Sept. 24, 1957 W. H. BURGER ET AL 2,807,054

FLUFF MAKING METHOD

Original Filed April 18, 1947 5 Sheets-Sheet 1

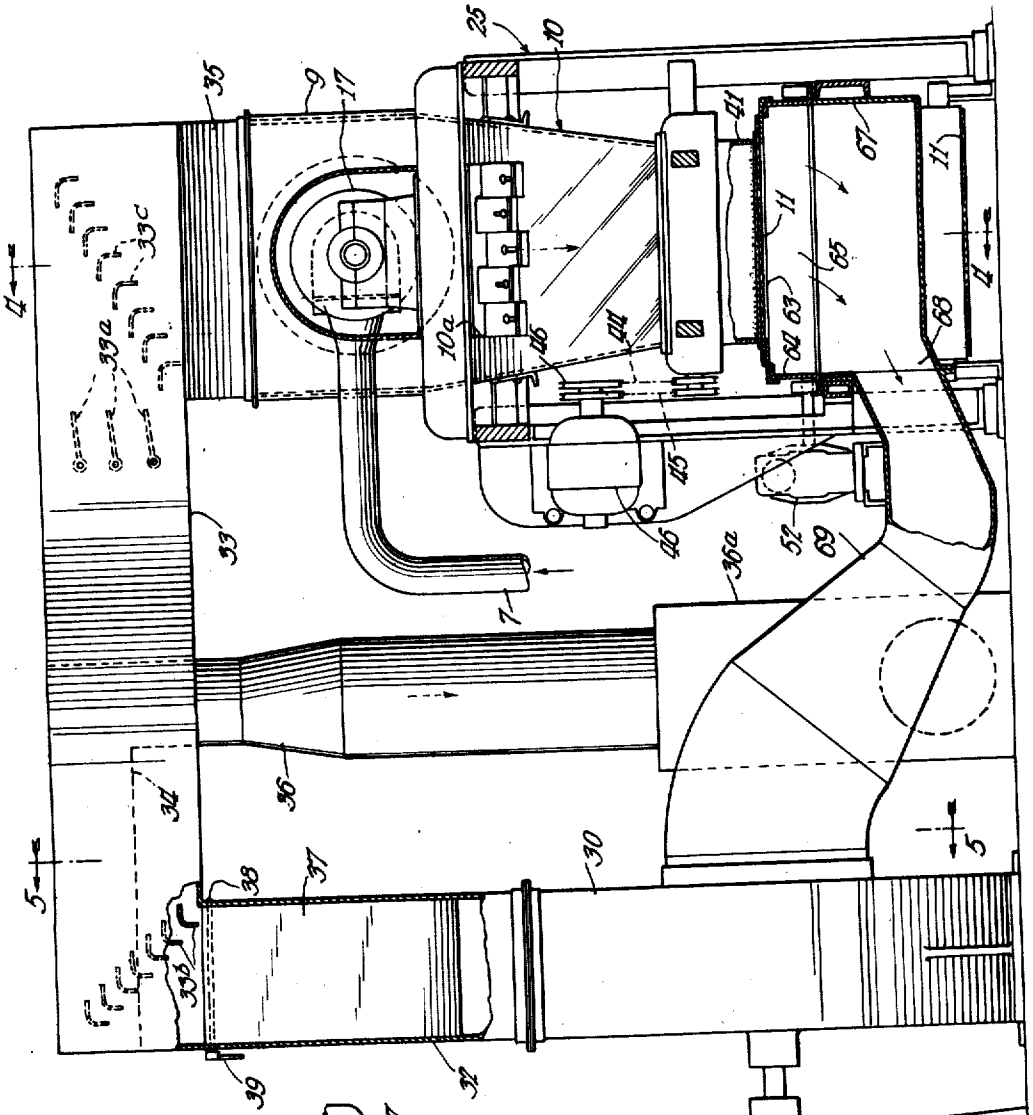


Fig. 2

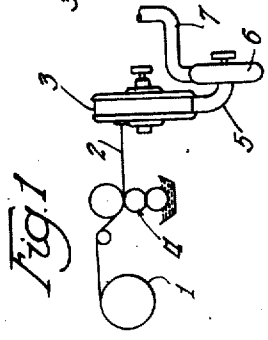


Fig. 1

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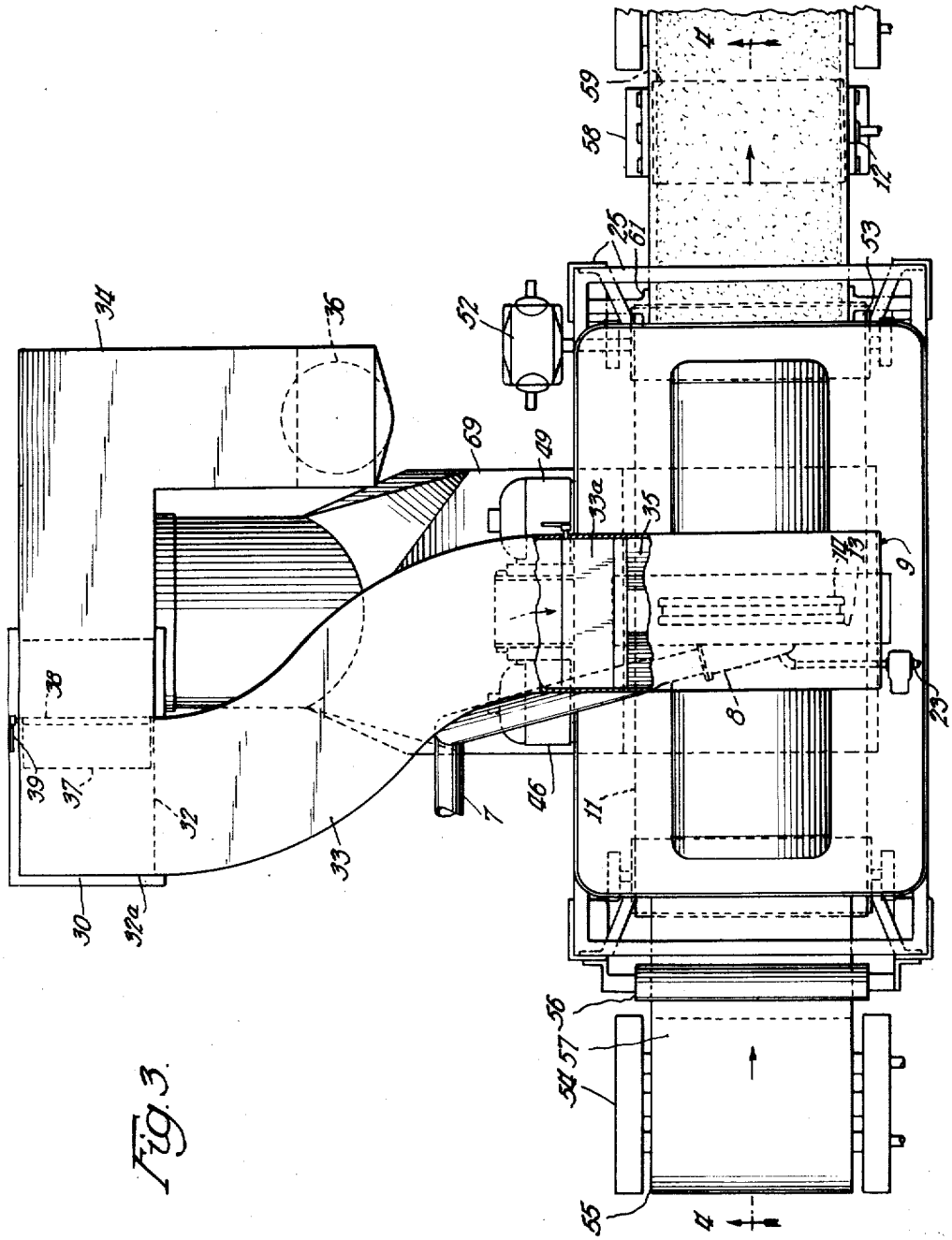


Fig. 3.

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FLUFF MAKING METHOD

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Fig. 4.

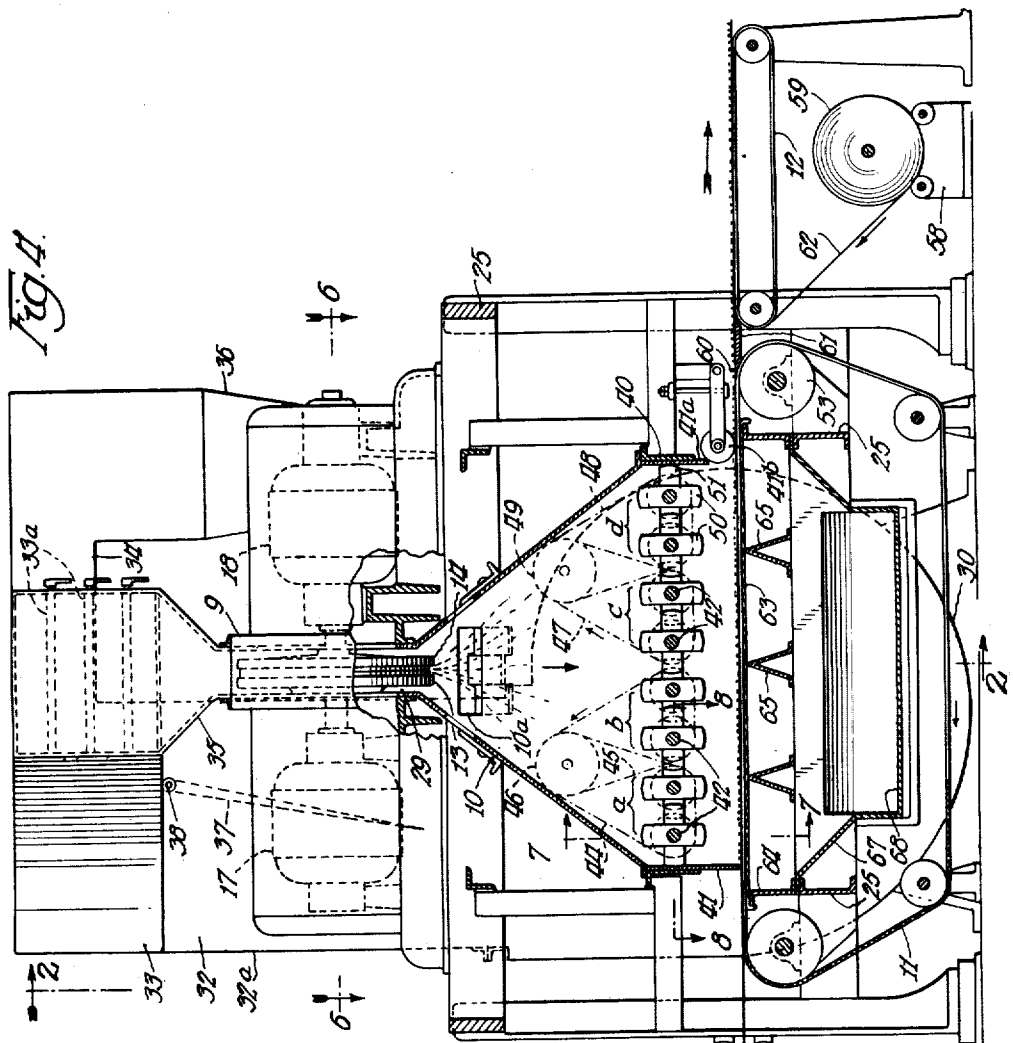
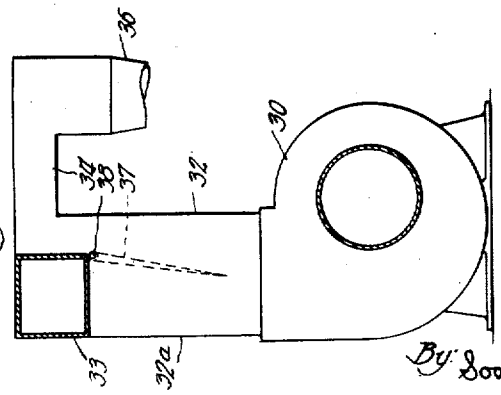


Fig. 5



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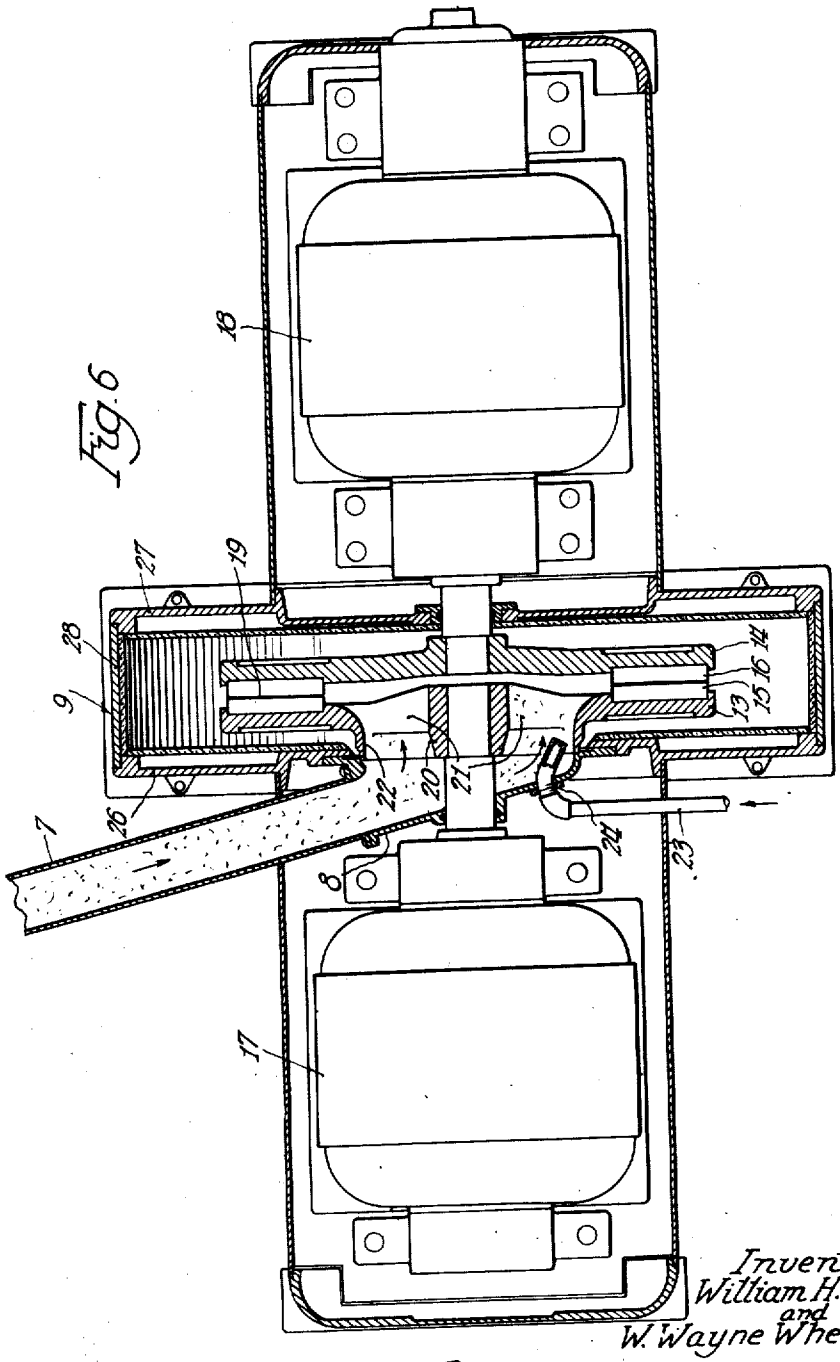
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FLUFF MAKING METHOD

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Fig. 6



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FLUFF MAKING METHOD

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Fig. 7

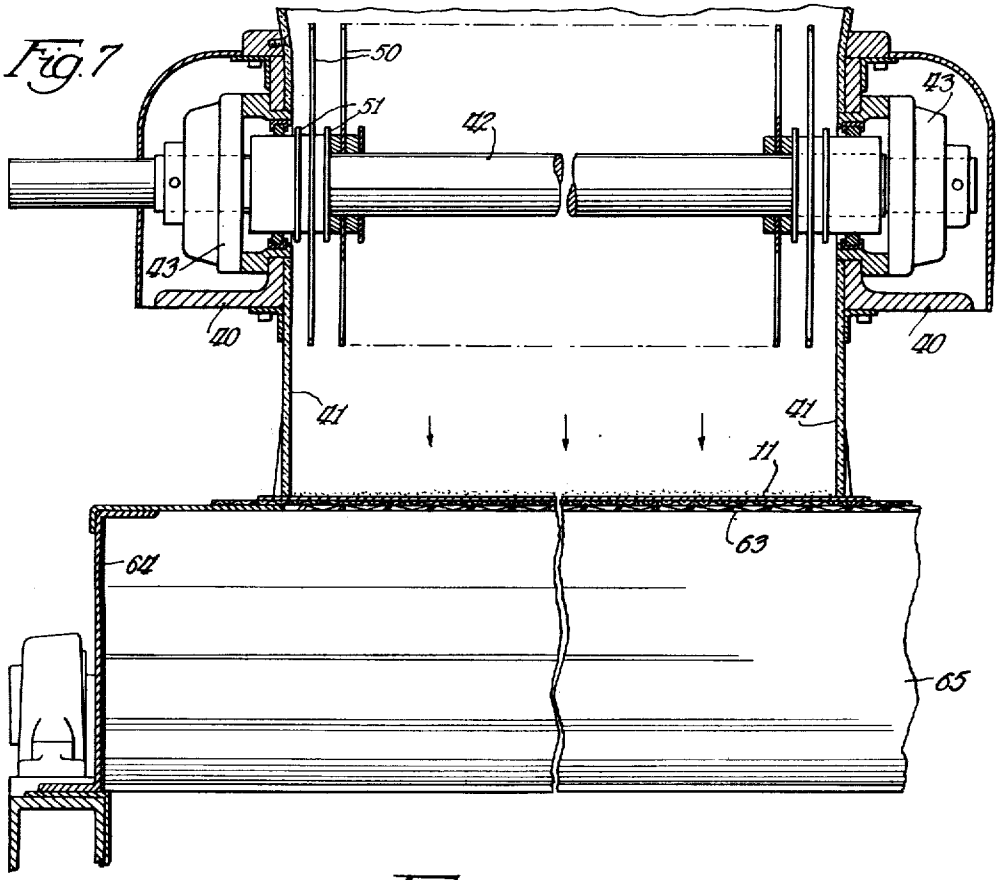
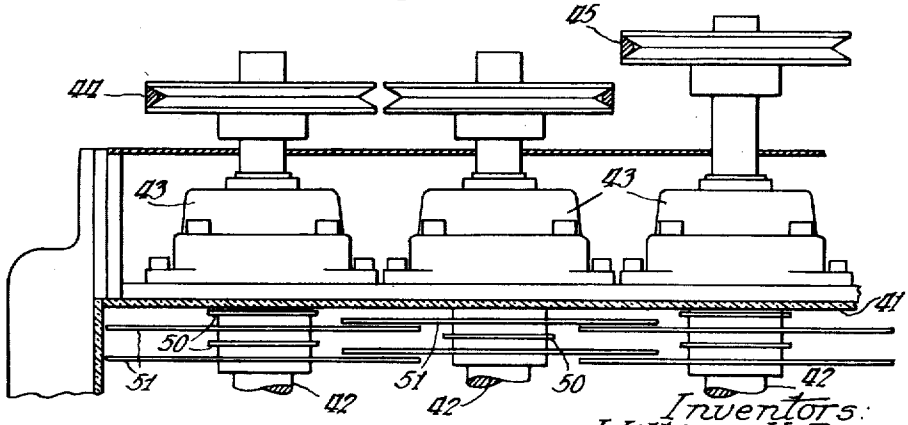


Fig. 8



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United States Patent Office 2,807,054 Patented Sept. 24, 1957

2,807,054

FLUFF MAKING METHOD

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Original application April 18, 1947, Serial No. 742,392, now Patent No. 2,689,985, dated September 28, 1954. Divided and this application January 29, 1953, Serial No. 334,050

7 Claims. (Cl. 19—156)

This invention relates to a fluff making method. The fluff referred to is a product made by disintegrating paper or papermaker's pulp so as to convert the material into a mass of independent fibres or small pieces which may embody a plurality of fibers in a single piece. Such disintegrated material is known and has been used for various purposes such as the preparation of absorbent and other pads. The material may also be used in the formation of insulation blankets, packaging materials such as padding, and other products.

The main object of the invention is to provide a method whereby papermaker's pulp, paper, paperboard or like material may be efficiently converted into fluff and into a web or pad of fluff material in which form it may be employed for making pad-like products, or any other products for which fluff may be suited.

Another object of the invention is to provide a method whereby the fluff produced will be of substantially uniform fineness and whereby the web or pad produced from the fluff will be very soft and of substantially uniform softness and thickness throughout its area.

Other objects and advantages of the invention will be understood by reference to the following specification and accompanying drawings (5 sheets).

In the drawings:

Fig. 1 is a more or less diagrammatic view illustrating typical mechanism employed for initially breaking down or disintegrating a web of papermaker's pulp;

Fig. 2 is an end view in which parts have been shown in section to reveal certain details of construction of apparatus for acting on the initially disintegrated material to complete its conversion into the desired fluff, the plane of Fig. 2 being represented by the line 2—2 in Fig. 4;

Fig. 3 is a plan view of the mechanism illustrated in Fig. 2;

Fig. 4 is a section on the line 4—4 of Fig. 2;

Fig. 5 is a section on the line 5—5 of Fig. 2 but on a reduced scale,

Fig. 6 is a plan section of the line 6—6 of Fig. 4; and

Figs. 7 and 8 are sections respectively on the lines 7—7 and 8—8 of Fig. 4.

Papermaker's pulpboard is a corse paper product which somewhat resembles ordinary blotting paper. Such pulpboard is well adapted to conversion into fluff because of the convenience with which the pulpboard may be handled and its low cost. Such pulpboard is supplied in rolls such as represented at 1 in Fig. 1 and the web 2 of the material (or scrap, clippings and other primary or recovered fibre material of suitable character) is suitably fed from the supply roll to a hammer mill 3 which is suitably actuated by any conventional means (not shown). For some purposes, the pulpboard may be moistened with water or other liquids or it may have wax or other material suitably applied to it by means of spraying or dipping, or by means of applicator rolls such as represented at 4 in Fig. 1. However, the application or other treatment of the pulpboard before being fed into the hammer mill 3 is not essential.

The outlet 5 of the hammer mill 3 is connected to a suitable blower 6 which may be also actuated by any power source (not shown), the partially disintegrated pulpboard being discharged through the conduit 7 which extends from the discharge port of the blower 6.

The conduit 7 carries the initially disintegrated material to the inlet port 8 (Figs. 3 and 6) of an attrition mill 9 which acts on the partially disintegrated material to break it down to the required fibre or fibre-like condition. From the attrition mill 9, the fibre-like material is discharged downwardly into the hood or forming chamber 10 (see Fig. 4) which is arranged over a foraminous belt 11 so that the fibre-like material will be deposited on the belt 11 to form a web or pad of the required thickness. The belt 11 is, of course, propelled continuously so as to deliver a finished pad from beneath the hood 10, the finished pad being transferred to a discharge conveyor 12 and thence to other mechanism for winding the pad on itself or otherwise treating or acting on the pad.

The attrition mill 9 consists of a pair of concentric, oppositely rotated plates or discs 13 and 14 (Fig. 6) which have their adjacent faces provided with cooperating grinding plates 15 and 16, respectively. The grinding plates 15 and 16 may each be formed in sections arranged continuously or in relatively spaced relation and their cooperating faces may be cut to provide various forms of ribs or ridges. The type generally known as "rapid-cut serrated plates" give good results under most conditions.

The discs 13 and 14 with their plates 15 and 16 are rotated in opposite directions by means of suitable electric motors 17 and 18 on the shafts of which the said discs are directly mounted. Provision is desirably made for adjusting the rotors 13 and 14 toward and from each other so that the spacing indicated at 19 between their grinding plates 15 and 16 may be varied to suit conditions incurred in operation. With certain kinds of papermaker's pulp, the clearance 19 between the grinding plates 15 and 16 should be about five thousandths (.005) of an inch, but this clearance may be reduced or increased to produce the desired results. The closer the plates are to each other, i. e., the less clearance provided, the finer will be the fluff discharged from the mill. The fineness of the fibre, that is to say, the degree of disintegration of the pulpboard, is also determined to some extent by the character of the ridges on the plates 15 and 16. In general, the finer the ridges, the greater will be the disintegration of the pulp.

As shown in Fig 6, the rotor 14 is a solid, plate-like member whereas the rotor 13 has its hub 20 connected by spoke-like elements 21 to the peripheral portion of the rotor. The rotor 13 is also preferably formed with a smooth-walled inlet opening or mouth portion 22 which communicates with the port 8 to receive the initially disintegrated pulp from the conduit 7. Moisture, preferably in the form of dry steam, may be injected into the initially disintegrated pulp through a steam pipe line 23 which communicates at 24 with the inlet port 8 so as to discharge moisture into the air-borne stream of fibrous material.

The steam is delivered under considerable pressure (for example, 50 to 60 pounds per square inch) and the jet of steam is advantageously directed toward the inside of the wall of the rotor mouth 22 so as to prevent the adherence of fibres thereto incident in part to centrifugal force. Stoppage of the mouth by accumulated fibre is thereby prevented. If the addition of moisture is not desired at this point, for example, if moisture is supplied elsewhere or not required, a jet of air may replace the jet of steam.

The attrition mill 9 and the driving motors 17 and 18 are suitably supported on a framework 25 (Fig. 4), which

is provided with suitable cross members and other parts for also supporting the forming hood **10**, conveyor **11** and other parts of the apparatus.

The disintegrated paper pulp delivered by the conduit **7** to the inlet of the attrition mill is caused by centrifugal force to pass between the cooperating grinding plates **15** and **16** of the mill to be thereby broken down to fibre-like form. The plates of the attrition mill may be so adjusted into such proximity to each other as to cause the pulp fed thereto to be discharged in the form of separated, substantially individual fibres, or the adjustment may be such that the discharged material will be in the form of fibre-like pieces embodying several fibers bound together. To produce a very light and well puffed-up fluff web, it is desirable that the discharge material be very fine but it is not essential that the pulp material be actually broken down into individual fibre form if that is ever actually accomplished.

The conduit **7** and all other paths through which the disintegrated pulpboard is caused to flow in the described apparatus are desirably made smooth walled and streamlined, i. e., free from recesses, projections and the like which would tend to trap any of the disintegrated material. The rotors **13** and **14** of the attrition mill are enclosed in a suitable metal casing which embodies outer side members **26** and **27** of metal and a metal circumferential band **28**, and a bottom discharge opening represented at **29** (Fig. 4) is provided in the casing. The casing comprising the said parts **26**, **27** and **28** is preferably lined with smooth surfaced material, the said lining being so arranged as to provide the desired smooth, non-trapping enclosure. Examples of suitable material for the lining are glass and synthetic glass-like sheeting, such as typified by commercially available "Lucite." Other smooth-surfaced materials may, of course, be employed, it being the purpose to prevent the disintegrated fibres from attaching themselves either mechanically or electrically to any of the surfaces with which they come in contact. Electrical attachment is preventable by proper moisture conditioning of the fibre and also, to some extent, by the use of lining material which is electrically non-conducting.

To promote the flow of the initially distintegrated material from the attrition mill and to deposit the material discharged from the hammer mill in the desired manner on the travelling screen **11**, a large volume of air is caused to travel downwardly through the attrition mill chamber. The volume of air is controlled so that its action on the fibers, and its fibre-depositing effect can readily be adjusted to obtain the required fluff deposit on the travelling belt **11**.

Air flow through the attrition mill housing or chamber **9** is induced by means of a blower **30** (Figs. 2, 3, and 5) which may be driven by an electric motor or the like indicated at **31**. The blower **30** discharges a column of air into an upwardly extending conduit **32** which is here represented as being of rectangular cross-section. At its upper end, said conduit **32** has two laterally extending branches **33** and **34**, the branch **33** leading to a downwardly extending hopper-like member **35** which communicates with the upper end of the attrition mill casing **9** as best shown in Figs. 2 and 4. The branch **34** connects with a downwardly extending conduit **36** which exhausts to the outside atmosphere through a suitable dust trap **36***a* which prevents any entrained fibre or fluff material from being discharged into the atmosphere.

The volume of air flowing through the attrition mill housing has an important bearing on the characteristic of the fluff material produced by the apparatus, and the said air volume is adjustable or controllable by means of an adjustable vane or valve plate **37** located in the rectangular riser **32** as best shown in Figs. 2 and 5. The vane **37** is hinged at its upper end as indicated at **38** so as to be pivotally adjustable toward and from opposite sides of the riser **32** to divide the column of air into separate columns which respectively enter the branches **33** and **34**. Adjustment of the vane **37** may be conveniently effected by means of a handle **39** secured to the pivot shaft **38** which carries the vane. Any suitable means (not shown) may be provided for locking the handle **39** and the vane **37** in selected position of adjustment.

As will presently appear, some of the air flowing through the apparatus is recirculated, and it will be seen that control of the volume or velocity of the air through the attrition mill housing and forming chamber is attained, at least in part, by regulation of the air columns which are directed into the branch **33** and outlet or discharge connection **36**.

The hood **10** previously referred to constitutes the upper portion of a chamber into which the disintegrated pulp is directly discharged by the attrition mill **9**. Said hood is supported on a horizontally disposed rectangular frame structure **40** which is in turn supported by suitably arranged main frame portions as represented in Fig. 4. Said horizontal frame **40** is provided with suitable lining plates **41** which extend from the upper edges of the respective sides of the frame structure downwardly to a point closely adjacent the conveyor belt **11** except to the extent that the liner plate **41***a* at the discharge side of said chamber has its lower edge spaced upwardly from the said conveyor a greater distance as indicated. A vertically adjustable sealing roll **41***b* is provided to more or less iron the issuing fluff web to uniform thickness as desired.

In said frame structure **40** there are rotatably mounted a series of shafts **42** which extend across the frame, the shafts being rotatably mounted in suitable bearings **43** carried by said frame **40**. Said bearings are sealed in any well known manner to prevent the entrance of any of the fluff material into said bearings. The shafts **42** are, in this instance, arranged in pairs, there being four pairs respectively designated, *a*, *b*, *c*, and *d* (Fig. 4). The shafts **42** of the pairs *a* and *b* are driven in a counterclockwise direaction as viewed in Fig. 4, the pair *a* being driven by means of a belt **44** and the pair *b* being driven by a belt **45**. The belts **44** and **45** cooperate with suitable pulleys on the shafts **42** and with suitable pulleys on the driven shaft of an electric motor **46** (Figs. 2 and 3) which is mounted on the main frame structure **25**.

The shafts **42** of the pairs *c* and *d* are driven in a clockwise direction as viewed in Fig. 4 by means of belts **47** and **48** which cooperate with suitable pulleys carried by the shafts and suitable pulleys carried by the driven shaft of an electric motor **49** which, like the motor **46** is supported by the main frame structure **25**.

Each of the shafts **42** is equipped with a series of plates or bars **50** and **51**, the said plates being of elongated form, and the plates **50** being disposed with their lengths extending transversely of the lengths of the plates **51**. The plates **50** and **51** of adjacent shafts **42** are staggered so that when the shafts rotate, the plates of one shaft will not engage the plates of another shaft but will pass each other side by side as shown in Fig. 8. The arrangement of plates **50** and **51** on the shafts **42** is continuous across the entire length of each shaft so that the fluff material descending in the chamber formed by the hood **10** and the frame **40** must pass through the screen-like bed formed by the multiplicity of plates **50** and **51** on the shafts **42**. These shafts are driven at a high rate of speed so that any collection of fibres can practically never pass through the said bed without being subjected to the breaking action of the plates of one or more of the rotating plate-carrying shafts which, for convenience, have been designated by the term "whizzers."

The fibrous material after passing through the whizzers is deposited on the screen conveyor **11** which is propelled continuously by means of a suitable electric motor **52** (Figs. 2 and 3) which, in this instance, directly drives the conveyor pulley **53** and thereby the conveyor band **11**. Suitable means is provided for adjusting the speed

at which the conveyor is driven so as to thereby permit adjustment of the depth of the fibrous material which will be collected on the conveyor belt and carried out of the depositing chamber under the edge of the lining plate **41***a*. Such speed-controlling means may consist of a variable speed motor **52** or any other desired equipment of which many are well known. In some instances it may be preferred to deposit the fibrous material directly on a web of creped tissue or other paper. To that end there is provided a suitable supporting stand **54** on one side of the mechanism for supporting a roll **55** of the desired paper, and guide rolls **56** for guiding the paper web **57** into place on the conveyor **11** as it enters the fluff-depositing chamber. A suitably driven feed belt **55***a* or other means may be provided for effecting delivery of the web to the screen belt **11**.

In other instances, it may be preferred to deposit the fibre directly on the belt **11** and to transfer the deposited web of fibres from the belt **11** to a paper web. For this purpose, a suitable stand **58** may be provided for supporting a roll **59** of the desired paper or other material, the web of material from the roll **59** being drawn upwardly and over the receiving end of another conveyor **12**. In that case, the web **60** of fluff can be stripped from the foraminous belt **11** by means of a transfer plate **61** which also serves to deliver the web of fluff to the conveyor **12** or to a web **62** on said conveyor **12**.

The foraminous conveyor belt **11** which passes under and forms the bottom of the depositing chamber, has its upper reach supported by means of a foraminous member **63** which may consist, for example, of a sheet of expanded metal. Said sheet of expanded metal is supported by a rectangular frame **64** which is slightly longer and wider than the rectangular frame **40** forming the lower portion of the depositing chamber, and said frame **64** is in turn supported by main frame portions **25** provided for that purpose. To further support the foraminous member **63**, a plurality of cross members **65** extend from side to side of the frame **64**, these supports being preferably in the form of inverted V-shaped members as represented in Fig. 4 so as to avoid any reduction in the area of air passageways through the supporting member **63**.

A hood **67** is formed below the frame **64** and suitably connected therewith as shown in Figs. 2 and 4 to provide a receiver for the air passing downwardly from the depositing chamber and through the conveyor **11** and supporting member **63**. Said hood **67** is provided with an outlet **68** at one side which is connected by means of a suitable conduit **69** to the inlet port of the blower **30** (see Fig. 2). The blower **30** is in a continuous flow air conduit or circuit wherein air is forced out of the discharge end of the blower through the conduit **32** into the branch conduit **33** and thence into the attrition mill housing **9** and downwardly through the forming chamber formed by the hood **10** and frame **40**, through the foraminous conveyor **11** and foraminous supporting member **63** into the hood **67** and back through the conduit **69** to the blower **30**.

The arrangement of the whizzers (the shafts **42** and plates **50** and **51**) in two oppositely rotating sets is such that these sets tend to spread the downward flow of fibre toward the ends of the forming chamber from the central portion thereof. This detail helps to secure even distribution of the fluff or fibre and the deposition of a uniform layer of fluff on the travelling conveyor. The fluff is, of course, somewhat forcefully deposited on the travelling conveyor incident to the air current which carries the fluff downwardly, and this is so even though a web of creped tissue or like paper **57** is first placed on the conveyor belt. The web of paper **57** will, of course, be quite porous as typified by creped tissue paper so that the air flow may continue at a sufficient velocity to produce the desired fibre deposition on the paper web.

The vane or deflector **37** should preferably be adjusted so that a slight vacuum will be maintained in the forming chamber. In the arrangement described, this is quite practicable by discharging an adequate portion of the air column through the discharge branches **34** and **36** by appropriate adjustment of the said deflector. It will be seen that the blower **30** is capable of withdrawing from the forming chamber through the conveyor belt, the hood **67** and the conduit **69** more air than is fed into the attrition mill through the conduit branch **33** when a sufficient portion of the withdrawn air is discharged to the atmosphere through the said discharge branch **34—36**. Pivotally adjustable deflectors represented at **33***a* in the conduit branch **33**, augmented by series **33***b* and **33***c* of deflectors or dividers, afford a desirable control of the air flow through the branch conduit **33** and into the attrition mill **9**. By appropriately positioning and adjusting these deflectors, substantially uniform dispersion of air currents through the housing of the attrition mill and into the forming chamber **10** can be effected.

The flow of the air-borne fibre from the attrition mill into the forming chamber may be further controlled by opening or closing openings such as indicated at **10***a* (Figs. 2 and 4) in the forming chamber hood. By regulation of such openings, the flow of fibre may be directed toward the central axis of the chamber which is between the two banks of whizzers. The fibres are then exposed to repeated action of the whizzers which tend to throw the fibres towards the opposite ends of the chamber. Complete breaking of any clots of fibres is thereby assured.

Although the forming chamber is preferably maintained under a slight vacuum, it should nevertheless be understood that the arrangement is such that a very high volume of air is maintained in the forming chamber in relation to the weight of fluff therein. The constant discharge of air from the circulating system is required to attain the indicated pressure control, because of the entrance of air into the system by leakage, especially at the forming screen, and because of the constant supply of air from the hammer mill **3** and its associated blower **6**.

In the production of a soft and uniformly deposited web of fluff material, it is desirable that the fiber-to-air ratio in the forming chamber be very low. A fiber-to-air ratio in that chamber of about 1.5 percent by weight, i. e., a weight ratio of about 1.5 to 100, or even less produces very desirable results for certain products. This ratio may be considerably lower and higher to produce acceptable products for various purposes. The moisture content and other characteristics of the fibre, the density of the desired product, its thickness, and other factors enter into the determination of the most suitable fibre-to-air ratio for production purposes.

About 15 pounds of pulp can be processed per minute with the recirculation of about 7000 cubic feet of air per minute in the illustrated apparatus in which the bottom dimensions of the forming hood are of the order of 60 inches in length and 30 inches in width, the length being in the direction in which the forming conveyor **11** travels. This air volume and screen size indicate an air velocity of the order of 500 feet per minute through the forming screen, but it may be observed that because of the expanding form of the chamber, this velocity is lower than that in the narrow upper portion of the forming chamber **10**. The said volumes of pulp and recirculated air indicate a fiber-to-air weight ratio of slightly less than 3 to 100.

The whizzers in the illustrated embodiment of apparatus are approximately 10 inches in diameter, and they are driven at a high rate of speed such as 1800 revolutions per minute. They are preferably located as near to the forming wire as possible without disturbing or preventing the fluff formation on the forming belt or conveyor **11**, the purpose of maintaining a close relationship between these parts being that of preventing re-clotting of the fibres which have passed through the whizzers, and which fibres it is desired to deposit in their separated form.

In apparatus of the illustrated proportions, there should be a pressure drop between the forming chamber above the forming wire **11** and the suction chamber below the same of from 2 to 10 inches of water, and it may be in the range of from 1 to 15 inches of water. Such a pressure relationship will insure the passage of the necessary amount of air through the forming area on the belt and the deposition of the separated fibres at the required rate for continuous operation of the apparatus. The higher the pressure differential, the closer can be the relationship between the whizzers and the forming area. Moreover, the higher pressure differential will result in faster movement of the separated fibres to deposited position on the forming belt, thereby aiding in preventing floating or migrating of the fibres toward each other into clotted or bunched condition.

In the described apparatus, steam has been referred to as being injected for moistening purposes. Other moistening means may be employed such as adding steam at the hammer mill entrance opening, spraying water on the pulpboard before it enters the hammer mill or humidifying the air before admitting it to the hammer mill. Also, the air which is recirculated in the apparatus may be humidified by any of the methods just indicated. However, the injection of steam into the attrition mill as illustrated is a very satisfactory manner of accomplishing the addition of moisture. Such steam does not merely moisten the fibres but also serves to humidify the air and serves as a conducting medium for transferring the charges on the fibres to the metal walls of the conduits which are grounded. This prevents static electricity from accumulating on the fibres and the fibres from being attracted to each other and to the walls of the conduits on which they might otherwise tend to collect with a tendency to close the conduits. Proper moistening of the fibres substantially eliminates adverse electrical effects and non-conducting conduits may be substituted for metal conduits if desired.

In addition to lining the attrition mill with smooth surfaced material such as glass or glass-like materials, plywood sheeting, stainless steel, etc., the walls of the forming chamber **10** and the lining plates **41** and **41***a* of the horizontal frame **40** are also preferably made of similar smooth surfaced materials so as to prevent as far as possible any adhesion and collection of fibres on those surfaces. Transparent glass-like material is preferably used for forming the walls of the forming chamber **10** so that the fibre formation can be readily observed and steps promptly taken to prevent any clotting tendency which may develop from time to time under varying operating conditions. Atmospheric temperature and humidity have some effect as do also the characteristics of the pulp being disintegrated and converted into fluff. Any pronounced tendency for fibre to collect on the walls of the forming chamber would be readily noticed, and it would, of course, be apparent that similar accumulation would be started on other passageways through which the fibre is conducted. Hence, the operators would be promptly forewarned of the need for the taking of steps to discourage and prevent such fibre accumulation.

The characteristics of the fluff web produced by the machine, especially the bulkiness or thickness of the web is influenced to a considerable extent by the pressure differential on the forming wire. The lower this pressure differential, the greater will be the bulk and softness of the fluff web formed.

The air-formed fluff web resulting from operation of the described apparatus is useful in many fields of which absorbent pads for bandages and other purposes, filters, insulation packing, etc., are examples. For application in these various fields, the density, thickness, and other characteristics of the web may require changing, and such changes can easily be effected by varying the pressure differential above and below the forming wire, the spacing of the cooperating plates of the attrition mill, the ratio

of fibre-to-air in the system, the speed at which the forming wire **11** is driven, and/or the mesh of said wire or a paper web thereon and other possible variables. The apparatus is capable of forming a 30-inch wide web of fluff material ⅛ inch thick at a speed of the order of 200 feet per minute. Greater speeds, for example 400 feet per minute may be attained under some circumstances and depending in part on the thickness and density of web desired, inherent capacity of the machine, character of the fibre, and other factors.

In instances where fine disintegration of the fibrous material is not required, and where the fibrous material supplied to the apparatus is of such character that it may be easily disintegrated, passage of the material through a single disintegrator such as a hammer mill or an attrition mill may be sufficient. In some instances, a hammer mill may be substituted for the attrition mill in the arrangement described.

Instead of mounting the attrition mill plates directly on the motor shafts, the mill plates may be belt or otherwise driven from the same or from separate motors.

The whizzers above referred to as being about 10 inches in diameter may be smaller or larger, if desired. Whizzers having a diameter of 6 inches have been successfully used.

This application is a division of our copending application, Serial No. 742,392, filed April 18, 1947, now Patent No. 2,689,985 issued September 28, 1954 and entitled "Fluff Making Method and Apparatus."

Various other changes in the described construction may be made while employing the principles of the apparatus as described, and without departing from the invention as set forth in the following claims.

We claim:

1. The method of making a loosely felted web of fibrous material which comprises the steps of producing an airborne stream of fibres in which the weight ratio of fibres to air is less than 10 to 100, and in which the velocity of the stream is of the order of 500 feet per minute, screening the fibre out of the stream, and subjecting the stream to a mechanical fibre-clot breaking and fibre spreading operation in advance of and in such proximity to said screening operation that the fiber travel distance between said operations is so short that the fibers are substantially provented from converging and forming slots during their travel between said operations, and maintaining the air pressure in said stream below surrounding atmospheric pressure.

2. The method of making a loosely felted web of fibrous material which comprises the steps of producing an airborne stream of fibers in which the weight ratio of fibres to air is within the range of from 1 up to 3 to 100, and in which the velocity of the stream is substantial, screening the fibre out of the stream, and subjecting the stream to a mechanical fibre-clot breaking and fibre spreading operation in advance of and in such proximity to said screening operation that the fiber travel distance between said operations is so short that the fibers are substantially prevented from converging and forming clots during their travel between said operations, and maintaining the air pressure in said stream below surrounding atmospheric pressure.

3. The method of making a loosely felted web of fibrous material which comprises the steps of producing an airborne stream of fibers having a fiber-to-air weight ratio which is less than 10 to 100, subjecting the stream to a screening operation by which the fibers are collected in layer form on a screen, causing the stream to flow at a velocity of around 500 feet per minute through the screen, and subjecting the stream to a fiber-clot breaking and fiber dispersing operation over an area which is approximately coextensive with the screening area and in advance of said screening operation but in such proximity thereto that the fiber travel distance between said operations is so short that the fibers are afforded but little

opportunity to converge and clot during their travel between said operations.

4. The method of making a loosely felted web of fibrous material which comprises the steps of producing an air borne stream of fibres in which the weight ratio of fibres-to-air is within the range of from about 1½ up to about 3 to 100, screening the fibres out of the stream by directing said stream at a substantial velocity under the action of a pressure differential against a travelling foraminous member, and subjecting the stream to a mechanical fibre-clot breaking and fibre spreading operation in advance of and in such proximity to said screening operation that the fibre travel distance between said operations is so short that the fibres are substantially prevented from converging and forming clots during their travel between said operations.

5. The method of making a loosely felted web of fibrous material which comprises the steps of producing an air borne stream of fibres in which the fibre-to-air weight ratio is about 1½ to 100, screening the fibres out of the stream by directing said stream at a substantial velocity under the action of a pressure differential against a travelling foraminous member, and subjecting the stream to a mechanical fibre-clot breaking and fibre spreading operation in advance of and in such proximity to said screening operation that the fibre travel distance between said operations is so short that the fibres are substantially prevented from converging and forming clots during their travel between said operations.

6. The method of making a loosely felted web of fibrous material which comprises the steps of producing an air borne stream of fibres in which the fibre-to-air weight ratio is sufficiently low that the fibre content of the stream is highly diluted, directing said stream at a substantial velocity against a travelling foraminous member while maintaining a pressure differential between the opposite sides of said foraminous member, thereby forcefully depositing said fibres on said foraminous member, subjecting the stream to a fibre-clot breaking and fibre spreading operation in advance of and in such proximity to said foraminous member to cause the fibrous material to reach said member as separated substantially individual fibres and/or fibre-like pieces, and maintaining the air pressure on both sides of said foraminous member below surrounding atmospheric pressure.

7. The method of making a loosely felted web of fibrous material which comprises the steps of producing an air borne stream of fibres in which the fibre-to-air weight ratio is within the range of from about 1½ to about 3 to 100, directing said stream at a substantial velocity against a travelling foraminous member while maintaining a pressure differential between the opposite sides of said foraminous member, thereby forcefully depositing said fibres on said foraminous member, subjecting the stream to a fibre-clot breaking and fibre spreading operation in advance of and in such proximity to said foraminous member to cause the fibrous material to reach said member as separated substantially individual fibres and/or fibre-like pieces, and maintaining the air pressure on both sides of said foraminous member below surrounding atmospheric pressure.

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