Oct. 14, 1941. W. G. COOK 2,259,241

STRIP REEL DRIVE

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Fig. 1.

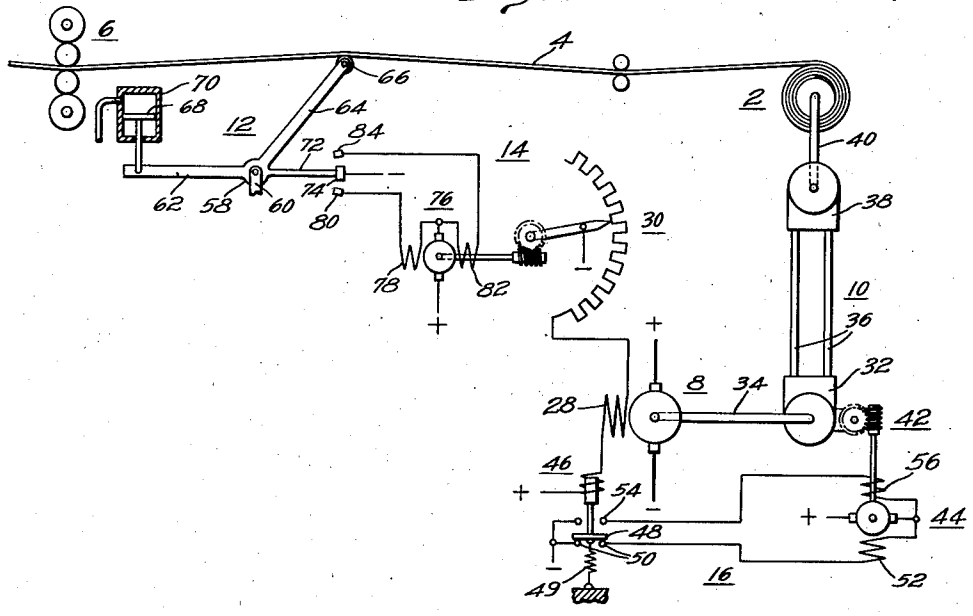

Fig. 2.

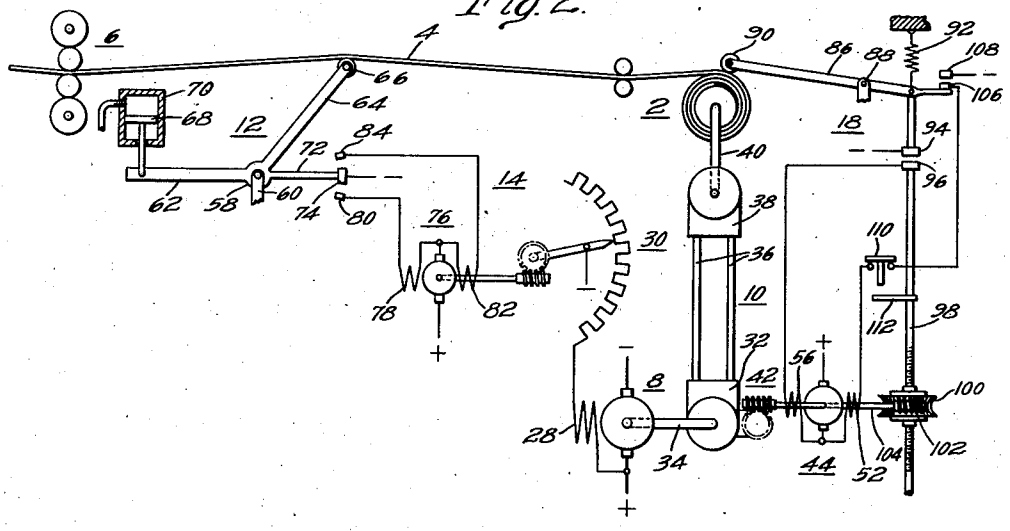

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Fig. 3.

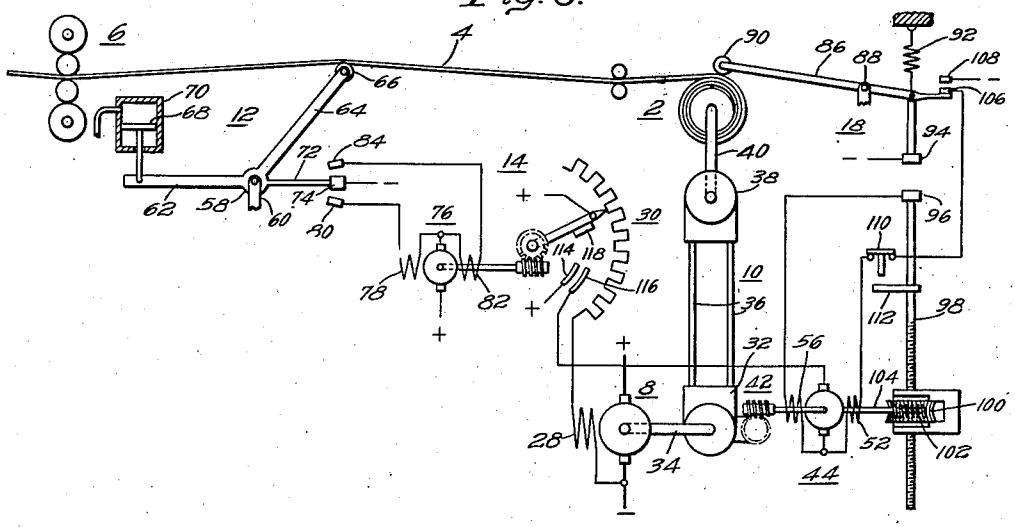
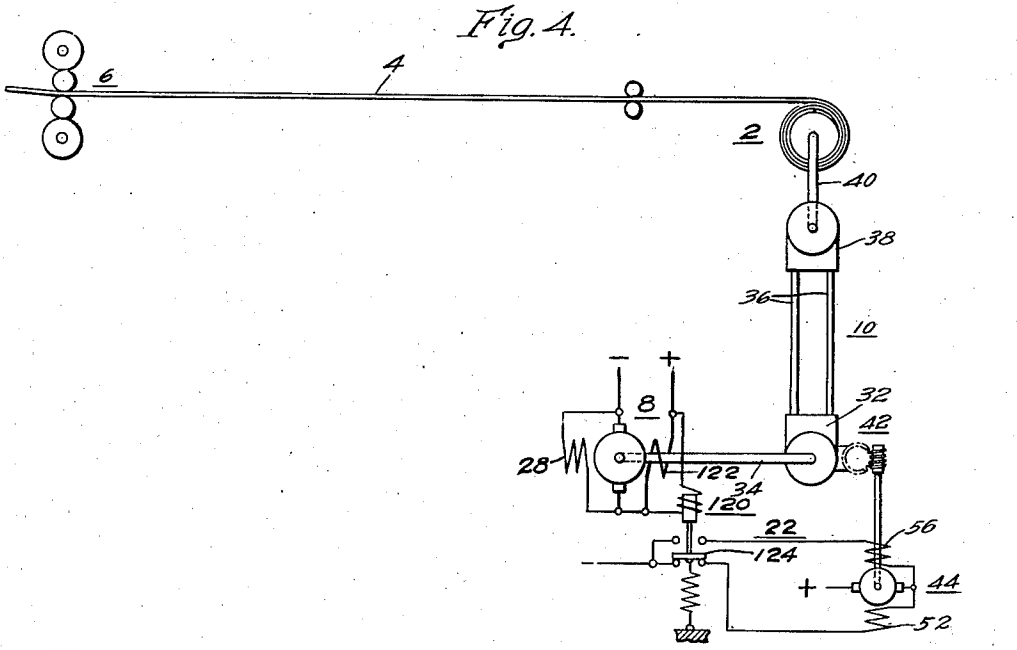


Fig. 4.



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STRIP REEL DRIVE

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Application October 12, 1938, Serial No. 234,740

13 Claims. (Cl. 242—75)

My invention relates, generally, to strip reel drives, and more particularly, to systems for extending the range of strip reel speeds.

In the production of sheet steel, it is common practice to wind the strip steel on reels as it is delivered from the reducing rolls and to stop the mill to cut the strip and start it on a new reel when a coil of strip has been reeled. Each of the stops for starting a new coil consumes the time of the mill operators as well as the production time of the mill and is an appreciable percentage of the running time of the mill.

Each of the coils of strip has slightly "off gauge" ends because the mill is not in normal operation while decelerating and accelerating to cut the strip and thread and start a new reel. Also, while decelerating and accelerating from and to normal mill speed for each reel, there is greater danger of strip breakage because of the difficulty of providing uniform acceleration and deceleration of the mill rolls and the strip reels. From these considerations, it will be apparent that the larger the amount of strip that can be placed on a single reel, the fewer the stops that will have to be made and the more efficiently may the mill be operated. With a substantially constant speed of delivery of the strip from the reducing roll stand to the reel, it will be seen that the peripheral speed of the coil of strip will be substantially constant, that the speed of rotation of the reel must decrease as the strip builds up on the reel, and that the greater the length of strip wound on a reel the greater will be the required range of speeds of rotation of the reel.

The size of coils of strip has been limited, heretofore, by the limit of the range of reel motor speeds by field control, and it is an object of my invention to provide a strip reel drive which shall function to provide a wide range of speeds of rotation of the reel.

Another object of the invention is to provide a strip reel drive which shall function to increase the efficiency of strip rolling mills by decreasing the number of mill stops required for rolling a given length of strip.

A further object of the invention is to provide a strip reel drive which shall function to provide coils of greater lengths of material, thus decreasing the number of mill stops required to produce a given length of material and decreasing the waste of time, energy and material incident to stopping and starting the mill when starting a new coil of strip.

These and other objects and advantages will be apparent from the following detailed description taken in connection with the accompanying drawings, in which like reference characters refer to corresponding parts in the several figures, and in which:

Figure 1 is a diagrammatic representation of a strip winding reel drive employing the principal features of the preferred embodiment of my invention; and

Figs. 2, 3, and 4 are diagrammatic illustrations of other strip winding reel drives embodying the principal features of my invention.

In carrying out the embodiment of my invention shown in Fig. 1, I provide a reel 2 for winding the strip of material 4 as it is delivered from the reducing rolls of roll stand 6. The reel 2 is driven by a motor 8 through a variable speed ratio mechanical power transmission system 10. A tensioning device 12 bears upon the strip 4 to deflect the strip and thus subject it to tension. A regulator 14 responsive to the amount of deflection of the strip 4, controls the speed of the reel motor 8 through field control to maintain the proper reel speed. A regulator 16, which is responsive to the field current of the reel motor 8, functions to vary the speed ratio of the transmission system 10 when the reel motor 8 has reached the limit of its speed variation by field control.

The embodiment of the invention shown in Fig. 2 is similar to that of Fig. 1 except that a regulator 18 is provided for controlling the speed ratio of the transmission system 10 in response to the increase of the diameter of the coil of strip as the strip is wound on the reel 2.

Another embodiment of the invention shown in Fig. 3 is similar to that of Fig. 2 except that the coil-build-up responsive regulator 18 is rendered operative only after a predetermined variation of the speed of the reel motor 8 by the regulator 14.

In Fig. 4 there is shown an embodiment of the invention in which no separate tensioning device is used. The reel motor 8 is a substantially constant speed motor and the speed ratio of the transmission system 10 is controlled by the regulator 22 which is responsive to the armature current of the reel motor 8.

These reel drive systems will each function to extend the winding reel speed range far beyond that available by reel motor field control alone, and will also maintain the desired tension on the strip as it is wound upon the reel.

It is to be understood that, although the discussion of the problems and their solutions in this specification is in terms of motor driven

winding reels, the invention relates equally as well to unwinding reels having dynamo-electric machines connected thereto and acting as a braking generator to subject the strip to tension as it is unwound from the reel. The controls described in detail herein are equally applicable to winding and unwinding reels.

Reference is again made to Fig. 1 of the drawings for a detailed description of the embodiment of the invention shown therein. The reel drive motor 8 has its armature connected to a source of power, as indicated, and has its field winding 28 connected in circuit with the rheostat 30 of the regulator 14. The variable ratio power transmission system 10 comprises a hydraulic transmitter unit 32 which is driven by the reel motor 8 through the shaft 34 connected by means of fluid conduits 36 to the hydraulic receiver unit 38. The reel 2 is driven by the receiver unit 38 through the shaft 40. The speed ratio between the transmitter and receiver units 32 and 38 may be varied by the speed ratio change mechanism 42 which is controlled by the regulator 16.

The reversible motor 44 of the regulator 16 is connected to drive the speed ratio change mechanism 42 in opposite directions. A relay 46 is connected in series circuit with the field winding 28 of the reel drive motor 8 and has a movable contact element 48 which, when it engages contact elements 50 under the influence of the biasing spring 49, will close a circuit through the field winding 52 of the reversible motor 44, and which when it engages the contact elements 54, will close a circuit through the field winding 56 of the motor 44. The field windings 52 and 56 of the motor 44 are such as to actuate the speed ratio change mechanism 42 to increase and decrease the speed of the hydraulic receiver unit 38, respectively, when these field windings are selectively energized.

The tensioning device 12 comprises a bell crank 58 pivotally mounted on a support 60. The bell crank comprises a substantially horizontal arm 62 and an arm 64 disposed at an angle to the arm 62 and mounting an idling roller 66 in a position to bear upon the strip 4 and deflect it from its normal pass line. The arm 62 is actuated by a piston 68 operating in a cylinder 70 under the influence of fluid pressure. The operation of this tensioning mechanism is substantially the same as that disclosed in detail in the copending application of G. P. Lessmann, Serial No. 133,419, filed March 27, 1937, now Patent No. 2,189,609, issued February 6, 1940, and having the common assignee of the present application, and reference is made to this copending application and patent for detailed description of the functioning of this tensioning device.

The regulator 14 includes an arm 72 mounted to be movable with the bell crank 58 and supporting a movable contact element 74. The rheostat 30 is actuated by a reversible motor 76 having a field winding 78 which is energized to move the rheostat 30 in a direction to decrease the effective resistance of the rheostat when the movable contact 74 engages a fixed contact 80. In a similar manner, the motor 76 will be actuated in a direction to increase the effective resistance of the rheostat 30 when its field winding 82 is energized by the engagement of the movable contact 74 with the fixed contact 84.

In the operation of the embodiment of the invention of Fig. 1, the reel drive motor 8 operates to drive the reel 2 through the power transmission system 10 as the strip 4 is delivered from the roll stand 6 and the tensioning device 12 operates to maintain a predetermined tension upon the strip. Assuming that the strip is delivered from the roll stand 6 at a substantially constant speed, as the strip builds up on the reel 2, the effective diameter of the coil will be increased and there will be a tendency to increase its peripheral speed. This tendency to increase the peripheral speed of the coil over the actual speed of delivery of the strip 4 from the roll stand 6 will increase the tension upon the strip, decreasing the deflection of the strip and causing contact element 74 to engage contact element 80. This will energize the field winding 78 of the reversible rheostat motor 76 and will actuate the rheostat 30 to increase the current flow in the field winding 28 of the motor 8 to thus decrease the speed of the motor 8. As the coil builds up, this action will continue to take place until the speed of the motor 8 has been varied through its entire range of speed variation by field control. After the current in the field winding 28 of the motor 8 has increased a predetermined amount, the relay 46 will cause its movable contact element 48 to engage the contact elements 54. The engagement of contact elements 48 and 54 will energize the field winding 56 of the reversible motor 44 to cause the motor 44 to drive the speed ratio change mechanism 42 in such a direction as to decrease the speed of the hydraulic receiver unit 38 and thus to decrease the speed of the reel 2.

Thus, as the strip material builds up on the reel 2, the reel motor speed will be varied through its range of speed variation by field control and then the range of speed variation of the reel 2 will be extended by automatically varying the speed ratio between the transmitter and receiver units 32 and 38 of the hydraulic power transmission system 10. If for any reason there should be increases or decreases in the slack in the strip 4 between the reel 2 and the roll stand 6, the tensioning device will actuate the regulator 14 to vary the excitation of the reel motor 8 to compensate for these variations by increasing or decreasing the speed of the reel motor 8 the necessary amount.

The strip reel drive mechanism of the embodiment of the invention of Fig. 2 is very similar to that of Fig. 1, except that there is an automatic variation of the speed ratio of the hydraulic power transmission system 10 dependent directly upon the amount of strip built up upon the reel. In this system a regulator 18 is provided for controlling the actuation of the reversible motor 44. The regulator 18 comprises an arm 86 pivotally mounted on a support 88 and mounting an idling roller 90 in a position to permit the idling roller 90 to engage the coil of strip material. The arm 86 is biased by the spring 92 to maintain the idling roller 90 in engagement with the coil of strip on the reel 2. The movable contact element 94 is mounted to be moved as the arm 86 is rotated by variations in the effective diameter of the coil of strip and is positioned to cooperate with the contact element 96 which is mounted upon a stem 98. The stem 98 has threaded engagement with a worm wheel 100 which may be driven by a worm 102 connected by a shaft 104 to the motor 44. A movable contact element 106 is mounted upon the arm 86 and is positioned to engage a fixed contact element 108 when the arm 86 is rotated a predetermined amount in the counter-clockwise direction.

A circuit control device 110 normally in closed

circuit position is arranged to be moved to open circuit position by an arm 112 fixed to the stem 98 when the stem has moved upwardly a predetermined amount. The reel motor 8 is arranged to drive the transmitter unit 32 and the tensioning device 12 is arranged to control the speed of the reel motor 8 through the regulator 14 as hereinbefore described.

In the operation of the embodiment of the invention of Fig. 2, the reel motor 8 and the tensioning device 12 will cooperate through the regulator 14 to maintain such a reel motor speed as will keep the tensioning device in a predetermined position and maintain the desired amount of slack in the strip 4. As the reel winds the strip 4 and as the diameter of the coil increases, the arm 86 will be rotated in the clockwise direction and contact element 94 will engage contact element 96. The engagement of contact elements 94 and 96 will close a circuit to energize the field winding 56 of the motor 44. This will cause the motor 44 to actuate the speed ratio change mechanism 42 in such a direction as to decrease the speed of the power transmission receiver unit 38 and thus decrease the speed of the reel 2. Simultaneously, the rotation of the motor 44 will cause the stem 98 to be moved downward through the worm and gear mechanism 102 and 100 which actuates the contact element 96 out of engagement with the contact element 94, thus deenergizing the field winding 56 and stopping the motor 44. While the motor 44 is not running, any necessary speed variations of the reel 2 are provided by the reel motor 8 under control of the tensioning device 12. Thus, when the contact element 96 is moved out of engagement with the contact element 94 to stop the motor 44, the tension device 12 will act through the regulator 14 and the motor 8 to provide the necessary speed variations in the reel 2. When the coil is again built up sufficiently to cause the contact element 94 to engage the contact element 96, the motor 44 will repeat the operation of causing a decrease in the speed of the reel 2 and moving the contact element 96 out of engagement with the contact element 94.

Thus, it will be seen that the speed of the reel motor 8 may be varied throughout its speed range by field control and an additional speed range for the reel 2 is provided for by the automatic variation of the reel speed in response to the build-up of the strip upon the reel. When the coil has been built up to a desired amount and a new reel substituted therefor, the spring 92 will cause the arm 86 to rotate in the counterclockwise direction and thus cause engagement of the contact element 106 with the contact element 108. This will close a circuit through the field winding 52 of the motor 44 to reverse the motor 44 and actuate the speed ratio change mechanism 42 to increase the relative speeds of the receiver unit 38 and the transmitter unit 32. At the same time, it will be seen that stem 98 will be moved upward and when the stem 98 has moved upward sufficiently to permit the arm 112 to actuate the circuit control device 110 to open circuit position, the field winding 52 of the motor 44 will be deenergized, thus stopping the motor 44. The regulator 18 will thus be reset preparatory to starting a new coil of strip and the proper adjustment will have been made between the relative speeds of the transmitting unit 32 and the receiving unit 38 to provide the necessary starting reel speed.

The embodiment of the invention shown in Fig. 3 is very similar to that of Fig. 2, but includes the additional feature that the coil build-up actuated regulator 18 is made inoperative to vary the speed ratio of the power transmission system 10 until a predetermined amount of variation of the reel speed has been provided by variation of the reel motor speed by field control. This is accomplished by so positioning the fixed contact elements 114 and 116 in the path of movement of the movable contact element 118 as to cause the engagement of these contact elements only after a predetermined variation of the effective resistance of the rheostat 30. The contact elements 114 and 116 are connected in the armature circuit of the motor 44 so that it may be energized only after a predetermined variation of the effective resistance of the rheostat 30. In this embodiment, the contact elements 94 and 96 are originally spaced a considerable distance apart so that they will not engage until a predetermined amount of strip has been built up on the reel 2. Thereafter, the regulating system 18 will function as described in connection with the embodiment of the invention of Fig. 2.

In the operation of the embodiment of the invention of Fig. 3, variations in the speed of the reel 2 will be under the control of the reel motor 8 as it is influenced by the tension device 12 through the regulator 14 until a predetermined range of speed variations has been traversed. The speed control of reel 2 will then be transferred to the regulator 18 by the engagement of the contact element 118 with the contact elements 114 and 116, which will provide energization of the armature of the motor 44 and permit the motor to be controlled by the contact elements 94 and 96 of the regulator 18. The remaining elements of the combination will function as hereinbefore described.

In the embodiment of the invention of Fig. 4, tension and speed control are provided without the separate tensioning device of the embodiments of the invention in Figs. 1, 2, and 3. In this embodiment of the invention the reel 2 is driven through a variable speed ratio power transmission system 10 by a substantially constant speed motor 8. A current responsive relay 120 is connected in shunt circuit relation with the series field winding 122 of the motor 8, thus providing energization of the relay 120 proportional to the armature current of the reel motor 8. The relay 120 has a movable contact element 124 which, at a predetermined minimum armature current of motor 8, will close a circuit, as indicated, through the field winding 52 of the motor 44, causing the motor 44 to so actuate the speed ratio change mechanism 42 as to increase the speed of the receiver unit 38 and thus increase the speed of the reel 2. At a predetermined maximum current in the armature of the reel motor 8 the contact element 124 will be moved upward by the relay 120 to close the circuit indicated through the field winding 56 of the motor 44. This will cause a reverse rotation of the motor 44 to decrease the speed of the reel 2.

In the operation of this system, if the speed ratio between the transmitter and receiver units 32 and 38 is such as to cause the reel 2 to tend to rotate too fast, to thus place too great a tension on the strip 4, the armature current of the reel motor 8 will increase due to the large amount of torque that it must transmit to the reel 2, and the contact element 124 will move upward to closed circuit position with respect to

the field winding 56 to change the speed ratio between the transmitter and receiver units 32 and 38 of the transmission system 10, thus decreasing the speed of the reel 2 and decreasing the torque applied to the strip 4 by the reel 2. As the strip gradually builds up on the reel 2, these adjustments in the speed ratio of the power transmission system will be made automatically in response to periodic increases of the armature current of the reel motor 8 to the predetermined maximum.

It will be seen that I have provided control systems for strip reel drives which will function to wind larger coils of strip material than have heretofore been possible by greatly extending the speed range of the strip reels, and which will function to maintain the predetermined desired tensions on the strip of material as it is being wound by the reels.

In compliance with the requirements of the patent statutes I have shown and described herein the preferred embodiments of my invention. It is to be understood, however, that the invention is not limited to the precise constructions shown and described but is capable of modification by one skilled in the art, the embodiments herein shown being illustrative of the principles of my invention.

I claim as my invention:

1. In a strip reel drive, in combination, a strip reel disposed to wind a length of strip material as it is delivered from a work device, a drive motor for the reel, a variable speed ratio power transmission system disposed in operative relation between said motor and said reel, a tensioning device disposed to tension the strip as it passes between the work device and the reel, speed control means responsive to the operation of said tensioning device for controlling the speed of said motor, and means responsive to the operation of said motor speed control means for controlling the speed ratio of said transmission system.

2. In a reel drive, in combination, a reel disposed to wind a length of strip material as it is delivered from a work device, a drive motor for the reel, a variable speed ratio power transmission system disposed in operative relation between said motor and said reel, a tensioning device disposed to tension the length of material as it passes between the work device and said reel, speed control means responsive to the operation of said tensioning device for controlling the speed of said reel motor, and means responsive to the coil build-up on the reel for controlling the speed ratio of said transmission system.

3. In a reel drive, in combination, a reel disposed to wind a length of strip material as it is delivered from a work device, a drive motor for the reel, a variable speed ratio power transmission system disposed in operative relation between said motor and said reel, a tensioning device disposed to tension the length of material as it passes between the work device and said reel, speed control means responsive to the operation of said tensioning device for controlling the speed of said reel motor, means responsive to the coil build-up on the reel for controlling the speed ratio of said transmission system, and means for rendering said speed ratio control means operative only after a predetermined operation of said speed control means.

4. In a reel drive system, in combination, a reel disposed to wind a length of material as it is delivered from a work device, a drive motor for said reel, a variable speed ratio transmission system disposed in operative relation between said motor and said reel, and means responsive to predetermined current flow in the armature of said reel motor for controlling the speed ratio of said transmission system.

5. In a reel drive, in combination, a reel disposed to wind a length of strip material as it is delivered from a work device, a drive motor for the reel, a variable speed ratio power transmission system disposed in operative relation between said motor and said reel, a tensioning device disposed to tension the length of material as it passes between the work device and said reel, a first control means responsive to the operation of said tensioning device for controlling the speed of said reel motor, a second control means responsive to the coil build-up on the reel for controlling the speed ratio of said transmission system, and means for rendering one of said first and second control means operative only after a predetermined operation of the other of said first and second control means.

6. In a strip reel drive, in combination, a strip reel disposed to wind a length of strip material as it is delivered from a work device, a drive motor for the reel, a variable speed ratio power transmission system disposed in operative relation between said motor and said reel, a tensioning device disposed to tension the strip as it passes between the work device and the reel, means responsive to the operation of said tensioning device for controlling the excitation of said drive motor, and means controlled by predetermined excitation of said drive motor for controlling the speed ratio of said variable speed ratio transmission system.

7. In a strip reel drive, in combination, a strip reel disposed to wind a length of strip material, a drive motor for the reel, a variable speed ratio power transmission system disposed in operative relation between said motor and said reel, a tensioning device disposed to tension the strip as it is wound on the reel, a variable resistor connected in circuit with the field winding of said reel drive motor, means responsive to the operation of said tensioning device for operating said variable resistor, and means responsive to a predetermined operation of said variable resistor for controlling the speed ratio of said transmission system.

8. In a strip reel drive, in combination, a strip reel disposed to wind a length of strip material, a drive motor for the reel, a variable speed ratio power transmission system disposed in operative relation between said motor and said reel, a tensioning device disposed to tension the material as it is wound on said reel, means responsive to the operation of said tensioning device for controlling the speed of said motor, a reversible motor disposed to control the speed ratio of said transmission system, means responsive to the build up of the strip on said reel for causing said reversible motor to operate in such a direction as to decrease the speed ratio of said transmission system as the strip builds up on the reel, and means for automatically operating said reversible motor in such a direction as to increase the speed ratio of the transmission system when said reel is replaced by an empty reel.

9. In a strip reel control system, in combination, a dynamo-electric machine, means for variably energizing the dynamo-electric machine, a variable speed ratio power transmission system

disposed in operative relation between said dynamo-electric machine and said reel, and means controlled by predetermined energization of said dynamo-electric machine for varying the speed ratio of said transmission system.

10. In a strip reel control system, in combination, a drive motor for the reel, means for variably energizing the motor, a variable speed ratio transmission system disposed in operative relation between said drive motor and said reel, and means controlled by predetermined energization of said motor for varying the speed ratio of said transmission system.

11. In a strip reel control system, in combination, a drive motor for the reel, means for variably energizing the motor, a variable speed ratio transmission system disposed in operative relation between said drive motor and said reel, and regulator means actuated by predetermined energization of said motor for varying the speed ratio of said transmission system.

12. In a strip reel control system, in combination, a dynamo-electric machine, means for variably energizing the dynamo-electric machine, a variable speed ratio transmission system disposed in operative relation between said dynamo-electric machine and the reel, and regulator means responsive to predetermined energization of said dynamo-electric machine for varying the speed ratio of said transmission system.

13. In a strip reel control, in combination, a reel for a strip of material, a tensioning device disposed to tension the strip of material as it is engaged by and extends from the reel, a dynamo-electric machine, a variable speed ratio power transmission system disposed in operative relation between said dynamo-electric machine and said reel, means responsive to the operation of said tensioning device for controlling the excitation of said dynamo-electric machine, and means responsive to predetermine excitation of said dynamo-electric machine for controlling the speed ratio of said variable speed ratio power transmission system.

WILLARD G. COOK.