United States Patent

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[72] Inventor **Erasmus A. Randich**
Pittsburgh, Pa.

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[73] Assignee Allegheny Ludlum Steel Corporation,
Brackenridge, Pa.

[54] **PROCESS AND APPARATUS FOR CONTINUOUSLY PROCESSING STEEL AND OTHER MATERIALS**
5 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **72/227,**
72/250, 226/104
[51] **Int. Cl.** **B21b 41/00**
[50] **Field of Search** 226/118,
119, 104, 107; 72/234, 203, 205, 227, 250, 251

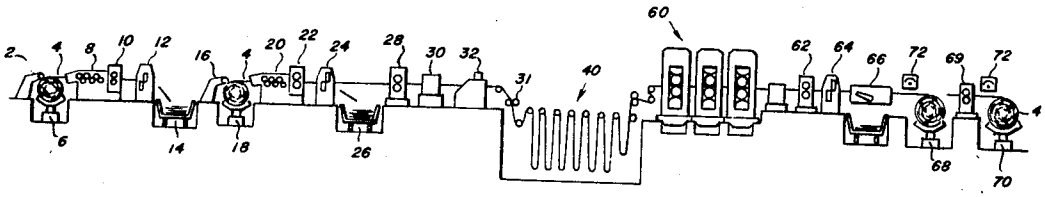
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Primary Examiner—Milton S. Mehr
Attorneys—Richard A. Speer and Vincent G. Gioia

ABSTRACT: A method and apparatus for continuously rolling metal strip and other materials by providing an apparatus to accumulate the moving material so that when performing an operation in the process that requires the material to be stationary the rolling mill and/or processing section can operate without changing speed by drawing from the accumulated material.



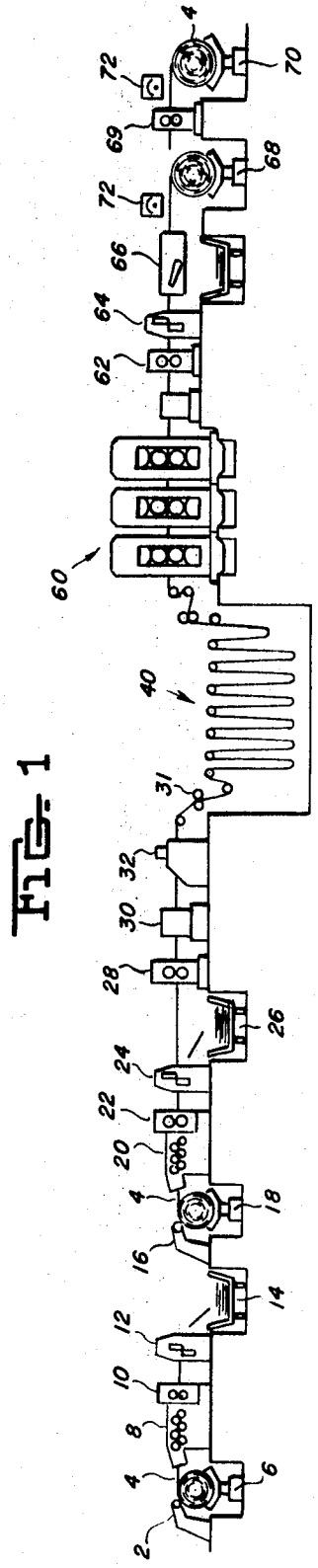


FIG. 1

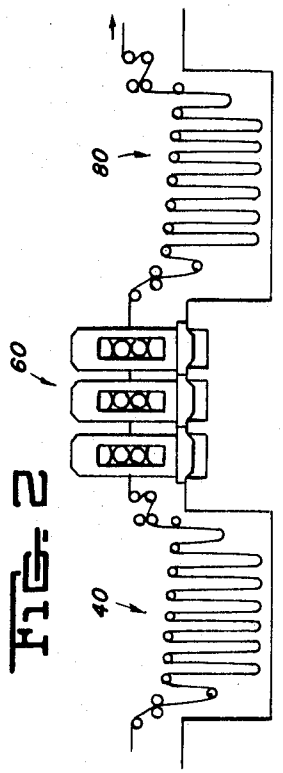


FIG. 2

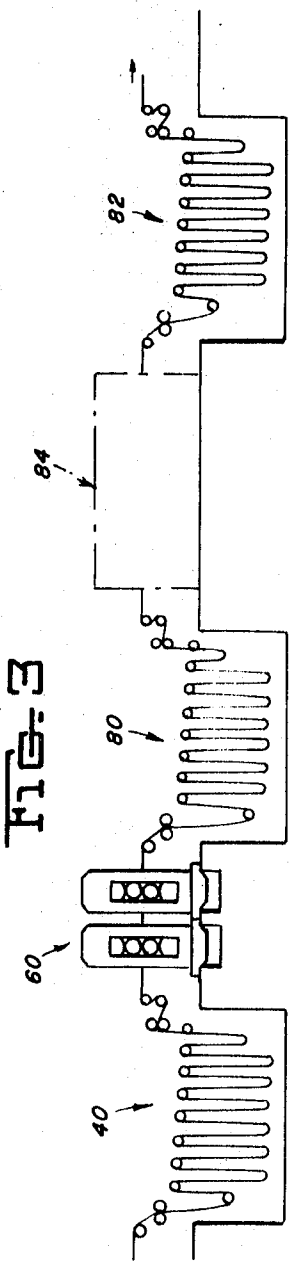


FIG. 3

INVENTOR
ERASMUS A. RANDICH

By Vincent G. Sirio
Attorney

FIG. 4a

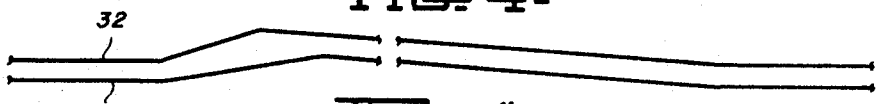


FIG. 4

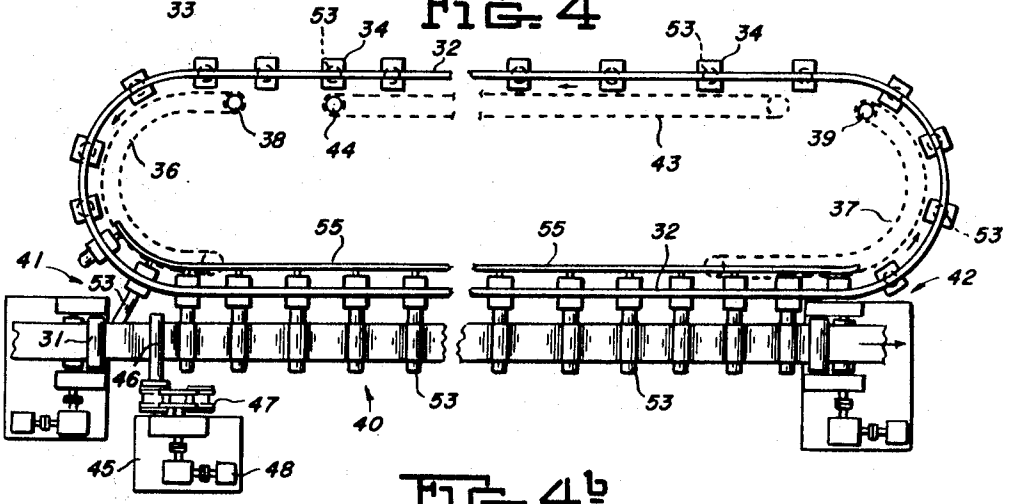


FIG. 4b

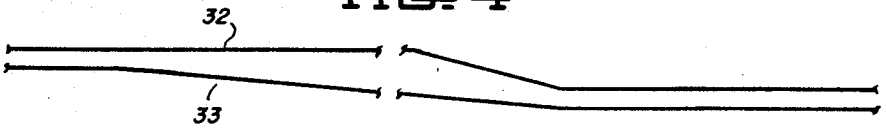
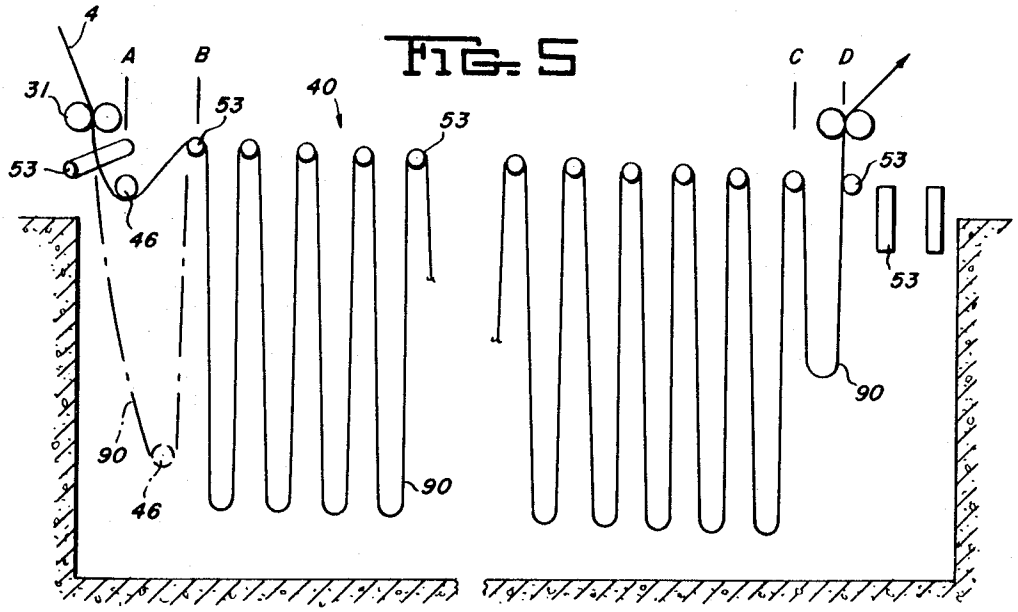


FIG. 5



INVENTOR
ERASMUS A. RANDICH

By Vincent D. Gioia

Attorney

FIG. 9

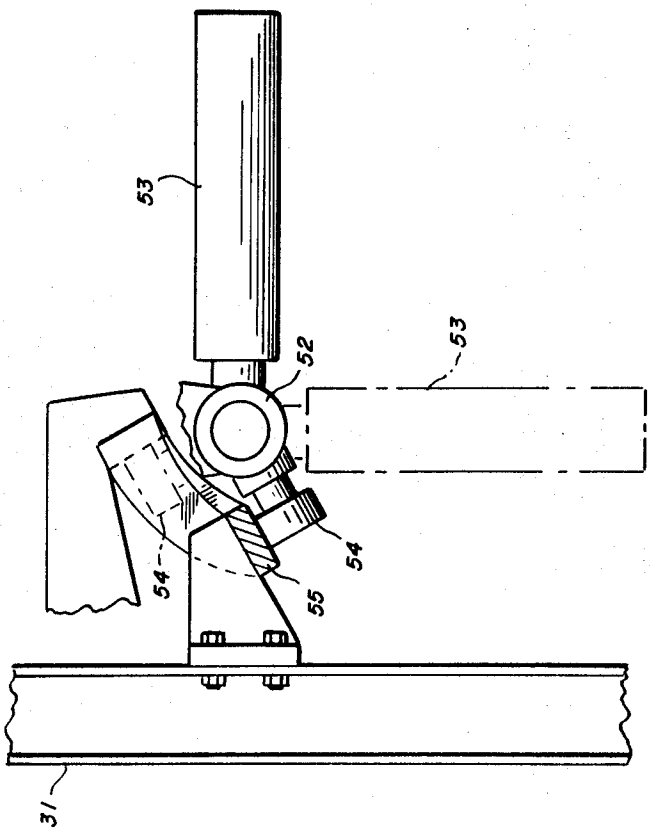
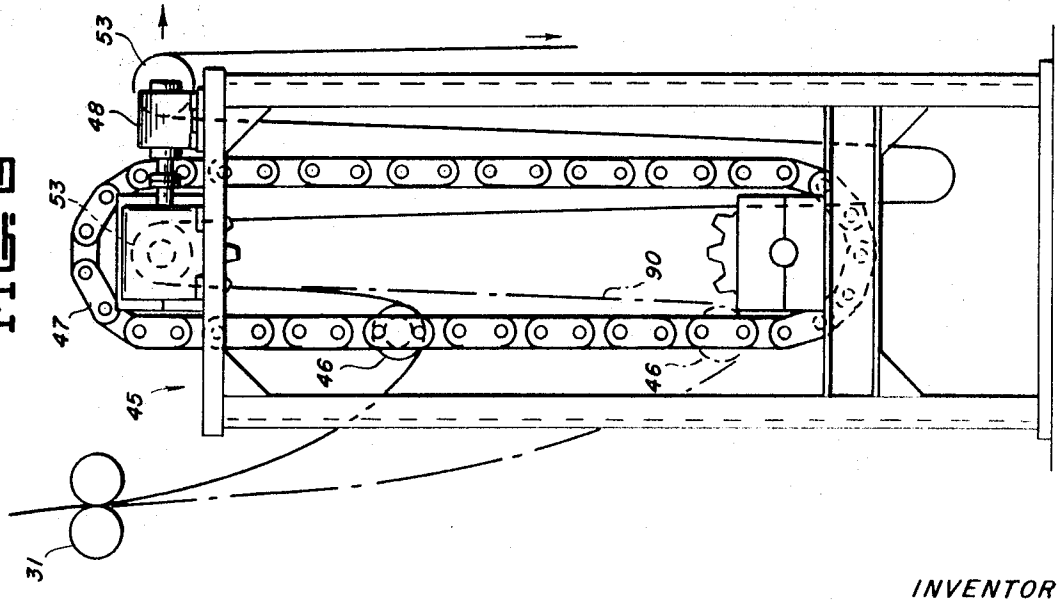


FIG. 5



INVENTOR
ERASMUS A. RANDICH
By Vincent G. Gioia
Attorney

FIG. 7

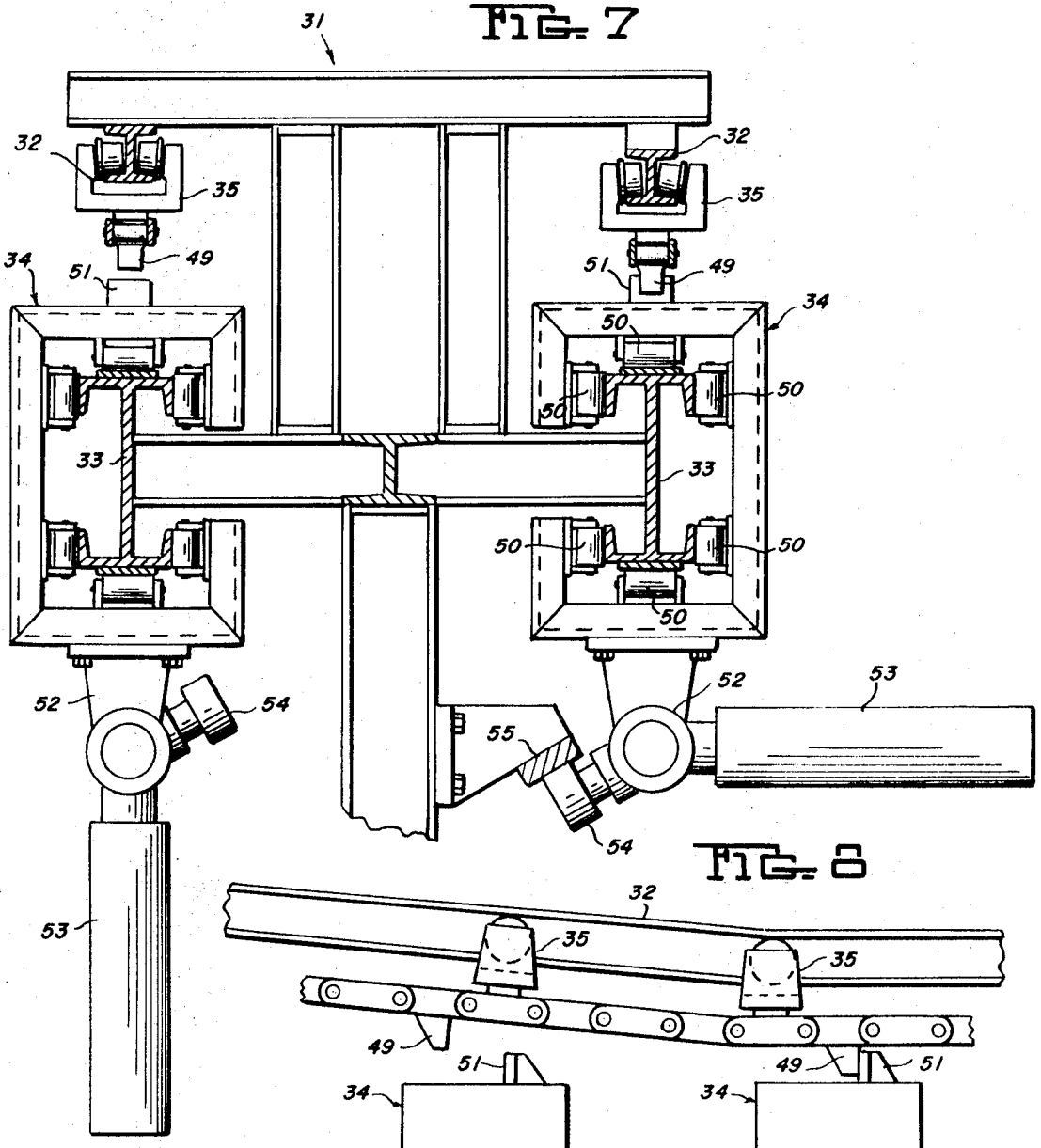
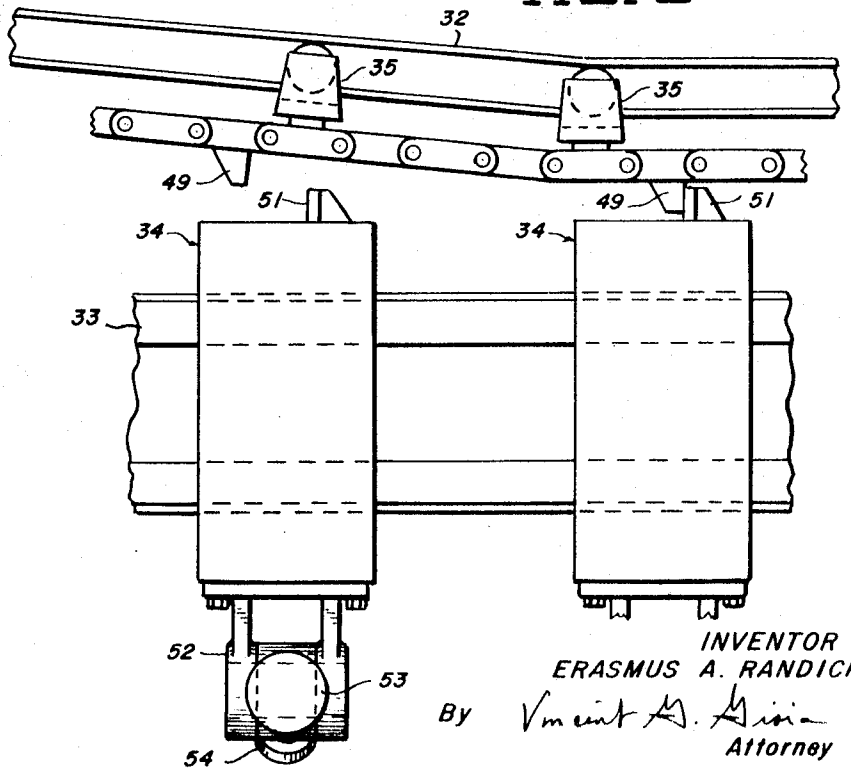


FIG. 8



INVENTOR
ERASMUS A. RANDICH
By Vincent A. Grisi
Attorney

PROCESS AND APPARATUS FOR CONTINUOUSLY PROCESSING STEEL AND OTHER MATERIALS

BACKGROUND OF THE INVENTION

This invention pertains to the processing of materials and more specifically to a method and apparatus for continuously operating a rolling mill, a metal processing line, or both operations combined.

Conventionally, steel strip is cold rolled either in single stand or in multiple stand mills, arranged in tandem and called tandem mills. The rolling process is an intermittent one, since only one coil of steel or metal is rolled at a time. After all the metal on a coil has been fed from a payoff reel and has passed through the mill, it is necessary to stop the rolling mill and allow the operator to fasten the coil end in the winding reel by the usual banding process, and then remove the full coil from the winding reel so that the next coil may be wound. Operators at the other end must also stop the mill to place another coil on the payoff reel or coil box, when the coil on the payoff reel is emptied. This handling of the coils is time consuming and valuable rolling time is lost as the mill is not operating during the coil changeover operation. Further, since the mill must be stopped and started for each new coil, unusable off-gauge strip will be produced at the beginning and end of each coil. These gauge variations are produced at the beginning and end of each coil as a result of the changing pressure on the material during acceleration and deceleration of the mill. This invention eliminates this unusable off-gauge strip by providing a method and apparatus for continuously operating the mill without changing the rolling mill speed during operation.

Presently, continuous operation of a processing line, other than a rolling mill, has been accomplished by combining looping pits or looping towers to accumulate strip. However, these types of accumulators have not been used in combination with a rolling mill as their size and cost would be prohibitive.

SUMMARY OF THE INVENTION

By the present invention it is possible to roll strip continuously without having to stop or vary the speed of the rolling mill for operations which require the strip to be stationary. This is accomplished by accumulating moving strip before and/or after such an operation. For instance, the operation of connecting the trailing end of the strip from the coil on the empty payoff reel to the leading end of the strip from a coil on a full payoff reel requires the strip to be stationary. Therefore, to avoid having to stop the rolling mill, sufficient strip is accumulated in an apparatus as hereinafter described for a time sufficient to permit the coil changeover without having to stop the mill.

The accumulator in accordance with the present invention has arms which can carry a variable number of loops of moving strip to the mill stand depending upon the amount of strip to be accumulated.

The method and apparatus of the invention is particularly useful in producing strip of uniform thickness at lower cost.

It is, therefore, an object of this invention to provide an apparatus capable of accumulating a plurality of loops of strip while simultaneously conveying the loops from one point to another.

It is another object of the invention to provide a method of continuously operating a rolling mill at a constant speed when changing payoff or winding reels or coils thereon.

It is a further object of this invention to utilize the accumulating apparatus in combination with a rolling mill and any subsequent processing equipment to obtain continuous operation of the line without having to change the speed of the rolling mill.

Other objects and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings of an embodiment of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram showing a preferred embodiment of the accumulator of the present invention in combination with a rolling mill; the accumulator being located before the first mill stand.

FIG. 2 is a schematic diagram showing two of the aforementioned accumulators in combination with a rolling mill; the accumulators being located before the first mill stand and after the last mill stand.

FIG. 3 is a schematic diagram showing three accumulators in combination with a rolling mill and a processing line; the accumulators being located before the mill, before the processing line, and after the processing line.

FIGS. 4 and 5 show top and side views of the accumulator described in FIGS. 1—3.

FIGS. 4A and 4B show front and rear elevations of the upper and lower tracks for the trolleys and carriages.

FIG. 6 shows a side elevation of the looper tower.

FIGS. 7 and 8 are an enlarged partial view of the accumulator showing the front and side views of one of the trolleys and carriages which convey the strip.

FIG. 9 shows a view of the cam action that raises the strip supporting arm into the horizontal position.

Referring now to the drawings, FIGS. 1, 2 and 3 show the accumulator in combination with different processing lines. FIG. 1 shows a holddown arm 2, for holding a coil of strip 4 in a first payoff reel 6. A first bending unit 8 facilitates flattening and feeding the strip to a first pinch roll assembly 10. A first shear 12 cuts the leading edge and trailing end of the strip from the coil 4 so it may be easily welded to strip on a succeeding coil. A first scrap bin 14 collects the pieces of scrap that are cut from the strip. A second holddown arm 16 holds down the coil of strip 4 on a second payoff reel 18. A second bending unit 20 facilitates flattening and feeding the strip from the second payoff reel 18 to a second pinch roll assembly 22. A second shear 24 and second scrap bin 26 perform the same function as the first shear 12 and first bin 14. A third pinch roll assembly 28 is fed alternatively by payoff reels 6 and its associated bending unit 8, pinch roll assembly 10, and first shear 14 or payoff reel 18 and its bending unit 20, pinch roll assembly 22, and shear 24. Pinch roll assembly 28 then guides the strip 4 past a first strip sensing device 30 and to a welding unit 32 that welds together the ends of the strip from one coil to another. A fourth pinch roll assembly 31 guides the strip into an accumulator 40 where it is then conveyed to a rolling mill 60. A fifth pinch roll assembly 62 feeds the strip past a third shear 64 and into an automatic guide unit 66 where it is guided onto a first winding reel 68 or through a sixth pinch roll assembly 69 and into a second winding reel 70. Second sensing devices 72 located at the winding reels activate the third shear 64 when a winding reel is full, e.g., a full coil of strip is on the reel. The automatic guide unit 66 then feeds the strip onto an empty winding reel.

FIG. 2 shows two accumulators used in combination with a rolling mill 60 and FIG. 3 shows three accumulators in combination with a rolling mill 60 and a processing line 84. The purpose of these accumulators will be discussed later.

FIGS. 4 and 5 show the top and side view of the accumulator 40 which is comprised of a series of support towers 31 (shown in FIG. 7) on which are mounted a continuous upper track 32 and a continuous lower track 33. Carriages 34 are moveably mounted on the lower track 33 and trolleys 35 (shown in FIG. 7) are moveably mounted on the upper track 32. Chain and sprocket drives 36, 37 powered by motors 38, 39, for propelling the trolleys 35, are located at the entry end 41 and delivery end 42 of the accumulator. Located at the rear of the accumulator 40 is chain and sprocket drive 43 powered by motor 44 which propels the carriages 34 along the track 33. FIGS. 4A and 4B show the path of the upper track 32 and lower tracks 33, 32 along the front and rear of the accumulator.

FIG. 6 shows the looping tower 45 which is located at the entry end of the accumulator. A loop forming arm 46, driven by chain and sprocket drive 47, and power driven by motor 48 is mounted in the looping tower 45.

FIGS. 7 and 8 show front and side views of one of the trolleys 35 and carriages 34 which convey the strip. Depending downward from each trolley 35 are protruding dogs 49. Mounted on each carriage 34 are rollers 50, a catch mechanism 51, and a support bracket 52. Pivotally mounted on the support bracket 52 is a strip support arm 53, and a cam follower 54. The strip support arm 52 is also mounted for rotation along its axis. A cam 55 is mounted on the support towers 31. FIG. 9 shows the cam action that raises the strip supporting arms 53 into a horizontal position.

OPERATION

Referring now to FIGS. 1, 2, and 3 and more specifically to FIG. 1, the entire line operates as follows: Strip 4 is unwound from a coil on a payoff reel 6, through the rolling mill 60 and onto a winding reel 70. When one payoff reel 6 or 18 is empty, i.e., all the strip in the coil is off the reel, and the opposite reel 18 or 6 is full, the first detecting device 30, which may be of the contact or noncontact type, located before or at the welding unit 32 detects and changes the velocity of the trailing end of the strip 4 from the empty payoff reel. The detecting device 30 simultaneously activates controls that begin feeding strip from a full payoff reel 6 or 18 as the case may be. The trailing end of the strip is then welded to the leading end of the strip on a full payoff reel. The shearing devices 12 and 24, located after each payoff reel 6 and 18 but before the welding device 32 cuts a straight edge on the trailing end and leading end of the strip 4 from each reel 6, 18 so that they may be properly welded together. The changeover of an empty to a full payoff reel and the associated shearing and welding of the strip may require as much as 3 minutes to accomplish. Therefore, the accumulator 40 must accumulate sufficient strip to allow the rolling mill 60 to continue to operate without stopping or slowing down.

An example of how the accumulator operates is as follows: In a rolling mill wherein strip is reduced from 0.325 inch to 0.080 inch thick, strip is entering the mill at about 500 feet per minute and leaving the mill at about 2000 feet per minute. As indicated above, when changing from an empty to a full payoff reel, it takes approximately 3 minutes to weld the trailing end of the strip from a coil leaving an empty payoff reel to the leading end of the strip from a coil on a full payoff reel. To eliminate changing the rolling mill speed or stopping the rolling mill for the welding operation, the accumulator must accumulate at least 1500 feet of strip to supply strip to the mill for 3 minutes. By running the strip from the coil on the payoff reel and into the accumulator at 100 percent overspeed, i.e., 1000 feet per minute which is 100 percent over the speed of the rolling mill in the above example, it would take 3 minutes to fill the accumulator with 1500 feet of strip. The computation is as follows:

Speed of strip entering mill 500 feet per minute;
Speed of strip entering accumulator 1000 feet per minute;
Excess strip remaining in accumulator 500 feet per minute;
Therefore, time required to accumulate 1500 feet is 1500 feet/500 feet per minute = 3 minutes.

The strip leaving the payoff reel must travel at 100 percent overspeed for slightly more than 3 minutes to compensate for the time it takes the strip to travel from one end of the accumulator to the other, e.g., where the accumulator is 40 feet long, and it takes about 5 seconds for a loop of strip to travel the length of the accumulator, the strip must be run off the coil on the payoff reel at 100 percent overspeed for at least 3 minutes and 5 seconds. Similarly, when a winding reel is full, i.e., a predetermined length is wound on the reel, a detecting device located after the last mill stand detects when the reel is full and actuates a flying shear which cuts the moving strip and feeds the strip onto an empty reel. Generally, the use of a flying shear makes it unnecessary to change or stop the movement of the strip when changing winding reels, and hence an accumulator between the last mill stand and the winding reel is not always required. However, flying shears, which cut moving strip, cannot cut strip properly when the velocity of the strip approaches about 600 feet per minute and cannot operate without damage to the shear, strip, and rolling mill at speeds of about 1000 feet per minute. Therefore, a second accumulator is desirable.

FIG. 2 shows a second accumulator 80 between the rolling mill 60 and the winding reels 68 and 70 to eliminate changing the mill speed when the mill is operating at a speed which would otherwise require a change in the mill speed to allow cutting the strip when changing winding reels. Obviously, as many accumulators as necessary can be used to maintain a constant mill speed. FIG. 3 shows how three accumulators 40, 80, 82 may be used in combination with a rolling mill 60 and a processing line 84. The processing line 84 could also be located after the accumulator 40 and the rolling mill after the accumulator 80 depending upon the line process function. The processing line may be any of a variety of operations, such as, heat treating, pickling, coating, shearing, or rolling. A first accumulator 40 between the payoff reels 6 and 18 and the mill 60 stores sufficient strip to eliminate stopping the rolling mill or varying its speed when changing payoff reels. A second accumulator 80 between the rolling mill 60 and the processing line 84 stores sufficient strip to eliminate changing the speed of the rolling mill when strip enters the processing line 84 where it may travel at a different speed. A third accumulator 82, between the processing line 84 and the winding reels 68, 70 stores sufficient strip to eliminate changing the speed of the rolling mill 60 and/or processing line 84 when changing winding reels. The operation of this combination is similar to that previously discussed for FIG. 2 except in the system just described there is a processing line 84 through which the strip 4 travels at a different speed than through the rolling mill 60. Therefore, to obtain a continuous flow of strip from the rolling mill to the processing line without having to change the mill speed, an additional accumulator is required. The amount of strip which must be stored on the second accumulator can be easily calculated. If, for example, the rolling mill is operating at 2010 feet per minute in combination with a processing line operating at 2000 feet per minute, there is an excess of 10 feet of strip per minute which must be stored on the accumulator. If the rolling mill is to operate without changing speed for 60 minutes, the second accumulator must accumulate at least 600 feet of strip.

Although the accumulators shown are located below the rolling mill in pits, accumulators may be located at or above the rolling mill level.

To illustrate how the accumulator operates, reference is made to FIGS. 4 through 9. Carriages 34 are mounted for travel around lower track 33, and are propelled along the rear portion of the lower track by the chain and sprocket drive 43, powered by motor 44. Trolleys 35 are mounted for travel around the upper track 32. At the entry end 41, the trolleys 35 are propelled by chain and sprocket drive 36 powered by motor 38. At the delivery end 42, the trolleys 35 are propelled by chain and sprocket drive 37 powered by motor 39. The chain and sprocket drives 36 and 37 are separately operated at predetermined speeds depending upon the amount of strip to be stored in the accumulator 40 and the amount of strip to be delivered to the rolling mill 60. As shown in FIG. 8 each trolley 35 has a protruding dog 49 which connects to the catch mechanism 51 on a carriage 34 to move the carriages at proper intervals at the entry end 41 and delivery end 42 of the accumulator 40. Between the entry end and the delivery end of the accumulator the lower track 33 descends at a decreasing angle so that the force of gravity acts to force a carriage 34 down the track to the delivery end of the accumulator. The combination of the trolleys 35, which pull carriages 34 along the track, the chain and sprocket drive 43, and the inclined track enables the carriages to travel completely around the

lower track. FIGS. 4A and 4B show the inclined paths of the tracks 32, 33 at the front and rear of the accumulator 40. As a carriage approaches the entry end of the accumulator, the cam follower 54, attached to the carriage 34 and support arm 53, engages the cam 55, mounted on the support towers 31, and rotates the vertically hanging strip support arm 53 into a horizontal position to support strip 4 entering the accumulator 40. The support arms 53 remain in the horizontal position as they travel down the track to the delivery end of the accumulator where the cam follower 54 disengages the cam 55 and the strip support arm 53 returns to a vertical hanging position. This cam action is shown in FIG. 9. As a support arm 53 travels from point A to B, as shown in FIG. 5, the loop forming arm 46 is synchronized to engage the top surface of the strip 4 and make one complete revolution as roll support 53 and carriage 34 move simultaneously from one station to the next. This action of the loop forming arm 46, as shown by FIG. 4, FIG. 5, and FIG. 6 forms a loop of strip 90.

When the accumulator is used in combination with a rolling mill and/or processing line it operates as follows: Strip 4 leaving the pinch rolls 31 is picked up at position A (see FIG. 5) by a strip support arm 53 which has been extended into a horizontal position by the action of the cam follower 54 engaging the cam 55. As the strip support arm 53 travels from position A to B, the looper arm 46 engages the strip and depresses it downward to form a loop of strip 90. The looper arm repeats this motion each time a support arm travels from position A to B to form a series of loops. To obtain this synchronized operation the motor 48 driving the chain and sprocket drive 47 which moves the looper arm 46 is in speed relation to the motor 38 driving chain and sprocket drive 36 which propels the trolleys at the entry end of the accumulator. The trolley motor 38 is in turn in speed relation to the speed of the strip 4 leaving the pinch rolls 31 so that the trolleys 35 move the carriages 34 and their strip support arms 53 at a rate sufficient to pick up the strip 4 leaving the pinch rolls 31. The loops of strip 90 are then conveyed by the carriages 34 from the entry end to the delivery end of the accumulator. At the delivery end the trolleys 35 move the carriages 34 and their strip support arms 53 at a rate sufficient to allow the rolling mill to pull each loop of strip out of the free hanging state as each support arm 53 moves from position C to D. As the carriages 34 leave position D, the cam follower 54 disengages the cam 55 and the strip support arms 53 return to the vertical hanging position. The carriages 34 are then returned to the entry end of the accumulator by chain and sprocket drive 43 powered by motor 44.

Although the invention has been shown in combination with certain specific embodiments, it will be readily apparent to those skilled in the art that various changes in form and arrangement of parts may be made to suit particular requirements without departing from the spirit and scope thereof.

I claim:

1. Apparatus to accumulate strip material in a strip processing line wherein said strip is continuously fed through said processing line from payoff reels and then automatically wound on winding reels comprising: a plurality of movable carriages each having a collapsible strip supporting arm; continuous track means for carrying said carriages; means for extending said supporting arm to a substantially horizontal position at the strip entry end; means for maintaining said supporting arm in said horizontal support position between the said entry end and said delivery end of said accumulator; first means for moving said carriages at said entry end at a rate related to the speed of said strip entering said accumulator; means for looping said strip over said support arms, thereby suspending it between adjacent support arms; second means for moving said carriages at said delivery end of said accumulator at a rate related to the speed of said strip leaving said accumulator, said second means of moving said carriages being independent of said first carriage moving means; third means for moving said carriages disposed intermediate said delivery end and said entry end independent of said first and second moving means for returning said carriages to said entry end from said delivery end.

2. Apparatus according to claim 1 wherein said collapsible supporting arm has a cam following arm and is pivotally attached to said carriage intermediate its strip supporting arm and cam following arm; and said means for maintaining said support arm in substantially horizontal position includes cam means disposed along said continuous track in the vicinity of said strip accumulating area intermediate said entry end and said delivery end disposed to coact with said cam following arm to raise and maintain said support arm in a substantially horizontal position.

3. Apparatus according to claim 2 wherein said support arm is rotatably mounted on said carriage about its longitudinal axis.

4. Apparatus according to claim 3 wherein said strip looping means includes a looping arm disposed in a plane substantially parallel to the plane of said strip; continuous track mean disposed in a plane substantially perpendicular to the plane of said looping arm and said strip; means for moving said looping arm around said endless track means in synchronism with said advancing strip whereby said looping arm will guide said strip to form a loop over said supporting arm, said looping arm guiding said looping strip over substantially the extent of the loop formed.

5. Apparatus according to claim 4 wherein said continuous track means includes a chain and sprocket means and said looping arm is rotatably mounted on said chain whereby it may rotate about its longitudinal axis as it transverses the circuit of the endless track to thereby eliminate relative movement between said strip surface and said looping arm perimeter to minimize marring of the surface of said strip.