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[54] **AUTOMATIC TRACKING CONTROL FOR LOOPING TOWER**

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[52] **U.S. Cl.** **226/1**, 226/36, 226/44, 226/113

[51] **Int. Cl.** **B65h 23/16**

[58] **Field of Search** 226/44, 1, 24, 36, 28, 226/38, 39, 113

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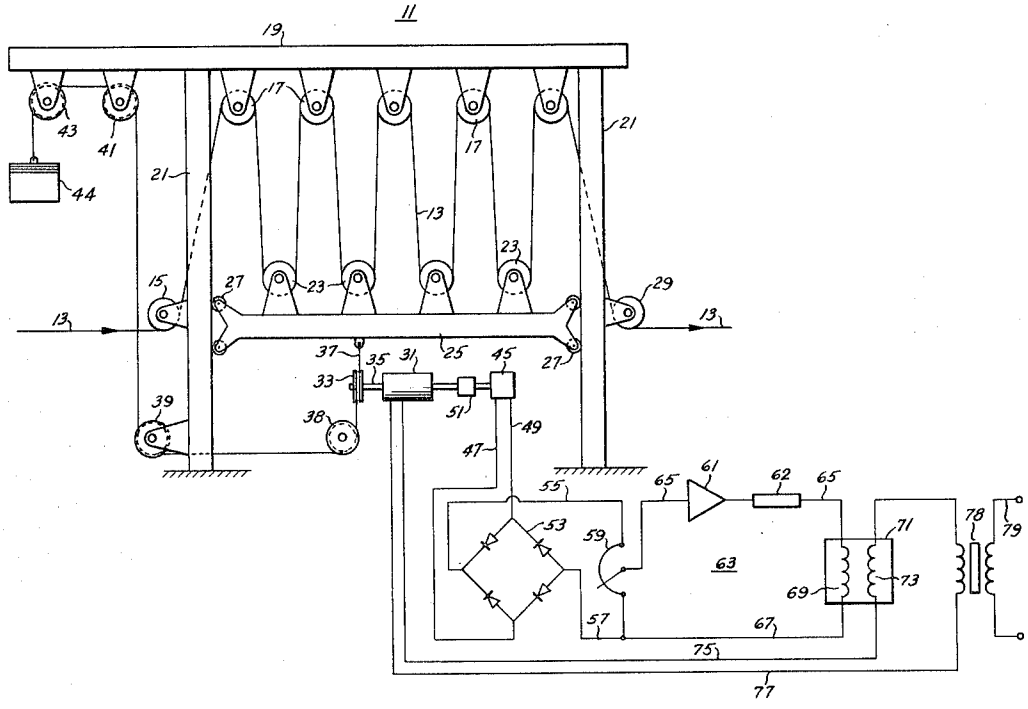
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[57] **ABSTRACT**

Tracking of strip evenly over the rolls of a looping tower is facilitated by detecting changes in the amount of strip accumulated in the looping tower and adjusting the tension in the strip proportionally to the rate of change in the amount of strip accumulated in the looping tower. The rate of change of strip so accumulated is preferably detected by measuring the rate of rotation of a torque motor arranged to provide a continuous tension in the strip as it passes through the looping tower.

23 Claims, 4 Drawing Figures



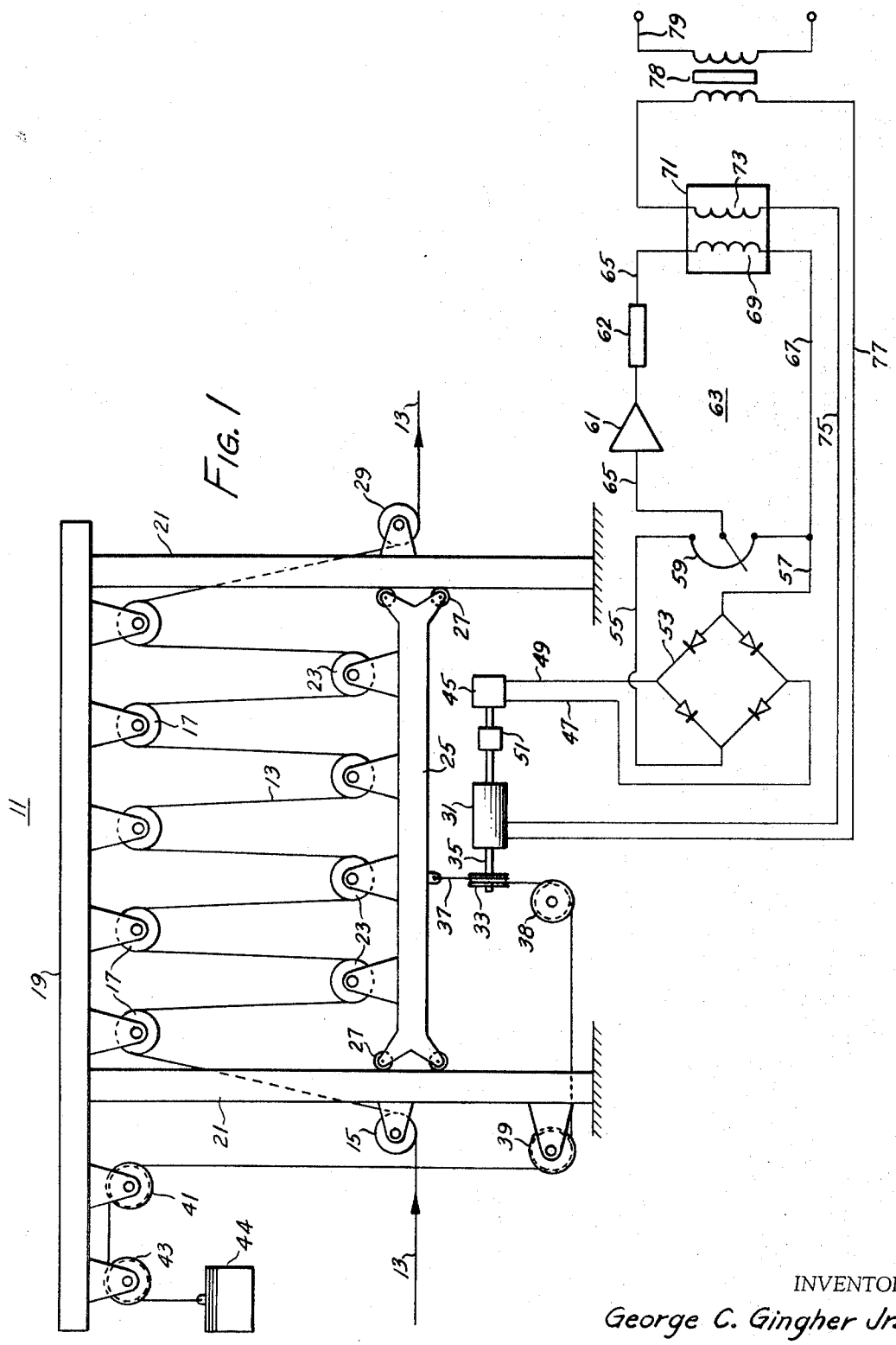
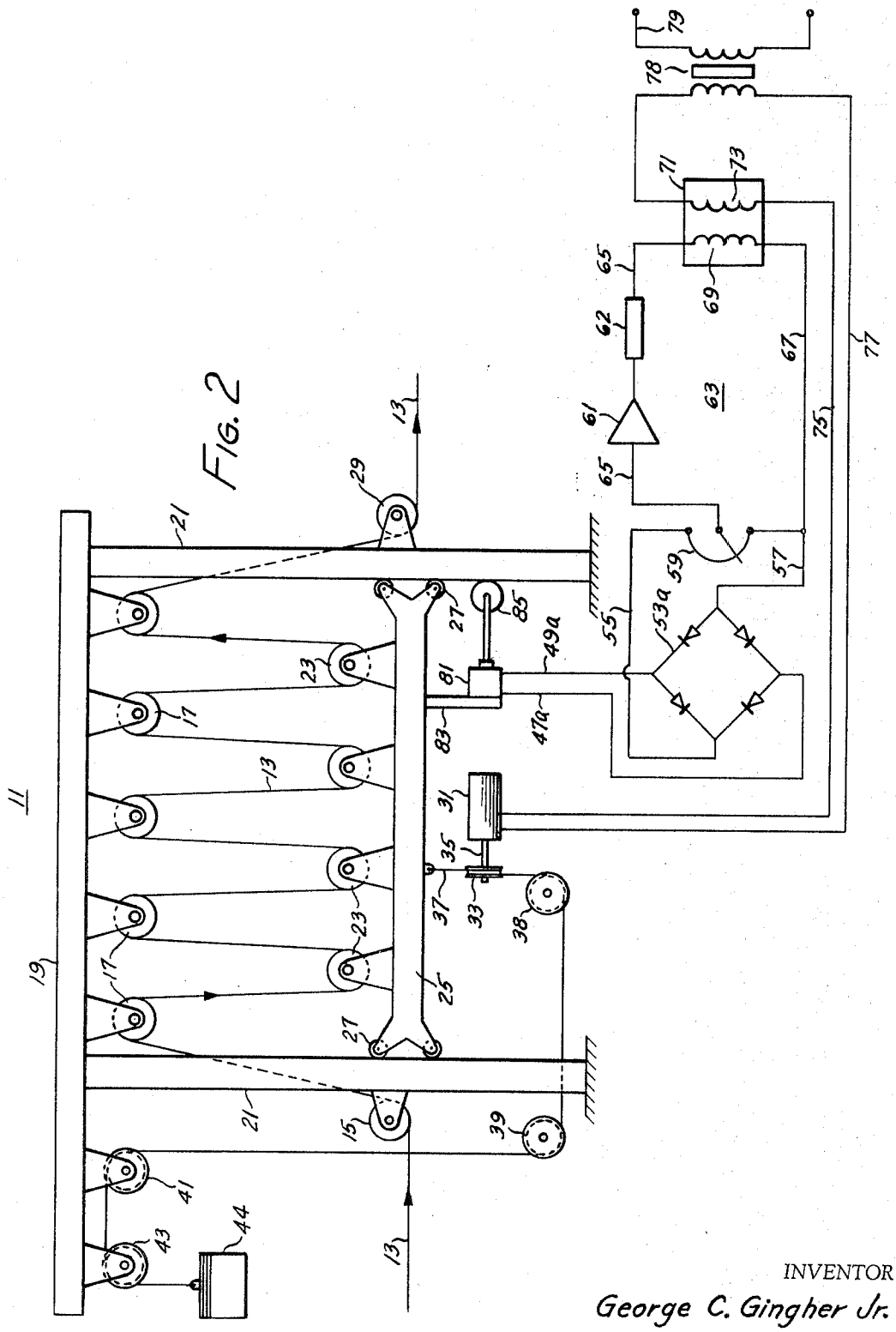


FIG. 1

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FIG. 2



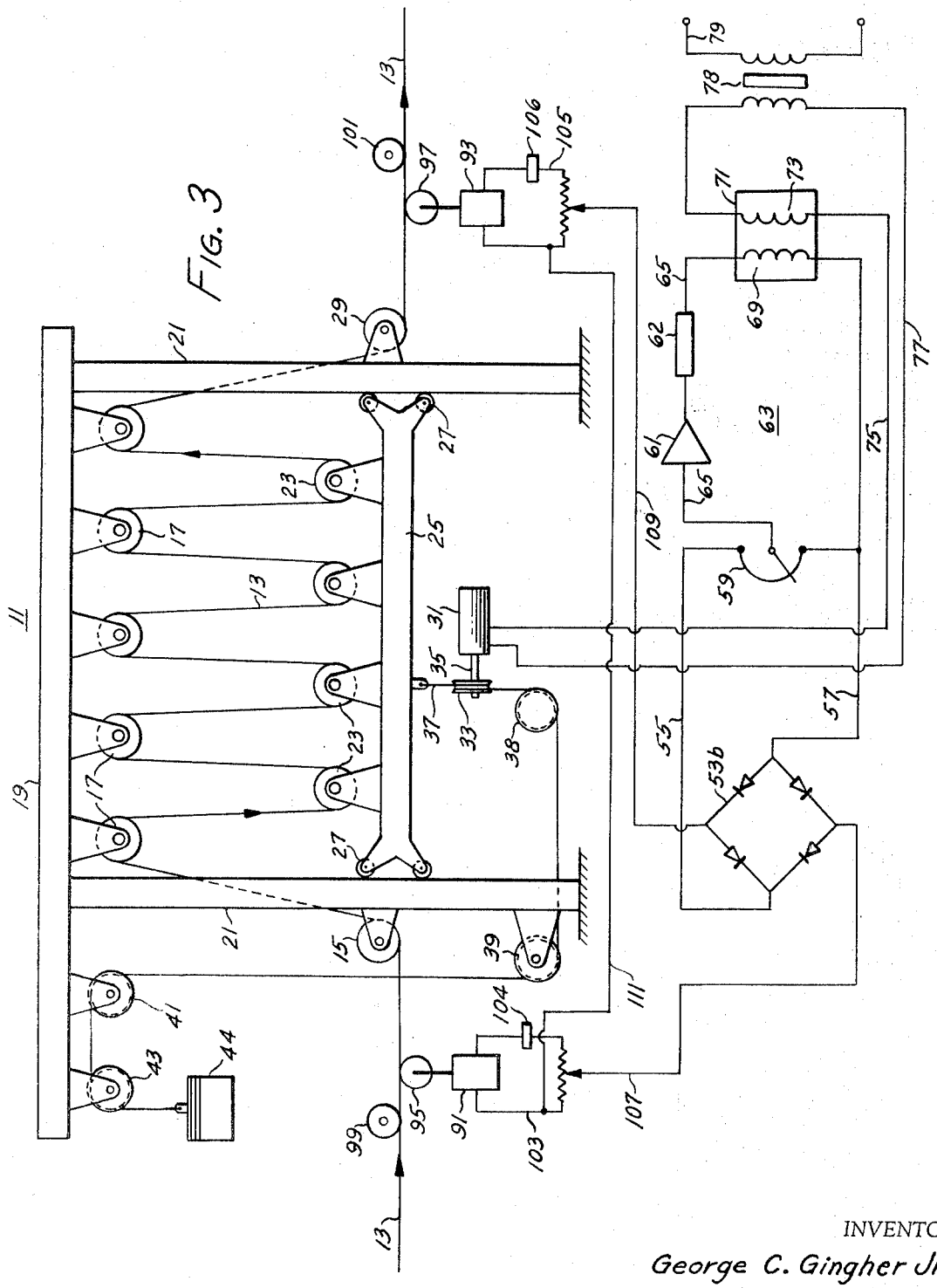
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FIG. 3



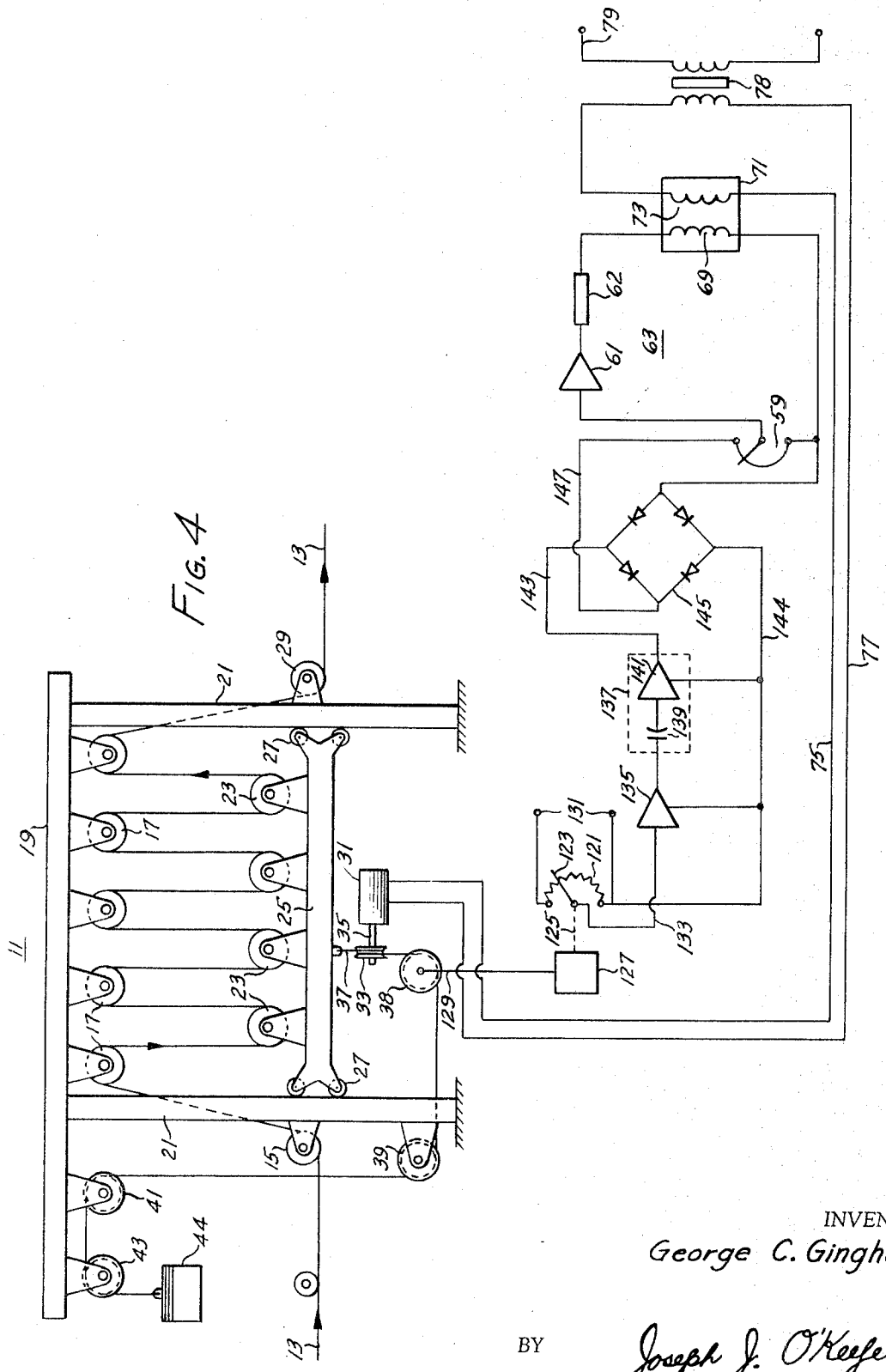
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FIG. 4



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AUTOMATIC TRACKING CONTROL FOR LOOPING TOWER

BACKGROUND OF THE INVENTION

The present invention relates to strip accumulation for continuous processing lines and more particularly to so-called "looping towers" and the improvement of strip tracking through looping towers.

It is customary in lines for the processing of strip such as ferrous strip or other strip to employ strip accumulators of various kinds to facilitate continuous processing. If any portion of the line must be stopped temporarily the accumulator will, dependent upon its intended use and location, either continue to feed strip to the still operating portions of the line or receive strip for storage from still operating portions of the line. When the line then resumes full operation the looping tower will, again dependent upon its intended function during temporarily interrupted operation, either store strip within itself or empty itself to prepare for the next period of interrupted operation.

In the past a common type of accumulator has been a looping pit. This consists merely of a pit in which a loop of material can be disposed. The pit, if full, can temporarily dispense strip material to the line even though no strip is being received in the pit. Alternatively, an empty pit can temporarily receive strip even though no strip is being withdrawn from the pit. Looping pits, however, while simple in construction, have the disadvantage that the strip disposed in them may easily be damaged by twisting or rubbing on itself or the sides of the pit, and pits of an impractical size are necessary to store large amounts of strip material.

In recent years looping pits have been largely superseded by so-called looping towers. In these towers a first series of rotatable rolls or sheaves are fixedly positioned at the top, or occasionally the bottom, of the tower on the tower framework. A second series of rotatable rolls or sheaves are movably mounted upon a carriage or other suitable mounting which moves up or down the tower toward or away from the fixed rolls. As the movably mounted rolls move away from the fixed rolls the tower will store progressively more and more strip material, and as the two series of rolls move toward each other the accumulated strip will be discharged from the looping tower. The strip storage capacity of the tower can be easily increased to any desired degree by increasing the number of sheaves in each series between which the strip passes. The movable series of sheaves may be located either at the top or the bottom of the tower.

Since strip passing through a looping tower is positively directed between rolls there is much less danger of the strip being damaged by contact with itself or the looping apparatus than there is with the use of looping pits or the like. However, considerable difficulty has been experienced in keeping the strip tracking correctly across the middle of the rolls. Incorrect tracking may cause the strip to run off the edges of rolls and/or bind on the tower framework and may often result in so-called "line wrecks." Since the speed of the strip inherently varies considerably over short periods of time as it passes through the looping tower, it has proven very difficult to keep the strip in adjustment so that it continuously tracks correctly. Various schemes have been tried to improve tracking of the strip, including automatic schemes for tilting the rolls dependent upon

the side of the roll toward which the strip is tending to move and the use of various side guides. Another scheme which has been used with some effectiveness is the provision of a predetermined tension upon the strip as it passes through the loop tower.

The tension in the strip passing through a looping tower can be continuously applied in several different manners. One very practical and satisfactory manner has been to attach a torque motor to the movable carriage upon which the second series of rolls are mounted. The torque motor applies a constant force to the carriage through a cable or the like connecting the shaft of the motor to the movable carriage. As long as the accumulation of strip in the tower remains constant the armature of the torque motor will not turn. The torque motor, however, even though not turning, will still apply a constant downward force to the carriage. If the carriage moves, the armature of the torque motor will rotate proportionally to the movement. The downward force applied by the torque motor to the carriage will, however, remain the same.

Another scheme which has been used to improve the tracking of the strip through looping towers has been to adjust the energization signal to the torque motor according to the speed of the strip through the processing line or through the looping tower. Still another scheme which has proved quite effective has been to adjust the energization signal to the torque motor according to the rate of change of speed of the strip through the looping tower. The speed of the strip has been obtained in this process from tachometers located either immediately before or after the looping tower, or both. While this arrangement has proven effective it has not been entirely satisfactory, particularly when the line is stopped but the looping tower is filling or discharging. At these times the amount of strip stored in the tower is actually changing at the fastest rate possible, yet, because the line is stopped no tension compensation at all may be applied. Tracking is therefore not satisfactory during these periods of operation. Tracking may in fact become so poor that line wrecks caused by the strip running off the rolls may occur. In addition, so-called transients occur with the tower tension changing abruptly at the times a line section speed starts or stops changing. These transients cause erratic tracking and may, due to the abrupt tension changes, damage or even break the strip.

SUMMARY OF THE INVENTION

The present applicant has discovered that the foregoing disadvantages of prior looping tower tension control systems can be obviated by adjusting the tension upon the strip in accordance with the rate of change of strip accumulated within the looping tower. A preferred embodiment, for example, detects the rotation of the shaft or armature of the torque motor which applies tension to the looper carriage and applies a tension energization signal to the torque motor proportional to the rate of rotation of the torque motor armature. The method and apparatus of the present invention, by using a completely different source of the tension compensation signal, avoids the loss of tension control during complete stops by the line, and in addition the tension compensation signal is automatically proportional to the rate of change of strip storage on a continuous basis, thus avoiding the detrimental transients of the prior art. Line stops and damaged product

due to trackoffs, running off the rolls, and transients are thus greatly reduced if not completely eliminated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a diagrammatic elevation of a looping tower incorporating a preferred embodiment of the tracking control of the present invention.

FIG. 2 shows a diagrammatic elevation of a looping tower incorporating another embodiment of the present invention.

FIG. 3 shows a diagrammatic elevation of a looping tower incorporating a still further embodiment of the present invention.

FIG. 4 shows a diagrammatic elevation of a looping tower incorporating a still further embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 there is shown a looping tower 11 having a strip 13 entering from a previous operation (not shown). The strip 13 passes first over a guide roll 15, then up over the first of a series of rotatable upper rolls 17 fixedly mounted on upper structural members 19, of the looping tower, which members 19 are supported on columns 21, then down over the first of a series of rotatable lower rolls 23 mounted upon a movable carriage 25 which is movable up and down the looping tower structure guided by suitable guide rolls 27. The strip 13 then passes up from the first of the lower rolls 23 to the second of the top rolls 17 and so on, back and forth between the top rolls 17 and the lower rolls 23 until the strip leaves the looping tower 11 by passage about a guide roll 29 and passes to a further operation (not shown).

A torque motor 31 is mounted at the base of the looping tower 11. A sheave 33 is mounted on the end of the shaft 35 of the torque motor 31. A cable 37 is secured to the bottom of the carriage 25, passes about the sheave 33, about guide sheaves 38, 39, 41, and 43 mounted on the framework of the tower 11 and is attached to a large counterweight 44 designed to place a certain predetermined minimum downward tension at all times upon the movable carriage 25 and the strip 13 passing about the lower rolls 23.

A tachometer generator 45 is secured to the opposite end of the shaft 35 from the sheave 33. When the amount of strip accumulated in the looping tower 11 is changing, that is to say when more strip is being fed from the tower 11 than is entering it, or more is entering the tower and being distributed between the upper series of rolls 17 and the lower series of rolls 23 than is leaving the looping tower, the shaft 35 of torque motor 31 will rotate in one direction or the other. The rate or speed of this rotation is detected by the tachometer generator 45 which will then put forth a current signal proportional to the rate of rotation in a direction in leads 47 and 49 appropriate to the rotational direction. Since the actual rotation of the torque motor 31 may not be very great, it may be advantageous or necessary to connect the tachometer generator 45 to the shaft 35 through an appropriate gearing or transmission 51 having a gear ratio suitable to rotate the tachometer generator 45 at a rate sufficient to generate a significant voltage regardless of the actual rate of rotation of the shaft 35.

The current generated by tachometer generator 45 proceeds by either lead 47 or 49 into a rectifying diode bridge circuit 53 which rectifies the current and directs it through leads 55 and 57 into an adjustable potentiometer 59 which suitably adjusts the current to any desired potential. An amplifier 61 is included with a suitable resistor 62 in the control circuit 63 comprised by leads 65 and 67 leading away from potentiometer 59 to the magnetic windings, or coil, 69 of a magnetic amplifier 71. The magnetic amplifier 71 controls the power supply to torque motor 31 through the agency of a coil 73 and a circuit comprised of leads 75 and 77 from a transformer 78 connected to an alternating current power supply 79.

The operation of the tension control of the present invention as embodied in FIG. 1 is as follows. When the feed through the strip line prior to the looping tower 11 is interrupted for any reason, such as, for instance, a halt to enable the ends of two metal strips to be welded together, strip previously accumulated in the tower will be fed from the tower over guide sheave 29, and the carriage 25 will be slowly, or quickly, as the case may be, drawn up the tower structure as the excess strip is fed from the tower. As the carriage is drawn up the tower the cable 37 will rotate sheave 33 and shaft 35 of torque motor 31. Shaft 35 will in turn rotate tachometer generator 45 through transmission 51 and said tachometer generator 45 will direct a signal along leads 47 and 49 proportional to the rate of rotation of the shaft 35 and in a direciton indicative of the direction of rotation of the shaft 35. The torque motor 31 meanwhile continues to apply a constant tension to strip 13 through cable 37 and carriage 25. This tension is determined by the torque of torque motor 31 as determined by the energization current which passes through leads 75 and 77. The current which passes through leads 47 and 49 is meanwhile proportional to the rotation of tachometer generator 45. This current is rectified in rectifier circuit 53 and is applied to the control circuit 63 where it is adjusted in amplitude by potentiometer 59, amplified by amplifier 61 and applied through coil 69 to magnetic amplifier 71 where it acts to increase the current through coil 73 and thus through leads 75 and 77 to the torque motor 31, in this manner increasing the torque of said motor 31 and thus the tension applied by the motor to carriage 25 and the strip 13 passing back and forth between the rolls 17 and 23. The additional tension, as the amount of strip stored in the looping tower changes, aids in maintaining proper tracking of the strip over the rolls of the tower and aids in the prevention of "track offs," or running off the rolls, "line wrecks" and the like. The additional tension will continue until the feed of strip into the looping tower is renewed at a rate sufficient to balance feed from the tower. When the two strip feed rates are balanced the carriage 25 will be stabilized in one position in the tower and the tachometer generator 45 will no longer rotate or direct a control current through leads 47 and 49.

Shortly after the line resumes full operation, the operator or an appropriate automatic control system (not shown) will increase the feed of strip to the looping tower 11 so that the feed rate of strip into the tower is temporarily greater than the feed rate out of the tower in order that the tower may be refilled with strip. When the feed rate into the tower is greater than the feed rate out, the torque motor 31 will draw the carriage 25

downwardly with a constant torque. The rotation of the shaft 35 of the torque motor 31 will rotate tachometer generator 45 which will, as a consequence, put out a current to the rectifier circuit 53 through leads 47 and 49. While the polarity of this current will be in a direction opposite to the polarity of the current passing through the circuit when the shaft 35 is rotated in the oppostie direction, the rectifier will rectify the current and apply it to the control circuit 63 in the same direction as before so that the control circuit will again increase the energization of the torque motor 31 and cause an increased torque to be applied to sheave 33 to increase the tension in strip 13 through cable 37 and carriage 25 proportionately to the speed of rotation of shaft 35 and thus the rate of change of the accumulation of strip in the looping tower. The tension in the strip is thus increased by the action of the control system proportionately to the rate of change of the accumulation of strip in the looping tower 11 regardless of whether the rate of change is positive or negative; that is to say, whether the absolute amount of strip accumulated in the tower is increasing or decreasing.

It will be readily understood that the action of the control system will be the same whether the line stoppage initially occurs before the strip reaches the looping tower 11, as just explained, or after the tower. If stoppage is expected subsequent to the tower, the tower will ordinarily be operated with as little strip accumulated in it as possible and during a stoppage the line will feed excess strip to the looping tower until the line operation resumes or until the storage capacity of the tower is exhausted. As soon then as the tower starts to accumulate excess strip, the shaft 35 of torque motor 31 will begin to rotate and the control system will act to increase the tension in the strip through the action of the torque motor to aid in proper tracking of the strip. When the line resumes full operation the tower will then feed out the accumulated strip and the shaft 35 of the torque motor will rotate in the opposite direction, again increasing the energization current to the torque motor through the action of the control system to increase the strip tension and aid in proper tracking of the strip over the tower rolls as the tower is emptying.

In FIG. 2 there is shown an alternative arrangement for detecting the movement of the carriage 25 of a looping tower 11. The numbers of the various parts in FIG. 2 are in general the same as those in FIG. 1 where the parts are the same and the operation of the various components are in general the same. In FIG. 2, however, there is no extension of shaft 35 of the torque motor 31 to operate a tachometer generator. Instead, a tachometer generator 81 is mounted upon a bracket 83 dependently attached to the carriage 25. A rotatable roller 85 mounted upon or otherwise operatively connected to the tachometer generator 81 contacts a supporting column 21 of the looping tower in a position such that the movement of the carriage 25 up and down the looping tower as the amount of strip accumulated in the tower changes will cause rotation of the roller 85 and energization of the tachometer generator 81. The tachometer generator 81 will then put out a signal on its leads 47*a* and 49*a* to the rectifier circuit 53*a* which is in every way comparable in function and operation to the rectifier 53 shown in FIG. 1. Th operation of the control circuit shown in FIG. 2 is then similar to that shown in FIG. 1 to increase the tension in the strip proportionately to the rate of change of any change in the amount of strip accumulated in the looping tower.

In FIG. 3 there is shown still another embodiment of the invention. As in FIG. 2, the numerals of the various parts and components shown are generally the same where the functions and operation of the components are the same. In FIG. 3, however, instead of there being one tachometer generator which detects the movement of carriage 25 directly through a suitable mechanical linkage with adjacent structures, there are provided instead two tachometer generators 91 and 93 positioned at opposite ends of the looping tower 11 which detect the speed of the strip passing by them through the agency of rollers 95 and 97 which contact the strip as it passes between guide rollers 99 and 15 and 29 and 101 respectively. Tachometer generators 91 and 93 each have a separate tachometer signal circuit of their own shown diagrammatically as 103 and 105 respectively with appropriate included resistors 104 and 106.

Leads 107 and 109 respectively tap off a potential from these circuits 103 and 105 and apply these separate potentials to a rectifier circuit 53*b*. A lead 111 meanwhile connects the two circuits 103 and 105 in opposition. If the two tachometer generators are generating the same current due to the travel of the strip being in the same direction (as it will invariably be) and at the same speed, the potential at the same point in each circuit 103 or 105 will be the same and there will be no flow of current through the circuit comprised of leads 107, 109 and 111. If either tachometer generator is rotating at a greater rate, than the other, however, due to the strip 13 either entering or leaving the looping tower faster than it is leaving or entering respectively, different potentials will be generated in each of the two tachometer circuits 103 and 105 at similar points in the circuits and a current will be induced within the circuit partially comprised of leads 107, 109 and 111. The direction of this current will depend upon which tachometer is registering the greatest speed of strip adjacent the looping tower 11. The rectifier circuit 53*b* will function, however, to rectify the resulting current so that it is always applied to the control circuit in the same direction. The currents in the tachometer circuits 103 and 105 are in effect subtracted from each other by the circuitry shown and the differential current remaining and detected by the control circuit 63 is proportional to the rate of change of accumulation of strip within the looping tower whether the tower is accumulating additional strip or is emptying itself. The differential current is amplified by the control circuit 63 and is used to control the energization current to the torque motor 31 through the agency of magnetic amplifier 71 to adjust the torque of motor 31 proportionally to the rate of change of strip accumulation. The tension in the strip 13 within the tower 11 is thus varied proportionally to the rate of change of accumulation of the strip in the tower and tracking of the strip over the rolls 17 and 23 of the looping tower 11 is greatly improved.

In FIG. 4 there is shown still another embodiment of the invention. As in FIGS. 2 and 3, the numerals of the various parts and components are the same. In FIG. 4 instead of using a tachometer generator to detect the movement of the carriage 25 directly, or indirectly, as the case may be, there is instead a potentiometer 121 having a movable contact 123 connected by a suitable

mechanical linkage **125** to the output of a step down gear assembly **127.** The input of the step down gear assembly **127** is connected to a shaft **129** secured to the axle of the sheave **38.** Sheave **38** may in this instance have a fairly large diameter in order to aid the gear assembly **127** in decreasing the movement of the movable contact **123** of potentiometer **121** in relation to the movement of cable **37** past sheave **38.** The movement of cable **37** is, of course, proportional to the movement of the carriage **25** and thus to the change in the amount of strip **13** distributed between the upper rolls **17** and the lower rolls **23** on carriage **25.**

Potentiometer **121** is energized by a voltage source **131.** Movable contact **123** of potentiometer **121** will develop a voltage signal dependent upon its position on potentiometer **121** and direct the signal through leads **133,** first to a filtering amplifier **135** and then into a suitable differentiator **137** shown diagrammatically as a capacitor **139** and an amplifier **141** arranged in series. As will be understood by those skilled in the art, the differentiator **137** will provide no output signal so long as the voltage of its input signal originating from potentiometer **121** remains constant. As the input signal varies, however, the differentiator will provide a varying output signal which will have a negative polarity if the input is decreasing and a positive polarity if the input is increasing. The output signal from the differentiator **137,** which is proportional to the rate of change of the setting of the movable contact **123** of potentiometer **121,** is applied through leads **143** and common lead **144** to a rectifier bridge circuit **145** which serves to rectify the signals from the differentiator **137** to a constant polarity. The rectified signals from bridge circuit **145** are then applied via lead **147** and variable potentiometer **59** to the control circuit **63** where they are suitably amplified in amplifier **61** and directed through resistor **62** into the windings **69** of magnetic amplifier **71** which controls the energization signal along leads **75** and **77** to the torque motor **31.** Filtering amplifier **135** is provided in the circuit to eliminate or reduce noise in the system. The operation of differentiators is generally quite easily disturbed by extraneous noise in a circuit.

Suitable selsyn and discrimination equipment could be substituted for the potentiometer arrangement in FIG. **4.** In such case the selsyn signal would serve as the position signal to determine movement of the movable carriage **25.** It will be recognized also that the potentiometer **121** in FIG. **4** could, as an alternative, also be connected through gearing **127** to the shaft of the torque motor **31** as shown in the case of tachometer **45,** in FIG. **1** or to a dancer roll as in FIG. **2.** Also the tachometer of FIG. **2,** potentiometer of FIG. **4,** or any other suitable detection device could be connected to any of the sheaves **38, 39, 41** or **43** through appropriate gearing.

The present invention has been found particularly useful for the control of the tracking of metallic strip through looping towers but it will be recognized that the principles of the invention can be applied to the tracking of other types of strip through looping towers and that arrangements of control systems may be used to adjust the tension in the strip proportionately to the rate of change of the accumulation of strip within a looping tower.

I claim:

1. A method of improving tracking of strip over the rolls of a looping tower by varying the tension in the strip as it passes through the looping tower comprising:

a. detecting the rate of change of any change in the amount of strip accumulated in the looping tower, and

b. altering the tension in the strip in the looping tower in proportion to the rate of change in the absolute amount of strip accumulated in the looping tower as the rate of change in the amount of strip accumulated in the looping tower is detected.

2. A method of improving tracking in a looping tower according to claim **1** wherein the tension in the strip is induced by torque motor means connected to movable sheave means on the looping tower.

3. A method of improving tracking in a looping tower according to claim **2** wherein the rate of change of strip in the looping tower is detected by measuring the rotation of the said torque motor means.

4. Looping tower apparatus for strip comprising:

a. a first series of positionally fixed rolls around which the strip passes,

b. a second series of movable rolls opposed to the first set of rolls and around which the strip passes in between passage about the first set of rolls,

c. tension means operatively connected to the second series of rolls to maintain tension in the strip as it passes through the looping tower,

d. detection means to detect a change in the amount of strip accumulated between the first and second series of rolls in the looping tower, and

e. means to direct an energization signal to the tension means proportional to the rate of change of the amount of strip accumulated between the first and second series of rolls.

5. Apparatus according to claim **4** wherein said tension means of (c) is comprised of torque motor means.

6. Apparatus according to claim **5** wherein the rate of change in the amount of strip accumulated between the first and second series of rolls is detected by detecting the rotation of the torque motor means.

7. Apparatus according to claim **4** wherein the second series of movable rolls of (b) are mounted upon movable frame means and the detection means of (d) detects the amount of strip accumulated in the looping tower by detection of the position of the movable frame means.

8. Apparatus according to claim **7** wherein the means of (d) to detect a change in the amount of strip accumulated in the looping tower comprises tachometer means which detects movement of the movable frame means.

9. Apparatus according to claim **8** wherein the amount of strip accumulated between the first and second series of rolls is detected by detecting the rotation of the torque motor means.

10. Apparatus according to claim **7** wherein said tension means of (c) is comprised of torque motor means operatively connected to the movable frame means.

11. Apparatus according to claim **7** wherein the means of (d) to detect a change in the amount of strip accumulated in the looping tower comprises potentiometer means which detects movement of the movable frame means.

12. Apparatus according to claim 4 wherein the rate of change in the amount of strip accumulated between the first and second series of rolls is detected by tachometer means positioned at the entrance and exit of said looping tower and the means of (e) directs an energization signal proportion to the speed differential between the said tachometers to the torque motor means.

13. A method for improving tracking of strip over the rolls of a looping tower comprising:

a. passing strip through the looping tower at a predetermined minimum tension,

b. detecting the rate of change of increases and decreases in the amount of strip accumulated in the looping tower,

c. increasing the tension in the strip passing over the rolls in the looping tower above the predetermined minimum tension of the strip in the tower in proportion to the rate change of such increases and decreases in the amount of strip accumulated in the looping tower as the rate of change of such increases and decreases in the amount of strip accumulated in the looping tower is detected.

14. A method of improving tracking in a looping tower according to claim 13 wherein the tension in the strip is induced by torque motor means connected to movable sheave means on the looping tower.

15. A method of improving tracking in a looping tower according to claim 14 wherein the rate of change of strip in the looping tower is detected by measuring the rotation of the said torque motor means.

16. A method of improving tracking of strip over the rolls of a looping tower comprising:

a. passing strip through the looping tower at a predetermined minimum tension;

b. detecting positive and negative rates of change in the amount of strip accumulated in the looping tower;

c. providing an additional amount of tension in the strip passing over the rolls in the looping tower above the predetermined minimum tension of the strip in proportion to the rate of change of at least one of such positive and negative changes in the amount of strip accumulated in the looping tower as the positive and negative rates of change in the amount of strip accumulated in the looping tower are detected.

17. A method of improving tracking of strip over the rolls of a looping tower according to claim 16 additionally comprising:

d. continuously altering the tension in the strip above the predetermined minimum tension in response to continuing detection of positive and negative changes in the accumulation of strip in the looping tower in proportion to the rates of such changes in the amount of strip accumulated in the looping tower.

18. A method of improving tracking of strip over the rolls of a looping tower according to claim 17 wherein the alteration in the tension in the strip is directly proportional to the rate of changes in the accumulation of strip in the looping tower.

19. A method for improving the tracking of strip over the rolls of a looping tower according to claim 18 wherein the tension in the strip is induced by torque motor means connected to movable sheave means on the looping tower.

20. A method for improving the tracking of strip over the rolls of a looping tower according to claim 19 wherein the rate of change of strip in the looping tower is detected by measuring the rotation of said torque motor means.

21. A method of improving tracking of strip over the rolls of a looping tower comprising:

a. passing strip through the looping tower at a predetermined minimum tension while the amount of strip accumulated in the looping tower is constant;

b. detecting the rate of change of increases in the amount of strip accumulated in the looping tower while at the same time increasing the tension in the strip passing over and between the rolls in the looping tower above the predetermined minimum tension of the strip in proportion to the detected rate of change of such increases in the amount of strip accumulated in the looping tower, and

d. detecting the rate of change of decreases in the amount of strip accumulated in the looping tower while at the same time increasing the tension in the strip passing over and between the rolls in the looping tower above the predetermined mimimum tension of the strip in proportion to the detected rate of change of such decreases in the amount of strip accumulated in the looping tower.

22. A method of improving tracking of strip over the rolls of a looping tower according to claim 21 wherein the alteration in the tension in the strip is directly proportional to the rate of changes in accumulation of strip in the looping tower.

23. Looping tower apparatus for strip comprising:

a. a roll support means,

b. a plurality of rolls around which the strip passes and which are arranged upon said roll support means in at least two oppositely disposed series of rolls between which the strip passes back and forth and is accumulated in the looping tower, at least one of said series of oppositely disposed rolls being movable with respect to the remaining series of rolls in order to vary the distance between the series of rolls and thereby vary the total accumulation of strip in the looping tower between the series of rolls,

c. tension means operatively connected to at least one of the series of rolls to maintain tension in the strip as it passes through the looping tower proportional to an energization signal directed to the tension means,

d. detection means to detect a change in the amount of strip accumulated between the series of rolls in the looping tower, and

e. means to direct an energization signal to the tension means proportional to the rate of change of the amount of strip accumulated between the series of rolls in the looping tower in accordance with and as signals are received from said detection means.

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