b* stored on the ramp **4.** A conventional roller conveyor **5** is rigidly mounted on the frame **32** above the members **38** and has horizontal side bars **41** rigidly connected to the standards **33** and the legs **35.** The bars may be inclined slightly to facilitate rolling movement by gravity.

The conveyor **5** is shown schematically with regularly spaced cylindrical rollers **42** extending laterally between the side bars **41.** It will be understood that the conveyor may be power driven and that other types of conveyors may also be employed including endless belt conveyors or the like.

The apparatus D may have two or more slings **20** spaced along the length of the rod **34.** As shown, two metal mesh slings **20** are provided, each being supported at one end by a loop portion **43** slidably mounted on the rod **34** and at the other end by a sling support wheel or drum **44.** The sling is preferably in the form of a flat metal mesh band which is wrapped around the drum **44** and fastened thereto at its end so that the drum reels in or pays out the sling when it is turned.

The drums **44** may be rotated by motor means or other drive means to effect the desired raising and lowering of the slings. Such drive means may, for example, be of the type disclosed in U.S. Pat. No. 3,604,563 or U.S. Pat. No. 3,055,515. The drive means preferably comprises a motor which may be controlled to provide raising and lowering of the slings in a regulated or predetermined manner. The motor may, for example, be a reversible motor as described in my U.S. Pat. No. 3,506,142.

As herein shown, both of the drums **44** are rigidly mounted on the shaft **37** and are rotated or turned in unison therewith by a reversible motor **45,** which may be an electric motor, a hydraulic motor, or a rotary air motor. The motor **45** is operably connected to shaft **37** by a suitable driving means **46** including a small drive wheel **47,** a drive belt **48,** a large wheel **49** driven by the belt, and a conventional gear reduction drive between shaft **50** and shaft **37.**

In accordance with the present invention, an automatic power strapping machine is provided for applying one or more straps or bands to a bundle to provide a tight permanent wrap. The strapping machine comprises an automatic strapping head and a specially constructed strap guide or chute for directing the strap or band around the bundle.

As herein shown, the bundler D includes an automatic power strapping machine **6** having a conventional automatic strapping head **61** with a replaceable magazine **62** containing the storage reels for the strapping bond or tape and having a specially constructed rectangular strap guide **70** for forming a loop around the bundle of bars. The strapping machine has a rigid stationary metal frame **63** for supporting the head **61** and the strap guide **70** in fixed positions including a horizontal member **64** and vertical legs **65** at opposite sides of the housing of head **61.** The strap guide **70** is part of this frame and comprises aligned upper and lower vertical portions **66** and **67** near the end of discharge ramp **4,** aligned upper and lower vertical portions **68** and **69** adjacent the strapping head **61,** an upper horizontal portion **71** extending between the upper vertical portions **66** and **68,** and a lower horizontal portion **72** extending between the lower vertical portions **67** and **69.** The portions **66–69, 71** and **72** have the same uniform cross section as shown, for example, in FIG. **3,** and each of said portions is preferably in the form of a channel **73** having a bottom wall **74** and integral vertical side flanges **75** of uniform width. Said portions provide a rectangular chute **70** with the flanges **75** located in a common vertical plane. In the machine shown herein, each channel **73** contains a guide channel **76** of the same length and of a width to fit between the flanges **75.** The channel **76** is of a size to receive and guide the strapping band or tape **54** which may have a width of ½ to ¾ inch, depending on the size and weight of the bars to be bundled. The side flanges **78** of the channel **76** may, therefore, be spaced apart ¾ inch or more.

If desired, the channels **73** and **76** may extend the full periphery of the strap guide **70,** in which case the cross section of the guide at lines A—A, B—B and **3—3** of FIG. **2** and at any other location around the periphery may be the same as shown in FIG. **3.** However, it is preferable to eliminate the sharp corners by providing the channels **76** with inclined portions **77** at each corner of the guide **70** or other means to guide the tape **54** around the corner. The inclined portions **77** provide reinforcement for the frame and may, if desired, be replaced at several corners by pairs of vertical triangular gusset plates **78a** which are spaced apart like the flanges **78** to receive the tape **54.** The method of guiding the tape **75** described above is conventional, and the tape guide portions **67, 68, 69, 71** and **72** described herein for purposes of illustration function in a conventional manner during the automatic strapping operation. It will be understood that the tape guide channels employed may have cross sections corresponding to those used in commercial strapping machines and may function generally like the tape guides of U.S. Pat. Nos. 3,120,171; 3,232,217 and 3,447,447 or other prior art patents.

For example, the strapping head **61** may be that of a standard Stanley Model CC1-ASF side-mounted strapping machine made by The Stanley Works, and the special strap guide **70** may have the same cross section as the strap chute of such Stanley machine. In other words, the strapping machine of the bundler D of this invention may be formed by modifying the strap guide or chute of such Stanley machine or of other conventional strapping machines.

In the strapping machine **60** of this invention the portion **66** of the strap guide is mounted to move into and out of the path of movement of the bars *b* leaving the discharge ramp **4,** and actuating means are provided to effect such movement at the desired time during the cycle.

In the Stanley machine described above and other commercial strapping machines, the strap guides do not permit lateral movement of long bars to a strapping position but require longitudinal movement of the bundle or other article to be strapped. Such machines must be modified to permit use in the apparatus of the present invention.

In accordance with the present invention, a special strap guide is employed having an open portion to per-

mit lateral feed of the bars *b* from the ramp **4** to the bundle carried by slings **20** and having means for directing the strapping tape across such open portion and around the bundle while such lateral feed is interrupted. SUch means preferably closes such open portion before the strapping operation is initiated. The strap guide may have an oval shape as disclosed in U.S. Pat. No. 3,086,451 but preferably has a generally rectangular shape as disclosed, for example, in U.S. Pat. No. 3,232,217 and U.S. Pat. No. 3,447,447.

The strapping head **61** is, of course, conventional, and well known in the art. It will be understood that many different strapping heads may be used in addition to the Stanley head described above. Suitable conventional strapping heads are disclosed, for example, in U.S. Pat. Nos. 3,120,171; 3,232,217 and 3,447,447 and in various other patents.

In the apparatus of this invention, the strap guide **70** is specially constructed to provide an opening between the portion **67** and the portion **71** to permit lateral movement of the bars b from the ramp **4** to the slings **20,** and a pivoted guide means (**66**) is provided to guide the tape across such opening during the strapping operation. In the specific apparatus shown, the portion **66** is a channel with a cross section as indicated in FIG. **3** and extends upwardly beyond the horizontal portion **71.** It is pivotally mounted on the portion **71** to swing about a horizontal pivot pin **55** carried by an L-shaped bracket **56** located at the outer end of the portion **71.** A bracket **57** is rigidly mounted at the opposite end of the portion **71** and pivotally supports a double-acting pneumatic cylinder **58** having a piston rod pivotally connected to the upper end portion of the guide member **66** by a pivot pin parallel to the pivots at **55** and **57.** The piston of the cylinder **58** moves the guide member **66** from a normal inclined retracted position out of the path of movement of the bars b as shown in dot-dash lines in FIG. **2** to a vertical operating position in alignment with guide portion **67** as shown in solid lines in that figure. In the latter position the lower end of portion **66** and the upper end of portion **67** are substantially in engagement a short distance below the lower end of the ramp **4** as indicated in dotted lines in FIG. **2** so that portions **66** and **67** function like a conventional continuous guide channel.

Means are provided for deflecting the strapping tape between portions **66** and **71** to assist it in moving around the corner. Such means functions like the inclined guide channels at **77** and like the guide means **78***a* and may be mounted on the member **66** to swing in unison therewith. As herein shown, such guide means comprises a pair of generally triangular vertical plates **78***b* similar to plates **78***a* and welded to the member **66.** The plates **78***b* are spaced apart to receive the tape **54** and fit between the flanges **75** of the horizontal portion **71** when the guide member **66** is in its vertical closed operating position shown in solid lines in FIG. **2.**

In the latter closed position, the guide member **66** completes the circuit so that the strapping tape from head **61** is guided all the way around the bundle of bars *b* on the slings **20** and back to the head. The head can then tighten the tape **54** around the bundle and thereafter cut the tape in the conventional manner.

The endless conveyor **5** is located so that it does not interfere with lowering of the slings **20** or strapping of the bundle. The rollers **42** are out of vertical alignment with the slings so that the slings may be lowered below the rollers to transfer the strapped bundle **100** from the slings to the conveyor and to permit longitudinal removal of the bundle on the conveyor. The number of rollers provided will, of course, be sufficient to provide adequate support for the bundles **100.**

The side bars **41** are located out of the path of movement of the strapping tape **54** and may have ends **39** spaced apart at opposite sides of the tape guide **70,** but it will be understood that enough rollers **42** will be provided to support the bundle **100** when it is released from the slings.

The strap guide **70** is located so that it does not interfere with longitudinal movement of the bundle **100** on the rollers **42** and so that the swinging portion **66** does not engage the discharge ramp. The guide portion **72** may be positioned just below the upper surface of said rollers or may be a substantial distance below as shown in FIG. **2.** The slots **28** of the discharge ramp may be aligned with the tape guide **70** to receive the portion **66** and to permit retraction thereof to the position shown in dot-dash lines in FIG. **2.** With this construction the end portion of the discharge ramp wall **26** may be closely adjacent the circumference of the sling support drums **44** as indicated in that figure without interfering with operation of the strapping machine but the stops **36** must be spaced a substantial distance from the drums **44.**

When the equipment of the present invention is in operation, strapped bundles of long bars **2** with a weight of many tons are delivered to the bundle loader-unscrambler A by an overhead crane, a fork lift truck or a roller conveyor (similar to conveyor **5**) and are transferred to the slings **15.** The bars are then unscrambled and delivered from the storage ramp to the feed trough **18** where they are fed axially by the pinch rolls **19** and **21** to the shear B one or two at a time, whereby the uncut bars **2** are continually fed to the shear and the cut bars *b* are continually delivered to the discharge ramp **4.** The bundler D is operated as long as the shear B is in operation.

Each cycle may be substantially as described below. Assuming that the shear is in operation and is delivering cut bars *b* to the ramp, the motor **94** of the escapement mechanism C is operated at regular intervals, such as one per second, to raise the bars *b* over the stops **36** one at a time and deliver them to the slings **20.** At the beginning of the cycle the slings are raised to the uppermost position and the guide member **66** is in the retracted position shown in dot-dash lines in FIG. **2.** As the bars roll down the ramp, they engage the arm **51** of a counter **31** which indicates the number of bars delivered to the slings.

The motor **45** is operated in response to an increase in the number of bars as indicated by the counter to lower the slings **20** slowly in increments a distance directly proportional to the number of bars sent to the slings. After a predetermined number of bars b have been placed on the slings as indicated by the counter **31** and before the slings have lowered the bundle against the rollers **42,** the operation of motor **94** is discontinued to allow the bars *b* to accumulate on the ramp and the motor **58** is actuated to swing the strap guide member **66** down to its vertical closed operating position. Immediately thereafter the strapping machine **6** is operated in the usual way to feed the steel strapping tape **54** from the head **61** around the guide **70** back to the head to form a loop around the bundle, to tension

it around the bundle **100**, to seal or fix the tensioned loop, and to shear the fixed tensioned loop from the remaining strapping material. As soon as the strapping machine **6** completes this cycle, the motor **45** is energized to lower the slings **20** below the rollers **42** and transfer the strapped bundle **100** to the conveyor **5**, whereupon the conveyor is actuated to move the bundle longitudinally away from the unit D. At this time the slings **20** are lowered sufficiently so they do not interfere with such removal of the bundle.

As the bundle **100** moves away from unit D, it engages limit switch **81** on conveyor **5** which indicates when the trailing edge of bundle **100** moves out of contact with said switch. As soon as this occurs, the motor **45** is energized to raise the slings **20** rapidly to their uppermost positions and the motor **58** is energized to cause retraction of the guide member **66** to its inclined open position. When the sling **20** arrives at its upper position, the motor **94** is again operated to effect further feed of bars by the escapement mechanism C and the aforesaid cycle is repeated to form another strapped bundle **100**. Thus, strapped bundles of uncut bars **2** may be continually supplied to the unit A by one roller conveyor while strapped bundles **100** of cut bars *b* are continually removed on another roller conveyor **5**. Fully automatic operation is achieved in a simple manner at minimum cost without the need for unduly expensive equipment.

Some of the steps of the process described above may be performed manually but it is preferable to employ an automatic electrical system using a counter, such as the counter **31**, in connection with the conventional electrical controls of the automatic strapping machine **6**.

As shown in FIG. **2**, the slings **20** may be lowered during each cycle a distance substantially greater than the diameter of the bundle **100** before the wrapping operation is initiated, whereby the slings provide means for compacting the bundle and for assisting in shaping the bundle as it is strapped. Thus, less tension need be applied to the strapping tape **54** by the strapping machine C to shape the bundle. This eliminates the need for a heavier and more expensive strapping machine.

Such lowering of the slings may be initiated during each cycle after all of the bars have been delivered to the bundle and while the uppermost bars are near the level of the drums **44** so that there is less chance for damage to the bars as they move over the drums to the slings **20**. Such lowering of the slings to the position shown in FIG. **2** may be effected rapidly by motor **45** while the guide member **66** is being swung to its vertical closed operating position just before the strapping operation. The motor **45** will, of course, be stopped during the wrapping as described above.

The distance between the sling supports at **34** and **44** may be reduced to assist the slings **20** in shaping the bundle or other means may be provided to reduce the horizontal width of the festoon when the slings are lowered. For example, means (**120**) may be provided to assist in shaping the slings and the bundle as indicated schematically in FIG. **5**. One way to reduce the width of the festoon and the width of the bundle of bars carried by the slings is to provide rollers engaging each sling.

As shown in FIGS. **5** and **6**, a pair of freely rotatable rollers **121** engages each sling **20** when it is lowered, each roller being aligned with the sling as indicated in FIG. **6** and mounted for rotation on a shaft **122**. The shafts **122** may have fixed axes and may be rigidly mounted on the frame **32** so that they remain stationary, but they are preferably moved in and out by suitable automatic power means, such as the motor means **130**.

When the shafts **122** are rigidly held against movement, the cycle of operations remains the same as previously described with respect to FIGS. **1** and **2**. As previously indicated, the slings are lowered during each cycle a distance substantially greater than the diameter of the bundle **100**. When the bundle is lowered below the rollers **121** in the embodiment of FIG. **5**, the rollers engage the slings **20** to limit the width of each festoon and thereby assist in shaping the bundle before it is strapped. The rollers **121** are optional and can be omitted, but they are highly desirable when forming large or heavy bundles containing large numbers of bars in each bundle because much less tension is required on the strapping tape **54** by the strapping machine C to shape the bundle and because there is less tendency to form "hollow" or abnormal bundles with the bars arranged in an undesirable manner. The rollers **121** provide more uniformity in the shape and diameter of the bundles **100**, facilitate trouble-free operation of the automatic strapping machine C, and make it possible to operate with a smaller size strapping machine than might otherwise be required for reliable operation.

FIG. **5** illustrates schematically the preferred type of apparatus D' wherein the rollers **121** are moved in and out at predetermined times during each cycle of operations by suitable power means controlled manually or automatically. For convenience of illustration, all of the parts of the bundler D' are the same as those of the bundler D and may be operated in the same manner, except for the means **120** and **130** and associated parts for shaping the slings **120** and the bundle of bars carried thereby.

The optional added equipment in the embodiment of FIG. **5** includes means **120** for engaging and shaping each of the slings **20** comprising a pair of rollers **121** at opposite sides of the festoon formed by the sling mounted to rotate on the horizontal shafts **122**, and motor means **130** for moving each of the rollers horizontally from an advanced position as shown in FIG. **5**, wherein the rollers are spaced apart a distance less than the diameter of the bundle, to a retracted position, wherein the rollers are farther apart. The motor means **130** for each roller **121** comprises a power cylinder **123** and a piston rod **124** having a stroke of at least several inches (for example, 4 to 10 inches). The end of each piston rod has a suitable connecting portion that fits on the shaft **122**.

The parts are shown schematically, it being understood that, in an actual machine, each power cylinder **123** would be rigidly mounted on the frame **32** and each piston rod **124** would be properly supported for horizontal movement to carry the vertical load imposed on the roller **121**. The power cylinders may be operated by conventional control means to move all of the rollers **121** in unison and to cause them to move the same horizontal distance between the retracted and the advanced positions (for example, a distance of 3 to 10 inches or so for each roller **121**) so that the rollers **121** for one sling remain axially aligned with the rollers **121** of the other sling or slings.

In the advanced positions, the rollers apply a high pressure to the slings **20** preferably sufficient to cause the bars on the sling to form a bundle which is generally round in cross section. As indicated in FIG. **5**, for example, the rollers in the advanced positions may be spaced apart a distance 25 to 50 percent less than the average diameter of the final bundle. The power cylinders **123** are made large enough to provide the required force and may be operated automatically by suitable electric control equipment if desired.

When the equipment is modified generally as indicated in schematic FIG. **5**, the cycle of operations may be modified slightly and may be generally as described below.

At the beginning of the cycle, the slings are raised and the guide member **66** is retracted. As the bars roll down the ramp, the motor **45** is operated in accordance with the number of bars counted by the counter **31** to lower the slings slowly. As more bars enter the bundle the bundle will be slowly lowered past the rollers **121.** These rollers do not interfere with lowering of the slings even if they are in their advanced positions; and, therefore, the rollers can, if desired, be held at all times in the advanced positions shown in FIG. **5** (in which case the cycle of operations would remain the same as previously described with respect to FIG. **2**). However, in the preferred process the rollers **121** are retracted at the start of each cycle and remain in the retracted position until the slings approach the lower position shown in solid lines in FIG. **5** wherein the bundle is just above the rollers of the conveyor **5.**

After a predetermined number of bars have entered the bundle on the slings as indicated by the counter **31** (for example, 30 or 40 bars), the motor **94** is stopped to discontinue the bar feed, the motor **58** is actuated to close the strap chute, and the power cylinders **123** are all actuated to advance the rollers **121** (for example, 6 inches or more) from their retracted to their advanced positions. Enough force is applied by the rollers **121** to the slings **20** to shape the bundle, for example, roughly as indicated schematically in FIG. **5.**

Suitable means may be provided to cause operation of the power cylinders **123** simultaneously with the power cylinder **58,** for example, by connecting them to the same source of air or other pressure fluid, so that the rollers **121** are advanced when the strap guide **66** is being advanced to the closed operating position and are retracted when the strap guide **66** is retracted to the open position. With this arrangement, the automatic controls may be the same as would be provided with the embodiment of FIG. **2.**

Immediately after the strap guide **66** and the rollers **121** are moved to their advanced operating positions, the strapping machine **6** is operated to apply the steel strapping tape **54** to the bundle. The rest of the cycle is as previously described with respect to FIG. **2.** As the bundle moves away from unit D on the conveyor **5,** the limit switch **81** causes actuation of motor **45** to raise the slings and actuation of the double-acting power cylinders **58** and **123** to retract the guide member **66** and the rollers **121.** When the slings **20** arrive at their upper positions, for example, as shown in dot-dash lines in FIG. **5,** the motor **94** is again operated to start another cycle.

If desired, the cycle may be modified when strapping very large bundles so that the maximum force is applied by the pneumatic cylinders **123** at the same time maximum tension is applied to the strapping tape by the strapping machine.

The process and apparatus of the present invention are suitable for handling bars and tubes of various cross sections, including rectangular, square, hexagonal and other polygonal or non-circular cross sections. The embodiment of FIGS. **5** and **6** is particularly well suited for bundling the flat or non-circular bars or tubes.

The apparatus illustrated herein is shown with electric motors for effecting raising and lowering of the slings, but excellent results can also be obtained with hydraulic or pneumatic motors.

It will be understood that, in accordance with the provisions of the patent statutes, variations and modifications of the specific processes and devices disclosed herein may be made without departing from the spirit of the invention.

Having described my invention, I claim:

1. A process for handling long hollow or solid bars (**2**) comprising supporting a bundle of said bars on spaced slings (**15**) of a bundle unscrambler (A), causing said slings (**15**) to move over longitudinally-aligned sling supports (**17**) located near the end of a storage ramp inclined downwardly from said sling supports while supporting the ends (**16**) of the slings remote from said storage ramp at an elevation greater than that of said sling supports to provide festoons extending under the bundle to support the same, repeatedly raising the bars and slings by moving the slings up over said sling supports (**17**) to cause some of the bars (**2**) to move laterally over the sling supports to said ramp and to form a row of parallel bars on said ramp, repeatedly feeding the bars from the ramp to a conveying means (**18,19**) generally parallel to the bars in said row, repeatedly causing each bar on said conveying means to move to a metalworking machine (B) which acts on the bar, continually discharging bars from said machine to a downwardly inclined discharge ramp (**4**), supporting the bars (*b*) discharged from said ramp on spaced slings (**20**) of a bundle banding apparatus (D), causing said last-named slings to move over longitudinally aligned sling supports (**44**) located near the end of said discharge ramp (**4**) while supporting the ends (**43**) of the slings remote from said discharge ramp to provide festoons extending under the bars (*b*) to support the same, transferring a small number of bars (*b*) from said discharge ramp (**4**) to said last-named slings (**20**) while the slings are in elevated positions, gradually lowering the slings (**20**) while transferring more bars (*b*) to the slings to form a bundle supported on the slings, providing a strapping machine (**6**) with a strapping head (**61**) and a strap guide (**70**) extending around the bundle, said strap guide having an open portion to permit lateral feed of the bars (*b*) from said discharge ramp (**4**) to said bundle and having guide means (**76,77,** 78*a*,78*b*) to direct a strapping tape (**54**) from said head (**61**) around the bundle and back to said head, whereby said head (**61**) can tighten the tape (**54**) around the bundle (**100**) and thereafter sever the tape to complete one cycle, counting the number of bars discharged from the ramp (**4**) to the slings (**20**), stopping the movement of bars from the ramp (**4**) to the bundle when a predetermined number of bars have been accumulated in the bundle, causing operation of the strapping machine while such movement is stopped and while the bars are forced together on the slings to form a strapped bundle (**100**) while bars continue to be fed

to said discharge ramp, removing the strapped bundle (100) from said slings, raising the slings (20) and thereafter restarting the feed of bars (*b*) from said discharge ramp (4) to said last-named slings (20) to repeat the cycle.

2. A process according to claim 1 wherein, during each cycle, a series of parallel bars (*b*) are held in a row on said discharge ramp (4) and the bars are fed one at a time from said row to said bundle at a predetermined rate greater than the average rate of feed of bars from said machine (B) to said discharge ramp (4).

3. A process according to claim 1 wherein, during each cycle, a predetermined number of bars (*b*) are fed from said discharge ramp (4) to said last-named slings (20) while said slings are gradually lowered a predetermined distance, and, thereafter, the movement of bars (*b*) from the discharge ramp (4) is discontinued until the cycle is completed.

4. A process according to claim 3 wherein, during each cycle, a series of parallel bars (*b*) are held in a row on said discharge ramp (4), the bars are slowly fed from said row to said bundle, said last-named slings (20) are lowered in accordance with the number of bars in the bundle, and, when a predetermined number of bars are in the bundle on the slings, the feeding of bars from said row is stopped without stopping the feeding of bars to said ramp while the strapping machine (D) is in operation.

5. A process according to claim 1 wherein a movable tape guide (66) is provided to guide the strapping tape (54) across said open portion of said tape guide (70) and is moved from a retracted position out of the path of movement of the bars (*b*) on said discharge ramp to a closed operating position in said path after a predetermined number of bars (*b*) have been fed to the slings (20) to complete the bundle.

6. A process according to claim 5 wherein the slings (20) are lowered as the movable tape guide (66) is moved to its operating position and the bars (*b*) are forced together into a compact bundle before a high tension is applied to the strapping tape to complete the shaping of the bundle.

7. A process according to claim 6 wherein the bars (*b*) are compacted by reducing the width of the festoon formed by said slings (20), whereby the strapped bundles are of substantially uniform size.

8. In a process according to claim 1 wherein a first reversible motor means (45) are provided for rotating said sling supports (44) to raise and lower the festoons formed by said slings (20), a second reversible motor means (58) are provided for moving a tape guide member (66) between a retracted position out of the path of movement of bars (*b*) on the discharge ramp to a closed operating position wherein said member guides the tape (54) across said open portion of the tape guide (70), an escapement mechanism (C) is provided for feeding the bars (*b*) at a slow rate from said discharge ramp (4) to the slings (20), a third motor means (94) are provided for operating said escapement mechanism, counter means (31) are provided for counting the number of bars (*b*) delivered from the discharge ramp (4), and a power roller conveyor (5) is provided below the slings (20) to receive the strapped bundle (100), and wherein, during each cycle, the first motor means (45) moves the slings to an upper position to receive the first bars (*b*) discharged from the ramp during that cycle, the second motor means (58) holds the movable tape guide member (66) in its retracted position during feed of the bars, the third motor means (94) is energized to cause operation of said escapement mechanism, the first motor means (45) is energized to cause lowering of the slings in accordance with the number of bars indicated by said counter, the third motor means (94) is deenergized to stop feeding of the bars (*b*) to the slings (20) when the counter (31) indicates that a predetermined number of bars (*b*) are on the slings, the second motor means is then operated in accordance with such indication by the counter to move the movable tape guide member (66) to its closed operating position, the first motor means (45) is operated to compact the bundle of bars and to lower it to a position adjacent the rollers (42) of said conveyor (5), the first motor means (45) is stopped and the strapping machine (6) is energized to feed the tape (54) through the tape guide (70), form a loop around the bundle, tension the loop and sever it from the remaining strapping tape in said machine (6), the first motor means is then energized to lower the slings (20) between the rollers (42) of the power conveyor and transfer the strapped bundle (100) to said conveyor, the conveyor (5) is operated to remove the strapped bundle, the first motor means (45) is energized to raise the slings rapidly to their upper position, the second motor means (58) is energized to retract the tape guide member (66), and the third motor means (94) is again energized to start another cycle.

9. In an apparatus for handling long hollow or solid bars comprising a rigid frame (7) having portions spaced apart to receive a bundle of bars (2), a storage ramp, spaced flexible slings (15) for supporting the bundle, means (14) on said frame for supporting the ends (16) of the slings at spaced elevated positions at one side remote from said storage ramp, sling supports (17) mounted on the opposite side near the end of said storage ramp for supporting the slings to provide festoons extending under the bundle to support the same, means for moving each sling upwardly from its festoon over its associated sling support to shorten and raise said festoon and to feed bars laterally from said sling supports to said storage ramp, means holding the bars on the ramp in parallel positions in a row, a metalworking machine (B) for acting on each bar, a conveying means (18,19) generally parallel to the bars in said machine, means for feeding the bars from the ramp to said conveying means, a downwardly inclined discharge ramp (4), and means for continually discharging bars (*b*) from said machine to said last-named ramp, the improvement which comprises a bundle banding apparatus (D) comprising a rigid frame (63) having portions spaced apart to receive a bundle of said bars and to permit vertical movement thereof, spaced flexible slings (20) for supporting such bundle, means (34,44) on opposite sides of said frame for supporting the slings while forming festoons for supporting said bundle, said last-named slings being located adjacent the end of said discharge ramp (4) to receive and support the bars (*b*) from said ramp, means (45) for slowly lowering said last-named slings as more bars are transferred thereto and for stopping movement of the slings when the desired number of bars are in the bundle, a strapping machine (6) with a strapping head (61) and a strap guide (70) extending around the bundle, said strap guide (70) having an open portion to permit lateral feed of the bars (*b*) from said discharge ramp (4) to the bundle

and having guide means (76,77,78*a*,78*b*) to direct a strapping tape (54) form said head (61) around the bundle and back to said head, whereby said head can tighten the tape (54) around the bundle and thereafter cut the tape to complete one cycle, means (36) for stopping the movement of bars from the ramp to the bundle when a full bundle has been accumulated, means for initiating operation of said strapping machine while such movement is stopped to form a strapped bundle, conveyor means (5) for removing the strapped bundle (100) from said slings, and means (45) for causing raising of said last-named slings after the strapped bundle has been removed and for restarting the feed of bars from said discharge ramp to said slings to repeat the cycle.

10. Apparatus according to claim **9** wherein means (36) are provided to hold the bars in a row on said discharge ramp, and escapement means (C) are provided to feed the bars one at a time from said row to said bundle at a predetermined rate greater than the average rate of feed of bars from said machine to said discharge ramp.

11. Apparatus according to claim **10** wherein means (31) are provided for counting the number of bars fed to said slings during each cycle and stopping operation of said escapement means when the desired number of bars are in the bundle.

12. Apparatus according to claim **11** wherein a roller conveyor (5) is located below said slings (20) to receive the strapped bundle (100) and said slings move downwardly between the rollers of said conveyor to release the bundle.

13. Apparatus according to claim **11** wherein the counting means (31) causes lowering of the slings during each cycle in accordance with the number of bars in the bundle.

14. Apparatus according to claim **9** wherein said strap guide (70) has a movable section (66) at said open portion mounted to move from a normal closed position in the path of movement of the bars on said ramp to an open retracted position out of said path of movement.

15. Apparatus according to claim **14** wherein motor means (58) are provided to move said movable section (66) between said open and said closed position.

16. Apparatus according to claim **15** wherein means are provided for causing operation of said motor means in a direction to effect closing of the strap guide a short time before operation of said strapping machine and for causing operation of said motor means in a direction to effect opening of the strap guide after a strap has been placed around the bundle.

17. Apparatus according to claim **16** wherein said movable section is mounted to swing about a horizontal axis from the open to the closed position and a reciprocating fluid operated motor is operable connected to said movable section to effect such swinging movement.

18. Apparatus according to claim **9** wherein said downwardly inclined discharge ramp has a stop member (36) which engages the lowermost bar of said row of bars on said ramp to hold the bars against rolling, an adjustable escapement means is provided having a portion (111) engageable with the lowermost bar for lifting said bar over said stop member, said portion having a surface (112) inclined in a direction to push the bar down the ramp, and means are provided for moving said escapement means upwardly between said lowermost bar and the next adjacent bar of the row to effect feeding of said lowermost bar over the stop.

19. Apparatus according to claim **9** wherein said improvement comprises means (120) for deflecting each sling above the bundle before operation of the strapping machine to assist in shaping the bundle.

20. Apparatus according to claim **9** wherein rollers (121) are provided for engaging each sling to assist in shaping the bundle.

21. Apparatus according to claim **9** wherein rollers (121) are provided at opposite sides of the apparatus (D) for engaging the slings (20) to assist in shaping the bundle, each roller being supported for movement toward and away from the sling from a retracted to an advanced position, and motor means (130) are provided for moving the rollers (121).

22. A process according to claim **1** wherein shaping means (120) are moved against the slings (20) to assist the strapping machine in shaping the bundle.

23. A process according to claim **1** wherein the upper portion of the bundle is deformed to provide the bundle with a substantially round cross section before the strapping tape is applied.

24. A process according to claim **1** wherein the slings are gradually lowered while feeding at least **25** long bars to the bundle, thereafter rollers are moved against each of the slings at opposite sides of the bundle to cause the bundle to assume a generally round cross section, and the strapping machine is operated while said rollers apply pressure to the slings, said rollers applying more pressure to the bundle than said strapping machine during application of the strapping tape to the bundle.

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