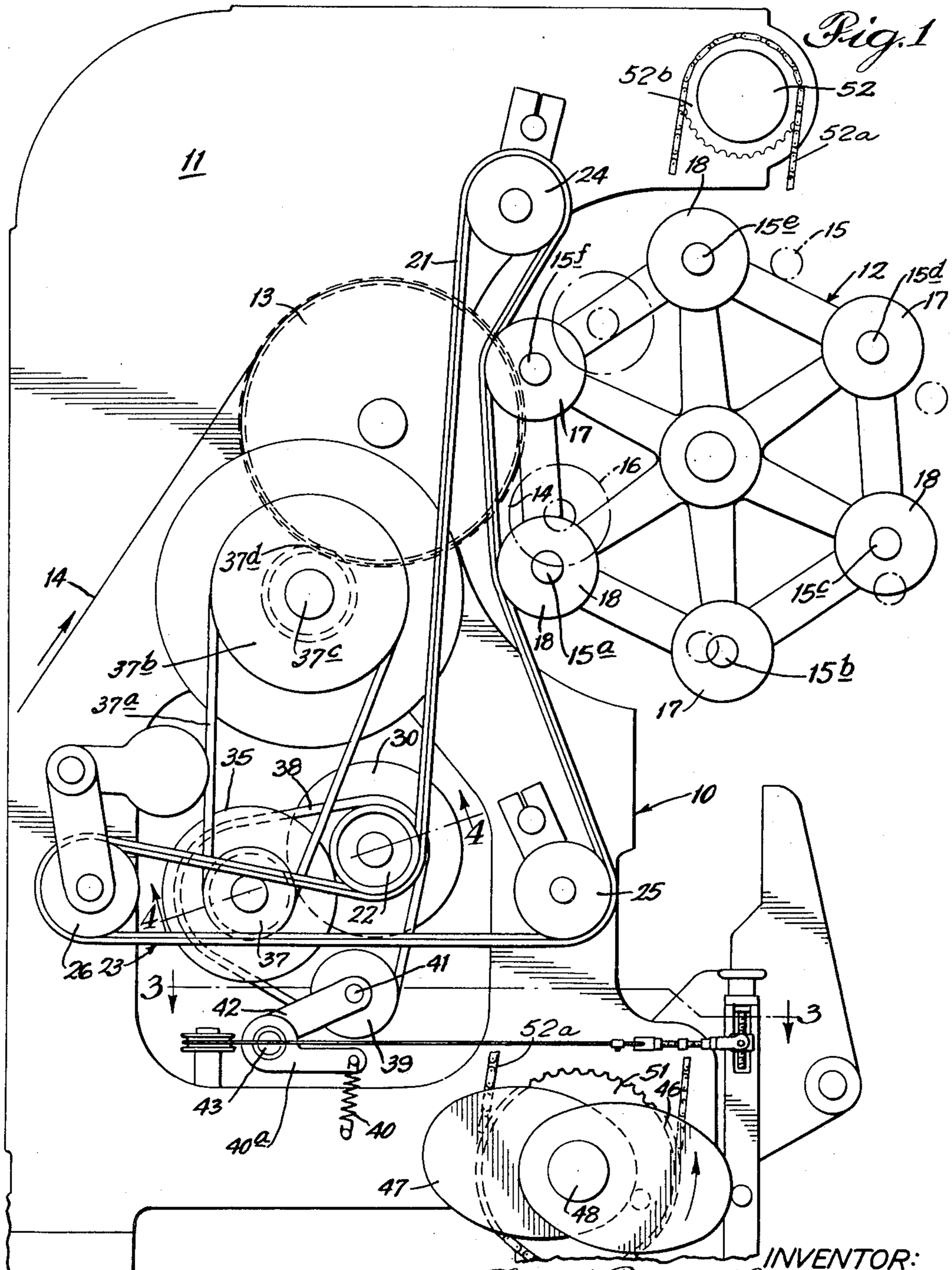
Aug. 8, 1961 E. D. NYSTRAND 2,995,314

WEB WINDING APPARATUS

Filed March 27, 1958 4 Sheets-Sheet 1

Fig. 1



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WEB WINDING APPARATUS

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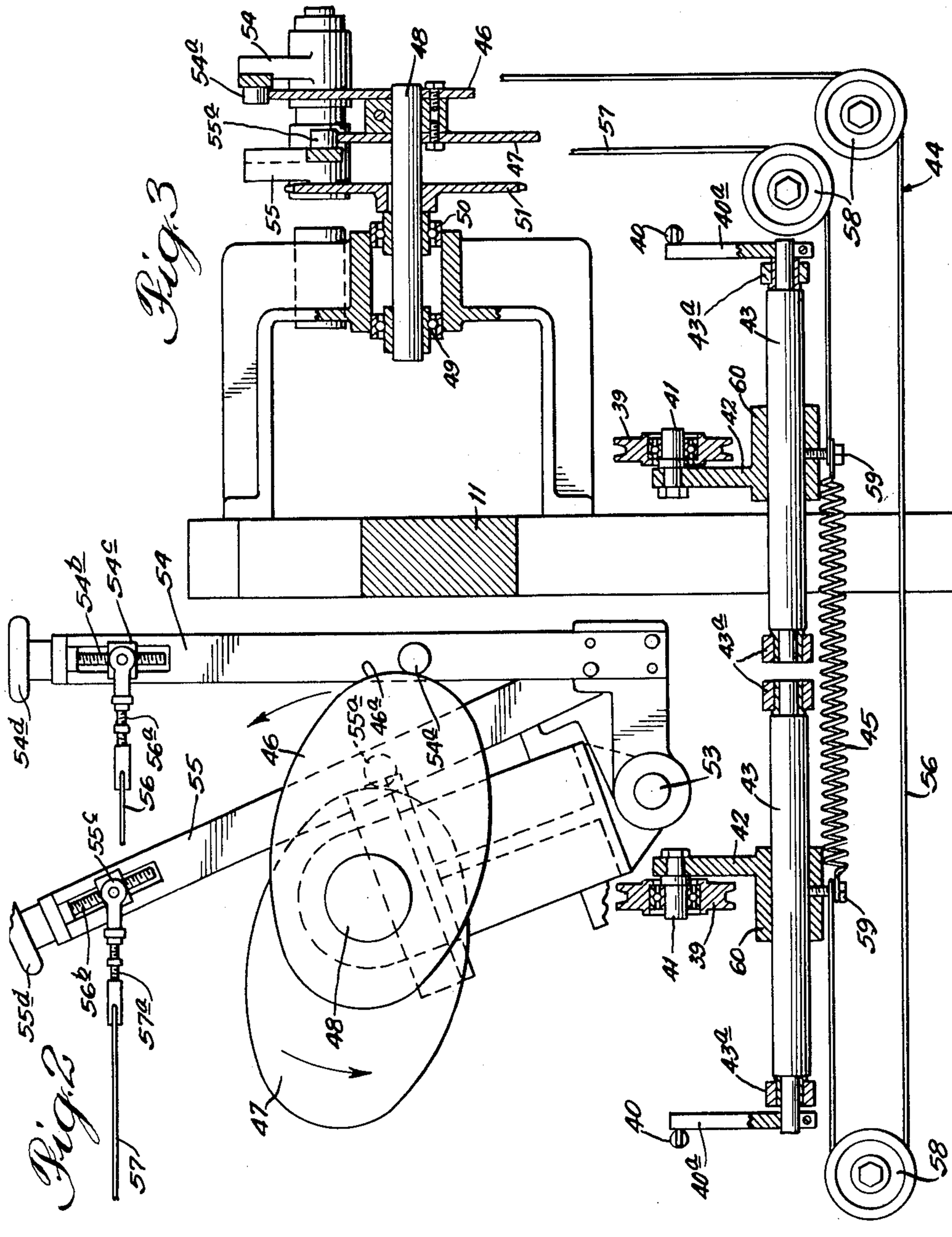

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WEB WINDING APPARATUS

Filed March 27, 1958 4 Sheets-Sheet 3

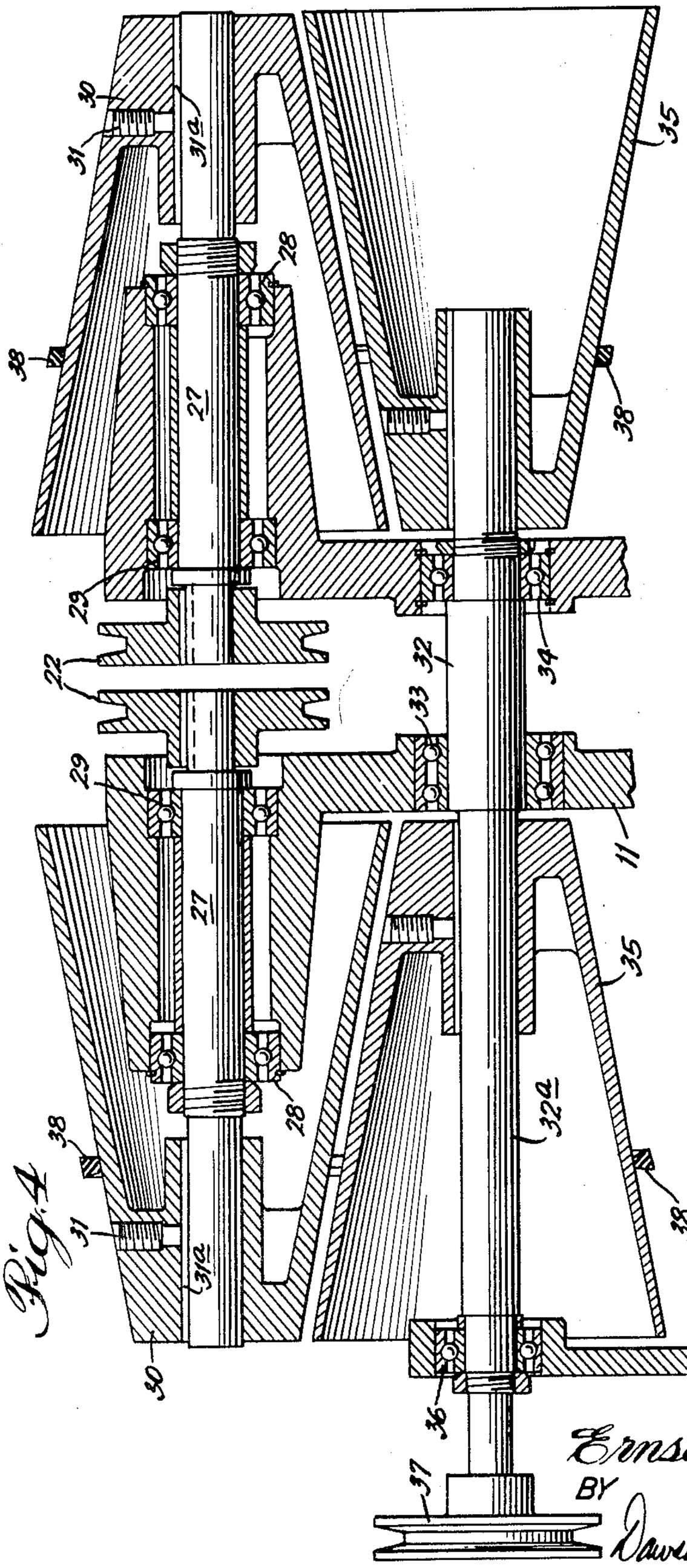

Fig. 4

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WEB WINDING APPARATUS

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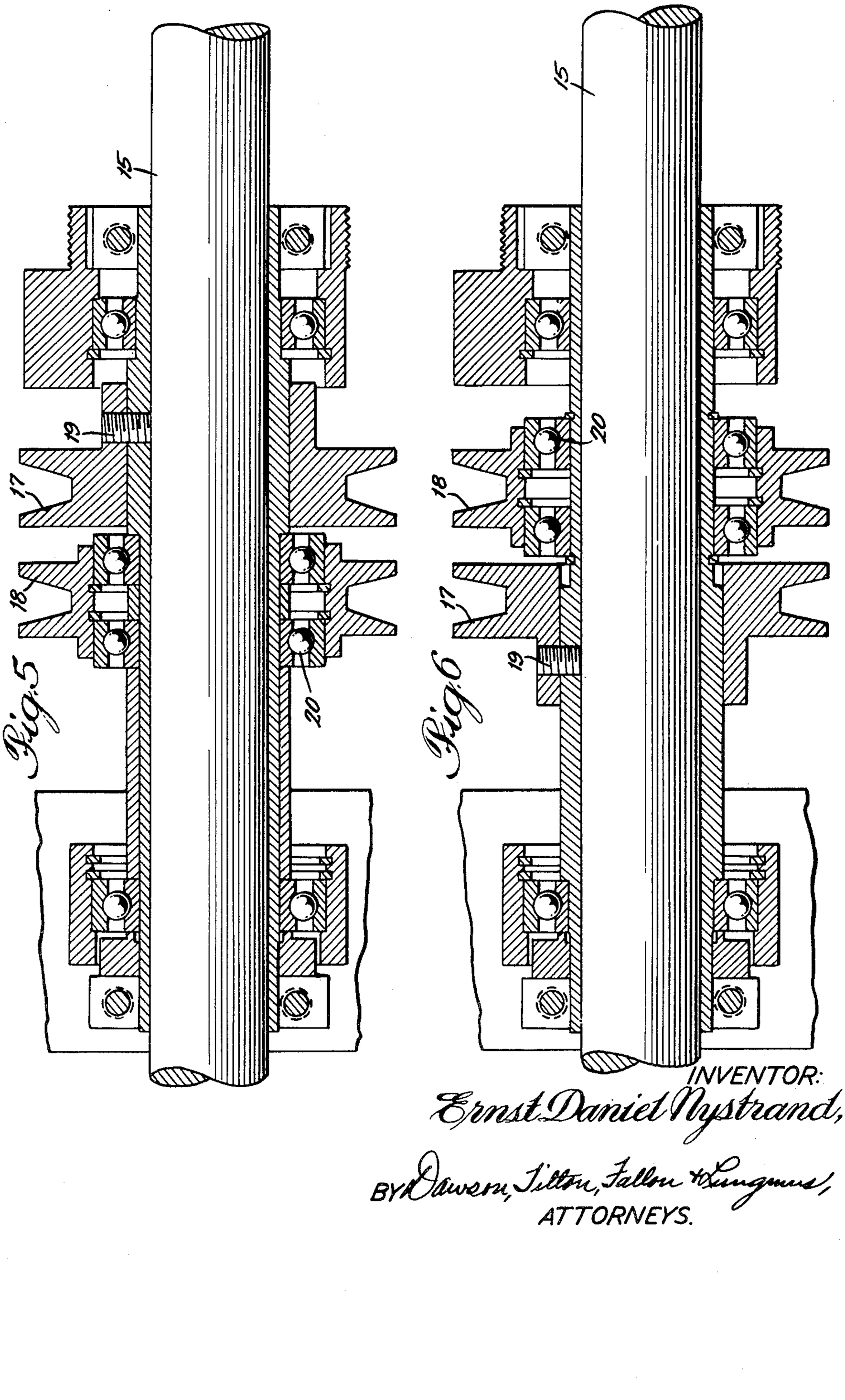

Fig. 5

Fig. 6

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WEB WINDING APPARATUS

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14 Claims. (Cl. 242—64)

This invention relates to a web winding apparatus and, more particularly, to a rewinder in which a web such as paper is rewound from a large roll into a number of smaller rolls.

The invention described herein can be used with a multiple stage winder of the character described in Kwitek and Nystrand Patent No. 2,769,600, and reference is hereby made to that patent.

Multiple stage rewinders of the character described in the above mentioned patent and with which this invention has to do, are used in large numbers in the paper-producing industry. Paper coming from a paper-making machine is most conveniently stored in large rolls, sometimes five feet in diameter or more. Before the paper can be marketed to the ultimate consumer, as would particularly be the case in toilet tissue, toweling, etc., it is necessary to provide much smaller rolls. To make the unrolling and rerolling as economical as possible, high speed rewinders have been developed. These machines take the paper as it is unwound at a constant rate of speed and slit into narrower widths and rewind the narrower widths continuously on small paperboard cores. When it is considered that the paper is traveling at speeds often well in excess of 1000 feet per minute, it will be appreciated that a large number of problems arise in rewinding.

Prominent among the many problems present is that of regulating the rotational speed of the rewinder element or mandrel on which the paper is to be rewound. In the case of toilet tissue, for example, a constant linear speed must be maintained throughout the rewinding despite the fact that the roll increases in diameter from 1½ inches to 4½ inches. Thus, there must be a continuous and gradual decrease in angular speed of the mandrel.

Heretofore, the speed reduction during rewinding has been generally provided through a friction drive which is sensitive to the tension in the web being rewound. Such an arrangement necessarily results in hunting and cycling of the mandrel speed about the proper speed needed for a constant linear web speed. Such hunting and cycling is tolerable, though not desirable, so long as the tension introduced thereby is at a value less than the tensile strength of the web. However, it is well known that the tensile strength of many webs, particularly tissue, is very small, so that it is not unusual in a rewinding operation to have many web breaks. Such breaks frequently occur shortly after the beginning of a particular rewinding operation where the stresses due to inertia and break-away torque are simultaneously impressed on the web. Ordinarily, these stresses are not troublesome, since each is below the tensile strength of the web. However, the slight extensibility of the web at the initiation of a rewinding operation permits the web-winding mandrel to exceed the proper speed and develop an inertia which cannot be resisted by the web with its very low tensile strength.

All of this could be avoided if the mandrel on which a web is rewound could be driven independently of the tension in the web, and the provision of such an apparatus is a principal object of this invention.

Another object of this invention is to provide a web-winding apparatus embodying a novel drive for a mandrel thereof, wherein the mandrel is driven from a variable speed drive and the rate of change in speed of the variable speed drive is mechanically controlled. Still another object is to provide a web winding apparatus having an even numbered plurality of web winding mandrels and in which two adjacent mandrels are driven by variable speed means independent of web tension, the mandrel on which the web is being wound being gradually reduced in speed, while the adjacent mandrel is being gradually brought up in speed to engage in subsequent rewinding.

Yet another object is to provide a web winding apparatus having a novel variable speed drive including a conical element in contact with an axially-movable belt. A further object is to provide a web winding apparatus of the character described in the objective immediately preceding, in which mechanical means in the nature of a cam assembly is employed to position the belt in a continuous, predetermined fashion. A still further object is to provide a variable speed drive for a web winding apparatus in which the initial rotational speed of the web winding mandrel is normally fixed but the speed at the end of a given rewinding operation is readily adjustable.

Other objects and advantages, both general and specific, may be seen as this specification proceeds.

This invention will be explained, in an illustrative embodiment, in conjunction with the accompanying drawing, in which—

FIG. 1 is a side elevational view of a winder which is equipped with a variable speed drive embodying teachings of this invention;

FIG. 2 is an enlarged fragmentary view of the portion of the drive shown in the lower right-hand portion of FIG. 1;

FIG. 3 is an enlarged fragmentary sectional view, taken along the line 3—3 of FIG. 1;

FIG. 4 is an enlarged fragmentary sectional view taken along the line 4—4 of FIG. 1;

FIG. 5 is an enlarged fragmentary cross-sectional view of one of the mandrels with which the rewinder is equipped; and

FIG. 6 is a view similar to FIG. 5 but showing a different mandrel arrangement.

In the illustration given, a web winding apparatus (commonly referred to as a "rewinder") is designated generally by the numeral **10**. Rewinder **10** includes a frame **11** on which is rotatably carried a multiple mandrel turret generally designated by the numeral **12**. The frame **11** also provides a rotatable mounting for bedroll **13**, over which a web **14** travels on its way to being wound on mandrels **15**.

In the illustration given, the turret **12** is provided with six web winding mandrels **15**. One web winding mandrel, designated by the numeral **15***a*, is shown in a web winding station. The mandrel designated **15***b* is shown in a roll-removing station; that designated **15***c* in a core-receiving station; that designated **15***d* in a core-cutting station; that designated **15***e* in a glue-application station; and that designated **15***f* in a station at which the mandrel has been brought up to the proper rotational speed at which the web winding operation on that particular mandrel is ready to begin. The turret **12** as illustrated is equipped with six mandrels, and such is considered an optimum number. However, a greater or lesser number may be satisfactorily employed in the practice of this invention, provided, however, that an even number are employed.

To initiate a rewinding on a particular mandrel, for example, mandrel **15***f* in the illustration given, the turret **12** is rotated counterclockwise and mandrel **15***f* is contacted with bedroll **13** which feeds the leading edge portions of the web against the core with which mandrel **15***f* is equipped. During the course of winding the web on a given mandrel, the turret is rotated further so as to position the mandrel at the end of a particular wind-

ing operation in the position occupied by mandrel **15***a*. For this purpose, it is necessary that the turret structure be swingably mounted in order to permit a mandrel to pass the bedroll **13**. An intermediate position of a mandrel between the positions designated **15***f* and **15***a* is designated by the numeral **16**. All of the foregoing is well established in the paper-producing art, and, in particular, is set forth in the above-identified Patent No. 2,769,600. A full explanation of the sequence of operations as the turret is indexed can be found therein.

Each mandrel **15** is equipped with a pair of pulleys or sheaves **17** and **18**, as can be best seen in FIGS. 5 and 6. Sheaves **17** and **18** are grooved for the receipt of belts such as V-belts, and are identically positioned longitudinally of each mandrel. Of the two sheaves provided on each mandrel, one sheave, that designated **17**, is fixed unrotatably to the mandrel as by a setscrew **19**, while the other sheave, that designated **18**, is journaled on mandrel **15** for rotational movement therewith, as by bearings **20**. In each adjacent mandrel, the character of the seating of the sheaves **17** and **18** thereon is reversed. For example, in mandrels **15***a*, **15***c* and **15***e*, the rotatable sheave **18** is outboard, while in mandrels **15***b*, **15***d* and **15***f*, the fixed sheave **17** is outboard. As will be described hereinafter in greater detail, this arrangement permits two belts to contact the sheaves on two adjacent mandrels simultaneously. One belt has a decreasing speed characteristic and is employed for driving the mandrel during the web winding period from station **15***f* to **15***a* and until the mandrel at **15***a* has its rolls completely wound. The other belt, at the time the first-mentioned belt has a decreasing speed characteristic, has an increasing speed characteristic and is employed for bringing the mandrel immediately behind the web-winding mandrel up to the proper web-engaging speed, the mandrel brought up to speed being designated by the numeral **15***f* in FIG. 1. The travel of both belts can be seen in FIG. 1, in which the belts **21** are seen contacting the sheaves on mandrels **15***a* and **15***f*.

Each mandrel-driving belt **21**, besides being entrained in the aligned sheaves **17** and **18** in adjacent mandrels, is entrained in a sheave **22** which is part of a variable speed drive designated generally by the numeral **23**. A portion of this variable speed drive can be seen in FIG. 4, wherein two centrally-positioned sheaves are designated **22** and are employed for varying the speed of belts **21**. In addition, a number of belt-tensioning sheaves or pulleys are provided and are designated by the numerals **24**, **25** and **26** in FIG. 1, each of the last-mentioned sheaves being suitably tensioned or counterbalanced in a manner well known in the art and suitably supported on frame **11**.

Referring now to FIG. 4, each sheave **22** is secured to a shaft **27** journaled in bearings **28** and **29** mounted on frame **11**. Each shaft **27** is also equipped with a frusto-conical member **30** secured in nonrotative relation thereto by means of setscrew **31** and key **31***a*. The frustoconical members **30** are oppositely oriented. In the illustration given, the larger ends are adjacent and each frustoconical member **30** is of considerable length in contrast to its change in diameter. Frame **11** also rotatably carries shaft **32**, which is suitably journaled in bearings **33** and **34**, the shaft **32** being disposed parallel to the shaft **27** carrying the frustoconical member **30**. Shaft **32** carries two frustoconical members **35** which are substantially identical to the frustoconical members **30** mounted on shafts **27**, the frustoconical members **35** carried by shaft **32** being oppositely oriented to each other and to the frustoconical members **30** carried by shafts **27**. The shaft **32** is equipped with an extension as at **32***a* journaled in frame **11** as at **36** and which carries a sheave **37** which is suitably powered through a belt **37***a* from a sheave **37***b* mounted on drive shaft **37***c* of rewinder, all as seen in FIG. 1, drive shaft **37***c* being geared to bedroll **13** as at **37***d*.

Riding over one frustoconical member **30** and its adjacent frustoconical member **35**, is a belt **38**, which couples the rotative motion of frustoconical member **35** induced by sheave **37** to frustoconical member **30**. As can be seen in FIG. 1, the belt **38** is also entrained over a sheave **39**, two of which are provided, one for each belt **38**, as can be seen in FIG. 3. The sheaves **39** serve a dual purpose in providing tension for the belts **38** through the action of springs **40** on levers **40***a* fixed on shafts **43**, and, by being movable in a direction parallel to the axis of shafts **32** and **27**, provide for changing the position of belts **38**. For this purpose, the sheaves **39** are rotatably mounted on stub shafts **41** (best seen in FIG. 3), which in turn are secured within arms **42** slidably carried on splined shafts **43**. Splined shafts **43** are rotatably mounted in bearings **43***a* on frame **11**.

By moving sheaves **39**, the position of belts **38** can be changed and thus the speed of frustoconical members **30** changed. For example, movement of one sheave **39** outwardly (i.e., away from the common end of oppositely-oriented members **30**, the rotational speed of the member **30** associated with the pulley **39** so moved is increased. In FIG. 4, movement of the right-hand belt **38** to the right increases the speed of frustoconical member **30** and its associated pulley **22**. Inward movement provides the reverse in speed change. This occurs in the left-hand portion of the system, since the two pulleys **39** are connected together by means of a cable and a spring system generally designated **44** and in which the numeral **45** refers to a coiled spring connecting arms **42**, as can be best seen in FIG. 3. Thus, movement to right of the pulley **39** over which the right-hand belt **38** in FIG. 4 is entrained increases the rotational speed of the right-hand frustoconical member **30**, while movement to the right of the left-hand belt provides an opposite change in speed in its associated frustoconical member **30**. As can be appreciated from what has gone before, the increase in speed of the right-hand frustoconical member **30** is employed to bring mandrel **15***f* up to web-engaging speed, while the decrease in speed of the other frustoconical member **30** is employed to decrease the speed of mandrel **15***a* during the course of a rewinding operation.

To achieve movement of each pulley **39** and thereby change the speed of the two mandrels **15***a* and **15***f*, speed variation control means are employed which operate through the cable and spring system designated **44** and which derives a signal from cams **46** and **47**. Cams **46** and **47** are secured to a shaft **48** (best seen in FIG. 3), which is suitably journaled in frame **11** as at **49** and **50**. Also secured to shaft **48** is a sprocket **51** which is suitably connected by intermediate chain **52***a* to a sprocket **52***b* on the main indexing shaft **52**. The main indexing shaft **52** (seen only in FIG. 1 and at the extreme upper right-hand corner thereof) is employed in rewinders to provide timing signals for the indexing of turret **12**. As in the Patent No. 2,769,600 mentioned above, this can be achieved through a Geneva arrangement (not shown). In any event, one rotation of shaft **52** produces, in the machine illustrated herein, a one-sixth rotation of turret **12**, thus bringing another mandrel into the web winding position. It will be appreciated that the residence time of a mandrel in the fixed position in a given station does not extend for all the entire one-sixth rotation of shaft **52**, but only for a fractional part thereof, it being necessary, for example, to have a mandrel remain in the station identified as the core-loading station and to which the numeral **15***c* is affixed for only so long as it is necessary to mount an elongated core thereon. The remainder of the "cycle" of shaft **52** (corresponding to a one-sixth revolution of turret **12**) is employed for bringing the mandrels into a subsequent station, i.e., mandrel **15***f* being moved downwardly and into engagement with bedroll **13**, while mandrel **15***a* is being moved away from

bedroll **13** and ultimately into the station designated by the numeral **15***b* for removal of the wound roll.

The chain connecting main indexing shaft **52** and shaft **48** which carries sprocket **51** is so arranged as to provide a two-to-one speed reduction, so that cams **46** and **47** make only one-half a revolution for each complete revolution of the main indexing shaft **52**. This provides for cam **46**, for example, to reduce the speed of mandrel **15***a* during winding, and on the next cycle of main indexing shaft **52**, for bringing the speed of belt **25** to engage sheave on mandrel **15***e* up to the required value.

Pivotally mounted on frame **11** as at **53** (see FIG. 2) are cam follower arms **54** and **55**, each of which is equipped with a cam follower roller designated respectively **54***a* and **55***a*. Cam follower arm **54** is shown in a position perpendicular to the ground, and in this position the portion of the cam in contact with the cam follower roller **54***a* is about to initiate the beginning of a winding of a new roll, i.e., the point of "transfer." It is to be noted that the high point of the cam designated **46***a* has already passed in contact with cam follower roller **54***a*, so that the point of transfer of web **14** to a new mandrel **15** occurs during the gradual decrease in speed of the mandrel that is just coming into the winding station. The movement of cam follower roller **54***a* in following cam **46** is transmitted from cam follower arm **54** to the left-hand sheave **39** in FIG. 3 by means of cable **56**. Correspondingly, the motion of cam follower roller **55***a* derived from cam **47** is transmitted to the right-hand sheave **39**, as seen in FIG. 3, through cable **57**. Each cable is suitably entrained in sheaves **58** in order to change the direction thereof, and the ends of cables **56** and **57** are secured to bolts **59** extending into sleeve portion **60** of the arms **42** which support the sheaves **39**.

The ends of cables **56** and **57** which are secured to cam follower arms **54** and **55** are equipped with turnbuckles **56***a* and **57***a*, respectively, for initial positioning of sheaves **35**. The upper end of each cam follower arm **54** and **55** is equipped with an elongated slot **54***b* and **55***b* which extend transversely therethrough. Each slot **54***b* and **55***b* carries a block designated **54***c* and **55***c*, respectively, which is positionable longitudinally of its associated slot by means of a control knob **54***d* and **55***d* which is threadedly received within a threaded opening in the top of each cam follower arm **54** and **55**. The ends of turnbuckles **56***a* and **57***a* not secured to the associated cables **56** and **57** are pinned to blocks **54***c* and **55***c*, respectively. Thus, by rotating control knobs **54***d* and **55***d*, the associated blocks **54***c* and **55***c* can be moved upwardly or downwardly in slots **54***b* and **55***b*, as the case may be, and thus change the angle between the cables **56** and **57** and the cam follower arms **54** and **55**. For example, by moving control knob **54***d* upwardly and thus moving block **54***c* upwardly, the length of cam follower arm **54** is effectively increased, the length of cable **56** remaining substantially constant, so that on movement of the cam follower arm in a counterclockwise direction, greater travel of the associated sheave **39** is afforded from approximately the same starting-point. The starting point corresponds to the transfer point of the web to the mandrel **15** just entering the web winding station designated **15***f*, and at this point the rotational speed of the mandrel must always be the same for any given web velocity. However, it is desirable to be able to change the terminal speed, i.e., the speed of mandrel **15***a* at the end of a web winding operation. Where, for example, a higher caliper (i.e., thickness) sheet is being run, it is necessary to have a lower terminal speed than that employed on a normal caliper sheet in order to produce a roll of larger diameter. Conversely, with lower caliper sheets, the terminal speed must be higher, producing a roll of smaller diameter. Both of these requisites can be met in the foregoing apparatus merely by adjusting the blocks **54***c* and **55***c* upwardly for a heavier caliper sheet or downwardly for a lighter caliper sheet than was previously being run.

It is believed that a brief description of the apparatus just described will further aid in understanding the invention, therefore such a description follows.

Operation

The apparatus is shown in a condition in which a new web winding operation is about to begin. In FIG. 1, it can be seen that very slight counterclockwise movement of turret **12** will bring mandrel **15***f* into contact with bedroll **13**. At this instant, a knife transversely severs web **14** between mandrels **15***f* and **15***a* so that the glue-equipped surface of the core on mandrel **15***f* picks up the leading edge of web **14** for winding. Mandrel **15***f* is being driven through its sheave **17** by belt **21**, which is entrained over the sheave **39** shown in the left-hand portion of FIG. 3 and which derives a continuous signal from cam **46**. Cam **46** has been contoured along the lower periphery thereof to provide the change in speed necessary to maintain a constant linear speed in mandrel **15***f* despite the enlargement of the diameter of the roll being wound thereon. In the illustration given, cam **46** rotates counterclockwise, as can be appreciated from the arrow shown in FIG. 2, and gradually permits cam follower arm **54** to pivot counterclockwise about its pivotal mounting at **53** on frame **11**. This movement of cam follower arm **54** permits the left-hand sheave **39** in FIG. 3 to move toward the right and to a position which entrains a greater portion of belt **38** about the left-hand frustoconical element **30** in FIG. 4. Inasmuch as belt **38** is moving at a constant speed, the right-hand movement of the left-hand belt **38** in FIG. 4 reduces the speed of the left-hand frustoconical member **30** and thus the speed of its associated pulley **22**. The pulley **22** carries belt **21** which provides the drive for mandrel **15***f* through its sheave **17**. The same belt that is driving sheave **17** of mandrel **15***f* is also entrained in sheave **18** of mandrel **15***e*, which has now advanced to the position previously occupied by mandrel **15***f*, but does not affect the operation of mandrel **15***e* inasmuch as the sheave **18** thereof is rotatably mounted thereon. The movement to the right of the left-hand sheave **39** is brought about through the cooperation of spring **45** and cable **57** in cooperation with the movement of cable **56**, since cable **57** is being drawn to the right in FIG. 2 under the influence of the clockwise movement of cam follower arm **55** as seen in FIG. 2. The movement of cable **57** moves the right-hand sheave **39** also toward the right in FIG. 3, which changes the position of its belt **38** to a position where more of belt **38** is wrapped about its associated frustoconical member **35** and less about frustoconical member **30**. This means that the associated sheave **22** (the right-hand sheave in FIG 4) has an increasing speed characteristic. The belt **21** entrained over this sheave will be operating on sheave **18** of mandrel **15***f* and have no effect thereon. However, as mandrel **15***e* moves into the position occupied by mandrel **15***f*, the belt having the increasing speed characteristic will operate against the sheave **17** of the next adjacent mandrel so as to bring that mandrel up to the proper web-engaging speed.

While, in the foregoing specification, a detailed description of an embodiment of the invention has been given for the purpose of explanation, it will be readily appreciated by those skilled in the art that the details herein may be varied widely without departing from the spirit and scope of the invention.

I claim:

1. In web winding apparatus, a frame, an even numbered plurality of mandrels movably, rotatably mounted on said frame, each of said mandrels being equipped at the same longitudinal positions with a pair of pulleys, one of said pair of pulleys being fixed to said mandrel and the other rotatable thereon, the positions of said one and said other pulleys being reversed in adjacent mandrels, and drive means simultaneously engageable with two adjacent mandrels, said drive means comprising a pair of belts entrained in the pulleys of said two adjacent

mandrels, and a mechanical variable speed drive operative to provide one belt with an increasing speed characteristic while providing the other belt with a decreasing speed characteristic.

2. In web winding apparatus, a frame, a mandrel-supporting turret rotatably mounted on said frame operative to sequentially position each mandrel in a web winding station, an even number of mandrels rotatably carried by said turret, each of said mandrels carrying a pair of pulleys at aligned positions along the length thereof, one of each pair of pulleys being fixed with the other rotatable with respect to the associated mandrel, corresponding pulleys on alternate mandrels being fixed and the remaining corresponding pulleys being rotatable, a pair of endless belts entrained in the pulleys of two adjacent mandrels, a pair of variable speed drives for said belts, one of said drives increasing the speed of its associated belt while the other of said drives decreases the speed of its associated belt, and means for controlling said drives, said controlling means being operative to cause the fixed pulley on a mandrel positioned in a web winding station to be coupled to the belt having a decreasing speed characteristic.

3. The apparatus of claim 2, in which each of said variable speed drives includes a conical member rotatably mounted on said frame and having a driving pulley axially secured thereto in which the said associated belt is entrained, separate powered belt means for each of said members positionable along the length thereof and transmitting motion to the conical surface thereof, the conical member associated with one belt being oppositely oriented from the conical member associated with the other of said belts, the said separate, powered belt means being entrained over sheaves mounted on said frame for movement parallel to the axes of said conical members, the said sheaves being so interrelated that movement in one sheave is accompanied by corresponding movement in the other.

4. The apparatus of claim 3, in which each of said sheaves is coupled by cable means to a cam follower arm pivotally mounted on said frame, an separate, identical cams are associated with each arm, the cam associated with one arm being reversely oriented to the cam associated with the other arm.

5. The apparatus of claim 4, in which said frame is equipped with rotatably-mounted shaft means for indexing said turret, and in which said cams are disposed in parallel, coaxial relation on a cam shaft, means coupling said cam shaft to said shaft means, said cam shaft passing through one-half a revolution for each rotation of said shaft means, each rotation of said shaft means being productive of the positioning of adjacent mandrels in the said web winding station.

6. In web winding apparatus having a plurality of rotatably mounted mandrels, means for varying the angular velocity of a mandrel independently of the tension of a web being wound thereon yet maintaining a substantially constant linear speed in peripheral portions of the web-wound mandrel comprising a frame equipped with a plurality of mandrels, shaft means rotatably carried by said frame and operative to index said mandrels, a mechanical variable speed drive for said mandrels, and means for controlling said variable speed drive, said controlling means comprising mechanical means responsive only to and powered by said shaft means.

7. The apparatus of claim 6 in which an even number of mandrels are provided, said drive being operative to bring a mandrel to web-engaging speed in one indexed position while an adjacent mandrel is being wound in another indexed position.

8. In web winding apparatus, a frame carrying an even-numbered plurality of mandrels, a variable speed drive for said mandrels adapted to drive said mandrels independently of the tension of a web being wound thereon, said drive comprising two pairs of cones mounted for rotation in said frame with the axes of the cones in each pair being disposed in parallel relation with the cones of each pair being oppositely oriented, belt means supported on each pair of cones, means on said frame for moving each of said belt means axially of said cones in a predetermined cyclic fashion, means on said frame for rotating one of each pair of cones, belt means coupling the other cone of each pair of cones sequentially with pairs of adjacent mandrels, each mandrel being equipped with a pair of pulleys for entrainment of said belts, one of said pulleys being rotatably mounted while the other pulley is fixed to said mandrel, the positions of said pulleys being reversed in adjacent mandrels.

9. The structure of claim 8 in which the said moving means comprises a sheave movably mounted on said frame for each of said belt means, cam means on said frame, and means connecting said sheaves with said cam means, said connecting means being adjustable to provide a variation in the terminal speed of the drive at the end of a winding cycle without affecting the initial speed at the beginning of a winding cycle.

10. The structure of claim 9 in which said connecting means for each sheave includes a pivotally-mounted cam follower arm having cable means connected thereto and secured to said sheave, the connection of said cable means being adjustable along the length of said arm, the angle between said cable means and said arm being about 90° at the beginning of a winding cycle.

11. In web winding apparatus, a frame, a turret rotatably mounted on said frame, an even-numbered plurality of mandrels rotatably mounted on said turret, a bedroll rotatably mounted on said frame and carrying a web for sequential winding on said mandrel, a pair of mechanical variable speed drives on said frame, said drives being arranged that when one has an increasing speed characteristic, the other has a decreasing speed characteristic, means for alternately varying the speed characteristic of each drive, a first means for coupling the decreasing speed characteristic drive with both the mandrel winding said web from said bedroll and the mandrel next in sequence for winding said web from said bedroll, idler means interposed between said first coupling means and said next in sequence mandrel, whereby said first coupling means is effective to rotate only said winding mandrel, and second means for coupling the increasing speed characteristic drive with both the said winding mandrel and the said next in sequence mandrel, idler means interposed between said second coupling means and said winding mandrel whereby said second coupling means is effective to rotate only said next in sequence mandrel.

12. In web winding apparatus having a plurality of rotatably mounted mandrels, means for varying the angular velocity of a mandrel independently of the tension of a web being wound thereon yet maintaining a substantially constant linear speed in peripheral portions of the web-wound mandrel, comprising a frame equipped with an even-numbered plurality of mandrels, shaft means rotatably carried by said frame and operative to index said mandrels, a bedroll rotatably mounted on said frame and carrying a web for sequential winding on said mandrels, a pair of mechanical variable speed drives for said mandrels, means for controlling said variable speed drives responsive to said shaft means, belts connecting each of said drives with the same pair of adjacent mandrels, the means for controlling said drives being effective to rotate the mandrel next in sequence to the mandrel winding said web at a speed in excess of the web speed and just prior to the time the web is transferred to said next in sequence mandrel.

13. In web winding apparatus for cyclic winding of webs, a frame, an even numbered plurality of mandrels movably, rotatably mounted on said frame, each of said mandrels being equipped at the same longitudinal positions with a pair of pulleys, one of said pair of pulleys being fixed to said mandrel and the other rotatable thereon, the positions of said one and said other pulleys being

reversed in adjacent mandrels, and drive means simultaneously engageable with two adjacent mandrels, said drive means comprising a pair of belts entrained in the pulleys of said two adjacent mandrels, and a mechanical variable speed drive operative to provide one belt with an increasing speed characteristic while providing the other belt with a decreasing speed characteristic, said drive being equipped with adjustable means for varying the terminal speed of the drive at the end of a given cycle of winding without affecting the initial speed of the drive at the beginning of a winding cycle.

14. In web winding apparatus for cyclic winding of webs and having a plurality of rotatably mounted mandrels, means for varying the angular velocity of a mandrel independently of the tension of a web being wound thereon yet maintaining a substantially constant linear speed in peripheral portions of the web-wound mandrel, comprising a frame equipped with a plurality of mandrels, shaft means rotatably carried by said frame and operative to index said mandrels, a mechanical variable speed drive for said mandrels, and means for controlling said variable speed drive, said controlling means comprising mechanical means responsive only to and powered by said shaft means, said controlling means being equipped with adjustable means for varying the terminal speed of the drive at the end of a given cycle of winding without affecting the initial speed of said drive at the beginning of a winding cycle.

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