Oct. 15, 1957 K. AVERY 2,809,401

PROCESS OF MAKING WORSTED TYPE YARN

Filed Dec. 2, 1955 5 Sheets-Sheet 1

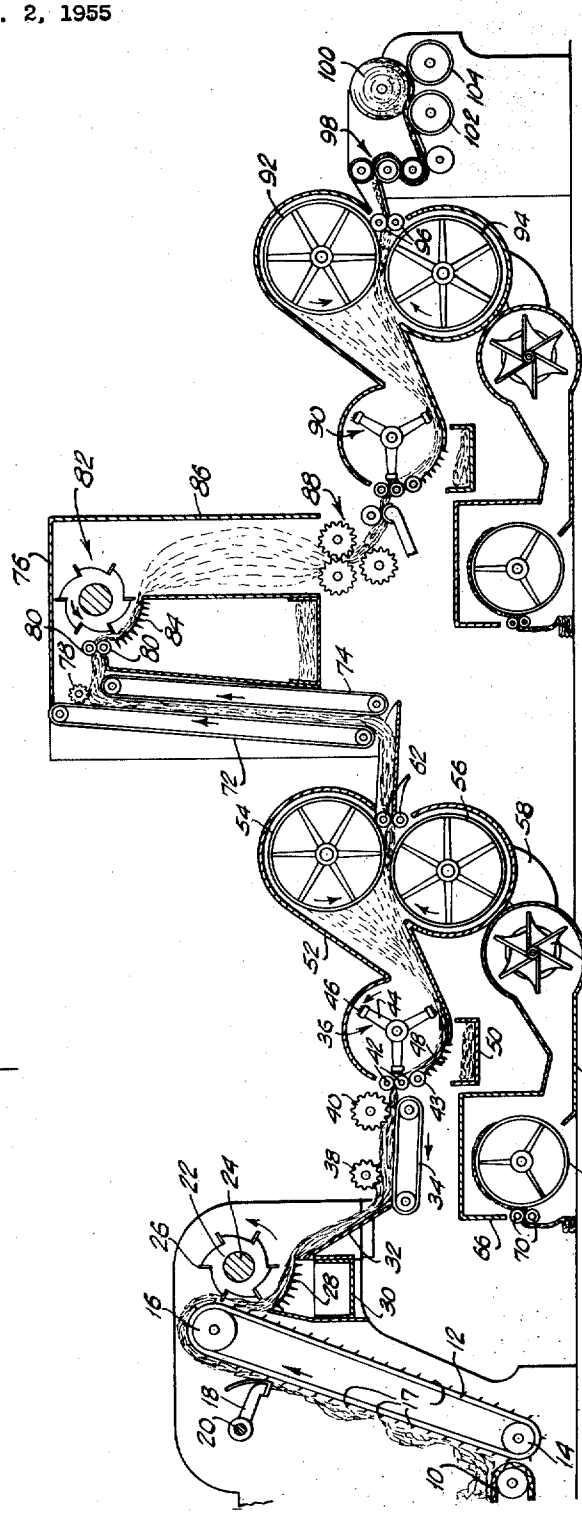


Fig. 1.

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PROCESS OF MAKING WORSTED TYPE YARN

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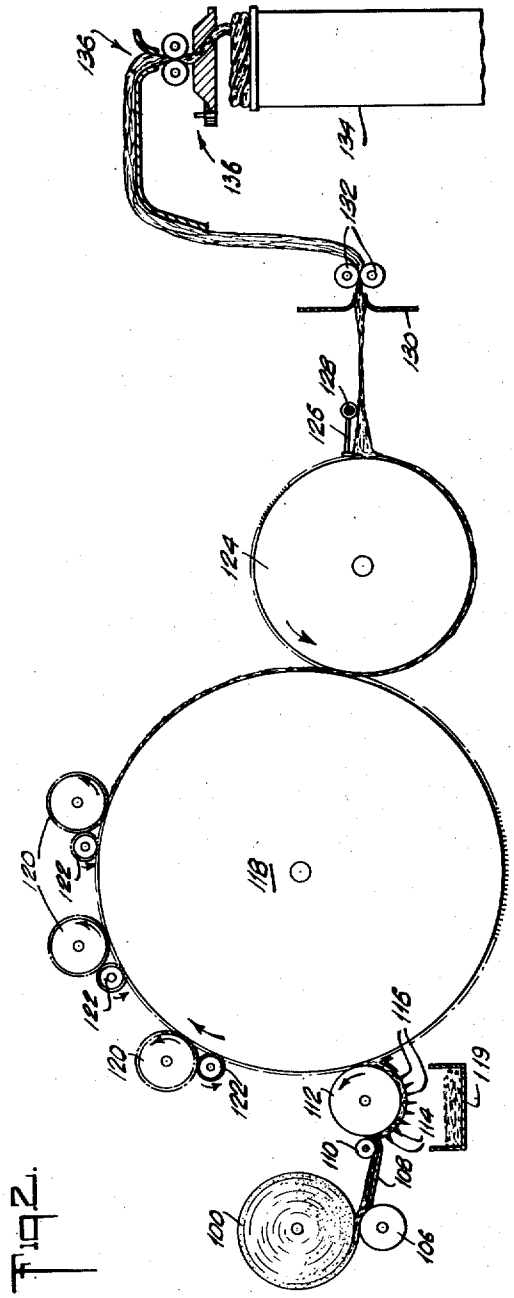


Fig. 2.

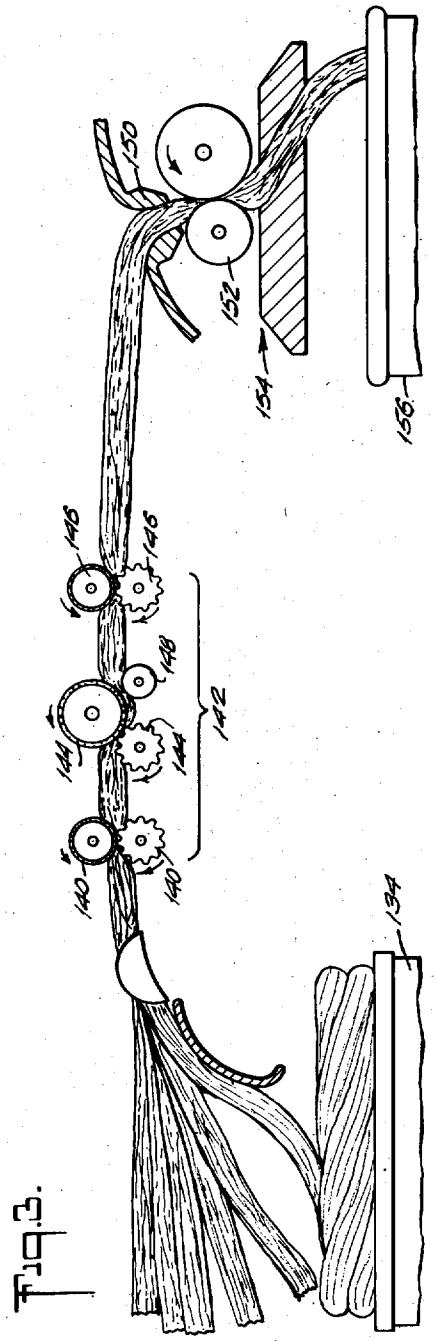


Fig. 3.

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Oct. 15, 1957 K. AVERY 2,809,401

PROCESS OF MAKING WORSTED TYPE YARN

Filed Dec. 2, 1955 5 Sheets-Sheet 3

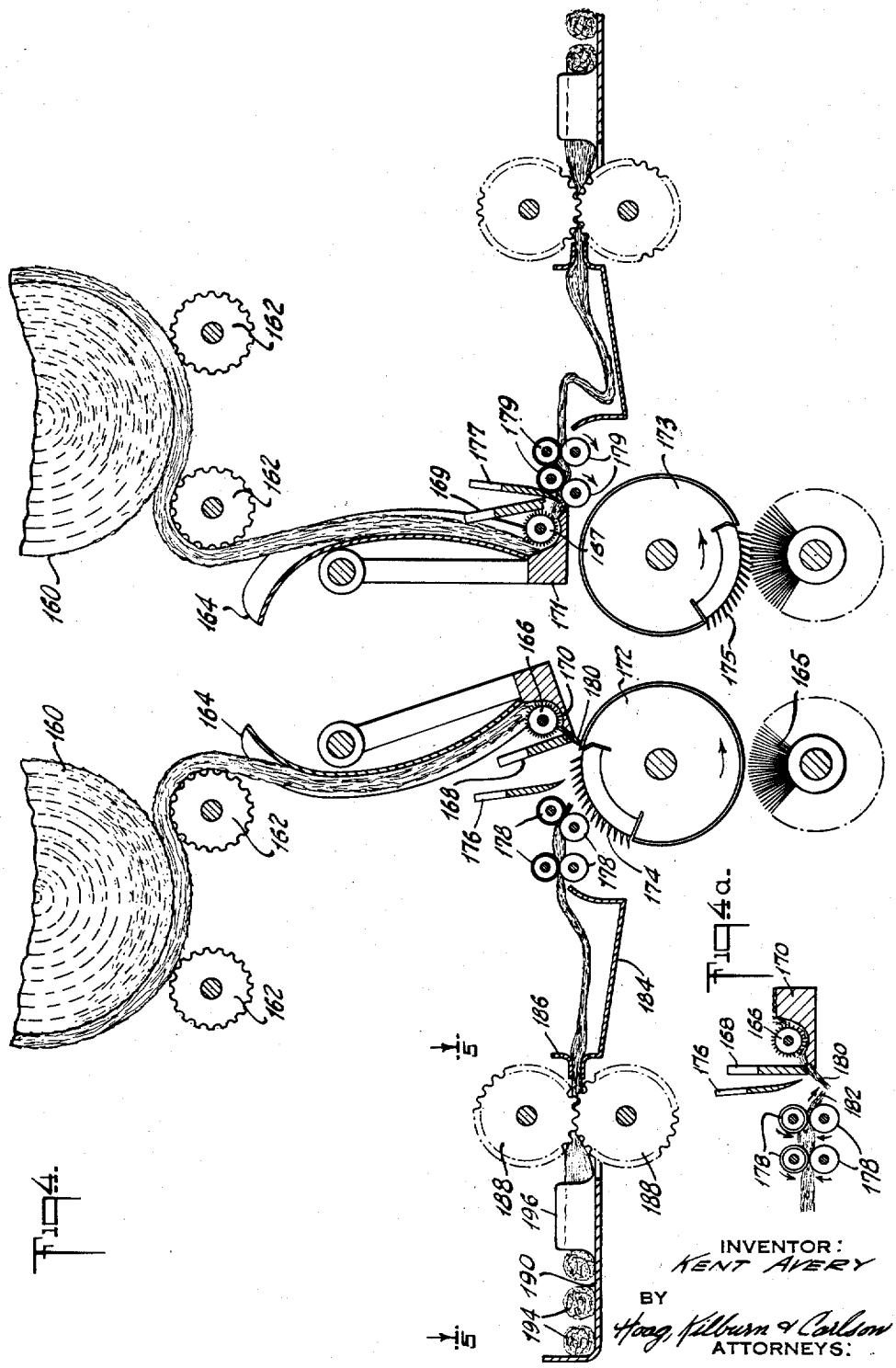


Fig 4.

Fig 4a.

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PROCESS OF MAKING WORSTED TYPE YARN

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Fig. 5.

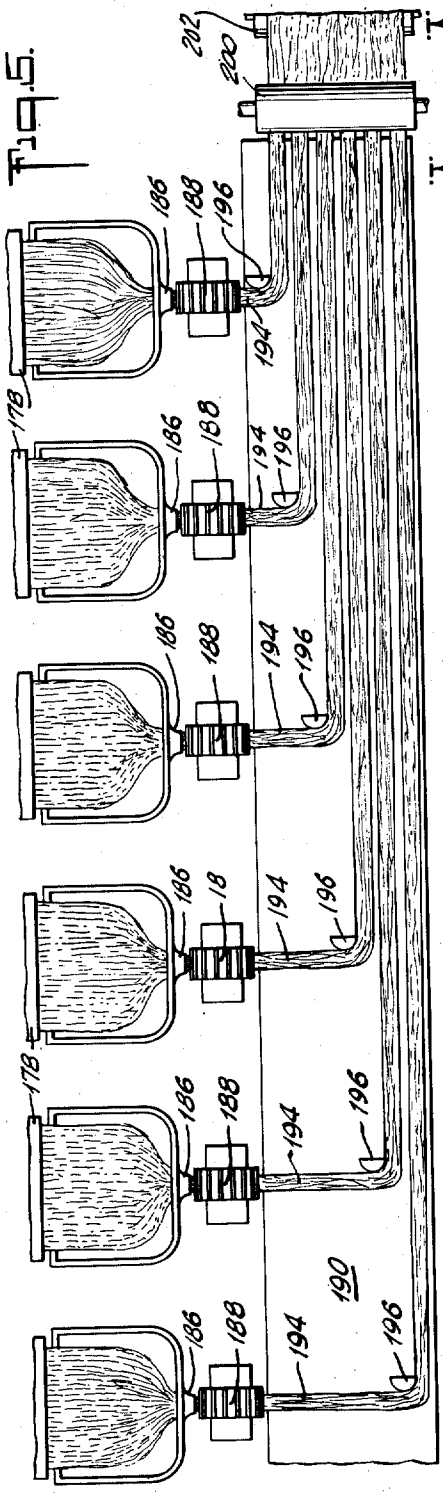
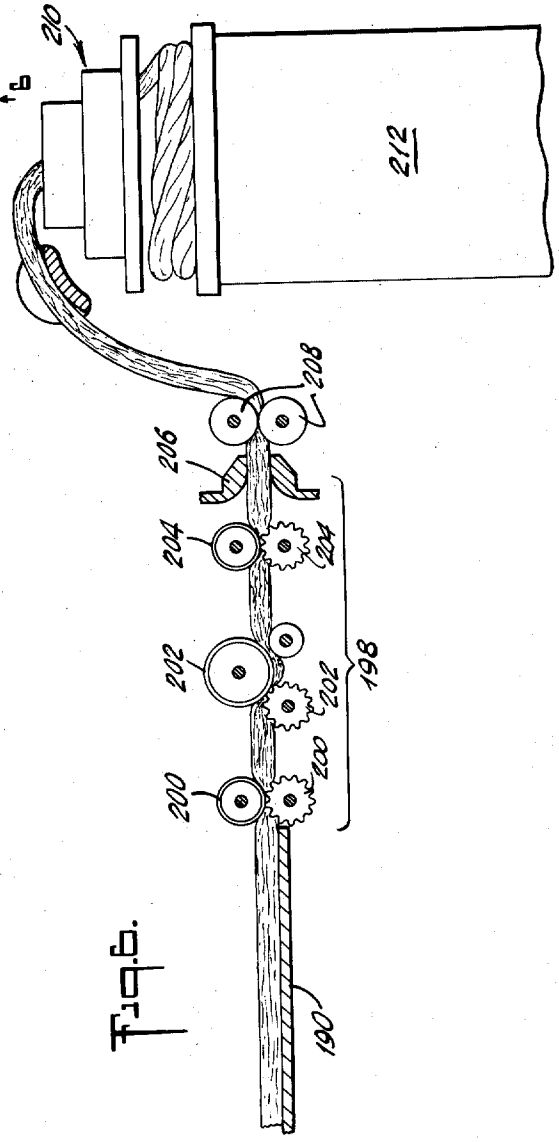


Fig. 6.



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Oct. 15, 1957 K. AVERY 2,809,401

PROCESS OF MAKING WORSTED TYPE YARN

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Fig. 7.

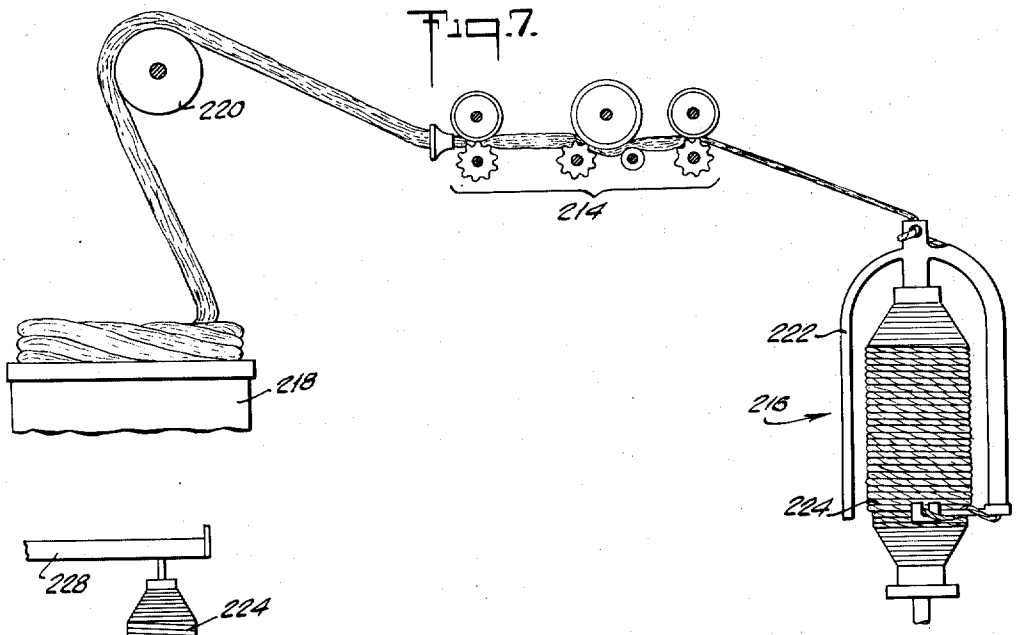
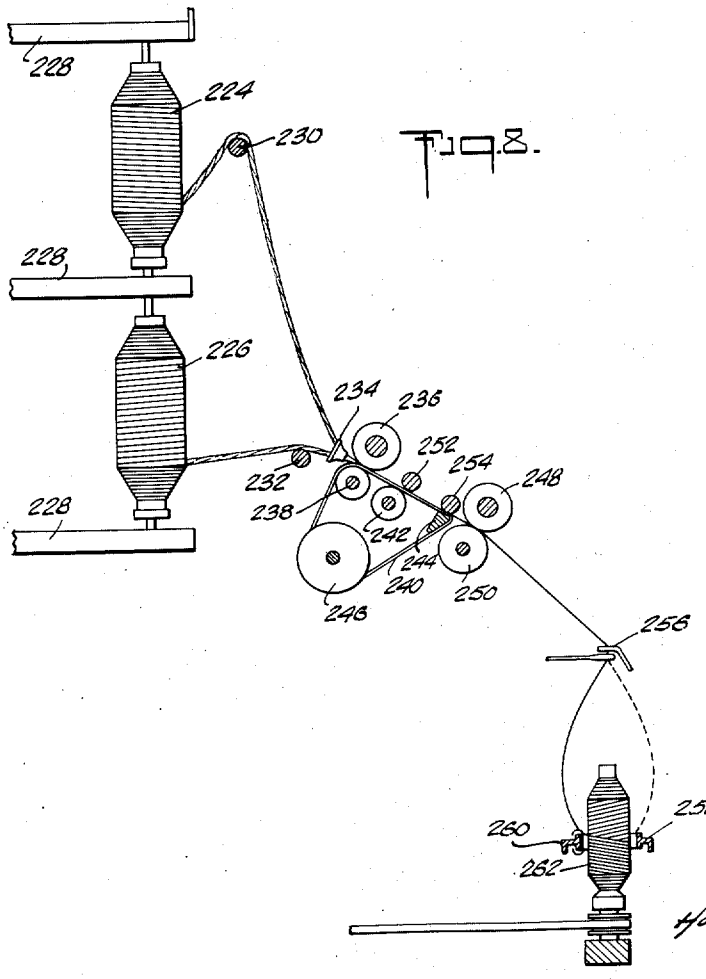


Fig. 8.



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United States Patent Office 2,809,401 Patented Oct. 15, 1957

2,809,401

PROCESS OF MAKING WORSTED TYPE YARN

Kent Avery, New York, N. Y., assignor to Bachmann Uxbridge Worsted Corporation, Uxbridge, Mass., a corporation of Massachusetts

Original application February 18, 1953, Serial No. 337,599. Divided and this application December 2, 1955, Serial No. 550,571

2 Claims. (Cl. 19—65)

This invention relates to worsted top and yarns suitable for use in the manufacture of wearing apparel including high quality worsted type fabrics. This application is a division of my copending application Serial No. 337,599, filed February 18, 1953, now abandoned, which was a continuation-in-part of my application Serial No. 670,752, filed May 18, 1946, now abandoned.

Existing standard practices or methods for making worsted yarn for wearing apparel, including the Bradford and French systems, employ long wool fibers, often referred to as "worsted wools," comprising fibers which run up to from 5" to 7" or more in length. Of these fibers approximately 65–80% by weight are over 2" in length and approximately 30–65% by weight are over 2½" in length. Such long fiber wools are substantially more expensive than the shorter fiber wools used in making the worsted type yarn as disclosed herein.

It is a principal object of the present invention to provide worsted top and yarn which compares favorably with high quality worsted top and yarn presently commercially available and which is unique in its short-fiber-length distribution.

Another object of the invention is to provide high quality worsted yarn which has the advantage of economy both in the raw material employed and in the processing of the fibers into yarn, and from which worsted top fabrics may be made effecting a substantial economy over fabrics of substantially equal quality made from standard "worsted wools."

Another object of the invention is to provide a simple, practical and efficient process for the production of worsted yarn.

Other objects of the invention will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of each of said steps to one or more of the others thereof, all as will be pointed out in the following description, and the scope of the application of which will be indicated in the following claims.

The invention will best be understood if the following description is read in connection with the drawings, in which,

Figure 1 is a diagrammatic elevation of the picker;

Figure 2 is a diagrammatic elevation of the card and associated feed and discharge apparatus;

Figure 3 is a diagrammatic elevation of a draw frame used in the first drawing operation;

Figure 4 is a diagrammatic elevation of the comber;

Figure 4ª is a diagrammatic detail view illustrating the joining of the trailing edge of the previously combed lap and the leading edge of the newly combed fringe, proportions being exaggerated in this view for clearness;

Figure 5 is a diagrammatic plan view of the discharge of the comber showing the manner in which slivers from the several combing heads of the machine are combined for drafting as they leave the comber;

Figure 6 is a diagrammatic elevation of a draw frame used in carrying out a drafting operation subsequent to the combing step;

Figure 7 is a diagrammatic elevation of roving apparatus and also shows a draw frame for carrying out a drafting operation just preceding the roving step; and

Figure 8 is a diagrammatic elevation of apparatus used in the spinning step of the process.

Wool suitable for use as a raw material in my process, may, for example, be the noil obtained as a by-product from the combing of worsted wools, or "woolen wools" such as "pieces," "crutchings" and "shortings" can be used. Suitable short-fiber wools are obtained from sheep that have been clipped more frequently than once a year or wools that have been pulled from the pelts of slaughtered sheep. By my process short-fiber scoured wools of the type referred to above may be made into worsted top and yarn of good quality. The process comprises fewer operations than standard processes of making worsted yarn, and yarns made by my process and having the short-fiber-length distribution taught in this disclosure, can be produced at lower cost than the longer-fiber yarns made by the prior art processes. The resulting worsted top and yarn has a strength and appearance comparable with the longer-fiber worsted yarns of the prior art. Moreover fabrics made from yarns produced by my process have strength, appearance and wearing quality substantially equal to those of fabrics produced from the customary long fiber worsted yarns.

In one of its broader aspects the present process comprises converting short-fiber wool top into spun worsted yarn by the steps of picking, carding, drawing, combing, drawing, roving and spinning. It should be noted that various operations such as gilling and back-washing ordinarily employed in the processing into worsted yarns of long-fiber wools can be eliminated in the present process. In standard worsted manufacture it is customary to control the shorter-than-maximum-length fibers during drafting by fiber carriers such as "gills" or "porcupines" but they are not necessary in the present process, and hence this process permits the use of simpler and less expensive machinery as well as eliminating a number of steps presently employed in producing worsted yarn.

In making my worsted top and yarn I have had very

satisfactory results using wool fibers at least 50% of which are not longer than 2" and at least 70% are not longer than 2½".

In the following schedules 1 and 2 the fiber distribution of wool top used in manufacturing worsted top and yarn of 64/70 grade by the Avery process, which is the subject of this application, is compared with the fiber distribution of the three different types of wool top known in the industry as "Warp" type, "Average" type and "French" type, which have long been used in making worsted yarn of 64/70 grade. The "Warp" type and "Average" type of top are processed by Bradford and other known worsted systems, and the "French" type is processed by the known French system. The fibers comprising each type of wool top are divided into groups according to length, each group comprising a range of ½", and the comparison is by groups in terms of percentages by weight. These schedules are prepared from records of the Barre Wool Combing Co., Ltd., South Barre, Mass., as representative of the average fiber distribution of the wool fiber stock used in the Avery process for making worsted top and yarn of grade 64/70 and of the wool fiber stock used in making worsted top and yarn of the said grade by the aforesaid known systems.

Schedule 1 gives the percent by weight in each ½" length group:

Schedule 1

Length of Fibers—Groups of ½"	Percent by Weight			
	Warp Type	Average Type	French Type	Avery Type
Mean Length	3-3½"	2½-2¾"	2-2½"	1½-1¾"
7-6.5	.06	0	0	0
6.5-6	.06	0	0	0
6-5.5	.28	0	0	0
5.5-5	.89	.08	0	0
5-4.5	2.56	.60	.06	0
4.5-4	8.33	2.49	.40	0
4-3.5	16.01	9.42	2.99	0
3.5-3	20.10	17.35	11.62	.68
3-2.5	19.36	21.41	21.67	4.87
2.5-2	14.43	21.17	23.07	21.84
2-1.5	10.03	13.79	20.03	36.06
1.5-1	5.36	8.67	13.31	26.34
1-0.5	1.88	4.09	5.84	9.0
0.5-0	0.65	0.93	1.01	1.21

Schedule 2 gives the percentages by weight of the fibers which do not exceed a stated length i. e. what percent of the total fibers of a given type of wool top do not exceed 1½"; what percent do not exceed 2"; what percent do not exceed 2½" in length etc.

Schedule 2

Length of Fibers—Groups of ½"	Percent by Weight			
	Warp Type	Average Type	French Type	Avery Type
Mean Length	3-3¼"	2½-2¾"	2-2¼"	1½-1¾"
7" or less	100			
6.5" or less	99.94			
6" or less	99.88			
5.5" or less	99.60	100		
5" or less	98.71	99.92	100	
4.5" or less	96.15	99.32	99.94	
4" or less	87.82	96.83	99.54	
3.5" or less	71.81	87.41	96.55	100
3" or less	51.71	70.06	84.93	99.32
2.5" or less	32.35	48.65	63.26	94.45
2" or less	17.92	27.48	40.19	72.61
1½" or less	7.89	13.69	20.16	36.55
1" or less	2.53	5.02	6.85	10.21
½" or less	0.65	0.93	1.01	1.21

The following Schedules 3 and 4 are prepared in the same way as Schedules 1 and 2 but relate to wool fiber stock used in making worsted yarn, and worsted top in the case of the Avery process, of grade 62:

Schedule 3

Length of Fibers—Groups of ½"	Percent by Weight			
	Warp Type	Average Type	French Type	Avery Type
Mean Length	3-3½"	2½-2¾"	2-2½"	1½-1¾"
7.5-7	0.20			
7-6.5	0.40			
6.5-6	1.90			
6-5.5	3.40	0.70		
5.5-5	5.80	1.60	0.40	
5-4.5	6.80	5.10	1.30	
4.5-4	10.30	10.10	3.80	
4-3.5	12.40	15.40	7.60	0.20
3.5-3	13.60	19.50	15.20	0.80
3-2.5	12.80	17.80	23.10	4.50
2.5-2	14.60	14.20	20.10	20.60
2-1.5	10.10	9.50	13.40	34.70
1.5-1	5.40	3.70	8.90	27.60
1-0.5	2.00	1.50	5.10	10.60
0.5-0	0.30	0.40	1.10	1.00

Schedule 4

Length of Fibers—Geoups of ½"	Percent by Weight			
	Warp Type	Average Type	French Type	Avery Type
Mean Length	3-3½"	2½-2¾"	2-½"	1½-1¾"
7.5" or less	100			
7" or less	99.8			
6.5" or less	99.4			
6" or less	97.5	100		
5.5" or less	94.1	99.3	100	
5" or less	88.3	97.7	99.6	
4.5" or less	81.5	92.6	98.3	
4" or less	71.2	82.5	94.5	100
3.5" or less	58.8	66.6	86.9	99.8
3" or less	45.2	47.1	71.7	99.0
2.5" or less	32.4	29.3	43.6	94.5
2" or less	17.8	15.1	28.5	73.9
1.5" or less	7.7	5.6	15.1	39.2
1" or less	2.3	1.9	6.2	11.6
½" or less	.3	.4	1.1	1.0

While there is some slight variation between different batches of fiber employed the above percentages given are representative of the fiber distribution in the Bradford and French prior art processes in making worsted yarn. While it is impossible for applicant to definitely state the range of such variations for all manufacturers it is believed that a range having a variation of approximately 5%–10% of the stated percentages would be acceptable, the acceptable variable being proportional to the length of the fibers.

It will be seen that as given in the above schedule wool fibers 1½" or less, comprise only 20.16% by weight of the total fibers in making worsted yarn by the French system; and only 7.89–13.69% by weight of the total fibers in making worsted yarn by the Bradford system; but comprise over 36% by weight of the total fibers used in making worsted yarn according to the Avery system; and whereas only 40.19% of the fibers used in the French system are 2" or less, and only 27.48%–17.92% of the fibers used in the Bradford system are 2" or less, over 72% of the fibers used in the Avery system are not over 2" i. e. 2" or less.

In making my worsted top and yarn I preferably use short wool fibers 30% or more of which by weight do not exceed 1½" in length and 65% or more of which do not exceed 2" in length, and 85% or more of which do not exceed 2½" in length.

In making worsted top and yarn of 64/70 grade I have obtained very good results using short fibers 99.6% of which do not exceed 3" in length; 41.8% by weight do not exceed 1½"; 80.1% by weight do not exceed 2"; and 97.6% by weight do not exceed 2½" in length. I have used stock in which the percent by weight of the fibers which are 1½" or less are greater than in the above ex-

ample. I have also successfully used stock in which the percent by weight of the fibers which are 2½" or less in length has been 95.2%; the percent by weight of fibers 2" or less has been 68.2%; and the percent by weight of fibers 1½" or less has been 28%.

The following table shows the distribution of both average and maximum length stock I have used in producing worsted top and yarn of 64/70 grade:

Average		Maximum	
Fiber length	Wt. in Percent	Fiber Length	Wt. in Percent
4.5–5.0	0	4.5–5.0	
4.0–4.5	0	4.0–4.5	
3.5–4.0	0	3.5–4.0	0.1
3.0–3.5	0.4	3.0–3.5	0.5
2.5–3.0	2.0	2.5–3.0	5.2
2.0–2.5	17.5	2.0–2.5	31.4
1.5–2.0	38.3	1.5–2.0	34.8
1.0–1.5	32.0	1.0–1.5	22.0
.75–1.0	6.6	.75–1.0	4.0
.50–.75	2.5	.50–.75	1.4
.25–.50	0.5	.25–.50	0.5
.00–.25	0.2	.00–.25	0.1
Total	100.0	Total	100.0

The following fiber distribution is representative of yarn I have made of 60/62 grade: 39.2% by weight of 1½" or less; 73.9% by weight of 2" or less, and 94.5% by weight of 2½" or less. I have used stock having a larger percentage of the fibers of said lengths, and I have also successfully used stock in which the percent by weight of the fibers which are 2½" or less has been 93.6%; in which the fibers 2" or less has been 56%, and in which the fibers 1½" or less has been 26.5%.

The following table shows the distribution representative of both average and maximum length stock I have used in producing worsted top and yarn of 60/62 grade:

Average		Maximum	
Fiber length	Wt. in Percent	Fiber Length	Wt. in Percent
4.5–5.0		4.5–5.0	
4.0–4.5		4.0–4.5	
3.5–4.0	0.2	3.5–4.0	0.2
3.0–3.5	0.8	3.0–3.5	0.8
2.5–3.0	4.5	2.5–3.0	5.6
2.0–2.5	20.6	2.0–2.5	37.6
1.5–2.0	34.7	1.5–2.0	29.3
1.0–1.5	27.6	1.0–1.5	19.9
.75–1.0	7.7	.75–1.0	4.6
.50–.75	2.9	.50–.75	1.5
.25–.50	0.7	.25–.50	0.4
.00–.25	0.3	.00–.25	0.1
Total	100.0	Total	100.0

The present method taught herein avoids the processing of fibers in bulk, such as occurs in the manufacture of "worsted top" which commonly weights 250 to 230 grains per linear yard. With the present process, the product is handled as a relatively light-weight sliver averaging about 40 grains per yard and at no time exceeding one hundred grains per linear yard. By avoiding the heavy bulk characteristic of prior processes, a satisfactory yarn can be produced with fewer reduction steps.

In accordance with a preferred embodiment wool top, comprising fibers the longest of which are on the order of three inches, and more than 50% of which by weight, and preferably more than 65%, are not over 2", i. e. 2" or less in length, is prepared for carding by being fed through a picker, similar in some respects to a cotton picker, but of modified construction as will be explained. The picking operation opens the wool and removes therefrom residual amounts of dirt, grit and other foreign material and also puts the material into lap form for the subsequent carding operation. It should be noted that worsted wools are not prepared for carding by picking in any of the conventional prior art systems.

The second step of the preferred embodiment of my process is carding, which in accordance with my invention can be carried out on a relatively simple one-cylinder roller card, employing as few as three workers and strippers. The wool is fed into the card in the form of a blanket-like lap as it comes from the picker. Since the wool has been previously opened by the picker, a relatively simple card can be used.

The product of the carding operation is a sliver which is lighter in weight per unit length than is obtained with long-fiber wools and has a smaller relative variation in weight from length to length and therefore requires less subsequent attenuation and "averaging out." The high degree of uniformity of the product of the carding operation is to a considerable extent due to the fact that the wool is fed to the card in lap form and hence the lap feed to the card is an important feature of this process.

Following the carding operation the fiber is subjected to drawing operations both before and after combing. In accordance with my invention, these drawings are carried out on a draw frame using drafting rolls only. As previously pointed out, this drafting operation differs from the corresponding operation of prior processes in that the prior processes used drafting apparatus incorporating gills or porcupines, whereas in the present process, the drafting can be effected by the use of rolls only. The purpose of the first drafting step is to parallelize the fibers as much as possible before combing.

The combing is carried out on a multiple-head comber described more fully hereafter. The machine is preferably so adjusted as to remove only a minimum of short fibers, thus reducing the waste or noil on the combing operation. The comber comprises a number of separate combing heads and the slivers from these separate heads are combined and drawn on the machine by drafting rolls similar to those employed on the draw frame used prior to the combing step. Thus the product of the combing operation is averaged, and is generally superior in evenness, and of less bulk, than the product obtained from the standard worsted combing operation.

The combing operation is followed by a drawing operation, usually two drawing steps, in addition to that which takes place as the product leaves the comber. In none of these drawing operations does this process employ gill boxes, or porcupines, nor does it use "twist" for fiber control. Due to the evenness of the product obtained from the comber, it has been found that two drawing steps subsequent to combing are desirable to produce a product comparable with that previously obtained in worsted manufacture by using five to nine gilling and drawing operations.

The drawing operations are followed by a single roving step and a single spinning step. For these steps I have found it possible to employ high draft roving and spinning frames similar to those used in the cotton and rayon industry but modified as will be described.

Referring to the drawings and particularly to the left-hand side of Figure 1, the raw wool is carried by an endless belt or apron **10** to an elevator **12** which is an endless belt mounted on the sprockets **14** and **16** and driven in the direction of the arrow. The surface of elevator **12** is provided with pins **17** that pick up the wool discharged by conveyor **10** and carry it upwardly. Near the top of elevator **12** there is an oscillating fork **18** that oscillates through a small angle about shaft **20**. The operating end of oscillating fork **18** is spaced a predetermined distance from the adjacent surface of elevator **12** and operates to limit the thickness of the layer of wool that is carried over sprocket **16**. Wool removed by the oscillating fork **18** is thrown downwardly toward the bottom of the elevator and this action serves to open up the wool to some extent.

The layer of wool on elevator **12** passes over the sprocket **16** and is removed from the elevator by a doffer-

beater roll **22** mounted on and driven by shaft **24** in the direction of the arrow and provided with blades **26**. The blades of roll **22** have a higher peripheral speed than the belt of elevator **12** and hence remove the layer of wool therefrom and drive it downwardly along an arcuate grid **28** adjacent to the periphery of roll **22**. The doffing and beating action of the roll **22** further opens up the wool and causes dirt and foreign material therefrom to pass through the interstices in grid **28** and fall into a container **30** which serves to collect these impurities.

From the grid **28** the wool passes down a ramp **32** onto an endless apron **34** which is driven in the direction of the arrow and carries the wool to a three-bladed carding beater generally designated **36**. As the wool is conducted toward the beater by apron **34**, it is held downwardly against the apron by a pair of corrugated press rolls **38** and **40**. At the discharge end of apron **34**, the layer or lap of wool passes between two feed rolls **42** which serve to feed the lap to the beater **36**. The beater comprises three blades **44** which are provided at their outer ends with pins **46**. The blades **44** rotate rapidly and carry the wool from feed roll **42** down over a fringe roll **43** and along an arcuately arranged series of grid bars **48**. Because of the high speed at which they rotate, the blades **44** further open up the wool, and dirt and other foreign matter contained therein pass through the grid bars **48** to a container **50** wherein they are collected. The wool in opened form is drawn through a channel **52** toward a pair of screen rolls **54** and **56** that are driven in the direction indicated by the arrows thereon. The rolls **54** and **56** have a screen surface and are internally evacuated through a conduit **58** by means of a fan **60**. The vacuum produced in the interior of rolls **54** and **56** draws the wool against the screen surfaces of the rolls from which the wool is removed, after passing through the bite between the rolls **54** and **56**, by the draw-off rolls **62**. Material passing through the screen surfaces of rolls **54** and **56** is driven by fan **60** through a channel **64** to a housing **66** containing a screen roll **68** having a fine screen surface. The roll **68** is internally evacuated to cause the fine material suspended in the air to collect on the surface of the roll, and this layer of material is removed by a pair of draw-off rolls **70** and rejected.

From the rolls **62** the wool passes to and between a pair of endless belt elevators **72** and **74** which are driven in the direction of the arrows thereon and by means of which the wool is raised and discharged into a housing **76**. At the top of the elevators, the wool passes between a press roll **78** and the top of elevator **74** and then through feed rolls **80** to a doffer-beater **82** similar to the doffer-beater **24**. The wool is driven downwardly by the doffer-beater **82** along a series of grid bars **84** similar to the bars **28** and is discharged into a compartment **86**. At the bottom of compartment **86** the wool is collected and conducted by a series of rolls generally indicated by the numeral **88** to a carding beater **90** similar to the beater **36**. From beater **90** the wool passes between screen drums **92** and **94** which are provided with a vacuum and waste disposal system similar to that associated with rolls **54** and **56**. The wool is removed from screen drums **92** and **94** by the draw-off rolls **96** and passes between calendar rolls **98** to a wind-up roll **100** which rests on the supporting rolls **102** and **104**.

The wool on the wind-up roll **100** is in blanket or lap form and in the next step of the process is fed in this form to a card in a manner which will now be described.

Referring to Figure 2, the roll **100** is mounted to rest on an idler supporting roll **106** and the lap is drawn over a feed plate **108** by a feed roll **110** and delivered to licker-in roll **112** at a relatively slow rate. The licker-in roll **112** is rotated at high speed in the direction of the arrow thereon and may have a surface speed of about 70 times the speed at which the lap is fed thereto. The surface of the licker-in roll is provided with pins or wires that catch the wool fibers and carry them downward past a pair of mote knives **114** and series of grid ba **116** to the surface of a main carding cylinder **118**. T high speed of the licker-in roll **112** serves to open up t wool considerably, and dirt and foreign materials ther by released from the wool pass through the grid bars 1 to a container **119**.

The main carding cylinder **118** is rotated in the dire tion indicated by the arrow thereon with a peripher speed approximately twice that of the licker-in roll. Tl surface of the carding cylinder is provided with pins wires and since the surface speed of the carding cylind is greater than that of the licker-in roll **112**, the cardi cylinder removes wool fibers from the licker-in roll ar carries them upwardly to a series of three worker rol **120** and stripper rolls **122** located adjacent to the top po tion of the carding cylinder **118**. The worker and stri per rolls **120** and **122** are provided with pins similar those on the surface of carding cylinder **118** and are r tated as indicated by the arrows. The worker rolls 12 rotate at a lower peripheral speed than the main car ing cylinder and remove a portion of the wool from th surface of the carding cylinder. The stripped rolls 12 rotate at a speed intermediate that of the main cardin cylinder and that of the worker rolls and serve to tran fer wool fibers from the worker roll back to the surfac of the carding cylinder again. As a result of this car ing action the wool is further opened and dirt remove therefrom.

At the down-turning side of the carding cylinder 11 there is a doffer roll **124**, the surface of which is pr vided with pins similar to those on the carding cylinde The doffer roll **124** is rotated at a surface speed consi erably less than that of the main carding cylinder an removes wool therefrom. Wool transferred to the doffe roll **124** is in turn removed therefrom by an oscillatin comb **126** oscillatable about a shaft **128**. The remove fibres are drawn through a funnel **130** by a pair of roll **132** and thereby converted into a sliver which is coile into a container **134** by a conventional coiling mechanisn generally designated **136**.

In the next step of my process the slivers produce from the carding operation are drawn in a draw frame il lustrated in Figure 3. As indicated in Figure 3, a num ber of slivers, in this case six, are combined and fed t the first pair of rolls **140** of a draw frame generally des ignated **142**. In the draw frame **142** the wool passe from the roll pair **140** successively through the roll pair **144** and **146**. The successive roll pairs are driven at suc cessively higher speeds and thus the wool is attenuate or drafted as it passes between the roll pairs. Associate with the rolls **144** there is a third roll **148**, the surface of which is spaced a predetermined distance from the surface of roll **144**. The purpose of roll **148** is to control the shorter fibers. It should be noted that the rol pairs **140**, **144** and **146** are relatively closely spaced and that no pins or gill fallers are used, control of the short fibers being obtained solely by close spacing of the rolls. From the rolls **146** the wool passes through a funnel **150** and calendar rolls **152** and is then coiled by a conventional coiling mechanism **154** into a container **156**.

In the next step of my process the wool is combed in a suitable comber, such as that shown in Figure 4 of the drawings. The wool is fed to the comber in the form of a relatively narrow lap made by combining a number of slivers from the preceding drawing operation. A number of these slivers, say twenty for example, can be combined in a conventional lap-winder to produce the feed lap for the comber. Since such a lap winder is well known in the art, it is not illustrated in the drawings.

Referring to Figure 4, a double-sided comber is illustrated wherein the rolls **160** of feed lap are supported on corrugated rolls **162** and the laps are fed downwardly along guide plates **164** to the feed rolls **166** and **167**,

the surfaces of which are provided with pins that engage the lap. It will be noted that the two sides of the comber are identical in construction but do not operate in phase, that is to say, at any given time the two sides of the comber are performing different parts of the combing operation. For convenience the left-hand side of the comber will be described first.

The principal parts of the comber associated with the roll **166** are an upper nipper jaw **168** and a lower nipper jaw **170** which are relatively movable, a rotary comb **172** having the combing needles **174** arranged around a predetermined portion of its periphery, a top comb **176** and the detaching rolls **178**. In general the sequence of operations is as follows: during the period when the nipper jaws **168** and **170** are separated, feed roll **166** is rotated to cause a small amount of the leading end of the lap to pass between the jaws, after which the nipper jaws are brought together to leave a fringe **180** of the lap protruding. The protruding fringe **180** is engaged by the needles **174** of rotary comb **172** as the comb rotates and is combed thereby. The length of the fringe **180** determines the amount of waste or noil combed out. Waste is removed from teeth **174** of comb **172** by a rotary brush **165**.

When the needles **174** have moved beyond the fringe **180**, the feed roll and nipper jaw assembly swings outward to the position shown in Figure 4*a*. At the same time, the detaching rolls **178** are rotated in the direction of the arrows shown in Figure 4*a* to move the previously combed lap back so that the trailing edge **182** thereof is engaged by the fringe **180** that has just been combed. The direction of rotation of rolls **178** is then reversed to draw the trailing edge **182** and newly combed fringe **180** between the detaching rolls. At approximately the same time the nipper jaws open and the top comb is lowered to cause the parts to occupy the position shown at the right side of Figure 4.

Referring particularly to the right-hand side of the comber of Figure 4, the principal parts of this side of the comber are feed roll **167**, upper jaw **169**, lower jaw **171**, rotary comb **173** with needles **175**, top comb **177**, and detaching rolls **179**. With the parts as shown in Figure 4, the detaching rolls rotate in the direction shown by the arrows and feed roll **167** also rotates, but at a slower speed than the detaching rolls. This action causes a portion of the lap to be detached at a point below feed roll **167**. Since the feed roll has a surface provided with spaced projections and since the feed roll is slowly rotating, this detachment is readily effected without breaking of the fibers. The detached portion of the lap is drawn by detaching rolls **179** through the top comb **177** and combed thereby. The feed roll **167** continues to rotate to feed another fringe through the nipper jaws for combing, after which the feed roll stops and the nipper jaws again come together to clamp the trailing end of the fringe for the next combing action.

Reverting to the left side of Figure 4, the combed wool passes through a sliver pan **184** and then through a funnel **186** and corrugated rolls **188** to a channel **190**.

Referring now to Figure 5 of the drawings, this is a diagrammatic plan view of some six combing heads of the type just described and further illustrates the manner in which the combed lap is drawn through funnel **186** to form a sliver and passes between corrugated rolls **188** of each of the combing heads. The resulting slivers designated **194** pass around the guide posts **196** in channel **190** and are combined as feed to draw frame generally designated **198** and particularly shown in Figure 6 of the drawings. Referring to Figure 6 the draw frame **198** is essentially the same as the draw frame **142** of Figure 3 and comprises the closely spaced roll pairs **200**, **202** and **204**. The rolls pairs are rotated at successively increasing speeds to attenuate and draft the fibers. From the draw frame **198**, the drawn sliver passes htrough a funnel **206** and calendar rolls **208** to a coiling mechanism **210** by which it is coiled into a container **212**.

Referring now to Figure 7 of the drawings, the roving apparatus there illustrated comprises a drawing mechanism **214** essentially similar to the draw frames **142** and **198** previously described and a roving spindle generally designated **216**. In accordance with the preferred embodiment of the present invention here being described, the wool sliver is preferably subjected to three drawing operations between the combing and roving steps, the first of these drawing operations being illustrated in Figure 6. The second of these drawing operations is not illustrated in the drawings, but can be carried out on a drawing frame such as frames **142**, **198** and **214** and the product coiled into a container **218** (illustrated in Figure 7).

Still referring to Figure 7, sliver from container **218** is fed over a guide roll **220** and then passes through the paired rolls of draw frame **214** where it is further attenuated. From the draw frame **214** the roving passes to the flyer **222** of the roving spindle **216** and is wound on a bobbin **224** in known manner.

The next step of my process is the spinning step which is illustrated in Figure 8 of the drawings. Referring to Figure 8, the roving creels or bobbins **224** and **226** are mounted for rotation in a frame **228**. The rovings from bobbins **224** and **226** pass over guide rolls **230** and **232** respectively and are drawn through a funnel **234** by cooperating rolls **236** and **238**. After passing through the rolls **236** and **238**, the roving is supported on an endless leather apron **240** which passes over and is driven by roll **238**. The apron **240** also passes over a supporting roll **242** and guide **244**, and is held in tension by a tensioning roll **246**. After leaving apron **240**, the roving passes between a pair of drafting rolls **248** and **250** which rotate somewhat faster than rolls **236** and **238** and thereby further attenuate the fibres. The apron **240** serves to control the shorter fibres as the roving passes from rolls **236—238** to rolls **248—250**. Slip rolls **252** and **254** are provided which bear against the roving on the apron to control the fibre mass.

From the rolls **248** and **250**, the emerging yarn or thread is spun in a conventional spinning device. Thus the yarn passes through a "pigtail" **256** to the traveler **258** of ring **260** and is then wound on the bobbin **262**.

From the foregoing description it is apparent that the present invention provides a combed worsted top or roving or yarn and a process for making these products capable of achieving the objects set forth in the introductory portion of the specification. It is of course to be understood that the preferred embodiment of the process here described is illustrative only and that numerous changes can be made therein without departing from the spirit of the invention as set forth in the appended claims.

What I claim is:

1. The system of processing to convert short wool fiber stock into worsted yarn which comprises, (1) opening and forming a lap, (2) carding the lap and converting it into a sliver, (3) combining a plurality of carded slivers and drawing them by passing them between successive pairs of rolls, rotating at successively higher speeds, and spaced to handle stock having an average length on the order of one and a quarter inches, (4) combining a plurality of drawn slivers thus forming a lap and combing the lap, (5) converting the lap into a sliver and drawing it by passing it between successive pairs of drafting rolls rotating at successively higher speeds spaced to handle said stock, and thereafter subjecting the sliver to (6) a single roving step, and (7) a single spinning step.

2. The system of processing to convert wool fibers which are predominately from one-half inch to three inches in length into worsted yarn which comprises, opening the fibers with a picker and forming them into a lap, carding the lap and converting it into a sliver, combining a plurality of carded slivers and drawing them by passing

them between successive pairs of rolls rotating at successively higher speeds and spaced to handle stock predominately one-half to three inches in length, combining a plurality of resulting drawn slivers thus again forming a lap and combing the lap, converting the combed lap into a sliver, combining a plurality of combed slivers and drawing by passing the combined slivers between successive pairs of drafting rolls rotating at successively higher speeds spaced to handle said stock, drafting the resulting sliver thereby further reducing its diameter and twisting it to form a roving, and spinning the resulting roving.

References Cited in the file of this patent

UNITED STATES PATENTS

287,405	Barker	Oct. 30, 1883
874,714	Westcott et al.	Dec. 24, 1907
1,939,525	Schmitt	Dec. 12, 1933
1,994,313	Jacobs	Mar. 12, 1935
2,244,363	Holdsworth	June 3, 1941

FOREIGN PATENTS

616,815	Great Britain	Jan. 27, 1949

OTHER REFERENCES

"Woollen and Worsted," by Roberts Beaumont; published in London in 1915 by G. Bell & Sons, Ltd. Copy in Division 21, pages 182; 198; 199.