

[54] **POTENTIAL-ENERGY
TORQUE-GENERATING MECHANISM FOR
OPERATING A TAKE-UP ROLL**

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[51] Int. Cl. **D03d 49/20**

[58] Field of Search **66/86 A, 149, 152,
66/153; 139/97, 99, 105, 109, 110, 304, 307,
308, 309, 310, 311; 74/577**

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[57] **ABSTRACT**

A torque-generating mechanism of the potential-energy type which steadily maintains a selected rotational force within selected limits for winding or unwinding operations. The mechanism comprises a toothed ratchet wheel which turns a drive shaft, a leverage means in the form of a lever arm and leverage weight which provides torque by pivotal movement through a selected arc, a torque arm means that transmits the pivotal movement to the perimeter of the ratchet wheel through a tooth-engaging pawl, a counter-rotation means, and an energy restoration means. The preferred counter-rotation means is a second leverage means which acts in alternating sequence and is disposed in opposed relationship to the first leverage means. When winding textiles, for example, the drive shaft may be connected to a sand roll which provides constant fabric tension at a single leverage weight setting or to the mandrel of a take-up roll which provides decreasing fabric tension at a constant leverage weight setting.

13 Claims, 20 Drawing Figures

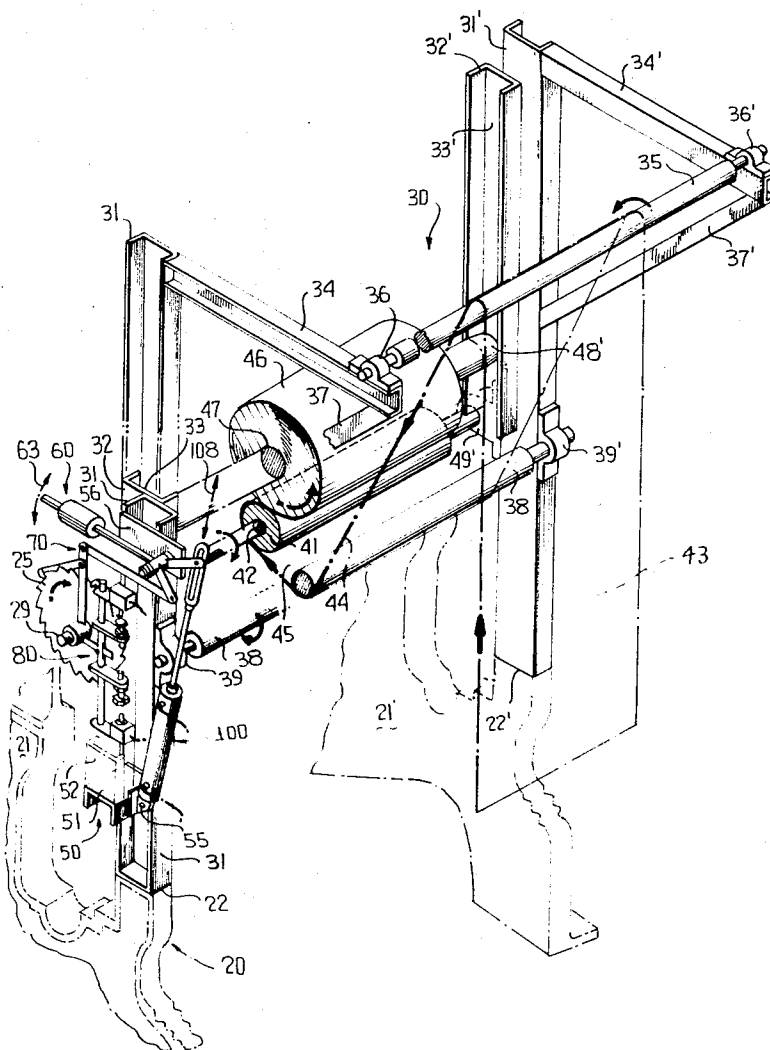
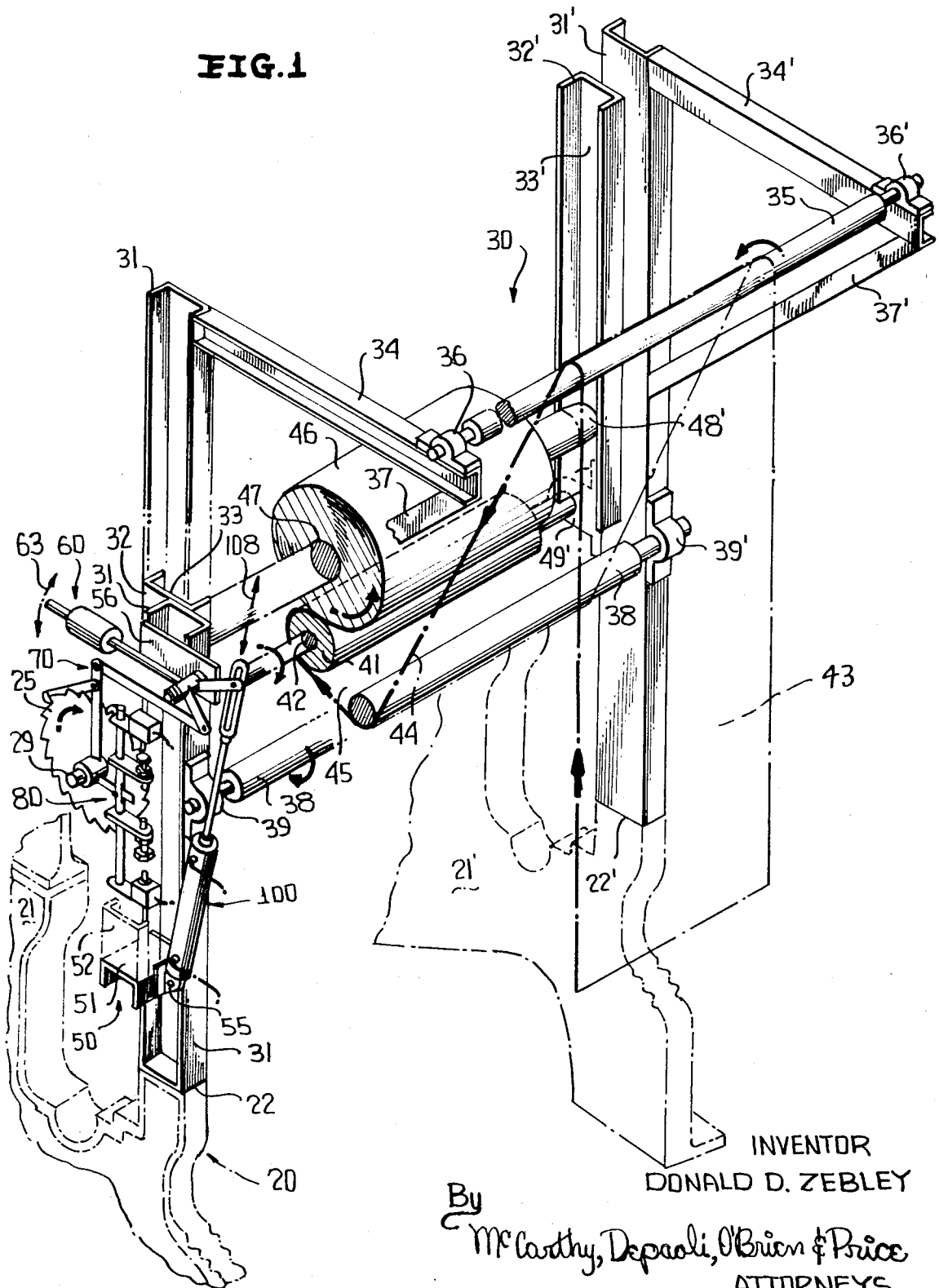


FIG. 1



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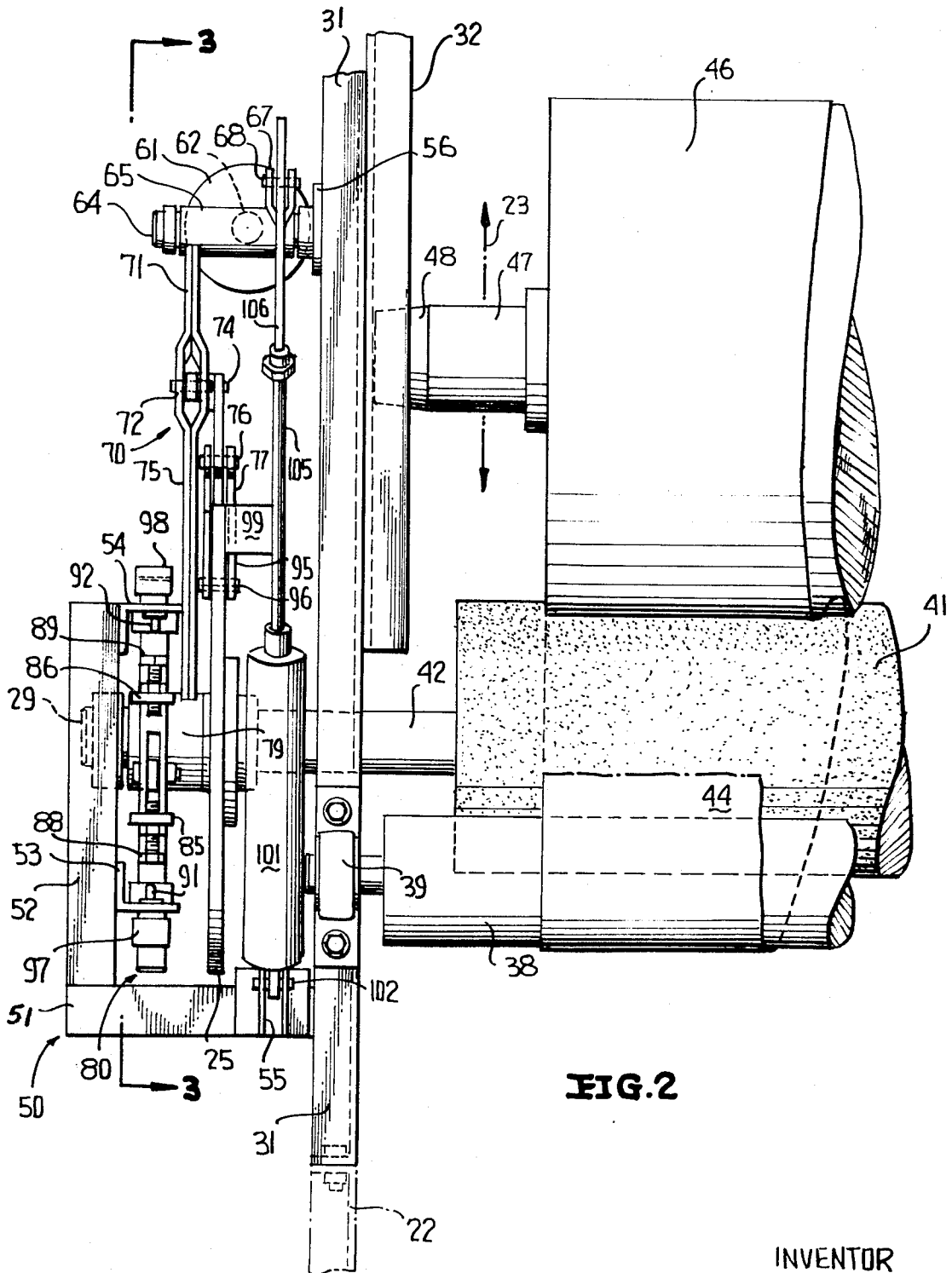


FIG. 2

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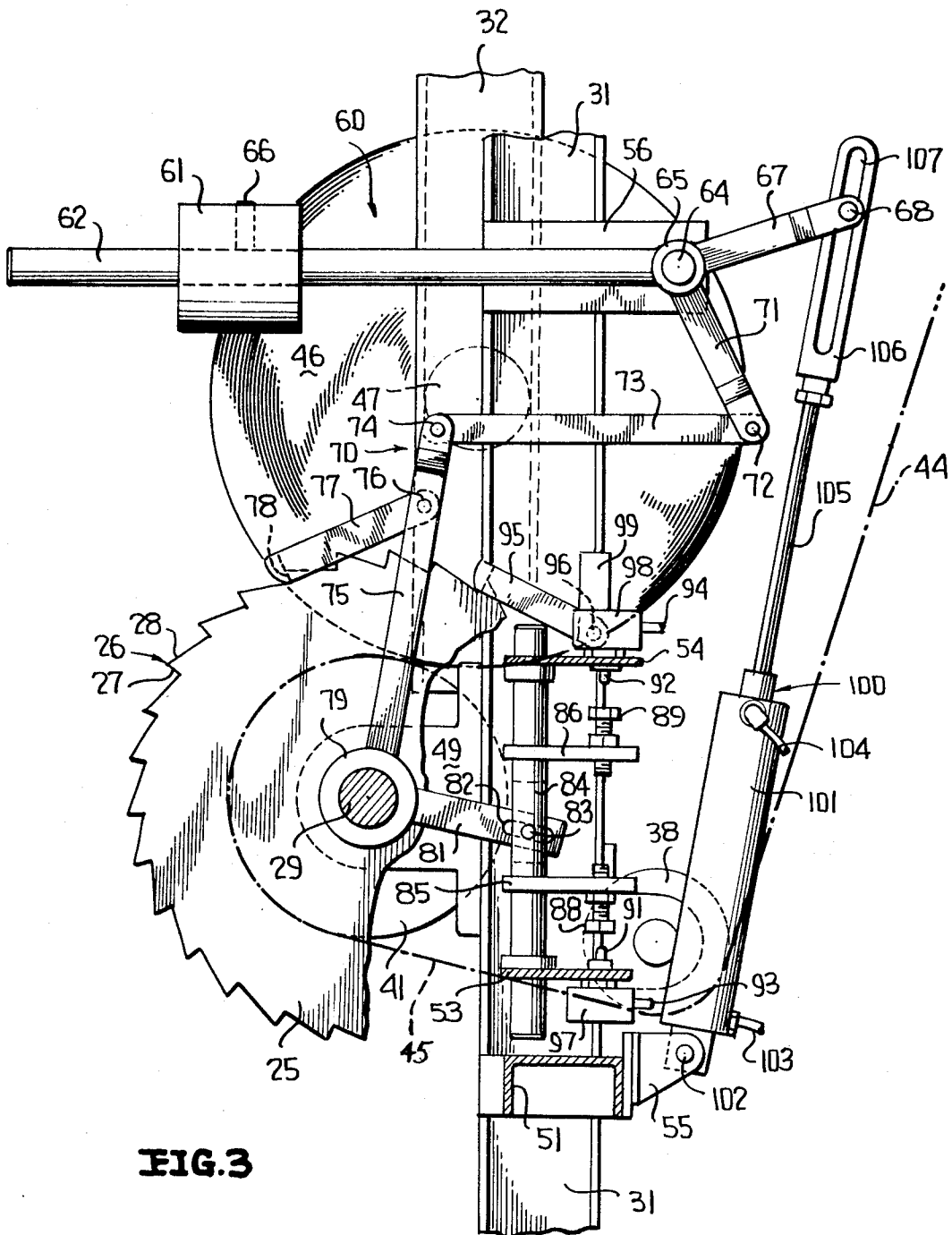


FIG. 3

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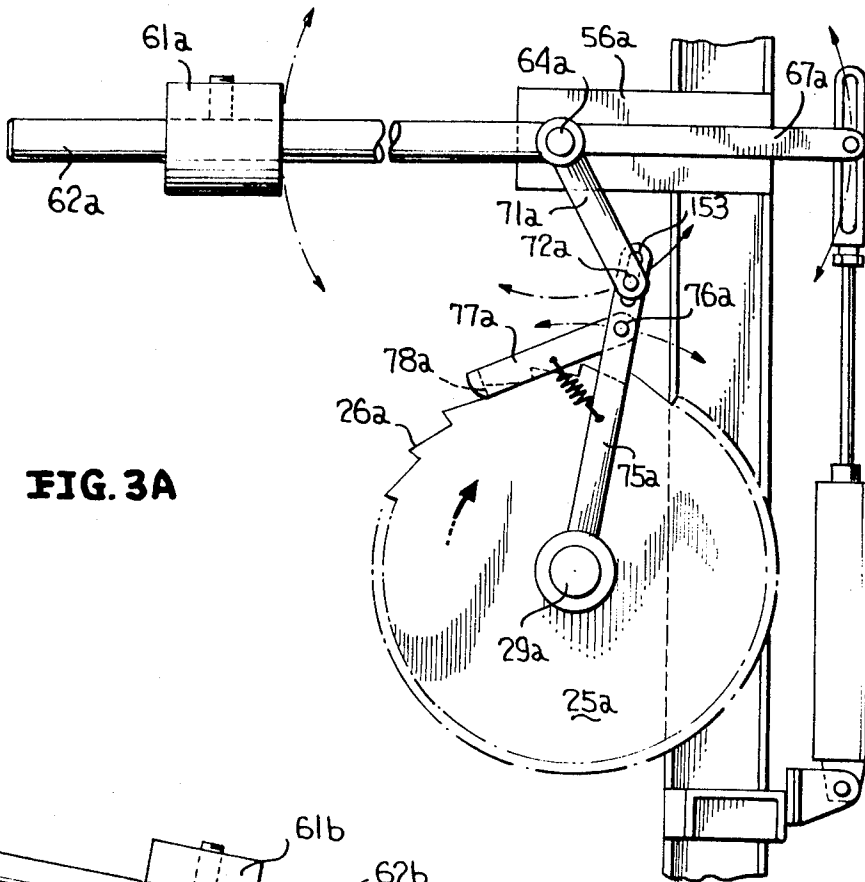


FIG. 3A

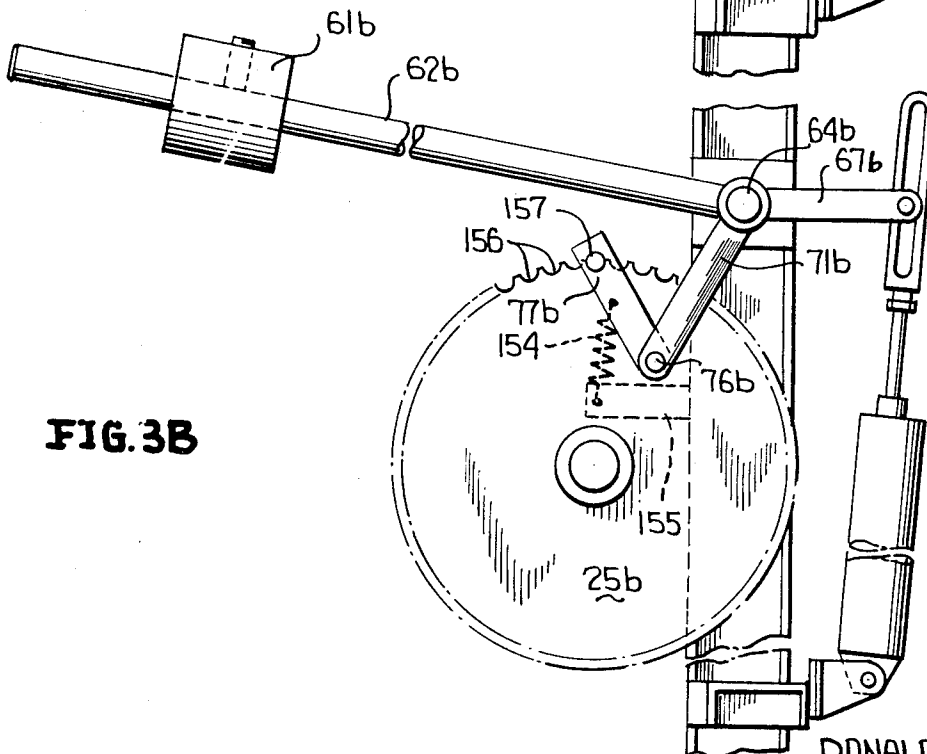


FIG. 3B

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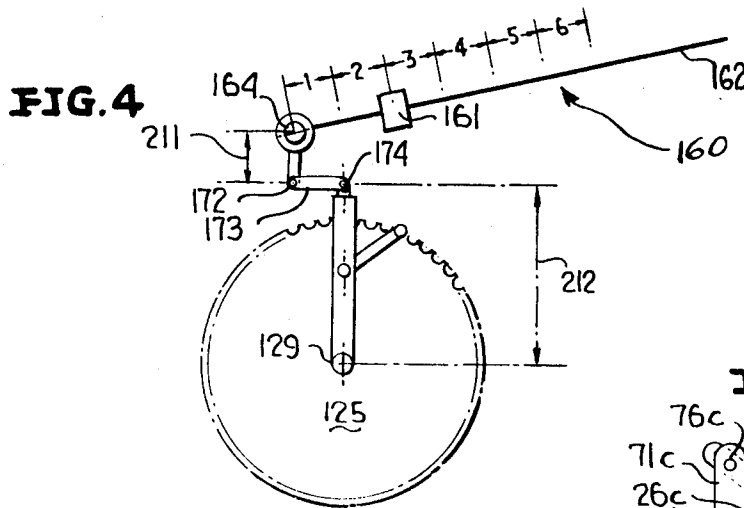
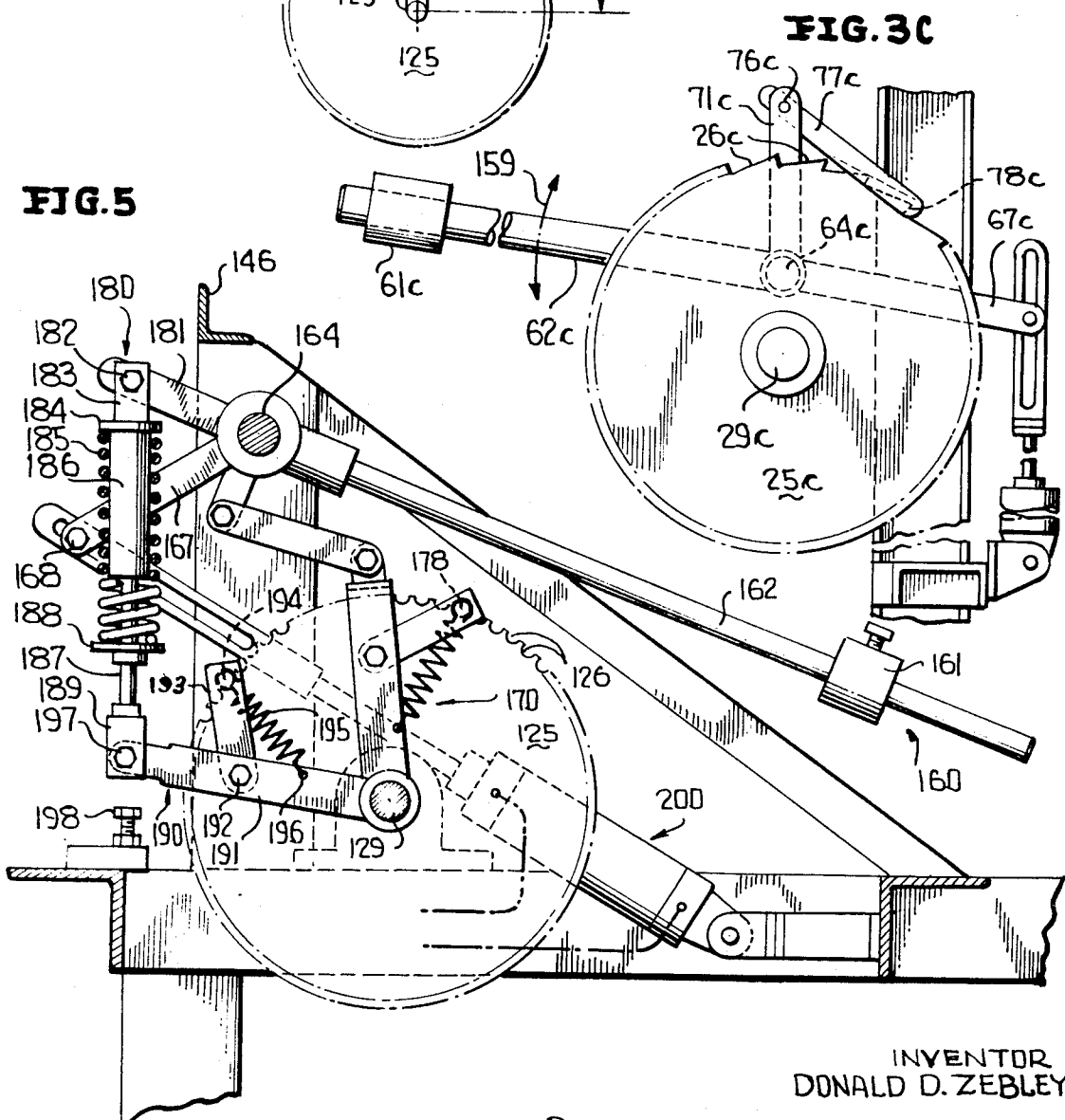


FIG. 5



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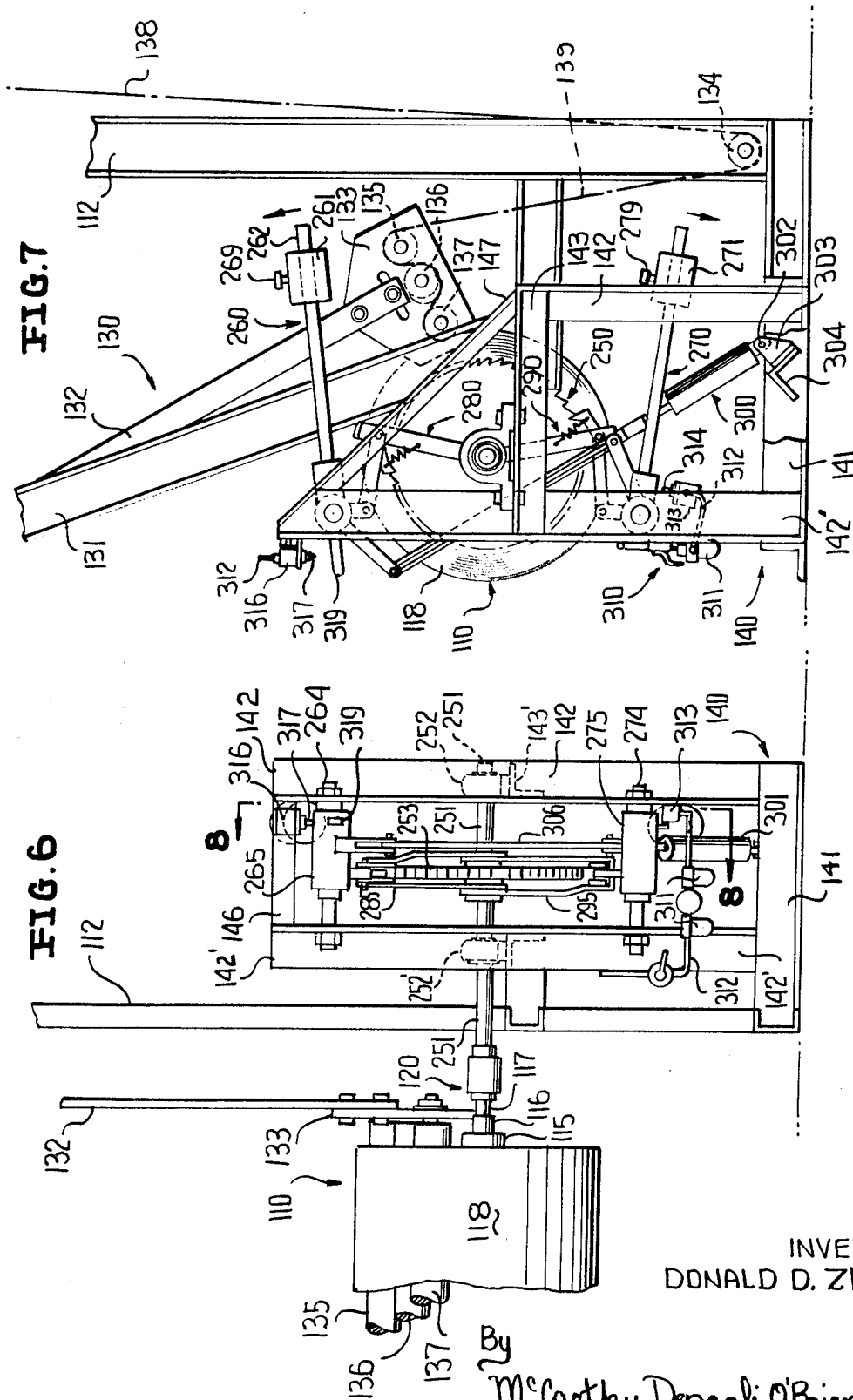
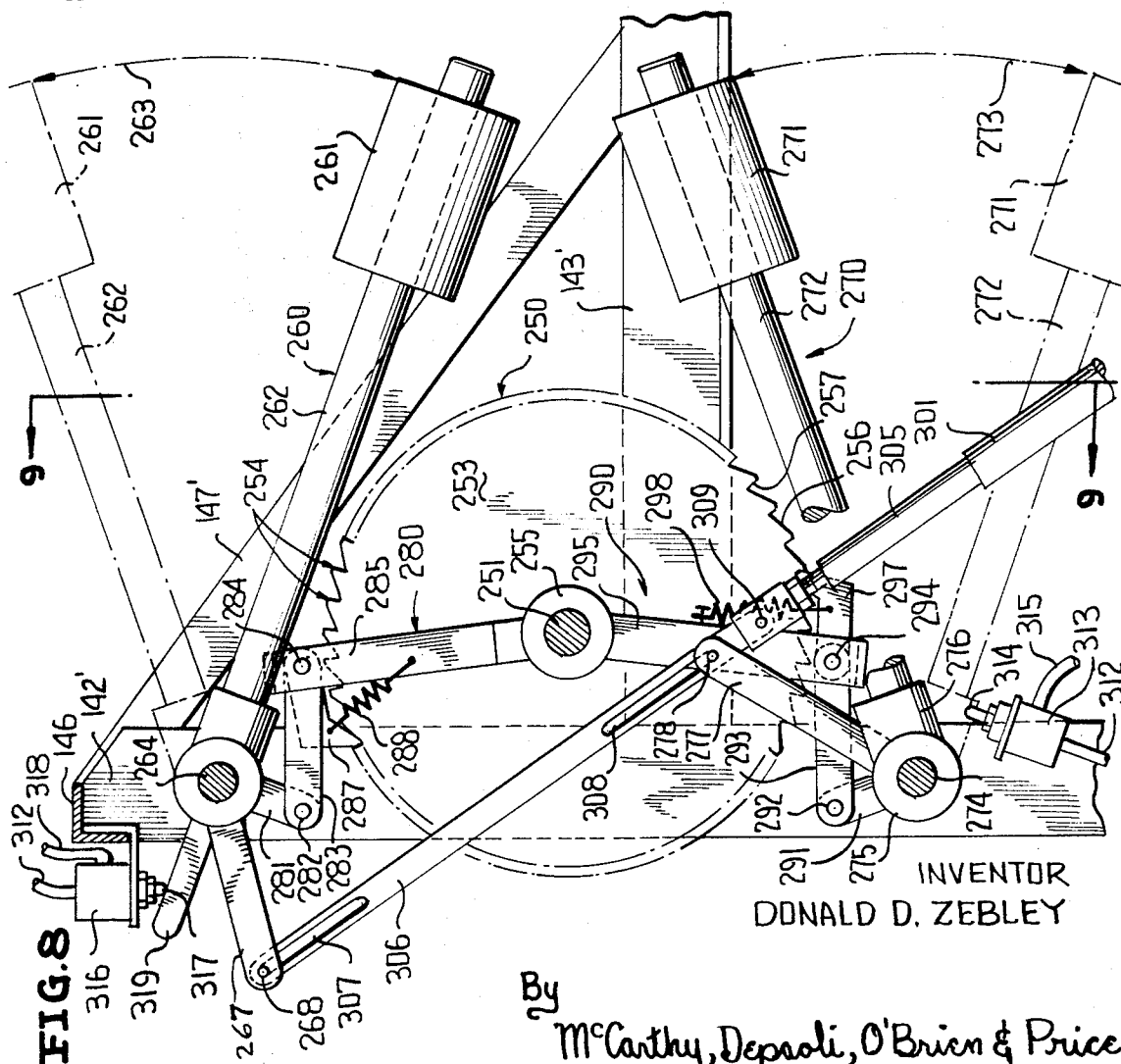
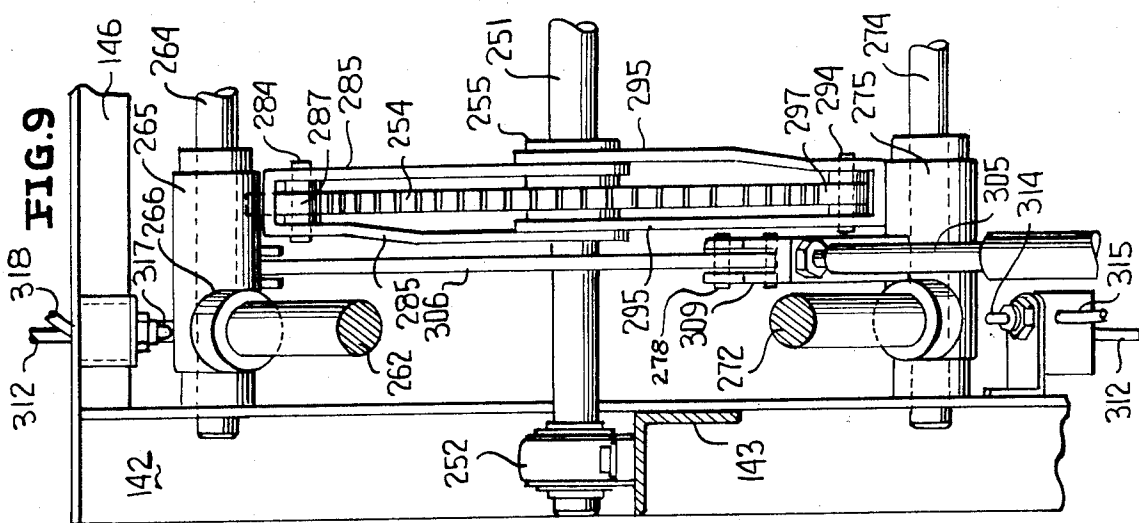


FIG. 7

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FIG. 10

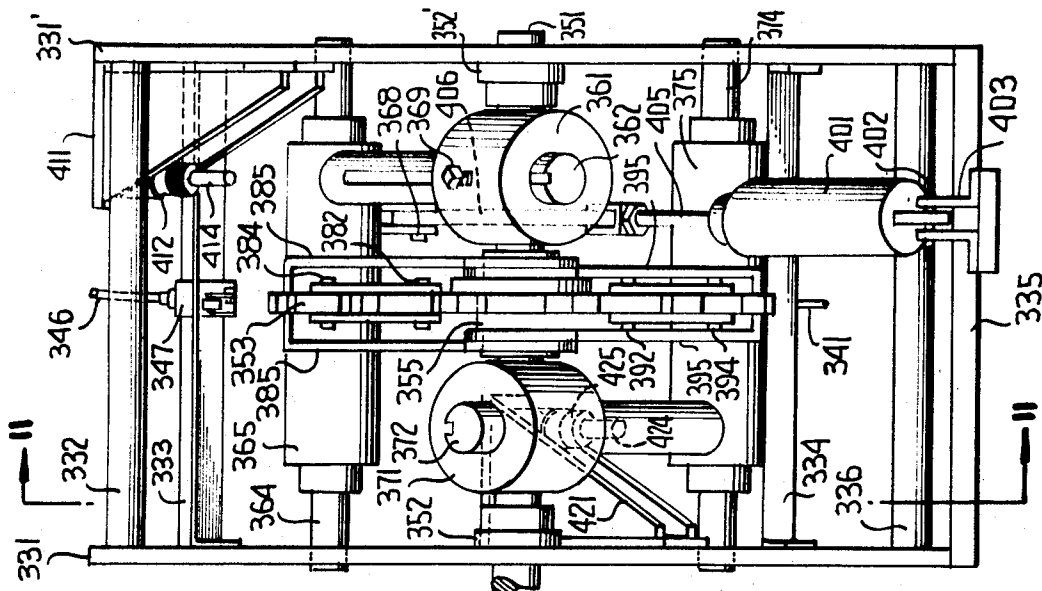
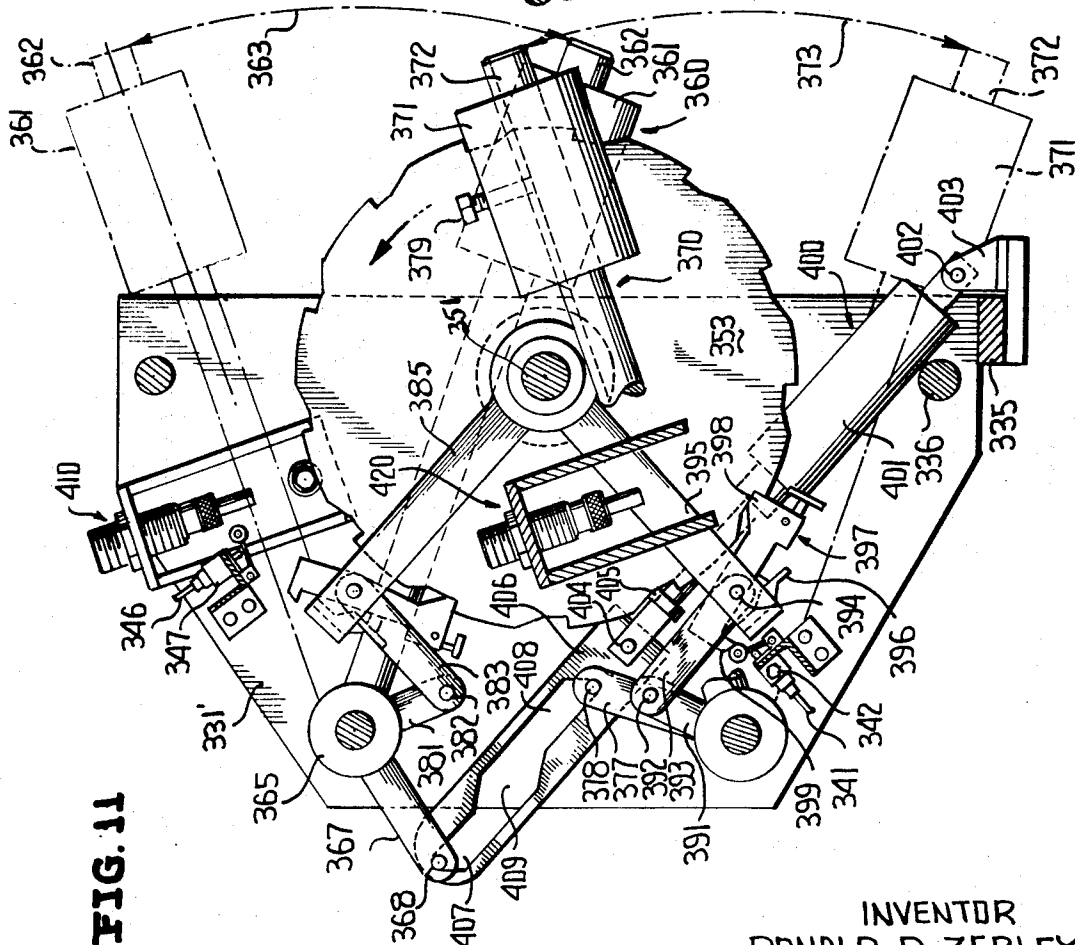


FIG. 11



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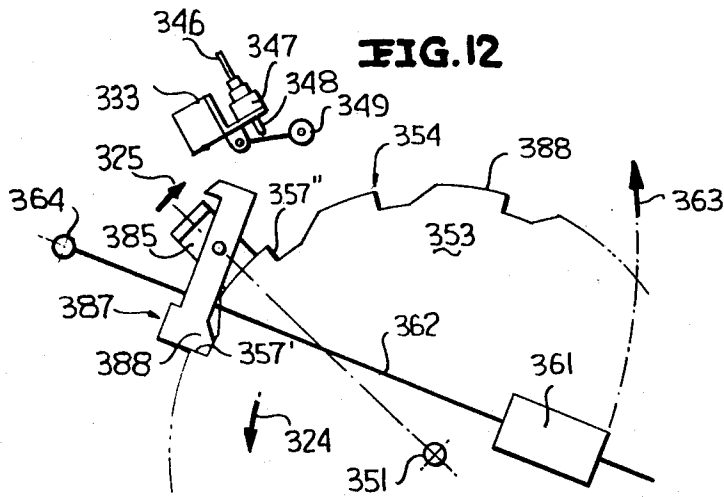


FIG. 13

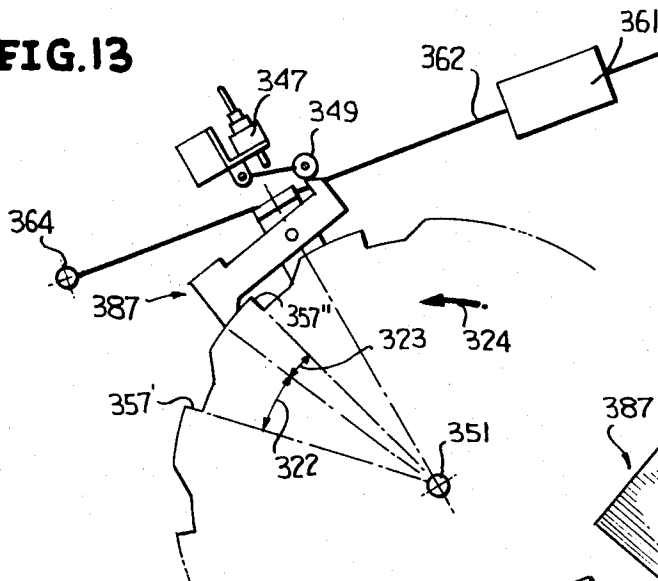


FIG. 14

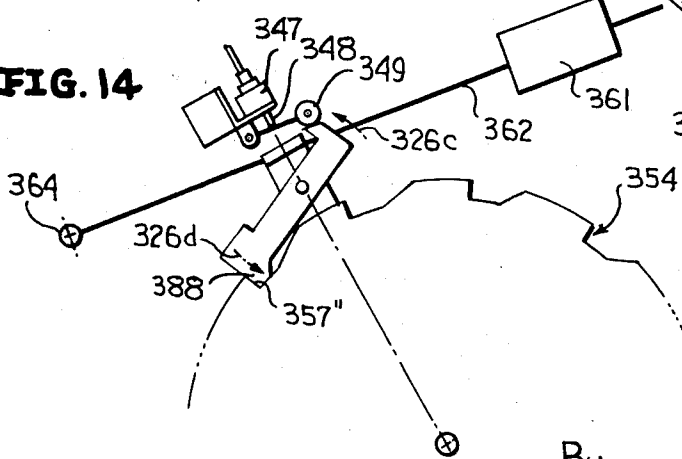
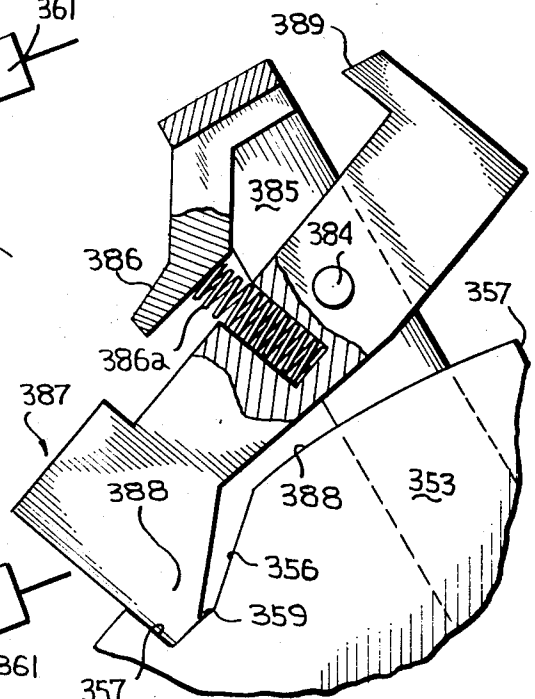


FIG. 15



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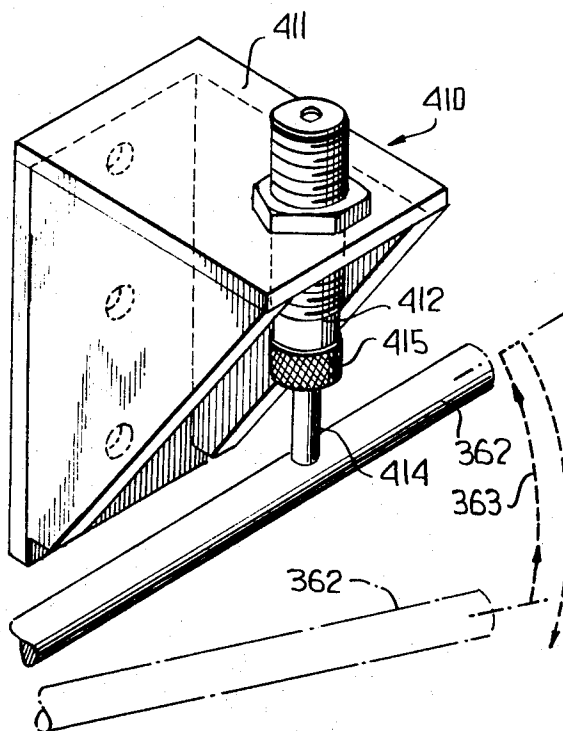


FIG. 16

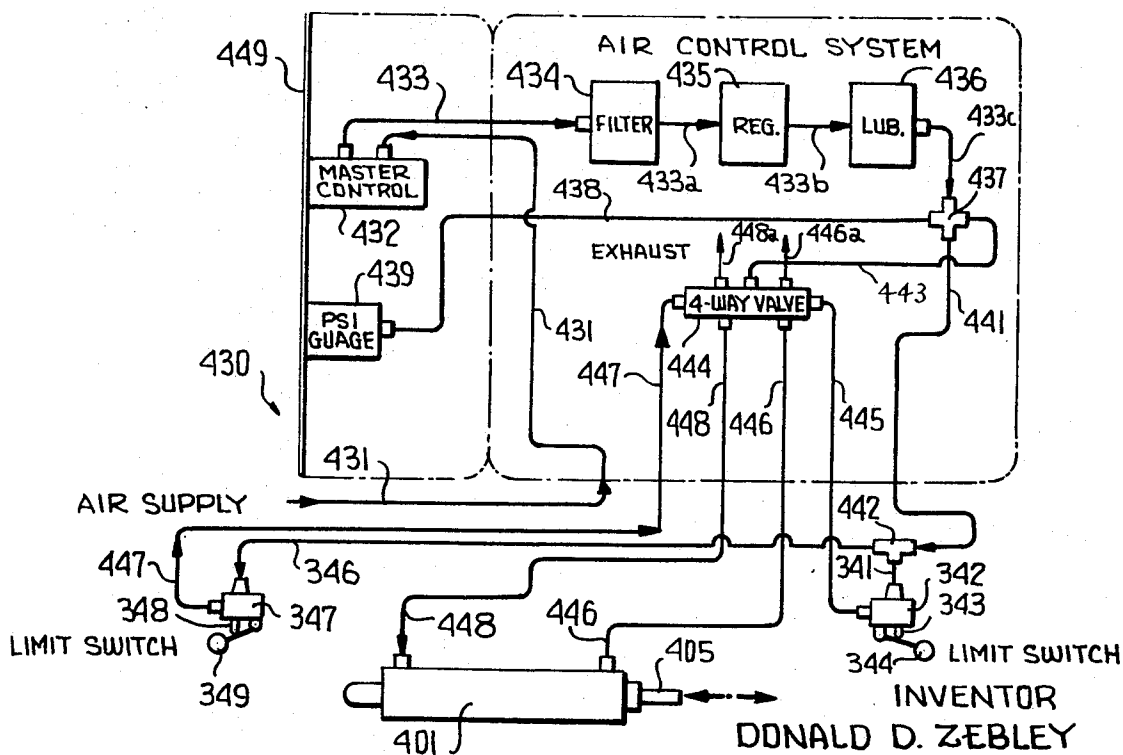


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POTENTIAL-ENERGY TORQUE-GENERATING MECHANISM FOR OPERATING A TAKE-UP ROLL

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to the following two applications, filed on even date herewith: "Take-Up Device Having a Tension-Derived Compacting Means" of Donald Dane Zebley and Joseph W. Cashion and "Torque Control Device for a Potential-Energy Torque-Generating Mechanism" of Donald Dane Zebley.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to mechanisms which utilize potential energy for generating or consuming rotational force. The invention particularly relates to a drive means for take-up devices used for winding a fabric, herein defined as a cloth made by weaving, knitting, or felting fibers upon a roll as the fabric is being formed on a loom, and also relates to a release means for an automatic constant-tension let-off and/or hold-back device for feeding warp to a loom. It especially relates to torque-generating mechanisms of the pawl-and-ratchet wheel type which embody a selective control means for providing a steady or selectively variable torque to a take-up device which operates in combination with the torque-generating mechanism, whereby the take-up device maintains a selected force within selected limits upon a fabric being woven and continues to maintain this force under all circumstances during the weaving process, including extended periods when the loom is stopped during which no energy is consumed.

2. Description of the Prior Art

Take-up and let-off devices of the prior art have utilized a variety of drive means such as manually set friction-slip clutch mechanisms, variable-speed electric-motor devices, and pawl-and-ratchet wheel mechanisms. In addition to creating considerable heat which imposes additional loads on air-conditioning systems, the friction-slip clutch mechanisms produce variant tension in accordance with humidity changes and require nearly constant adjustment as the humidity varies.

Electric drives are commonly used at the present time to generate torque for winding relatively slow-moving flexible materials of indeterminate length, or to brake the unwinding thereof. However, as the roll being wound or unwound becomes larger, disproportionate amounts of electricity are consumed and equivalent heat is generated. For example, in a textile mill, 20 take-up machines roughly require 1 ton of air conditioning to offset their heat output. Furthermore, if a few picks are missed in a loom, an electric-motor powered take-up device therefore cannot be backed-up for fabric repair without loss of tension in the fabric and telescoping of the roll being wound. Other disadvantages of electric-motor drive for a take-up device in a textile mill include sudden power demands when a plurality of looms go on the line and sudden increases in tension caused by power surges which may cause the fabric to pull through the loom, resulting in missed picks or other defects. In addition, during shut down, as over weekends and holidays, electric power continues to be consumed by electric-motor take-up devices for maintenance of tension on the fabric being woven.

The pawl-and-ratchet wheel mechanism for take-up devices, used many years ago in the textile industry, caused intermittent, step-by-step rotation of the ratchet wheel and the attached take-up roll from tooth-by-tooth pushing by a pawl in response to movement of the rocker-pin of the loom, the beat of the lay, or intermittent movement of similar moving parts of a connected loom. The resultant tension upon the fabric was not steady.

Of particular importance in many relatively slow-moving operations are effects which cause either contraction or relaxation during the winding operation or during stoppage thereof. Shrinkage effects and relaxation effects occurring in loomed cloth are particularly troublesome. Even more so are shrinkage effects, such as are shown by endless filaments when drying, and elongation effects, such as are shown by staple fibers when drying, during the letting-off of freshly sized warp to a loom. Accordingly, a controlled-tension hold-back device to a loom is as badly needed as a controlled-tension take-up or receiving device from a loom.

It is desirable that both take-up devices and let-off devices be operated with a uniform force or with a force that varies as controlled by the operator for both winding and unwinding. The principles of this invention can be applied for torque generation with a take-up device or for torque consumption with a let-off device. Suitably modified for each end of a loom, these devices function equally effectively in either capacity and in complete communication with each other.

Presently used take-up devices are mounted so closely within a loom that it is usually impossible to produce wound fabric rolls of relatively large diameter. Furthermore, the rolls which are produced are softly wound throughout and are telescoped at both ends. A need exists for devices which can produce a tightly wound fabric roll having even ends in very large diameters. It is also desirable that a take-up device be capable of operation at a remote location with respect to the loom, such as overhead, in a basement location therebelow, or in a room thereabove. It is of great practical importance that a take-up device be able to: (a) steadily maintain a selected tension upon the fabric web being wound at all times, (b) instantaneously stop the winding operation when the loom stops, (c) maintain said tension, without energy consumption, while the loom remains stopped, and (d) instantaneously start the winding operation when the loom starts while maintaining said tension.

Furthermore, a take-up device for fabrics flowing from a loom should be able to do more than simply maintain the desired tension when the loom has come to a complete stop. Because the disabled loom may require backing up in order to make repairs to the fabric, it is desirable that the take-up device also be capable of backing up without the operator having to disengage motors throw clutches, or flick a series of switches, whereby the desired constant tension may be interrupted and the repairmen may be impeded in their activities. Accordingly, the torque-generating mechanism being used as the drive means for a fabric take-up device should be capable of smooth and automatic backing up while maintaining the desired constant tension at all times while the disabled loom or fabric is being repaired.

Torque is herein defined as a force which produces rotation and the effectiveness of which is measured by the

product of the force and the perpendicular distance from the line of action of the force to the axis of rotation of a drive shaft used in a winding operation. Torque produces torsion in the drive shaft to the extent that rotation thereof is resisted. Torsion is herein defined as the twisting of a drive shaft by the transverse exertion of torque when one end of the drive shaft tends to turn about its longitudinal axis while the other end of the drive shaft tends to be retarded by resisting forces. When a drive means for a take-up device is torsionally connected to the shaft of a take-up roll in a take-up device being used in a winding operation, the torque exerted by the drive means is generally transmitted completely without torsional loss of the flexible web, such as fabric incoming from a loom of indefinite or running length which is being wound upon the take-up roll.

A preferred take-up device for use in combination with the torque-generating mechanism of this invention, as the drive means therefor, is a take-up roll assembly as described in the co-pending application, entitled "Take-Up Device Having a Tension-Derived Compacting Means."

SUMMARY OF THE INVENTION

It is, therefore, the object of this invention to provide a torque-generating mechanism that is powered by potential energy and is capable of steadily, as contrasted to intermittently, maintaining a selected torque upon a drive shaft.

It is another object to provide means for maintaining said selected torque within selected limits.

It is a further object of this invention to combine said torque-generating mechanism with a take-up device for winding flexible materials of indeterminate length, whereby said selected torque is translated into a selected tension upon said flexible material.

It is an additional object of this invention to combine said torque-generating mechanism with a let-off device for unwinding flexible materials of indeterminate length, whereby said selected torque is translated into a selected tension upon said flexible material.

It is a further object of this invention to provide means for optionally maintaining said selected tension as a constant force or as a progressively declining or selectively variable force.

It is a further object, when said flexible material is a fabric flowing from a loom, to maintain constant communication with the loom while operating said take-up device in combination with said torque-generating mechanism at a location remote from the loom.

It is also an object of this invention to provide means for maintaining said selected tension: (a) when the loom stops operation, (b) while the loom remains stopped, even for protracted periods, without consumption of energy therefor, and (c) when the loom resumes operation.

DESCRIPTION OF THE INVENTION

These objectives are achieved with the torque-generating mechanism of this invention in which potential energy is used to maintain a steady pull, by means of a driving pawl, upon the perimeter of a ratchet wheel which is rigidly attached to a drive shaft. This steady pull is expressed as a steady torque when multiplied by the radius of the ratchet wheel. It produces a steady torsional force upon the drive shaft which can be trans-

mitted to any desired take-up device combined therewith. When combined with a take-up device for winding fabric flowing from a loom, the drive shaft may be attached to the shaft or mandrel of a take-up roll, whereby the steady torque is translated into a progressively declining or selectively variable fabric tension as incoming fabric is wound thereupon, or the drive shaft may be attached to, or be an extension of, the shaft of a sand roll, whereby the steady torque is translated into constant fabric tension.

The potential energy is maintained with preselected upper and lower limits which are defined by the angular position of a pivotably mounted lever arm bearing a selectively positioned leverage weight.

The rotation-producing force or torque which is generated by the leverage weight is the product of the leverage weight (neglecting the weight of the lever arm itself, for simplicity) and the horizontal distance between this weight and a vertical line through the axis around which the lever arm pivots, herein termed the leverage distance. The upper selected limit for the torque corresponds to the horizontal position of the lever arm, for the horizontal distance between the weight and the pivot axis then equals the lever arm length and is at a maximum. The lower selected limit for the torque corresponds to the highest and lowest positions of the lever arm, for the cosine of the angles between the lever arm and the horizontal, multiplied by the lever arm length, equals the leverage distance. Clearly, the maximum leverage distance equals the lever arm length when the lever arm is horizontal. Using selected upper and lower angular limits of $\pm 22^\circ$ has been found to produce negligible variations in fabric tension.

During a brief restorative interval, an energy restoration means restores the lever arm to its high angular position, thereby restoring potential energy to its original level, in response to a position-actuated control means when the lever arm reaches its low angular position. A counter-rotation means, such as a holding pawl, maintains the position of the ratchet wheel during the restorative interval.

Although any type of rapid-acting motor means can be employed for raising the lever arm, the preferred means for use in the textile industry in a pneumatic device such as an air cylinder which is pivotably attached at its base to the supporting structure and is also engaged with a pin to the lever arm. This pin slides within a guide slot at the end of the cylinder rod and may be attached to an extension of the lever arm, opposite to the pivot shaft or between the pivot shaft and the leverage weight.

One of a pair of limit switches, which is also attached to the supporting structure as part of the control means, is actuated when the lever arm is at either its high or low position so that air is released by a connected valve to the air cylinder. Depending on the pin location and whether the limit switch is actuated at the high or low position of the lever arm, the air cylinder rod retracts or extends. After raising the lever arm, the cylinder is returned upon actuation by the other limit switch so that the pin has space to move within the slot as the lever arm descends during expenditure of the potential energy in the leverage weight, arcuate motion being accommodated by pivoting of the air cylinder at its base.

In summary, the potential-energy mechanism of this invention for steadily maintaining a selected rotational force within selected limits comprises:

- A. a drive shaft which is rotatably attached to a supporting structure;
- B. a pivot shaft which is attached to the supporting structure in parallel to the drive shaft;
- C. a leverage means for generating torque, comprising a lever arm which is perpendicularly and pivotably attached to the pivot shaft and a leverage weight which is attached to and selectively positioned along the lever arm;
- D. a torque transmission means for transferring torque from the leverage means to the drive shaft;
- E. an energy restoration means, comprising a power means which is adapted to raise the lever arm pivotably through a selected arc during a restoration interval;
- F. a control means which is adapted to actuate the energy restoration means when the lever arm is in a selected low position; and
- G. a counter-rotation means which is adapted to prevent counter rotation of the drive shaft during the restoration interval.

The torque transmission means comprises:

- A. a ratchet wheel which is rigidly and concentrically attached to the drive shaft and has ratchet teeth along its perimeter;
- B. a torque arm means, comprising a torque arm which is rigidly attached to one end to the lever arm near to the pivot shaft, whereby the torque arm pivots through the selected arc simultaneously with the lever arm; and
- C. a drive means which is pivotably attached to the torque arm and is adapted to engage the ratchet teeth, whereby pivotal movement of the torque arm through the selected arc is transmitted to the ratchet wheel.

The torque arm means may further comprise:

- A. the torque arm,
- B. a transversely disposed link which is pivotably attached, at one end thereof, to one end of the torque arm, and
- C. a steady arm which is pivotably attached, at one end thereof, to the other end of the link and is pivotably attached, at the other end thereof, to the drive shaft.

The drive means is preferably attached pivotably to the steady arm so that it is disposed as an ordinary tangent to the ratchet teeth. The drive means is preferably a pawl of either pushing or pulling type.

The ratchet teeth preferably have radially disposed faces but may be arcuately shaped and adapted to receive transversely disposed roller-type dogs functioning as a part of the pawl.

The pawl may be held against the ratchet teeth by gravity or by a spring means which may be external or internal of the pawl. The ratchet-tooth engaging means may be a roller which is disposed in parallel to the drive shaft or may be a recessed plate, hook, or tooth which is disposed so that the lower part of a ratchet wheel tooth is engaged at all times during any pivotal movement of the pawl.

The counter-rotation means may be a holding pawl which is pivotably attached to the supporting structure and rests by gravity upon the ratchet wheel teeth or is held thereagainst by a spring. Because the holding pawl immobilizes the ratchet wheel during the restorative interval, while incoming flexible material continuous to travel toward the take-up device being driven by the

drive shaft, a slight slackness may appear in the flexible material. In consequence, the initial downward movement of the lever arm may be relatively rapid as the mechanism "catches up" with the travel of the incoming flexible material. At the moment of doing so, the onset of tautness may be sudden, causing a slight shock and a rebound of approximately one-eighth of an inch along the perimeter of the ratchet wheel. In order to minimize unevenness of travel, a third pawl, which functions as a back-up holding pawl, may be used by off-setting it from the holding pawl a distance equal to the rebound distance at any suitable position along the perimeter of the ratchet wheel. Obviously, however, it is preferable to minimize slackness by keeping the restoration interval as brief as possible. To do so requires a more powerful restoration means and imparts greater momentum to the leverage means during upward pivoting of the lever arm, which creates undesirable, repetitive shocks in the mechanism.

As one means of avoiding these consequences, this invention includes the use of an energy-storage spring which is pivotably attached to the leverage means, so that kinetic energy is stored therein by the energy restoration means while lifting the lever arm, and which simultaneously imparts this energy to the ratchet wheel through a second driving pawl which principally functions during the restorative interval and which also acts as a counter-rotation means. This energy-storage spring is useful with or without a third pawl. Both the third pawl and the energy-storage spring function as a rotational smoothing means.

The energy-storage spring imparts rotation to the ratchet wheel through the second driving pawl rather than merely holding it in place during the restorative interval. However, it is difficult to obtain a desired smoothness of operation with an energy-storage spring. An ideal counter-rotation means would impart continuous positive rotational force to the ratchet wheel.

Two preferred embodiments of the invention embody this concept. These embodiments have dual torque-generating systems which derive power from dual leverage means in mutually opposed relationship. In consequence, one of the two pawls is always in operation during a restorative interval and thereby functions as a counter-rotation means while continuing to exert the same steady force, thereby producing relatively little winding hiatus.

These preferred embodiments having continuous operational characteristics and using dual lever arms without a holding pawl are:

- A. the double-slide embodiment which depends upon a long stroke for energy restoration, and
- B. the single-slide embodiment which depends upon a short stroke for energy restoration.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1, 2, 3, 3A, 3B, and 3C pertain to the single-lever arm embodiment in which a holding pawl is used during the restorative interval.

FIGS. 6, 7, 8, and 9 pertain to the double-slide embodiment.

FIGS. 10, 11, 12, 13, 14, 15, 16, and 17 pertain to the single-slide embodiment.

FIGS. 1 is a perspective view which shows the single-lever arm embodiment of this invention for operating a sand roll which is mounted on the front side of a Draper Loom for illustration.

FIG. 2 is a front view of the device at the left-hand end of the sand roll in FIG. 1.

FIG. 3 is a sectional side view from the left-hand end of the sand roll as seen in FIG. 1, looking in the direction of the arrows 3—3 in FIG. 2.

FIG. 3A is a diagrammatic side elevational view of the single-lever arm embodiment in which the torque arm means comprises a slotted steady arm to which the drive means is pivotably attached and a torque arm which is slideably attached directly to the steady arm by means of the slot therein.

FIG. 3B is another diagrammatic side elevational view of the single-lever arm embodiment in which the torque transmission means comprises a torque arm and a pivotably attached drive means.

FIG. 3C is a third diagrammatic side elevational view of the single-lever arm embodiment which is similar to FIG. 3B except that the pivot shaft is between the drive shaft and the wheel periphery.

FIG. 4 is a schematic diagram, similar to a side elevational view of the single-lever arm embodiment, which shows the levering relationship between selective placement of the leverage weight along the lever arm and resultant torque output at the drive shaft.

FIG. 5 is a side elevational sectional view of a single-lever arm embodiment having a rotational smoothing means combined with a counter-rotation means and using an energy-storage spring.

FIG. 6 is the front elevational view of the double-slide, dual-arm embodiment of the device of this invention which is mounted in winding relation to the shaft of a take-up roll upon which incoming flexible material is being compacted by the free-swinging spreader roll assembly having a tension-derived compacting means.

FIG. 7 is a right-hand elevational view of the device shown in FIG. 6.

FIG. 8 is a sectional elevational view of the device shown in FIG. 7 as an enlargement thereof at a half-cycle subsequent position of the lever arms, looking in the direction of the arrows 8—8 in FIG. 6.

FIG. 9 is a sectional elevational view of the device shown in FIG. 8 looking in the direction of the arrows 9—9 in FIG. 8.

FIG. 10 is a front elevational view of the short-stroke, single-slide, dual-arm embodiment of the device of this invention.

FIG. 11 is a sectional view, taken in the direction of the arrows 11—11 in FIG. 10.

FIG. 12 is a side elevational view of the pull pawl, the upper air switch, and a fragment of the ratchet wheel of the single-slide embodiment which is shown in FIGS. 10 and 11, with the upper lever arm depicted diagrammatically as positioned at the very beginning of the restorative interval.

FIG. 13 is the same view shown in FIG. 12 except that the lever arm is substantially at the end of the restorative interval so that the pull pawl is riding atop the ratchet wheel teeth, awaiting sufficient rotation of the ratchet wheel.

FIG. 14 is the same view shown in FIGS. 12 and 13 except that the lever arm has just dropped to the bottom of a ratchet wheel tooth and has simultaneously actuated the upper air switch which causes the restorative means to raise the lower lever arm.

FIG. 15 is a greatly enlarged view of the pawl, steady arm, and ratchet wheel shown in FIGS. 12, 13, and 14 which illustrates in a broken-away section the internal

spring-biasing means used in the single-slide embodiment for seating the pawl.

FIG. 16 is an enlarged perspective view of the upper shock absorption means shown in FIGS. 10 and 11.

FIG. 17 is a schematic arrangement of the pneumatic control circuit for the single-slide embodiments shown in FIGS. 10 and 11.

Any of the embodiments of the potential-energy torque-generating mechanism described herein can turn a drive shaft which can be used to turn a sand roll or a take-up roll upon which the fabric is wound. At a single setting of the leverage weight on the lever arm, the torque remains constant. If the radial distance from the center of the drive shaft to the surface of the roll remains constant, the pulling force per linear inch of fabric being wound from the loom also remains constant; this condition occurs when the drive shaft is the shaft of the sand roll. If the radial distance from the center of the drive shaft to the surface of the roll increases, the tension per linear inch of fabric being wound from the loom steadily decreases; this condition occurs when the drive shaft is the shaft of the take-up or cloth roll upon which the fabric is being wound.

The single-lever arm embodiment, shown in FIGS. 1, 2, and 3, is illustrated in combination with a sand roll and the other embodiments described hereinafter are shown in combination with a take-up roll. However, any of the embodiments may be substituted in any desired combination. Obviously, the leverage weight can be moved outwards incrementally by hand or continuously with a motorized drive means in any selected or synchronous relationship to the build-up of wound fabric on the take-up roll, so that the tension can be varied independently of or directly, according to any desired pattern of response, with the progressive increase in the thickness of the wound fabric.

The related application, "Torque-Control Device for a Potential-Energy Torque-Generating Mechanism," describes a device for accurately and sensitively positioning the leverage weight along the lever arm in accordance with radius changes of a roll being wound or unwound. This device utilizes cable-and-sheave power and return assemblies. The power assembly is attached to a distance measuring means sensing the periphery of the roll and to one end of the leverage weight. The return assembly is attached to the other end of the leverage weight and to the return weight. Consequently, the leverage weight is maintained in equilibrium between the assemblies and sensitively responsive to the smallest changes in roll radius.

DESCRIPTION OF THE SINGLE-LEVER ARM EMBODIMENT

As shown in FIGS. 1, 2, and 3, a suitable supporting structure for a take-up device in the form of a roll assembly to be located at a remote distance from a loom is a loom frame 20 which is, for illustration a Draper loom frame having left-hand and right-hand loom-sides 21, 21' and left-hand and right-hand arch supports 22, 22' upon which the frame 30 of the take-up device is mounted. Because, by definition, the incoming fabric enters from the rear of the take-up roll assembly, its front is mounted on the rear of the loom frame 20. Alternatively, the take-up roll assembly can be rigidly attached to a floor, overhead, or other parts of a building structure.

The take-up frame 30, which is mounted upon the loom frame 20, comprises the outer-facing main up-rights 31, 31', the inward-facing inner up-rights 32, 32' which are rigidly attached to the respective main up-rights 31, 31' in staggered, back-to-back relationship so that the inner up-rights 32, 32' are forward of the main up-rights 31, 31', the outriggers 34, 34' which are rigidly attached to the tops of the main up-rights 31, 31' at the rear sides thereof, and the outrigger brackets 37, 37' which are attached to the main up-rights 31, 31' and to the outer edges of the outriggers 34, 34' in supporting relationship.

Conventional auxiliary parts of the take-up roll assembly include the top idler roll 35, which is rotatably attached atop the outriggers 34, 34' with top idler roll bearings 36, 36', and the bottom idler roll 38, which is attached to the rear sides of the main up-rights 31, 31' with the bottom idler roll bearings 39, 39'. Slightly above and forwardly of the bottom idler roll 38, as shown clearly in FIG. 1, the shaft 42 of the sand roll 41 is rotatably attached to the main up-rights 31, 31' with the sand roll support brackets 49, 49' which contain journals for the sand roll shaft 42. The left-hand end of the sand roll shaft 42 projects beyond the up-rights 31, 32, as shown in FIGS. 1 and 2, forming the drive shaft 29.

In this surface-drive embodiment which imparts constant tension to the incoming fabric, regardless of the diameter of built-up incoming fabric as wound fabric 46 on take-up roll 47, the sand roll shaft 42 and the drive shaft 29 are a single, integral shaft as a matter of convenience. However, the drive shaft 29 is considered to be a part of the potential-energy torque-generating device of this invention and should be thought of as a separate and distinct shaft which is merely coupled to the sand roll shaft 42.

The take-up roll 47 rest on top of the sand roll 41 and rotates at the same surface speed as the sand roll 41 which has a roughened or sandpaper-covered surface, as indicated in FIG. 2. The tapered ends 48, 48' of the take-up roll 47 rotate within the take-up roll guides 33, 33' formed by the channel shape of the main up-rights 31, 31' and rise therewithin in the direction 23, illustrated in FIG. 2, as wound fabric 46 builds up on the take-up roll 47.

A fabric incoming from a loom moves upward as at 43, passes over the top idler roll 35, passes diagonally downward as fabric section 44, turns beneath the bottom idler roll 38, then moves approximately horizontally as fabric section 45 to pass beneath and around the sand roll 41 and between the sand roll 41 and the wound fabric 46 upon the take-up roll 47. As is well known in the art, this wound fabric 46 builds up in thickness so that the take-up roll 47 rotates with increasing slowness while the sand roll 41 continues to rotate at the original rotational speed and hence at the original peripheral speed.

The support means 50, for supporting portions of the single-lever-arm embodiment not directly attached to the take-up roll assembly, comprises the control shelf 51, the control support 52, the lower control bracket 53, the upper control bracket 54, the cylinder bracket 55, and the pivot bracket 56. The control shelf 51 is rigidly attached to the outer side of the main upright 31, near the lower end thereof, as seen from the rear and as shown in FIG. 1. The control support 52 is rigidly attached to the outer edge thereof and extends high

enough for the upper and lower control brackets 54 and 53 to be rigidly attached on the inner side thereof as shown in FIG. 2. The control support 52 is partially cut away in FIG. 1 to reveal the control means which is mounted behind it. At the rear side of the control shelf 51, the cylinder bracket 55 is rigidly attached thereto.

The pivot bracket 56 is rigidly attached to the supporting structure and preferably is attached to the main upright 31 on the outer side thereof, as shown in FIGS. 1 and 3, at any position that is readily accessible to the periphery of the ratchet wheel 25. The pivot shaft 64 is attached thereto in parallel disposition to the drive shaft 29. Although the preferred location for the pivot shaft 64 is beyond the periphery of the ratchet wheel 25, it is within the scope of this invention to locate the pivot shaft 64 between this periphery and the drive shaft 29, as shown in FIG. 3C.

The leverage means 60 comprises the leverage weight 61, having a weight set screw 66 set thereinto as shown in FIG. 3, the lever arm 62, the pivot hub 65, the lift arm 67, and the lift pin 68. The lift arm 67 and the lever arm 62 are rigidly attached to opposite sides of the pivot hub 65 which is journaled around the pivot shaft 64. The lever arm 62 pivots upwardly and downwardly through arc 63, as shown in FIG. 1. The lift arm 67 is simply an extension of the lever arm 62 beyond the pivot shaft 64 for convenience, so that lifting of the lever arm 62 can be accomplished by a downward pull.

The torque transmission means for transferring torque from the leverage means 60 to the drive shaft 29 comprises the ratchet wheel 25 which is rigidly and concentrically attached to the drive shaft 29 and has ratchet teeth 26 along its perimeter, a drive means which engages the ratchet teeth 26 at one end, and a torque arm means which is rigidly attached to the lever arm 62 and is pivotally attached to the drive means so that it transfers torque from the lever arm 62 to the drive means as a force which is disposed tangentially to the perimeter of the ratchet wheel 25 and compels rotation thereof in arcuate correspondence to the arcuate movement 63. The drive means is suitably a pawl 77 having a pin 76 at one end and a suitable recess 78 at the other end for engaging the edge 27 of each ratchet tooth 26 and a curved outer end, beyond this recess, for smoothly sliding over each sloping edge 28.

The torque arm means comprises, in its simplest form as shown in FIGS. 3B and 3C, the torque arm 71b or 71c and a drive means, such as the pawl 77b or 77c, which is pivotally attached thereto and which may comprise a dog 157 held against the ratchet recesses 156 of the wheel 25b by the spring 154 attached to the bracket 155. In a slightly more complex form, the torque arm means comprises, as shown in FIG. 3A, the slotted steady arm 75a which is pivotally attached to the drive shaft 29a, a drive means such as the pawl 77a which is pivotally attached to the steady arm 75a with the pin 76a, and the torque arm 71a which is rigidly attached at one end to the lever arm 62a, near to the pivot shaft 64a, and is slideably connected at the other end to the steady arm 75a with the pin 72a which moves freely within the slot 153.

The torque arm means in FIGS. 3B and 3C may be characterized as a singly segmented arm means and that in FIG. 3A may be characterized as a doubly segmented arm means. The preferred form of the torque arm means, which is shown in all of the other drawings

herein, may be characterized as a triply segmented arm.

The triply segmented torque arm means 70 comprises two generally vertical terminal segments and a pivotally connected middle segment or link which is substantially horizontal. One terminal segment, the torque arm 71 is rigidly attached to the lever arm 62 at the pivot hub 65 and projects radially and downwardly therefrom. The other terminal segment, the steady arm 75, is rigidly attached to the drive hub 79 into which the drive shaft 29 is journaled. The steady arm 75 projects radially and upwardly from the drive hub 79. The link 73 is attached at each end to the terminal segments 71 and 75 with the lever pin 72 and the pull pin 74, respectively.

The pulling pawl 77 is pivotably attached with the pawl pin 76 to the steady arm 75 at a position between the ratchet wheel perimeter and the pull pin 74 so that the pawl 77 lays by its own weight upon the ratchet teeth 26 and is disposed substantially tangentially to the perimeter of the ratchet wheel 25. When the leverage weight 61 causes the lever arm 62 to pivot downwardly, the torque arm 71 pivots to the right as shown in FIG. 3, pulls the link 73 horizontally to the right, and pivots the steady arm 75 to the right so that the pawl 77 is pulled to the right, substantially perpendicularly to the radial edges 27 of the teeth 26 of the ratchet wheel 25.

This pull is steady and is in direct relationship to the weight of the leverage weight 61 and its leverage distance from the center of the pivot shaft 64. Although this force is continuous and substantially uniform, it is somewhat diminished as the lever arm 62 varies from the horizontal. The leverage weight 61, multiplied by the selected length of lever arm 62 (distance from the center of the leverage weight 62 to the center of the pivot shaft 64) and by the cosine of the angle that the lever arm 62 makes with the horizontal, furnishes the exact leverage force at any time. This leverage force and, consequently, the angle that the lever arm 62 makes with the horizontal in moving through the arc 63, must be used in calculating the preselected limits of tension that are desired for the fabric sections 43, 44, 45.

The control means 80 comprises the indicating arm 87 which is rigidly attached to the steady arm 75 at or near to the drive hub 79, and the vertically disposed indicating rod 84. The indicating arm 81 contains a longitudinally disposed indicating slot 82 in the outer end thereof, and the rod 84 has a perpendicularly attached indicating pin 83 which fits slideably therewithin.

The indicating rod 84 is loosely supported by the lower control bracket 53 and the upper control bracket 54, so that it is free to move up and down in response to pivotal movement of the indicating arm 81.

The lower stop 85 and the upper stop 86 are rigidly and perpendicularly attached to the indicating rod 84 on either side of the indicating pin 83 and project away from the drive shaft 29, as shown in FIG. 3. The lower switch contact 88 is adjustably attached to the lower stop 85 and projects downwardly therefrom. The upper switch contact 89 is adjustably attached to the upper stop 86 and projects upwardly therefrom. The switch contacts 88, 89 are suitably made of nuts and bolts.

Also attached to the upper and lower control brackets 54, 53 are the upper limit plunger 92 and the upper air switch 98 and the lower limit plunger 91 and the lower air switch 97, respectively. The limit plungers 91,

92 are so disposed that the switch contacts 88, 89 are in potentially contacting relationship therewith.

The energy restoration means 100 comprises the air cylinder 101, the air cylinder pin 102, the air hoses 103, 104, the cylinder rod 105, the cylinder guide 106, and the cylinder guide slot 107. The small air cylinder 101 is attached by means of the air cylinder pin 102 to the cylinder bracket 55. The air hoses 103 and 104 are attached thereto. The cylinder rod 105 moves upwardly and downwardly in response to air movements through the hoses 103, 104 from the air switches 97, 98. At the outer end of the cylinder rod 105 is the rigidly attached cylinder guide 106 containing the elongated cylinder guide slot 107. The lift pin 68, attached to the lift arm 67, fits loosely therewithin so that the lift arm 67 is connected to the cylinder 101.

The counter-rotation means comprises the pawl bracket 99 which is attached to the supporting structure such as the upright 31, the pin 96, and the holding pawl 95 which is pivotably attached to the pawl bracket 99 with the pin 96. The holding pawl 95 is actuated entirely by gravity and operates as a counter-rotational means at all times. During normal operation, the pawl 95 slides over one tooth slope 28 after another. If it is desired to back up a loom connected to a take-up roll being powered by this single-lever arm embodiment, both the holding pawl 95 and the pulling pawl 77 must first be disengaged from the ratchet teeth 26.

When the lever arm 62 has dropped to a selected angle below the horizontal, the indicating arm 81 has moved downwardly through a corresponding angle and has brought the indicating rod 84 sufficiently far downwardly that the lower switch contact 88 touches the lower limit plunger 91 and sends a pneumatic impulse through the air line 93 to the air line 104 which immediately retracts the cylinder rod 105. The top of the cylinder guide slot 107 immediately contacts the lift pin 68 and pulls the lift arm 67 and lever arm 62 pivotably downward in a clockwise direction as shown in FIG. 3. Up-and-down movement 108 of the cylinder guide 106 is shown in FIG. 1.

This retraction by cylinder rod 105 ceases when the lever arm 62 reaches its selected upper position which brings the leverage weight 61 to its original or starting position where potential energy is again at its selected maximum. This selected upper position is set by the position of the upper switch contact 89. When this switch contact 89 touches the upper limit plunger 92, a pneumatic impulse is sent by the upper air valve 98 through the upper switch air hose 94 to the cylinder air hose 103 which moves the cylinder rod 105 upwardly again and brings the lift pin 68 into approximate contact with the bottom of the cylinder guide slot 107 so that the lift pin 68 has the full length of the cylinder guide slot 107 for arcuate movement therewithin as the lever arm 62 continues in its downward motion, pulling the fabric from the loom in tiny start-and-stop movements as rapidly as it is woven while maintaining a selected tension thereupon within the selected limits.

If, as shown in FIG. 3C, for example, the pivot shaft 64 is attached to the supporting structure so that is generally above the drive shaft 29c and between the drive shaft 29c and the perimeter of the ratchet wheel 25c, the torque arm 71c projects toward the ratchet teeth 26c and describes an arc 159 which is relatively concentric with the perimeter of the ratchet wheel 25c. Design advantages, in addition to saving space, include

selective use of a pair of lever arms which straddle the ratchet wheel, are pivotably attached to a single pulling pawl or pushing pawl, and are attached to a single energy restoration means.

As an improvement to the single-lever-arm embodiment, a counter-rotational means having a driving capability is shown in FIG. 5. This improvement comprises a torque arm means 170 and an energy-storage spring means 180 which is pivotably attached to the leverage means 160 of a torque-generating mechanism having a ratchet wheel 125 with circular recesses 126 along its perimeter. The energy-storage means 180 comprises the spring arm 181 which is rigidly attached to the lever arm 162 close to the pivot shaft 164, the spring lug 183 which is pivotably attached to the spring arm 181 with the pin 182, the spring top plate 184 which is rigidly attached to the lug 183, the spring cylinder 186 which is attached at its top edge to the plate 184, the energy-storage spring 185 which surrounds the cylinder 186, the spring rod 187 which is longitudinally movable within the cylinder 186, the bottom plate 188 which is rigidly attached to the rod 187, and the spring bracket 189. The storage pawl means 190 comprises the pawl arm 191 which is pivotably attached to the drive shaft 129, the storage pawl 193 which is pivotably attached to the arm 191 with the pin 192 and engages the recesses 126 with the roller dog 194, and the pawl retaining spring 195 which is attached at one end to the dog 194 and at the other end to the arm 191 with the pin 196. The arm 191 is pivotably attached to the bracket 189 with the pin 197.

When the energy restoration means 200 pulls on the pin 168, lifting the leverage means 160, the spring 185 is simultaneously compressed as the arm 181 pushes downward on the pin 182. A downward push on the plate 188 occurs almost immediately and is transmitted to the dog 194 and the ratchet recess 126 in which it is seated. The driving action continues during the restorative interval and for a period thereafter during which the leverage means 160 is held motionless in its uppermost position. When the ratchet wheel 125 has rotated sufficiently, the energy-storage spring 185 becomes sufficiently extended that further downward pushing by dog 194 nearly ceases, whereupon the spring bracket 189 contacts the stop 198 and simultaneously contacts an air switch (not shown in FIG. 5) which releases the leverage means 160. Thereafter, the dog 194 rolls out of successive ratchet recesses 126 until the energy restoration means 200 is again activated and is kept in operative synchronous relationship with the driving dog 178 by means not shown in the drawings.

The torque relationships for the potential-energy torque mechanism of this invention are shown diagrammatically in FIG. 4. Using the mechanism of FIG. 5, for illustration, the leverage means 160 exerts a gravitational force which varies with the distance from the center of the weight 161 to the center of the pivot shaft 164 along the lever arm 162. This distance is shown, for example, as two of the unit multiples 1, 2, 3, 4, 5, 6, of the length 211, which equals the distance from the center of the lever pin 172 to the center of the pivot shaft 164. With the weight 161 equalling 10 pound and positioned as shown and the distance 212 equalling 10 inches, a pull of 20 pounds is transmitted along the link 173 to the pin 174, thereby exerting a torque of 200 inch-pounds upon the shaft 129.

DESCRIPTION OF THE DOUBLE-SLIDE EMBODIMENT

FIGS. 6-9 show this embodiment in combination with a take-up device as described in the related application, "Take-up Device Having a Tension-Derived Compacting Means." FIGS. 6 and 7 show the tilt shift embodiment of a take-up device having tension-derived compaction, the center-driven take-up roll of which is torsionally connected with a clutch to the drive shaft of this double-slide embodiment as the motor means therefor. The take-up device comprises the take-up roll assembly 110, The clutch assembly 120, and the S-wrap assembly and shifting means 130. With reference to the fragment shown, the take-up roll assembly 110 comprises the stud beam 112, the take-up roll 115, its square core 116, the journal rod 117, and the wound fabric 118. The S-wrap assembly 130 comprises the shifting arm 131, the support arm 132, the end plate 133, the reverse roll 135, the spreader roll 136, and the pressure roll 137.

This double-slide embodiment is preferably mounted upon the drive frame 140 which is described hereinafter. This embodiment comprises the ratchet wheel assembly 250, the pull leverage means 260, the push leverage means 270, the pull means 280, the push means 290, the energy restoration means 300, and the control means 310, as indicated in detail in FIGS. 8 and 9. The ratchet wheel assembly 250 comprises the drive shaft 251, the bearings 252, 252' in which the drive shaft is journaled close to each end thereof upon the table side members 143, 143', the ratchet wheel 253 which is rigidly and concentrically attached to the drive shaft 251 near the middle thereof as shown in FIG. 6, the ratchet wheel teeth 254 along the perimeter of the ratchet wheel 253 which are clearly shown in FIG. 8, and the ratchet wheel hub 255 which is visible in FIGS. 6 and 9. A ratchet wheel tooth 254 has a radial face 257 and a sloping face 256, as shown in FIG. 8.

The pull leverage means 260 comprises the leverage weight 261, the lever arm 262 on which the leverage weight 261 is selectively positioned, the pull pivot shaft 264 which is journaled between the rear supports 145, 145' as shown in FIG. 6, the pull pivot hub 265 which is rotatably attached to the pivot shaft 264, the pivot socket 266 to which the lever arm 262 is rigidly attached, the lift arm 267 which is also rigidly attached to the pivot hub 265 and extends oppositely to the lever arm 262, the lift pin 268 which is transversely attached to the lift arm 267, and the set screw 269 with which the leverage weight 261 is secured to the lever arm 262.

Arcuate motion of the leverage weight 261 is indicated by the number 263. The upper position of the leverage weight 261 at the upper limit of the available potential energy is shown in phantom in FIG. 8 after having been lifted through arc 263.

The push leverage means 270 comprises the leverage weight 271, the lever arm 272 on which the leverage weight 271 is selectively positioned, the push pivot shaft 274 which is journaled between the rear supports 145 and 145' at a distance below the ratchet teeth of the ratchet wheel 253 approximately equalling the distance that the pull pivot shaft 264 is located thereabove as shown in FIGS. 7 and 8, the push pivot hub 274 which is rotatably attached to the pivot shaft 274, the pivot socket 276 to which the lever arm 272 is rigidly attached, the lift arm 277 which is also rigidly and radi-

ally attached to the pivot hub 275 and extends toward the drive shaft 251, and the set screw 279 with which the leverage weight 271 is selectively positioned along the lever arm 272. Arcuate motion of the lever arm 272 is indicated by number 273 in FIG. 8. The expended position, from the standpoint of its potential energy resources, of the leverage weight 271 is shown in FIG. 8 in phantom after travel through the arc 273.

The torque arm means 280 comprises the torque arm 281 which is rigidly attached to the pivot hub 265 and projects radially therefrom toward the pivot shaft 274, the steady arm 285 which is pivotably attached to the drive shaft 251 and projects radially therefrom toward the pull pivot shaft 264, the link 283 which is pivotably attached at the ends thereof to the torque arm 281 with the pin 282 and to the U-shaped steady arm 285 with the pin 284, the pulling pawl 287 which is attached to the steady arm 285 and to the link 283 with the pin 284, and the retaining spring 288 at the outer end of the pulling pawl 287. The steady arm 285 straddles the wheel 253 and is pivotably attached at each end thereof to the shaft 251 so that the upper radius of the ratchet wheel 253 is fully encompassed by a balanced U-shaped device that furnishes uniform support to the pin 284.

The torque arm means 290 comprises the torque arm 291 which is rigidly attached to the pivot hub 275 and projects radially therefrom toward the pivot shaft 264, the steady arm 295 which is pivotably attached to the drive shaft 251 and projects radially therefrom toward the pivot shaft 274, the link 293 which is pivotably attached at the ends thereof to the torque arm 291 with the pin 292 and to the U-shaped steady arm 295 with the pin 294, the pushing pawl 297 which is attached to the steady arm 295 with the pin 294, and the retaining spring 298 at the outer end of the pushing pawl 297. The steady arm 295 is consequently in opposed relationship to the steady arm 285, as shown in FIGS. 8 and 9, whereby the ratchet wheel 253 is bracketed by two perimeter-encompassing arms which are substantially opposed.

potential-energy potential-energy torque mechanism of this invention may be described as a motor means for taking up fabric or cloth upon a take-up roll as it comes in from the loom, while maintaining a constant pulling force thereupon. This torque mechanism is suitably mounted on its own drive frame 140, as seen in FIGS. 6 and 7. The drive frame 140 comprises the bottom members 141, the plurality of studs 142, 142', the table side members 143, 143', the cross beam 146, and the angle brackets 147, 147'. This frame forms a table structure which is rigidly attached to the take-up roll assembly 110 on the right side thereof, considering that the side from which the fabric approaches the take-up roll assembly 110 is the rear side when combined with any embodiment of this invention. This drive frame 140 forms a strong and rigid supporting structure for the potential-energy torque mechanism to provide winding power to the take-up roll 115.

The energy restoration means 300 can be any power means which is capable of raising the two leverage means 260 and 270 at selected times indicated by the control means 310. For example, an electric motor is quite satisfactory, but in textile mills a pneumatic system is preferred. As shown in FIGS. 6-9, the energy restoration means 300 comprises the cross brace 304 which is attached at each end to two parallel bottom

members 141, the cylinder bracket 303 which is attached to the cross brace 304, the cylinder 301 which is attached to the cylinder bracket 303 with the cylinder pin 302, the cylinder rod 305 which retractably extends from the cylinder 301, the cylinder guide 306 which is attached with the flex pin 309 to the outer end of the cylinder rod 305, the pull slot 307 which is longitudinally disposed within the guide 306 near the outer end thereof, and the push slot 308 which is longitudinally disposed within the guide 306 near to the flex pin 309. The lift pin 268 fits slideably within the pull slot 307, and the lift pin 278 fits slideably within the push slot 308.

The control means 310 comprises the air filters 311, the incoming air line 312, the push air switch 313 which is attached to a stud 142, the push limit plunger 314 which is attached to the push air switch 313 so that it is contacted by the push pivot socket 276 when the lever arm 272 is at its low desired position, the air line 315 carrying air to the air cylinder 301 from the air switch 313, the pull air switch 316 which is attached to the cross beam 146, the pull limit plunger 317 which is attached to the pull air switch 316 so that it is contacted by the indicating arm 319 when the lever arm 262 is at its desired low position, and the air line 318 from the pull air switch 316 to the air cylinder 301.

The term "pull" is herein used to designate the upper drive system comprising the leverage means 260 and the torque arm means 280 as a term of convenience, based on the link 283 being in tension. Similarly, the term "push" is herein used to designate the lower drive system comprising the leverage means 270 and the torque arm means 290 as a term of convenience, based on the link 293 being in compression.

The alternating sequence of the drive systems of this embodiment operate by means of a holding action which is exerted by the slots 307, 308. As seen in FIG. 8, when the arm 319 contacts the plunger 317, the cylinder rod 304 is retracted so that the leverage means 270, which had been held by the lower end of the slot 308 against the pin 278, is released. The lever arm 262, which is simultaneously in substantial contact with the upper end of the slot 307, is raised by the same retraction of the cylinder rod 305. The time required for this retraction is the restorative interval and need not be as brief as is desirable for the single lever-arm embodiment. As depicted in FIG. 7, the pull leverage means 260 is being raised at an imperceptibly greater speed than the push leverage means 270 is falling. However, the lever arm 262 must reach its waiting position, like a cocked gun, before the hub 276 depresses the plunger 314. After reaching its waiting position, as shown in phantom in FIG. 8, it is held by the upper end of the slot 307 as the cylinder rod 305 waits in retracted position for the next signal to be sent from the switch 313.

DESCRIPTION OF THE SINGLE-SLIDE EMBODIMENT

FIGS. 10 and 11 show this embodiment without reference to a connected let-off or take-up device and without showing a supporting structure. However, this embodiment can readily be mounted upon a drive frame 140 or other suitable supporting structure and can be torsionally attached to the shaft of a take-up roll in a take-up device or to any other suitable winding device or, after suitable modification, to an unwinding device.

The single-slide embodiment comprises a mounting means, a switch means, the ratchet wheel 350, the pull leverage means 360, the push leverage means 370, a pull means, a push means, the energy restoration means 400, and the air control system 430 shown in FIG. 17. The description hereinafter also refers to FIGS. 12-15 for details.

The mounting means comprises a pair of mounting plates 331, 331' and a plurality of transverse strengthening members which are rigidly attached at each end to these mounting plates 331, 331': the top cross rod 332, the upper cross brace 333, the lower cross brace 334, the bottom cross beam 335, and the bottom cross rod 336. This mounting forms a rigid, strong, and readily adaptable mounting assembly for installation on any suitably supporting structure, such as the frame 140.

The ratchet wheel assembly comprises the drive shaft 351, the bearings 352, 352' in which the drive shaft 351 is journaled close to each end thereof and which are attached to the mounting plates 331, 331', the ratchet wheel 353 which is rigidly and concentrically attached to the drive shaft 351 near the middle thereof as shown in FIG. 10, the ratchet wheel teeth 354 along the perimeter of the ratchet wheel 353 which are clearly visible in FIG. 11, and the ratchet wheel hub 355. A ratchet wheel tooth 354 has a radial face 357 and a sloping face 356, as shown in FIGS. 11-15.

The pull means and the push means are power transmission means which are identical as to both structure and mode of operation. For descriptive purposes only, differentiation is based on the forces acting on the links 383 and 393. Because the link 383 is in tension, "pull" is applied thereto and to the entire potential-energy generation and transmission systems associated therewith; similarly, because the link 393 is in compression, "push" is applied thereto and to the entire systems associated therewith. This usage is a matter of lexicographic convenience, however, and, accordingly, is not necessarily related to the action of the drive pawls 387 and 397, as described hereinafter.

The pull leverage means 360 comprises the leverage weight 361, the lever arm 362 on which the leverage weight 361 is selectively positioned, the pull pivot shaft 364 which is attached at each end thereof to the mounting plates 331, 331', the pull pivot hub 365 which is rotatably attached to the pull pivot shaft 364 and to which the lever arm 362 is rigidly attached, the lift arm 367 which is also rigidly attached to the pivot hub 365, the lift pin 368 which is attached to the lift arm 367, and the set screw 369 with which the leverage weight 361 is selectively secured to the lever arm 362.

Arcuate motion of the leverage weight 360 is indicated by the number 363. The high position of the leverage weight 361 at the upper limit of the available potential energy is shown in phantom in FIG. 11 after the weight has been lifted through arc 363.

The push leverage means 370 comprises the leverage weight 371, the lever arm 372 on which the leverage weight 371 is selectively positioned, the push pivot shaft 374 which is attached at each end to the mounting plates 331, 331' at a position directly beneath the pull pivot shaft 364, the push pivot hub 375 which is rotatably attached to the pivot shaft 374 and to which the lever arm 372 is rigidly attached, the lift arm 377 which is also rigidly attached to the push pivot hub 375, the lift pin 378 which is attached to the lift arm 377, and

the set screw 379 with which the leverage weight 371 is selectively positioned along the lever arm 372. Arcuate motion of the lever arm 372 is indicated by number 373 in FIG. 11. The expended position, from the standpoint of potential energy resources, of the leverage weight 371 is shown in FIG. 11 in phantom after travel through arc 373.

The pull means is a triply segmented torque arm means that includes the torque arm 381 which is rigidly attached to the pull pivot hub 365 and projects radially therefrom, the steady arm 385 which is pivotably attached to the drive shaft 351 and projects radially therefrom toward the pull pivot shaft 364, the link 383 which is pivotably attached at the ends thereof to the torque arm 381 with the pin 382 and to the U-shaped steady arm 385 with the pin 384, the pulling pawl 387 which is attached to the steady arm 385 with the pin 384, the pull dog 388 on the outer end of the pulling pawl 387, the spring seat 386 which is attached to the transverse part of the steady arm 385 astraddle of the ratchet wheel 353, the spring 386a within the pawl 387, and the roller seat 389. The spring 386a presses against the spring seat 386. Thus the pawl 387 is resiliently urged against the teeth 354, as shown in detail in FIG. 15, and is capable of riding up and down over the teeth 354.

The push means is a triply segmented torque arm means that includes the torque arm 391 which is rigidly attached to the pivot hub 375 and projects radially therefrom, the steady arm 395 which is pivotably attached to the drive shaft 351 and projects radially therefrom toward the push pivot shaft 374, the link 393 which is pivotably attached at the ends thereof to the torque arm 391 with the pin 392 and to the U-shaped steady arm 395 with the pin 394, the pushing pawl 397 which is attached to the steady arm 395 with the pin 394, the pushing dog 398 at one end of the pushing pawl 397, the spring seat 396 which is attached to the transverse part of the steady arm 395 astraddle of the ratchet wheel 353, the spring 396a (not shown in the drawings), and the roller seat 399.

The energy restoration means 400 can be any power means of suitable nature, as described in the other embodiments. As shown in FIGS. 10 and 11, the preferred energy restoration means 400 comprises the bracket 403 which is attached to the bottom cross beam 335, the air cylinder 401 which is attached to the bracket 403 with the pin 402, the cylinder rod 405 which extends longitudinally from the air cylinder 401, the cylinder guide 406 which is pivotably attached to the rod 405 with the flex pin 404, the pull slot 407 in the guide 406 at the outer end thereof, the push slot 408 in the guide 406 at the inner end thereof, and the enlarged middle slot 409 therebetween.

With particular reference to FIGS. 10, 11, and 17, the switch means comprises the lower air line 341, the lower air switch 342 which is attached to the lower cross brace 334, the lower plunger 343 which is attached to the air switch 342, the lower contact roller 344 which is also attached to the air switch 342, the upper air line 346, the upper air switch 347 which is attached to the upper cross brace 333, the upper limit plunger 348 which is attached to the upper air switch 347, and the upper contact roller 349 which is also attached to the upper air switch 347. The lower contact roller 344 engages the roller seat 399 on the pushing

pawl 397. The upper contact roller 349 engages the roller seat 389 on the pulling pawl 387.

The air control system 430 is shown in FIG. 17. Compressed air from a constant-pressure source, such as plant air, enters the control panel 449 and passes through the feed line 431 to the master control valve 432, then moves successively through the line 433, the air filter 434, the line 433a, the pressure regulator 435, the line 433b, the lubricator 436, and the line 433c to the four-way fitting 437. Air to the pressure gage 439 is supplied by the line 438. Air for switching operations is supplied through the switch supply line 441 to the fitting 442 from which the supply line 341 feeds the lower air switch 342 and the supply line 346 supplies the upper air switch 347.

Restoration air, as both extension air and retraction air, moves through the line 443 from the four-way fitting 437 to the four-way valve 444. Retraction air passes from the four-way valve 444, when suitably signalled by the lower switch 342 by air movement through the line 445 after the plunger 343 is depressed, through the air line 446 to the retraction end of the air cylinder 401 and forces back the piston therein during the restorative interval 322, of selected duration as indicated in FIG. 12, whereby the cylinder rod 405 is retracted. The lift arm 367 is simultaneously pulled downwards in a counterclockwise movement, and the lever arm 362 is raised correspondingly, whereby the pulling pawl 387 is moved backwards in direction 325 as seen in FIG. 12, i.e., to the right or clockwise as seen in FIGS. 11, 12, 13, 14, and 15, oppositely to the direction of rotation 324 of the ratchet wheel 353.

Extension air passes from the four-way valve 444, when suitably signalled by the upper switch 347 by air movement through the line 447 after the plunger 348 is depressed, through the air line 448 to the extension end of the cylinder 401 and forces outwardly the piston therein and the cylinder rod 405 during the restorative interval therefor which is of equal length to the restorative interval 322 shown in FIG. 12. The lift arm 377 is simultaneously pushed upwardly in a counterclockwise movement, and the lever arm 372 is raised correspondingly, whereby the pushing pawl 397 is moved backwards, oppositely to the direction of rotation 324 of the ratchet wheel 353.

When the extension air moves through the line 448 and enters the extension end of the air cylinder 401, the air within the retraction end of the air cylinder 401 is forced back through the line 446 to the four-way valve 444 and thence exhausts to the outside air through the exhaust port 446a. Correspondingly, when the retraction air moves through the line 446 and enters the retraction end of the air cylinder 401, air within the extension end thereof is forced back through the line 448 to the four-way valve 444 and thence exhausts to the outside air through the exhaust port 448a.

As can be seen by inspection of FIGS. 11-15, there are 12 teeth 354 in the ratchet wheel 353 so that each tooth 354 subtends an angle of 30°. FIG. 11 shows the dogs 388, 398 of both pawls 387, 397 as seated against a radial face 357 of the respective ratchet teeth 354. However, this situation can exist but momentarily. The pushing pawl 397 has obviously just been seated, for the lever arm 372 is in its uppermost position, and the pushing pawl 397 has simultaneously depressed the plunger 343 with the pivotable attachment for the contact roller 344 as the push dog 388 plunged inwardly at

the moment that the radial face 357 passed therebeneath and threw the spring seat 399 against the contact roller 344.

This action has actuated the switch 342, sent an air signal through the line 445 to the four-way valve 444 and caused retraction air to move through the line 446 to the retraction end of the air cylinder 401 so that the cylinder rod 405 is being retracted while the lever arm 372 moves downwardly. Retraction of the cylinder rod 405, as shown in FIG. 11, pulls against the pin 368 and pivots the lift arm 367 so that the lever arm 362 is raised at a desired speed and the torque arm 381 is simultaneously pivoted, whereby the link 383 and the pawl 387 are moved in the direction 325, oppositely to the direction of rotation 324 of the ratchet wheel 353. Thus, the dog 388 separates from the specific radial face 357', against which it had been pushing, through the sum of two opposite movements: (1.) the rotational movement 324 of the ratchet wheel 353 and (2.) the restorative pivotal movement 325 of the pawl 387 through the restorative interval 322, which is measured on the ratchet wheel 353 in FIG. 13.

When the pushing pawl 387 reaches the end of the movement interval 322 at the moment that the cylinder rod 405 has been fully retracted, the pawl 387 waits through the waiting interval 323, like a cocked gun, held by the extreme end of the slot 407 as a sear holds a spring-loaded hammer, for the face 357'' to pass therebeneath, as seen in FIG. 13. At that moment, the dog 388 moves inwardly in direction 326d and the roller seat 389 moves upwardly in direction 326s to engage the contact roller 349 and depress the plunger 348.

For ordinary winding speeds in the textile industry, this embodiment is adequate as herein described. For winding fabrics at higher speeds, such as is required for winding eight-pick fabrics, for example, a shock absorption means is needed whereby the momentum of each upward movement of the leverage weights 361, 371 can be smoothly dissipated at the termination thereof. The pull shock absorption means 410, shown in detail in FIG. 16, and the push shock absorption means 420 dissipate this momentum.

The pull shock absorption means 410 includes the outer body 412 which is attached to the mounting plate 331' with the mounting bracket 411, the piston rod 414 which is aligned with the pull lever arm 362, and the adjustment 415 which can be adjusted to provide a selected stopping speed. The outer end of the rod 414 is struck by the lever arm 362 a short distance before the end of the upward arcuate motion 363 thereof and slightly before the retractive motion of the cylinder rod 405 has ceased.

The push shock absorption means 420 comprises the mounting bracket 421 which is attached to the mounting plate 331 on the inner side thereof, the outer body 424 which is attached to the bracket 421, the piston rod 424 which is aligned with the push lever arm 372, and the adjustment. The outer end of the piston 424 is struck by the lever arm 372 a short distance before the end of the upward arcuate motion 373 thereof and slightly before the extensive motion of the cylinder rod 405 has ceased.

OPERATIONAL DESCRIPTION WHEN COMBINED WITH A TAKE-UP DEVICE

The potential-energy torque-generating mechanism of this invention has proved to be successful as a drive means for various take-up devices in winding various fabrics through a speed range of from about 2 inches per minute to about 40 inches per minute, for example, and more. As a surface drive, it has achieved a steady tension on an incoming fabric varying from 10 pounds to 50 pounds, for example, throughout the entire build-up of a large roll. When combined with a center-drive take-up roll of a take-up roll assembly for winding fabric flowing from a loom, this torque-generating mechanism has successfully tapered the tension progressively during the build-up of a roll. The tapering tension ratio decrease was 10:1 and downward, such as from 600 pounds of tension down to about 60 pounds, as an example.

The tension tolerance, measured at approximately the point where the fabric leaves the loom, was found to be within plus or minus 3 percent of the selected setting when using either of the constant-operation embodiments described hereinbefore. The single-lever arm embodiment achieved a tension tolerance of approximately 5 percent of the selected setting, thereby producing steady tension.

In some instances, it is necessary to have constant torque throughout the entire build-up of a roll of fabric which is incoming from a loom. The tension upon the fabric consequently decreases in direct proportion to the progressive build-up of the roll. In other instances, it is desirable that the drive means be capable of increasing the torque in direct proportion to the progressive build-up of the roll of fabric so that the tension upon the fabric is at all times constant. These diverse torque requirements mean that a torque-generating drive means must be capable of producing from 30 inch-pounds of torque to 3,000 inch-pounds of torque and more.

As a practical matter, a take-up device must be in constant communication with the loom and be able to maintain the selected torque and/or tension settings throughout the entire build-up of the roll, whether progressively decreasing or constant, which will require from 1 week to 3 weeks or more, depending on the construction of the fabric. When the loom stops, for any reason, the take-up device must instantaneously stop while maintaining the selected tension and torque settings upon the fabric. When the loom starts up, the take-up device must instantaneously start, continuing to maintain the proper tension and torque during the acceleration of the moving parts of the take-up roll assembly. Based on a 5-day work week, a loom usually stands idle for 2 days. It has been found that during any stop off, for very short or long periods, this torque-generating drive means for a take-up roll connected to a loom does not consume any power or energy while maintaining the proper torque and tension settings throughout the stop off.

The embodiments of the instant potential-energy torque-generating drive means, in combination with take-up roll assemblies for various fabrics in which both center-drive and surface-drive rolls were combined with the torque-generating drive means, as described hereinbefore, have performed entirely satisfac-

torily according to the highly demanding requirements set forth herein. When used in combination with the S-wrap assembly of the co-pending application as identified hereinbefore, it has produced a hard, straight-ended fabric roll of 12,000 yards. The mechanism has also run trouble-free with very little maintenance. Moreover, it has produced a large roll capable of being doffed in a narrow alley weave room by means of a monorail hoist or other suitable handling means.

Experimentally, a very valuable utility was established for this torque-generating mechanism as a drive means for a take-up roll assembly receiving loomed cloth by cutting a filling repeatedly with scissors and then backing up the loom without changing the tension between the take-up roll assembly and the loom or on the torque-generating mechanism itself. The lever arm and its leverage weight simply raised in accordance with the backward movement while maintaining its pull on the ratchet wheel. Tension on the incoming cloth was never varied, and consequently telescoping did not occur.

Less than 3.5 average cubic feet of compressed air at 60 psig was consumed per hour over the entire build-up of a large roll for a take-up device utilizing tension-derived compaction and powered with the single-slide embodiment of this invention when connected to a loom which was fabricating closely woven textile materials. In general, it has been found that a take-up device which is powered with this torque-generating mechanism consumes about 75 percent less horse-power than one run by electric drive; when holiday and weekend standby use is included, the horse-power consumption is considerably less.

It has also been established that a take-up roll assembly which was powered with the torque-generating means of this invention was capable of operating in weave rooms having very limited floor space and narrow alleys. It was capable of installation in a basement under the loom, it was hung from a ceiling, and it was floor-mounted over the warp beam area of the loom.

This potential-energy torque-generating mechanism for maintaining a selected torque within selected limits is suitable for various winding operations wherever a selected tension is needed without expensive and delicate power means and control means and particularly for relatively slow-moving operations and is equally suitable for unwinding operations when suitably modified. This torque-generating mechanism can thus also be connected to a winding or unwinding device through a speed-increasing gear train within the limitation of horse-power requirements.

Modification of the single-slide embodiment for use with an unwinding device, as a torque-consuming means, is suitably accomplished by:

- a. deleting the restoration means 400;
- b. adding a pawl "springaway" means for each pawl 385, 395 that forcibly removes the dogs 388, 398 from the ratchet teeth 357 at the instant that the respective lever arm 362, 372 reaches the top of its upward motion;
- c. adding a pawl "holdaway" means that maintains the dogs 388, 398 out of contact with the ratchet teeth 357 throughout the restorative and waiting intervals;
- d. relocating the shock absorption means 410, 420 so as to cushion each falling lever arm 262, 272 at the bottom of its selected arc of travel, so that the re-

storative interval is quite small and the waiting interval is correspondingly large, or, alternatively, using an energy-absorption means throughout the arc of descent, so that the waiting interval is selectively small.

The principles of the instant invention have been described with respect to a limited number of embodiments which have been found to be operative and useful. The specific methods and embodiments described hereinbefore are merely for the purpose of illustrating the invention, it being understood that some modifications and changes may be made therein without departing from the spirit and principles of the invention. Therefore, the terminology used throughout the specification is for the purpose of description and not limitation, the scope of the invention being defined in the claims.

What is claimed is:

1. A torque-generating mechanism for rotatively driving a shaft comprising: lever means mounted for rotation about a pivot point; leverage weight means mounted upon said lever means at a location spaced from said pivot point for applying a force to said lever means to effect rotation thereof about said pivot point from a first to a second angular position; energy restoration means adapted to restore said lever means from said second to said first position; a ratchet mechanism for transferring torque from said lever means to said driven shaft when said lever means is rotated from said first to said second angular position by said leverage weight means, said ratchet mechanism including means from preventing counter-rotation of said shaft when said lever means is being restored from said second to said first angular position; and control means responsive to the positioning of said lever means for actuating said restoration means to restore said lever means to said first position each time that said lever means reaches said second position, said control means including means for sensing arrival of said lever means at said first and said second positions.

2. A mechanism according to claim 1 wherein said lever means comprise at least two levers each having leverage weight means mounted thereon, said levers operating in tandem to continuously alternately apply through said ratchet mechanism a torsional driving force to said driven shaft.

3. A mechanism according to claim 2 wherein said ratchet mechanism comprises a pair of driving pawls, each operatively associated, respectively, with one of said levers, and a ratchet wheel rotatively driven by said pawls, said control means including switch means actuated by said pawls to alternately effect driving of said ratchet wheel by one of said levers while the other is being restored to a driving position, and driving by the other of said levers while said one lever is being restored to a driving position.

4. A mechanism according to claim 3 wherein said pawls operate to actuate said switch means individually only when either of said pawls has come into driving engagement with said ratchet wheel after the lever associated with said drivingly engaged pawl has been restored to a driving position.

5. The mechanism of claim 1 wherein said restoration means comprises an air cylinder including a cylinder rod, said air cylinder being operative to extend and retract said cylinder rod, and connecting means including a lift pin and a guide slot within which said lift pin loosely fits, said connecting means being operatively engaged between said cylinder rod and said lever means, with said lift pin engaging said guide slot to enable free movement of said lever means from said first to said second position and to enable the restoration thereof from said second to said first position by operation of said air cylinder.

6. The mechanism of claim 1 wherein said counterrotation means is a pivotally mounted holding pawl.

7. The mechanism of claim 1 wherein said control means comprises upper and lower limit switches operatively associated with said restoration means, and a position transmittal means that actuates said limit switches when said lever means reaches said first or said second positions.

8. The mechanism of claim 1 wherein said drive shaft is attached to wind a take-up roll assembly for fabric flowing from a loom.

9. The mechanism of claim 8 wherein said take-up roll assembly includes a tension-derived compacting means.

10. The mechanism of claim 1 including shock absorption means disposed to be struck by said lever means when said lever means is restored to said first position whereby the momentum of said leverage weight attached thereto is dissipated in order to stop motion of said lever means at said first position.

11. The mechanism of claim 1 including means for selectively changing the position at which said leverage weight is mounted upon said lever means thereby to enable selective alteration of the distance between said leverage weight and said pivot point.

12. The mechanism of claim 2 wherein said lever means comprise a pair of levers and wherein said control means and said energy restoration means include means for alternately moving said pair of levers between first and second positions, respectively, with one of said levers moving from a first position to a second position while the other of said levers moves from a second position to a first position and vice versa.

13. The mechanism of claim 12 wherein said ratchet mechanism includes a pair of pawls each operatively associated, respectively, with one of said levers, a toothed ratchet wheel operatively engaged to transmit torque to said driven shaft and positioned to be engaged by said pawls for transmission thereto of torque from said pair of levers, a pair of switches each operatively associated, respectively, with one of said pawls and adapted to sense the position of said pawls, said switches including means for controlling said energy restoration means to return either of said levers from its second to its first position only after the other of said levers has reached its first position with its respective pawl having become drivingly engaged with a tooth of said ratchet wheel.

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