Sept. 22, 1970 A. J. LIEBMAN 3,529,782

DISINTEGRATING MACHINE

Filed Feb. 13, 1967 2 Sheets-Sheet 1

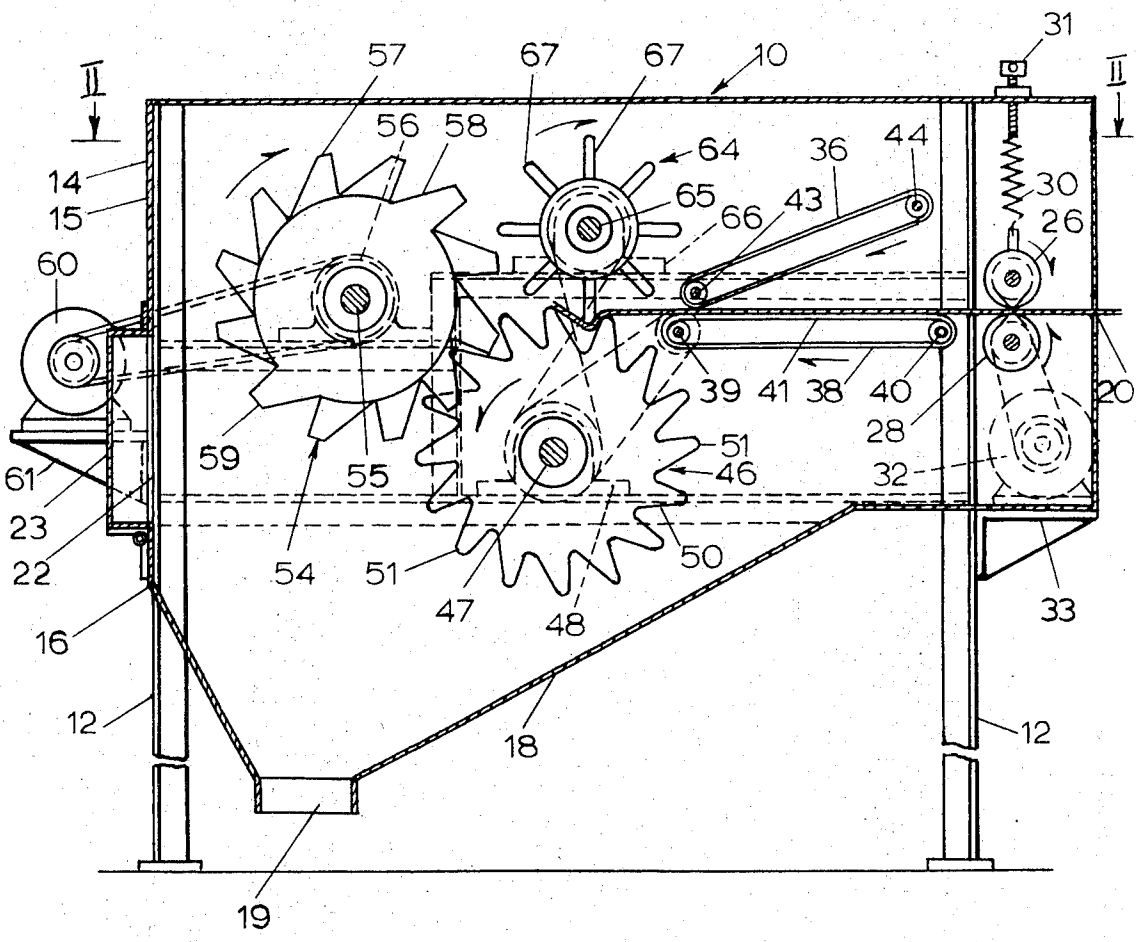


Fig. 1.

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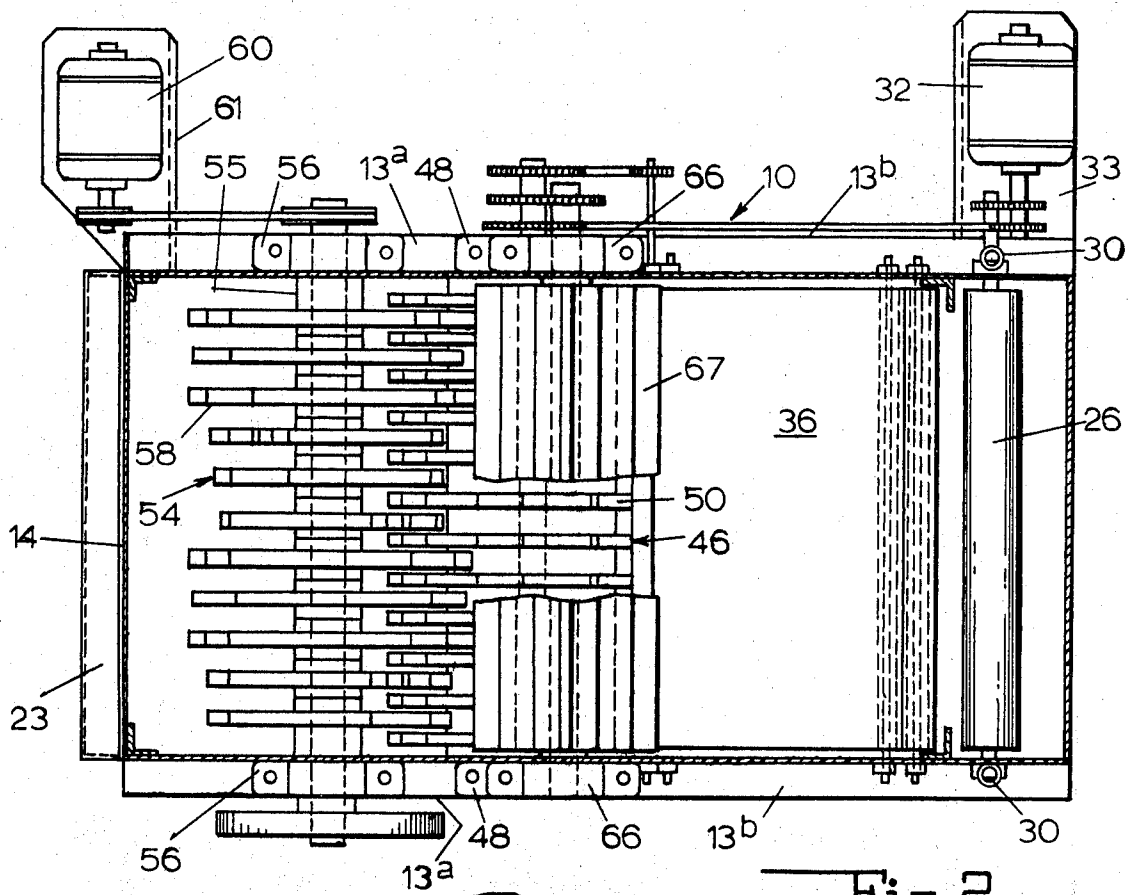


Fig. 2.

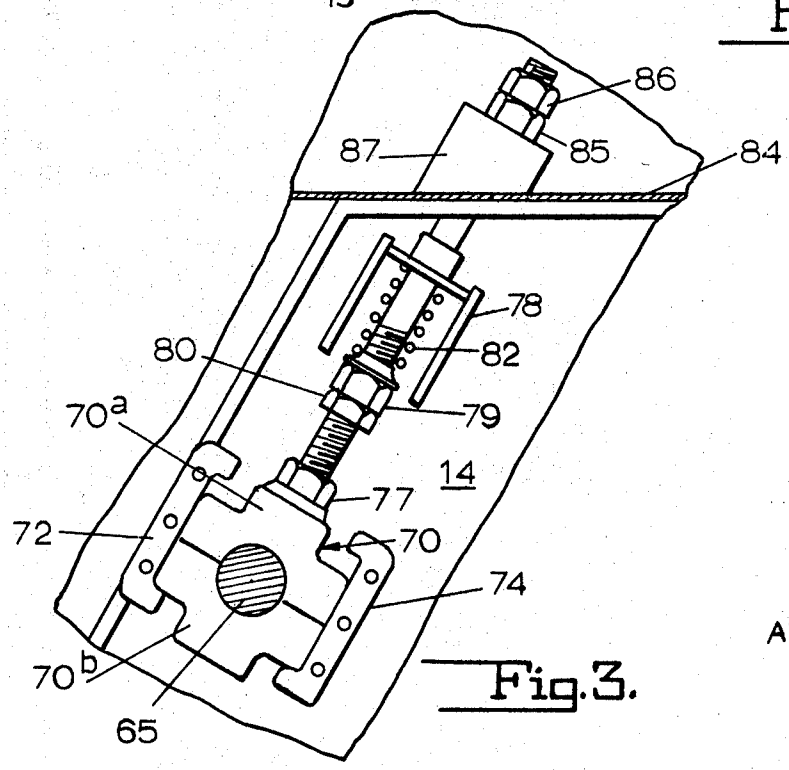


Fig. 3.

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DISINTEGRATING MACHINE

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U.S. Cl. 241—190 4 Claims

ABSTRACT OF THE DISCLOSURE

A disintegrating machine of the type having overlapping, cooperating primary feed and disintegrating rotors and an auxiliary feed roll rotatable counter to the primary feed rotor for biasing material into support engagement with the feed rotor.

The present invention relates to a disintegrating apparatus and methods for feeding material in such apparatus with the apparatus including an elongated feed rotor means having a plurality of axially spaced support surfaces thereon; means for biasing material into supporting engagement with at least one of the support surfaces; and elongated disintegrating rotor means for disintegrating material subsequent to the engagement of such material with the support surfaces. The method of feed material of the present invention includes the steps of directing material toward a rotating feed rotor having axially spaced material supporting surfaces; engaging the material before it reaches the feed rotor; biasing the material into supporting engagement with at least one support surface of the feed rotor; and carrying the material while biased on the feed rotor toward a disintegrating rotor rotating counter to and at a higher speed than the feed rotor.

FIG. 1 is a side elevation view partly in section of an improved material disintegrating machine of the present invention;

FIG. 2 is a view taken along the lines 2—2 of FIG. 1 showing further details of construction;

FIG. 3 is partial side elevation view of the machine of FIG. 1 showing elements for a modification of the present invention.

A disintegrating machine **10** constructed in accordance with the principles of this invention includes four spaced upright structural members **12** suitably adapted at the lower portions thereof to stably support the disintegrating machine **10** on a level surface. The support members **12** are further stabilized by four oppositely arranged, horizontal upper and lower struts **13***a* and **13***b* fixedly disposed in vertically spaced relationship intermediate the lengths of support members **12**. The support members **12** have fixed thereto at their upper portions an enclosure **14** having a longitudinal axis lying in a horizontal plane and extending from left to right as viewed in FIG. 1. Enclosure **14** includes an upper portion **15** and a lower portion **16** suitably fixed to the support members **12**. The bottom portion **18** of the lower portion **16** is inclined downwardly to an opening **19** for discharging material therefrom. At one end of the enclosure **14**, namely, the right hand end as viewed in FIG. 1, a laterally extending elongated inlet opening **20** is suitably arranged between the upper portion **15** and the lower portion **16**. An optional discharge opening **22** is provided at the left hand end of the enclosure **14** and specifically in the lower portion **16** thereof. A suitable cover **23** is suitably pivotably mounted on lower portion **16** to close discharge opening **22**.

Two elongated rollers **26** and **28** for frictionally engaging and feeding material are suitably, rotatably arranged between the side walls of the enclosure **14** with their

axes extending transversely of enclosure **14** and lying in a common generally vertical plane disposed inwardly of the inlet opening **20** at the right side of the enclosure **14**. The rollers **26** and **28** are suitably arranged in bearings supported at either side of the enclosure **14** with the rollers being vertically spaced to define a clearance therebetween of a suitable dimension for receiving and frictionally engaging sheet material or the like through the inlet opening **20**. Two laterally spaced, downwardly extending adjustable compression springs **30** supported by the top of enclosure **14** are arranged on either end of the upper roller **26** on the bearings thereof for applying pressure on the roller **26**. The compression of the springs **30** may be varied by turning the set screws **31** in the direction desired. An electrical motor **32** supported on a pad **34** fixed to the enclosure **14** and right hand support members **12**, is coupled to the rollers **26** and **28** through pulleys and belts to counterrotate the rollers **26** and **28** at the same speed with respect to each other.

Two endless belts **36** and **38** are disposed inwardly of the rollers **26** and **28**, the belts converging inwardly with respect to one another. The lower belt **38** is supported on rollers **39** and **40** suitably transversely arranged between the sides of the enclosure **14** with the center lines of the rollers **39** and **40** lying in a common, substantially horizontal plane in a position relative to the sides of the enclosure **14** such that the upper or conveying traverse **41** of the belt **38** lies substantially in the same horizontal plane as does the uppermost point of the lower roller **28**. By this arrangement any sheet like material inserted into the enclosure **14** through the inlet opening **20** will be carried between the rollers **26** and **28** and onto the upper traverse **41** of endless belt **38**. The upper belt **36** is suitably arranged on rollers **43** and **44** the center lines of which are in a common plane forming an acute angle to the horizontal so that the upper belt **36** is closer to the lower belt **38** at the innermost turn-around thereof than at the turn-around closest to the inlet opening **20**. This arrangement of the belts **36** and **38** serves to guide any sheet like material inwardly of the enclosure **14**. The belts **36** and **38** are moved in the same direction with respect to each other, as indicated by the arrows in FIG. 1 and at substantially the same speed as rollers **26** and **28**, by motor **32** through a suitably coupled pulley and belt arrangement.

The narrow space between the inward ends, that is, the discharge end, of the belts **36** and **38** is suitably located above a feed rotor designated generally as **46** for feeding material onto such feed rotor **46**. The feed rotor **46** comprises an elongated shaft **47** extending transversely of the enclosure **14** and suitably supported in bearings **48** suitably mounted on lower struts **13***b* at opposite sides of the enclosure **14**. A series of disks **50** having peripherally spaced teeth **51** thereabout are uniformly laterally spaced longitudinally on the shaft **47**. The spacing between the disks **50** are suitably arranged and sized to suit a desired condition determined by the type of material to be disintegrated.

The shaft **47** of the feed rotor **46** is suitably coupled through a pulley and belt arrangement to motor **32** to be rotated in a counter clockwise direction as shown in FIG. 1. Feed rotor **46** is rotated at a relatively low speed, typically about 5 to 95 r.p.m., but this may vary according to the size of fragments desired. The speed of the belts **36** and **38** are generally about 10% less than the linear speed of the teeth **51** of the disks **50** of feed drum **46**. This speed differential will cause material engaged by teeth **51** (i.e., sheet like material) to be drawn under tension.

An elongated disintegrator rotor generally designated as **54** is transversely arranged with respect to the enclosure

14 inwardly of and above feed rotor 46. The disintegrator rotor 54 comprises an elongated shaft 55 suitably mounted in bearings 56 suitably mounted on upper struts 13*a* at opposite sides of the enclosure 14. A series of disks 58 are fixed to and laterally spaced longitudinally on shaft 55. Each disk 58 has two oppositely disposed radially extending projections 59 thereon. The projections 59 serve as hammers for acting on material to disintegrate it. The disks 58 are arranged with respect to one another so that the projections 59 are generally serpentine along the shaft 55. The lateral spacing of the disks 58 are arranged so that disks 58 pass between adjacent disks 50 of the feed rotor 46. The respective circles of revolution along the radial length of the projections 59 and the teeth 51 overlap. This overlapping of the circles of revolution should be such that the projections 59 extend to at least the root between the teeth 51. The expression "overlap" as used herein should be understood to mean the intersection of the circles of revolution of respective sets of teeth or projections (typically as illustrated) without the teeth or projections of such sets contacting each other when the sets are being separately rotated. (It should be noted that under certain circumstances the teeth or projections could contact each other, but only where they cooperate so that one of the sets of teeth or projections imparts a driving force to the other of the sets of teeth or projections. This will become apparent hereinafter.)

The disintegrator rotor 54 rotates at relatively high peripheral speed as compared to the feed rotor 46. A motor 60 suitably supported on a pad 61 suitably fixed to the left side of enclosure 14 is suitably coupled to the shaft 55 of the disintegrator drum 54 through a pulley and belt arrangement. The speed of rotation of the disintegrator rotor 54 is typically about 2250 r.p.m., but this may be varied to suit a desired disintegrating condition, controlled by the type of material to be disintegrated. The reason for this great speed differential between the disintegrator rotor 54 and feed rotor 46 is set forth in detail in co-pending application Ser. No. 534,506 now U.S. Pat. 3,396,514.

An elongated auxiliary feed roll 64 extending transversely of enclosure 14 as illustrated is arranged above the feed rotor 46 and slightly rearwardly thereof toward the inlet opening 20. The auxiliary feed roll 64 comprises a transversely extending generally cylindrical elongated shaft 65 suitably rotatably carried by bearings 66 suitably arranged on upper struts 13*a* at opposite sides of the enclosure 14. A plurality of rigid ribs 67 (eight illustrated) extend radially outwardly from and longitudinally of the shaft 65 in uniform angularly spaced relationship (45° as illustrated) with respect to one another. The center line of the shaft 65 is arranged with respect to the center line of the feed rotor 46 in such a manner, and the ribs 67 are of such a radial length, that ribs 67 overlap with the teeth 51 of disks 50 to about the mid point of the radial length of teeth 51. The radial length of the ribs 67 are of a suitable length so that any material fed into the enclosure 14 and carried forwardly by the belts 36 and 38 is engaged by the ribs 67 as the material is discharged through the space between the belts 36 and 38. The shaft 65 is coupled with motor 32 through a pulley and belt arrangement to rotate counter to and isochronously (i.e., uniformity of rate, and specifically uniformity of the linear speeds of the fins 67 and teeth 51) with the feed rotor 46. By so rotating, the ribs 67 of the auxiliary feed roll 64 will engage a portion B of sheet material A and bias that same portion B to distort it and urge it forwardly toward the feed rotor 46, and since the ribs 67 overlap with the teeth 51, that portion B of material A will be biased and deformed in between the teeth 51. The portion B of material A being held under tension on the teeth 51 of feed rotor 46 by the ribs 67 will then be carried by the teeth 51 in the direction of the disintegrator rotor 54. The biasing of the portion B of material A by the ribs 67 is released just prior to the initial impact of an impacting tooth 59 with the portion B. Subsequent portions of material A will be acted upon as just described and the material A disintegrated into distinct, substantially uniform pieces in the manner set forth in co-pending application Ser. No. 534,506.

It should be understood the shape of the auxiliary feed roll 64 is independent of any desirable variations of the other elements of this integrating machine 10. For example, the projections of hammers 59 of the disintegrator rotor could be replaced with radially outwardly extending pivotally mounted hammers without changing the characteristics of the auxiliary feed roll 64.

It should be further noted that certain material, such as paper cartons, small cans, hosing and the like, does not require tensioning on the feed rotor 46 in order to be efficiently disintegrated and in such cases the auxiliary feed roll 64 of the present invention would not require the converging belt arrangement of belts 36 and 38. For example, a chute could be arranged relative to the auxiliary feed roll 64 and feed rotor 46 for feeding material by gravity in between the auxiliary feed roll 64 and feed rotor 46. The results would be the same.

It should be also noted in the above description that due to the speed differential between the belts 36 and 38 and feed rotor 46 the auxiliary feed roll 64 causes the material being fed into the disintegrator to be placed in tension on the feed rotor 46. This is particularly desirable for certain materials, such as sheet material, for achieving disintegration of that material into distinct, substantially uniform pieces. This tensioning of the material on the feed rotor 46 will insure that the disintegrator drum 54 will efficiently shear the material by its projections or hammers 59 (in the manner set forth in co-pending application Ser. No. 534,506). Due to its ability to assist the tensioning of the material on the feed rotor 46 by holding the material in between the teeth 51, the auxiliary feed roll 64 provides positive advantages especially when used with material which would resist being impaled on the teeth 51 of feed rotor 46, such as sheet metal, rubbery material or the like. Furthermore, the auxiliary feed roll 64 is also effective with material which does not require tensioning on the teeth 51 of the feed rotor 46, such as material having a cross-sectional dimension less than the spacing between the disks 50 of the feed rotor 46. In this case the ribs 67 of the auxiliary feed roll 64 will engage such narrow material and force it in between the disks 50 so that this material will be wedged and held between the disks 50 and thus acted upon efficiently by the projections or hammers 59 of the disintegrator rotor 54. It might also be noted that where such narrow material is concerned the elongated ribs 67 could be replaced with axially spaced disks arranged to run in overlapping fashion in between the disks 50 of feed rotor 46.

Although the shaft 65 of the auxiliary feed roll 64 is described above as being fixed against vertical movement in bearings 66, it should be noted that a floating arrangement of shaft 65 can be provided. A typical floating arrangement is partially shown in FIG. 3. In this view, shaft 65 is suitably supported in bearings 70 (one of which is shown) disposed at an acute angle to the vertical on opposite sides of enclosure 14. The bearing 70 includes a lower portion 70*a*, suitably fixed to enclosure 14, and an upper portion 70*b*, slidably supported between oppositely arranged guide brackets 72 and 74. Guide brackets 72 and 74 are fixed with respect to enclosure 14. An elongated, upwardly extending threaded shaft 76 and is threadedly arranged at the lower end thereof in an opening (not shown) in the upper portion 70*a* of bearing 70. The shaft 76 has its longitudinal axis pitched at the same angle as the bearing 70. The shaft 76 is held fixed with respect to upper portion 70*a* by a nut and washer unit 77. A cup-like hollow housing 78 having an open lower end and a closed upper end is suitably fixed at its upper end to an intermediate portion of the shaft 76. A pair of nuts 79 and 80 is disposed on the

shaft near the lower end of the housing **78**. A coil spring **82** in compression surrounds the portion of shaft **76** within housing **78** and is suitably fixed between the inner upper end of the housing **78** and the nut **79**. A generally horizontal support member **84** is fixed to the enclosure **14** above the housing **78**, and the upper portion of shaft **76** extends through an opening (not shown) therethrough. A pair of nuts **85** and **86** are threaded at the upper end portion of the shaft **76**. A bushing **87** having a central opening therethrough is slidably disposed on shaft **76** between nut **86** and support member **84** and has a bevelled lower end in abutment with support member **84**. By this floating arrangement sheet-like materials of varying thickness can be accommodated by the auxiliary feed roll **64**. For example, auxiliary feed roll **64** could be arranged to act on a sheet material of known characteristics and thickness to urge such material in between disks **50** to a known depth. Further, in this example, the material could be sheet resilient rubber-like material. It should be noted parenthetically, that resilient, rubber-like material is best disintegrated with a typical disintegrating machine **10** by urging it relatively deeply between disks **50** to insure impaling on teeth **51**. Back to the example, if a thicker sheet material were then fed into disintegrating machine **10**, the auxiliary feed roll **64** would be urged upwardly against the spring **82**, thus preventing damage to feed roll **64** while at the same time providing the proper depth of interposing between disks **50** for such thicker material.

It should be further noted with respect to the floating arrangement described, that the vertical position of the auxiliary feed roll **64** can be adjusted by suitably turning the nuts on shaft **76** in the desired direction. The auxiliary feed roll **64** of FIGS. 1 and 2, although described as fixed in a horizontal plane, can also be readily adjusted in its vertical position by shimming the bearings **66** as desired, or in any other suitable manner.

The radial length of ribs **67** was described as being of a length to engage and bias a material to about the mid point of the radial length of teeth **51**. This radial length of ribs **67** can be changed to give a shallower or deeper urging on material, as desired. It has been found that rubbery and light weight material requires deeper urging while heavier weight material can be efficiently disintegrated with a shallow urging or by merely holding such heavier weight material on the teeth **51** without any significant distorting thereof.

Although the auxiliary feed roll **64** has been described as being separately driven isochronously with feed rotor **46**, this does not have to be the case. The auxiliary feed roll **64**, can be mounted to rotate freely, and in a manner to be given a driving force by the feed rotor **46** through the teeth **51** thereof engaging the ribs **67** of the auxiliary feed roll **46**. An isochronous relationship between the feed roll **64** and feed rotor **46** will still exist. It has been found that such a free rotating arrangement of the auxiliary feed roll **64** performs very effectively with newspapers, magazines, and such like materials. This free rotating variation applies to the parenthetical notation made previously with regard to the definition of "overlap" as used herein.

In all of the various arrangements set forth above the results are always the same—the particular material to be disintegrated is engaged by the projections or ribs **67** of the auxiliary feed roll **64** and urged toward and held on the feed rotor to be carried toward the disintegrator rotor. Accordingly, the number of ribs **67** illustrated, and the overall orientation of the auxiliary feed roll **46** with respect to the feed rotor **46**, can be readily varied as to number and position respectively, so long as the above function results.

What I claim is:

1. A method for feeding material in a disintegrating apparatus for being disintegrated therein, including the steps of directing material toward a rotating feed rotor having axially spaced material supporting surfaces; engaging the material before it reaches the feed rotor; biasing the material into supporting engagement with at least one support surface of the feed rotor; moving the material while in contact with said surfaces of the feed rotor into engagement with a disintegrating rotor rotating at a higher peripheral speed than the feed rotor; impacting the material a plurality of times while on the feed rotor.

2. The method as set forth in claim **1** including the step of releasing the biasing force on a part of the material just prior to contact of that part of the material by a disintegrating rotor.

3. The method as set forth in claim **1** wherein said engaging and biasing is by radially extending projections mounted on a rotating shaft mounted parallel to the feed rotor.

4. The method as set forth in claim **1** including the additional step of regulating the biasing of at least a part of the material in proportion to the relative thickness and hardness of different materials.

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