July 22, 1958 A. P. LEWIS ET AL 2,843,882

EVENER

Filed June 8, 1955 2 Sheets-Sheet 1

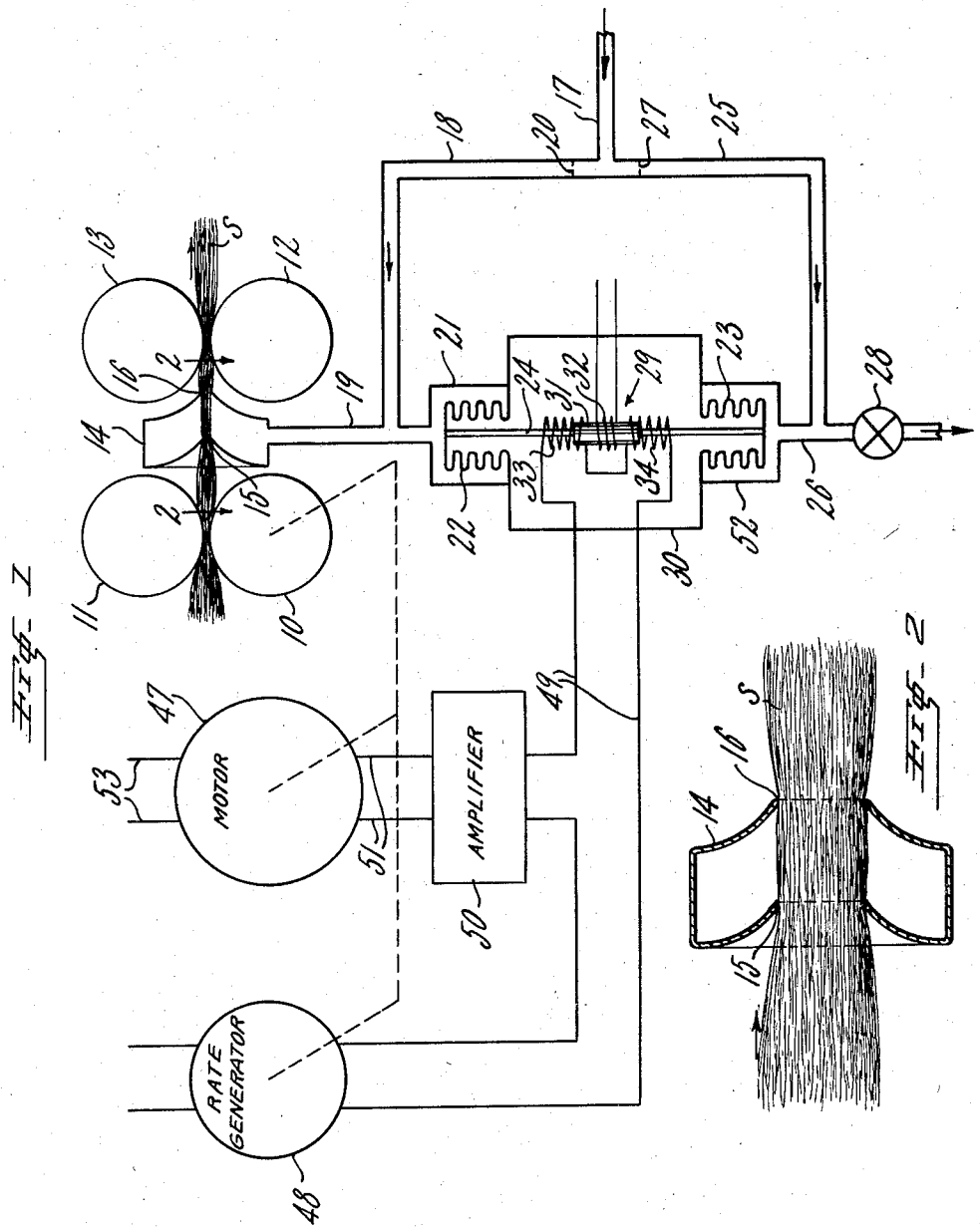


Fig. 1

Fig. 2

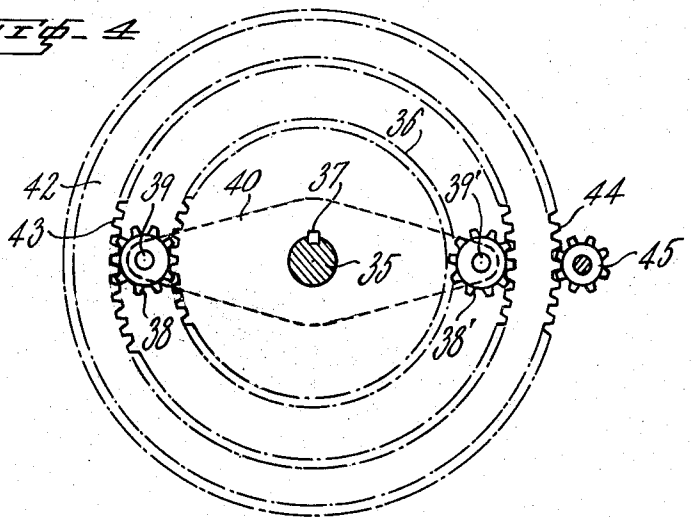
INVENTORS
Donald C. MacDonald
Arthur P. Lewis
BY
Donald B. Miller
ATTORNEY

July 22, 1958 A. P. LEWIS ET AL 2,843,882

EVENER

Filed June 8, 1955 2 Sheets-Sheet 2

Fig. 4



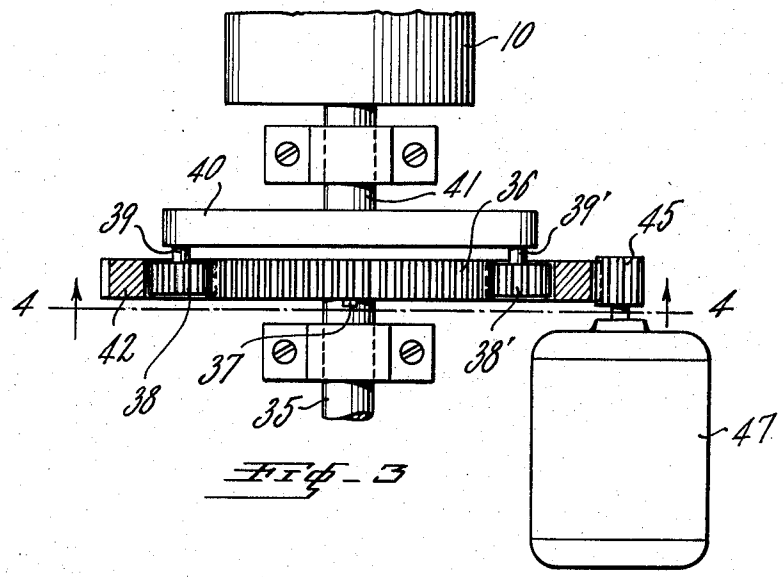


Fig. 3

INVENTORS
Donald C. MacDonald
Arthur P. Lewis
BY
David B. Miller
ATTORNEY

United States Patent Office 2,843,882 Patented July 22, 1958

2,843,882

EVENER

Arthur P. Lewis, Fairhaven, Mass., and Donald C. MacDonald, Ridgewood, N. J., assignors to United States Rubber Company, New York, N. Y., a corporation of New Jersey

Application June 3, 1955, Serial No. 513,978

15 Claims. (Cl. 19—70)

This invention relates to mechanisms for controlling the weight of a running textile strand to thereby produce a strand having a uniform weight throughout its length.

Uniformity in yarns has long been sought after in the textile industry, yet the yarns produced today are not uniform. This lack of uniformity in yarns is very undesirable for various reasons. For example, when plied yarns are used in mechanical applications where tensile strength is important, losses in strength of the yarns due to weak or fine regions in the individual yarn plies are reflected as a loss of strength in the fabric where such weak regions in the individual yarns occur in parallel. Lack of uniformity also presents a serious sales problem in high quality commercial yarns, because a non-uniform yarns has a bad appearance which results from the variations in size of the yarn throughout its length.

Conventional methods of yarn weight control involve control of sliver weight by controlling the draft simultaneously on all deliveries of a draw frame or slubber, and accordingly these methods are capable only of controlling the average weight of all ends in the frame. In addition, the frequency with which corrections (gear changes) can economically be made is quite limited, so that the only control available on conventional equipment is that of very long-term average weights. It is well known in the art, however, that short-term variations in sliver weight of one-half to one or two inches' duration are normally of much greater magnitude than the long-term effects. As an example, short-term variations in typical two-process finisher drawing sliver frequently reach ±20 percent of the average weight. It is these short-term variations of large magnitude which must be corrected in order to achieve a substantially uniform sliver.

It is a primary object of this invention to provide an apparatus for controlling the size of a sliver so that a uniform yarn may be spun therefrom. In particular, this invention contemplates an apparatus for detecting variations in the weight (i. e., the weight per unit length) of a moving textile strand, and for attenuating this strand in response to the variations detected to produce a finished strand having a substantially uniform weight throughout its length.

In accordance with this invention, two pairs of drafting rolls are provided, spaced as closely together as good drafting practice permits, and adapted to attenuate a strand as it passes through these rolls. Means are provided, intermediate of these pairs of drafting rolls, for continuously detecting variations in strand weight as it passes therebetween. The front drafting rolls are driven directly at a substantially constant speed, as is usual, and we provide novel coupling and control means for varying the speed of the rear drafting rolls automatically in response to detected variations in strand weight, to thereby vary the draft exerted on the strand by the rolls and thus produce a strand of uniform size.

While these two pairs of drafting rolls and the evener my be located at any point in the drafting system, or may

even be set up as a separate operation, they are preferably positioned at the rear of the slubber frame so that as the strand leaves them it may pass directly to this frame. The positioning of the evener at the slubber frame is particularly advantageous because at this frame only one finisher drawing sliver is normally creeled in, whereas at other points in the spinning of yarn normally six or more slivers are creeled in. Furthermore, as the sliver enters the slubber frame, it is traveling at a relatively low rate of speed, hence variations in the weight of the sliver may be detected and compensated for promptly by using relatively simple apparatus. Drafting rolls normally found in the slubber frame may be used for one or both of the pairs of rolls contemplated in this invention, by suitable modification of the slubber frame.

The contemplated means for detecting strand weight variations comprises an air chamber having entrance and exit openings therein through which the moving strand passes as it proceeds from one pair of drafting rolls to the next. These openings are at the smaller ends of trumpet-like constrictions and are oppositely disposed in the air chamber. The openings preferably comprise flattened, somewhat elliptical openings of nearly the cross-sectional size shape possessed by the moving strand as it leaves the rear pair of drafting rolls. The choice of this shape of opening results from the necessity for filling the openings essentially uniformly with the array of fibers comprising the sliver in order to force the air to flow through the mass of fibers, not around it, in leaving the chamber. It is at the same time essential that the openings shall not restrict the sliver unduly, else serious disturbance of the drafting process could result.

A source of gas, preferably air, under a regulable pressure is supplied through a constriction to the pressure chamber so that an above-ambient pressure is maintained therein. In passing through the pressure chamber, the strand whose weight is to be controlled fills the entrance and exit openings of the chamber. The air in the pressure chamber will escape, then, by flowing among the fibers comprising the sliver and out through the openings. The resistance offered to the escape of the air will be dependent principally upon the tightness with which the openings are filled with fiber; hence it will vary in accordance with variations in the sliver weight. The varying back pressure developed between the pressure chamber and the constriction in the supply line thus provides a continuous measure of the relative weight of the sliver passing through the chamber.

The means contemplated for detecting pressure variations within this pressure chamber comprise two coupled pressure-sensitive members. The first pressure-sensitive member is subject to the pressure of the gas within the chamber, and is responsive to variations therein. The gas from the same regulable source used to supply the chamber is also supplied through a second constriction to an adjustable bleeder valve. The back pressure maintained between the bleeder valve and the second constriction is transmitted to a second pressure-sensitive member which is coupled to the first pressure-sensitive member in opposition, so that the resultant motion of the pressure-sensitive members corresponds to the difference between the two back pressures. The second pressure-sensitive member serves to balance out any fluctuations in pressure in the source of gas, so that they will not interfere with proper operation. The bleeder valve provides means for adjusting the reference level for the system.

The means connecting the two pressure-sensitive elements carries the core of a differential transformer. The transformer has plural secondaries which are arranged about the core in a manner such that the core may be moved relative thereto to vary the excitation of the

secondaries. The secondaries are connected in opposition, so that when the core is in a certain predetermined position a null point will result, since no net signal will be generated in the secondary circuit. However, when the core moves in either direction from this null point in response to a variation in pressure within the pressure chamber, the secondaries of the transformer will be differentially excited, and a signal will be generated in the secondary circuit. This signal actuates a motive means controlling a variable coupling of the power supply to the rear drafting rolls. In this manner, if the sliver is running too heavy, the air pressure in the chamber increases, the transformer core shifts, the resulting electrical signal energizes the motive means governing the variable coupling in the power train to the rear draft rolls so as to slow down the rear draft rolls. The draft ratio is thereby increased, and the drafted sliver becomes lighter. Conversely, if the sliver is running too light, the mechanism operates to speed up the rear draft rolls, and thus to decrease the attenuation and make the sliver run heavier. In this manner the draft exerted upon the moving strand is varied so as to produce a strand having substantially uniform weight throughout its length.

The operating point of this system for the correct sliver weight need not correspond to the balanced state (null point) of the transformer. However, it is preferable to operate in the vicinity of this null point, so that a minimum amount of power will be required from the motive means which drives the variable coupling.

The exact location of the detector air chamber openings between the drafting rolls is important for the successful operation of the evener. These openings should be in such a position that the increased (or decreased) drafting ratio resulting from the passage of a thick (or thin) region in the sliver through the detector will act on that portion of the sliver which originates the corrective action. If the detector is too far to the rear (or front), the correction will be made on a region of the sliver ahead of (or behind) the region of incorrect size. This incorrect type of action could result in exaggeration of irregularities in the sliver, or even in the introduction of new irregularities.

The drive and control system for the two pairs of drafting rolls consists of a driving means common to both pairs; a variable coupling means for varying the speed of the rear rolls; a motive means for varying the coupling in response to the detector signal; and a signal generator driven by the coupling motive means, which gives a signal proportional to the activity of this motive means. The common drive drives the front rolls at constant speed and gives to the rear rolls a component of speed in constant ratio to the speed of the front rolls. The variable coupling acts as described above to correct variations in sliver weight, by supplying a variable component of speed to the rear rolls. The signal from the signal generator is suitably combined with the detector output signal before feeding it to the coupling motive means; this feedback results in improved performance of the control system.

For a better understanding of the nature of this invention, reference should be made to the following detailed description of one preferred embodiment thereof in conjunction with the accompanying drawings, wherein:

Fig. 1 is a schematic view of the apparatus embodying this invention;

Fig. 2 is a cross-sectional view through the pressure chamber taken along the line 2—2 of Fig. 1;

Fig. 3 is a plan view, partially in section, of the coupling to the rear pair of drafting rolls, and

Fig. 4 is a side elevational view of the coupling shown in Fig. 3, looking along the line 4—4 of Fig. 3.

Referring now to the drawings, there is shown one embodiment of an evener in accordance with this invention. The embodiment there shown comprises a rear pair of drafting rolls 10, 11 and a front pair of drafting rolls 12, 13 through which a sliver S passes to be attenuated by the action of the drafting rolls. There is disposed between the drafting rolls 10, 11 and the rolls 12, 13 a pressure head shown in cross-section in Fig. 2. This pressure head comprises a hollow chamber 14 having an entrance opening 15 and an oppositely disposed exit opening 16 through which the sliver S passes as it proceeds from the rear to the front drafting rolls. As above described, these openings 15, 16 have a flattened, somewhat elliptical cross-section as shown in Figs. 1 and 2, so that the sliver in the condition shown in Figs. 1 and 2, as it leaves the rear pair of drafting rolls 10, 11, will substantially uniformly fill the openings 15, 16.

As the sliver passes through the openings 15 and 16 of the chamber 14 the fibers comprising it will be more or less crowded together, depending upon the weight of the sliver at those points. A source of gas, preferably air, under regulated pressure is supplied to the interior of pressure chamber 14 from a source (not shown) through pipes 17 and 18 having communication with a pipe 19 that leads to the interior of pressure chamber 14. Connecting pipe 18 has a constriction 20 therein providing a pressure drop from the regulated supply pressure, the drop being dependent upon the rate of flow of the gas through pipe 18. The gas supplied to chamber 14 will escape therefrom by flowing among the fibers through openings 15 and 16, and the rate at which the gas will escape through these openings will be dependent upon the degree to which the fibers comprising the sliver fill the cross-sectional area of the openings 15 and 16. Changes in the rate of escape of gas from the pressure chamber 14 will in turn be reflected as variations in pressure within this chamber 14 which are substantially proportional to the strand weight of the sliver S as it moves continuously through chamber 14.

Means are provided, responsive to the pressure changes within the chamber 14, for detecting variations in weight of the moving strand. In the embodiment shown in the drawings, this means comprises a measuring chamber 21 communicating with pipe 19 so that the pressure within chamber 21 is always the same as that within chamber 14 and pipe 19. There is disposed within chamber 21 a bellows 22 arranged to be actuated by changes in the pressure within chamber 14. Means are provided for generating a signal in response to movement of bellows 22. A second pressure-responsive bellows 23 is disposed in opposition to bellows 22, and a rod 24 is connected axially between bellows 22 and 23. Gas from the same source under the regulated pressure is admitted through pipe 17 to the bellows 23, housed in the compensating chamber 52, by means of branch pipes 25 and 26. A constriction 27 in pipe 25 provides a drop in pressure, from that of the regulated supply, dependent in magnitude upon the rate of flow of gas through pipe 25. Bleeder valve 28 connected to pipe 26 provides an adjustable bleed of gas from pipes 26 and 25 and thus affords a means for adjusting the pressure in compensating chamber 52. It will thus be seen that rod 24 will be moved in response to the differential pressure on the bellows 22 and 23. Inasmuch as both the sliver-measuring branch and the compensating branch are supplied with gas from a common source, and both discharge against the common ambient pressure of the atmosphere, it is apparent that the position of rod 24 will be virtually insensitive to changes in supply pressure or in atmospheric pressure. Rod 24 will move only in response to variations in pressure occurring within pressure chamber 14 which result from changes in sliver weight. It will be seen that bleeder valve 28 can be employed to adjust the position of rod 24 to correspond to a given sliver weight and thus provides a convenient zero adjustment.

Means are provided for generating a signal in accordance with the position of rod 24. In the embodiment shown in the drawings, this means comprises a differential transformer 29 in a housing 30. The rod 24 may be of

any suitable non-magnetic material, for example brass, and it carries intermediate of its ends an iron core 31 that is movably mounted with respect to the primary and secondaries of the differential transformer 29. The primary 32 and the divided secondaries 33, 34 of the differential transformer are mounted coaxially about core 31, the secondaries being connected in opposition to each other. As the rod 24 and hence the core 31 move in response to variations in pressure within chamber 14, the secondaries 33, 34 will be differentially excited and will generate a signal output reflecting, and substantially proportional to, variations in weight of the moving strand S.

In Figs. 3 and 4 there is shown means for varying the speed of the rear drafting rolls 10, 11, relative to that of the front rolls 12, 13. A driving means (not shown), operating at a constant but adjustable speed, drives rolls 12, 13 and drive shaft 35, maintaining a suitable constant ratio between the speed of rolls 12, 13 and that of drive shaft 35. Drive shaft 35 is coupled, through a differential gear mechanism to be described, to shaft 41 on which is mounted draft roll 10. The differential gear train comprises a sun gear 36, planetary pinions 38, 38', and ring gear 42 having external teeth as well as internal teeth so that it may be driven independently. Gear 36 is keyed by key 37 to shaft 35 to be rotated therewith. A pair of planetary pinions 38, 38' are mounted on opposite sides of gear 36 to mesh therewith. Pinions 38, 38' are mounted on shafts 39, 39' which in turn are journaled in the planet carrier 40 that is fixed to the shaft 41 of drafting roll 10. Ring gear 42, mounted about sun gear 36 and planetary gears 38, 38', has internal teeth 43 adapted to mesh with planetary gears 38, 38', and it also has external teeth 44 in meshing relation with drive pinion 45 which is fixed to the output shaft of motor 47. By this arrangement, variation in the speed of drive pinion 45, and hence of ring gear 42, can be used to vary the coupling of shaft 35 to shaft 41. Thus, if ring gear 42 is rotated at the same angular speed as gear 36, these gears are in effect keyed together by the pinion gears 38, 38', and hence shaft 41 and roll 10 will rotate at the same speed as shaft 35. If the speed of shaft 35 and gear 36 is made constant, decreasing the speed of ring gear 42 will decrease the speed of shaft 41 correspondingly, in proportion to the difference in the angular velocities of gears 36 and 42. Consequently motor 47 may be actuated to increase or decrease the speeds of rolls 10, 11 and therefore to decrease or increase the draft ratio.

Reversible motor 47, amplifier 50, and rate generator 48, constitute a well-known rate or velocity servo-mechanism. The rate generator 48 is coupled to the shaft of motor 47 and generates a signal which is dependent upon the rotational velocity of motor 47. This rate signal is fed back to the input of amplifier 50 in opposition to the external signal from circuit 49. The function of this rate servo is that of causing the motor shaft to rotate at a speed directly proportional to the magnitude of the external signal.

Transformer secondaries 33, 34 are connected in circuit 49 in opposition so that when the sliver S is of a given predetermined weight the net electrical output from this transformer is zero. Should sliver S vary from this predetermined weight a signal proportional to the deviation in the weight of sliver S is generated in circuit 49 by transformer 29. This signal is fed as the external signal to the rate servo, causing motor 47, driven from power source 53, to rotate in such a direction and with such a velocity that the draft ratio is changed so as to correct the weight of the sliver. Thus a uniform sliver is delivered by front drafting rolls 12, 13.

The practice of our invention has resulted in reductions in standard deviation of cotton sliver weight by as much as two-thirds.

Although one specific embodiment of this invention has been shown in the drawings and described in detail, it will be appreciated that many variations will occur therein to those skilled in the art. Thus, for example, although the correction has been shown as being applied to the rear pair of drafting rolls 10, 11, it will be apparent that uniformity may be achieved in the sliver by controlling the rotational speeds of the front rolls 12, 13 instead. However, by adapting the apparatus to vary the rotational speeds of the rear pair of drafting rolls, an advantage may be obtained in that the linear rate of sliver output from the apparatus, i. e., from rolls 12 and 13, is constant. This is significant in adapting the device to use in the regular drafting operation, because the sliver may proceed to further handling apparatus which is generally set for a constant rate of sliver delivery thereto.

So, also, although bellows have been disclosed as the pressure-sensitive means, it will be appreciated that other pressure-measuring devices, such as diaphragms, may be substituted therefor to achieve the beneficial results of this invention. Still other and further modifications within the scope of this invention will occur to those skilled in the art.

Having thus described our invention, what we claim and desire to protect by Letters Patent is:

1. Apparatus for reducing weight variations in a non-twisted textile strand, comprising a first and a second pair of draft rolls, means for rotating the first pair of said rolls at a fixed speed, means for rotating the second pair of said rolls at a base speed, a chamber between said pairs of rolls through which said strand passes, a source of gas under pressure connected through a constriction to said chamber, means responsive to pressure deviations in said chamber for generating a correcting signal, coupling means for driving the second of said pairs of rolls at speeds differing from its base speed in response to said correcting signal, monitoring means responsive to the speed of said second pair of rolls to generate a monitoring signal responsive to variations from its base speed, and means for combining said monitoring and correcting signals to control said coupling means.

2. Apparatus for reducing weight variations in a non-twisted textile strand, comprising a rear and a front pair of drafting rolls, means for rotating the front pair of rolls at a fixed speed, means for rotating the rear pair of rolls at a base speed, a chamber between said pairs of rolls through which said strand passes, a source of gas under a regulated pressure connected through a constriction to said chamber, pressure-sensitive means responsive to pressure deviations in said chamber, means responsive to said pressure-sensitive means for generating a correcting signal, a coupler in the drive to the rear pair of rolls, motive means for controlling said coupler to vary the rotational speed of said rear pair of rolls, monitoring means responsive to said motive means for generating a monitoring signal responsive to variations in its speed, means for combining said monitoring and correcting signals, and means connecting said motive means to be responsive to the combined signal.

3. Apparatus for reducing variations in the weight of a textile strand, comprising a rear and a front pair of drafting rolls, means for rotating each pair of drafting rolls at base speeds, a pressure chamber between said pairs of drafting rolls having openings therein through which said strand passes, a source of gas under regulated pressure connected through a constriction to said chamber, pressure-sensitive means connected to said pressure chamber and responsive to variations in pressure therein, a differential transformer having a core which is movable in response to the action of said pressure-sensitive means thereby varying the output of said transformer, a coupler through which one of said pairs of rolls is driven, a motor controlling said coupler so as to vary the speed of said pair of rolls, and means for driving said motor at vary-

ing speeds in response to variations in the output signal of said transformer, whereby the draft exerted on the strand is varied to produce a uniform strand.

4. Apparatus for reducing variations in a textile strand, comprising a rear and a front pair of drafting rolls, said drafting rolls being spaced as closely together as is consonant with fiber length, means for rotating each pair of drafting rolls at base speeds, a pressure chamber between said pairs of drafting rolls having openings therein through which said strand passes, a source of gas under regulated pressure connected through a constriction to said chamber, pressure-sensitive means connected to said pressure chamber and responsive to variations in pressure therein, a second pressure-sensitive means connected through a second constriction to said source of gas and through an adjustable valve to the atmosphere, connecting means between said pressure-sensitive means, a differential transformer, a core for said transformer carried by said connecting means, a coupler through which the rear pair of rolls is driven, a motor controlling said coupler to vary the speed of said rear pair of rolls, and means for driving said motor at varying speeds in response to variations in the output signal of said transformer.

5. Apparatus for reducing variations in the weight of a textile strand, comprising a front and a rear pair of drafting rolls, means for rotating said pairs of rolls at base speeds, a pressure chamber between said rolls, said pressure chamber having openings therein through which said strand passes, a source of gas under regulated pressure, means connecting said chamber through a constriction to said source of gas, pressure-sensitive means connected to said pressure chamber and responsive to variations in pressure therein, means controlled by said pressure-sensitive means for generating a correcting signal, a coupler for driving one of said pairs of rolls at speeds differing from its base speed, a motor controlling said coupler, monitoring means responsive to the speed of said motor to generate a monitoring signal responsive to variations in its speed, means for combining said monitoring and correcting signals to produce a combined signal, and means for varying the speed of said motor in response to said combined signal.

6. Apparatus for reducing variations in a textile strand, comprising a rear and a front pair of drafting rolls, means for rotating each pair of drafting rolls at base speeds, a pressure chamber between said pairs of drafting rolls having openings therein through which said strand passes, a source of gas under regulated pressure connected through a constriction to said chamber, means responsive to deviations in the pressure in said chamber for generating a correcting signal, a coupler through which one of said pairs of rolls is driven, a motor controlling said coupler to vary the rotational speed transmitted to said pair of rolls, a rate generator connected to said motor for generating a signal responsive to the rotational velocity of said motor, circuit means for combining the signal from said rate generator and said correcting signal to produce a combined signal, an amplifier for said combined signal, and circuit means connecting said motor to said amplifier to drive the motor in response to the amplified signal.

7. Apparatus for reducing variations in a textile strand containing an array of loose fibers, comprising a rear and a front pair of drafting rolls, means for rotating one of said pair of rolls at a fixed speed, a pressure chamber between said pairs of drafting rolls having openings therein through which said strand passes, a source of gas under regulated pressure connected through a constriction to said chamber, means responsive to the pressure deviations in said chamber for generating a correcting signal, a power source for driving the other of said pair of rolls, a planetary gear train between said power source and said other pair of rolls, said planetary gear train including a sun gear connected to said power source, a ring gear concentric with said sun gear and a pinion connected to said other pair of rolls to drive the same and meshing with both said sun and ring gears, a motor controlling said planetary gear train by controlling the rotational speed of said ring gear to vary the rotational speed transmitted therethrough to said other pair of rolls, and means causing said motor to be responsive to said correcting signal.

8. Apparatus in accordance with claim 7 wherein said rear and front pair of drafting rolls are spaced as closely together as is consonant with fiber length, and wherein said planetary gear train is disposed in the drive to the rear pair of drafting rolls.

9. Apparatus for reducing variations in a textile strand containing an array of loose fibers, comprising a rear and a front pair of drafting rolls, means for rotating each pair of drafting rolls at base speeds, a pressure chamber between said pairs of drafting rolls having openings therein through which said strand passes, a source of gas under regulated pressure connected through a constriction to said chamber, pressure-sensitive means connected to said pressure chamber responsive to variations in pressure therein, a differential transformer, a core for said transformer moveable in response to variations detected by said pressure-sensitive means thereby to vary the output of said transformer, a coupler through which one of said pair of rolls is driven, a motor controlling said coupler to vary the speed of said pair of rolls, a signal generator driven by said motor for generating a signal in response to the speed of said motor, means connecting said signal generator to the output circuit of said transformer for combining said signal with the output of said transformer to produce a combined signal, and means for driving said motor in response to said combined signal.

10. Apparatus for reducing variations in the weight of a textile strand, comprising a front and a rear pair of drafting rolls, said drafting rolls being spaced as closely together as is consonant with fiber length, a pressure chamber between said rolls, said pressure chamber having openings therein through which said strand passes, a source of gas under regulated pressure, means connecting said chamber through a constriction to said source of gas, first pressure-sensitive means connected to said pressure chamber responsive to variations in pressure therein, second pressure-sensitive means connected through a constriction to said source of fluid and through an adjustable nozzle to the atmosphere, a differential transformer having plural secondaries connected in opposition, means connecting said first and second pressure-sensitive means and carrying a core for said transformer, said core being moveable in response to the differential pressure between said pressure-sensitive means, a coupler through which the rear pair of drafting rolls is driven, a motor controlling said coupler to vary the rotational speed transmitted to said pair of rolls, a signal generator responsive to the speed of said motor for generating a monitoring signal, means connecting said monitoring signal to the output of said differential transformer for combining said monitoring signal with the output signal of said transformer, an amplifier for amplifying the resulting combined signal, and means connecting the output of said amplifier to said motor to control the motor in response to the amplified signal.

11. In apparatus for reducing variations in a textile strand including a rear and a front pair of drafting rolls with means for rotating each pair of drafting rolls at base speeds, a pressure chamber between said pairs of drafting rolls having openings therein through which said strand passes, and a source of gas under regulated pressure connected through a constriction to said chamber, the combination which comprises a pressure-sensitive means responsive to the pressure in said chamber, a differential transformer having plural secondaries, a core for said transformer movable in response to variations detected by said pressure-sensitive means thereby to vary

the output of said transformer, a coupler through which one of said pairs of rolls is driven, a motor controlling said coupler to vary the speed of said pair of rolls, a signal generator connected to said motor for generating a signal in response to the speed of said motor, means connecting said signal generator to the output circuit of said transformer for combining said signal with the output of said transformer to produce a combined signal, and means for driving said motor in response to said combined signal.

12. Apparatus in accordance with claim 11 wherein the plural secondaries of said transformer are connected in opposition and wherein the signal from said signal generator is combined in opposition with the output of said transformer.

13. Apparatus in accordance with claim 11 wherein said pressure-sensitive means comprises a bellows.

14. Apparatus in accordance with claim 11 wherein a second pressure-sensitive means is provided connected

through a constriction to said source of gas and connected also through an adjustable valve to the atmosphere and including a rod connecting the two pressure-sensitive means, and wherein the core for said transformer is carried by said.

15. Aparatus in accordance with claim 14 wherein said two pressure-sensitive means comprise bellows oppositely disposed.

References Cited in the file of this patent

UNITED STATES PATENTS

2,115,086	Riggs	Apr. 26, 1938
2,407,100	Richardson	Sept. 3, 1946
2,627,183	Greenwood et al.	Feb. 3, 1953
2,648,502	Trofimov	Aug. 11, 1953
2,664,749	Jones	Jan. 5, 1954
2,695,981	Smoot	Nov. 30, 1954