Dec. 3, 1968 J. J. KOVALESKI 3,413,834

STRAND WORKING AND SPOOLING APPARATUS AND METHOD

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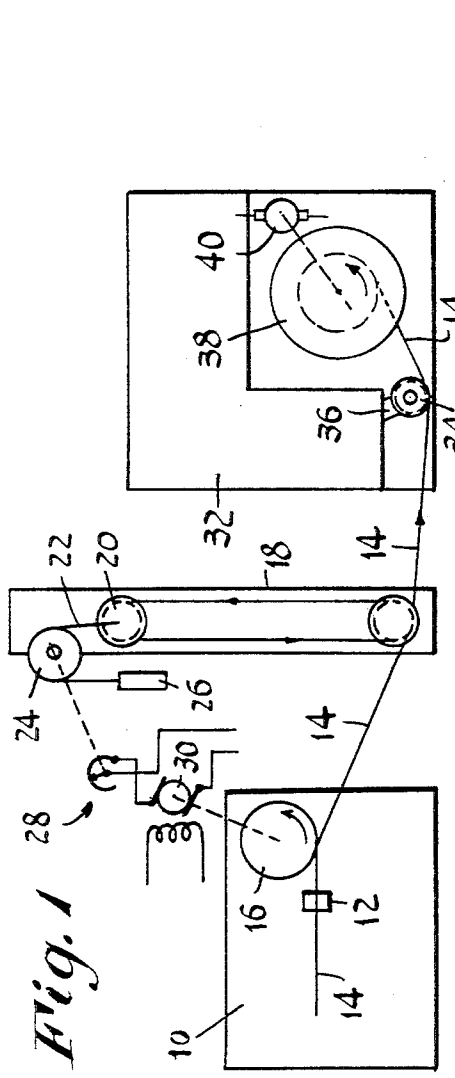


Fig. 1

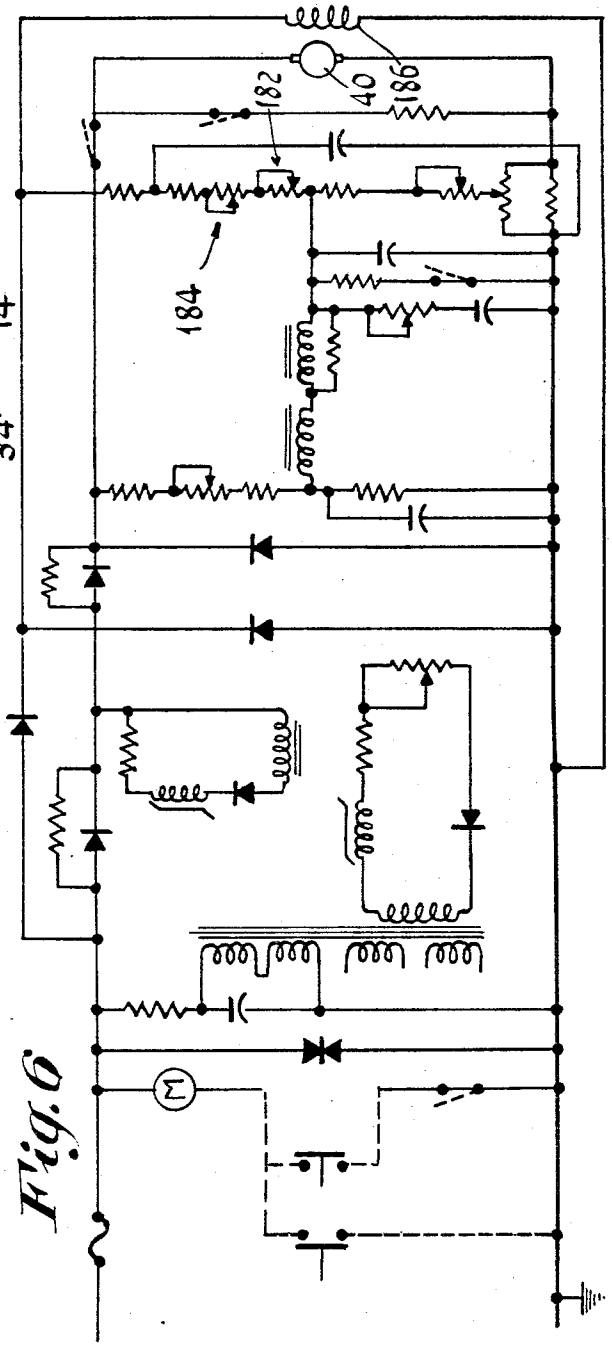


Fig. 6

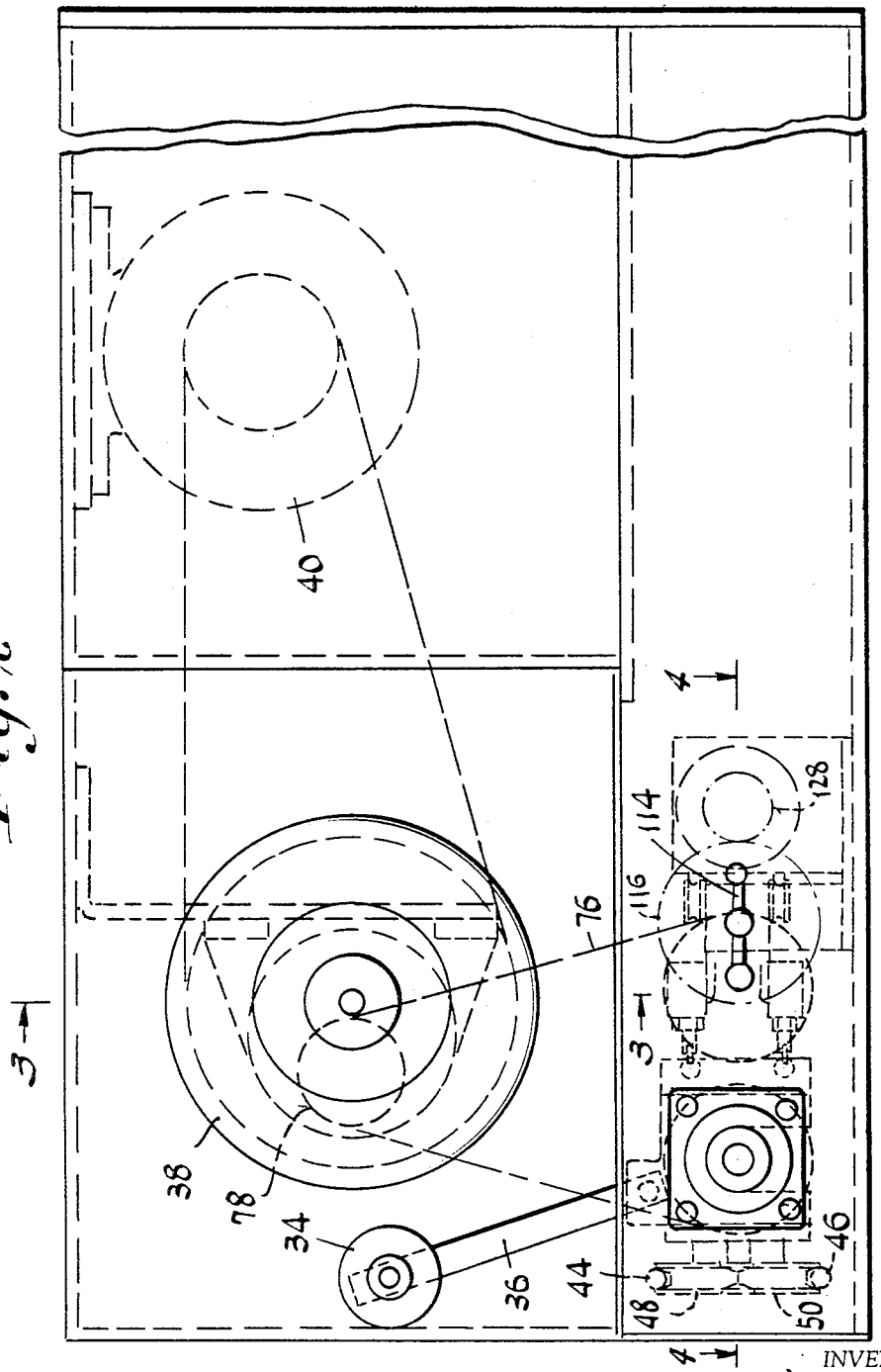
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STRAND WORKING AND SPOOLING APPARATUS AND METHOD

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Fig. 2



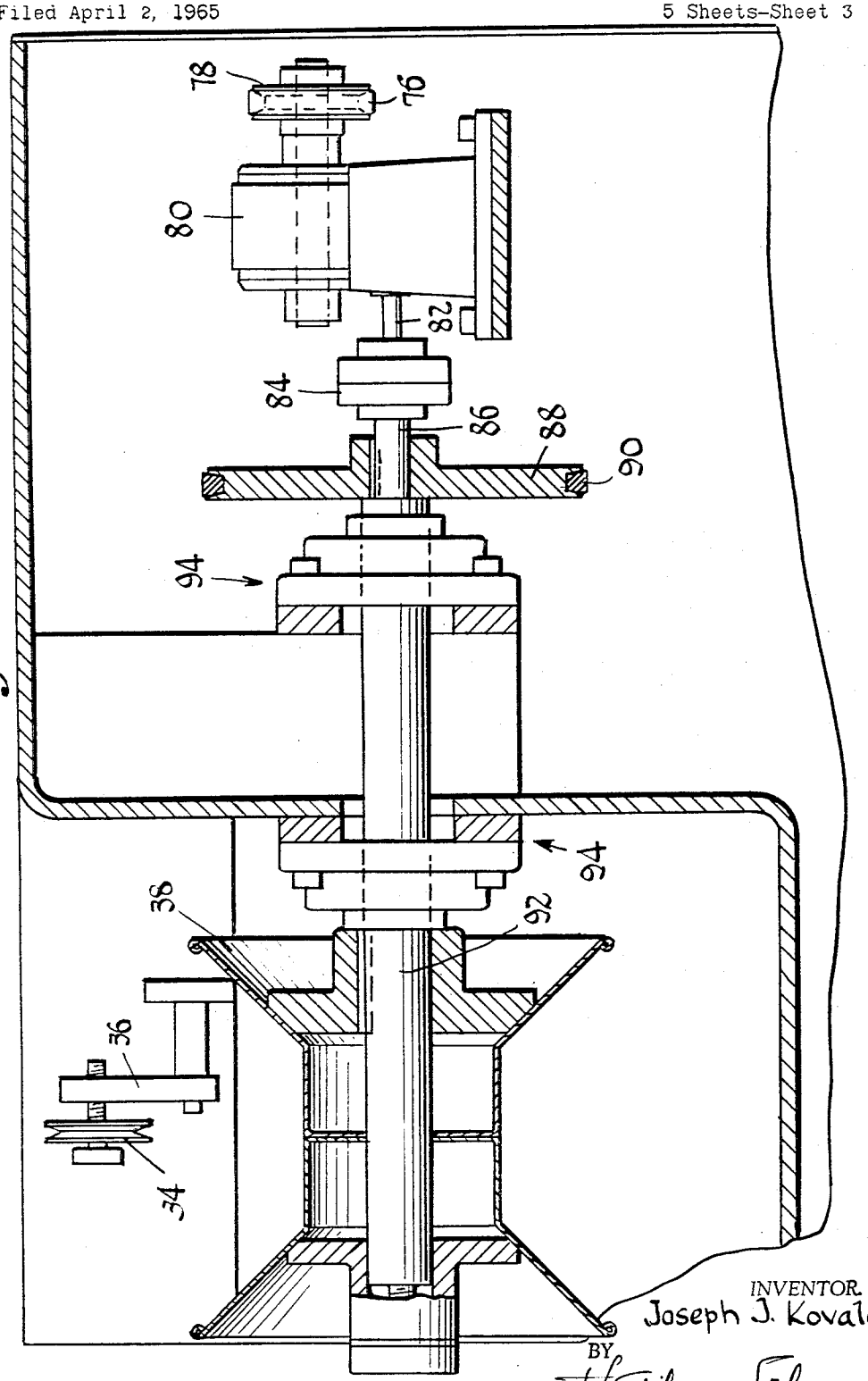
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STRAND WORKING AND SPOOLING APPARATUS AND METHOD

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Fig. 3



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STRAND WORKING AND SPOOLING APPARATUS AND METHOD

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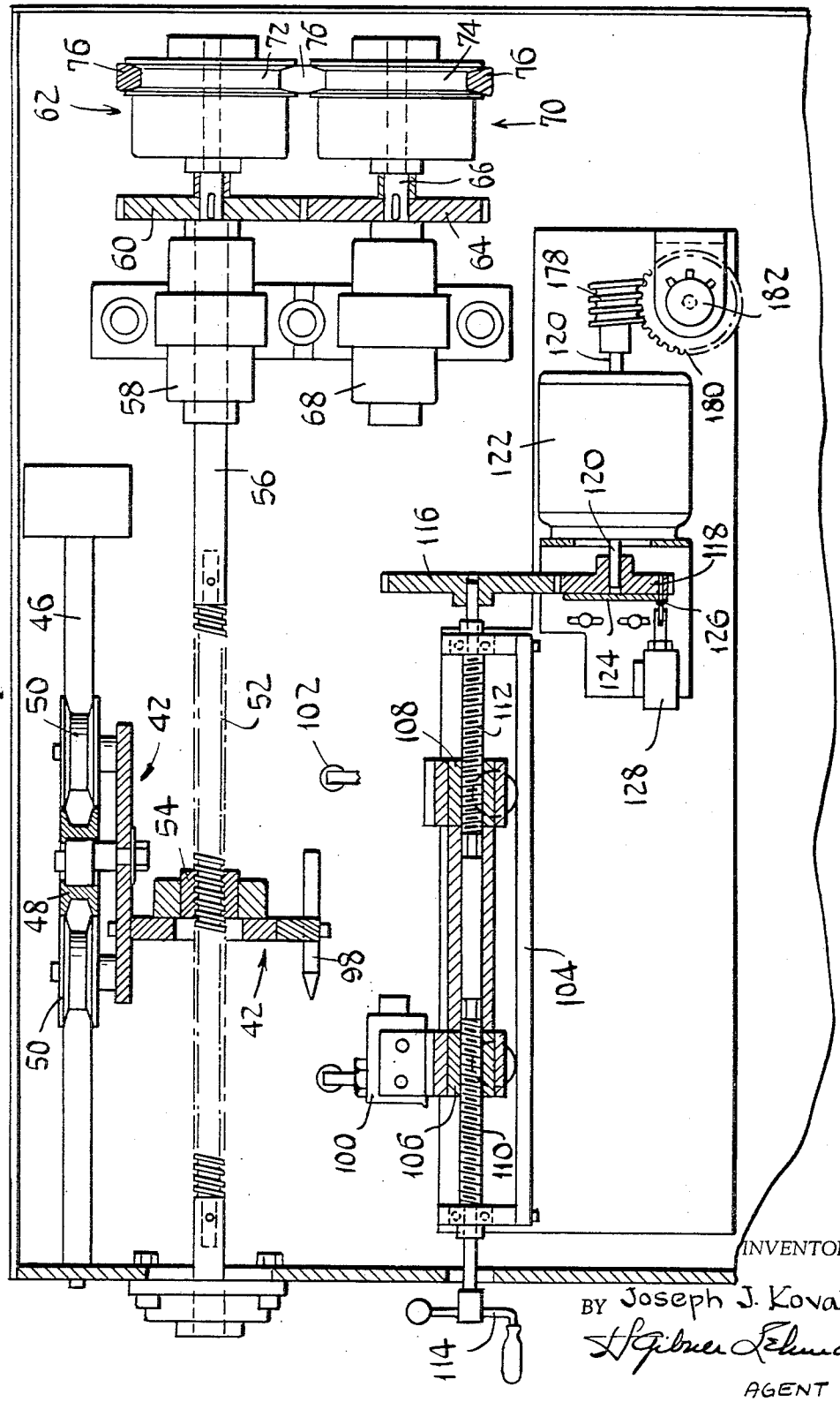


Fig. 4

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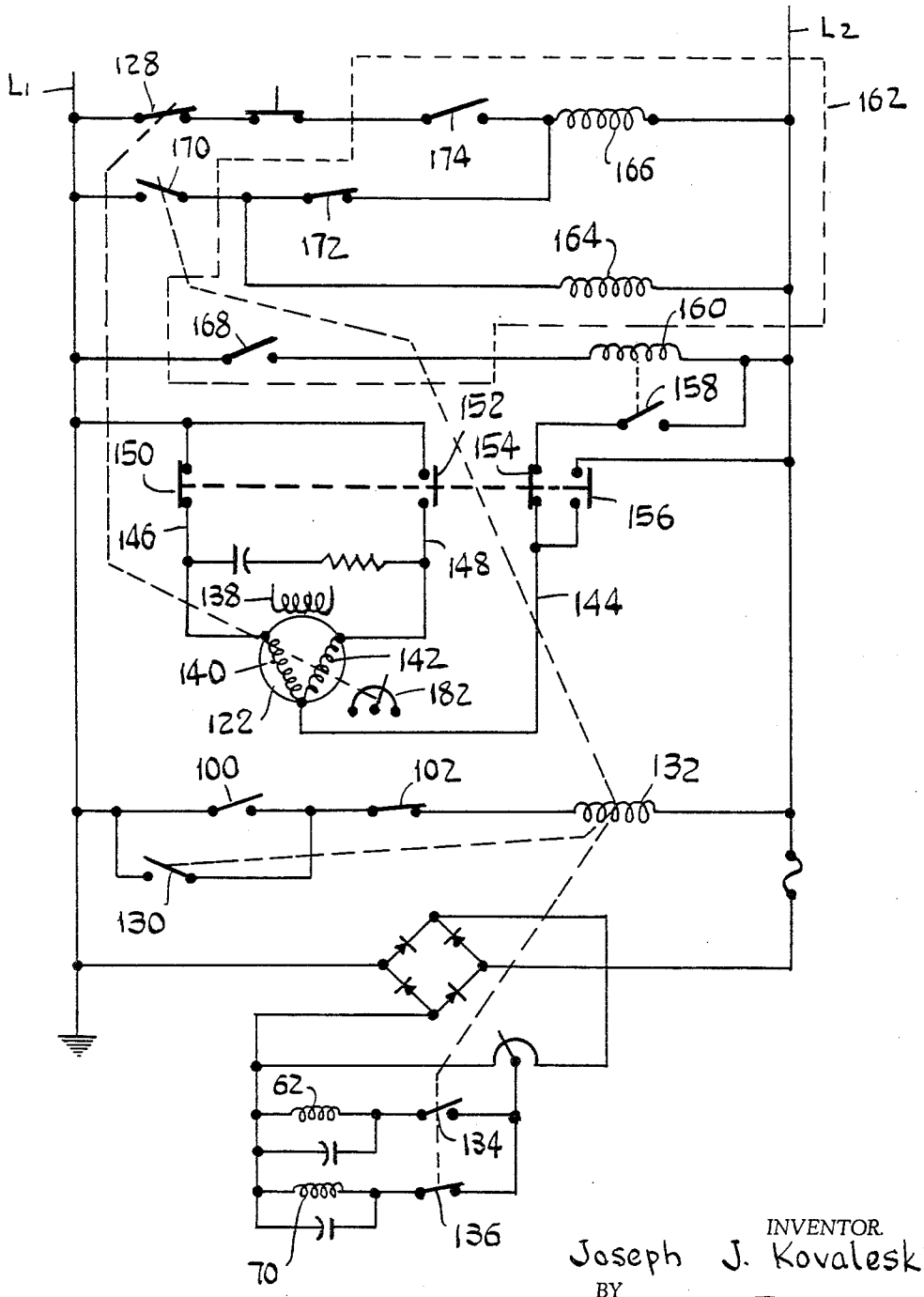
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STRAND WORKING AND SPOOLING APPARATUS AND METHOD

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Fig. 5



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STRAND WORKING AND SPOOLING APPARATUS AND METHOD

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Filed Apr. 2, 1965, Ser. No. 445,079
19 Claims. (Cl. 72—289)

ABSTRACT OF THE DISCLOSURE

A spooling machine having a powered spool traverse whose limits are adjustable. There is an adjustable, independent or master timing device which provides successive, adjustable time intervals, and a control mechanism activated by the timing device, which periodically automatically increases the separation or spacing of the limits of the traverse and simultaneously reduces the spool speed by predetermined increments. The time period between the increments can be varied by adjusting the timing device, and is a multiple of the traverse period whereby either many or else few traverses can occur between separation increments of the traverse limits and decrements of the spool speed.

This invention relates to the processing and spooling of wire and other strands.

An object of the invention is to provide a novel and improved apparatus and method for working and spooling strands of material, as for example metal wire, by which there is effected a highly desirable simplicity, economy and also reliability, and by which there is also provided generally an improved and more effective operation beyond that heretofore obtainable with known methods and equipment.

When applied to the art of metal wire, the invention effects specific improvements as follows:

Heretofore, in spooling metal wire which emerges from a wire drawing machine, control of the build-up on the spool was effected by a dancer arrangement which included special and somewhat complicated controls to govern the speed of spooling. The spooling speed being a variable, was controlled by the wire tension in the cases where dancer type controls were utilized.

One specific object of the present invention is to provide an improved wire working and spooling apparatus and method by which a substantially constant wire speed, as in feet per minute, is effected while at the same time eliminating the drawbacks heretofore accompanying constant speed operation.

Another object of the invention is to provide an improved apparatus and method as above set forth, wherein substantially constant tension in the wire is also maintained, as well as a substantially constant speed, during the full build-up of the wire on the spool.

A feature of the invention resides in the provision of a spooling apparatus and method as above characterized, wherein the ratio of the barrel to flange diameter of the spool may be as great as two to one while still attaining the desired objectives.

A still further object of the invention is to provide an improved wire spooling apparatus and method in accordance with the foregoing, wherein variations in the speed of the wire are held to small values, well within a figure of 5%, for instance.

Yet another object of the invention is to provide improved means for effecting an automatic spreading of the traverse travel-limit devices, in conjunction with the foregoing objectives and features.

A further feature of the invention resides in the provision of an improved wire drawing and spooling apparatus and method characterized by substantially constant wire speed and wire tension, wherein the speed of the wire drawing machine is within limits made to be a subservient factor, such speed having relatively small variations as dictated by incremental build-up of the wire on the spooling equipment.

Yet another feature of the invention is the provision of a combination wire drawing and spooling machine as above set forth, wherein the inherent friction or drag of the wire-drawing die is utilized to effect the necessary deceleration required by the incremental speed control of the spooling equipment.

Still another feature of the invention resides in the provision of a constant speed and constant tension wire drawing and spooling combination as outlined, wherein a dancer which controls the speed of the wire drawing machine will have a relatively stable function involving only small movements throughout the full build-up of the wire on the spool. In consequence, the effective range of movement of the dancer is relatively small, occupying but a minor zone of the entire range available.

Other features of the invention involve the provision of an improved apparatus and method as above characterized, wherein a highly desirable uniformity in the product is obtained, with greatly reduced waste.

Other features and advantages will hereinafter appear.

In the drawings accompanying this specification, similar characters of reference are used to designate like components throughout the several views, in which:

FIG. 1 is a diagrammatic representation of a processing and spooling apparatus as provided by the invention, illustrating a wire drawing machine, a dancer speed control therefor and a wire spooling machine.

FIG. 2 is a side elevational view of one type of spooling apparatus as provided by the invention.

FIG. 3 is a horizontal sectional view taken on the line 3—3 of FIG. 2.

FIG. 4 is a horizontal sectional view taken on the line 4—4 of FIG. 2.

FIG. 5 is a schematic circuit diagram illustrating a major portion of the spooling speed and traverse control mechanism provided by the invention.

FIG. 6 is a schematic circuit diagram illustrating another portion of the spooling speed control system.

Considering first FIG. 1, there is illustrated a wire drawing machine **10** including a drawing die **12**. A strand of wire **14** is shown as passing through the die **12** and around a final block or capstan **16**, after which it passes to a dancer assemblage **18** having sheaves **20** movable vertically in suitable supports (not shown). Connected with the sheaves **20** is a cable **22** passing over a pulley **24** and having a weight **26** by which the sheave assemblage **20** is continually urged in an upward direction. Any increase in the tension of the wire strand **14** results in the sheave assemblage **20** moving downward, the reverse being true when the strand **14** experiences a decrease in tension.

The pulley **24** is mechanically coupled to a variable resistor **28** which controls the drive motor **30** for the capstan **16**. The above arrangement represents one conventional way for controlling the linear speed of the wire strand **14** in accordance with the tension existing in the strand, as it is sensed by the dancer assemblage **18**.

From the dancer **18** the wire strand **14** enters the spooling machine **32** and passes over a traverse pulley **34** carried by a supporting arm **36**. From the pulley **34**, the wire is reeled onto a spool **38** driven from a variable speed electric motor **40**.

Referring to FIGS. 2–4, the traverse pulley **34** and arm **36** are carried by a carriage **42** which travels along slide bars **44**, **46** engaged by pulleys **48**, **50** of the carriage.

Driving of the carriage **42** in reverse directions is effected by a drive screw **52** threaded into a nut **54** on the carriage. The drive screw **52** is mounted on a shaft **56** carried by a bearing **58** and having at its outer end a spur gear **60** and an electric clutch **62**. Engaged with the spur gear **60** is another spur gear **64** of like diameter, carried on a jack shaft **66** mounted in a bearing **68**. The jack shaft **66** also has an electric clutch **70**, and the clutches **62, 70** are connected to drive pulleys **72, 74** respectively which are driven by a common belt **76** passing over a powered pulley **78**. A speed reducer **80** carries the pulley **78** and is in turn powered through its input shaft **82** which is connected by a coupling **84** to the drive shaft **86** for the spool **38**. On the drive shaft **86** a pulley **88** is mounted, being driven by a belt **90** from the motor **40**. The spool **38** is carried by a spool spindle **92** mounted in bearings **94** and carrying the drive shaft **86** and pulley **88**.

With the above organization, driving power which turns the spool **38** is also applied to the clutch pulleys **72, 74,** and depending on which one of the two clutches **62, 70** is energized, the drive screw **52** will be driven or turned in one direction or the other, thereby effecting a movement of the traverse carriage **42** either to the left or to the right. By properly controlling the clutches **62, 70** the carriage **42** may be reciprocated from left to right, and the extent of movement of the carriage (and consequently of the traverse pulley **34**) may be varied by effecting longer or shorter intervals of energization of the clutches.

In accordance with the present invention, the extent of movement of the traverse pulley **34** and carriage **42** is automatically controlled and increased as the spooling of the wire **14** proceeds, thereby to take care of the conical configuration of the end flanges of the spool **38**. Also, at the same time the speed of turning of the spool **38** is automatically decreased in order to effect a substantially constant linear speed of the strand **14**, such traverse movement and speed adjustment being controlled by an independent or settable adjustable timing device which constitutes the master control for determining the linear speed, wire speed, and wire build-up on the spool **38**.

Referring again to FIG. 1, by establishing a given linear speed for the wire **14** which is being reeled onto the spool **38**, a control is had over the speed of the wire drawing machine, notably the final block or capstan **16** thereof. For, if the speed of the capstan **16** is too fast as compared with the speed of the spooling machine **32**, the tension in the strand **14** will be lessened, and the result on the dancer arrangement **18** will be a counterclockwise turning of the pulley **24** and the adjustable resistor **28**, to the end that the speed of the motor **30** which drives the capstan **16** will be decreased. On the other hand, if the speed established by the independent timer associated with the spooling machine is too great, as compared with the speed of the wire drawing machine, a dancer response **18** will be such as to effect a clockwise turning of the pulley **24** and the adjustable resistor **28**, to the end that the motor **30** will be speeded to bring up the speed of the wire drawing machine to the proper value. Thus, in accordance with the present invention, an indirect control of the speed of the wire drawing machine is had by means of the spooling machine and the associated control circuitry, through the medium of the tension in the wire **14** and operation of the dancer assemblage **18** which controls the wire drawing machine speed. The advantageous result is that the linear speed of the wire strand **14** is maintained quite constant, within a variation of less than 5%, and also that the tension in the strand is maintained substantially constant, all with relatively simple equipment and in a simple manner.

The speed and traverse travel control effected by the adjustable timer device is accomplished as follows: Considering first the traverse travel, adjustable trip members **98** (only one of which shows in FIG. 4) are mounted on the traverse carriage **42**, such trip members being engageable with limit switches **100** and **102** respectively, which are adjustably carried by a slide **104** and have threaded nuts **106, 108** receiving screws **110, 112** respectively. The drive screws **110, 112** are coaxial and manually adjustable by a hand wheel **114**.

Also, such screws are automatically adjusted or turned by increments, through the medium of a spur gear **116** meshing with a smaller spur gear **118** on the shaft **120** of an index motor **122** of slow speed characteristic and capable of starting and stopping instantly.

The gear **118** has a face plate **124** carrying actuator buttons **126** engageable seriatim with an index switch **128** so arranged as to effect a halting of the index motor **122** after the latter has turned through a fraction of a revolution.

The actuation of the limit switches **100, 102** effects an automatic control of the electric clutches **70** whereby an automatic reversing movement of the carriage **42** takes place between the limits established by the particular position of the limit switches.

Further, an actuation of one of the limit switches, as for example the limit switch **100**, will start an independent timer device which thereafter, independently of a succeeding reciprocation of the carriage **42**, will after a predetermined interval of time energize the index motor **122**. This will cause an incremental adjustment of the adjustable limits, **100, 102** by virtue of turning of the drive screw **110, 112** through part of a revolution.

Such turning, effected by the index motor **122**, will also result in actuation of the switch **128** by which the motor **122** is deenergized through inactivation of the timer device and a switch later described. Upon this deenergization and then a succeeding actuation of the limit switch **100**, the timing cycle and adjustment of the limit switches is repeated. The timing cycle is long enough to enable a number of traversals to be effected before the motor **122** adjusts the limits **100, 102** to their next settings.

The control circuit by which this is accomplished is shown in FIG. 5. In this figure, the limit switches **100, 102** are shown as connected in series, the latter switch being normally closed whereas the switch **100** is normally open. Across the switch **100** are connected a set of relay contacts **130**, which constitute holding contacts for a relay coil **132** which controls additional sets of relay contacts **134** and **136**, connected respectively to the clutches **62, 70**. Direct current is supplied to the clutches through the relay contacts **134, 136** in the manner shown in the circuit.

It will be noted that the contacts **136** are normally closed, and open when the relay coil **132** is energized, the reverse being true for the contacts **134**. Thus, alternate energization of the clutches **62, 70** is effected in response to energization and deenergization of the relay coil **132**. If the limit switch **100** is closed, even momentarily, the energization of the relay coil **132** will be continued through the holding contacts **130**, and will only be discontinued upon actuation of the limit switch **102** to open the circuit through the coil. Thus, an automatic traversal control occurs, by virtue of the above described circuit components.

The index motor **122** is of the reversible type having an exciting winding **138**, as well as load windings **140, 142** which latter are connected to a common energizing lead **144** and also to separate energizing leads **146, 148** joined to the main feed line L1 and having respectively in their circuits mechanically coupled control switches **150, 152** by which either one line or the other (and one winding **140** or the other **142**) may be energized individually, but not simultaneously.

Thus, actuation of the switches **150, 152** may result in either forward or reverse rotation of the motor **122**, providing a circuit is completed through the common lead **144** to the main line L2. The switch **150** is normally closed and the switch **152** normally open, except when these are manually shifted. Mechanically connected to

the switches **150**, **152** are switches **154** and **156**, the latter being directly connected to the line L2 and the switch **154** being connectable to the line L2 through a time delay switching device including a switch **158** and a solenoid actuator **160** for the switch **158**.

It will be understood that if the coupled switches **150**, **152**, **154**, **156** are actuated from the positions shown to their opposite conditions the motor **122** will be immediately energized for reverse movement, whereas when these switches are in the shown positions forward movement of the motor can occur, but not until the time delay switch **158** is closed.

Closing of such time relay switch is effected by an independent settable counter device having components located within the dotted box outline **162**. This is an adjustable counter or time delay switch mechanism which is produced commercially under the tradename "Micro-Flex" No. HZ40A6. The delay switching device includes a "counting" coil **164**, which effects synchronous rotation of an armature (not shown). Associated with the armature is a clutch coil **166** operating a clutch (not shown) which drives a switch operator having a delayed action in closing a normally open switch **168**. The switch **168** is connected to effect energization of the solenoid **160**.

Energization of the counting coil **164** is effected immediately upon energization of the traverse relay **132**, by virtue of a set of relay contacts **170** in the counting coil circuit. The relay contacts **170** are also connected with a normally closed switch **172** of the clutch coil whereby the latter is simultaneously energized with energization of the counting coil. Holding contacts **174** also connect with the clutch coil **166** to maintain energization of the latter after opening of the relay contacts **170** as a consequence of deenergization of the traverse relay **132**.

For each period of energization of the relay coil **132**, the counting coil **164** will be operative, and upon reverse travel of the traverse during which the relay **132** is deenergized, the counting coil will be deenergized and inoperative. Thus, the counting or timing procedure is effective only during movements of the traverse in one direction, as from left-to-right when viewing FIGS. 3 and 4.

Upon the desired overall elapse of time being effected by the delay device **162**, the delay action operator for the switch **168** which is under the control of the clutch coil **166** will be effective in closing the switch **168**, whereupon the time delay switch **158** will be closed, effecting a forward energization of the index motor **122**. This will tend to separate the limit switches **100**, **102** by a fixed small increment as determined by the spacing between the actuator buttons **126** engageable with the switch **128**. The incremental adjustment of the traverse is thus halted by a button **126** opening the index switch **128** which action, as seen in FIG. 5, deenergizes the clutch coil **166** during the next right-to-left movement of the traverse. By suitable adjustment of the time delay device **162** the incremental adjustment of the traverse limits may be made to occur after each two complete traversals, or after three complete traversals, four complete traversals, etc. depending on the overall range of delay incorporated in the device.

Accordingly it is seen that a repeating incremental increase in the movement of the traverse is effected under the control of an independent timing device, and such incremental adjustment may be made to suit the size of the wire being reeled on the spool **38**, whereby in conjunction with the angular end flanges of the spool, a satisfactory layering of the wire will occur.

Also, in accordance with the invention, simultaneously with the repeated incremental adjustment of the traverse limits there is effected an automatic decrease in the speed of the drive means which powers the spool **38** and spindle **92** therefor, such that as the wire builds up on the spool the rate of turning of the latter is correspondingly decreased. In consequence, a substantially constant linear speed of the wire strand **14** may be readily effected, the speed adjustment being also incremental but occurring with such frequency that a speed variation well within a 5% limit is readily effected. And, in accordance with the invention, the same time delay device and index motor which is used to adjust the traverse limits is also employed for effecting the speed decrease of the spool **38**.

Referring to FIG. 4, a motor shaft **120** is provided with a worm **178** which meshes with a worm gear **180** carried by a shaft of an adjustable resistor **182** which is included in the circuit of the motor **40** driving the spool **38**. Accordingly, upon the indexing movements of the motor **122**, the adjustable resistor **182** will also be adjusted, resulting in a generally gradual decrease in the motor speed and speed of the spool **38**. Such decrease, in conjunction with the increase of travel of the traverse, makes possible a substantially smooth layering of the wire on the spool **38**, and a linear wire speed which is substantially constant, as well as effecting a substantially constant tension in the wire between the spooling and wire drive machines.

The energizing and speed control circuit for the spool driving motor **40** is shown in FIG. 6. In this figure, a basic adjustable resistor **184** is connected in series with the adjustable resistor **182** to provide the necessary overall speed range and calibration of the spooling motor **40**. The field coil **186** of the motor **40** has variable energization, as shown, this being effected by the adjustable resistors **182**, **184**. The resistor **182** is automatically adjusted by the index motor **122**, as already explained.

It will now be understood from the foregoing that I have provided a novel and improved combination strand processing and handling or spooling apparatus and method which in a unique manner effects a substantially constant linear speed of the strand or wire, and simultaneously maintains a substantially constant tension in the wire, all by means of a single independent timing device which not only controls the spooling apparatus but also indirectly controls the speed of the wire drawing machine or processing equipment located ahead of the spooling apparatus. The operation of the equipment as provided by the invention is reliable and foolproof, and enables a superior product to be produced with very little waste, and at a relatively high rate of production. The adjustment or setting of the apparatus provided by the invention may be easily and quickly effected, involving essentially a setting of the independent timing device to provide the desired incremental adjustment of the traverse and reduction in spooling speed of the spool driving means.

Variations and modifications may be made within the scope of the invention, and portions of the improvement may be used without others.

I claim:

1. In a spooling machine, in combination:

(a) reversible reciprocative means for guiding a strand of material back and forth, onto a spool,

(b) adjustable limit means operable to control the extent of movement of said reciprocative means,

(c) power means for operating said reciprocative means,

(d) an adjustable independent timing device providing a time base whereby a time period of determinate length can be run off,

(e) means for rendering said timing device operative in response to an operation of said limit means, and

(f) means controlled by said independent timing device, for effecting automatic adjustment of said limit means upon the expiration of said determined period of time.

2. A spooling machine as in claim **1**, wherein:

(a) means are provided, responsive to the operation of said limit adjustment means, for automatically limiting the extent of said adjustment.

3. A spooling machine as in claim **1**, wherein:

(a) the adjustable limit means comprises limit switches and reversing means controlled by said switches, for

effecting automatic reversal of said reciprocative means,

(b) said means controlled by the timing device effecting shifting of said limit switches to new positions.

4. A spooling machine as in claim 2, wherein:

(a) the timing device comprises an electrical counter,

(b) said means for limiting the extent of adjustment of the limit means rendering temporarily inoperative the counter each time that the adjustment is limited.

5. In a spooling machine, in combination:

(a) means including a powered spindle, for spooling a strand of material,

(b) reversible reciprocative means for guiding said strand of material back and forth, onto said spooling means,

(c) an adjustable speed power drive for said spindle,

(d) an adjustable independent timing device, providing a time base whereby a time period of determinate length can be run off,

(e) control means responsive to an operation of said reciprocative means, for automatically rendering operative said independent timing device, and

(f) means controlled by said timing device, for effecting automatic speed adjustment of said power drive after the elapse of said time period starting from the beginning of operation of the timing device.

6. A spooling machine as in claim 5, wherein:

(a) operation-sustaining means are provided for said control means, said sustaining means acting independently of said reciprocative means after the latter has initially effected operation of the control means.

7. A spooling machine as in claim 6, wherein:

(a) the means for effecting said automatic speed adjustment comprises an adjustable resistor and a motor for adjusting the same, and comprises means for temporarily rendering the timing device inoperative to further effect speed adjustment of the power drive after a specified amount of operation of said speed adjustment means.

8. In a spooling machine, in combination:

(a) means including a powdered spindle, for spooling a strand of material,

(b) reversible reciprocative means for guiding said strand of material back and forth, onto said spooling means,

(c) an adjustable speed power drive for said spindle,

(d) adjustable limit means operable to control the extent of movement of said reciprocative means,

(e) power means for operating said reciprocative means,

(f) an adjustable independent timing device, providing a time base whereby a time period of determinate length can be run off,

(g) control means responsive to an operation of said limit means, for automatically rendering operative said independent timing device,

(h) means controlled by said timing device, for effecting automatic speed adjustment of said power drive after the elapse of said time period starting from the beginning of operation of the timing device, and

(i) means controlled by said timing device, for effecting automatic adjustment of said limit means after said elapse of time.

9. A spooling machine as in claim 8, wherein:

(a) the adjustable limit means includes limit switches and a relay controlled thereby, and

(b) the means for rendering the timing device operative includes contacts controlled by said relay.

10. A spooling machine as in claim 9, wherein:

(a) the means for effecting speed adjustment and for effecting adjustment of the limit means comprises an electric motor made operative by the timing device, and

(b) automatic means for deenergizing the electric motor after it has operated for an interval of time.

11. Apparatus for processing and handling wire comprising, in combination:

(a) means for performing at one station an operation on a strand of wire,

(b) adjustable-speed power means for pulling said strand from said station,

(c) means including a powdered spindle, for spooling said strand at another station,

(d) means responsive to the tension in the strand between said pulling and spooling means, for automatically controlling the speed of said power means,

(e) an adjustable speed power drive for said spindle,

(f) an adjustable independent timing device, providing a time base whereby a time period of determinate length can be run off, and

(g) control means controlled by said timing device, for effecting automatic speed adjustment of said power after the elapse of said time period starting from the beginning of operation of the timing device drive.

12. The invention as defined in claim 11, wherein:

(a) the operation-performing means includes a wire-drawing die,

(b) the means controlled by the timing device comprises a motor-operated adjustable resistor and means for causing the operation thereof to be incremental.

13. Apparatus for processing and handling wire comprising, in combination:

(a) means for performing at one station an operation on a strand of wire,

(b) adjustable-speed power means for pulling said strand from said station,

(c) means including a powered spindle, for spooling said strand at another station,

(d) reciprocative means for guiding said strand back and forth, onto said spooling means,

(e) means responsive to the tension in the strand between said pulling and spooling means, for automatically controlling the speed of said power means,

(f) an adjustable speed power drive for said spindle,

(g) an adjustable independent timing device, providing a time base whereby a time period of determinate length can be run off,

(h) control means responsive to operation of said reciprocative means, for automatically rendering operative said independent timing device, and

(i) speed adjustment means controlled by said timing device, for effecting automatic speed adjustment of said power drive after the elapse of said time period starting from the beginning of operation of the timing device.

14. The invention as defined in claim 13, wherein:

(a) operation-sustaining means are provided for said control means, said sustaining means becoming operative after the control means has been initially rendered operative by the reciprocative means, and

(b) means for causing the operation of the speed adjustment means to be incremental, each different increment occurring in a different one of said time periods.

15. The method of increasing the extent of traverse movement in a spooling machine, which includes the steps of starting an independent timer when the traverse attains a predetermined position in its operating movement, and shifting a movement limit of the traverse after a fixed amount of operation of the timer.

16. The method of increasing the extent of traverse movement in a spooling machine, which includes the steps of starting an independent timer when the traverse attains a predetermined position in its operating movement, and shifting a movement limit of the traverse after a fixed amount of operation of the timer corresponding to a number of complete cycles of the traverse.

17. The method of decreasing the speed of the spool during strand build-up in a spooling machine of the type having a spool traverse, which includes the steps of starting an independent timer when the traverse attains a predetermined position in its operating movement, and slowing the spool drive by an increment after a fixed interval of operation of the timer.

18. The method of increasing the extent of traverse movement and simultaneously decreasing the speed of the spool during strand build-up in a spooling machine, which includes the steps of starting an independent timer when the traverse attains a predetermined position in its operating movement, and shifting a movement limit of the traverse while simultaneously slowing the spool drive by fixed increments after a fixed interval of operation of the timer.

19. The method of processing and handling wire, which includes the steps of performing an operation on a strand of wire at one station, feeding the strand to a spooling means having a spool traverse at another station, pulling the strand from said one station at a speed commensurate

with the tension in the strand at a point ahead of said spooling means, and decreasing the rotary speed of the spooling means by increments following each other in regularly timed sequence wherein the time periods between increments are of fixed length, each time period corresponding to a given fixed number of traversals of the spool traverse.

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