

July 8, 1952

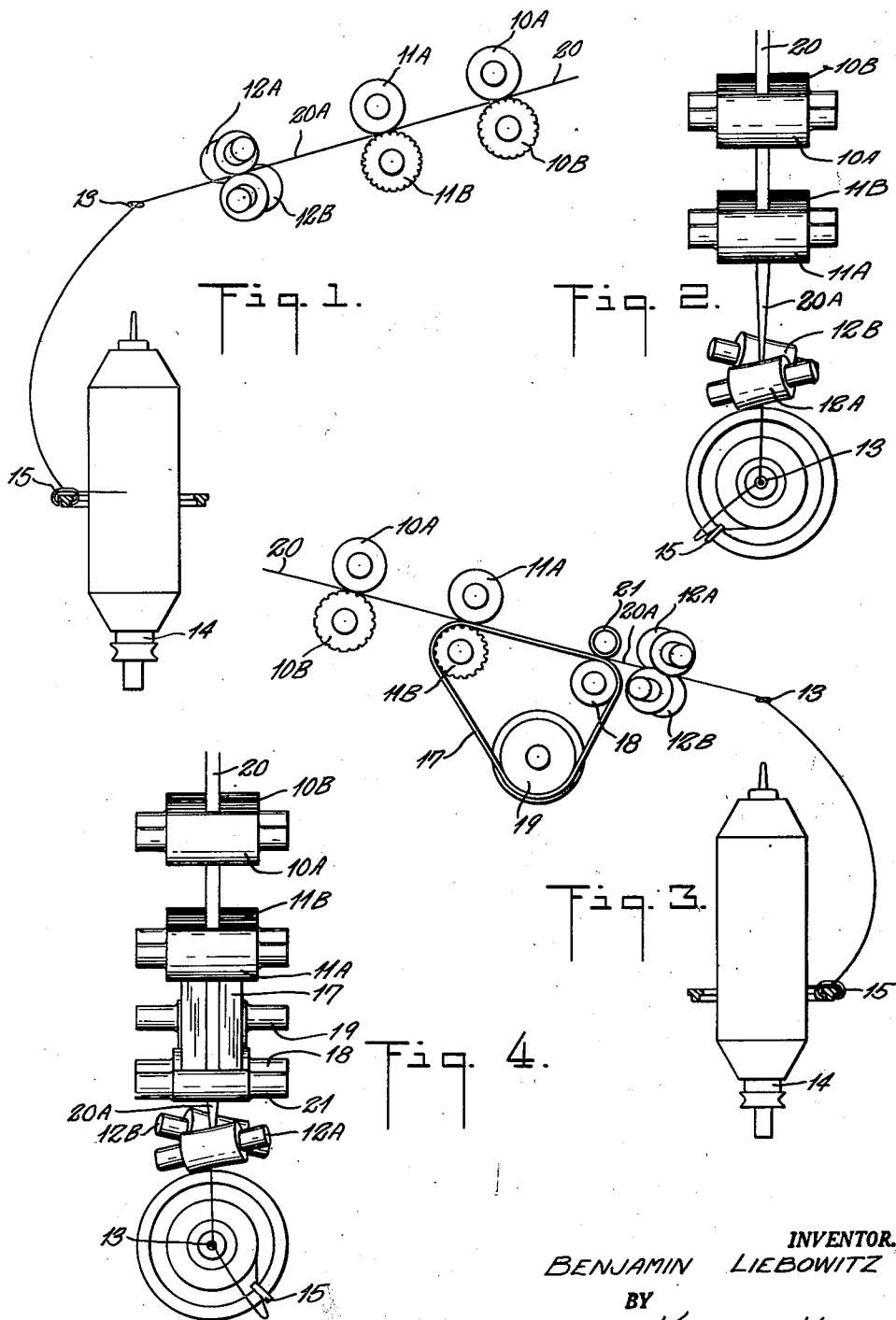
B. LIEBOWITZ

2,602,195

SPINNING METHOD AND APPARATUS

Filed April 9, 1948

5 Sheets-Sheet 1



INVENTOR.
BENJAMIN LIEBOWITZ
BY
Kenyon & Kenyon
ATTORNEYS

July 8, 1952

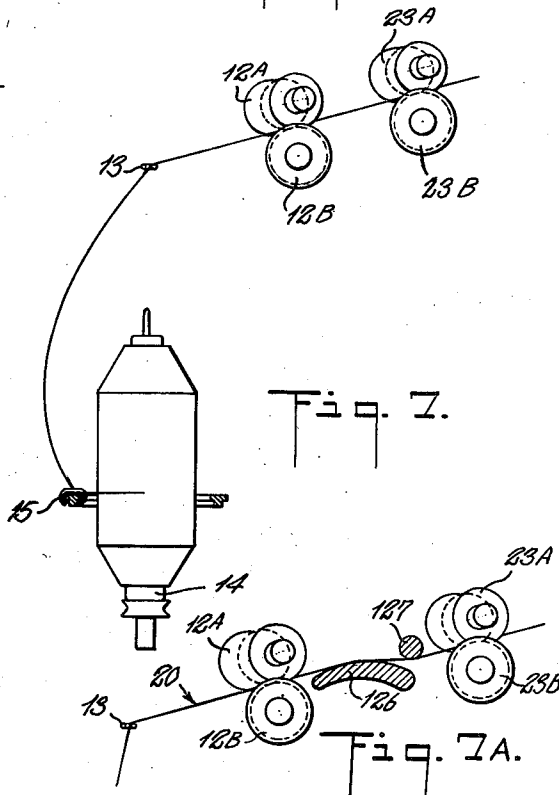
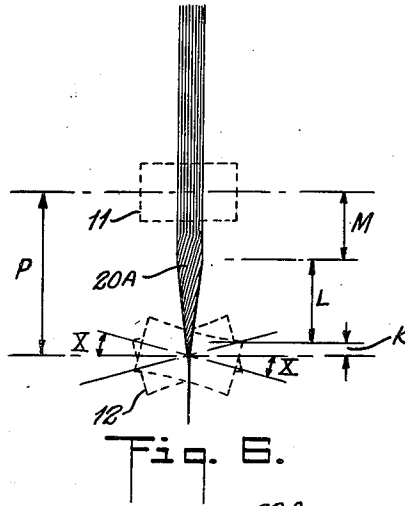
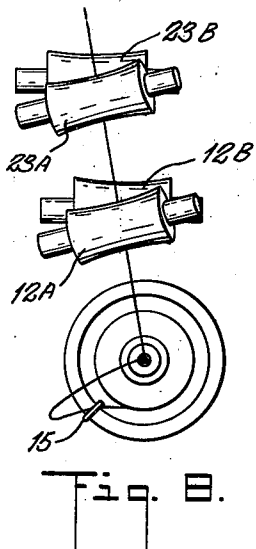
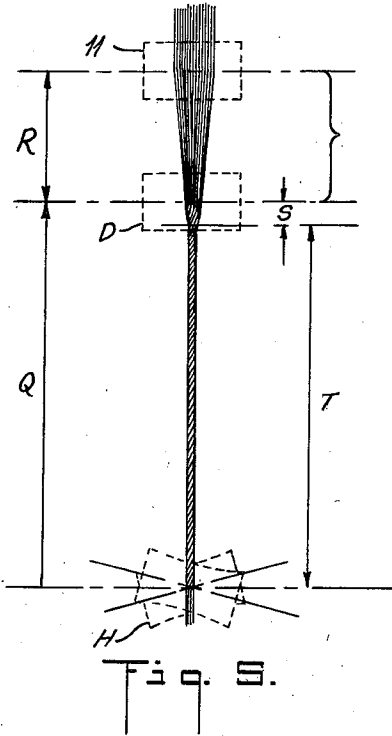
B. LIEBOWITZ

2,602,195

SPINNING METHOD AND APPARATUS

Filed April 9, 1948

5 Sheets-Sheet 2



INVENTOR.
BENJAMIN LIEBOWITZ
BY
Kenyon & Kenyon
ATTORNEYS

July 8, 1952

B. LIEBOWITZ

2,602,195

SPINNING METHOD AND APPARATUS

Filed April 9, 1948

5 Sheets-Sheet 3

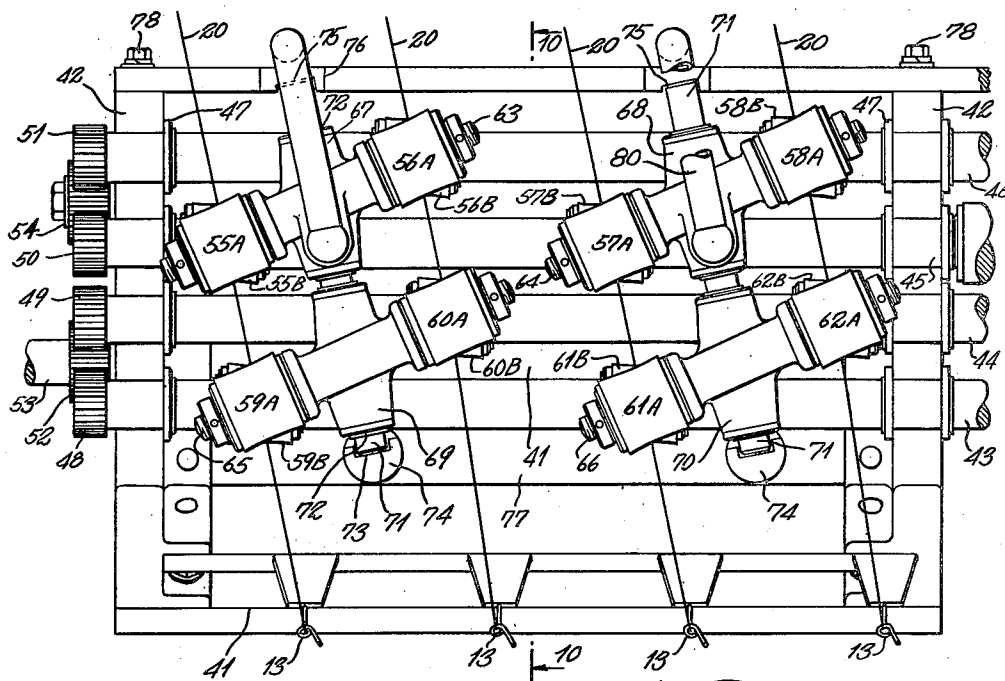


Fig. 9.

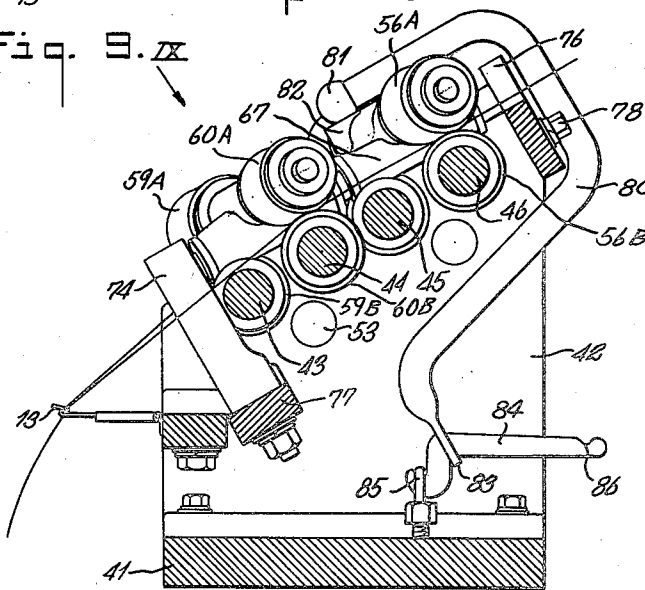


Fig. 10.

INVENTOR.
BENJAMIN LIEBOWITZ
BY
Kenyon & Kenyon
ATTORNEYS

July 8, 1952

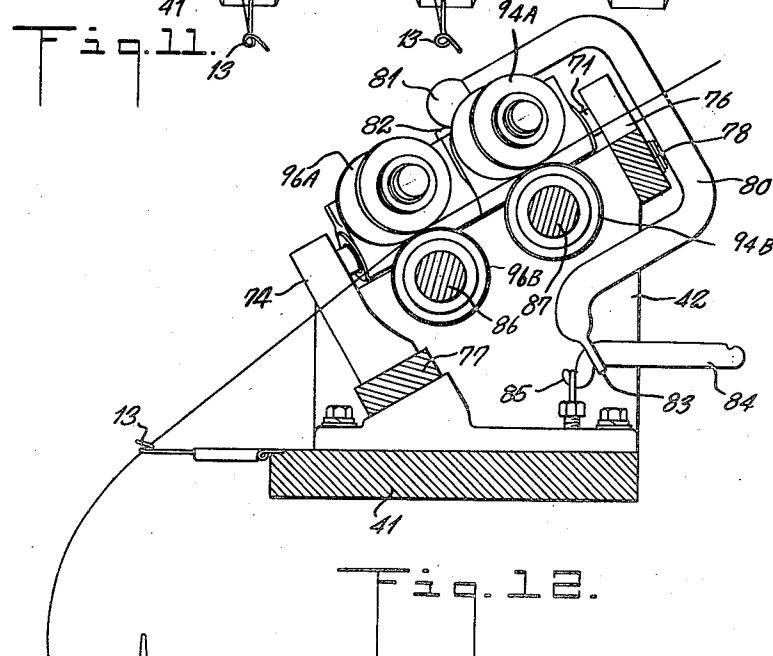
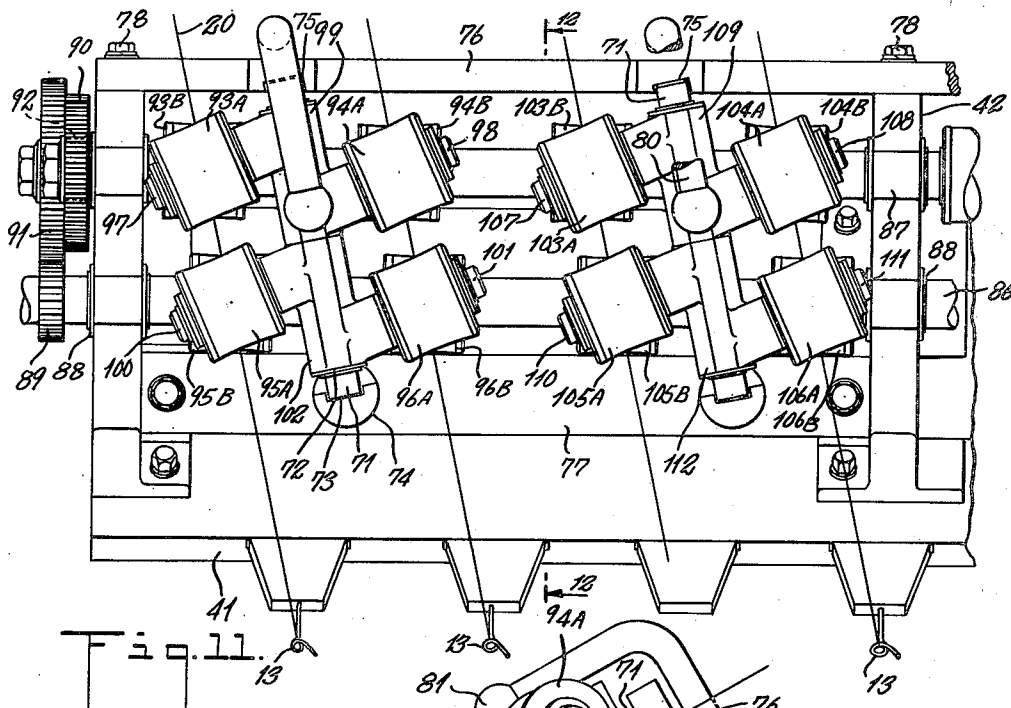
B. LIEBOWITZ

2,602,195

SPINNING METHOD AND APPARATUS

Filed April 9, 1948

5 Sheets-Sheet 4



INVENTOR.
BENJAMIN LIEBOWITZ
BY
Kenyon & Kenyon
ATTORNEYS

July 8, 1952

B. LIEBOWITZ

2,602,195

SPINNING METHOD AND APPARATUS

Filed April 9, 1948

5 Sheets-Sheet 5

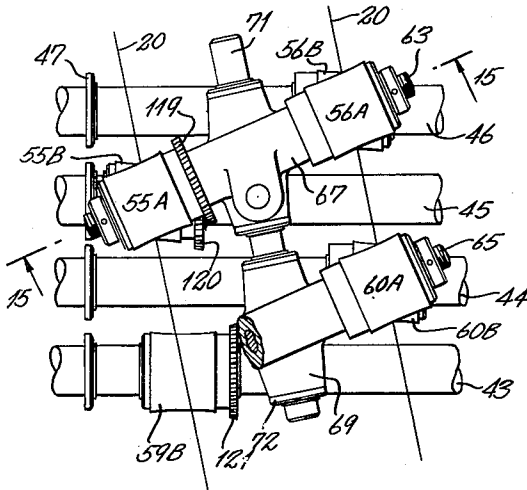


Fig. 13.

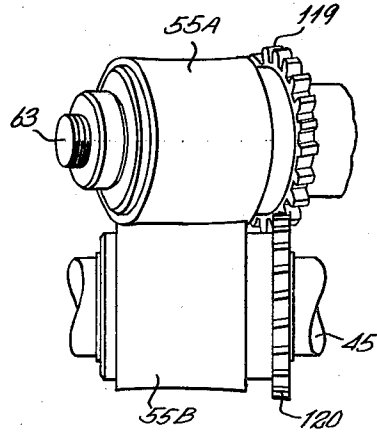


Fig. 14.

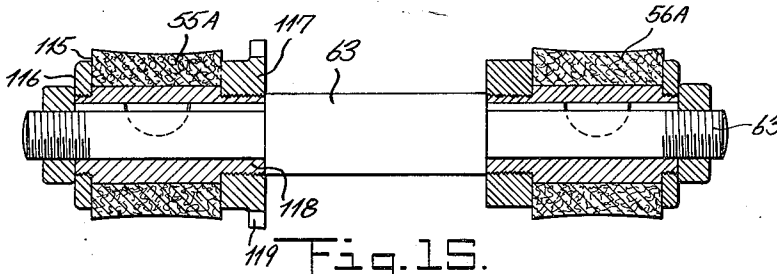


Fig. 15.

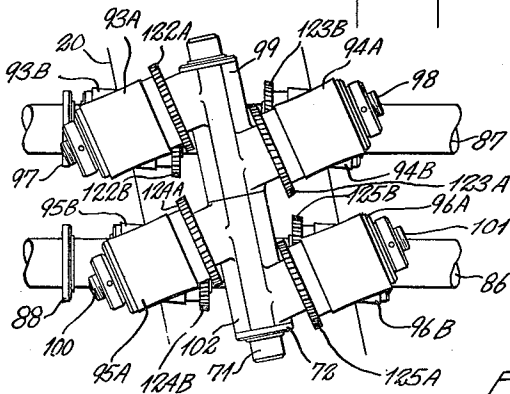


Fig. 16.

INVENTOR.
BENJAMIN LIEBOWITZ
BY
Kenyon & Kenyon
ATTORNEYS

UNITED STATES PATENT OFFICE

2,602,195

SPINNING METHOD AND APPARATUS

Benjamin Liebowitz, Lewisboro, N. Y.

Application April 9, 1948, Serial No. 20,045

19 Claims. (Cl. 19—130)

1

This invention relates to the drafting of roving and to the spinning of roving into yarn. It is particularly adaptable to cotton rovings and yarns and to mixtures of cotton and other fibers, but is also applicable to other kinds of fibers.

The objectives of this invention are:

- (1) To obtain greater uniformity and smoothness of finish so as to obtain substantially a combed yarn appearance from roving which is not combed;
- (2) To be able to spin yarns of good quality from shorter-fibers;
- (3) To increase the speed of spinning;
- (4) To reduce the cost of spinning;
- (5) To reduce the rate of ends coming down;

and to achieve other advantages, particularly certain structural advantages, as will hereinafter become clear.

These objectives are achieved to a greater or less extent by a method which combines drafting and twisting operations in an entirely new way and by novel apparatus of simple form adapted to carry out this method.

It has long been known to combine drafting and twisting in a single operation. The mule type spinning equipment which is prevalent in England employs a set of feed and drafting rolls of a kind which is more or less common to all types of spinning machines, and which imparts the bulk of the draft to the roving; from the drafting rolls the roving passes to the spindle, which during part of the cycle travels away from the drafting rolls and simultaneously imparts twist; the rate of travel of the spindle away from the drafting rolls is such as to impose a small additional draft on the roving. Whereas the draft in the ordinary drafting roll system may be of the order of 5 or more, the draft imparted in combination with twisting is normally only a few percent, perhaps 25% or 30%, at the most. The stretch of roving which is being drafted varies in length from a few inches, when the spindle is at its closest approach to the drafting rolls, to a matter of 5 or 6 feet when the mule spindle is at the outermost end of its travel. This stretch of roving being simultaneously drafted and twisted is in effect substantially uniformly twisted over its entire length, except for a very short distance from the last nip of the feed roll system to the twisted portion of the roving.

In American practice, as contrasted to the English, the roving travels from the drafting rolls to the spindle which does not travel but only rotates. That is, the operations of drafting and

2

twisting do not overlap as they do in the mule, but are entirely consecutive. However, the American system is continuous as contrasted with the intermittency of the British system, and the difference in cost of spinning on this account is so large that there are practically no mules used in the U. S. except possibly for a very small number spinning exceedingly fine yarns.

Instead of imparting simultaneous drafting and twisting by means of a traveling spindle, as in the mule, it has been proposed in German Patent 502,216 (1928) to impart this simultaneous draft and twist by means of a pair of hyperboloidal rolls whose axes make an angle with each other and thereby impart a rotation to the roving about its axis as well as a draft on it. This proposal is in essence an adaptation of the mule idea in which the bulk of the drafting is done by ordinary drafting rolls; and it was devised for the purpose of combining twisting and drafting without intermittency. It has the same basic characteristics as the mule in that the stretch of the yarn being simultaneously drafted and twisted is substantially uniformly twisted through its entire length and in that said stretch of roving is very long compared with the fiber length, the amount of the draft itself being very small. In fact, experiments which will be described below show that it is not possible to obtain anything more than a very small draft under these conditions and still produce a reasonably uniform yarn.

In my system, I obtain the combined drafting and twisting also by means of hyperboloidal rolls, but I employ the hyperboloids as the main drafting rolls to produce long drafts, e. g., up to 20 or perhaps more. This is possible in my system because in it the bulk of the twisting action is restricted to a small region close to the nip of the hyperboloids; the long draft and simultaneously a small amount of twist is imparted to a relatively short stretch of roving extending from the highly twisted part back toward the nip of the feed roll system. The total distance from the nip of the hyperboloids to the nearest nip of the feed roll system may be of the order of magnitude of a few fiber lengths, more or less, i. e., a relatively short distance compared with previous usage and/or proposals for combined twisting and drafting; as will be described and illustrated in greater detail hereinbelow.

Stated in other terms, I employ hyperboloids for the purpose of producing long draft in a single step and do not employ them as heretofore proposed, i. e., merely as an auxiliary to add

3

a small amount of draft to a much longer draft previously produced in the conventional manner.

When simultaneous draft and twist is imposed, as in the mule, or as in the German proposal, the advantage claimed is that those portions of the roving which are relatively thin will take more twist and hence less draft. American spinners have claimed that this advantage does not produce any appreciable improvement in the yarn except possibly for exceedingly fine yarns. My experiments support this latter view as will be described below.

When simultaneous twisting and drafting is imposed, as in my system, however, my experiments show that I do produce a smoother and more uniform yarn. The reasons for this will be discussed in connection with Figs. 5 and 6 below.

My invention will be more fully understood by reference to the accompanying drawings, in which

Fig. 1 shows a diagrammatic side elevation of the essential parts of a spinning frame employing hyperboloidal rolls as the main drafting rolls according to my invention;

Fig. 2 is a plan view corresponding to Fig. 1;

Fig. 3 is a diagrammatic side elevation of a spinning frame employing hyperboloidal rolls as the main drafting rolls, in which a belt system is employed in a manner which is well known in the spinning art today;

Fig. 4 is a plan view corresponding to Fig. 3;

Fig. 5 is a diagrammatic plan view showing the effect on the roving of the process employed in mule spinning or in the German disclosure referred to;

Fig. 6 is a plan view showing diagrammatically the effect on the roving of the hyperboloids as employed according to my invention;

Fig. 7 is a diagrammatic side elevation showing the essential parts of a spinning frame employing hyperboloids both as feed rolls and as drafting rolls according to my invention;

Fig. 7A is similar to Fig. 7, showing a modification thereof comprising a friction drag between the feed rolls and the drafting rolls;

Fig. 8 is a plan view corresponding to Fig. 7;

Fig. 9 is a plan view in the direction of the arrow IX of Fig. 10 showing diagrammatically the application of hyperboloids both as draft rolls and feed rolls to a spinning frame;

Fig. 10 is a side elevation of the apparatus shown in Fig. 9, the apparatus being shown partly in section on the line 10—10 of Fig. 9;

Figs. 11 and 12 are similar to Figs. 9 and 10 respectively and show an alternative embodiment, Fig. 12 being taken on the line 12—12 of Fig. 11;

Fig. 13 is a plan view showing a portion of the apparatus of Fig. 9 as modified by the provision of a positive drive for the upper feed rolls and for the upper draft rolls;

Fig. 14 is a front elevation detail view showing one of the mating pairs of hyperboloidal rolls of Fig. 13 and the gearing associated therewith;

Fig. 15 is a detail section on the line 15—15 of Fig. 13, and

Fig. 16 is a plan view showing a portion of the apparatus of Fig. 11 as modified by the provision of a positive drive for the upper feed rolls and for the upper draft rolls.

Referring to the drawings, 10A and 10B represent a pair of feed rolls as employed in conventional frames. 11A and 11B represent a pair of so-called breaker-draft rolls also as employed in conventional frames. The amount of draft im-

4

posed by the breaker-draft rolls 11A—B is only a matter of a few percent; in fact, the main function of using two sets of rolls, 10 and 11, for feeding purposes is to insure more uniform feed without employing excessive pressures. The system of rolls 10A and B, 11A and B, will hereafter be collectively referred to as the "feed roll system" or as the "feed roll means." Under suitable conditions they may comprise only a single pair of rolls instead of two pairs as shown in Fig. 1.

From the feed roll system the roving 20 passes to the hyperboloidal long draft rolls 12A—12B. In modern systems the drafting rolls impart long drafts of the order of 10 to 20, or even more. In my system I impose the same order of magnitude of draft by the drafting rolls 12A—12B. But instead of being cylindrical in form the draft rolls are hyperboloidal with axes making an angle with each other. Hyperboloidal surfaces are used in my system because they have the property of having line contact. If cylindrical rolls were employed with non-parallel shafts, the contact between the roll surfaces would only be at a flattened point instead of along a line and hence would not be suitable for the purposes here intended. Of course, it is not necessary that the surfaces employed be accurately hyperboloidal, in a mathematical sense, but only that they shall be hyperboloidal within the accuracy required for the purposes intended. The action of these hyperboloidal rollers is to roll the roving while drafting it, thereby imparting simultaneous draft and twist. However, it must be understood that the twist imposed is only a "false twist" or "non-conservative twist." For example, in Fig. 1 the effect of the hyperboloidal rollers 12A—12B is to impart a twist to the stretch of roving 20A between the nip of the hyperboloids and the nip of the breaker-draft rolls 11A—B. The roving issuing from the hyperboloids toward the eye 13 of the spindle will have no twist, except insofar as twist is imparted by the spindle 14.

From the eye 13 the roving passes as usual to the traveler 15 and thence to the spindle 14 whose rotation serves to subject the roving to true spinning in the well-known manner in order to impart permanent twist. The permanent twist thus imparted ordinarily is in the same direction as the false or non-conservative twist imparted by the hyperboloids and serves to conserve at least in part the non-conservative twist.

In modern American drafting frames, it is customary to use some sort of belt arrangement to support the roving as it passes from the breaker-draft rolls 11A—B to the drafting rolls. The same sort of system can be employed when the drafting rolls are hyperboloidal, as is shown in Fig. 3, in which 17 is a thin flat belt which is driven by the breaker-draft roller 11B, and passes over pulleys 18 and 19. Directly over the roller 18 is an auxiliary roller 21 which rests on the roving which in turn is supported by the upper stretch of the belt 17. The advantages accruing from the use of such belting arrangements are well known, among which may be mentioned the advantage of not requiring adjustment for small variations in fiber length. Instead of the belt arrangement, I may employ a frictional drag 126 as shown in Fig. 7A. To guide the roving to the drag, I may employ a guiding element 127 which preferably does not touch the frictional drag 126. However, the use of belts or drags is not essential in the practice of my invention.

In place of employing conventional types of

drical rolls. Again, the fact that the roving emerges from the hyperboloids in the form of a small approximately cylindrical rod, instead of in the form of a relatively wide tenuous ribbon as in conventional systems, also helps the propagation of spindle twist to the nip of the roving and again reduces the tendency of the yarn to break at this point. These improvements in twist propagation allow the use of higher speeds. Thus the advantages accruing from the use of long draft hyperboloidal rolls comprise greater uniformity of yarn, greater smoothness of yarn, less tendency for the yarn to break both in the drafting part and in the true spinning part, hence less attention, also higher speeds, and finally, lower costs. Furthermore, I have found that I can obtain very satisfactory yarns using rovings of materially shorter fiber length than is customary for the type of yarn involved. This constitutes one of the most important savings introduced by my system of hyperboloidal spinning.

In this specification I have described the distance between the nip of the draft rolls and the nip of the feed rolls as being of the order of a few fibers in length. The expression "a few fiber lengths" as used herein and in the claims is intended to mean anything from a little more than unity to, roughly, 3 or thereabouts, and is not to be restricted to integer values, but may be any integer or any fraction in that neighborhood. The fiber length referred to is that determined by standard procedure. It is not feasible to define the length of the stretch between the nip of the draft rolls and the nearest nip of the feed roll system more precisely than this for reasons which are apparent from the following data respecting certain of my experiments which are illustrative of the practice of my invention in connection with the drafting of cotton roving, the "nip distance" referred being the length of the stretch between the nip of the hyperboloidal drafting rolls and the nearest nip of the feed roll system.

In some of these experiments I have drafted successfully roving whose fiber length is $1\frac{1}{8}$ " using a nip distance of about 2", and using the same nip distance I have also drafted roving successfully whose fiber length is $1\frac{3}{8}$ ". In still other experiments I have used a nip distance of around $2\frac{1}{2}$ " with fiber lengths in the neighborhood of $1\frac{1}{8}$ " and have obtained successful results, but found it necessary in order to obtain good uniformity to employ a frictional drag as shown in Fig. 7A. It will be seen in connection with these experiments that I have used ratios of nip distance to fiber lengths varying from about 1.25 or 1.3 up to around $2\frac{1}{2}$.

In any case, the expression "a few fiber lengths" as defined and illustrated above covers a bracket of nip distances which is entirely different from the distances of many fiber lengths employed in mule spinning and proposed in mule substitutes.

My system differs from previous systems employing combined drafting and twisting not only with respect to the roller nip distance but also with respect to the amount of drafting. Previous systems (i. e., the mule or the mule substitutes) employ only very small drafts of the order of a few percent or perhaps 25 or 30% or in that neighborhood; while in my system I employ long draft, by which I mean, in cotton, something at least of the order of 4-to-1 or thereabouts. Of course, in drafting other fibers, e. g., wool, the term "long draft" is to be construed as low as 2-to-1 or thereabouts, because such fibers are habitually drafted to a much less extent than

cotton fibers. On the other hand, in drafting synthetic fibers long draft again is to be interpreted as having a meaning very much the same as for cotton. With regard to fibers such as jute or ramie fibers of extremely long length, such fibers are not well suited for being handled in the practice of my invention unless they are artificially shortened. In actual practice, in drafting cotton fibers of ordinary staple length, my invention contemplates obtaining drafts of 10-to-1 and preferably more; and in practice I have succeeded in obtaining drafts of 20-to-1 and more in cotton roving whose staple length is of the order of $1\frac{1}{8}$ ". I have also successfully obtained drafts of the order of 20-to-1 using synthetic fibers, e. g., a mixture of $1\frac{5}{8}$ " acetate fiber and $1\frac{3}{8}$ " viscose fiber. I have not determined the upper limit of drafting obtainable by my method, but I have found that the usual rule of thumb according to which the draft shall not exceed one fold for each $\frac{1}{8}$ " fiber length, does not apply to my system, because I can use substantially greater drafts than specified by this rule of thumb.

Other quantitative conditions which have been mentioned above, for example, the setting of the hyperboloidal rolls at a 12° angle, are likewise to be considered as illustrative rather than as definitive.

The amount of false or non-conservative twist imparted to the roving by the action of the hyperboloids is dependent upon the hyperboloidal angle X of Fig. 6. As soon as the hyperboloidal angle X is prescribed, the helical angle of twist is also prescribed, and from the helical angle of twist the number of turns per inch can be calculated by the following formula:

Number of turns per inch = $\tan X + 2\pi r$ where r is the radius of the roving being twisted. When the hyperboloidal angle X is 12° , for example, it follows that the tangent of 12° is 0.212. Also by way of example, if the yarn being twisted has a diameter of 0.003 inch, then the number of turns per inch imparted to the roving by the pair of hyperboloidal rolls equals

$$0.212 + (2\pi \times 0.0015) = 22.5$$

As the formula indicates, increasing the size of the roving will decrease the number of turns per inch in proportion, and vice versa. The twist imparted by a pair of hyperboloidal rolls whose hyperboloidal angle is 12° corresponds roughly with normal fully twisted yarn. It will be recognized that the twist imparted by a pair of hyperboloidal rolls whose hyperboloidal angle is 12° is such that the roving could not be substantially drafted if the twist were to be propagated substantially uniformly from the nip between the hyperboloidal draft rolls to the nearest nip of the feed roll system. However, by virtue of the fact that in the practice of this invention the long draft imposed by the hyperboloidal draft rolls prevents propagation of the twist created by said rolls beyond a short distance from the nip of said rolls, the roving becomes locally attenuated so that most of the twist becomes concentrated in the attenuated region immediately adjacent the hyperboloidal draft rolls and the portion of the stretch merging with this region contains less twist which permits long drafting of the fibers as they are drawn into the more highly twisted region adjacent the nip of the hyperboloidal rolls where no substantial drafting of the fibers occurs. At the same time, by restricting the distance from the nip of the hyperboloids to the nearest nip of the feed roll system to a few

5

feed roll systems, I may employ hyperboloidal rolls for the feed rolls as well as the draft rolls, as shown in Figs. 7 and 8. Here the hyperboloidal rolls 23A and 23B take the place of the breaker-draft rollers 11A—11B or may be used just by themselves for the feed roll system. The structural advantages gained by employing hyperboloidal feed rolls in this way will become manifest from Figs. 9 and 10.

In order to understand more clearly the action of the hyperboloidal rolls as used in my system to produce a combination of long draft and twisting simultaneously, I have shown diagrammatically in Fig. 6 the action of the hyperboloidal rolls on the stretch of roving 20A between the feed or breaker-draft rolls 11 and the hyperboloidal draft rolls 12. It will be seen that close to the nip of the hyperboloidal rolls there is a region K of the roving which is highly twisted. This region is comparatively short. In it no drafting takes place. Next to the region K is a region L which is the transition region in which combined drafting and twisting takes place, the amount of twist being relatively small while the amount of the draft is large. M is the region of the roving nearest to the nip of the feed or breaker draft rolls 11 in which there is no twist (except that initially in the roving) and apparently very little, if any, draft. The sum of the lengths K, L, M, denoted by P, is of the order of a few fibers in length, more or less (see below). It will be understood that the transition from region K to region L is gradual, not sharp, and likewise from region L to M. The lines of demarcation between these regions are, therefore, drawn somewhat arbitrarily but they serve to show the existence of the three zones K, L, M, and to indicate roughly their respective extents.

In contrast with the situation shown in Fig. 6, I show in Fig. 5 the corresponding state of affairs obtaining in the mule or in the mule-substitute shown in the German disclosure referred to above. Here a feed roll system is indicated by the reference character 11. From 11 the roving passes to the cylindrical drafting roll-pair D which imparts nearly all the draft the roving is to receive, but no twist. The roving then passes to a pair of hyperboloidal rolls H (in the German disclosure) or to a traveling spindle (in the mule). The stretch of roving between D and H is many fibers in length, and, as shown, is substantially uniformly twisted over its entire length Q except for a very small region S close to the nip of D. The length R, i. e., the distance between the nip of the feed roll system 11 and the drafting roll-pair D is only somewhat more than a fiber in length, unless a belt system is used, in which case it may be somewhat longer. In the region Q the amount of twist and the amount of draft are both small.

The basic difference between my use of the hyperboloidal rolls and the previous proposals will be clear from Figs. 5 and 6. It will be understood that in Fig. 5, which we may call "mule type spinning" no draft can take place in the short region S between the nip of the draft rolls D and the twisted part of the roving, since this distance S is generally substantially less than a fiber in length; the drafting due to the hyperboloids or spindle H, to the extent that it exists at all, is in the long-twisted stretch $T=Q-S$. Attempts which I have made to obtain long drafts with an arrangement corresponding to Fig. 5 have shown that there is an instability between drafting and twisting in the sense that if long draft is imposed the twist is not propagated back along the

6

stretch of roving Q, except for a short twisted portion near the hyperboloids; almost the entire long region Q is therefore subject to draft and, having no twist, emerges highly non-uniform and subject to frequent breakage. If, however, only small drafts are imposed and only a moderate amount of twist, then it is possible to obtain, say, 30% draft in the manner shown in Fig. 5, but my experiments have actually shown that so far as yarns of ordinary size are concerned, say up to 40s or 50s, there is no improvement in the quality of the yarn obtained by using hyperboloids in this way, i. e., as an auxiliary to a modern long draft system. If, however, a relatively high degree of twist is imposed, i. e., if the angles of the hyperboloids shown at X in Fig. 6 are fairly large (in my experiments 12 degrees), and if the stretch P of Fig. 6 is suitably chosen, then long draft and high twist can be simultaneously imposed with the part of the roving subject to draft and twist taking the form shown diagrammatically in Fig. 6. Under these conditions, i. e., with relatively large angles X, with relative short stretch P, and with long draft imposed, the resulting yarn is very uniform and not subject to frequent breakage.

At the same time, my system as illustrated in Fig. 6 differs radically in its action from ordinary systems employing cylindrical draft rolls. In the conventional system only those fibers are drawn out which are nipped by the draft rolls. In my system, however, the fibers which are drawn out are not only those that are nipped by the hyperboloids but also those which are caught in the highly twisted region K. In fact, in the practice of my invention the length of the stretch of roving that is being drafted is so restricted that substantially those fibers only are drafted whose ends have become entrained in the highly twisted region K. Now, if a thinner portion of the roving comes along it will begin to experience this high twist earlier in its travel and hence will tend to pull out more fibers from the roving following it. On the other hand, if a thick portion comes along it will become subject to high twist later in its travel and hence will draw out less fibers from the roving following it. In this way my system acts to even out irregularities in the roving and thereby helps to produce a more uniform yarn than the conventional system. Moreover, the rolling action of the hyperboloids tends to produce a smoother yarn with less hairiness so that the resulting yarn looks much like a combed yarn even when the roving itself is not combed. Furthermore, because of the strength imparted to the roving in the region K and in the lower part of the region L there is less tendency for the roving to break. It is preferable that the twist imparted by the hyperboloids in the zone L and K shall be in the same direction as the twist initially in the roving and also in the same direction as the final true twist imparted by the spindle. Having the initial twist in the roving in the same direction as that imparted by the hyperboloids helps to produce more uniform yarn. The highly twisted portion K after passing through the hyperboloids has no twist (except the attenuated residuum of twist initially in the roving) but having once been twisted, it accepts the twist imparted by the spindle more readily. This means that the twist imparted by the spindle will be more readily propagated back toward the nip of the hyperboloids. This in turn means less tendency for the yarn to break as it emerges from the drafting rolls, as compared with conventional systems using cylin-

fibers in length, the zone of drafting is confined to a stretch of roving not greatly in excess of one fiber length. My experiments have demonstrated that this restriction on the drafting zone is essential for uniformity. While a hyperboloidal angle of 12° for the hyperboloidal draft rolls has been found to afford highly satisfactory results in the spinning of cotton yarn from roving, other angles may be used for imparting either a greater or lesser non-conservative twist as may be desired. However, it is contemplated in the practice of this invention that the feed roll system and drafting rolls shall be operatively arranged so that a long draft will be accomplished across a stretch limited to a few fibers in length while simultaneously roll twisting the roving in the immediate neighborhood of the nip between the drafting rolls sufficiently to substantially prevent drafting of the fibers in this region while drawing the fibers into this region from the portion of stretch more adjacent the feed roll system wherein diminishing twist permits the long draft to be accomplished. In other words, any such non-conservative twisting of the roving creates a "high twist" and at the same time, according to this invention, a long draft is also created as the fibers are drawn into a localized region of the high twist. The magnitude of the draft serves to confine the high twist to the region immediately adjacent the draft roll nip and to confine the draft within said limited stretch as the roving is passed through the system.

The problem of driving hyperboloidal rolls in a drafting frame is by no means simple when approached along conventional lines. The multiplicity of skew-gears which would ordinarily be involved because of the angles made by the hyperboloidal axes represent not only a burdensome addition to first cost but also added maintenance and operating costs and complications. Moreover, the problem of supporting the hyperboloids in such a way as to put the pressure in a well-defined manner on the roving and not partly on the roving and partly on the rolls is not easy of simple solution when approached in conventional manner. I have overcome all of these and other difficulties in a simple and efficient manner by (1) employing hyperboloidal feed rolls as well as hyperboloidal drafting rolls (the two sets of rolls having the same angle), (2) by assembling one roll of one pair to a corresponding roll of a neighboring pair on a common shaft in "dumb-bell" fashion, and (3) by mounting the corresponding mating hyperboloids on separate adjacent parallel shafts. This arrangement permits of the use of long straight shafts running the length of the frame, in a manner corresponding to that employed in conventional spinning frames, and of associating hyperboloids with these shafts in such a manner as to require no gearing other than employed at the ends of the shafts as in conventional spinning frames. So far as the driving arrangement is concerned, the only difference between my system and the conventional system is that I employ two longitudinal shafts where the conventional system employs only one. On the other hand, in view of the improved feeding characteristics of the hyperboloidal feed rolls, it is not essential that I use both feed rolls and breaker-draft rolls, although I may use this combination if I choose. By dispensing with one pair of rolls of the feed roll system, I require only four shafts, which is a trivial disadvantage with respect to the three shafts employed in conventional frames.

All of this will be more clearly understood by reference to Figs. 9 and 10, in which 41 is a base member carried by the spinning frame in any convenient or conventional manner. Mounted on this base 41 is a succession of brackets 42 in which are mounted bearings for the four shafts 43, 44, 45 and 46. These shafts may be restrained against endwise movement by washers or collars 47. At the one end of shaft 43 is a gear 48, likewise 44 has gear 49, 45 has gear 50, and 46 has gear 51. Mating with both gears 48 and 49 is a gear 52 on driving shaft 53. Likewise mating with gears 50 and 51 is a gear 54 which is driven by a conventional system of change gears from the shaft 53. By choice of gears in the change gear system, the relative speed between shafts 43—44 on the one hand and 45—46 on the other hand is controlled so as to determine the amount of draft imposed by the system. A set of four upper hyperboloidal feed rolls is shown at 55A, 56A, 57A and 58A. Likewise a corresponding set of four lower hyperboloidal feed rolls is indicated at 55B, 56B, 57B and 58B. Similarly, a set of four upper hyperboloidal drafting rolls is shown at 59A, 60A, 61A and 62A, and a corresponding set of lower hyperboloidal drafting rolls is indicated at 59B, 60B, 61B and 62B. The manner in which the hyperboloidal rolls are disposed in pairs is clear from Fig. 9. A brace of two neighboring upper feed rolls 55A and 56A is mounted on a common shaft whose end is shown at 63. The shaft 63 passes through a small X-casting 67 which serves to locate the rolls 55A and 56A in all ways except as to an angular orientation which will be described presently. In the embodiment shown, the rolls 55A and 56A are mounted for rotation with the shaft 63 which rotates relatively to a bearing surface provided by the casting 67, and this construction is preferable from an operational standpoint. However, the shaft 63 may, if desired, be carried non-rotationally by the casting 67 and each of the rolls 55A and 56A may be provided with a bearing between it and the shaft 63. Similarly, the two neighboring upper hyperboloidal feed rolls 57A and 57B are associated on a common shaft 64. Likewise, the neighboring upper hyperboloidal draft rolls 59A and 60A are associated on a common shaft 65, while neighboring upper hyperboloidal draft rolls 61A and 62A are associated on a common shaft 66.

The shaft 63 common to the brace of upper feed rolls 55A and 56A is mounted in a small X-casting 67. Likewise 68 denotes the X-casting which carries the shaft 64, 69 that which carries the shaft 65, and 70 that which carries the shaft 66. Each of these X-castings is drilled to receive a cylindrical rod 71 whose axis makes with the axis of the roll-shaft an angle of 90 degrees minus the hyperboloidal angle shown at X in Fig. 6. The rod 71 which passes through the casting 67 also passes through the casting 69 so that these two X-castings are also associated in pairs. In this manner common carriage means is provided for the group of rolls 55A, 56A, 59A and 60A whose axes of rotation are disposed substantially in a common plane which is in parallel relation to the plane in which the axes of rotation of the lower group of rolls 55B, 56B, 59B and 60B are disposed. Each of these castings is located endwise on the rod by means of snap rings or collars shown at 72. The rod 71 itself is slidably held at one end in a vertical groove 73 in post 74, while the other end is similarly constrained by groove 75 in the bar 76. The post 74 is rigidly mounted on the base by means of the

bar 77 which is rigidly supported on the brackets 42. The bar 76 is likewise rigidly attached to the brackets 42 as by means of bolts 78. In this way the cylindrical rod 71 is so mounted that each end can move up and down freely, but at the same time is restrained so that it cannot move endwise and so that it maintains a fixed angle with the shafts 43—44 etc. The X-castings 67 and 69 which are bored to receive the rod 71 can rotate freely on rod 71. Hence, if a load is applied vertically to the plane of the drawing of Fig. 9 to the rod 71, the pressure caused by said load on the rolls 55A, 56A, e. g., will be evenly distributed between them. It is thus seen that this system of mounting accurately locates all of the upper hyperboloidal rolls in their desired positions and at the same time acts as a distributor so that the load in fixed and desired proportions will be distributed among the four rollers 55A, 56A, 59A, 60A, all four said rollers constituting a group. The load is equalized between the pairs of feed rolls 55A and 56A; likewise it is equalized between the pairs of drafting rolls 59A and 60A. However, the proportion of the load carried by the feed rolls 55A and 56A on the one hand, and that carried by the draft rolls 59A and 60A on the other hand, is determined by the point at which the load is applied with respect to the centers of the shafts 63 and 65.

As shown in the drawings, this load may be applied by means of a bent rod 80 whose upper end may terminate in a ball 81 which rests in a slight depression on a boss 82 of the X-casting 67. At its lower end the bent rod 80 carries a fulcrum 83 for the lever 84 pivotally attached to the base at 85. Weights may be applied in the conventional way at the end 86 of the lever 84. It will be seen that in the scheme shown the vertical load is applied to the X-casting 67 instead of directly to the rod 71, but this mode of applying the pressure is such as not to interfere appreciably with the rocking motion of shaft 63 relative to rod 71 and hence this mode of application of pressure is permissible. As here shown, the point of application of the load is closer to the shaft 63 than to the shaft 65. Hence, the pressure of the hyperboloidal feed rolls 55A and 56A will be greater than on the hyperboloidal draft rolls 59A—60A.

Corresponding to the description of the X-castings 67 and 69 and the rod 71, etc., associated with the draft rolls 55A, 56A, 59A, 60A, is an identical set associated with the rolls 57A, 58A, 61A, 62A. This structure is repeated throughout the frame. Each set of four rolls provides for feed rolls and drafting rolls for two spindles. I have not shown any breaker-draft rolls, but it is clear that by adding another pair of longitudinal shafts and extending the rod 71, an additional set of rolls can be handled, although it will be recognized by all competent machine designers that this will require that one set have an additional degree of freedom vertically and that additional means must be provided for applying the vertical load on the additional set of rolls. The matter of providing an extra set of rolls for the feed roll system, i. e., providing a set of breaker-draft rolls, will be discussed presently.

Associated with each upper roll, whether it be a feed roll or a draft roll, is of necessity a lower roll on which the upper roll bears with the pressure created by the weighting system. The problem of properly locating and driving these lower rolls has been solved by placing alternate lower rolls on alternate shafts, as shown, i. e., the

lower feed roll 55B mating with the upper feed roll 55A, is carried on shaft 45, while the lower feed roll 56B which mates with the upper feed roll 56A is carried on shaft 46. Each of these lower rolls is keyed in any conventional manner to its respective shaft and is likewise located endwise and prevented from endwise movements in any conventional manner. The distance between the centers of the shafts of the pair 45—46 when divided by the distance between the gorge circles of the hyperboloids 55A, 56A shall equal the sine of twice the angle of the hyperboloids as shown at X in Fig. 6, e. g., shall equal $\sin 2X$. Once the distance between hyperboloids on a common shaft has been fixed, and the angle of the hyperboloids has been fixed, the distance between the shafts of the pair 45—46 is determined. Since we have chosen to make the angle of the hyperboloids of the feed rolls the same as that of the draft rolls, the distance between shafts of the pair 43—44 will be equal to the distance between shafts of the pair 45—46.

It will be seen, then, that by this arrangement of upper pairs of hyperboloids on a common shaft in dumbbell fashion and of corresponding lower hyperboloids on suitably-spaced separate shafts, we are able to drive the entire hyperboloidal system by a means which is no more complicated than the means for driving conventional cylindrical rolls except for the addition of one shaft.

It is true that if we include another set of feed rolls so as to obtain the benefits of breaker-draft rolls, we would complicate the system by adding two more shafts besides adding the breaker-draft rolls themselves. However, it is possible to obtain sufficiently uniform feed using hyperboloidal feed rolls of properly selected materials and of adequate diameters so that the use of the breaker-draft roll is not essential so far as obtaining uniformity of feed is concerned. Moreover, if an additional pair of hyperboloidal feed rolls is added, the region of the roving between that pair and the next pair following it (i. e., the breaker-draft pair) will be highly twisted by the action of the hyperboloids, and since the draft in the breaker-draft rolls is usually very small, this twist will be propagated all the way back to the nip of the first pair of hyperboloidal feed rolls. It is thus seen that any attempt to create small draft by means of breaker-draft rolls would be frustrated by the fact that the roving in this region would be highly twisted. Moreover, in conventional spinning frames the breaker-draft per se is very small indeed, of the order of 6% in many commercial frames. This amount of draft is trivial and the only significant purpose of breaker-draft rolls is to obtain more uniform feed.

One of the reasons why single pairs of hyperboloidal feed rolls tend to give more uniform feed than cylindrical feed rolls lies in the fact that the hyperboloidal feed rolls will twist the roving entering the nip, and since there is no draft between the feed roll and the creel, the twist thus created will be propagated all the way back to the creel, as experiment shows. The roving thus enters the feed rolls in the form, roughly, of a slender rod, and not as a flat ribbon, so that, although it is to a large extent flattened by the pressure on the feed rolls, the feed rolls nevertheless have a more uniform hold on the roving.

Returning to Figs. 9 and 10, the rest of the description will be clear to those skilled in the art. From the draft rolls the roving passes as usual to an eye 13 from the eye to the spindle

as shown in the earlier figures, and as is well known in the art.

While the arrangement shown in Figs. 9 and 10 of associating two upper feed rolls (or drafting rolls) in pairs in dumbbell fashion is well known in the spinning art so far as cylindrical rolls are concerned, it is entirely new, so far as I am aware, when applied to hyperboloidal rolls. It has many advantages in achieving simplicity and in reducing to a minimum the number of parts which have to be made.

While suitable apparatus of simple and efficient construction has been shown in Figs. 9 and 10 which embodies and which is adapted for the practice of my invention, the principles utilized in the specific construction shown and described can be availed of in other constructions. Generally speaking, the principles illustrated in connection with the specific construction shown can be availed of according to my invention by pairing adjacent hyperboloidal roll-pairs of like function (e. g., two pairs of feed rolls) in sets so that each set comprises four rolls; two like-mounted rolls (e. g., two upper rolls) are associated to form a "brace"; similarly, the other two like-mounted rolls (e. g., two lower rolls) constitute a second "brace." The hyperboloidal rolls of one brace have spaced parallel axes, while the hyperboloids of the other brace have either a common axis or spaced parallel axes, so disposed that the rolls of one pair of mating hyperboloids of the set make contact with each other along a generator which is parallel to the generator along which the rolls of the other pair of mating hyperboloids make contact with each other. It will be readily understood that if the axes of both braces are each spaced and parallel, the plane determined by the parallel axes of one brace will be parallel to the plane determined by the parallel axes of the other brace. In short, adjacent pairs of mating hyperboloids of like function are associated in sets; each set comprises two braces, and each brace comprises two like-mounted rolls; the axes of at least one brace are spaced and parallel; the axes of the other brace are preferably coincident but may be spaced and parallel; and the generator of contact of one mating pair is parallel to the generator of contact of the other mating pair. The rolls constituting one of the braces can be carried by common mounting means therefor so as to maintain the gorge circles thereof in substantially opposed relation to the gorge circles of the respective rolls of the other brace for frictional contact with roving therebetween. Moreover, the mounting means for one of the braces of rolls can be of the character hereinabove described whereby means is afforded for urging the brace of rolls carried thereby toward the rolls of the other brace with substantially equal distribution of load between each of the pairs of hyperboloidal rolls. (When a surface is generated by the motion of a straight line, that line is called "the generator," and each position of the line in the surface is called "a-generator." A hyperboloidal surface is produced by the rotation of a straight line, i. e., the generator, about a second non-parallel non-intersecting straight line called the axis. When two hyperboloids are in proper mating contact, that contact is along a straight line which is a-generator common to both hyperboloids.)

In Figs. 11 and 12, the above-mentioned principles are embodied in an alternative construction embodying my invention. In this embodiment, the number of shafts extending along the

spinning frame has been reduced so that instead of two shafts being required for the lower rolls of two adjacent pairs of rolls only one is required, while modified support means of the upper rolls of the adjacent pairs is employed so that the upper rolls will mate properly with the lower rolls.

In the embodiment shown in Figs. 11 and 12, the base 41 and the brackets 42 are the same as in Figs. 9 and 10. The brackets contain bearings for the shafts 86 and 87 which are restrained from endwise movements by the collars 88. Shaft 86 is the driving shaft and on the end of it is mounted the gear 89. The gear 90 on the shaft 87 is driven from the gear 89 through a conventional change gear system such as gears 91 and 92 so as to determine the amount of draft imposed by the system.

A brace of lower hyperboloidal rolls 93B and 94B is mounted on shaft 87 in spaced relation for rotation with the shaft 87 about its axis. Another brace of hyperboloidal rolls 95B and 96B is similarly mounted on shaft 86. The upper hyperboloidal rolls 93A and 94A are rotatable about the shafts 97 and 98 respectively whose axes are carried in spaced parallel relation by the casting 99 so that the angle between the axes of rotation of the pair 93A, 93B is the same as that between the axes of rotation of the pair 94A and 94B, the rolls of each pair being disposed with their gorge circles in substantially opposed relation. The upper rolls 95A and 96A are rotatable about the shafts 100 and 101 respectively which are carried by the casting 102 with their axes in parallel spaced relation so that the gorge circles of the pair 95A, 95B and of the pair 96A and 96B are in substantially opposed relation.

The castings 99 and 102 are carried by mounting means corresponding to the mounting means for the castings 67 and 69 of the embodiment shown in Figs. 9 and 10, and the elements thereof are indicated by like reference characters. Thus, the castings 99 and 102 are bored to receive the rod 71 for free rotation about the axis of rod 71, and are held in place endwise of the rod by the collars or snap rings 72. One end of the rod 71 is slidably held in the vertical groove 73 in the post 74 while the other end of the rod is similarly constrained by the groove 75 in the bar 76. The means for urging the upper rolls 93A, 94A, 95A and 96A toward the lower rolls 93B, 94B, 95B, and 96B is also the same as that shown in Figs. 9 and 10 including the rod 80 terminating in the ball 81 which rests in a slight depression in a boss 82 on casting 99, the lower end of the rod 80 being provided with the fulcrum 83 for the lever 84 pivotally attached to the base at 85. The relative distribution of the load corresponds with that described more fully hereinabove in connection with the embodiment shown in Figs. 9 and 10.

Another group consisting of one set of two adjacent pairs of hyperboloidal rolls arranged in tandem with another set of two adjacent pairs of hyperboloidal rolls is shown in Figs. 11 and 12 which duplicates the group just described. In this group, the lower hyperboloidal rolls 103B and 104B are mounted for co-axial rotation with the shaft 87, and the lower hyperboloidal rolls 105B and 106B are mounted for co-axial rotation with shaft 86. The upper rolls 103A and 104A are mounted for rotation about shafts 107 and 108 respectively which are carried with their axes in parallel spaced relation by the casting 109, and the upper rolls 105A and 106A are mounted for rotation about shafts 110 and 111 respectively

which are carried with their axes in parallel spaced relation by the casting 112. The mounting means for the castings 109 and 112 is a duplication of that provided for castings 99 and 102 and the parts thereof are indicated by like reference characters. These structures are repeated throughout the frame.

As in the embodiment shown in Figs. 9 and 10, the roving 20 first passes between the feed rolls, e. g., 93A, 93B and thence to the drafting rolls, in this case 95A, 95B. The roving then passes through the eye 13 and the traveler 15 to the spindle 14 for reception thereby while it is subjected to true spinning as hereinabove described.

In comparing the embodiment shown in Figs. 9 and 10 with that shown in Figs. 11 and 12, it will be seen that they both comprise two kinds of braces of hyperboloidal rolls in which the two rolls of one brace are mounted on parallel spaced shafts and the two rolls of the other brace are mounted on co-axial shafts. Thus, in Figs. 9 and 10, the hyperboloidal rolls of each driving brace (lower rolls) are mounted on spaced parallel shafts, while the hyperboloidal rolls of each idling brace (upper rolls) are co-axial. In Figs. 11 and 12, however, the reverse is true, viz., the rolls of the lower braces are co-axial while the rolls of the upper braces have spaced parallel axes. It will be immediately recognized that it is possible to construct the spinning frame so that it is a hybrid between that shown in Figs. 9 and 10 on the one hand, and that shown in Figs. 11 and 12 on the other. It will be obvious that matters can be so arranged that the rolls of both upper and lower braces can be mounted on spaced parallel shafts by using a combination of the upper structure of Figs. 11 and 12 with the dual shafts of Figs. 9 and 10.

The structure shown in Figs. 9 and 10 and likewise that shown in Figs. 11 and 12 disclose an association of braces of rolls of different function on a common rod or shaft, for instance, the rod 71 in Fig. 9, by means of which the drafting brace of rolls 59A—60A and the feeding brace of rolls 55A—56A are located on the frame in proper relationship to their respective mating hyperboloids. This arrangement has structurally advantages which are applicable not only to hyperboloidal spinning but also to spinning frames employing cylindrical rolls. It will be seen that base of the machine is provided with a grooved post 74 and a grooved bar 76 which together serve to locate all four upper rolls for two adjacent spindles. In conventional frame structures, however, it is necessary to employ twice as many locating means for the same duty. While the upper hyperboloids of a brace of rolls of Fig. 9 are co-axial and those of Fig. 11 are mounted on spaced parallel axes, nevertheless they have in common the feature that a brace of hyperboloids of one function (e. g., feeding) and a brace of hyperboloids of another function (drafting) are associated on a common member which locates both braces with respect to the frame and which permits each brace to rock independently about the axis of the common member. Moreover, this common member serves as a load distributor to distribute the applied load in predetermined ratios among the four rolls associated with it.

In the drawings of Figs. 9 and 10 as well as of Figs. 11 and 12, I have shown the conventional driving arrangement for the upper rolls, that is to say, only the lower rolls are power driven and the upper rolls are driven by friction from the

lower rolls. In my experiments, I have used this same arrangement. However, it must be borne in mind that the conditions obtaining in hyperboloidal rolls differ substantially from those obtaining in cylindrical rolls so that whereas, in the case of cylindrical rolls, satisfactory drive of the upper rolls is obtained by frictional drive from the lower rolls, nevertheless the altered circumstances may make it desirable to drive the upper hyperboloidal rolls mechanically so as to insure more positive equalization of the speed of the upper rolls with that of the lower rolls. By a simple modification of the arrangement shown in Figs. 9 and 10, it is feasible to drive the brace of upper feed rolls and the brace of upper draft rolls from one of the shafts of the lower feed rolls and one of the shafts of the lower draft rolls respectively as shown in Figs. 13, 14 and 15.

In Figs. 13, 14 and 15, the shafts 43, 44, 45 and 46 are power driven and are the same shafts which are indicated by like reference characters in Figs. 9 and 10 and which carry for rotation therewith the lower hyperboloidal rolls 55B, 56B, 59B and 60B. Also as in Figs. 9 and 10, the brace of upper feed rolls 55A, 56A is mounted on the shaft 63 which is rotatably mounted in the casting 67 that is rockable about the shaft 71. For the sake of clarity, only the upper roll 50A of the brace of upper draft rolls 59A and 60A is shown in Fig. 13, the brace being mounted on the shaft 65 which is rotatably carried by the casting 69 that likewise is rockable about the shaft 71. In Fig. 15, the hyperboloidal roll 55A is shown as comprising the surfacing layer 115 of fibrous composition which is held between the collars 116 and 117 for rotation with the annular core 118 that is keyed to the shaft 63 for rotation therewith. The roll 56A is of similar construction, and the same applies to all hyperboloidal rolls that are shown in Figs. 13, 14 and 15.

In order that the upper hyperboloidal rolls 55A and 56A may be positively driven, the collar 117 has a gear 119 machined integrally therewith which meshes with the gear 120 that rotates integrally with the roll 55B and with the driven shaft 45. The gears 119, 120 are hyperboloidal so that when the shaft 45 and the hyperboloidal roll 55B are rotated, the hyperboloidal roll 55A and the shaft 63 are rotated in the opposite direction and at the same speed. Since the roll 56A likewise is keyed to the shaft 63, the roll 56A is positively driven so that its peripheral speed will correspond with that of its mating roll 55B. Similarly, the brace of rolls 59A and 60A (roll 60A only being shown in Fig. 13) is positively driven from the driven shaft 43 by corresponding hyperboloidal gears of which only one gear, namely, the gear 121, is shown in Fig. 13.

Referring to Fig. 16, the means for positively driving the upper feed rolls and upper draft rolls is analogous to that described above in connection with Figs. 13, 14 and 15. In Fig. 16, the upper rolls 93A, 94A, 95A and 96A; the lower rolls 93B, 94B, 95B, and 96B; the shafts 86 and 87; the castings 99 and 102; and the shaft 71 are the same as the parts bearing the same reference characters shown in Figs. 11 and 12. In this embodiment, the upper rolls 93A, 94A, 95A and 96A have the gears 122A, 123A, 124A and 125A respectively that are mounted for rotation therewith and that are driven by the gears 122B, 123B, 124B and 125B that are mounted for rotation with the lower rolls 93B, 94B, 95B and 96B. It is apparent, therefore, that each of the upper

hyperboloidal feed rolls 33A and 34A is positively driven from the driven shaft 87, while each of the upper hyperboloidal draft rolls 35A and 36A is positively driven from the driven shaft 88.

In the design of the gearing for the embodiment shown in Figs. 13 to 16, gearing having teeth with long addenda permits the movements of the upper roll braces relatively to the rolls of the lower braces in the manner and for the purposes as hereinabove described while maintaining the positive drive for the upper rolls. While hyperboloidal gears are preferred, the more commonly used helical gears approximate the shape of hyperboloidal gears sufficiently closely to permit the use of helical gears.

In conventional systems using cylindrical rolls, it is usual to employ lower or driven rolls of steel suitably fluted and upper or idling rolls of rubber both for the feeding and for the drafting. I have used the same combination of materials for my experiments on hyperboloidal spinning, but my invention is not to be construed as being in any way restricted to such materials. For example, I have succeeded in obtaining satisfactory results by using steel for both the upper and lower rolls of the drafting pair of hyperboloids, provided that the working surfaces of such hard rolls are suitably roughened, e. g., by "schreinerling." In fact, hard surfaced rolls for both upper and lower rolls of the drafting pair of hyperboloids appear to be much more stable in their action than rolls of softer material like rubber or rubber-like plastics. In lieu of roughening the surface of the roll material itself in order to provide a surface having greater friction with roving passed therebetween, when the roll material employed is steel or is any other material of such hardness as to maintain the hyperboloidal drafting rolls out-of-contact with each other during drafting, a similar effect can be obtained by surfacing the roll material with a thin layer of softer material such as rubber or a plastic. When the roll material is hard, such as roughened steel or such as steel coated with a thin layer of a softer material such as rubber or plastic, I prefer to employ hyperboloidal rolls which are relatively narrow as compared with the draft rolls used in conventional systems or as compared with the practice of my invention using hyperboloidal rolls composed of a soft material such as rubber.

While apparatus according to the embodiments of my invention shown in Figs. 9 to 16 comprises weighting means specially provided for imposing load on the upper braces of feed rolls and draft rolls, it is not in all cases necessary to employ such special weighting or other load imposing means. Thus, in the constructions shown, the weight of the upper roll braces and the mounting means therefor, e. g., in Fig. 9 the braces of rolls 55A—56A and 49A—50A, the castings 67 and 69, and the rod 71, may be sufficient to provide the necessary load on roving passing between the upper and lower hyperboloids of the mating roll pairs. This is especially the case when the hyperboloidal rolls present a surface such as rubber that produces relatively high friction with the roving and when the upper rolls as well as the lower rolls are positively driven. In such cases it is apparent that the weight of upper roll braces and the mounting means therefor constitute loading means for urging the rolls of the upper braces toward the respective mating rolls of the lower braces. However, the employment of loading means effective

in accordance with the constructions shown in Figs. 9 and 16 is preferable in that the amount of load may be more readily adjusted to meet varying requirements, while at the same time avoiding the necessity for manufacturing the upper hyperboloids and the mounting means therefor to predetermined weight requirements.

The diameter of a hyperboloidal surface of revolution is a minimum at the gorge circle and increases according to a parabolic law as one goes away from the gorge circle in a direction parallel to the axis. The rate of change of diameter is very small at first and increases more rapidly as the distance from the gorge circle increases, in accordance with said parabolic law. If the angle of the hyperboloids is not too large, then, for small distances on either side of the gorge circle, the change in diameter of each hyperboloid is very small. Hence, as is well known in the spinning art, I can cause the roving to oscillate over this small distance so as to distribute the wear on the rolls. Alternatively, I can oscillate one of the hyperboloids of the pairs of hyperboloidal rolls along a generator thereof over a short distance on either side of its gorge circle without appreciably affecting the rate of feed or the rate of draft. By thus oscillating one of the hyperboloids of each pair over a short distance on each side of its gorge circle, I can distribute the wear on the rolls to a material extent. This oscillation can be imparted, for example, by oscillating in the proper direction either the shafts on which the lower rolls are mounted or the shaft on which the upper rolls are mounted. The rate of oscillation is slow relatively to the feed.

While this invention has been described in connection with certain specific embodiments and examples, it is to be understood that this has been done for purposes of illustration and that this invention comprises features which are preferably availed of in combination for the purposes herein stated but which may be availed of separately and that the practice of this invention may be varied within the scope thereof as governed by the language of the following claims as construed in the light of the foregoing description.

I claim:

1. A method of drafting a stretch of roving which comprises the step of subjecting said roving to a long draft of at least about 4 to 1 by drawing said roving across a stretch not exceeding substantially three fiber lengths while subjecting said roving in the region of minor length adjacent the end of said stretch toward which said roving is drawn to a false twist in excess of that permitting substantial drafting of the fibers in said region, said false twist in excess of that permitting substantial drafting being localized in said region by said long draft and the fibers of said roving being drawn into said region of false twist wherein said false twist is in excess of that permitting substantial drafting, from the balance of said stretch of greater length merging therewith in which there is diminishing twist away from said region permitting said long drafting of said roving.

2. A method of drafting a stretch of roving comprising the step according to claim 1 and wherein the roving immediately prior to being fed into said stretch is subjected to a false twist in the same direction as the false twist to which said roving is subjected in said region adjacent the end of said stretch.

3. A method of drafting a stretch of roving

comprising the step of claim 1 wherein said long draft is at least 10 to 1.

4. In apparatus for drafting roving, a pair of hyperboloidal rolls comprising an upper roll and a lower roll, an adjacent pair of hyperboloidal rolls likewise comprising an upper roll and a lower roll, a common shaft upon which both upper rolls of said pairs are mounted in dumb-bell fashion, and a pair of spaced parallel shafts on one of which one of said lower rolls is mounted and on the other of which the other of said lower rolls is mounted, the spacing between said parallel shafts and the angle made by said common shaft with said parallel shafts being such that the upper roll of each of said pairs mates properly with the corresponding lower roll.

5. In apparatus for drafting roving, two adjacent pairs of hyperboloidal rolls, one roll of one pair and one roll of the other pair being carried on a common shaft, and the remaining rolls of said pairs being carried by spaced parallel shafts, a common support for said rolls carried by said common shaft, and means permitting movement of said support and the rolls carried thereby for urging same toward said rolls carried by said spaced parallel shafts with substantially equal distribution of load between each of said pairs of rolls while maintaining the gorge circles of said pairs of rolls in substantially opposed relation.

6. Apparatus for drafting roving comprising two adjacent pairs of hyperboloidal rolls, the rolls of each pair being rotatably mounted for rotation about axes disposed at an angle which is essentially the same for each pair of rolls, the axis of rotation of one roll of one of said pairs being parallel to and spaced from the axis of rotation of one roll of the other pair, and the remaining rolls of said pairs being rotatable about a common axis disposed at said angle with respect to said spaced parallel axes.

7. Apparatus for drafting roving according to claim 6 wherein said rolls rotatable about a common axis are carried by a common shaft having a support therefor located between said rolls.

8. Apparatus for drafting roving according to claim 6 wherein said rolls rotatable about spaced parallel axes are carried by spaced parallel rotatable driven shafts and are mounted for rotation with said shafts, and which comprises a common shaft for carrying said rolls rotatable about a common axis, a support for said common shaft located between the said rolls carried thereby, means for mounting said support adapted to afford bodily and rocking movements thereof for permitting variations in the spacing of the rolls of said respective pairs while maintaining the gorge circles of the rolls of each of said pairs in substantially opposed relation, and means for urging said support toward said parallel shafts to maintain roving in frictional contact with and between said rolls carried by said common shaft and said rolls carried by said spaced parallel shafts.

9. Apparatus for drafting roving according to claim 6 wherein said rolls of said pairs which are rotatable about spaced parallel axes are carried by a common support located between said rolls.

10. Apparatus for drafting roving according to claim 6 wherein said rolls rotatable about a common axis are mounted on a common driven shaft for rotation therewith, and which comprises a common support for said rolls rotatable about said spaced parallel axes, means for mounting said support adapted to afford bodily and rocking movements thereof for permitting variations in the spacing of the rolls of said respective pairs

while maintaining the gorge circles of the rolls of each of said pairs in substantially opposed relation, and means for urging said support and the rolls carried thereby toward said rolls carried by said common shaft to maintain roving in frictional contact with and between said rolls carried by said support and said rolls carried by said common shaft.

11. In apparatus for drafting roving, two adjacent pairs of hyperboloidal rolls, one roll of each pair being mounted on a common shaft and the remaining rolls of said pairs being carried by a common support for rotation about spaced parallel axes, and means permitting movement of said common support and the rolls carried thereby for urging same toward said rolls carried by said common shaft with substantially equal distribution of load between each of said pairs of rolls while maintaining the gorge circles of said pairs of rolls in substantially opposed relation.

12. Apparatus for drafting roving which comprises two adjacent pairs of mating rotatably mounted hyperboloidal rolls, one roll of one of said pairs and one roll of the other of said pairs constituting a brace of rolls wherein the axis of rotation of one of said rolls is parallel to and spaced from the axis of rotation of the other roll, and the remaining rolls of said pairs constituting a second brace of rolls the axis of rotation of each of which makes the same angle with the axis of rotation of each of the rolls of the other brace, and common mounting means for the rolls of one of said braces of rolls adapted to maintain the gorge circles of the rolls of said brace in substantially opposed relation with the gorge circles of the rolls constituting said other brace for frictional contact with roving therebetween.

13. Apparatus for drafting roving according to claim 12 which comprises two additional adjacent pairs of hyperboloidal rolls according to those defined in claim 12 and arranged in tandem therewith.

14. Apparatus for drafting roving which comprises two adjacent pairs of mating rotatably mounted hyperboloidal rolls, one roll of one of said pairs and one roll of the other of said pairs constituting a first brace of rolls wherein the axis of rotation of one of said rolls is parallel to and spaced from the axis of rotation of the other roll, and the remaining rolls of said pairs of rolls constituting a second brace of rolls the axis of rotation of each of which makes the same angle with the axis of rotation of each of the rolls in said first brace of rolls, common mounting means for carrying one of said braces of rolls, and means permitting movement of said common mounting means and said brace of rolls carried thereby for urging same toward the rolls constituting said other brace with substantially equal distribution of load between each of said pairs of rolls.

15. Apparatus for drafting roving which comprises two adjacent pairs of mating hyperboloidal rolls, each roll rotatably mounted about its axis in substantially opposed relation to its mate at the gorge circles thereof, one roll of one of said pairs and one roll of the other of said pairs constituting a first brace of rolls wherein the axis of rotation of one of said rolls is parallel to and spaced from the axis of rotation of the other roll, and the remaining rolls of said pairs of rolls constituting a second brace of rolls, said braces of rolls being arranged with the generator of contact of one mating roll pair parallel to the gen-

erator of contact of the other mating roll pair and with the axes of rotation of the rolls of one brace fixed, a common support for the rolls of the other brace adapted to fixedly determine the axes of rotation of the rolls in said brace relatively to said support, mounting means for said support which allows rocking movements of said support about an axis substantially parallel to the direction of draft and substantially equally distant from the locus of the opposed gorge circles of the respective pairs and which permits movement of said support and the brace of rolls carried thereby for urging same toward the other brace of rolls.

16. Apparatus for drafting roving which comprises a first set of two adjacent pairs of mating rotatably mounted hyperboloidal rolls, a second set of two adjacent pairs of mating rotatably mounted hyperboloidal rolls arranged with each pair thereof in tandem to each pair respectively of said first set for sequential action on roving passed therebetween, in each set there being one roll of one pair disposed with its axis of rotation parallel to and spaced from the axis of rotation of one roll of the other pair and each of the remaining rolls of said pairs being rotatable about an axis disposed at the same angle with respect to said spaced parallel axes, four rolls of said first and second sets having their axes of rotation disposed substantially in one plane and constituting a first group and the other four rolls of said first and second sets having their axes of rotation disposed substantially in another plane in parallel spaced relation to said first plane and constituting the second group, common carriage means for carrying the rolls of one of said groups, and means for urging said common carriage means and the rolls carried thereby toward the rolls of the other group while maintaining the gorge circles of each pair of rolls in substantially opposed relation.

17. Apparatus for drafting roving according to claim 16 wherein the distance from the nip between the pairs of hyperboloidal rolls in said second set to the nip between the hyperboloidal rolls of the first set is of the order of magnitude not greater than three fiber lengths and wherein said first and second sets are operatively arranged for subjecting roving passing from the hyperboloidal rolls of said first set to the hyperboloidal rolls of said second set to a long draft in the stretch between the aforesaid nips, the rolls of said second set being adapted to impart twist to roving in the region of the immediate neighborhood of the nip therebetween sufficient to prevent substantial drawing of the fibers in said region while permitting long draft of the fibers in the portion of said stretch more adjacent the nip between the rolls of said first set wherein less twist occurs.

18. Apparatus for drafting roving which comprises two adjacent pairs of mating rotatably mounted hyperboloidal rolls, one roll of one of said pairs and one roll of the other of said pairs constituting a first brace of rolls wherein the axis of rotation of one of said rolls is parallel to and spaced from the axis of rotation of the

other roll, and the remaining rolls of said pairs constituting a second brace of rolls the axis of rotation of each of which makes the same angle with the axis of rotation of each of the rolls of the other brace, a shaft equally spaced from the locus of the opposed gorge circles of the respective pairs whose longitudinal axis is disposed normally to the bisector of said angle in a plane substantially parallel to the plane of the lines of contact of said pairs of rolls, a support carried by said shaft which is rockable about said axis of said shaft in fixed relation to the longitudinal extent of said shaft, means for rotatably carrying the rolls of one of said braces of rolls by said support with the gorge circles thereof substantially opposed respectively to the gorge circles of the rolls of the other brace, means for mounting said shaft to permit movement thereof limited to non-axial movement normal to said plane, and means for imposing force applied in a direction substantially intersecting the axis of said shaft and effective for urging the brace of rolls carried by said support toward the other brace of rolls with substantially equal distribution of load between the rolls of said brace carried by said support.

19. Apparatus for drafting roving according to claim 18 wherein there is a second set of two adjacent pairs of hyperboloidal rolls arranged in tandem with the first set of hyperboloidal rolls, said second set of adjacent pairs of hyperboloidal rolls being arranged in braces as defined for the aforesaid braces of said first set, the rolls of one of the braces of said second set being carried by a second support which also is carried by said shaft and which is rockable about the longitudinal axis of said shaft in fixed relation to the longitudinal extent of said shaft, and wherein said means for imposing force is effective to urge the rolls of the braces of said first and second sets carried by said supports therefor toward the other rolls of the pairs in said sets with equal distribution of load between the pairs of each set and with predetermined distribution of load between the respective sets.

BENJAMIN LIEBOWITZ.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
32,923	Partridge	July 30, 1861
1,772,109	Quaas	Aug. 5, 1930
1,922,949	Harris	Aug. 15, 1933
2,246,474	Stahlecker	June 17, 1941

FOREIGN PATENTS

Number	Country	Date
28,325	Great Britain	July 2, 1908
275,875	Italy	July 5, 1930
324,540	Great Britain	Jan. 30, 1930
502,216	Germany	July 11, 1930
588,401	Germany	Nov. 18, 1933
769,512	France	Aug. 28, 1934