# United States Patent [19]

**Knight**

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[54] **APPARATUS FOR SPREADING TOWS OF FIBROUS MATERIALS**


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[52] **U.S. Cl.** ..... **19/65T**, 26/63, 242/157

[51] **Int. Cl.** ..... **D01d 11/02**

[58] **Field of Search** ..... 19/65 T, 66 T; 226/108, 226/109, 168, 189; 26/63; 242/157



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,171,579 | 3/1965 | Robertson | 26/63 |
| 3,665,572 | 5/1972 | Robertson | 26/63 |

FOREIGN PATENTS OR APPLICATIONS

| | | | |
|---|---|---|---|
| 358,943 | 1/1906 | France | 26/63 |
| 4,172 | 1887 | United Kingdom | 26/63 |
| 21,269 | 1914 | United Kingdom | 26/63 |
| 30,067 | 1/1885 | Germany | 26/63 |



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[57] **ABSTRACT**

Method and apparatus for spreading webs of spreadable materials is disclosed. A web of such material is advanced into contact with the convex periphery of a plurality of curved rolls to effect successive incremental lateral spreading of the web material on each curved roll, the curved rolls being spacedly disposed about a fixed axis and rotatably supported between aligned mounting centers disposed on axes extending parallel to the fixed axis. While the web is advanced in an open loop travel course around and in contact with the convex peripheries of the curved rolls, the curved rolls are concurrently unitarily orbited about said fixed axis in a path counter to the advance course of the tow and at an orbiting speed such that a given point on the web contacts the convex peripheries of the curved rolls a plurality of times in excess of the plural number of curved rolls disposed about the fixed axis.


**7 Claims, 3 Drawing Figures**

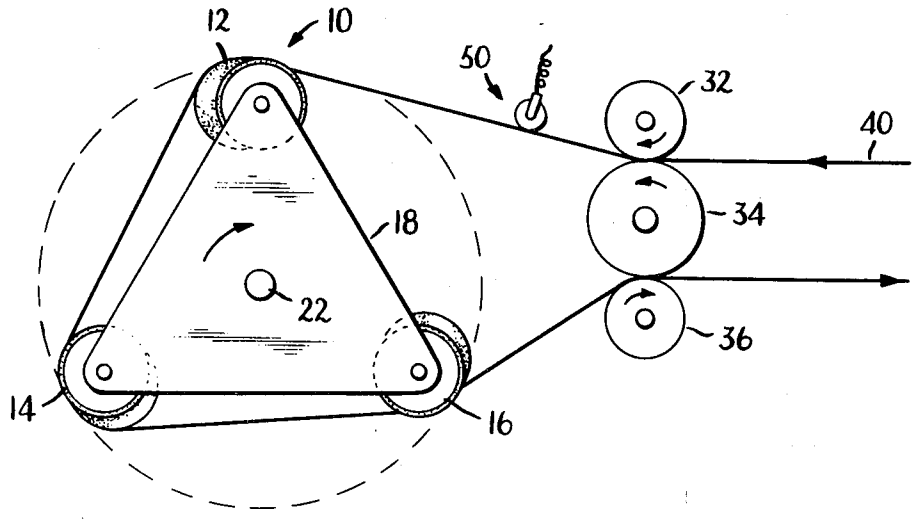


FIG. 1

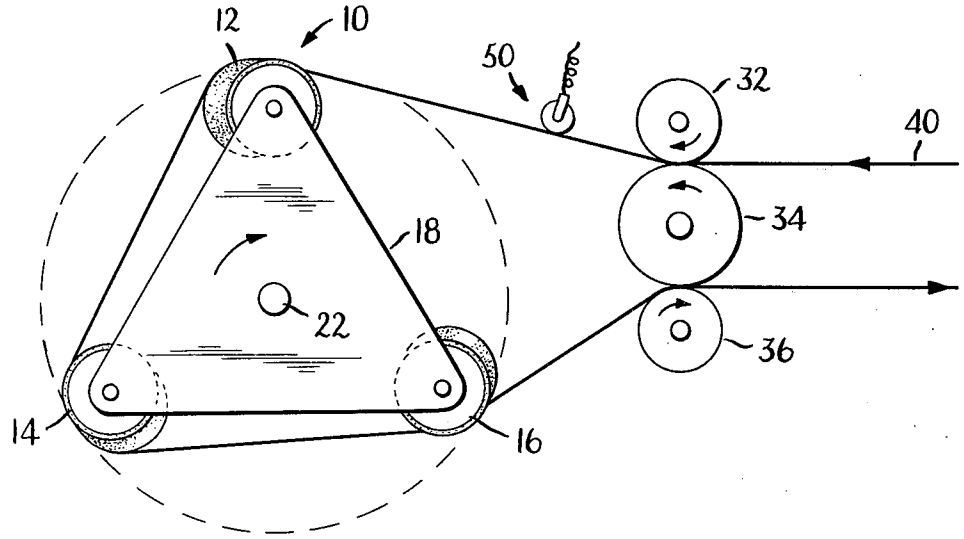

12
10
50
32
40
18
34
22
36
14
16

FIG. 2

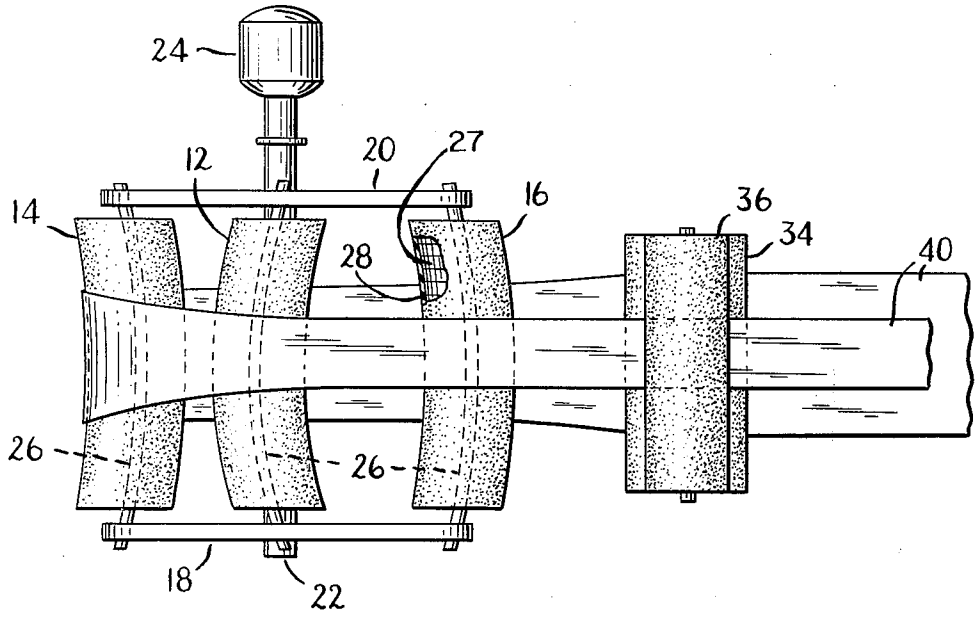
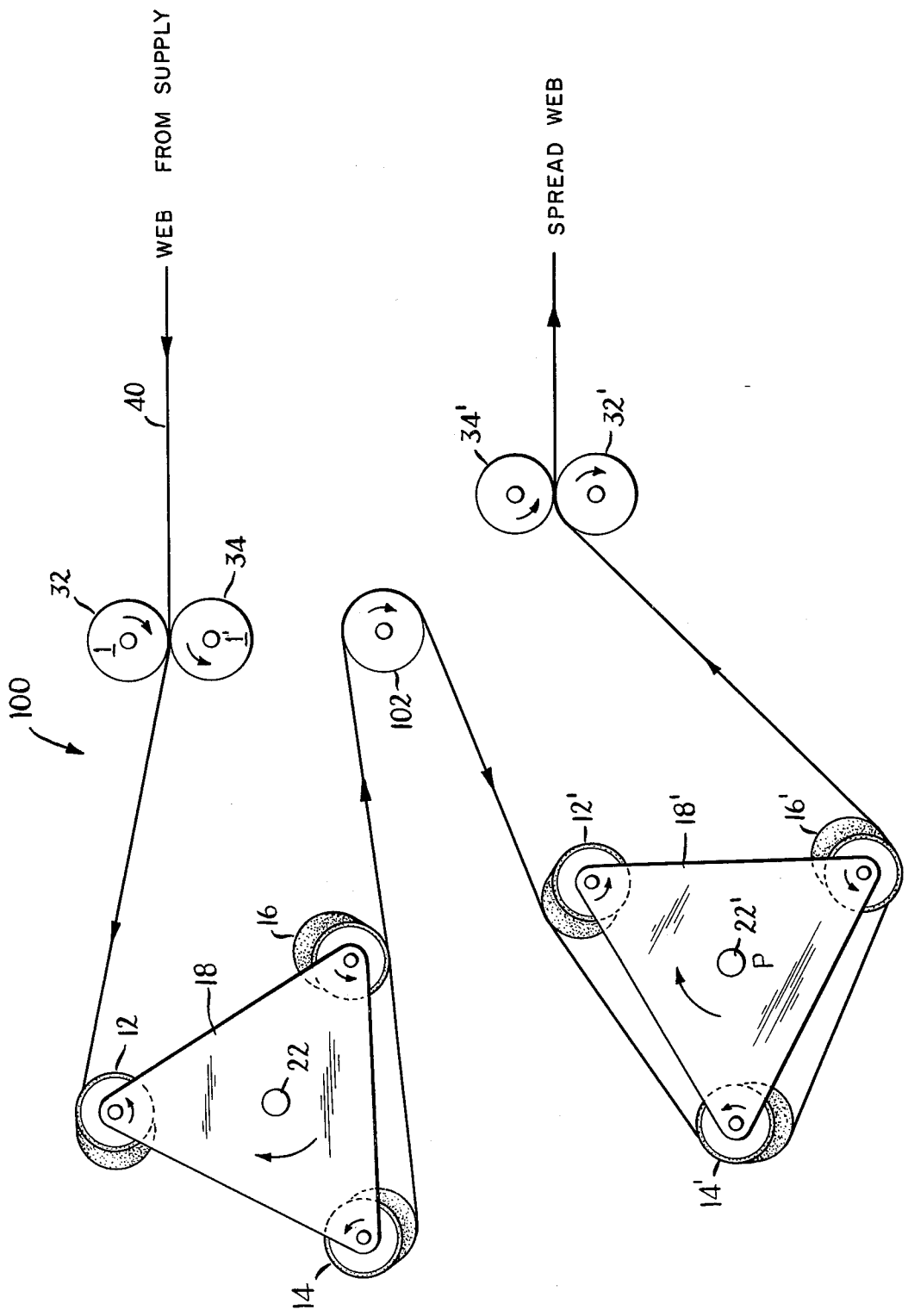

24
12
20
27
14
16
36
34
40
28
26
26
18
22

FIG. 3


WEB FROM SUPPLY
SPREAD WEB
100
102
12
14
16
18
22
32
34
40
12'
14'
16'
18'
22'
32'
34'
P

# APPARATUS FOR SPREADING TOWS OF FIBROUS MATERIALS

## BACKGROUND OF THE INVENTION

Webs of spreadable materials such as, for example, a filter tow for forming cigarette filter plugs generally is supplied in bulk continuous form most usually in a compact bale of such material in which the material has a high density. Accordingly, such materials prior to processing of the same in filter plug forming apparatus must be opened or bloomed to lessen the density thereof. The spreading or opening of such materials, whether they be in tow, non-woven web, carded batts or like continuous stock form, can be accomplished in various known ways. The material may, for example, be passed (primarily for effecting fluffing in 2 or 3 dimensions) through air jets, or over or between roller devices. Such rolls may have knurled, threaded, or slatted surfaces. Edge guide rolls pull the edges of a web outward. One particularly effective type of roll which can be used for spreading is a smooth-surfaced roll which is bowed at its mid-point instead of being in the conventional right cylinder form. It is not used for spreading in contact or cooperating relation with an opposing roll but rather as a single unit. Such curved roll can be, for example, of the type manufactured by the Mt. Hope Machinery Co. Such curved rolls have been employed by passing the material over the roll and in first contact with the concave side, and in an exiting contact with the convex side and in a contact course up to 120° wrap so that the longer curvature of the convex side vs. the concave side produces a uniform spreading action toward the ends of the roll. The curved roll aforesaid has a fixed axle on which is mounted a series of ball bearing assemblies, with the outer races of the latter free to turn while the inner races are fixed to the axle. A rubber sleeve encloses the outer races and rotates therewith. Thus, in operation the sleeve expands and contracts as it rotates about the axle to produce the desired even or uniform spreading. Several rolls in series will accomplish a certain amount of opening of the web. An advantage of using this roll for spreading webs of spreadable material is that it does not produce a severe tearing action on the material, as do knurled or threaded rolls. The curved or bowed rolls act more evenly over the entire web, whereas edge guide rolls may tear the edges with little effect at the center. Slatted rolls are less easily controlled. Thus, while curved rolls are particularly effective for spreading material webs generally where such is in a form that is difficult to open or spread, a great many bowed rolls in series are required since with a 4 ¼-inch diameter roll, for example, each spreads the width only about 5 percent. It is desirable therefore, that efficient spreading be accomplished with a relatively small number of curved rolls and that such equipment in addition to being relatively inexpensive to provide, be compact so that the same can operate in and require but a relatively small space in the cigarette filter making apparatus line. In spreading of woven and non-woven textile fabric or sheet materials which have been bundled, twisted and otherwise foreshortened in the crosswise direction in normal processing, a large number of curved rolls normally are used to effect the large spreading ratio required to return the fabric or sheet to its original width.



## SUMMARY OF THE INVENTION

The present invention provides method and apparatus with which webs of spreadable material can be spread from a relatively compact dense continuous stock thereof such as a bale of such material into an opened or bloomed relatively low density form for further processing, as for example, for use in making cigarette filter stock. In making such stock, the opened or bloomed material is fed into cigarette filter rod making machinery of known construction wherein it is formed in a continuous stock of light density material and subsequently sectioned into plug length pieces for incorporation in a cigarette making machine. It also could be employed, e.g., in the textile industry where cloth is twisted, bleached, dyed and untwisted as part of normal processing and then must be spread to its original width for drying. The economics and space requirements of this invention offer a great advantage in such uses. The present invention provides for efficient and effective spreading of such materials, using for that purpose a relatively small number of curved rolls, such curved rolls being arranged in a manner that requires use of only a small space in the filter making apparatus or other production line as well as requiring only a limited investment to provide apparatus for such purposes.

In accordance with the present invention, a plurality of curved rolls of known construction are spacedly disposed about a fixed axis and also rotatably between aligned mounting centers which in turn are disposed on axes extending parallel to the fixed axis. The web or other form of material to be spread is advanced in an open loop travel course around and in first contact with the concave periphery, and then contact with the convex periphery of each of the curved rolls with each roll contact producing a successive incremental lateral separation of the material in the web. Conveniently the curved rolls are mounted on structure which includes a pair of spaced apart plates mounted on and fixed to a central shaft which shaft provides the fixed axis. During the course of the travel of the web around the curved rolls, the same are concurrently and unitarily orbited about the fixed axis in a path counter to the advance course of the web and at an orbiting speed such that a given point on the web in traversing the course contacts the convex peripheries of the curved rolls a plurality of times in excess of the plural number of curved rolls disposed about the fixed axis. Suitable means to feed the web in its open loop travel course around the plurality of curved rolls and also to off-feed the web from the rolls is provided as well as means for rotating the mounting structure.

Advantageously three curved rolls are employed and they are spaced on the mounting structure equilaterally about and in respect of the fixed axis of the latter structure.

During the course of travel of the web around the curved rolls tension may be produced in the web and to compensate for the same suitable means for variably controlling the degree of tension in the web is provided, such means advantageously being disposed at the entry of the web to its open loop travel course and being, for example, a spring-loaded roller which engages with the web to selectively vary the tension therein.

It also is possible to employ for purposes of controlling or eliminating web tension in the web during the open loop travel course thereof, a second like set of

curved rolls which are disposed in and unitarily orbit in like manner with the first-mentioned plurality of curved rolls, the second plurality being orbited in synchronization with the first plurality to produce in the web a tension which is exactly out of phase with that produced by the first plurality.

The invention accordingly comprises the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth and the scope of the invention will be indicated in the claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

A fuller understanding of the nature and objects of the invention will be had from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. **1** is a side elevational view of spreading apparatus constructed in accordance with the principles of the present invention.

FIG. **2** is a plan view of the apparatus depicted in FIG. **1.**

FIG. **3** is a side elevational view of a modified form of apparatus comprising two sets of curved rolls in which the second set is synchronized to give a web tension exactly out of phase with that in the first set.

Throughout the description like reference numerals are used to denote like parts in the drawings.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is concerned with a method and apparatus for spreading webs of spreadable materials. As used herein "web" is intended to include various types and forms of material stock in which various materials can be packaged following manufacture thereof and is inclusive of a tow of fibers, non-woven webs, carded batts and woven and non-woven textile fabrics and sheet materials in continuous processes and bulk quantities. Generally, the finished material, if fibrous, can be packed in a relatively dense continuous stock form such as a bale. On the other hand, in textile and sheet processes the material is usually in a continuous stream and requires spreading on a continuous basis. The present invention provides apparatus and method which can be employed conveniently in the production apparatus line for making cigarette filter material since it occupies minimum space particularly in the longitudinal dimension. As is known by those skilled in the art, such cigarette filter manufacture involves taking a tow of fibrous material, opening or blooming the same to lower the density thereof, and then forming it in suitable apparatus into a continuous wrapped stock of filter material which can be sectioned to provide individual plugs for later use in a cigarette making machine.

Referring now to FIG. **1,** there is shown apparatus with which a continuous web of spreadable material can be spread. The apparatus **10** includes a set of curved rolls **12, 14** and **16** each of which is a curved roll of known type as, for example, one manufactured by the Mt. Hope Machinery Company of Taunton, Massachusetts. The curved rolls **12, 14** and **16** are mounted on a suitable mounting structure which includes a pair of plates **18, 20** (FIG. **2**) which are spacedly mounted on and fixed to rotate with a central shaft **22,** the central shaft being driven by suitable drive means such as an electric motor **24** although other forms of drive also can be employed for this purpose. The curved rolls **12,** 14 and **16** as will be noted from FIGS. **1** and **2,** have each an axle **26** which is fixedly or non-rotatably received in aligned mounting centers located in the two plates **18, 20,** the mounting centers being arranged in pairs in correspondence to the numbers of curved rolls in the assembly and being aligned such that a line passing through each pair of mounting centers is parallel with the shaft **22.** The axles **26** of the curved rolls as will be noted, are curved or bowed in a curved path extending radially of a line connecting the aligned mounting centers and being at maximum curvature at midlength of the axle. The curved roll includes suitable ball bearing assemblies **27** rotatable on the axle **26,** the ball bearing assemblies being shown in FIG. **2,** and in turn being covered by a resilient sleeve **28** which encloses all of the ball bearing assemblies in each curved roll and rotates with the ball bearing assemblies, the sleeve **28** preferably being made of rubber. With the curved rolls **21, 14** and **16** thus disposed in plates **18, 20,** the convex surfaces thereof are generally disposed outermost on the apparatus so that when the mounting structure is rotated in the manner to be described later, the convex surfaces will engage the travel course of the web **40** of spreadable material as shown. For the purposes of feeding the web **40** of spreadable material onto the apparatus **10,** a feed roller assembly comprising rollers **32, 34** and **36** is provided. Rollers **32, 34** function to feed the web **40** onto the apparatus **10** whereas the rollers **34** and **36** function to off-feed the web following the spreading treatment of the same. During the travel of the web **40** through the apparatus and as will appear from later description herein of the operation of the same, there may be produced certain undesirable tension in the web **40.** To control variably the degree of tension present in the web **40** while it is on the apparatus **10,** there can be provided a tension control mechanism shown generally at **50** which can include a spring-loaded roller mechanism which engages the web **40** to alter or vary the tension therein.

In operation, the web **40** is fed through the roller set **32, 34** onto the apparatus **10** and around the peripheries of the rollers **12, 14** and **16** in an open loop travel course with the web **40** making a first contact with the concave periphery and a second or exit contact with the convex periphery and up to 120° wrap on each curved roll. Concurrently with the travel of the web around the rollers **12, 14** and **16,** the mounting structure is rotated in a direction counter to the loop travel course of the web so as to unitarily orbit the curved rolls about the axis defined by shaft **22** with the rotational speed of the mounting structure being such as to provide an orbiting speed in the curved rolls that causes a given point on the web **40** in traversing its travel course to contact the convex peripheries of the curved rolls a plurality of times in excess of the plural number of curved rolls in the assembly. During such orbital movement, the curved rolls **12, 14** and **16** also rotate about the axis defined by a line passing through the associated mounting centers for the curved rolls. Further, they rotate in the same direction as the web travel at substantially the same surface speed as the web so that there occurs no slip between the rolls and the web **40** in that direction. The rotation of the curved rolls **12, 14** and **16** caused by web travel generally can be provided as a free rotation if the web is sufficiently strong to that

purpose, but if required positive drive means for each roll can be provided. Generally, the line speed of the web in its travel course is limited by the rotational speed allowable for the particular curved roll employed. During the course of each contact of the web with a curved roll convex surface, the web is spread slightly laterally in an incremental amount which due to the effect of the rotation of the frame providing many such contacts during the travel of the web around the apparatus results in a net spreading many times greater than that which would be obtained if stationary curved roll assemblies were employed. For example, if the peripheral line speed of the planetary arranged curved roller assembly is about equal to the web speed, the web will make 1 ½ times the number of curved rolls contacts with the convex surfaces of the latter.

In a particularly advantageous form, three curved rolls are provided and mounted as depicted in FIGS. **1** and **2** providing for most cigarette filter forming operations a satisfactory measure of spreading of the fibrous materials. Other numbers of curved rolls could be employed in the assembly, as for example two, with the upper limit on such rolls being defined only by space limitations and degree of spreading to be achieved. Where a larger number of curved rolls, as for example six, are used in an assembly the amount of spreading effected per roll for a mounting structure of essentially the same dimensions as that depicted in FIG. **1** will be decreased because of a shorter contact arc of the web on each roll so that the net spreading effect produced during one revolution of the mounting structure would be approximately the same as where only three curved rolls are employed.

The FIG. **3** apparatus is employed where a web of material of low elasticity property is to be spread. With such material the creation of tension in a single spreading assembly may as indicated earlier be provided with a tension controlling device such as a spring-loaded roller. However, it is also possible to offset the effect of any tension produced in the first roller assembly by providing a second like assembly in which the latter is rotated to give the curved rolls therein an orbiting movement in synchronization with the first plurality to produce in the second plurality a web tension exactly out of phase with that produced in the first plurality. Thus, there will be no net variation in the total path length or tension of the web during the course of its travel through the apparatus **100.** In the FIG. **3** apparatus, corresponding parts are designated with the same reference numerals as shown in FIG. **1** with the second set of curved rolls being given prime designations for like parts in such second assembly. The roller **102** is used to guide the web **40** in its off-feed from the first assembly and on to the second assembly. When using a second set of curved rolls as shown in FIG. **3,** the spreading action of course is doubled approximately if the same rotational speed of the mounting structure in both assemblies is employed. On the other hand, since the spreading action can be doubled it, accordingly, is possible to reduce the rotational speeds of the mounting structure by one-half if only the same total degree of spreading is desired.

In the foregoing description it will be noted that the same side of the web of material has been treated, that is, spread. It will be apparent however, that the treatment may be applied to both sides of the web as where it might have different side characteristics. Thus, the apparatus of FIG. **3** could be modified so that the first assembly would treat one side of the web and by employing a suitable arrangement of idler rolls, the other side could be treated on the second assembly. This would be advantageous in the instance where one side of the sheet was, for example, very abrasive resistant and the other side had very low resistance to abrasion.

It will be apparent from a reading of the foregoing that the method and apparatus for spreading a web of spreadable material as provided in the present invention has been disclosed in certain embodiments thereof only and it is possible to produce still other embodiments without departing from the scope of the inventive concept herein disclosed and, accordingly, it should be understood that all matter contained in the above description and in the accompanying drawing should be interpreted as illustrative and not in a limiting sense.

What is claimed is:

**1.** In apparatus for spreading the fibers of a web of spreadable material which includes an assembly of a plurality of curved rolls each having a smooth concave peripheral surface portion and a smooth convex peripheral surface portion over which said web can be advanced to effect successive incremental lateral separation of the web on each of said curved rolls,

mounting structure for supporting said curved rolls for rotation in planetary disposition about a fixed axis and for rotation of each about an axis defined by aligned mounting centers disposed parallel with the axes of the others and parallel with said fixed axis,

means for feeding said web in an open loop travel course around and in contact with first the concave peripheral surface portion and then the convex peripheral surface portion of each of said curved rolls, and

means for rotating said mounting structure about said fixed axis in a direction counter to the travel course of said web at a predetermined speed whereby said curved rolls transit an orbiting course about said fixed axis and a given point on the web contacts the convex peripheral portion of said curved rolls a plurality of times in excess of the plural number of rolls in said assembly.

**2.** The apparatus of claim **1** in which said curved rolls are spaced uniformly from each other and equidistant from said fixed axis.

**3.** The apparatus of claim **1** in which said assembly comprises three curved rolls, said three curved rolls being disposed equilaterally about said fixed axis.

**4.** The apparatus of claim **1** in which said mounting structure includes

a shaft, and

a pair of plates spaced on and fixed to said shaft said plates having mounting centers thereon, each mounting center on each plate being aligned with a corresponding mounting center on the other plate, a line passing through each pair of aligned mounting centers being parallel with said shaft, said curved rollers each including an axle fixedly received in one of said pairs of aligned mounting centers, said axle traversing a curved path between said mounting centers, said curved path extending radially outwardly relatively of said line passing through said mounting centers to a maximum curvature at midlength of said axle, ball bearing as-

semblies rotatable on said axle, and a resilient sleeve enclosing said ball bearing assemblies and rotatable therewith.

5. The apparatus of claim 1 further comprising means for variable controlling tension in said web at the entry thereof to said open loop travel course to compensate for any such tension produced in said web in said open loop travel course.

6. The apparatus of claim 5 in which said tension control means comprises a spring-loaded roller engageable with said web.

7. The apparatus of claim 1 comprising a second like plurality of curved rolls, mounting structure for supporting said second plurality in like manner as said first plurality, means for guiding said web in off-feed from said first plurality of curved rolls into an open loop travel course around and in contact with first the concave peripheral surface portion and then the convex peripheral surface portion of each the rolls of said second plurality of curved rolls, and means for rotating said second plurality of curved rolls in a direction counter to the travel course of said web at a predetermined speed to orbit said second plurality in synchronization with said first plurality to produce a web tension therein exactly out of phase with that produced in said first plurality.

* * * * *