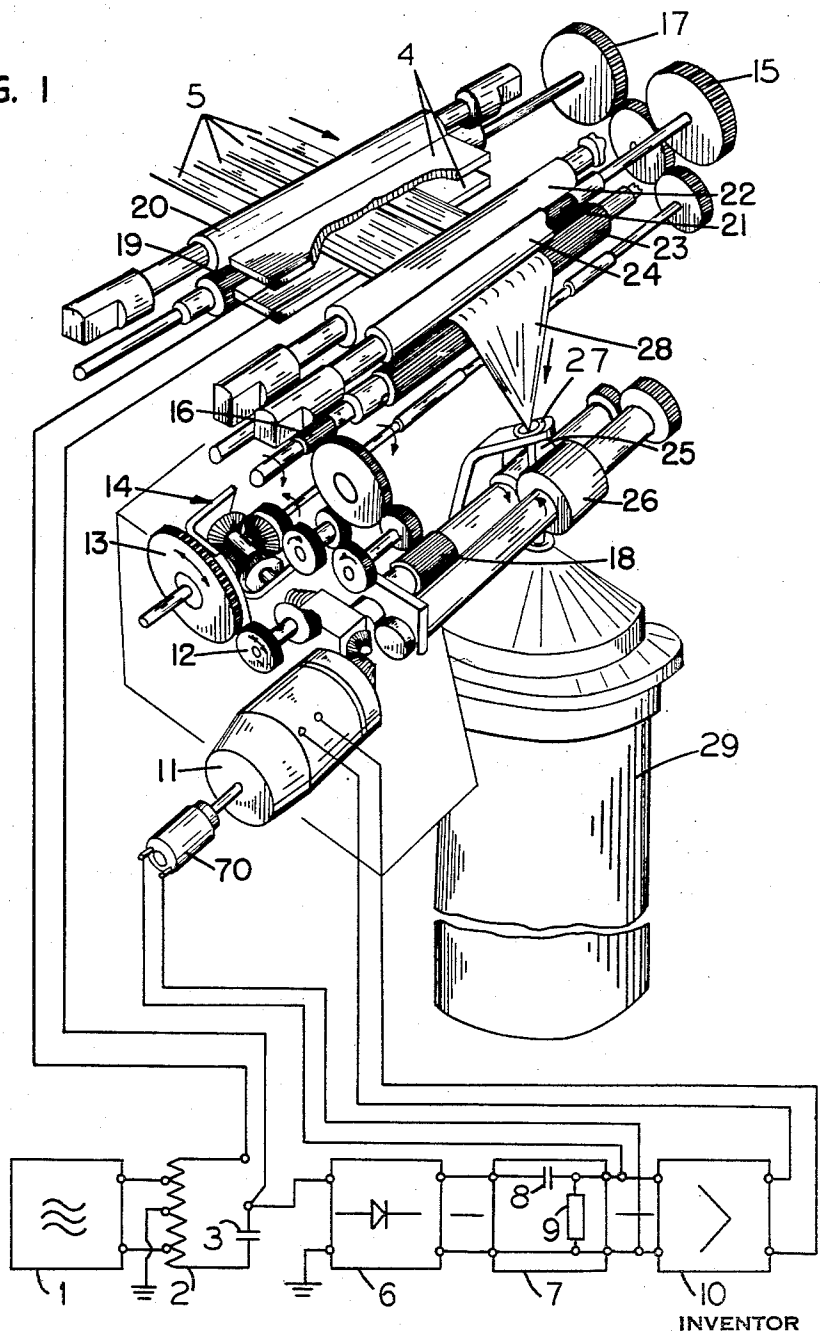
Aug. 30, 1960 H. LOCHER 2,950,508

METHOD AND APPARATUS FOR AUTOMATICALLY CONTROLLING THE WEIGHT PER UNIT LENGTH OF TEXTILE MATERIALS

Filed Dec. 16, 1955 3 Sheets-Sheet 1

FIG. 1



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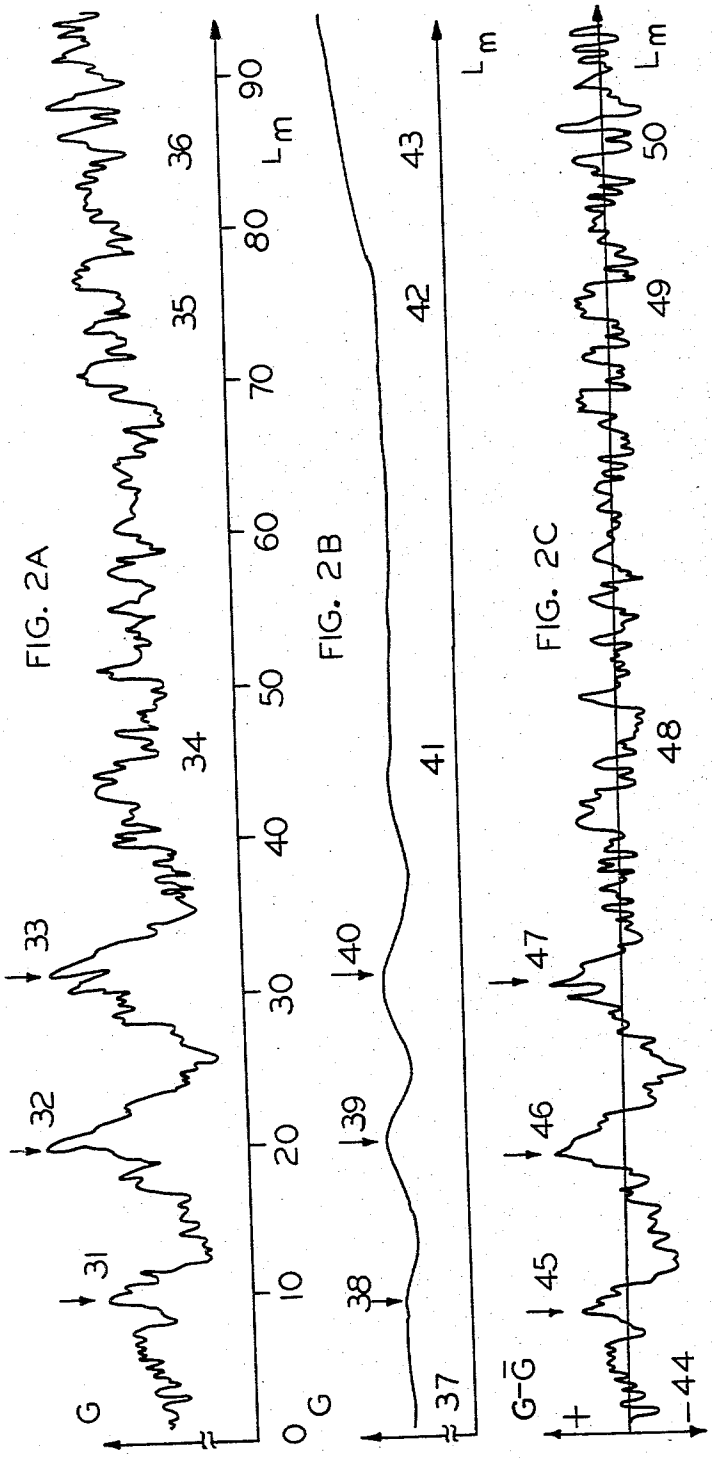
Filed Dec. 16, 1955 3 Sheets-Sheet 2



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Filed Dec. 16, 1955 3 Sheets-Sheet 3

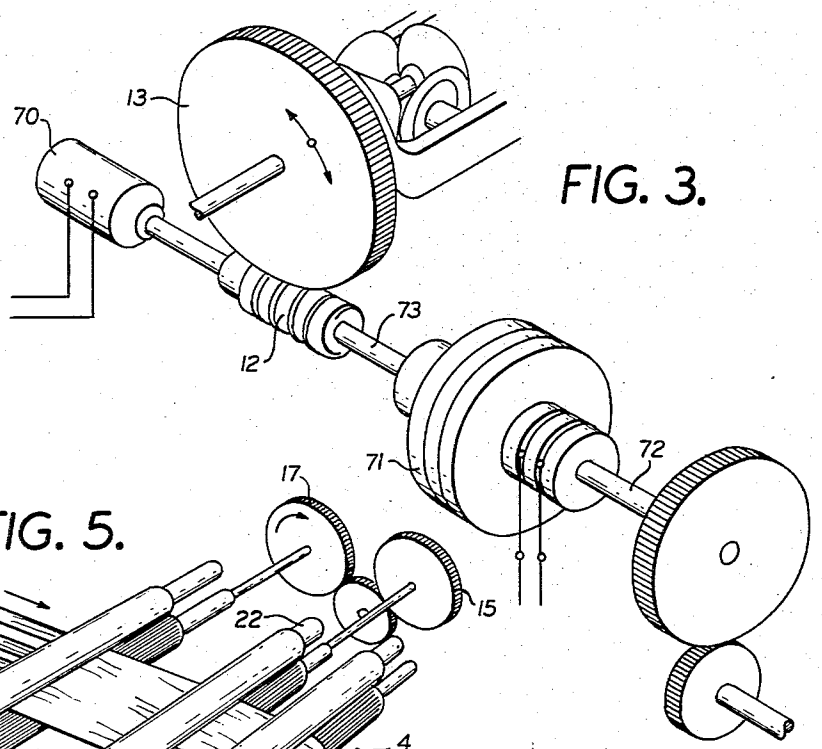
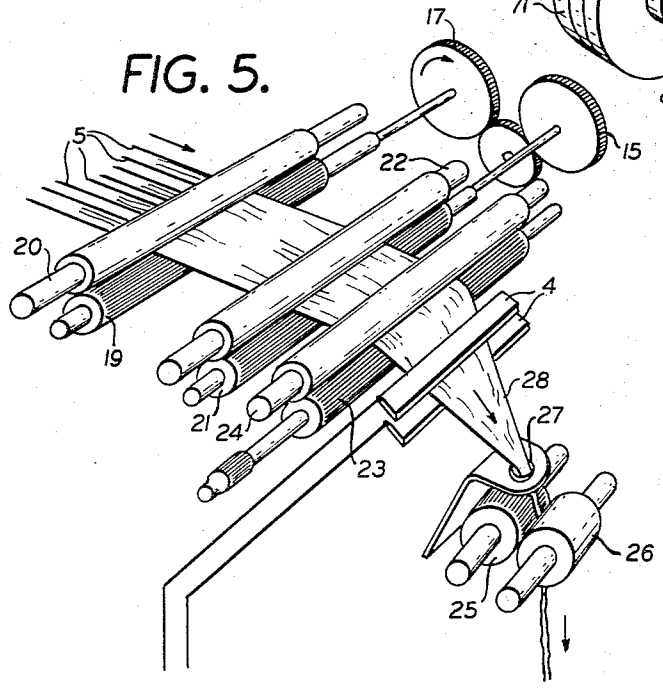


FIG. 3.

FIG. 5.



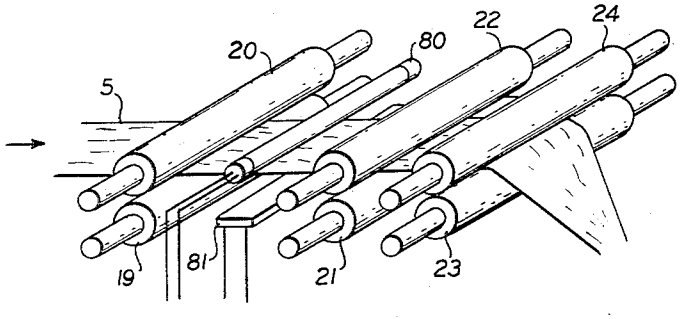


FIG. 4.

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2,950,508

METHOD AND APPARATUS FOR AUTOMATICALLY CONTROLLING THE WEIGHT PER UNIT LENGTH OF TEXTILE MATERIALS

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18 Claims. (Cl. 19—70)

This invention relates to control means, more particularly to methods and apparatus for automatically controlling the weight per unit length of textile materials during the spinning thereof.

In the course of the various processes to which textile materials are subjected in the spinning of yarn, a number of evening processes must be employed in order to obtain the required uniformity of weight of the end product. This is necessary since irregularities are produced in the feeding of the so-called "picker," and because all subsequent machines produce some irregularities in the material. The evening process is usually accomplished by doubling of several slivers or rovings, which are then drafted together. The product manufactured in this manner is, under certain conditions, more uniform than a product obtained without doublings.

The reduction of irregularity which is obtained by doubling without any subsequent drafting can easily be calculated, if it is assumed that the variations of the weight per unit length are of a random nature. In this case the resulting irregularity is given by the formula:

$$CV_2=\frac{CV_1}{\sqrt{D}}$$

where:

CV_1=coefficient of variation of the individual slivers and rovings respectively before doubling.
CV_2=coefficient of variation after doubling.
D=number of doublings.

The coefficient of variation of irregularity is expressed as CV and is defined as the average square deviation of the weight per unit length of the infinitely small assumed lengths of specimen, from the average weight of the sample, expressed as a percentage of the average weight.

It has been proved empirically that during doubling with subsequent drafting, the long term variations are actually reduced. On the other hand, during each drafting process, new short term undesirable variations in cross section are produced, making it impossible to obtain considerable improvements of regularity by introducing additional doubling processes. Practical tests reveal a certain optimum number of doublings for certain yarn qualities. By employing only the necessary number of doublings, manufacturing processes are minimized thus considerably reducing manufacturing costs.

Some sources of the short term variations in the drafting process may be reduced by alterations in the design of the drafting systems, but it appears impossible to obtain a faultless drafting process for cotton fibers.

The following values are to be considered in cotton spinning:

For a number of doublings of

$$D=6$$

and

$$CV_1=4\%$$

it may theoretically be derived from the formula above given that

$$CV_2=1.6\%$$

practically however, a value for

$$CV_2 \text{ of } 3 \text{ to } 3.5\%$$

is obtained.

From these results it is seen that the drafting process is the cause of considerable irregularities, which are, as already mentioned, of a short term nature. These short term variations of the rovings produce undesired count variations in the yarn in the range of approximately 50–500 yards wave length. The cause of these variations, in cotton spinning, is clearly due to the imperfect working of the draw frame.

There is thus a need, particularly in connection with short cut processes, for means providing an even drawing of slivers. Since today's drafting systems do not, in practice, meet theoretical requirements, attempts have been made to obtain more regular slivers by means of automatic control.

Contemporary technology employs mechanical scanning methods by which the outer form of the sliver, or the lap respectively, can be scanned by means of a feeler member. Measurements of this outer form indicate a certain value for the cross section per unit length. Control is based on the result of this scanning.

This mechanical method has the disadvantage that the weight per unit length is not clearly given by the outer form of the sliver, lap, etc. Therefore, the desired uniformity of weight per unit length cannot be determined with certainty and precision. Furthermore, yarns in many of the intermediate spinning stages are not suitable for mechanical scanning due to inadequate tensile strength, the presence of slubs, or the like. Mechanical automatic control devices are successfully used today for feeding aggregates, since the textile material in this stage can endure mechanical scanning. However, mechanical scanning breaks down completely for most intermediate processes, such as, for instance, during drawing in the draw frames.

Methods and devices are known which measure the weight per unit length optically, pneumatically or by means of electrical measuring condensers. These methods and apparatus employ a signal denoting the instantaneous weight per unit length, which is compared with a signal denoting the desired control value. However, difficulties are encountered, which are basically due to the course of the variance length curve of the textile material. Hereafter, the function of the variance length curve characteristic will be defined.

According to the definition, the coefficient of variation CV is obtained by determining the average deviation of the weight of the elements, having an assumed infinitely small length, from the average weight of the sample. However, it is also of interest in the determination of a coefficient of variation, to determine the average weight deviation of a specimen of finite length from the average weight of the sample. Since the length L of each sample specimen is different, the coefficient of variation is seen to be a function of the specimen length L. In textile technique this function of L is expressed as a variance length curve characteristic, and is mathematically defined as $CV_Z(L)$, whereby the index Z signifies that the deviations between the specimens of length L are calculated.

For weight variations in a textile material of more or less random nature, it is to be expected that the function $CV_Z(L)$ with an increasing L, approaches the value zero. As a matter of fact, the bigger the unit length of the individually tested cuts chosen, the less does the weight of slivers and rovings in spinning deviate from its average

or nominal value. For instance, the following guide values apply for cotton spinning:

Unit Length of the Individually Measured Specimen L	$CV_Z(L)$, Percent
1 cm	6
10 cm	4
1 m	2
10 m	0.6
100 m	0.2

whereby:

$CV_Z(L)$, percent=coefficient of variation between length elements L.

L=length of the elements to be measured.

If the deviation of the weights of individual elements with a length of, for instance, 1 cm. is determined from the average weight a coefficient of variation of, for instance, 6% is obtained. If this length is, for example, chosen to be 10 m., duly insignificant deviations of, for instance, approx. 0.6% are to be observed.

Due to disturbing influences of various kinds, such as instability of condensers, influence of dust, humidity and temperature, etc., to which electrical, optical and pneumatic controlling systems are subject under mill conditions, control is not achieved more accurately than to approx. ±1% referred to its controlled value.

However, the lengths longer than 10 yards the deviation of the average value of the intermediate products of spinning is considerably less, due to the weight controls of the aggregate feeders and the doublings.

Therefore, there is the danger that a new electrical, optical or pneumatic controlling would on one hand eliminate the short term variations, but on the other hand, the long term variations would be increased. Such an altering of the average weight, in other words, the count of the slivers and rovings, must not take place, as it would have disastrous consequences in spinning.

The present invention eliminates all disadvantages of the known mechanical, optical, pneumatic and electrical devices for controlling slivers and rovings during spinning.

It is accordingly a primary object of this invention to provide an improved means for automatically controlling the weight per unit length of textile materials.

A further object of this invention is to provide means for controlling the weight of textile materials during their formation, said means being adjustable to compensate for the effects of any disturbing influences.

Another object of this invention is to provide novel textile weight control means which function equally well in the elimination of long or short range variations.

These and other objects of the invention which will be apparent from the following disclosure and claims are achieved by employing the novel apparatus and method of this invention.

According to the novel method, the material is drawn through a measuring device by means of a drafting roll pair. The indicating value of said device changes according to the instantaneous weight of the specimen tested, and from this indicating value a first electrical magnitude is gained, from which a second electrical magnitude is formed by forming the average value over a period of time. This second electrical magnitude is then subtracted from the first electrical magnitude, so that a third electrical magnitude is formed, which corresponds to the deviations of the weight per unit length of the textile material from its average value over a certain length. The impulse producing this third electrical magnitude is then amplified as control energy and employed to control the drive of the drafting rolls which are employed in drafting the textile material. The aforesaid control is such that the angular speed of the drafting rolls on the appearance of a negative deviation in the weight per unit length of the textile material is correspondingly reduced, and on the appearance of a positive deviation correspondingly increased.

Apparatus is provided for carrying out the novel method, characterized by provision of a measuring device, through which the textile material is drawn by means of a drafting roll pair. The measuring device produces a first electrical impulse which is proportional to the weight of the instantaneously tested cut of textile material. A filter comprising an electrical storage condenser and electrical resistor is provided to which said impulse is directed whereby a second electrical impulse is transmitted from the condenser, and a third electrical impulse is obtained from the resistor. The output impulse of the resistor corresponds in magnitude to the difference between the magnitude of the first and second electrical impulses which is proportional to the deviations of the weight per unit length of the textile material from its average value. An amplifier is provided in the resistor circuit to amplify the third electrical impulse and for producing a control signal from this impulse. This control signal regulates a ridgeless working gear which determines the angular speed of a drafting roll pair.

The specific constructional features of the invention, their mode of utilization, and the novel method will be made most manifest and particularly pointed out in conjunction with the accompanying drawings, wherein:

Figure 1 schematically illustrates a perspective view of a device embodying the invention.

Figure 2 shows in form of 3 diagrams 2A, 2B, and 2C, curves indicating the magnitudes of the first electrical impulse denoting the weight of the textile material, the second electrical impulse obtained by forming the average value over a certain material length, as well as the third electrical impulse obtained from these two electrical impulses, which corresponds to the difference between the magnitudes of the first and second electrical impulses.

Fig. 3 is a schematic detail view showing a modified version of the drive mechanism of Fig. 1 in which a variable slip electro-magnetic clutch is utilized.

Fig. 4 is a schematic detail view of a modified form of the measuring device utilized for detecting the condition of the textile material. In this modified form a radiation source, and radiation sensitive cell are illustrated positioned to detect the condition of the material passing between the drafting rolls of an apparatus such as shown in Fig. 1.

Fig. 5 is a schematic detail view illustrating a modification of the point of positioning of the measuring device. In this modification the measuring device is shown arranged to measure the material condition after it passes through the drafting rolls.

In Figure 1 the number **5** denotes the non-controlled textile material, for instance, a draw sliver, which is moved in the direction of the arrow by means of a pair of rolls **19** and **20** rotating at a constant peripheral speed. A drafting roll pair **21** and **22** runs at practically the same peripheral speed as the first pair of rolls **19** and **20**. A measuring device **4** is positioned between the two pairs of rolls, said device measuring the weight deviation of the textile material extending between said rolls. This device is most advantageously in the form of a plate condenser between which the textile material passes, the thickness of material determining the capacitance of the condenser. However, it is also possible (as seen in Fig. 4) to employ, as a measuring device, a cell **81** which is sensitive to electromagnetic waves from radiation source **80**, which is responsive to electromagnetic radiation through the textile material from a radiation source. Thereby, an electrical impulse is obtained which has a magnitude representative of the weight of the textile material, since with the empty measuring device no damping is present, whereas with a measuring device completely filled with textile material, very strong damping is obtained. The method and the apparatus of this invention also permit an arrangement in

which a measuring device 4 may be provided after the rolls 23, 24 (as seen in Fig. 5) which have a variable peripheral speed. In this manner, a feed back control would be obtained which, however, in certain regards is not suitable.

For the proper functioning of the apparatus it is of utmost importance that the measuring device 4 be placed as closely as possible to the drafting roller pair 21, 22 and 23, 24 respectively, between which the controlling takes place. It is thus desirable to make the drafting field equal to approximately 1 staple length measured from the centre of the measuring device to the centre of the drafting field. If this distance is larger than approximately 3 times the staple length of the textile material, the transmission from the measuring device to the drafting field, of the weight variations to be controlled, will lead to difficulties.

The pair of rolls 23, 24 is driven by the differential gear 14, which is arranged to drive the gear wheels 15 and 16 of the roll pairs 21, 22 and 23, 24 respectively. The average peripheral speed of the rolls 23, 24 is approximately 10–50% higher than that of the rolls 21, 22. This difference of peripheral speed is chosen according to the thinnest spots in the textile material 5 to be controlled. If a difference of peripheral speed of, for instance 25% is chosen it means that thin spots with up to 25% variations in weight from the average value can still be controlled.

The control motor 11 acts on the pair of rolls 23, 24 through differential gear 14. The controlled textile material 28 is drawn in known manner through a guide 27 by means of a pair of rolls 25, 26, and then deposited in can 29. The rolls 25, 26 are driven from roll 23 through a gear train including gears 16 and 18. Due to the controlling, the length of textile material delivered by the machine per unit time by the rolls 25, 26, is not constant. This, however, does not hamper the depositing in the can 29. It is, however, important that the roll pair 25, 26 has nearly the same peripheral speed as the drafting roll pair 23, 24. The regulation of control motor 11 by the capacitance variations produced in the electrical measuring condenser 4, are produced as follows:

The coil 2, the balancing condenser 3 and the measuring condenser 4, through which the textile material is drawn, form together a conventional alternating current bridge, which is fed by the A.C. source, 1. When the bridge is balanced, in the absence of textile material, and textile material is thereafter trained between the plates of condenser 4, a first electrical impulse in the form of an A.C. voltage will be produced on the points of the bridge diagonal to the current input points which gives an indicating value proportional to the instantaneous weight per unit length of the textile material. This A.C. voltage is rectified in rectifier 6 to give a first electrical magnitude which varies according to the weight per unit length of the textile material, and the rectified impulse is fed to the input terminals of filter 7. The filter 7, preferably comprises an electrical resistor 9, connected to storage condenser 8. The storage condenser 8 is charged to a voltage which corresponds to the integrated average values of the first electrical impulse over a given material length, thereby providing a second electrical magnitude.

A third electrical impulse is obtained in the resistor 9, connected to the storage condenser 8, which has a magnitude which is the difference between the magnitude of the first electrical impulse and the magnitude of the second electrical impulse. Instead of an electrical resistor 9 and the storage condenser 8, it is possible to use a mechanical or combined mechanical-electrical follower, which produces an electrical impulse which corresponds to the difference between an electrical impulse corresponding to the instantaneous value of the weight of the textile material 5 and a second electrical impulse which is obtained by forming the average value.

The third electrical impulse corresponding to the deviations of the weight of the textile material 5 from its average value is amplified in an amplifier 10 and then led to the control motor 11.

The amplifier 10 should have a steady amplification constant which will not be influenced by the ageing of the elements. It is of advantage to use a magnetic amplifier.

In a preferred embodiment, the control motor 11 changes its direction of rotation according to the deviations of the weight of the textile material 5, from its average value. For this purpose, a D.C. motor or a two-phase A.C. motor can be used. In the latter case, the amplifier 10 must be an A.C. amplifier, which is built in such a manner that the A.C. voltage delivered is 180° out of phase, if the deviations of the weight of the textile material from its average value change from positive to negative or vice-versa.

The control motor 11 can also be replaced by an electromagnetic clutch 71 (as shown in Fig. 3) whereby a control signal will influence the slip between a driving shaft 72 with constant angular speed and the driven shaft 73 with variable angular speed. A voltage proportional to the angular speed of the rotor and the peripheral speed of the roller pair 23, 24 respectively, is fed back to the input of the amplifier 10 from the control motor 11, whereby an improved linearity of the angular speed of the shaft of the control motor 11, results. Furthermore, the angular speed of the shaft of the control motor 11, remains independent of the torsional moment of the motor. The feed back voltage can also be produced by means of a small auxiliary generator such as shown in the illustrated embodiment as coupled to the rotor of the motor. The value of said feed back voltage is then proportional to the angular speed of the motor shaft.

The control motor 11 actuates the differential gear 14, by means of gear 12, through pinion 13, which serve as reduction gears, and thereby control the angular speed of the roller pair 23, 24.

It is desirable to provide an alarm for indicating breakdown of the automatic controlling device or non-symmetrical functioning thereof.

It is of advantage if the measuring device is separated from the current supply elements, as well as from the evaluating elements for the control signal obtained from the measuring device, and connected only by means of electrical wires.

Based on the three diagrams A, B and C, Figure 2 explains the device according to the invention when material is run through. The diagram 2A shows the course 30 of the instantaneous value of the weight per unit length G of a sliver. Conventional cartesian representation is employed marking the length of the textile material on the abscissa, and the weight per unit length G on the ordinate.

The method according to the invention and the device for carrying it out, contain, as mentioned previously, means for obtaining an electrical magnitude 30, which represents the weight per unit length. By forming the average value of the course 30 over a specific material length a second electrical magnitude 37, according to diagram 2B, is obtained. The average value G is marked on the abscissa. If these two electrical magnitudes 30 and 37 are compared with each other, a third electrical magnitude 44 is obtained indicating the difference as seen on diagram 2C. The indicated values are influenced by heat variations in the humidity of the air, and other disturbing influences. This means that the electrical magnitude 30, which is proportional to the weight per unit length of the textile material is effected. If the arrangement is suitably designed, the disturbing influences are only of long term characteristic.

In known methods for automatic control of the evenness of slivers and rovings, disturbance influences may also cause an incorrect controlling effect. As the dis-

turbance influences are of long term characteristic they cannot cause any controlling effect on the method and device as is shown hereafter.

It has been shown previously, that, for instance, in cotton spinning, due to careful weight checks of the deliveries of the feeding aggregates, in other words the weight of the lap of the picker, as well as due to the doublings which reduce the irregularity, length cuts of approximately 10 yards of draw slivers do not show any significant variation. As the draw frames produce approximately 30 yards of sliver per minute, it is sufficient to form the average value according to Figure 2B, over a period of approximately 20 seconds, in order to cover the largest part of the length variations. As shown previously in this manner the irregularity can be reduced by approximately 90%.

Other disturbing influences are of considerably longer duration. Temperature variations, for example generally occur over a 10 minute period. The longest variations, for example, ageing of components can last weeks or months. Therefore, all these disturbing influences can cause no controlling effect, as shown hereafter:

When comparing the course of the first electrical magnitude **30**, according to diagram 2A, with the course of the second electrical magnitude **37**, according to diagram 2B, the following is to be seen:

After evaluating over a material length of approximately 10 yards, the heavy variations in weight with the maxima points **31**, **32** and **33** appear only as slight elevations **38**, **39** and **40**. The course **34—35** shows only short term variations, so that the course **41—42** remains straight. At **35** a systematic deviation commences, which is usually caused only by a disturbing influence. At **36**, i.e. after 10 yards of material length, the deviation still continues. The course of the second electrical magnitude starts to rise at **42**. The third electrical magnitude which starts to be effective, and which is represented in diagram 2C, shows the following course:

The heavy weight deviations **31**, **32** and **33** result in a corresponding control magnitude **45**, **46**, and **47**. This control magnitude is nearly able to control the variations. The course **48—49** represents the complete controlling of all variations. In the course **49—50** and further, however, the disturbing influence does not appear, as the average value **42—43** is able to follow the course **35—36**. The short term variations, however, are completely controlled.

For operation of the novel apparatus, it is desirable to make the length, above which no controlling takes place, adjustable. A significant advantage of the described method and the corresponding apparatus, is that this system works symmetrically, i.e. positive and negative weight variations in the textile material are controlled separately, so that the average weight of the textile material will not be changed by the automatic control. This means that, if the control breaks down, or is switched off, the average weight of the textile material and consequently the count of the spun yarns, remains the same on the average. This is attained as follows:

The control is not operated in case of constant weight which corresponds exactly to the average value of the corresponding weight per unit length of the textile material **5**. In case of a positive deviation of the weight from the average value, a corresponding increase of the angular speed of the drafting roller pair **23**, **24** takes place. In case of a negative deviation, however, a corresponding decrease takes place. When switching on the apparatus, it is advantageous during the time required for forming the second electrical magnitude, namely the average value **37**, for instance, during the first 20 seconds, to switch off the automatic control system, or to temporarily set it at least during the integrating time, to a lower value. After this time, the integrating time may be brought to its normal value. In principle, there is the possibility of not controlling the positive and negative weight deviations separately but of operating the control one-sided that is only with regard to thinnest spots to be expected in the textile material.

The above disclosure has been given by way of illustration and elucidation and not by way of limitation and it is desired to protect all embodiments of the hereindisclosed inventive concept within the scope of the appended claims.

What is claimed is:

1. A method for automatically controlling weight deviations of textile material during spinning, comprising the steps of: drawing the material through a measuring device, the indicating value of which changes according to the instantaneous weight of the specimen tested; obtaining a first electrical magnitude from this indicating value; obtaining a second electrical magnitude from said first magnitude by integrating the average value over a certain period of time; subtracting said second electrical magnitude from the first electrical magnitude to produce a third electrical magnitude which corresponds to the deviations of the weight per unit length of the textile material from its average value over a certain length; amplifying the impulse having said third electrical magnitude; directing the energy derived by amplification of said impulse to effect the drive of a drafting roller pair which serves for drafting the textile material, whereby the angular speed of said roller pair on the appearance of a negative deviation in the weight per unit length of the textile material is correspondingly reduced, and on the appearance of a positive deviation correspondingly increased.

2. A method according to claim 1 in which only weight deviations within a limited range are measured.

3. A method according to claim 1 in which the textile material is passed through the measuring device; and then through the drafting rolls.

4. A method according to claim 1 in which the textile material is first passed through the drafting rolls; and then through the measuring device.

5. Apparatus for automatically controlling the weight of textile materials during spinning, said apparatus comprising: constantly driven drafting rolls; a measuring device adjacent said rolls through which said textiles are drawn and which produces a first electrical impulse which corresponds to the weight of material passing therethrough; a filter connected to receive said first electrical impulse, said filter including means to block an electrical impulse component having a magnitude proportional to the average value of the weight per unit length of the textile material, to provide the filter output with an electrical impulse proportional to the deviation of the weight per unit length of the textile material from its average value; an amplifier to which said last named electrical impulse is fed and for producing a control impulse; a controlling drive mechanism which is actuated by said control impulse to regulate the angular speed of the constantly driven drafting rolls.

6. Apparatus according to claim 5 in which a differential gear is employed as part of the controlling drive mechanism.

7. Apparatus as in claim 5 in which said controlling drive mechanism comprises a D.C. motor.

8. Apparatus as in claim 5 in which said drive mechanism comprises a variable speed two phase A.C. motor.

9. Apparatus as in claim 5 in which said drive mechanism comprises a variable slip electro-magnetic clutch.

10. Apparatus as in claim 5 in which said measuring device comprises an electrical measuring condenser, said condenser forming part of an A.C. bridge.

11. Apparatus as in claim 5 in which said measuring device comprises a cell sensitive to electromagnetic radiation positioned adjacent the path of travel of the textile material; and a radiation source on the opposite side of said path.

12. Apparatus as in claim 5 in which said measuring

device is positioned at a distance from the drafting rolls, which is less than five times the staple length of the textile material.

13. Apparatus as in claim 5 in which said measuring device comprises a plate condenser.

14. Apparatus as in claim 5 in which said measuring device is coupled to the filter only electrically.

15. Apparatus as in claim 5 in which said drive mechanism is irreversible.

16. Apparatus as in claim 5 in which said filter comprises: an electrical condenser which stores electrical energy of a magnitude proportional to the average weight of the length of the textile material passing through said measuring device; and a resistor through which electrical impulses proportional to the weight deviations per unit length from the average value are passed.

17. Apparatus for automatically controlling the weight of textile materials during spinning, said apparatus comprising: a primary drive shaft, at least two pairs of constantly driven drafting rolls driven thereby, one pair having a constant angular speed, another pair having a variable speed subject to control, a measuring device adjacent said rolls through which said textiles are drawn and which produces a first electrical impulse which corresponds to the weight of material passing therethrough; a filter connected to receive said first electrical impulse, said filter including means to block an electrical impulse component having a magnitude proportional to the average value of the weight per unit length of the textile material, to provide the filter output with an electrical impulse proportional to the deviation of the weight per unit length of the textile material from its average value; an amplifier to which said last named electrical impulse is fed and for producing a control signal; a control drive mechanism which is actuated by said control signal to increase or decrease the angular speed of said variable speed roll pair with respect to the constant drive transferred to said drafting rolls.

18. Apparatus according to claim 5 in which a mechanical differential gear, using bevelled gears, is employed as part of the control drive mechanism.

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