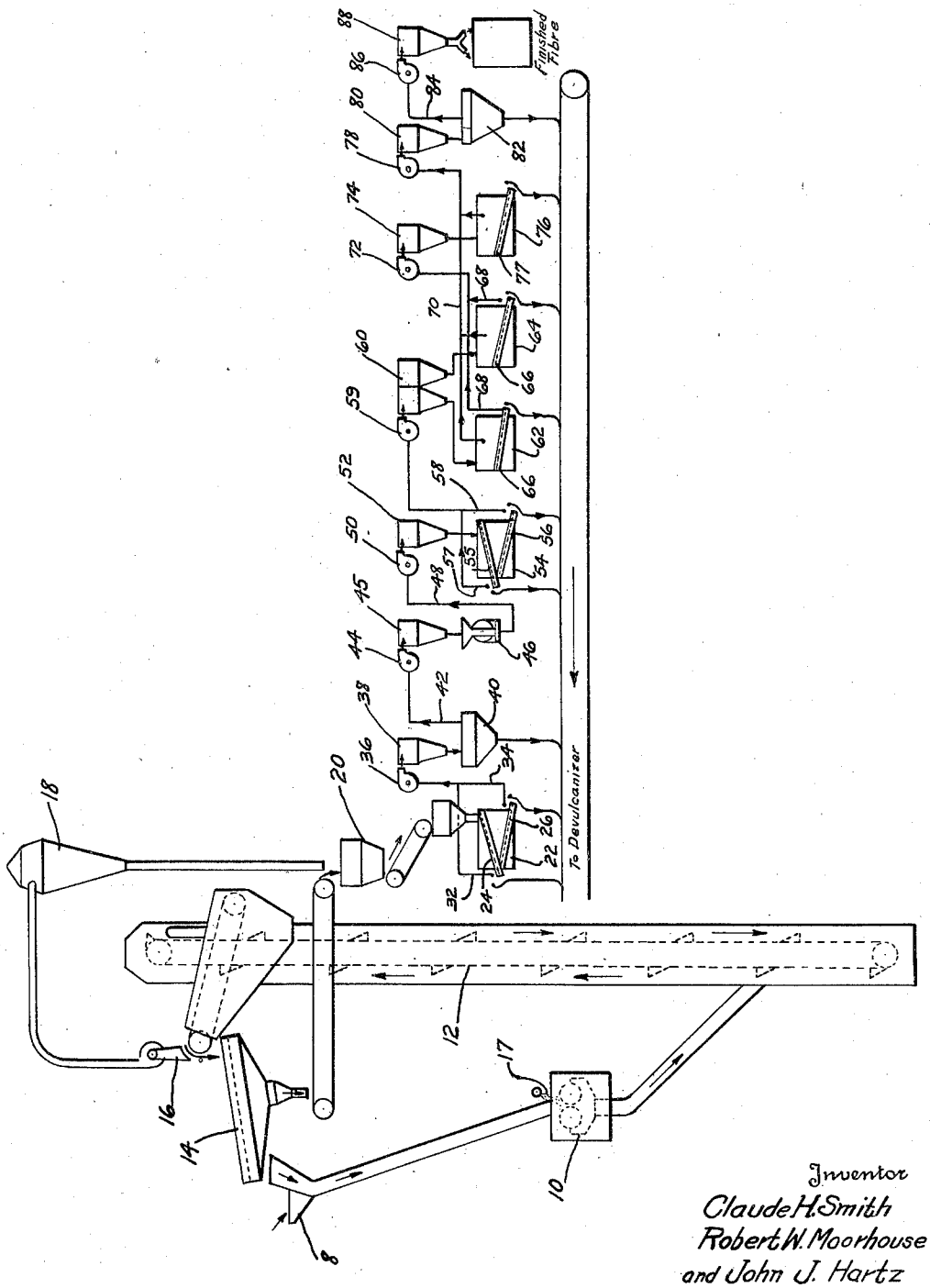
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PROCESS FOR SEPARATING FIBER FROM RUBBER

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PROCESS FOR SEPARATING FIBER FROM RUBBER

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This invention relates to a process of separating fiber from vulcanized rubber-fiber articles. More particularly, it relates to improvements in the dry process of recovering fiber in usable form from vulcanized rubber articles such as automobile tires. It also includes the product of the process.

When vulcanized rubber which contains fibrous material is reclaimed, it is necessary in order to suitably reclaim the rubber to eliminate the fibrous material from the rubber. This has been accomplished by various chemical methods, in most cases the fibrous material being destroyed. It has, however, for many years, been a desideratum to recover this fibrous material from vulcanized articles in usable form rather than to destroy it. Various methods have heretofore been proposed. One of such methods involves a chemical method of separation which comprises adding various materials to vulcanized articles which aid in stripping the rubber from the fibrous material. Another process involves the wet beating of ground rubber-fibrous material. Still another process involves the separation of fiber from vulcanized rubber by a dry process which is wholly mechanical. This dry process has involved the grinding of vulcanized rubber-fibrous articles and then feeding this ground material to two attrition mills in series where the material is fluffed, comminuted and dissociated. This material is then sent through two beaters in series, generally called cotton-hull beaters, where the fluffed, comminuted and dissociated particles of rubber and fiber are separated. The product of this process has been a fibrous mass containing a too large amount of rubber, and fibers which are too short as a whole and too low in tensile strength for application successfully in many uses. Furthermore, this old process is not very efficient in that only relatively small yields can be obtained, the yield loss being due to overgrinding the fiber in the presence of large amounts of rubber.

It is to improvements in this old dry process of separating fiber from rubber that the present invention relates. By the improvements of this invention, the yield is considerably increased and the product is a relatively long length matted fibrous mass containing from 5 to 15% rubber and fluffed-up fibers and opened-up cords which are as long as 1½ inches in some cases and will be found to average throughout the mass approximately ¾ inch in length. In some cases there is also a very small amount of unopened cords. The invention is particularly directed to the recovery of the cotton in the carcasses of automobile tires and makes possible the recovery of the cotton with very little decrease in tensile strength of the fibers.

Briefly, the invention comprises the discovery that by more properly grinding the rubber-fibrous articles originally and then preliminarily separating a large amount of the rubber from this ground material before subjecting the material to an attrition mill, an improved product as well as much higher yields are obtained.

Referring more particularly to the drawing disclosing a flow sheet of our preferred process, it will be seen that the debeaded and chopped automobile tires are fed from a chute 8 leading from the choppers to one or more crackers 10, sometimes called cracker grinders, which are two-roll fluted mills well known in the rubber industry and described in "Rubber machinery" by H. C. Pearson, 1920, at page 72. The chopped pieces fed to the cracker vary in size but are in general about 1–2 inches wide and about the length from bead to bead. The material passes through the cracker and drops by gravity to a bucket elevator 12 where it is carried to a Rotex screen 14 for sizing.

While the screen 14 may have any size mesh that is desirable, it is preferred to employ a ¼ inch mesh since it is most desirable for devulcanizing rubber to first reduce the rubber to be devulcanized to not more than ¼ inch size. Actually the greater part of the fines through the screen will pass between 20 and 42 mesh screens (Tyler Standard), the 20 mesh screen having openings of .0328 inch in diameter and the 40 mesh screen having openings of .0138 inch. At the feed to this screen there is placed an aspirator leg 16 which takes up to a cyclone separator 18 a large amount of the material which is sufficiently ground to size after the first passage through the cracker. This aspirator leg merely provides a current of air passing through the free falling ground stock, not directionally countercurrent, but within 0–90° of this condition. By so arranging this current, the smaller particles respond quickly to the air current and change their direction to correspond with the air flow. The velocity of air flow is adjusted so that it is in direct relationship to the distortion of the particle from its path but in inverse relationship to its mass.

The remaining material which passes through the screen is joined with the material aspirated from the head end of the screen at the stock bin 20. The material which passes over the end of

the screen is returned to the cracker and reground until it reaches the proper size.

The placing of the aspirator leg over the Rotex screen and, particularly at the feed to the screen so that it operates on "free-falling" stock, is a desirable improvement in this invention and has been found to aid in the production of a fibrous long length product and in the prevention of over-grinding and thus lowering of the tensile of the fiber. It also aids in decreasing the tendency to enmesh ground fiber and rubber particles. This perhaps is caused by the fact that the material does not pass through the cracker any more than is necessary. The aspirator leg also increases the capacity of the cracker approximately four times.

Another improvement which has been found to aid in providing a long length fiber in the product is the step of adding a fine spray of water **17** to the cracker rolls so that the action of the cracker is to cut the material cleanly the same as is done when a wet knife is used in cutting rubber instead of a dry knife. The amount of water added can be varied according to the finished material desired and in some cases enough water to give a moisture content of 20% by weight in the finished material may be used. When dry, the action of the cracker rolls is more of a macerating or chewing action, the effect of which is to grind the fabric and rubber together so intimately that they are much more difficult to separate. Also, the fibers or threads are ground so finely that they have much less tensile strength. Of course, for some purposes such as in paper pulp, a finely ground fiber is satisfactory. For paper pulp the opened-up cords or threads should be unravelled to the cotton fibers, although broken or ground fibers as are given by dry grinding are satisfactory. The water spray **17** aids in unravelling or fibrillating the cords.

From the stock bin **20** the ground material drops through a double deck shaker screen **22** where the bulk of the rubber is separated before the fluffing operation in the attrition mill. The ground material contains by weight 80–85% rubber in the stock bin, but after passing through the screen **22** the fibrous material has a rubber content of only 20–30%. This step is essential for best results since with a large amount of rubber in the material fed into the attrition mill, the action of the mill tends to enmesh the rubber with the fiber. It will be understood that any other separation system could be employed here but the double deck screen seems to give best results. The double deck shaker screen **22** comprises an upper deck **24** operated by an eccentric revolving at 304 R. P. M. and made up of five sections of perforated plate with holes of the following successive diameters: $\frac{7}{16}''$, $\frac{7}{16}''$, $\frac{1}{4}''$, $\frac{1}{4}''$ and $\frac{1}{4}''$. These holes, and in fact the holes in the succeeding screening equipment, are determined by the sizing of the material from the cracker. With $\frac{1}{4}''$ material it has been found that the holes described hereinafter give best results. The medium and fine rubber particles and the medium and fine cords and lint pass through this top screen **24** onto the lower screen **26** operated by an eccentric revolving at 304 R. P. M. An aspirator **32** is located over the base of this top screen and lifts the long cords out but not the oversize rubber which goes to the devulcanizer in case the rubber is to be reclaimed. It will be understood that the rubber may be used for other than reclaiming purposes. The throughs of this top screen pass to the head of the lower screen **26** which is clothed with five plates perforated as follows: $\frac{5}{32}''$, $\frac{1}{4}''$, $\frac{1}{4}''$, $\frac{5}{32}''$ and $\frac{5}{32}''$. The fine cords and lint and the fine rubber pass through the lower screen **26** and then to the devulcanizer. An aspirator **34** is located at the base of this screen and lifts out only the medium cords, the overs passing to the devulcanizer.

The aspirated material is then led by a fan **36** revolving at 2375 R. P. M. to a cyclone separator **38** from which it drops into an ordinary cotton hull beater **40** which does not contain a shaking screen. It is of standard construction and functions to shake free from the entangled fibers the small particles of loose rubber which are present and consists of two semi-cylindrical horizontal cradles of perforated metal with inlet and outlet screens both perforated with $\frac{7}{32}''$ diameter holes. Two shafts revolving at 304 R. P. M. run down the length of these cradles and carry spatulate arms or spikes so turned as to feed the mixture along the cradles and maintain it in a loose, open suspension, so that the loose rubber may be more readily liberated and passed through the perforations. The small amount of loose rubber present is not passed out of the perforated cradles but falls through to the conveyor carrying the rubber to the devulcanizer.

The fibrous material is then sucked through an aspirator leg **42** by a fan **44** revolving at 2330 R. P. M. to a cyclone separator **45** from which the material drops to an attrition mill **46**. This machine is of ordinary construction known to the art and serves to scuff or knock off the rubber adhering to the fiber and to unravel the cords into threads and is so arranged that it does not further break down the threads to very short fiber which is undesirable for certain uses. It comprises two accurately machined and balanced discs 36" in diameter and driven in opposite directions to 1800 R. P. M. Other constructions can be used also; e. g. 20" discs are quite satisfactory as is also a single disc type attrition mill. However, the 36" double disc type appears to give the greatest yields and increased efficiency in unravelling and opening up the cords. The material is fed between these discs and passes through an aspirator leg **48** operated by a fan **50** revolving at 2110 R. P. M. to a cyclone **52** where it drops by gravity to a double deck screen **54** in which both screens operate at 304 R. P. M.

This screen is similar to the double deck screen **22** but the top deck **55** is clothed with $\frac{1}{2}''$ openings throughout, while the lower deck **56** contains five sections with holes as follows: $\frac{5}{32}''$, $\frac{3}{16}''$, $\frac{3}{16}''$, $\frac{3}{16}''$ and $\frac{3}{16}''$. This screen **54**, while not essential, aids considerably in increasing the yield. If the fluffed fiber from the attrition mill **46** is taken directly to a beater, the perforations in the cloth of the beater screen must be quite small in order to prevent a large yield loss. In so doing, however, it is impossible to remove those rubber particles which are larger than the holes. This is accomplished by the screen **54**.

The fibrous material is carried by aspirator legs **57** and **58** operated by a fan **59** revolving at 2400 R. P. M. to a double cyclone separator **60** which divides the material sending it half and half to beaters **62** and **64**, both operating at 330 R. P. M. These beaters are similar in construction to beater **40** but have inlet plates of $\frac{7}{16}''$ perforation and outlet plates of $\frac{3}{8}''$ and, in addition, have shaking screens **66**. The screens **66** located below these beaters **62** and **64** operate at 286 R. P. M. and are clothed with $\frac{1}{8}''$, $\frac{1}{8}''$, $\frac{1}{8}''$, $\frac{1}{8}''$ and $\frac{3}{16}''$ perforated plate sections. The

throughs of these beaters pass to the shaking screens **66** and the throughs of the shaking screens go to the devulcanizer. An aspirator **68** is located over the ends of these screens and lifts out the medium sized fiber, the overs passing to the devulcanizer. The beaten fiber remaining in the beaters is picked up at the outlet by an aspirator **70** and carried to a cyclone separator **80** by a fan **78** revolving at 2440 R. P. M. The material carried by the aspirator **68** is conducted to a cyclone **74** by a fan **72** revolving at 1720 R. P. M. from which it drops to beater **76** operating at 330 R. P. M. and clothed with 3/8" perforations on both the inlet and outlet plates. The throughs of this beater pass to the shaking screen **77** operating at 286 R. P. M. and clothed with five sections 1/8", 1/8", 1/8", 1/8" and 3/16" and the throughs of screen **77** pass to the devulcanizer. The beaten fiber not passing through the beater perforations is picked up at the beater outlet by aspirator **70** and carried to cyclone separator **80** by a fan **78** revolving at 2440 R. P. M.

The material conducted to cyclone separator **80** is led to beater **82** operating at 318 R. P. M. and clothed with 5/32" perforations on both the inlet and outlet plates. The throughs pass to the devulcanizer. The purpose of this beater is to remove the lint and to mix the two fractions. While desirable, it is not necessary. At the outlet of beater **82**, the beaten fiber is picked up by aspirator **84** operated by a fan **86** revolving at 2250 R. P. M. to cyclone separator **88** in which the fiber is separated from the air current. This fiber is the finished material and contains a rubber content averaging from 5 to 17% by weight. The fiber is a matted, fluffed mass of mostly opened cords (threads) ranging in length from 1/2" to 1 1/2" and probably averaging 3/4" in length. It also contains some fiber and in some cases a small amount of unopened cords.

If a finer fibrous material and one with less rubber content is desired, the material may be sent back through the system of beaters and the attrition mill, although this is not necessary for a product capable of employment in various uses such as upholstery and the like. In certain cases, the material is sent only through the beaters.

It will be understood that the process described in detail herein may be varied in many respects by those familiar with the art. For instance, in order to produce fibrous material having certain uses, it may be desirable to add more beaters. Also, it may be desirable to send the material through a second attrition mill, although for the improved product of this process it is not desirable. The speeds of the various fans, beaters, screens and mill and the holes of the various screens also may be adjusted as desirable. It will be understood that these are determined largely by the size of the material employed.

What we claim is:

1. In the process of separating fiber from vulcanized rubber tires comprising the grinding of debeaded and chopped rubber tires to small size and subjecting said ground rubber fibrous material to attritioning and to beating, the improvement which comprises the step of adding sufficient water to the material at the grinder so that it receives a cutting action rather than a macerating action.

2. A process of separating improved fibrous material from cord rubber tires which comprises the successive steps of grinding debeaded and chopped tires in a cracker to a maximum particle size of 1/4", adding a small amount of water to the cracker during said grinding, separating a large portion of the rubber from the ground rubber-fibrous mixture by screening, beating the resulting fibrous material, attritioning the fibrous material obtained from the beater, and then beating the attritioned fibrous material.

3. A process of separating improved fibrous material from cord rubber tires which comprises the successive steps of grinding debeaded and chopped tires in a cracker to a maximum particle size of 1/4", adding a small amount of water to the cracker during said grinding, separating a large portion of the rubber from the ground rubber-fibrous mixture by screening, beating the resulting fibrous material, attritioning the fibrous material obtained from the beater, screening the attritioned material, and then beating the attrioned fibrous material.

4. A process of separating improved fibrous material from cord rubber tires which comprises the successive steps of grinding debeaded and chopped tires in a cracker to a maximum particle size of 1/4", adding a small amount of water to the cracker during said grinding, aspirating the ground material after it passes through the cracker, screening the ground material not taken up by the aspirator, separating a large portion of the rubber from the aspirated material and screened material by screening and aspirating, beating the resulting aspirated material, attritioning the resulting beaten material, separating rubber from the attritioned material by screening and aspirating, and beating the resulting aspirated attritioned material sufficiently to reduce the rubber content of the resulting fibrous material to 5–17% by weight.

5. The process of separating improved fibrous material from cord rubber tires which comprises the successive steps of grinding debeaded and chopped tires in a cracker to small particle size, aspirating the ground material after it passes through the cracker, screening the ground material not taken up by the aspirator, returning to the cracker for regrinding the ground material which does not pass through the screen, separating a large portion of the rubber from the aspirated material and screened material, beating the resulting fibrous material, attritioning the resulting beaten material, separating rubber from the attritioned material, and beating and then separating the resulting fibrous material sufficiently to reduce the rubber content of the fibrous material to 5–17% by weight.

6. In the dry process of separating vulcanized rubber from fiber comprising grinding rubber-fibrous articles to small size and subjecting said ground rubber-fibrous material to means for reducing the rubber content of the fibrous product to 5–17% by weight, the improvement which comprises the step of adding sufficient water to the material before it is ground so that it receives at the grinder a cutting action rather than a macerating action.

7. In the dry process of separating vulcanized rubber from fiber comprising grinding rubber-fibrous articles to small size and subjecting said ground rubber-fibrous material to attritioning and to beating, the improvements which comprise the step of adding sufficient water to the rubber-fibrous material before it is ground so that it receives at the grinder a cutting action rather than a macerating action, and the step of separating a large portion of the rubber from the

ground rubber-fibrous material prior to the attritioning and beating.

8. The process of recovering rubber and fiber from cord rubber tires which comprises grinding the tires to composite rubber and fiber material of relatively small particle size, successively aspirating, screening, beating, attritioning and rebeating the ground composite material, and removing some of the rubber from the composite material after each of said successive operations.

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