Sept. 13, 1960 A. A. BURGENI 2,952,260

ABSORBENT PRODUCT

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Fig. 1.

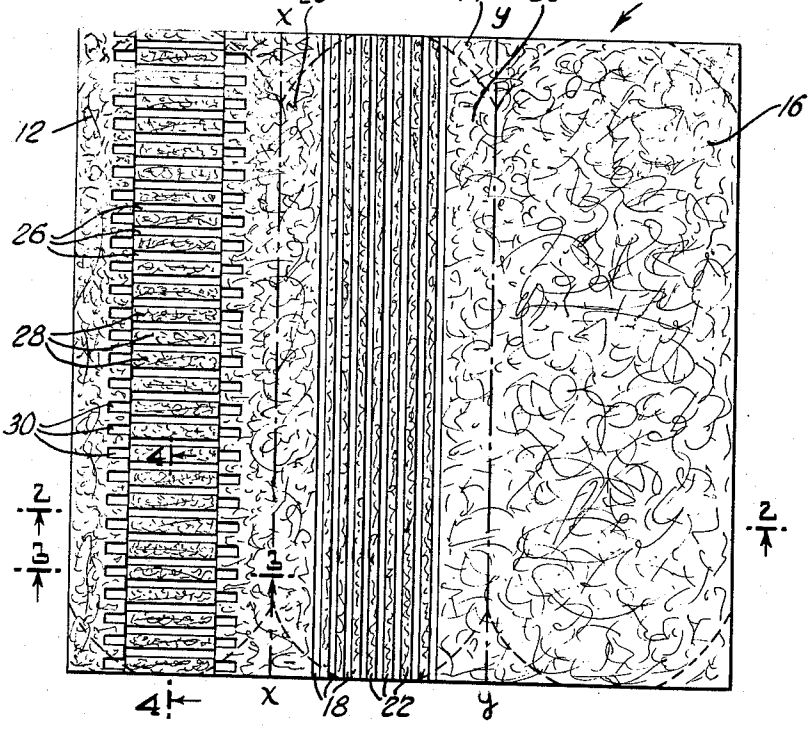


Fig. 2.

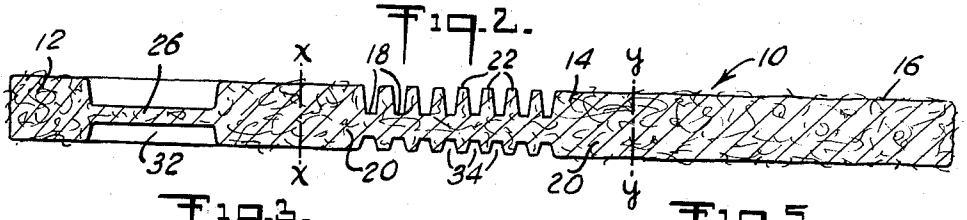


Fig. 3.

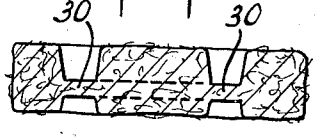


Fig. 5.

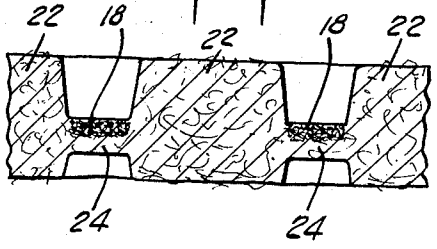
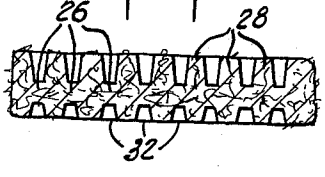


Fig. 4.



INVENTOR
ALFRED A. BURGENI
BY John Bennett
ATTORNEY

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ABSORBENT PRODUCT

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Fig. 6.

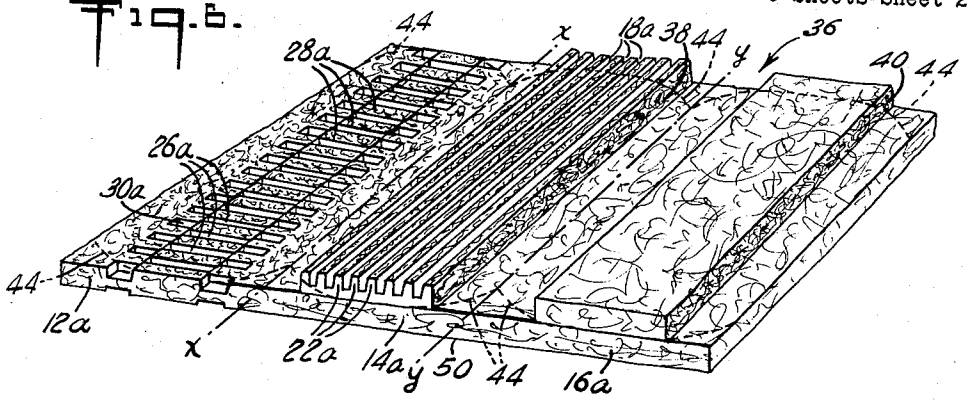


Fig. 7.

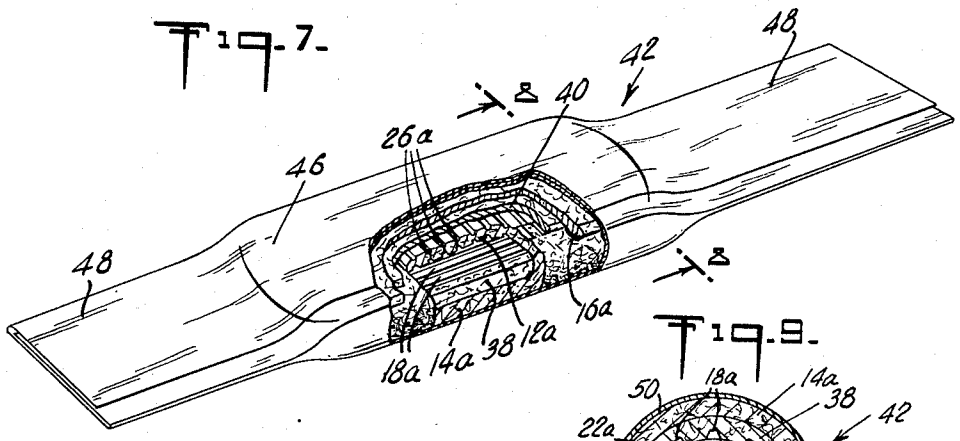


Fig. 9.

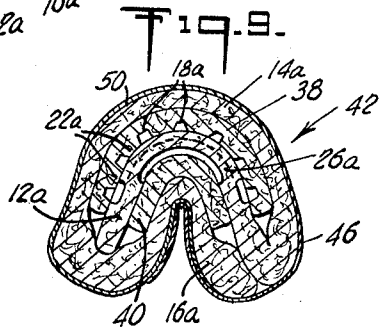


Fig. 8.

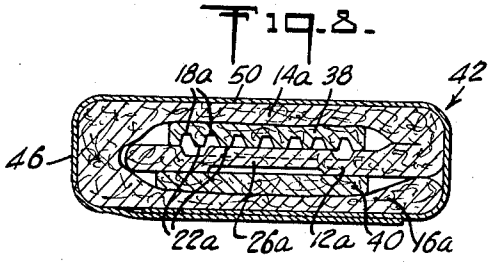


Fig. 11.

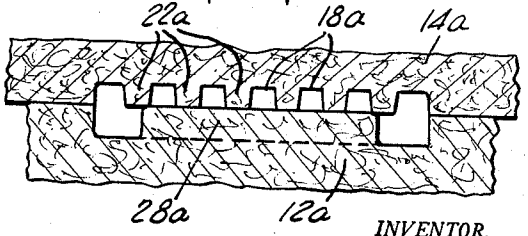
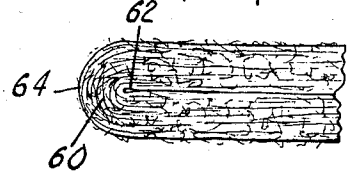


Fig. 10.



INVENTOR.
ALFRED A. BURGENI

BY

ATTORNEY

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Fig. 12.

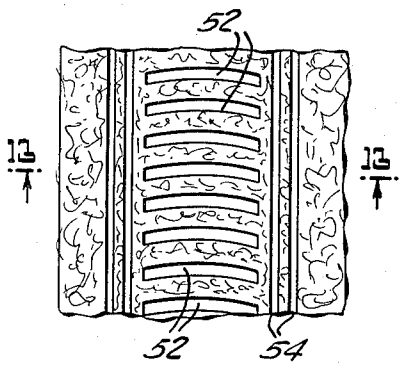


Fig. 13.

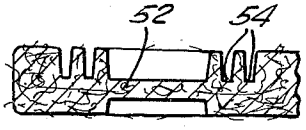


Fig. 14.

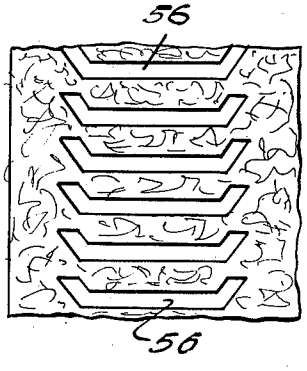
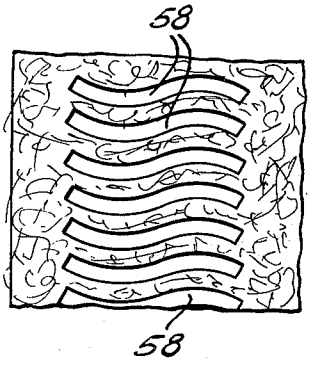


Fig. 15.



INVENTOR
ALFRED A. BURGENI
BY
ATTORNEY

United States Patent Office 2,952,260 Patented Sept. 13, 1960

2,952,260

ABSORBENT PRODUCT

Alfred A. Burgeni, Short Hills, N.J., assignor to Personal Products Corporation, a corporation of New Jersey

Filed Apr. 23, 1958, Ser. No. 730,285

28 Claims. (Cl. 128—290)

This invention relates to an absorbent product and more particularly to an absorbent fibrous body containing short, absorbent cellulosic fibers which may be used as an absorbent component in sanitary napkins and similar products for absorbing body fluids.

Short absorbent cellulosic fibers, such as comminuted wood pulp fibers and cotton linters whose lengths are in the region of about two mm. are low in cost and readily available. They are particularly suitable for use as absorbent components in numerous absorbent articles in the form of thick bats or plies because such bats have high bulk and volume, and rapidly absorb fluids. However, bats of such fibers are unstable, due mainly to the shortness of fiber length. They are tenuous and have low cohesive and tensile strength, do not retain their shape and volume when compressed or moistened, and have low capillary attraction and low fluid retentivity. When a bat of such fibers is saturated with fluid, it mats, becomes distorted and falls apart readily. When incorporated into an absorbent article, such as a sanitary napkin, it has been common practice to include with such bats other components, such as gauze, paper, or high bulk wadding, to impart to the napkin form and structural stability and desired fluid flow and fluid absorbency characteristics. A sanitary napkin without these additional components lacked form and structural stability and distorted readily in use upon the absorption of fluid.

The fluid absorption and fluid flow characteristics of bats of wood pulp fibers and like short absorbent cellulosic fibers, while suitable in some respects are unsatisfactory in others. When fluid is applied to the surface of a bat of such fibers, it penetrates the bat rapidly and strikes through to the bottom surface. The fluid absorbed remains essentially confined in the part of the bat directly under the area of application; i.e. it is not distributed laterally through the bat to any appreciable extent. Due to the low capillarity of the bat, it becomes quickly saturated with fluid in the region of application and its full absorbent capacity is not utilized. When a plurality of such bats is used, the bats still have poor fluid flow and fluid absorbency characteristics and, in effect, act as a single bat.

Attempts to overcome the problems noted above have included incorporating spacing elements and separate elements of paper and the like having elongated compressed areas on their surfaces to form channeling areas to aid in the distribution of fluid. However, in addition to increasing the costs of manufacture of such napkins, the inclusion of such elements still required additional components to provide form and structural stability and to obtain fluid penetration and absorbency laterally of the napkin. The bats still possessed their inherent disadvantages and their full potential had not been utilized.

In accordance with this invention, absorbent products, such as sanitary napkins, having as components thereof normally unstable fibrous bats containing a major portion of short, absorbent cellulosic fibers, such as comminuted wood pulp fibers, are provided with form and

structural stability and improved fluid flow and fluid absorbency characteristics by incorporating therein a plurality of such bats which have been stabilized longitudinally and, in the preferred form of the invention, transversely and longitudinally and which are so constructed and arranged as to provide for transmission of absorbed fluid from one bat to an adjacent bat. The absorbent products of the invention, as contrasted to like products which do not have incorporated therein the novel features of the invention, have increased capillarity, increased fluid retentivity and increased cohesive strength.

The invention contemplates a sanitary napkin consisting mainly of a cover and an absorbent core containing short, absorbent cellulosic fibers in the form of a plurality of layers or plies provided with zones of compacted and densified, cohered fibers to direct absorbed fluid lengthwise through the core and to impart longitudinal stability to the core. Such a sanitary napkin may include a ply or plies with zones of similar form and effect extending transversely of the plies, the zones of the respective plies cooperating to absorb fluid and to transmit the fluid from one ply to an adjacent ply whereby the absorbing effectiveness of the plies will be more fully utilized.

The invention also includes an absorbent core having zones of compacted and densified fibers and zones of uncompacted and undensified fibers arranged to define and limit the extent of absorption of fluid by the core. The invention further includes an absorbent core having at least two plies of short, absorbent, cellulosic fibers which plies have zones of compacted and densified fibers having high cohesive strength, capillarity and fluid retentivity and zones of uncompacted and undensified relatively non-coherent fibers of relatively low capillarity and fluid retentivity, the zones of uncompacted and undensified fibers being contiguous, but preferably in face-to-face contact, whereby fluid may be transferred from one ply to an adjacent ply through such zones.

The term "contiguous" zones includes zones which contact each other and also zones which are near or adjacent each other and which may be brought into operative relationship through the use of other components which permit transmission of fluid in the desired manner.

Reference is made to the accompanying drawings and the following description, wherein for illustrative purposes, the invention is described in connection with a sanitary napkin. It is to be understood, however, that the invention is not to be so limited and may be utilized in other products of similar function.

In the drawings,

Fig. 1 is a plan view of an integral web of absorbent fibers from which an absorbent core of the invention may be formed, illustrating different sections of the web provided with zones of compacted and densified, cohered fibers and zones of uncompacted and undensified, non-cohered fibers;

Fig. 2 is an enlarged sectional view of Fig. 1 along lines 2—2;

Fig. 3 is an enlarged sectional view of Fig. 1 along lines 3—3;

Fig. 4 is an enlarged sectional view of Fig. 1 along lines 4—4;

Fig. 5 is a magnified view illustrating in more detail the fiber form and arrangement of compacted and densified fibrous zones and uncompacted and undensified zones through certain parts of the web;

Fig. 6 is a perspective view in the preferred form of web from which the absorbent core of the invention may be formed, illustrating the build-up of certain areas thereon;

Fig. 7 is a perspective view of a sanitary napkin incor-

porating the absorbent core of the invention, cut away to reveal its interior construction;

Fig. 8 is an enlarged section of the napkin of Fig. 7 along lines 7—7, and inverted;

Fig. 9 is a view of Fig. 8 illustrating the form the napkin of Fig. 7 assumes when it is being worn in the preferred position;

Fig. 10 is an enlarged fragmentary view of the folded edge portion of the core formed by folding the webs of Figs. 1 and 6;

Fig. 11 is an enlarged view of a portion of the core illustrating the arrangement of the respective plies;

Fig. 12 is a plan view of a variation of the left panel portion of the web of Figs. 1 and 6;

Fig. 13 is a vertical section of Fig. 12 along lines **10—10**.

Fig. 14 is still another variation of the left panel portion of the web of Figs. 1 and 6; and

Fig. 15 is a still further variation.

Referring to Fig. 1 of the drawings, there is shown a thick rectangular-shaped web or bat **10** of short absorbent, cellulosic fibrous material, such as comminuted wood pulp fibers, cotton linters and the like, from which an absorbent core embodying the invention may be formed. The absorbent core is formed by folding the web longitudinally to form three superposed substantially co-extensive plies. By way of example, if it is desired to form an absorbent core 6.8 centimeters wide and 19.5 centimeters long for use in a sanitary napkin, the web would be about three times as wide as the desired width of the core, i.e. about 20 centimeters wide, and of the same length as the length of the core. Web **10** is divided into three parts or panels; a left panel **12**, a center panel **14** and a right panel **16**. The left panel includes the area of the web from its left side edge to fold line *x—x*; the center panel includes the area of the web between fold lines *x—x* and fold lines *y—y*; and the right panel includes the area of the web from fold line *y—y* to the right side edge of the web.

The absorbent core is formed from the web by first folding the left panel along fold lines *x—x* over on top of the center panel and then folding the right panel along lines *y—y* over the top of the folded left panel thereby forming three superposed plies with the left panel positioned in the center. The resulting folded web provides a core which has the form illustrated in Fig. 7, inverted. The left and center panels are approximately the same width and the right panel made slightly wider to allow for the extra width needed to fold the right panel over both the left and center panels.

A simple folded conventional web of short, absorbent, cellulosic fibers of the type described above in connection with Fig. 1 is tenuous and difficult to handle. Further an absorbent core formed from such a web possesses essentially all the inherent disadvantages of the web including lack of form and structural stability, poor capillarity and low tensile strength. In such form, its use in an absorbent product is limited and its use as the principal absorbent component in a sanitary napkin would be unacceptable.

To provide the absorbent core with the necessary properties of strength, form and structural stability, dimensional stability, high capillarity and fluid absorbency, the center panel **14** of the web is provided with a series of spaced longitudinally extending porous zones **18** in the form of rectangular bands of compacted and densified, cohered fibers. The compacted and densified zones may be continuous and extend the entire length of the panel, as shown, although this is not essential. Preferably, the series of longitudinally extending densified zones of fibers does not extend across the entire width of the panel, thereby leaving on each side zones **20** of relatively uncompacted, uncompressed fibers.

Referring to Fig. 5, the longitudinally extending zones **18** of compacted and densified fibers preferably do not extend through the web thickness; however, they may do so. The fibers in these zones, because of their compactness and density, have high capillarity and high fluid retentivity. The zones are sufficiently porous to permit fluid to be absorbed readily and to spread longitudinally in the direction of the zones. The zones **22** between the zones **18** of compacted and densified fibers consist of relatively uncompacted, non-coherent fibers. The zones **24** below the longitudinally extending zones may also be compacted and densified and have relatively high capillarity and fluid retentivity. Preferably, however, zones **24** below are less densified and have less capillarity and fluid retentivity than zones **18**. In the latter form, there is a transition in web characteristics through the web with regard to fiber density, coherency, capillarity and the like.

Again referring to Fig. 5, zones **18** in the web provide strength, form and structural stability to the web because of the compaction and densification, and coherency of the fibers therein. They are sufficiently porous, while still integrated, to permit absorption and penetration of fluid. The fibers in zones **22** and in zones **24** are relatively less dense, uncompacted and more porous, but have less capillarity. There is thus provided in the center panel longitudinally extending densified zones of compacted cohered fibers in part of the panel and adjacent zones of relatively uncompacted, non-cohered fibers.

The longitudinally extending zones **18** of compacted and densified cohered fibers impart longitudinal form and structural stability to the absorbent core and aid in integrating the web structurally in this direction. In addition thereto, they impart desired fluid absorbency and fluid flow characteristics to the core. The zones possess high capillarity and high fluid retentivity with the result that fluid impinged thereon will be distributed longitudinally of the web along the zones. When these zones become saturated with fluid, the excess fluid will spread to the adjacent relatively more porous zones **22**, and in one form of the invention to zones **24**, of relatively uncompacted, undensified, non-cohered fibers. These parts of the web act, in effect, as reservoirs for fluid.

Preferably, the side edge portions **20** of the center panel between the end longitudinally extending densified zones and the fold lines *x—x* and *y—y* are not formed with compacted and densified zones. In consequence, these parts of the panel are relatively bulky and of high volume. In this form they have low capillarity, and fluid reaching the longitudinally extending densified zones **18** will not tend to pass into these side portions but instead will tend to be transmitted mainly longitudinally in the direction of the longitudinally extending densified zones, thus minimizing side spread of fluid and maintaining the side edges of the panel in a relatively dry condition.

As noted above, longitudinal strength, form and structural stability is imparted to the absorbent core by the longitudinally extending zones of densified cohered fibers. The core thus resists deformation in the longitudinal direction. Transverse form and structural stability may be provided by forming, by way of example, the left panel with transversely extending spaced zones **26** of compacted and densified, cohered fibers like those extending longitudinally on the center panel. They are preferably somewhat denser than the longitudinally extending zones in the center panel and desirably extend through the panel in these regions. Zones **26** have characteristics similar to those in the zones **18** extending longitudinally on the center panel with regard to compactedness, coherency, tensile strength, good shape and structural stability and high capillarity and fluid absorbency and retentivity. The zones **28** on the left panel between the densified zones **26** are similar to the zones **22** in the center panel as described in connection with Fig. 5. The fibers in these zones are relatively uncompacted, undensified, non-coherent and of low capillarity. Preferably, the transversely extending densified zones **26** on the left panel do not extend to the side edges of the panel, but

terminate short thereof. This arrangement also minimizes the spread of absorbed fluid to the side edges of the panel.

In one suitable form of a sanitary napkin in accordance with the invention, the transversely extending densified zones **26** on the left panel are in the form of elongated rectangles of appreciable length positioned in the center of the panel. In addition thereto, similar, but considerably shorter, rectangular offset zones **30** are alternately positioned in the spaces between the centrally positioned densified zones and at the ends thereof. Zones **30**, which have the physical characteristics of transversely extending zones **26**, act as a further barrier to the flow of fluid to the side edges of the panel.

The right panel **16** does not have densified zones and has essentially the characteristics of the web as it is formed from the comminuted wood pulp fibers. Its principal purpose is to provide the desired thickness and bulk to the absorbent core to aid in integrating the structure and to absorb any fluid which may penetrate the center panel.

A suitable absorbent core embodying the invention for use in a sanitary napkin may be made from the web of Fig. 1 by comminuting sheet wood pulp in a mill to individualize the fibers, laying the fibers in the form of a thick bat 20 centimeters wide to a bulk density of about 0.031 gram per cc. and weighing 0.032 gram per square centimeter, and then spraying the surfaces of the web parts described above, specifically, the left and center panels, with about 0.003 ccs. of water per square centimeter of web surface. The amount of moisture applied to the surface of the web may be varied, but it is sufficient to insure the formation of coherent bonds such as hydrate bonds, between the cellulosic fibers in the zones desired upon the application of pressure.

Preferably, the left panel is formed with transversely extending zones of densified, cohered fibers which extend substantially through the entire thickness of the left panel, thereby imparting somewhat greater transverse strength to the left panel. As a consequence, the bottom surface of the left panel may have transversely extending corrugations **32** almost as distinctly defined as those formed on the top portion of the panel. This may be obtained by applying greater amounts of pressure to the left panel. The amounts of moisture and pressure may be suitably varied over a wide range as is known to provide transversely extending zones which have the desired properties in varying degrees, of porosity, high tensile strength, coherency, high capillarity, and the like.

Directly after the web is moistened, it is passed beneath compressing rollers having a peripheral form suitable to provide the densified zones of the desired shape on the left and center panels and compressed with sufficient pressure to form the coherent compacted and densified zones.

The center panel, which is approximately 6.8 centimeters wide, may be provided with eight, nine, or even more longitudinally extending densified zones **18** centrally positioned in the center panel, and being about 2 millimeters wide and spaced about 2.7 millimeters apart, thereby extending over a width of about 40 millimeters. The left panel having about the same width as the center panel, is provided with centrally positioned transversely extending densified zones **26** 39 millimeters long, 3.5 millimeters wide and spaced 3.5 millimeters.

The combination of moisture and pressure on the selected portions of the web results in the formation of the porous zones of compacted and densified, cohered fibers. The remaining portions of the web not contacted by the moisture and not compressed by the compression rollers remains relatively uncompacted, undensified and non-coherent. In the center panel some embossing **34** may be obtained on the surface of the panel opposite that to which moisture and compression is applied, and in the interior of the web, due to the compressing effect exerted upon these parts of the web by the compressing

roller. In the left panel, it is preferred, as noted above, that the zones of densified fibers extend through the panel. The web may then be folded along the fold lines of Fig. 1 to form the absorbent core in the manner described above, and enclosed within a cover or wrapper of suitable form.

The amount of moisture which may be applied to the web may vary, as for example, from about 0.002 to about 0.02 ccs. per square centimeter of web surface. When greater amounts of moisture are applied to the surface of the web, the moisture will penetrate deeper into the interior of the web. Consequently, when the moistened web is subjected to compression, somewhat denser zones of compacted cohered fibers will form. The amount of compression applied may also be suitably varied over a range as, for example, from about 10 to about 50 pounds per square inch. The amounts of moisture and compression applied are controlled on the basis of web thickness and density to provide porous, densified, coherent fibrous zones of high capillarity while simultaneously leaving the adjacent fibrous areas relatively uncompacted and non-coherent. Sufficient amounts of moisture and pressure are applied so that adjacent fibers in the moistened, compressed zones will be coherent, thereby integrating the fibers in the zones, and the absorbent core.

In Fig. 6, there is illustrated a web **36** of fibers from which an absorbent core embodying a preferred aspect of the invention is made. The web is basically similar to that illustrated in Fig. 1 and has a left panel **12***a*, center panel **14***a* and right panel **16***a*. In addition thereto, the center panel **14***a* and the right panel **16***a* are provided with increased thickness on their center portions by adding plies **38** and **40**, respectively, of absorbent fibrous material, to increase the bulk and volume of the absorbent core. The built up areas on the center and right panels may be formed integrally with the remainder of the web at the same time, or alternatively, may be formed as separate webs and then placed upon the panels.

A suitable web incorporating the features illustrated in Fig. 6 may be formed by first providing a base web by comminuting sheet wood pulp and laying the individualized fibers as a bat having the desired dimensions such as that described above in connection with Fig. 1 and weighing 0.020 gram per square cm. and having a bulk density of 0.031 gram per cubic centimeter. The additional ply **38** of absorbent fibers about 42 millimeters wide and of the same length as the length of the web is placed centrally upon the center panel **14***a* of the web. The ply may be of any suitable weight and bulk density and preferably weighs about 0.028 gram per square cm. The second ply **40** is placed centrally on the right panel **16***a*. This ply may also have substantially the weight and size of that placed on the center panel; preferably, it weighs about 0.020 gram per square centimeter. The left and center panels of the web are then sprayed with moisture. Preferably, the left panel is sprayed with less moisture than the right panel. By way of example, the left panel may be sprayed with 0.0012 ccs. of water per square centimeter of surface area and the center panel with 0.0045 ccs. of water per square centimeter of surface area. After the web panels have been sprayed with moisture, the web is then compressed by passing through compressing rollers having peripheral surfaces of suitable form to provide the longitudinally extending densified zones **18***a* and undensified zones **22***a* on the center panel, and the transversely extending densified zones **26***a* and undensified zones **28***a*, and the shorter, rectangular offset zones **30***a*, on the left panel.

In Fig. 11 there is illustrated the manner in which the superposed plies formed by folding the webs of Fig. 1 and Fig. 6 cooperate with each other to enable fluid absorbed by one ply to be transmitted to an adjacent ply. As illustrated in Fig. 11, and referring to Fig. 6, the longitudinally extending densified zones **18***a* on the

center panel are depressed below the top surface of the panel. The transversely extending densified zones **26***a* and the offset zones **30***a* on the left panel are similarly depressed. The zones, **22***a* and **28***a* on the respective panels between the depressed densified zones are relatively uncompacted and undensified.

When the plies are superposed, the zones of undensified fibers intersect and contact each other at their points of intersection. Due to their uncompacted, undensified structure the zones are highly porous to fluid. Accordingly, when the center panel **14***a*, or a region thereof, becomes saturated with fluid, the excess fluid will be transferred from the center panel to the left panel **12***a* through the uncompressed, undensified zones **22***a* on the center panel to the contiguous uncompressed zones **28***a* on the left panel. Transferrence of excess fluid from the center panel to the left panel through these zones is rapid and hence over-saturation of the center panel is minimized. As the excess fluid enters the left panel through its zones of uncompacted and undensified fibers, it is drawn into the transversely extending densified zones **26***a* and the offset zones **30***a* whereupon, because of the high capillarity of these zones, the fluid is spread transversely of the left panel. In this manner, the absorbing effectiveness of the left panel is utilized.

The contiguous zones of uncompacted, undensified fibers on the left and center panels may be arranged in any suitable manner whereby fluid will be transferred from the center to the left panel. If desired, a web of fluid permeable material, such as a thin, porous web of absorbent fibers, may be interposed between the left and center panels. In this form of the invention one side of the web would contact the uncompressed zones **28***a* on the left panel and the other side the uncompressed zones **22***a* on the center panel, thereby providing for transmission of fluid from the zones of uncompacted fibers on one panel through the web to the zones of uncompacted fibers on the other panel. Other suitable arrangements involving the inclusion of separate or additional elements between the panels may be employed while still retaining the desired fluid transmission features of the invention.

A sanitary napkin **42** incorporating the absorbent core of the invention and illustrated in Figs. 7–9 exemplifies the manner in which the arrangement of the compacted and densified, cohered fiber zones and the uncompacted and undensified, non-coherent zones in the various plies cooperate to provide the necessary form and structural stability to the sanitary napkin while also providing the desired fluid flow and fluid absorbency characteristics. The absorbent core portion of the napkin may be formed by folding the web of Fig. 1 or Fig. 6 in the manner described above. Referring to Fig. 6, after folding, the ends of the folded web may be cut, if desired, along the dotted lines **44** in an arcuate shape to form rounded ends on the absorbent core. The absorbent core so formed is enclosed within an outer cover or wrapper **46** of any suitable material, such as a permeable woven or non-woven fabric, having ends **48** extending beyond the ends of the absorbent core for attaching the napkin in position on the body of the wearer.

Preferably, the napkin incorporating the absorbent core formed from the folded web of Fig. 6 is placed in position on the body in a position inverted from that illustrated in Fig. 7 and in the manner illustrated in Figs. 8 and 9 so that the surface **50** of the center panel opposite the side having the longitudinally extending densified zones is placed against the body. In this manner of placement a surface area of relatively soft, highly porous, loosely compacted fibers will be adjacent the body and provide comfort. However, the napkin may be worn in a reversed position.

When fluid contacts surface **50** of the napkin, it rapidly penetrates the center panel into the interior of the absorbent core due to the uncompacted, highly porous nature of the surface fibers. Only a small stain pattern is formed on the surface of the napkin and lateral distribution of the fluid over the surface of the napkin is minimized. As the fluid penetrates through the loosely uncompacted surface fibers, it contacts the inner portion of the center panel having the longitudinally extending zones **18***a* of densified fibers of high capillarity whereupon the fluid is directed along the length of the absorbent core in the direction of the longitudinally extending densified zones. When the longitudinally extending densified zones become saturated with fluid, the fluid spreads into the adjacent zones **22***a* of relatively uncompacted fibers between the densified zones **18***a*. These zones are relatively uncompacted and have low capillarity and because of their high bulk and volume can store large amounts of fluid. If a zone of densified fibers adjacent the zone of undensified fibers is dry and has not been moistened with fluid, the fluid will be drawn by the dry zone of densified fibers from the moistened zone of undensified fibers because the densified zone has higher capillarity and then will be distributed longitudinally along the densified zone. By this arrangement, the absorbency features of the center panel are effectively utilized.

When the center panel or a region thereof becomes saturated with fluid, excess fluid is transferred to the left panel **12***a*, which is positioned directly below, primarily through the contiguous zones **22***a* and **28***a* of uncompacted and undensified fibers whereupon it is transferred transversely in densified zones in the left panel in a manner similar to that in which fluid is transmitted longitudinally in the center panel. Further, as the transversely extending densified zones in the center panel become saturated with fluid, the intervening zones of uncompacted, undensified fibers receive the excess fluid and retain it. It is thus seen that fluid passing from the center panel to the left panel is distributed laterally in the left panel after passing through the center panel, to utilize the absorbent effectiveness of the panel. Preferably, to prevent fluid absorbed by the panel from reaching the side edges of the panel and contacting the body of the wearer, the transversely extending densified zones terminate short of the side edges of the panel. The areas between the ends of the transversely extending densified zones and the side edges of the left panel consist of relatively uncompacted, undensified fibers having low capillarity and high volume. Accordingly, when fluid reaches the ends of the transversely extending densified zones, it will be restricted from spreading to these areas.

Transverse and longitudinal form and structural stability and the desired fluid flow characteristics may be imparted to the absorbent core of the invention through the use of zones of compacted and densified fibers and zones of uncompacted, undensified fibers of various forms. In Fig. 12, compacted and densified zones in the form of spaced, slightly arcuate bands **52** are shown positioned in the center of the panel and terminate short of the side edges thereof. In this form, there is also provided a spaced pair of longitudinally extending densified zones **54** on each side of the ends of the arcuate, transversely extending densified zones. Zones **54** are spaced slightly from arcuate zones **52** to minimize spreading of fluid passing beyond the ends of the arcuate zones and to transfer it longitudinally in the direction of the length of the panel, thereby preventing the fluid from striking through to the sides of the panel.

In Fig. 14, the transversely extending densified zones **56** are in the form of flat U's and in Fig. 15 the zones **58** are sinuous.

The variations illustrated in Figs. 14 and 15 do not disclose longitudinally extending densified zones of the type shown in Fig. 12, but may include such zones or other suitable modifications. The longitudinally extending zones on the center panel may also be similarly varied in form.

The zones of uncompacted and undensified fibers be-

tween the densified zones in each of the left panels of the foregoing examples are shaped similarly to the densified zones and are contiguous in part with the longitudinally extending zones of like characteristics on the center panel.

By way of example, there has been illustrated and described an absorbent core of the invention formed by folding an integral web having the respective panel portions including the longitudinally and transversely extending uncompacted and undensified zones as in Figs. 1 and 6. The formation of the absorbent core from an integral folded web has advantages and in some respects is preferred; however, the invention contemplates absorbent cores made from superposed individual plies of absorbent material. With an integral folded web shifting of the plies is minimized and further core stability is obtained. This feature is illustrated in Fig. 10 wherein there is shown a fold edge of the core formed by folding the plies on top of each other. The fibers **60** in the web at the fold **62** integrate the absorbent core and hold together the respective superposed plies by forming a side wall **64** common to the plies.

It is to be understood that web forms other than those referred to above may be used, that the absorbent core of the invention may be formed from folded or unfolded webs having densified zones of different configurations and arranged in different laminar relationships, and that other numerous variations and modifications may be made without departing from the spirit of the invention.

It is also to be understood that although the invention is particularly adapted to the making of highly absorbent cores from short, absorbent cellulosic fibers such as comminuted wood pulp fibers and cotton linters, the invention is not limited to cores of these short fibers, but is applicable to the making of similar cores from other similar fibers of different lengths.

This invention is a continuation-in-part of my copending applications, Ser. No. 579,083, filed April 18, 1956, and Ser. No. 587,015, filed May 24, 1956.

What is claimed is:

1. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, another of said plies having porous zones of compacted and densified, coherent fibers and intervening zones of loosely associated uncompacted fibers extending transversely of said ply, at least parts of said zones of uncompacted fibers in said plies being contiguous, whereby fluid may be transferred from one ply to the other ply.

2. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing comminuted wood pulp fibers, one of said plies having longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, another of said plies having porous zones of compacted and densified, coherent fibers and intervening zones of loosely associated uncompacted fibers extending transversely of said ply, at least parts of said zones of uncompacted fibers in said plies being contiguous, whereby fluid may be transferred from one ply to an adjacent ply.

3. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies formed from a folded web containing absorbent, cellulosic fibers, one of said plies having longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, another of said plies having porous zones of compacted and densified, coherent fibers and intervening zones of loosely associated uncompacted fibers extending transversely of said ply, at least parts of said zones of uncompacted fibers in said plies being contiguous whereby fluid may be transferred from one ply to the other ply.

4. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent, cellulosic fibers, one of said plies having longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, another of said plies having porous zones of compacted and densified, coherent fibers and intervening zones of loosely associated uncompacted fibers extending transversely of said ply, said zones of uncompacted fibers in said plies intersecting each other and being contiguous at the intersections whereby fluid may be transferred from one ply to the other ply.

5. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having longitudinally extending depressed porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening raised zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, another of said plies having depressed porous zones of compacted and densified, coherent fibers and intervening raised zones of loosely associated uncompacted fibers extending transversely of said ply, at least parts of said raised zones of uncompacted fibers in said plies being contiguous whereby fluid may be transferred from one ply to the adjacent ply.

6. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, an adjacent ply having porous zones of compacted and densified, coherent fibers and intervening zones of loosely associated uncompacted fibers extending transversely of said ply, the compacted and densified, transversely extending zones on said adjacent ply terminating short of the side edges thereof, at least parts of said zones of uncompacted fibers in said plies being contiguous, whereby fluid may be transferred from one ply to an adjacent ply.

7. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having continuous, longitudinally extending porous zones of compacted and densified, coherent, hydrate-bonded cellulosic fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, an adjacent ply having porous zones of compacted and densified, coherent, hydrate-bonded cellulosic fibers and intervening zones of loosely associated uncompacted fibers extending transversely of said ply, the compacted and densified, transversely extending zones on said adjacent ply terminating short of the side edges thereof, at least parts of said zones of uncompacted fibers in said plies being contiguous, whereby fluid may be transferred from one ply to the adjacent ply.

8. A sanitary napkin having an absorbent core and a cover for said core, said core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having longitudinally

extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, another ply having porous zones of compacted and densified, coherent fibers and intervening zones of loosely associated uncompacted fibers extending transversely of said ply, at least parts of said zones of uncompacted fibers in said plies being contiguous whereby fluid may be transferred from one ply to the other ply.

9. A sanitary napkin having an absorbent core and a cover for said core, said core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, an outer ply having longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, an adjacent inner ply having porous zones of compacted and densified, coherent fibers and intervening zones of loosely associated uncompacted fibers extending transversely of said ply, at least part of said zones of uncompacted fibers in said plies being contiguous, whereby fluid may be transferred from the outer ply to the adjacent inner ply.

10. A sanitary napkin having an absorbent core and a cover for said core, said core comprising a plurality of superposed absorbent fibrous plies formed from a folded web containing absorbent cellulosic fibers, an outer ply having continuous longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, an adjacent inner ply having porous zones of compacted and densified, coherent fibers and intervening zones of loosely associated uncompacted fibers extending transversely of said ply, at least part of said zones of uncompacted fibers in said plies being contiguous, whereby fluid may be transferred from the outer ply to the adjacent inner ply.

11. A sanitary napkin having an absorbent core and a cover for said core, said core comprising a plurality of superposed absorbent fibrous plies containing comminuted wood pulp fibers, an outer ply having continuous longitudinally exending porous zones of compacted and densified, hydrate-bonded cellulosic fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity; an adjacent inner ply having porous zones of compacted and densified, hydrate-bonded cellulosic fibers and intervening zones of loosely associated uncompacted fibers extending transversely of said ply, the compacted and densified transversely extending zones on said adjacent inner ply terminating short of the side edges thereof, said zones of uncompacted fibers in said plies intersecting each other and being contiguous at the intersections, whereby fluid may be transferred from the outer ply to the adjacent inner ply.

12. A sanitary napkin having an absorbent core and a cover for said core, said core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, an outer ply having longitudinally extending depressed porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening raised zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, an adjacent inner ply having depressed porous zones of compacted and densified, coherent fibers and intervening raised zones of loosely associated uncompacted fibers extending transversely of said ply, at least part of said zones of uncompacted fibers in said plies being contiguous, whereby fluid may be transferred from the outer ply to the adjacent inner ply.

13. A sanitary napkin having an absorbent core and a cover for said core, said core comprising a plurality of superposed absorbent fibrous plies formed from a single web containing comminuted wood pulp fibers, an outer ply having longitudinally extending depressed porous zones of compacted and densified, hydrate-bonded cellulosic fibers having high capillarity and fluid retentivity and intervening raised zones of loosely associated relatively uncompacted fibers having high volume, low capillarity and fluid retentivity, an adjacent inner ply having depressed porous zones of compacted and densified, hydrate-bonded cellulosic fibers and intervening raised zones of loosely associated uncompacted fibers extending transversely of said ply, the compacted and densified transversely extending zones on said adjacent inner ply terminating short of the side edges thereof, at least part of said zones of uncompacted fibers in said plies being contiguous, whereby fluid may be transferred from the outer ply to the adjacent inner ply.

14. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having a plurality of longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and similarly extending zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, another of said plies also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity extending transversely of said ply, said compacted and densified fibrous zones imparting form and structural stability to said core.

15. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having a plurality of spaced, longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, another of said plies also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers extending transversely of said ply, said compacted and densified fibrous zones imparting form and structural stability to said core.

16. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having a plurality of spaced, longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, another of said plies also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers extending transversely of said ply, said transversely extending compacted and densified zones terminating short of the side edges of said ply, said ply also having zones of compacted and densified, coherent fibers offset from said transversely extending zones and at the ends thereof, said compacted and densified fibrous zones imparting form and structural stability to said core.

17. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having a plurality of spaced, longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity

and intervening zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, another of said plies also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers extending transversely of said ply, said transversely extending compacted and densified zones terminating short of the side edges of said ply, said ply also having longitudinally extending porous zones of compacted and densified, coherent fibers between the ends of said transversely extending zones of compacted and densified, coherent fibers and the side edges of said ply, said compacted and densified fibrous zones imparting form and structural stability to said core.

18. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having a plurality of longitudinally extending porous zones of compacted and densified, coherent hydrate-bonded cellulosic fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, another of said plies also having zones of compacted and densified, coherent hydrate-bonded cellulosic fibers having high capillarity and fluid retentivity extending transversely of said ply, said compacted and densified fibrous zones imparting form and structural stability to said core.

19. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having a plurality of longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and similarly extending zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, another of said plies also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity extending transversely of and through said ply, said compacted and densified fibrous zones imparting form and structural stability to said core.

20. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having a plurality of longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and similarly extending zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, another of said plies also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity extending transversely of said ply and terminating short of the side edges of said ply, said compacted and densified fibrous zones imparting form and structural stability to said core.

21. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, one of said plies having a plurality of spaced, longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and similarly extending zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, another of said plies also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity extending transversely of said ply, said compacted and densified fibrous zones terminating short of the side edges of said plies, the fibers in the plies between the compacted and densified zones and the side edges of the plies being relatively loosely associated and uncompacted, said compacted and densified fibrous zones imparting form and structural stability to said core.

22. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies formed from an integral folded web, said plies containing absorbent cellulosic fibers, one of said plies having a plurality of spaced, elongated longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and similarly extending zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, another of said plies also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity extending transversely of said ply, said compacted and densified fibrous zones imparting form and structural stability to said core.

23. For use in an absorbent product, an absorbent core comprising a plurality of superposed absorbent fibrous plies of comminuted wood pulp fibers, one of said plies having a plurality of longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and similarly extending zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, another of said plies also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity extending transversely of said ply, said compacted and densified fibrous zones imparting form and structural stability to said core.

24. A sanitary napkin having an absorbent core and a cover for said core, said core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, an outer ply having a plurality of longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and similarly extending zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, an inner ply also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity extending transversely of said ply, said compacted and densified fibrous zones imparting form and structural stability to said napkin.

25. A sanitary napkin having an absorbent core and a cover for said core, said core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, an outer ply having on its inner side a plurality of longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and similarly extending zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, an inner ply also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity extending transversely of said ply, said compacted and densified fibrous zones imparting form and structural stability to said napkin.

26. A sanitary napkin having an absorbent core and a cover for said core, said core comprising a plurality of superposed absorbent fibrous plies containing absorbent cellulosic fibers, an outer ply having on its inner side a plurality of longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and similarly extending zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, an inner adjacent ply also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity extending transversely of said ply, said transversely extending zones terminating short of the side edges of said ply, said compacted and densified fibrous zones imparting form and structural stability to said napkin.

27. A sanitary napkin having an absorbent core and a cover for said core, said core comprising a plurality of superposed absorbent fibrous plies containing com-

minuted wood pulp fibers, an outer ply having on its inner side a plurality of longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and similarly extending zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, an adjacent side on an adjacent inner ply also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity extending transversely of said ply, said compacted and densified fibrous zones imparting form and structural stability to said napkin.

28. A sanitary napkin having an absorbent core and a cover for said core, said core comprising a plurality of superposed absorbent fibrous plies containing comminuted wood pulp fibers, an outer ply having on its inner side a plurality of spaced, continuous, longitudinally extending porous zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated relatively uncompacted fibers having high volume and low capillarity and fluid retentivity, an adjacent side on an inner ply also having zones of compacted and densified, coherent fibers having high capillarity and fluid retentivity and intervening zones of loosely associated uncompacted fibers extending transversely of said ply, said transversely extending compacted and densified zones terminating short of the side edges of the ply, said ply also having zones of compacted and densified, coherent fibers offset from said transversely extending zones and at the ends thereof, said compacted and densified fibrous zones imparting form and structural stability to said napkin.

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