United States Patent

Oelmann et al.

[15] **3,640,522**

[45] **Feb. 8, 1972**

[54] SHEET FOLDING APPARATUS

[72] Inventors: **Peter Oelmann**, Mount Royal, Quebec; **Peter Weisshuhn**, Willowdale, Ontario, both of Canada

[73] Assignee: **Johnson & Johnson**, New Brunswick, N.J.

[22] Filed: **Mar. 12, 1970**

[21] Appl. No.: **18,947**

[52] **U.S. Cl.** **270/72**, 270/93

[51] **Int. Cl.** **B65h 45/16**

[58] **Field of Search** 270/72, 61, 70, 71, 62, 63, 270/64, 65, 49, 50

[56] **References Cited**

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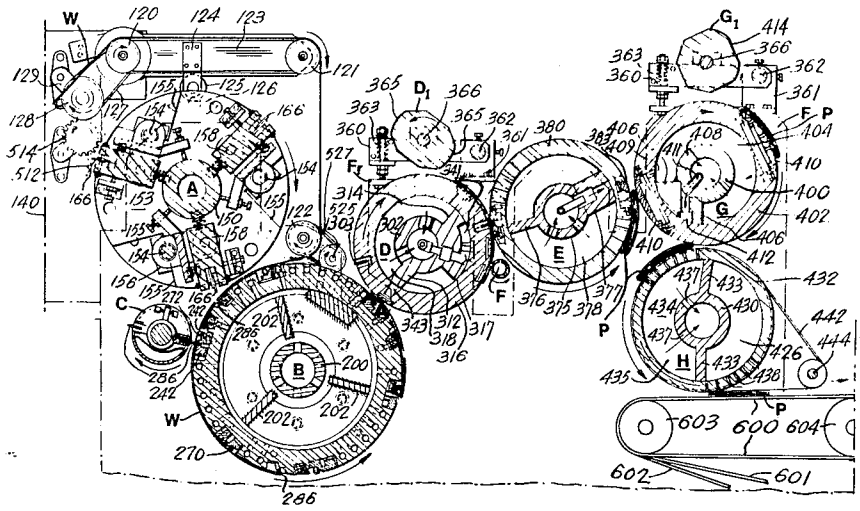
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Primary Examiner—Robert W. Michell
Assistant Examiner—R. P. Dyer
Attorney—Michael Q. Tatlow, Harold L. Warner and Robert L. Minier

[57] **ABSTRACT**

There is disclosed an apparatus for folding flexible material to form folded products such as dressings or surgical sponges at high production rate. The apparatus employs rotary drums to fold the flexible material in the longitudinal or machine direction and moving belts to fold the material in the lateral or cross machine direction. There are a number of rotary drums to cut and fold the material with transfer drums to move the material from one folding drum to the next.

36 Claims, 47 Drawing Figures



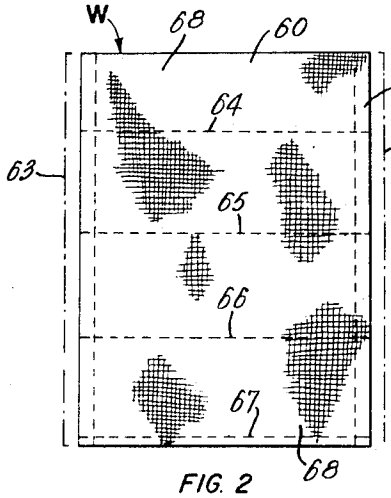


FIG. 2

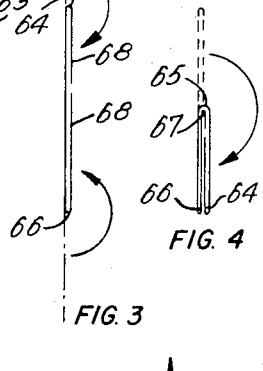


FIG. 3

FIG. 4

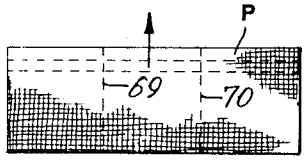


FIG. 5

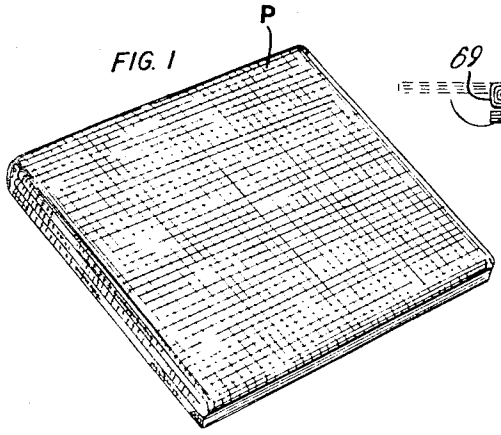


FIG. 1

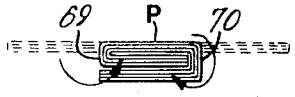


FIG. 6

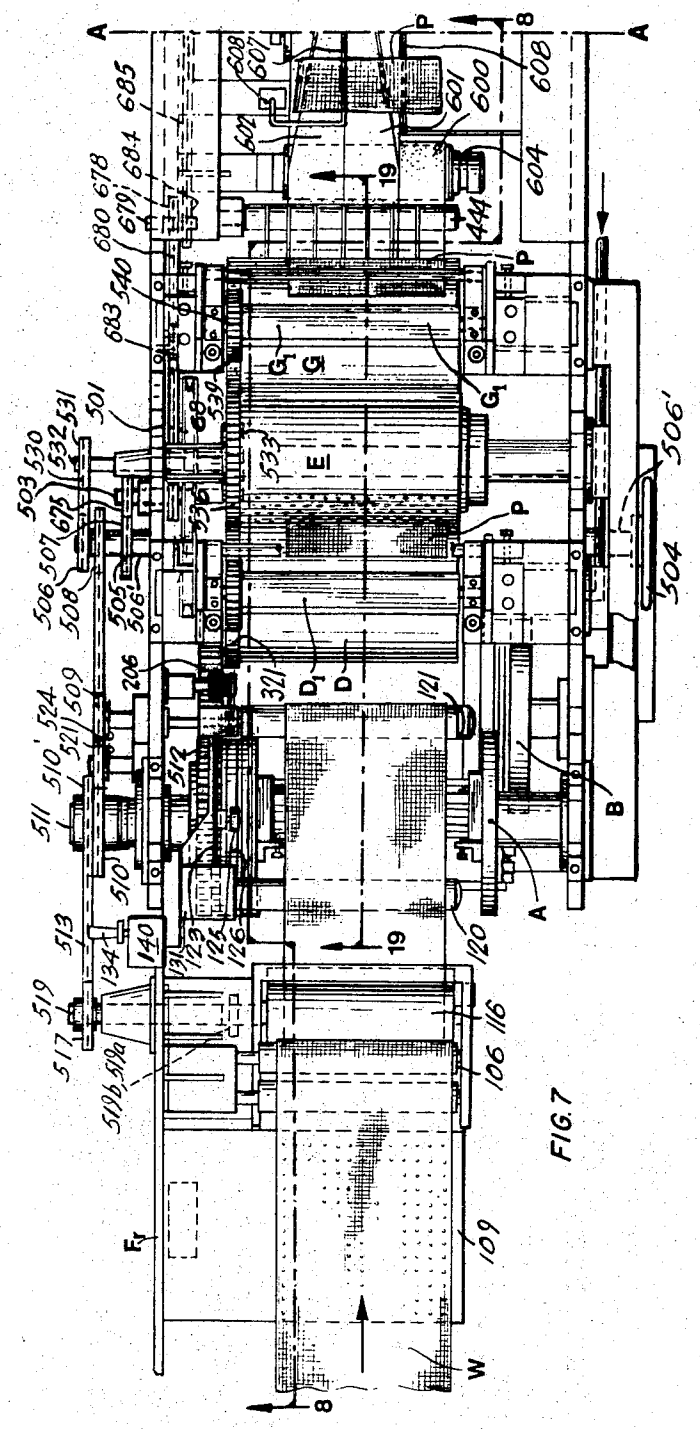

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FIG. 7

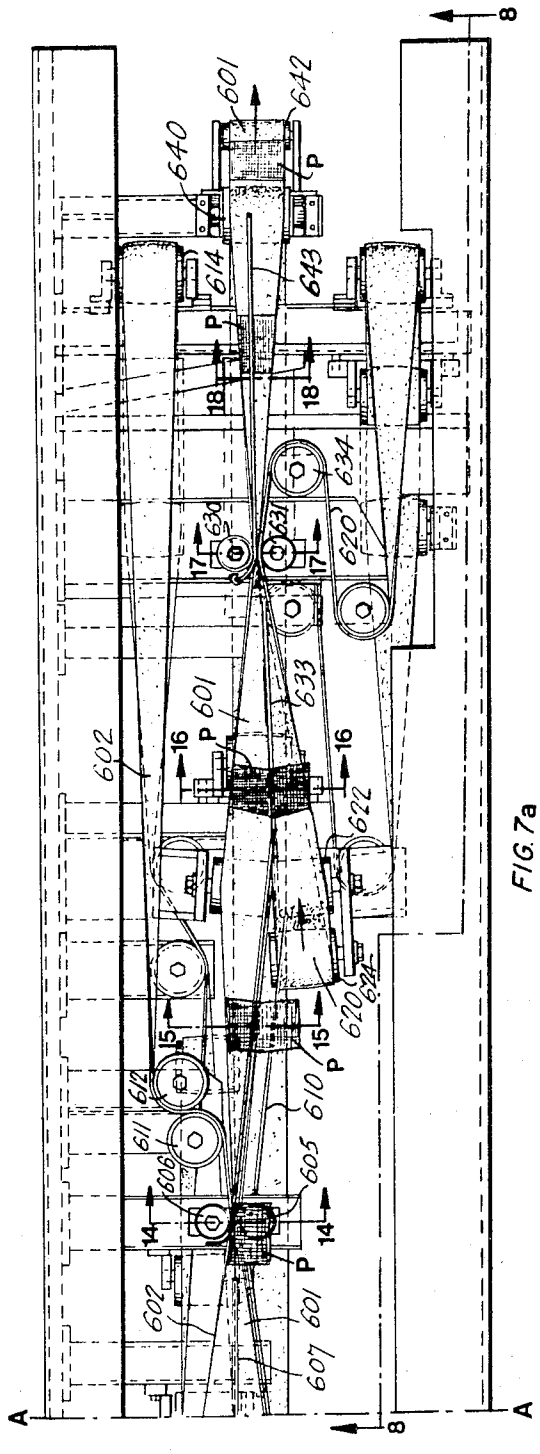


FIG. 7a

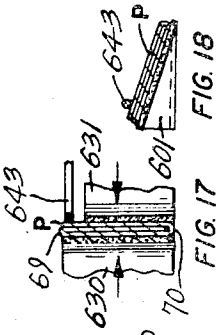


FIG. 17

FIG. 18

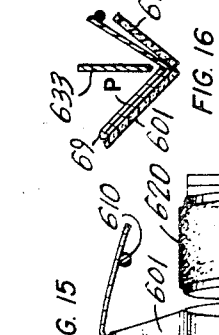


FIG. 16

FIG. 15

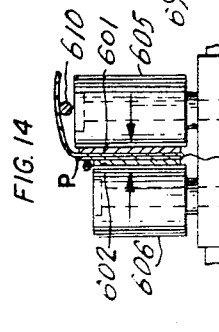


FIG. 14

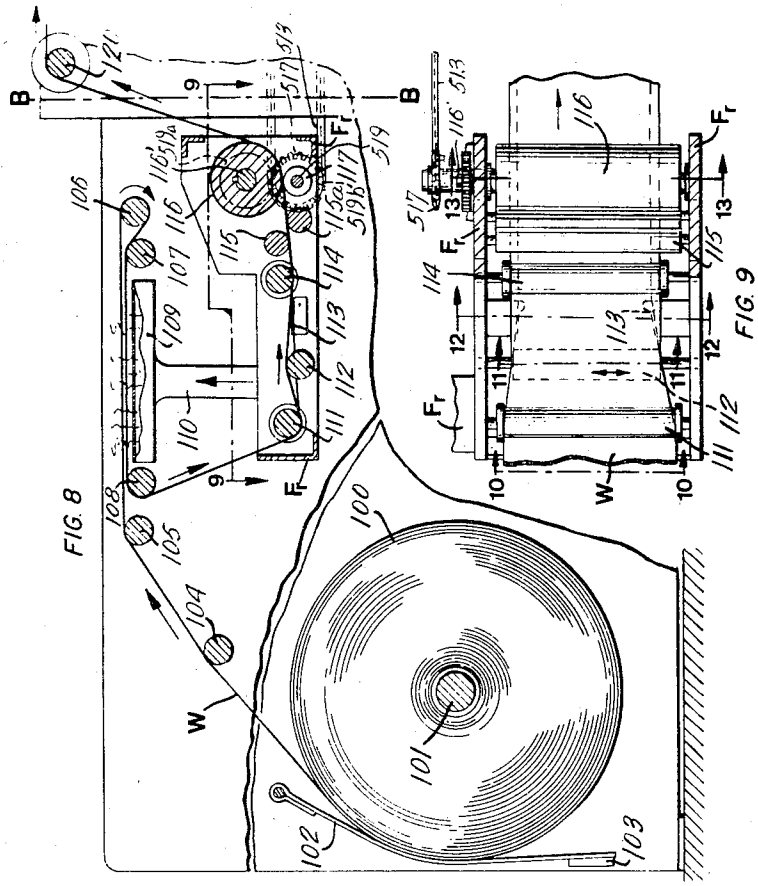


FIG. 8

FIG. 9



FIG. 10

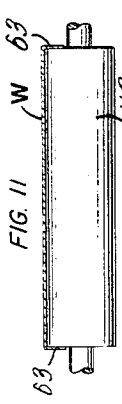


FIG. 11

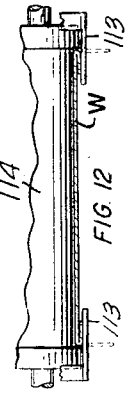


FIG. 12

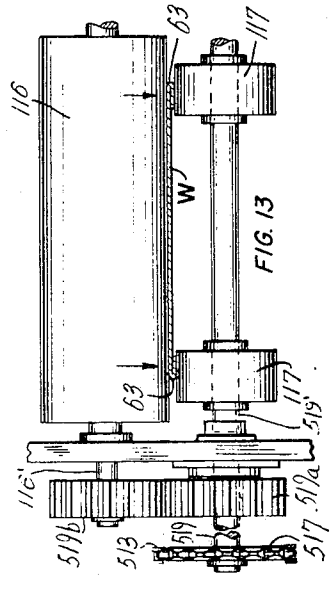


FIG. 13

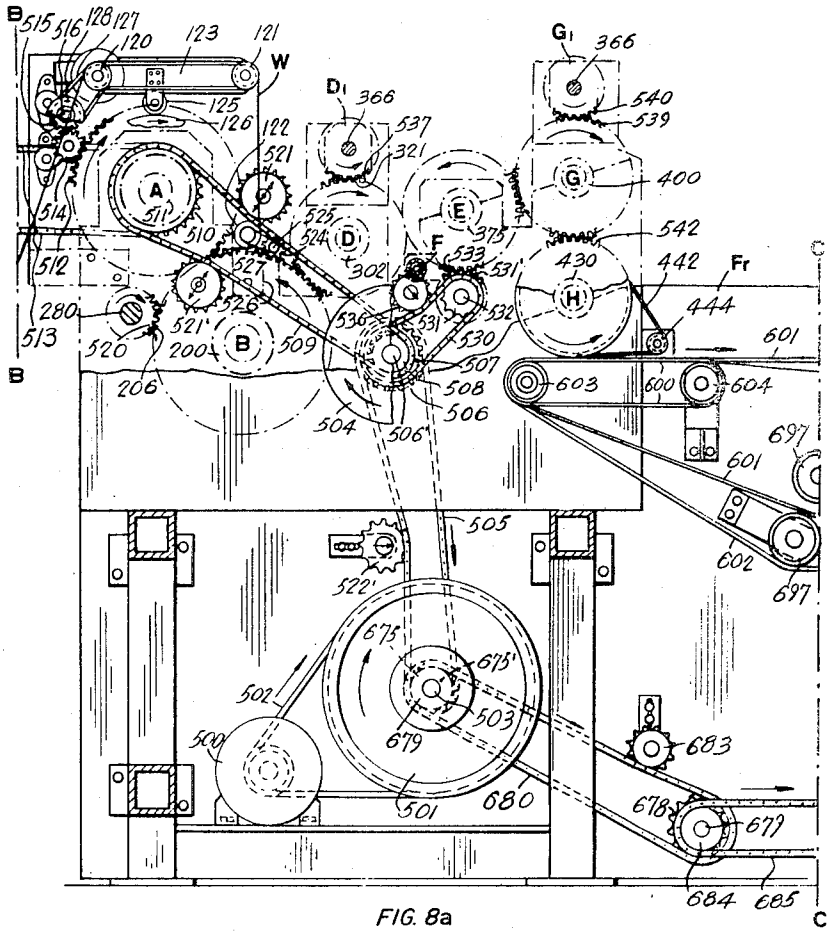

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FIG. 8a

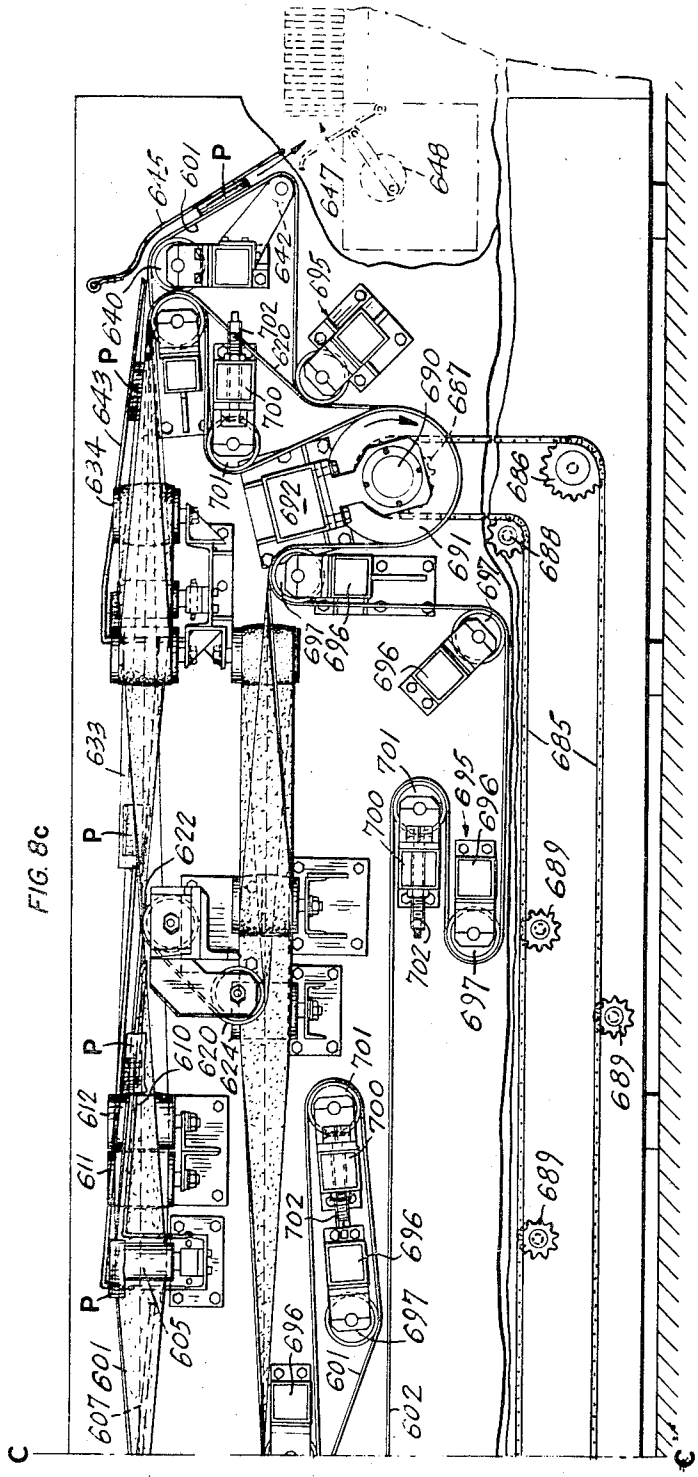

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FIG. 8c

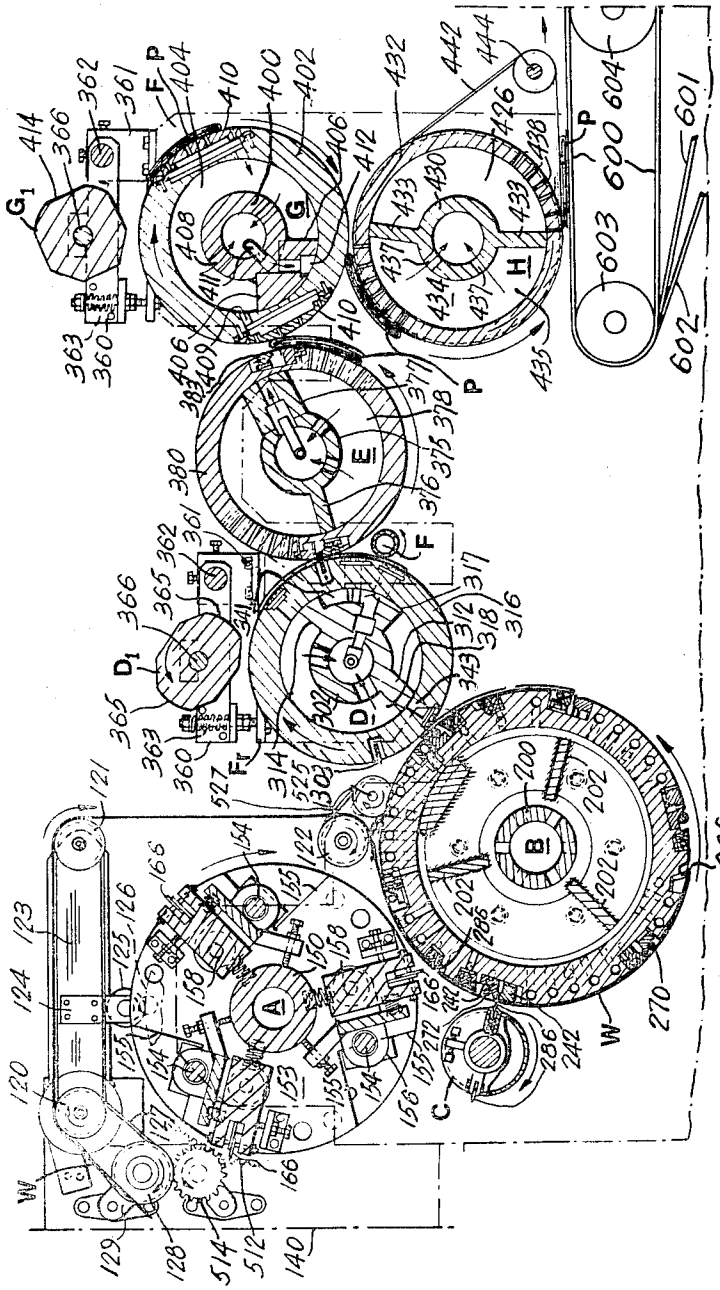


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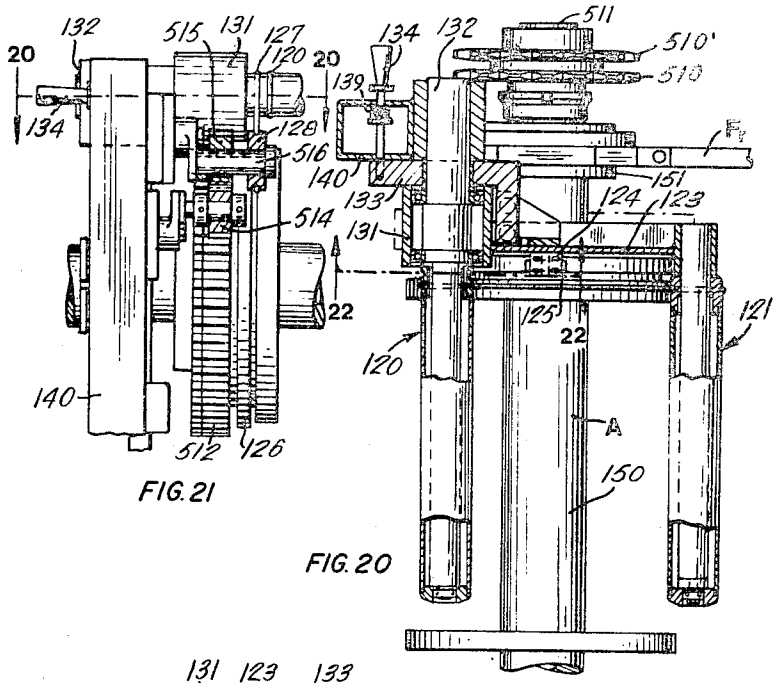


FIG. 21

FIG. 20

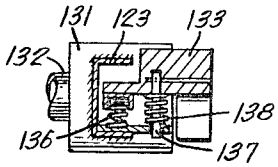
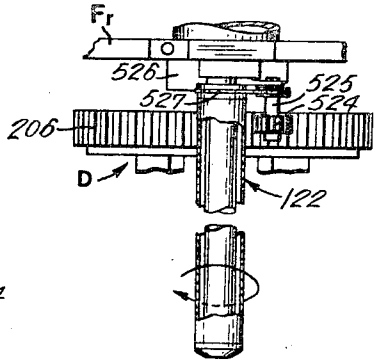


FIG. 23



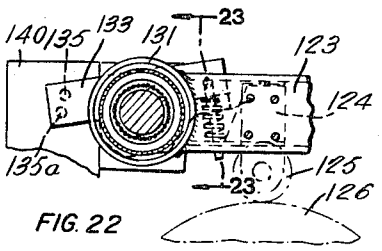


FIG. 22

FIG. 24

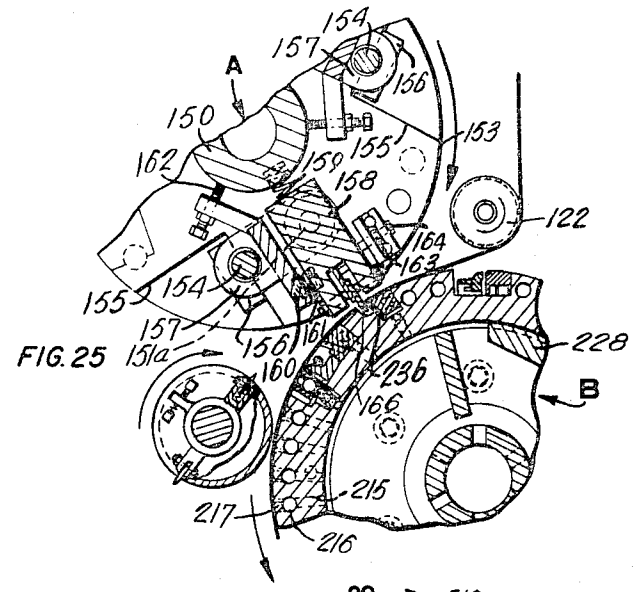


FIG. 25

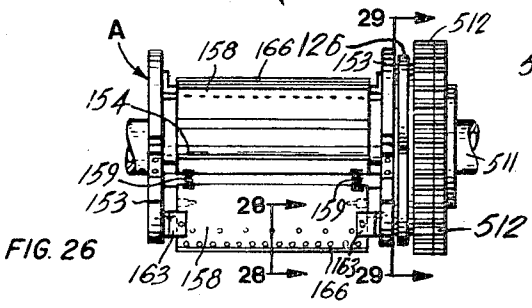


FIG. 26

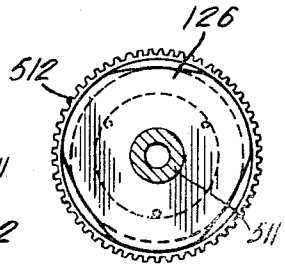


FIG. 29

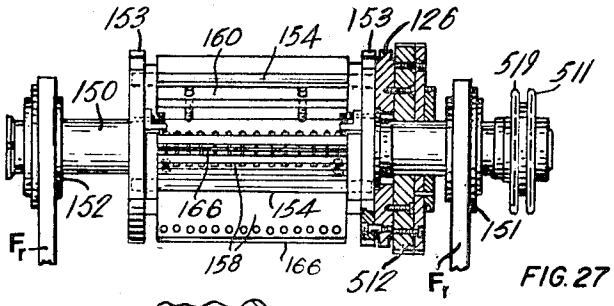


FIG. 27

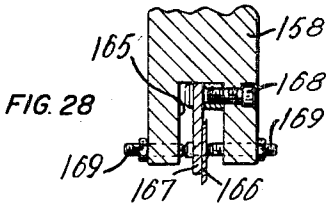


FIG. 28

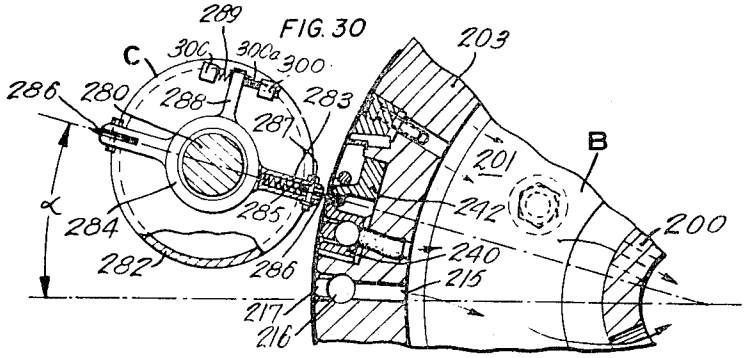


FIG. 30

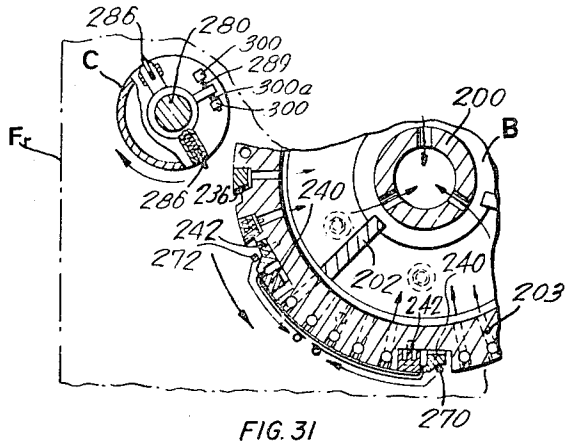


FIG. 31

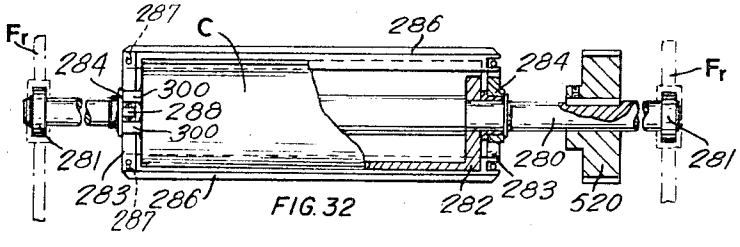


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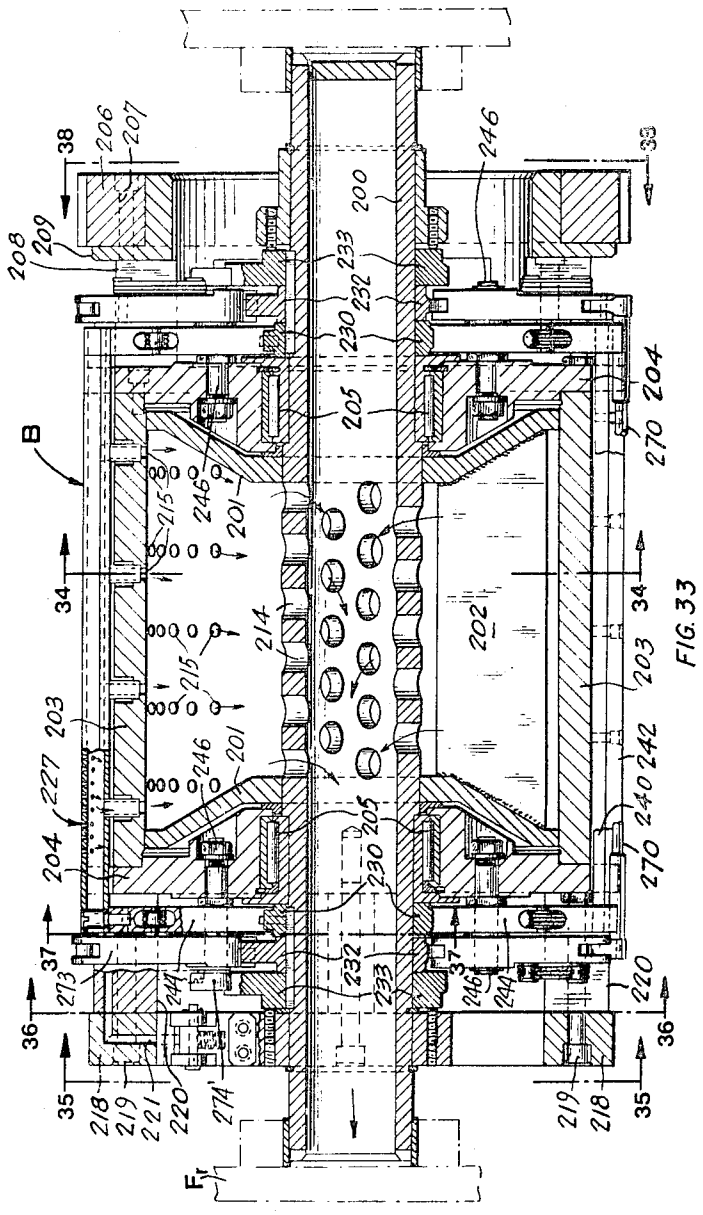
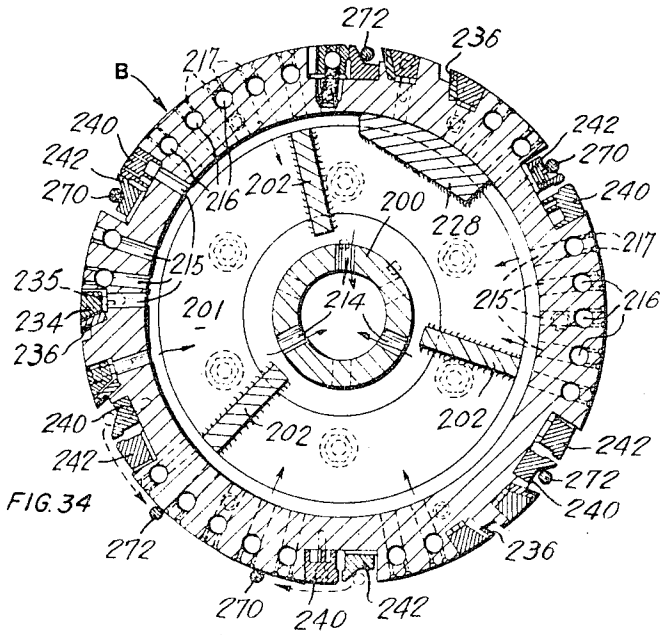
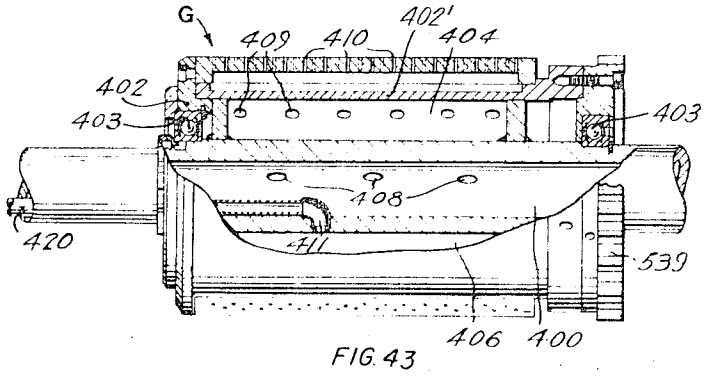

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FIG. 33


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FIG. 34


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FIG. 43

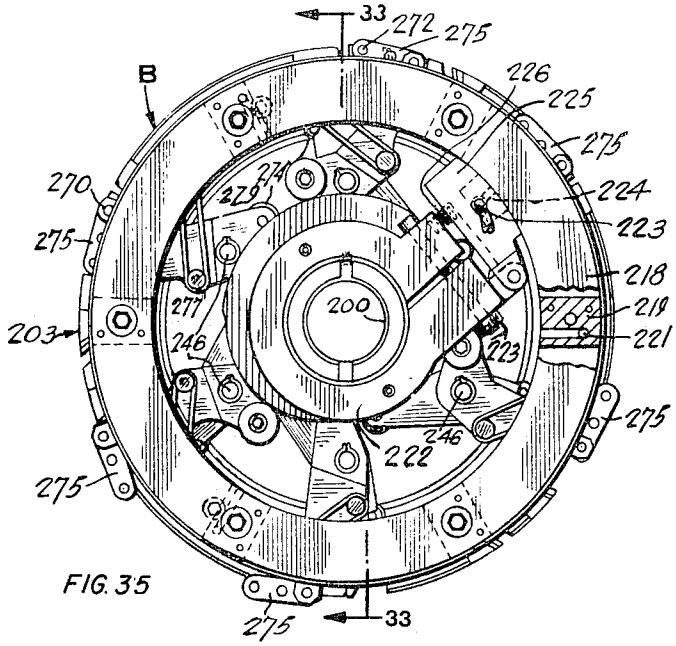

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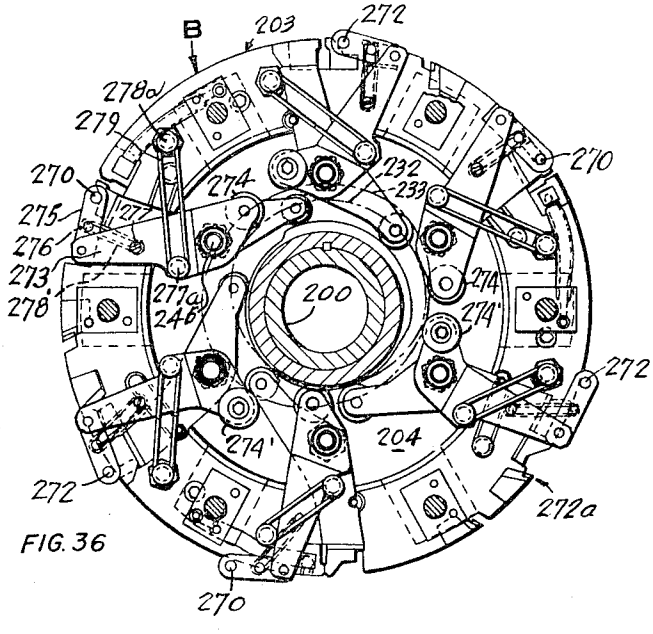

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FIG. 36

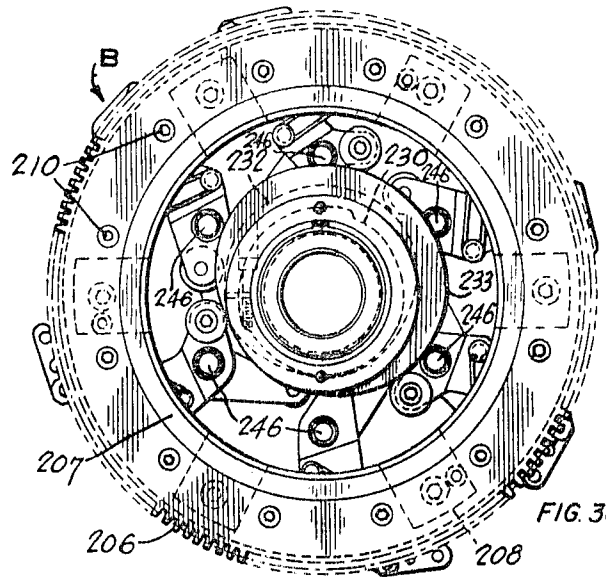


FIG. 38

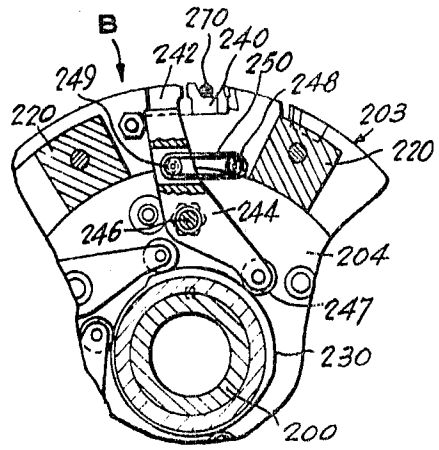


FIG. 37

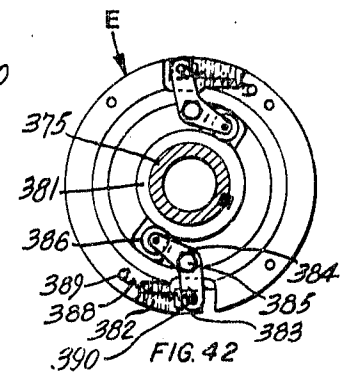


FIG. 42

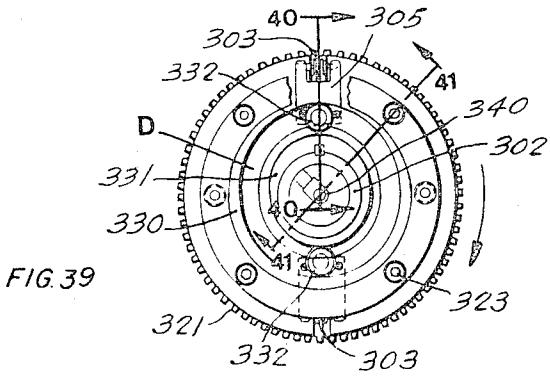


FIG. 39

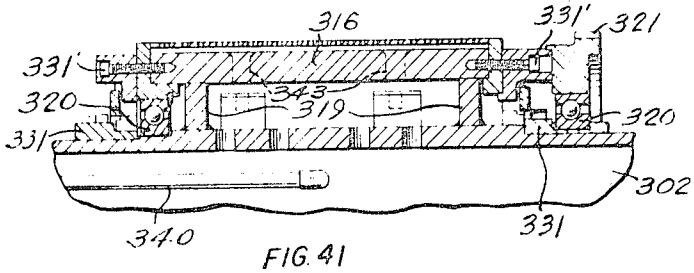


FIG. 41

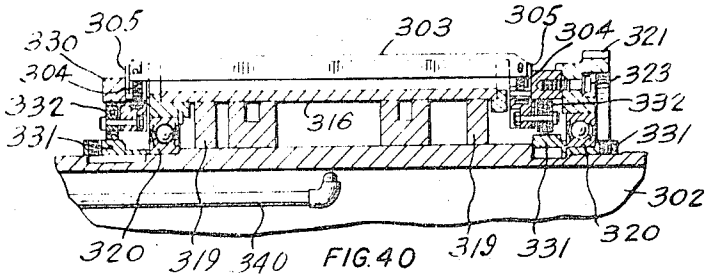


FIG. 40

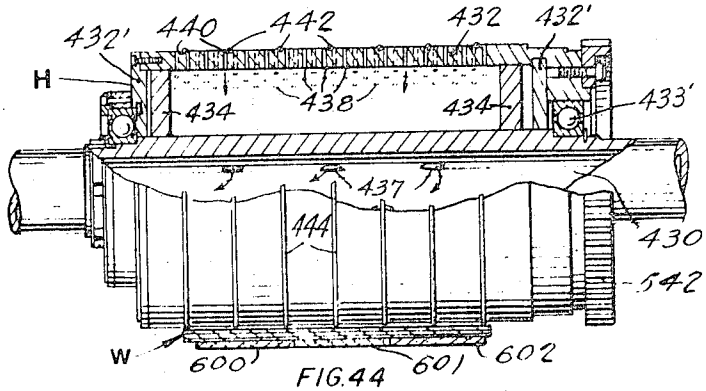


FIG. 44

SHEET FOLDING APPARATUS

This invention relates to an apparatus.

More particularly, this invention relates to an apparatus suitable for forming folded flexible material.

Various materials have to be folded for use in given fields from a single blank of the material. For example, in the manufacture of dressings, surgical sponges, etc., a web of suitable material is supplied in the form of a roll, which then has to be cut into individual blank portions, and folded one or more times to form a product having a suitable number of plies for the end use desired.

Several types of machines and methods are known for carrying out such an operation. For example, known in this art is a "Granz" machine operating on an essentially "in line" basis and briefly summarized, functions by continuously drawing web material from a supply thereby to present it to a pair of feed rolls where mechanical fingers grip the web. The fingers serve to intermittently draw a predetermined amount of the web through a knife arrangement to cut the web. At this point, the cut web is acted on by folding arms which serve to push the web into transverse folding stations to form one or more transverse folds. Thereafter the web is fed to a further station where depending on the type of product desired, further folding arms will cause one or more lateral folds in the product in a manner similar to that by which the transverse folds are made. Such "in line" operations as described above are essentially lineal operations and due to the nature of the apparatus inherently the speed is very slow.

There is a need for a faster machine capable of allowing higher outputs of production and at the same time, producing a product which is accurately folded. However, a higher production output, using a principle of folding material in a horizontal plane or by performing the folding operation over several intermittent steps is not desirable because of the problems associated with machinery design and the lineal speed which can be attained in such an operation.

With this invention, applicant has developed an apparatus for producing folded articles from flexible material which is capable of attaining a high production rate and while at the same time accurately preparing folded products.

In accordance with this invention, there is provided a rotary system of folding articles which comprises, feeding means, first rotary means for receiving a sheet fed by said feeding means, and for rotating it about a fixed axis, said first rotary means including means for retaining said sheet in juxtaposition therewith, and leading and trailing folding means for folding leading and trailing portion of said sheet into juxtaposition with said sheet, means for rotating said first rotary means about said axis, means for actuating said leading and trailing folding means as said first rotary means rotates, transfer means for receiving said sheet from said first rotary means after said leading and trailing folding means have folded the leading and trailing portions of said sheet, second rotary means operating in conjunction with said transfer means whereby said transfer means is effective to present said sheet to said second rotary means from said first rotary means, means for rotating said second rotary means about a fixed axis, said second rotary means having means for retaining said folded sheet in juxtaposition therewith, and means for folding at least one portion of said sheet in overlapping relationship to the remainder of said sheet, and means for operating said apparatus in a time related sequence whereby said sheet is fed to said first rotary means, the leading and trailing portions of said sheet are folded onto the sheet during rotation of the first rotary means by said means for rotating it and thereafter the transfer means transfers the folded sheet from the first rotary means to the second rotary means with the folding means of the second rotary means subsequently folding at least one further portion of the sheet while the means for rotating the second rotary means rotates it.

In greater detail, the apparatus of this invention also includes means for feeding the blank to the rotary unit. The feeding means may be set up to feed individual precut sheets of material; however, in most cases, material will be fed to the operation from a roll of material. To this end, the apparatus will include associated cutting means for cutting predetermined lengths of material to provide the blank for subsequent processes. Such an apparatus may include any suitable means for mounting a roll of material, and for feeding at least one layer of the material to subsequent operations.

It is also within the scope of this invention that the feeding means may include means for feeding and delivering two or more layers of different or identical material to the folding operation. This may be accomplished by having two different sources of material located more preferably in the same general plane, with guide means for combining the individual webs of the material in the direction of feeding prior to entry of the combined web to the folding operation. The combination of two or more different layers of material finds particular application in the manufacture of certain types of surgical sponges where for example an outer layer of gauze or nonwoven fabric is required which envelops an inner layer of absorbent material.

Depending on the material employed, it may be desirable to include, in certain cases, means for pretreating the material fed to the folding operation in order to make the material more readily obtain a subsequent fold. Thus, for example, when using certain types of flexible fabric material—e.g., nonwoven fabrics, the binder used for the fabric and sometimes the material itself has a tendency to stiffen the fabric whereby folds are somewhat difficult to retain. This invention therefore contemplates that such fabrics may be pretreated by passing the fabrics through a source of humidity—e.g., a steam bath, water spray or similar means, whereby the fabrics absorb sufficient moisture to render them flexible.

If a pretreatment stage is carried out, a saving of equipment and processing time can be effected by passing the fabric through the steam bath or water spray in tiers rather than passing the web through an elongated bath.

Again, depending on the type of end product desired, in certain instances, it is desirable to provide a product which has the side edges inwardly folded so as to avoid exposing "cut" edges. To this end, the apparatus of this invention may include a side edge folding mechanism whereby the side edges of the material are in-folded for example, three-eighth or one-fourth of an inch. This may be carried out by passing the material being fed to the folding operation over folding fingers which inwardly turn the side edges into juxtaposition with the main body of the web. Again, depending on the type of material it may be desirable to press the folded side edges by subjecting them to the action of press rollers, for example to create a definite crease.

Where the material to be processed is provided in the form of a web forming a continuous source of material, suitable cutting means will have to be provided to supply predetermined lengths of material to the folding operations. The cutting of a continuous web can be accomplished by any suitable means; however, in accordance with a preferred embodiment of the present invention, a rotary cutting system is employed, preferably in conjunction with a metering system for metering a predetermined amount of material to be cut. The rotary cutting system, broadly stated, includes at least one cutting means, means for rotating said cutting means about an axis and means for rotating said cutting means in timed relationship to the feeding of the material to sever a predetermined amount of material.

Preferably, the rotary cutting system operates in time-related sequence to the rotary folding means as hereinafter described. To this end, the cutting means and the folding means may be so arranged whereby a predetermined amount of material, having been fed by the metering system, is fed to the rotary system where the material is cut and the rotary folding system assumes control of the cut material.

The rotary cutting system may include more than one cutting means. In a continuous high speed operation, the rotary cutting system will have two or more cutting knives, mounted on a rotating drum. The diameter of the drum and/or

the means for rotating the drum will determine just how many knives are required for any given operation. In a preferred construction of the cutting means, the rotary drum includes housing means mounting a cutting knife and means for resiliently mounting said cutting knife of a length sufficient to cut the width of material presented to the cutting means.

The metering system preferably comprises means for advancing a predetermined amount of material from a supply thereof to the cutting means. Accordingly, the metering system may be adapted to receive a web of material from a supply thereof, and to control delivery of the amount of the web by a suitable governing action, i.e., a relative speed, imparted to the web. This governing action may be imparted by suitable driven rollers geared to feed the web at a predetermined speed.

In an alternative embodiment of the present invention, this invention also contemplates that a positioning device may be employed to position the web after feeding with respect to subsequent operations—e.g., cutting and folding, etc. To this end, the positioning device will receive the web as it is fed, and in turn permit the web to be fed to the first rotary means in a predetermined amount and once that amount has been so fed and positioned on the first rotary means, the web section may then be severed by the cutting means and control of the web section assumed by the first rotary means.

A preferred form of this alternative feature includes a rotatable roller over which the web material is adapted to pass, means for displacing the roller from a given position relative to the direction of feed of the web and with respect to the position of the first rotary means whereby displacement of the roller after the web has been fed to the first rotary means in a desired amount, positions that portion of the web on the first rotary means for subsequent operations—e.g., cutting, folding, etc.

Referring now to the rotary system, and the first rotary means in greater detail, said system preferably comprises a rotatable drum rotatable about a fixed axis, folding means for folding the leading and trailing edges of the web and control means for retaining the web in juxtaposition with the surface of the rotating drum while the folding operations are being carried out.

Depending on the particular cutting arrangement used in the rotary cutting system, the first rotary means may include a portion of the cutting system complementary to that of the rotary cutter—thus, the latter may include the cutting knife as previously described above, with the complementary cutting members being located on the drum in a spaced manner so as to coincide with the action of the cutting system. In one embodiment, the complementary cutting system may include a cooperating cutting blade. In a further embodiment, the rotating drum may include a cutting base of hardened material.

The control means for controlling a severed portion of a web preferably comprises a vacuum system within the drum effective to retain the web. Preferably this vacuum system is operated in conjunction with supplementary means—e.g., clamping jaws. A suitable means may be provided for operating the clamping jaws for opening and closing as desired and when required. The vacuum system may be provided by any suitable means and transmitted to the surface of the drum by means of suitable apertures extending inwardly into a vacuum chamber. The folding means preferably comprises two substantially similar units, one adapted to fold the leading edge of the blank and the other the trailing edge. The folding means each comprise a folding bar adapted to act on the sheet of material to raise the leading (or trailing) edge and by a folding action to place the portion of the sheet thus lifted into juxtaposition with the main portion of the body. Each folding bar is preferably mounted beneath the surface of the drum, and is operative to meet and lift a portion of the sheet to fold that portion onto the main body of the sheet otherwise retained by a suitable retaining means—e.g., vacuum preferably operating in conjunction with suitable clamp means, in juxtaposition with the surface of the drum. Each folding means may be operated by suitable means—e.g., a cam system whereby the cam is actuated in response to movement of the drum about the axis.

The length of the material which is folded onto the main body of the sheet depends on the type of product required and of course will vary accordingly. The amount of material folded in terms of its length may be varied by varying the diameter of the first rotary means, by the spacing of the gripping means and the cutting means.

As mentioned above, the first rotary means preferably includes gripping means within the rotating drum to grip the sheet material to prevent movement of the material during the folding operation by the leading and trailing folding means. To this end, a cooperating tucking roller operating in conjunction with the rotary system may be employed to tuck an area of the sheet into clamp jaws mounted in the surface of the rotating drum, which serves to aid in retaining the material in position.

According to a preferred embodiment, guide means are preferably stationed between the metering and the positioning device if used and the cutting means whereby the sheet material is preferably placed into juxtaposition with the surface of the first rotating drum prior to it being cut. In this embodiment, where cooperating cutting means are included on the drum operating in conjunction with the cutter, the cutter will sever the desired length of material while the material is rotating about the drum. In this manner, each cut will sever a portion of the web which is maintained by suitable means, e.g., a vacuum, thereby forming the trailing edge of a previous cut sheet and the leading edge of the next sheet to be cut on the next stroke of the cutter. The leading and trailing folding means are preferably actuated while the sheet of material is being rotated about the axis on the surface of the drum. At the point where the folding operations are completed, a product is produced which has folded leading and trailing edges and optionally folded lateral edges.

In the next operation, the product is acted on to press the folds in the product by subjecting the product to the action of press rollers or other suitable means, should this operation be required for the particular type of material being used. Thus, this operation is only necessary insofar as the material being folded requires pressing to be thin enough to be subjected to additional operations. In a preferred embodiment this operation is carried out in conjunction with transfer means which transfer the sheet from the first rotary drum to the second rotary means, as hereinafter described. In this respect, the transfer means serves to transfer the sheet from the first rotary means to the second rotary means and preferably comprises a rotatable drum, means for rotating the drum about the fixed axis, and means for retaining a sheet received from the first rotary drum in juxtaposition with the transfer means and to present the sheet from the transfer means to the second rotary means.

The most preferred form of the transfer means is a rotatable drum, with suitable means being provided for rotating the drum. In the transfer means, the means for retaining the folded sheet as received from the first rotary drum in juxtaposition with the transfer drum, preferably comprises a vacuum source within the drum. This vacuum source may be created by any suitable means and may extend over a predetermined portion of the surface of the drum commensurate with the scope of the area of the product.

In a preferred embodiment, the transfer drum also includes pressurized air acting from the interior of the drum outwardly to aid in the transfer of the folded sheet to the second rotary means. This pressurized air is intermittently or continuously actuated at the point where it is desired to remove the folded sheet from the transfer drum.

As mentioned above, the pressing means desirably operates in conjunction with the transfer means. Thus, the pressing means may take the form of a rotatable roller mounted in operative relationship to the rotating transfer drum, with drive means provided for rotating the pressing roller and suitable drum means for mounting the pressing roller. The pressing

roller may have an elongated octagonal shape if desired whereby the rotation of the pressing roller effectively presses only those portions of the sheet material which require pressing.

The second rotary means preferably comprises a rotating drum of a similar construction with respect to that described for the first rotary means. Thus, the second rotary means preferably includes means for retaining a folded sheet product transferred by said transfer means in juxtaposition with the surface of the drum and which means may comprise vacuum means within the drum. Secondary rotary means also includes folding means for folding the folded sheet received from the first rotary means whereby a further fold in the sheet is obtained to form a product having at least a two-ply thickness. Desirably, cooperating means operating in conjunction with the vacuum means is provided in the form of gripping means, which gripping means preferably comprises gripping jaws. In this embodiment, the gripping means may form a component of the folding means of the second rotary drum as hereinafter described. Operating in conjunction with the gripping means of the second rotary drum, the transfer drum may include complementary means for urging the sheet of folded material into contact with the gripping jaws during transfer of the folded sheet material to the second rotary means, and for accomplishing the folding action. Such complementary means may be in the form of a tucking mechanism—e.g., a protruding blade.

With the above arrangement, folding of the product produced by the first rotary means can be accomplished as the folded sheet is transferred from this transfer drum to the second rotary drum if the transfer drum and the second rotary drum are so arranged as to be rotated in opposite directions as hereinafter described. It will be understood that such an arrangement constitutes a preferred embodiment of the invention and that various types of folding arrangements may be provided for. In the preferred embodiment, the folding action taking place on the second rotary drum may fold the product in half, thus creating a product having at least two plies in at least a portion of its total area.

As an alternate arrangement to the above, the second rotary drum may be provided with a folding arrangement similar to that of the first rotary drum whereby the same folding action may be accomplished.

The first rotary means, the transfer means and the second rotary means operate in time-related sequence and are preferably arranged in a spatial configuration whereby the transfer from the first rotary means of folded sheet to the second rotary means may be carried out without intermediate intermittent operations. To this end, the means for rotating each of these components of applicant's invention are adapted to rotate the drums whereby the first and second rotary means are rotatable in the same direction with the transfer means being rotatable in the opposite direction. In this arrangement, a product will be produced in which all of the exposed transverse edges are located interiorly. It is to be understood, however, that the folds need not be located in this manner.

Production of a product with exposed edges will find use in various fields; however in the case of surgical sponges, for example, it is desirable that no exposed edges be exhibited in the product.

As an alternative embodiment, a rotatable roller or a stationary guide means may be located between the transfer drum to aid in controlling the sheet as it is being transferred from the transfer drum to the second rotary drum. More specifically, such means may be spatially arranged to control a portion of the sheet which forms the leading portion, after the cooperating clamping jaws and tucking mechanism of the second rotary drum and transfer drum respectively engage the sheet whereby the said means will operate to control the folding of the leading portion onto the body of the sheet as the sheet rotates in juxtaposition with the second rotary means.

Following this last folding operation, the apparatus may include means similar to that previously described to press the material further, should this be required—which depends on the type of material to be employed. If required, preferably the folded sheet product is transferred from the second rotary means to a further rotatable drum operating in conjunction with a rotatable pressing roller. To this end, the further rotatable drum may include vacuum or other suitable means for retaining the article in juxtaposition with its surface. In order to effect exchange of this sheet article to the further rotary drum, the second rotary means may be provided with a source of pressurized air and with suitable means for removing the vacuum at a predetermined point; while the further drum may be provided with a source of vacuum therein and/or with suitable clamping means.

The pressing roller serves to press the folded area created in the product by the folding means on the second rotary drum and like the first pressing means may operate solely on that portion of the product which requires pressing or may press the whole product. Suitable means should provide for rotating the press roller at a predetermined speed commensurate with that of the cooperating rotating roller.

Any suitable discharge means may be used for removing the product from the second rotary drum or from the above mentioned further drum if the product required pressing. Such means may include a discharge roller operating in conjunction with the above-mentioned rotatable drum or the second rotary drum.

The discharge roller desirably employs a vacuum to obtain the transferred folded sheet in juxtaposition with the surface of the discharge roller with means for releasing the vacuum at a desired point thereby to discharge the folded product. Such means for releasing the vacuum may also operate in conjunction with auxiliary means for aiding in the discharge, which may comprise a further rotatable roller with a plurality of endless belts extending between the two rollers with the folded product being adapted to overlie the belts on the surface of the discharge roller. In this manner, the folded products may be positively displaced relative to the discharge roller. Whether the product is discharged from the second rotary means or the cooperating rotary drum used in conjunction with the pressing means, either may include pressurized air connected to the respective means or drum to aid in the transfer. The source of pressurized air may be provided by a suitable means connected to the interior of the drum.

While any suitable means for actuating the above-described components may be employed, in operating the individual components in time-related sequence, a preferred drive system includes the provision of a central drive means—e.g., in the form of a rotatable shaft mounting gear wheels, the shaft being driven by an electric motor, with the shaft in turn driving various subassemblies through suitable gearing systems.

Should further thicknesses be desired in the product, this invention also provides a further apparatus assembly whereby the product obtained may be laterally folded. As used herein, the term lateral fold is a fold around a line extending in a longitudinal direction of the web. To this end, the apparatus may include a system of endless belts receiving and acting on the product discharged from the discharge roller. For example, where it is desired to double or triple, etc., the number of plies by means of lateral plies, two or more belts operate in conjunction with each other to receive the folded product discharged from the discharge drum. The width of each belt will depend largely on the relationship of the lateral folds desired in the product. If for example, it is desired to fold the product into three equal plies, the belts will each have a width approximately one third of the width of the product discharged from the discharge roller.

The product may be preferably conveyed on two of the belts with one third of the product not supported by the belts where after the belts are brought together into vertical alignment with suitable guiding means between the belts to depress the product and ensure that it folds over. In this manner, there will be obtained a product in which two thirds of the product is folded. By using a subsequent belt, the remaining flap can be

brought into alignment with the previously folded portion thereby to provide a product folded laterally into three layers. Any suitable means for driving the endless belts may be provided, preferably the driving means is integrally associated with the central driving means of the rotary systems.

The apparatus of the present invention produces a product which may be folded laterally any number of desired times. Thus, if a product was desired in which only two lateral layers were provided, the above belt system may be employed whereby the product may be divided into half with two belts.

If a four ply laterally folded product is desired, then additional belts can be included to fold the product into four equal or unequal sections as required.

The apparatus of the present invention may include stacking means for receiving "finished" products to align a plurality of such products into a stack. The stacking means may be any conventional component, and may include counting means for stacking a predetermined number of products. Preferably, the stacking means will operate in conjunction with either the discharge roller or the lateral folding system.

While in the above description, and as shown in the drawings, a single mechanism has been shown for each component, the present apparatus lends itself to "duplexing" whereby two side-by-side apparatuses, driven by the same drive system and mounted on the same frame, may be employed to produce twice the number of articles as a single apparatus.

In the apparatus of this invention, the lateral folding system described above may be located so that the lateral folding means would thus be located in advance of the feeding means. In one embodiment, the lateral folding means could replace the "hem" folding mechanism which is employed to fold in the side edges to avoid having exposed cut edges.

When the product is subjected to lateral folding prior to it being cut by the rotary system, suitable means such as guide bars or rollers may be employed.

The present invention lends itself to the folding of various types of materials, particularly sheet material such as non-woven fabrics, gauze, etc. As previously mentioned, more than one layer of material may be used in forming a folded product, such products being useful as surgical sponges, etc. To this end, the additional layers such as absorbent materials, will be juxtaposed with the basic layer during feeding, or prior to being fed, to the folding operations.

Having thus generally described the invention more particularly, reference will now be made to the accompanying drawings illustrating preferred embodiments in which

FIG. 1 is a perspective view of a typical product produced by the apparatus of the present invention;

FIG. 2 is a plan view of a blank with the lateral edges folded inwardly;

FIG. 3 shows diagrammatically a folding operation;

FIG. 4 illustrates a further folding operation;

FIG. 5 shows a product with the leading and trailing edges folded inwardly;

FIG. 6 shows diagrammatically the transverse folding of the product;

FIGS. 7 and 7*a* are a top plan view of an apparatus according to the present invention;

FIGS. 8, 8*a* and 8*c* are vertical sections of the apparatus along the line 8—8 of FIG. 7 and 7*a*; showing the web being fed to a series of rollers in the machine and showing more particularly in FIG. 8, the manner in which the web is fed to the material folding device, while FIG. 8*a* shows particularly the drive of the rollers and FIG. 8*c* the belts which fold the product laterally as shown in FIGS. 5 and 6;

FIG. 9 is a plan view along the line 9—9 of FIG. 8;

FIG. 10 is a vertical section of the web taken along the line 10—10 of FIG. 9 showing the initial width of the web of material;

FIG. 11 is a vertical section taken along the line 11—11 of FIG. 8 showing the first folding step of the web along its lateral edges;

FIG. 12 is a fragmentary vertical section taken along the line 12—12 of FIG. 9 showing the lateral edge folding mechanism;

FIG. 13 is a vertical cross section along line 13—13 of FIG. 9 showing the pressing of the folded edges; FIG. 14 through 18 are on the same sheet as FIG. 7*a*;

FIG. 14 is a vertical section along line 14—14 of FIG. 7*a* showing the first lateral panel folding step;

FIG. 15 is a vertical cross section along line 15—15 of FIG. 7*a* showing the beginning of the second folding step;

FIG. 16 is a vertical section taken along the line 16—16 of FIG. 7*a* showing the beginning of the third folding step;

FIG. 17 is a vertical section taken along the line 17—17 of FIG. 7*a* showing the completely folded product;

FIG. 18 is a vertical section taken along the line 18—18 of FIG. 7*a* showing the product fully folded and being discharged towards the stacking unit;

FIG. 19 is a vertical cross section along the line 19—19 of FIG. 7 showing the different folding steps as the material passes from roll B to roll H;

FIG. 20 is a top plan view partly in cross section, along line 20—20 of FIG. 21, showing the positioning system;

FIG. 21 is a front elevation on the positioning system partly in cross section showing the drive of the positioning system;

FIG. 22 is a vertical cross section taken along the line 22—22 of FIG. 20 showing how the positioning arm is mounted to the frame;

FIG. 23 is a vertical cross section taken along the line 23—23 of FIG. 22 showing the flexible mounting between the lever arm and the positioning bracket;

FIG. 24 is a top plan view partly in section of the feeding roller adjacent roller B;

FIG. 25 is a fragmentary enlarged diametric cross section taken through the cutting roll A, pickup roll B and tucker roll C showing how the web is cut by roller A and roller B;

FIG. 26 is a top plan view of the cutting roller A;

FIG. 27 is a front elevation of the cutting roller A shown in FIG. 26 and mounted to the frame of machine;

FIG. 28 is a vertical cross section taken along the line 28—28 of FIG. 26 showing the details of knife;

FIG. 29 is a vertical cross section taken along the line 29—29 of FIG. 26 showing a three lobed cam;

FIG. 30 is an enlarged fragmentary diametric cross sectional view of roller B showing one of the tucking jaws, the web of material and the tucking blade of roll C;

FIG. 31 is an enlarged fragmentary diametric cross section of the rotary roll B showing the folding bars in operation folding the leading and trailing edge portions of the web of material;

FIG. 32 is a front elevation of the tucking roll C partly in section to show the assembly in detail.

FIG. 33 is a longitudinal cross section of roll B showing its general assembly;

FIG. 34 is a diametric cross section taken along the line 34—34 of FIG. 33;

FIG. 35 is an end elevation of roller B looking in the direction of line 35—35 on FIG. 33;

FIG. 36 is a diametric cross section taken on the line 36—36 of FIG. 33 showing the levers controlling the folding bars and the tucking jaws;

FIG. 37 is an enlarged partial vertical cross section taken on the line 37—37 of FIG. 33 showing how the expandable band is connected to the jaw lever;

FIG. 38 is an end elevation looking in the direction of line 38—38 of FIG. 33;

FIG. 39 is an end elevation of the tucking roll D showing the cam arrangement which operates the tucking blade;

FIG. 40 is a diametric section along the line 40—40 of FIG. 39 showing the assembly of the tucker blade;

FIG. 41 is a diametric cross section along the line 41—41 of FIG. 39 showing the vacuum chamber of the assembly of roller D in detail;

FIG. 42 is an end elevation of the roll E showing the jaw operating mechanism;

FIG. 43 which is on the same sheet as FIG. 34, is a longitudinal view partly in section of the pickup roll G showing the assembly in detail;

FIG. 44 is a longitudinal view partly in section of the delivery roll H showing its construction in more detail.

In the attached drawings, the frame members of the apparatus are described by the term "Fr." The apparatus illustrated depicts a preferred embodiment in that the apparatus produces transversely and laterally folded material.

Referring now to FIGS. 1 to 4 first of all, there is illustrated a product which may be produced using the apparatus hereinafter described. The end product is illustrated in FIG. 1 and in the embodiment shown, consists of a nonwoven fabric folded several times.

The nonwoven fabric, prior to formation of the product of FIG. 1, is illustrated in FIG. 2 and consists of a rectangular blank 60. The blank 60 of FIG. 2 shows in dotted lines several of the fold lines. Initially, the lateral edges are folded inwardly as designated by reference numeral 62 from a width shown by the lateral dotted side lines 63. The purpose of these lateral folds is to avoid having exposed cut edges.

The product is then subjected to numerous folds in the longitudinal direction along fold lines 64, 65, 66 and 67 extending transversely across the blank. These folds will hereinafter be referred to as longitudinal folds. In sequence, the longitudinal portions of the product designated by reference numeral 68 are folded inwardly (see FIG. 3) about fold lines 64 and 66 respectively. Following this, the product of FIG. 3 is then folded about transversely extending fold line 65 to assume the arrangement shown in FIG. 4—simultaneously the product being folded about line 67 (as shown in FIG. 4). The product thus obtained is that illustrated in FIG. 5. In turn, this product is laterally folded upon itself to approximately thirds along longitudinal extending lines 69 and 70 (the sequence being shown in FIG. 6) to produce the product of FIG. 1. The folds along the longitudinal extending lines are herein referred to as lateral folds.

Referring now to FIG. 8, there is shown a supply roll of material 100 mounted on a rotatable roll 101 journaled to the frame of the apparatus. A brake consisting of a strap 102 with a weight 103 suspended therefrom serves to exert a restraining force on the roll of material 100. The material is led off from the roll in a single layer W over guide rolls 104 and 105 to an optional embodiment. According to this optional embodiment, the web W is subjected to steam treatment by passing over rotatable rolls 106 and 107 to reverse the web and over roll 108. In this manner, the web W is subjected to the rising steam vapors from a steam distribution 109 twice so as to sufficiently "plasticize" the web. Steam is fed through feeder 110 from an outside source (not shown) to steam distribution 109.

Following the steam treatment, the first step in the operation takes place by passing the web W under rotatable roll 111 which has a width equal to or wider than that of the web. In advance of roll 111, a further rotatable roll 112 is located which has a width less than the width of the web. Due to the tension placed on the web, the side edges of the web indicated by reference numeral 63 thereby are folded downwards on the end edges of the roller as will be seen from FIG. 11. At this point, the side edges 63 are at approximately right angles to the plane of the web W whereafter the web is fed into a folding system by passing the web over a folding plate 113 to fold the side edges 63 into juxtaposition with the web W (as seen in FIG. 12) to from side edge folds. In advance of the folding plate, a guide roller 114 with shoulders is located to center the web, as well as passing between further alignment rollers 115 and 115*a*.

The metering system of this invention includes a driven roller 116 mounted on a shaft 116' driven as hereinafter described. The rotational speed of roller 116 acts to feed or meter a determined amount of web material to subsequent operations. In conjunction with the metering system, the web is subjected to a pressing action to press the folded edges 63 flat—this occurs as the web passes between the driven roller 116 and press rollers 117 freely mounted on shaft 519'. As the product emerges from between rollers 116 and 117, it has the configuration shown in FIG. 2.

Referring now to FIG. 19, there is illustrated an optional feature in accordance with the present invention where positioning means may be employed. This positioning means includes a rotatable roll 120 over which the web is passed, whereafter the web is subsequently directed over rotatable roll 121 and then down under roll 122. Rollers 120 and 121 are both drive rollers driven as hereinafter described, both form part of a positioning system designed to position a predetermined amount of web material for feeding to the subsequent cutting and folding operations (as illustrated in greater detail in FIGS. 20 to 22). Rollers 120 and 121 are connected together by means of an arm 123 and a bracket 124 connected to a roller 125 which is connected to a cam system which is part of the optional positioning system. The cam per se which is shown in FIGS. 26, 27 and 29, is designated by reference numeral 126 which as will be seen from FIG. 29 is a three-lobe cam. The rotatable wheel 125 by passing over the lobes of cam 126 causes the arm 123 and the roller 121 to rise a predetermined distance (as seen in FIG. 8*a*).

Operating in conjunction with the positioning system is a drive system to rotate rollers 120 and 121 part of which are now to be described and shown in FIG. 19. Roller 120 is rotated by means of a belt 127 rotated about a driven pulley 128. Pulley 128 is mounted by means of a spring-loaded bracket 129 to the frame of the apparatus to retain it in operative relationship to the main drive system hereinafter described. Pulley 120 includes a belt 130 which rotates about pulley 121 thus driving the latter.

As will be seen from the above description, when the positioning system is employed, the web of material W is fed to the positioning system advanced by the rotating pulleys 120 and 121 and the position of web subsequently fed into the cutting and other operations is governed by the raising and lowering of arm 123 mounting pulley 121. Thus, raising of the arm 123 will retard the web and position its leading point on the rotary system where it is desired.

With respect to the positioning system, the mounting of the arm 123 will be described in greater detail by referring to FIGS. 20 and 22. The arm 123 is mounted by means of a bracket 131 which in turn, is mounted on a pivot shaft 132. A further bracket designated by reference numeral 133 is also connected to the arm 123 by means of springs (FIG. 23) indicated by reference numerals 136 and 138. With this arrangement, the arm 123 when lifted and lowered, is always under control and is maintained in contact with the cam 126.

When it is desired to use the apparatus of the present invention without the positioning component, this may be accomplished by merely feeding the web to the cutting system using one or more guide rollers, or alternately, the positioning component may be rendered inactive. To this end, the apparatus may include an adjustable pin arrangement designated by reference numeral 134 which may be inserted into one of two apertures 135 to prevent movement of the bracket 133. However, when in use, a pair of springs, one fixed spring 136 and one moveable spring 138 on a moveable guide 137 provides the arm 123 with sufficient flexibility to raise and lower. It should be mentioned with respect to the adjustable pin 134 that it is spring loaded by means of spring 139 and is mounted by means of a bracket 140 to a frame member of the machine.

At this point in the description of the drawings, reference will be made in general to the various rollers employed so as to provide a general orientation. Roller A constitutes a cutting roller; roller B the first rotary means which also functions as a folding roller in addition to cooperating with roller A for cutting the web; roller C constitutes a cooperating tucking roller with roller B; roller D constitutes a transfer and one member of a tucking assembly; roller E constitutes the second rotary means; roller F is a transfer control roller; roller G is a pick up roller; and roller H discharges the resulting product to the final folding stages. In addition to the above rollers, rollers D_1 and G_1 constitute pressing rollers cooperating with rollers D and G respectively.

Each of the above mentioned rollers will be described individually as follows.

A metered amount of web material W passing beneath roller **122** which is part of the positioning system is placed on the surface of roller B in a continuous length. After traveling a predetermined distance over the roller B, the cutting roller A severs a predetermined length of the material to be processed as will be hereinafter described.

Cutting Roller A is illustrated in detail in FIGS. **19** and **25** and consists of a rotatable core **150** mounted by means of bearings **151** and **152** to frame member Fr. The drive system for the core **150** will be described hereinafter.

Mounted to the core are a pair of flanges **153** which serve to support the various cutting knives, etc. In the embodiment illustrated, there are three sets of cutting knives; the number of the cutting knives may vary and as previously mentioned any suitable cutting means may be employed within the scope of this invention.

In the preferred embodiment, extending between the two flanges **153** are three rigidly mounted shafts **154**, one for each cutting assembly, located in cutout portions of the flanges, the cutout portions being shown by lines **155**. Cooperating in mounting the shafts **154** are brackets **156** which are connected to the flanges **153**. Each shaft **154** mounts a further bracket extending between the flanges designated by reference numeral **157** which is free to pivot about the shaft **154**. Mounted to the bracket **157** is a pivot pin **157***a* (shown in dotted lines in FIG. **25**) to which supporting housing **158** is pivoted for mounting knives. The housing **158** is spring loaded by means of spring **159**, against the rotatable core **150**. A further angled bracket **160**, also extending between the two flanges, spring loads the housing **158** by means of spring **161** at one end. The bracket **160** at the other end is adjustably urged against the core **150** by means of adjustable bolt **162**. With respect to bracket **160**, this bracket is rigidly mounted to bracket **157**.

The housing **158** includes a further adjustment consisting of a bracket **163** with an adjustable screw **164**. Bracket **163** is mounted to each flange **153** by suitable means—e.g., bolts.

Referring now to the knife assembly per se and in particular as shown in FIG. **28**, the housing **158** includes an aperture therein designated by reference numeral **165**. The knife blade is indicated by reference numeral **166** mounted to a backing plate **167**. The backing plate in turn is rigidly mounted in the housing by means of screw **168**. Screws **169** permit adjustment and alignment of the backing plate **167** and the knife blade **166** within the aperture **165**.

To summarize the description of roller A, in the embodiment shown, there are three separate cutting assemblies each containing a knife blade. The knife blades are mounted within adjustable and spring loaded housing **158**. The rotation of the roller **150** will thus rotate the knife blades into position for a cutting operation.

Referring now to roller B, this is illustrated in FIGS. **19**, **25**, **30**, **31**, **33**, **34**, **35**, **36**, **37**, and **38**. Roller B includes a rigid core **200** mounted to frame members by suitable means, with a pair of flange members **201** rigidly connected to the core and joined together by means of three plates **202**. Roller B includes an outer rotatable drum portion designated by reference numeral **203**. The rotatable portion of the roller B is mounted by means of flanges **204**, the flanges **204** being mounted on bearings **205** which are resting on core **200**.

The rotatable core **203** is driven by the main drive system which will primarily be described hereinafter; however, the drive from the main drive system is transmitted to the rotatable core by means of a peripheral gear **206**. Gear **206** is connected to a ring **207** which ring **207** includes legs **208** and a flange **209**. Bolts **210** connect gear **206** to the flange **209** thus rigidly connecting the two.

Legs **208** in turn are rigidly connected to the flanges **204** thus providing means for rotating the rotatable core **203**.

Roller B operates using a vacuum for the purpose of retaining the material being acted on in juxtaposition with the outer surface of the rotatable portion **203**.

To this end, the core **200** is a hollow core with a source of vacuum (not shown) being connected to the core. Apertures **214** are included in the core extending into the inner surface of the drum defined between the flanges **201** and the portions **203** surrounding the flanges thereby forming a vacuum chamber. To create a vacuum on the surface of the rotatable drum **203**, passageways **215** are included in the portions **203** at predetermined locations. The passageways extend through to transversely extending passageways **216** located beneath the surface of the drum; the passageways **216** in turn penetrate to the outer surface of the drum **203** by means of connecting passageways **217**. In this manner, vacuum applied through the core of the drum will be transmitted to the surface **203** at certain locations so chosen to provide control of the web as the roller B is rotating.

In the above description, the drive system for the roller B has been described. Roller B is driven only at one end with the other end being mounted to a frame member and including additional components now to be described.

One of these components involves a release system for releasing the web from roller B at a desired location. This system includes a pressurized air system composed of an air ring generally indicated by reference numeral **218** rigidly connected to flanges **204** by means of bolts **219** with intermediate spacers **220** therebetween. The air ring **218** is thus rotatable with the outer core. The air ring includes three air channels **221** extending through the ring. Operating in conjunction with the air ring **218** is a support member **222** rigidly mounted to the core **200** by suitable means. Support **222** is locked onto the core by means of a bolt **223** which may be tightened as desired. The mounting member mounts a contact valve assembly **225** which consists of an air ring connection **223** and an air output channel **224**. The member **225** is maintained in contact with the air ring **218** by means of a spring **226** urging the member **225** outwardly.

The air ring system just described intermittently functions whereby the air is transmitted through passage **224** exiting through passageway **221** to flow through the drum **203** and out through apertures **227**, thereby to displace a web otherwise maintained in contact with the drum **203**.

A further component employed in conjunction with the air ring system is a shutoff device indicated generally by reference numeral **228** which prevents the flow of vacuum through to the surface of the drum **203**. This vacuum cutoff device permits the air ring system to take over and displace the web.

A further component of roller B involves the folding of the web in both the leading and trailing directions of the web, as well as a gripping component for operating with the tucking assembly of roller C (FIG. **38**). To this end, roller B includes three cams on each side of flange **204**. The first of these cams designated by reference numeral **230** is the cam for operating the gripping jaws; the second cam **232** for operating one section of the folding assembly; and the third cam **233** for operating a further component of the folding assembly. All three cams **230**, **232**, and **233** are rigidly mounted to the core **200**.

Referring now to the cooperating cutting component associated with roller B, the outer drum **203** is provided with transversely cut out portions, within which there is rigidly mounted a cutting blade backing member **234** connected by means of bolts **235**. The backing portion **234** mounts cutting knives **236** which, as will be seen from FIG. **34**, are angled to present the cutting surface to cooperate with the knives **166** of the roller A. In this respect, as will be seen from FIG. **34**, there are two series of a plurality of cooperating cutting members, each series being adapted to cut a different length of material. Each series of knives actually includes three separate stations located on roller B whereby each revolution of roller B will present three cutting positions to cooperate with roller A.

In greater detail, upon rotation of roller A and presentation of the cutting knife **166**, roller B will align with roller A whereby the cutting blade **236** will mate with blade **166** to sever a length of material from the web W. The alignment of the cutting blades is shown in FIG. **25**. It will be appreciated

that once the overall apparatus is operating, the cutting blades 166 and 236 sever the trailing end of a length of material.

Roller B also includes a gripping system whereby a severed portion of the material is gripped by gripping means to aid in holding the material for subsequent folding operations. To this end, the gripping components each include a pair of gripping jaws designated by reference numerals 240 and 242. Jaw 240 is rigidly mounted to the rotatable drum by suitable means. Jaw 242 is a movable jaw actuated by a system now to be described and illustrated in detail in FIGS. 36 and 37.

The system includes a lever 244 pivotable about a pivot 246, the pivot being connected to flange 204. Connected to one end of the lever 244 is a rotatable roller 247 adapted to engage the cam 230. In order to maintain roller 247 in contact with cam 230, a pair of anchoring pins 248 and 249 are provided, pin 248 being connected to flange 204 and pin 249 being connected to lever 244, with a tensioning belt or spring 250 extending between the pins to urge the lever 244 towards pin 248. The jaw 242 is rigidly mounted to the end of a pair of levers 244 in a suitable manner.

Further components associated with roller B are folding bars adapted to carry out the folds along fold lines 64 and 66 of the product shown in FIG. 2. For this purpose, the surface of the roller B is provided with transverse cut out portions where the folding bars are normally lying.

Each set of folding bars (there are three sets on roller B) includes a leading folding bar designated by reference numeral 270 and a trailing folding bar 272. The construction of the folding bar component involves a pair of separate levers 273 pivoted about pivot 246 with a rotatable roller 274 mounted on one end of the levers 273 on one side of the pivot 246. Each folding bar 270 and 272 is indirectly connected to levers 273 by means of a linking arm 275 pivotally mounted to the ends of levers 273, on the other side of the pivot 246. The linking arm 275 (see FIG. 36) includes a pin 276 on member 275, and there is provided a pin 277 on lever 273 and a tension band 278 connecting the pins. Thus the folding arms 270 and 272 are always resiliently maintained in contact with the surface of roller B.

As previously mentioned, cams 232 and 233 are provided for actuating the leading and trailing folding bars.

In order to maintain the roller 274 in contact with the appropriate cams 232 and 233, there is provided anchoring pins 277*a* and 278*a* (the former connected to lever 273, the latter to the flange 204 and being interconnected by means of a tension belt or spring 279) function to accomplish this purpose.

It will be understood, as will be seen from FIG. 36, that the structure of the leading and trailing folding arms is substantially identical with the exception that the structure of the trailing arm is reversed to that shown in the leading arm.

Referring now to roller C, illustrated in FIGS. 30 to 32 in greater detail, roller C consists of a rotatable shaft 280 mounted to frame members by suitable means, e.g., bearings 281. The shaft mounts a drum 282 with transverse apertures therein. In the embodiment shown in the drawings, roller C includes a pair of tucking members in a diametrically opposed relationship, each consisting of a mounting bracket 283 connected to a hub 284 which is rotatably journaled on the shaft 280. There are a pair of brackets 283 as will be seen from FIG. 32, mounted at each end of the drum 282. Each bracket 283 includes an open slot receiving the tucking blade 286 anchored to the bracket 283 by means of a pin 287, with a spring 285 provided in a bore in the bracket 283 urging the tucking blade 286 outwardly.

In order to provide resiliency and limited rotational movement for the tucking blades 286, an extension arm 288 is connected to the hub 284 at either end which is spring loaded by means of spring 289 between the stop 300 and stop adjustment screw 300A.

Referring now to roller D illustrated in greater detail in FIGS. 19 and 39, 40 and 41, the roller D consists of a central core 302 rigidly connected to the frame members of the apparatus. Roller D mounts a tucking mechanism for folding the product presented to it along line 65 of the product shown in FIG. 2. Roller D involves the use of both a vacuum and a pressurized source of air. To this end, the roller includes transversely extending plates 312 and 214 which separate the pressure from the vacuum chamber 318 created. The outer shell of the roller is indicated by reference numeral 316 and encloses the space defined by plates 312 and 314. Plate 314 includes a solid portion indicated by reference numeral 317 in which there is no vacuum.

Mounted to the core of roller 302 are supporting members 319 which support the outer shell 316. The outer shell 316 rotates around the core 302 over bearings 320. The drive system for rotation of the outer shell will be primarily described hereinafter; however, a gear 321 is included connected to the shell 316 by bolts 323.

The roller D includes a pair of diametrically opposed tucking blades 303, spring loaded by means of springs 304 in a portion of the outer drum indicated by reference numeral 305. The blades are held in position in member 305 in a manner similar to that described with respect to the tucking blades of roller C.

Connected to the core 302 are a pair of cams designated by reference numerals 330 and 331 forming therebetween a track (see FIGS. 39 and 40). Rotating in this track is a roller 332 which in turn is connected to the member 305. In this manner, the tucking blades 303 will be raised and lowered radially according to the shape of the cams 330 and 331.

Roller D also includes a pressurized air system. To this end, a source of pressurized air is introduced through conduit 340, through the core 302, and leads to a chamber 341. The outer shell 316 includes an aperture 343, which when aligned with the chamber 341 will permit air to pass through the aperture 343 through the surface of the drum 316.

The vacuum chamber 318 connects through the outer surface of the drum through apertures indicated by reference numeral 343 contained in the outer drum 316. Again when the apertures 343 are aligned with the vacuum chamber 318, a vacuum will be drawn.

Operating in conjunction with the roller D is a pressing roller D_1. This pressing roller is mounted by means of a frame member 360 to the frame of the machine by means of a bracket 361. Frame member 360 is actually pivotally journaled to bracket 361 by means of a shaft 362.

A spring 363 is included between bracket 360 and the frame to create the desired degree of pressure for the roller D_1.

Roller D_1 is irregularly shaped with two round end portions 365 proportioned to press leading and trailing edges of the folded sheet material. It is mounted to the frame 360 by means of a shaft 366. The drive system for roller D_1 will be described hereinafter.

Referring now to roller E, (see FIGS. 19 and 42), the roller includes a core 375 rigidly mounted by suitable means to the frame of the apparatus. Extending outwardly from the core are a pair of transversely extending plates 376 and 377 which form a vacuum chamber designated by reference numeral 378. The roller E includes an outer shell component 380, which is mounted for rotation in a manner similar to that described with respect to roller D. For this reason, the specific construction has not been illustrated in detail.

Roller E, like roller D includes a single cam 381 at each end of the roller, connected to the core 375. Roller E includes a pair of transversely extending apertures on its surface in a substantially diametrically opposed relationship, for mounting cooperating tucking members which operate in conjunction with the tucking members described with respect to roller D. To this end, each tucking mechanism consists of a fixed jaw 382 and a movable jaw 383. Jaw 382 is rigidly mounted to the outer shell of the drum 380 by suitable means. Jaw 383 is made movable by a pair of levers 384 pivotally mounted by means of a pivot 385 to flange 386 connected to the inner core 375. Mounted at one end of the pair of levers 384 is a rotatable wheel 386 riding against cam 381, and maintained against the cam by means of a spring 388 anchored by pins 389 and

390. The other end of the levers 384 mounts the movable jaw 383.

According to a preferred embodiment of the apparatus illustrated in the drawings, there is included roller F which may either take the form of a simple roller acting as a guide bar or alternately, a rotatable roller which is provided with a vacuum surface to aid in the control of the transfer of the folded sheet from the transfer roll to the second rotary means. Thus roller F may be made with an internal vacuum chamber connected to its vacuum source, and driven by suitable means.

Roller G also includes a nonrotatable core portion 400 rigidly connected to the frame of the apparatus. The construction or roller G is substantially the same as that of rollers D and E. Roller G, the details of which are shown in FIGS. 19 and 43, includes a rotatable outer shell 402, rotating about bearings 403. The outer shell, as shown in FIG. 43 includes an outer surface 402' and sidewall members 402. The roller G is divided into portions, including a vacuum chamber indicated generally by reference numeral 404 and defined by the outer shell 402 and the inner core 400. A transversely extending solid member 406 segregates the chamber within the roller G into vacuum and nonvacuum areas. A source of vacuum is attached to the end of hollow core 400, which transmits this vacuum through the vacuum chamber by means of apertures 408'; and from the surface of the drum 402 by means of apertures 409 and 410. As will be seen from FIG. 19, the vacuum only extends over a portion of the surface of the drum 402.

Roller G also includes a source of pressurized air fed into the roller by means of a conduit 420 (FIG. 43) from a suitable source. From the conduit 420, the air passes through the core 400 into a further conduit 411 and through an aperture 412, which forms a chamber transversely extending along the member 406. Thus, as will be seen from FIG. 19, when the drum 402 rotates, and aperture 409 comes into registry with chamber 412, pressurized air is blown out of the apertures 410.

Cooperating with roller G is pressing roller G_1 which is constructed in a manner similar to that described with reference to roller D_1. To this end, like reference numerals have been used to describe like parts with respect to pressing roller G_1. It will be noted from FIG. 19 that roller G_1 preferably has a shape slightly different from that of roller D_1 wherein the arcuate surface 414 has a portion of the roll removed to compensate for the shorter length of material which is to be pressed.

Referring now to roller H, which is illustrated in FIGS. 19 and 44, there is included a nonrotatable core 430 mounted to the frame of the apparatus in a suitable manner. Roller H includes a rotatable outer drum 432 with side panels 432'. The drum rotates about bearings 433', and interior flanges 434 divide the interior of the drum into a chamber 435 with transversely extending members 433. A source of vacuum is connected to the hollow core 430 and connected to chamber 435 by means of apertures 437 in the core 430. The roller H also includes a nonvacuum chamber designated generally by reference numeral 426.

As will be seen from FIG. 19, the outer surface of the drum 432 includes apertures 438 to permit the vacuum to be transmitted from the chamber 435 to the surface of the drum.

Again, as will be seen from FIG. 19, there are two substantially diametrically opposed areas provided with apertures 438.

In the preferred embodiment shown, in FIG. 44, the outer surface of the drum is provided with a plurality of spaced apart grooves generally designated by reference numeral 440 adapted to receive a plurality of elastic bands 442. These bands pass over the surface of roller H and about a small rotatable roller 444. The bands serve to aid in the transferring of the product from the surface of roller H to a subsequent folding system to be described hereinafter.

The drive system for the above described components illustrated in FIG. 8*a*, will now be described.

An electric motor 500, mounted by suitable means, to the frame of the apparatus, drives the main pulley 501 through belt 502. The pulley 501 is mounted on a rotatable shaft 503 which in turn, mounts two sprockets 675 and 675'. One sprocket 675 mounts a chain 505 which drives a sprocket 506, mounted on a shaft 506', from which the power for the various rollers described above is provided. Shaft 506' mounts a further sprocket 508 which in turn mounts a chain 509 driving a further sprocket 510 mounted on a shaft 511. This shaft 511 rotates the gear 512 of roller A shown more clearly in FIG. 20. Shaft 511 also mounts a further gear 512, which gear is rigidly connected to roller A. Gear 512 serves to drive the positioning system by driving a gear 514; gear 514 in turn drives another gear 515 which is mounted on a shaft 516. Shaft 516 mounts a further pulley 128 which in turn drives roller 120 by means of a belt 127.

Gear 512 also meshes with a gear 206 of roller B, previously described with respect to roller B. In turn, gear 206 meshes with a gear 520 mounted on the core 280 of the roller C.

The drive system described thus far includes several chain tensioning devices adapted to create the desired tension on the various chains. Reference numerals 521 and 521' (FIG. 8*a*) show two of these tensioning gears operating in conjunction with chain 509 to permit tensioning of the chain 509 on both sides to facilitate the placement of fold 65. A further tensioning gear 522' is adapted to engage chain 505 to permit tensioning of this chain drive.

Gear 206 also drives the roller 122 by engaging a small gear 524 (FIG. 24) which gear 527 is mounted on a shaft 525. In turn, shaft 525 is mounted by means of a bracket 526 which in turn also mounts the roller 122. A pulley arrangement including belt 527 drives the shaft 122 from the shaft 525.

Shaft 506' mounts a further sprocket 507 which drives a chain 530. Chain 530 rotates about a sprocket 531 to rotate a shaft 532. Shaft 532 in turn includes a gear wheel 531' which drives a gear wheel connected to roller E. The gear wheel is designated by reference numeral 533 (FIG. 8*a*). Gear 533 drives a gear 321 mounted on roller D (FIGS. 39 to 41). In turn, gear 321 engages a further gear 537 mounted on shaft 366 to rotate the pressing roller D_1.

Gear 533 also engages gear 539 (FIG. 8*a*) mounted on drum 402 of roller G in order to provide the necessary rotation for roller G. The gear 539 of roller G drives press roller G_1 by meshing with a gear 540 mounted on shaft 366. A tensioning gear may be included for the chain 530, the gear being shown by reference numeral 536. In turn, roller H is driven by gear 539 meshing with a gear 542 of roller H. Also roller H drives roller 444 by means of belts 442. Rotation of roller F is achieved in a similar manner to roller 122 through belts and a gear mounted on shaft 532 and through a second gear (not shown).

Referring to the drive of the web feeding mechanism up to the positioning system shaft 511 which mounts a sprocket 510, is also provided with an additional sprocket 510'. This drives a chain 513 which in turn drives a sprocket 517 on a shaft 519.

Shaft 519 has a gear 519*a* mounted thereon, which in turn meshes with a further gear 519*b* mounted on a shaft 116' which mounts the drive roller 116. In this manner, the drive roller 116 may be driven at a predetermined speed to advance the web of material.

As previously described, the web of material W is fed from the metering system to positioning rolls 120, 121 and 122. The roll 122 holds the web W in proximity to the surface of roller B. The vacuum system in roller B as previously described retains the web W on the surface of the roller B. A knife 166 of the roller A comes into contact with the web of material W on the surface of the roller B as shown particularly in FIG. 25, in cooperation with the recess adjacent the knife 236 in the roller B. The knife 166 of roller A operates in a scissor fashion with the knife 236 of the roller B severing a length of the web of material W, when this length corresponds to the predetermined length of the tissue to be used. Of course, as previously explained, the knives are spaced such that each time cooperating knives of rollers A and B come into contact in a scissor fashion, they cut a predetermined length of the web W. As the

roller B rotates counterclockwise, the tucking roller C rotates clockwise as shown in FIG. 30, for example to engage the cut length of fabric W and to press it between jaws 240 and 242. As previously described, the movable jaw 242 presses against the tucking blade 286 pressing the web to form a definite fold. The roller C can have a pair of blades 286, as shown in FIG. 30, which are spaced circumferentially such that there is a fold formed near the trailing edge of the length of fabric W and a fold near the leading edge of fabric W.

Referring now to FIG. 19, a length of fabric W continues always being adhered to the surface of the roller B by the vacuum system, and the trailing folding bar 272 and leading folding bar 270 come into play as shown in FIG. 31, to fold the leading edge panel and trailing edge panel of the web over the middle panel of the length of web of fabric W. It is noted that the newly formed folding creases formed by roller C of the length of fabric W is retained between the jaws 240 and 242. Of course, the vacuum system will retain the overlapped leading and trailing edge panels of the web on the middle portion of the middle panel of the web as the roller B continues its course counterclockwise. The length of material W is now folded in the position shown in FIG. 3. Roller D which is rotating clockwise picks up the so-folded length of material W from the roller B by its own vacuum system and is so arranged that one of the tucking blades on the roller D coincides with the predetermined fold crease 65 shown in FIG. 4. The piece of fabric as it rotates with the drum D passes below the irregularly shaped press roll D_1, which acts to press the folds 64 and 66 on the length of fabric. As the roller D continues to rotate in the clockwise direction, the tucking blade which is pressing against the proposed imaginary lateral line 65 on the length of fabric engages this length of fabric within the jaws 382, and 383 provided in the roller E.

Jaws 382 and 383 which function as earlier described, engage with the tucking blade to form the crease 65 in the fabric as the tucking blade is removed from the recess between the jaws. As the roller D continues to rotate, the jaws urge against this newly formed fold crease 65 in the fabric to retain the fabric and drag it off the roller D. It is also noted in the earlier description that air pressure has now been provided on the surface of this section of the rotation of the roller D causing the length of fabric to be easily picked up by the roller E. As the jaws in the roller E engage the newly formed fold crease in the fabric and the roller E continues to rotate in a counterclockwise direction, this causes the length of fabric to fold inwardly on itself, particularly with the aid of the roller F. The vacuum system in the roller E maintains both flaps which are now folded in the manner shown in FIG. 4 and as the roller E continues to rotate in counterclockwise direction, it passes the air pressure system of the roller E. Simultaneously the jaws 382 and 383 are actuated to release the now folded fabric so that it is easily picked up by the vacuum system on the transfer roller G. The transfer roller G rotates in a clockwise direction past the irregularly shaped roller G_1, which, as the previous roller D_1 presses the folded fabric which is now folded in four ply thickness as shown in FIG. 5. As the fabric continues on the surface of the roller G in a clockwise direction, it reaches the pressure section 406 of the roller G to be picked up by the vacuum system 435 of transfer roller H. Roller H delivers the four-ply folded fabric onto a belt system partially shown in FIG. 19. It is engaged by the flexible straps 442 which remove the fabric from the roller H and transfers it on the conveyor belt 600 shown at the end of FIG. 19.

The vacuum system which is connected to each of the rollers A, B, D, E, G and H comprises individual ducts going to each of the fixed cores of these rollers which lead to a collection header. The other ends of the cores of the rollers are closed to form a vacuum chamber within the roller. Each duct leading to the header includes a valve system which can be individually adjusted to suit the vacuum so that the valve systems are between the collector header and the ports leading the individual ducts to the rollers. In this way, the vacuum level for individual rollers can be varied depending on the vacuum requirements of the individual rollers.

Referring now to FIGS. 7, 7a, 8c, 14 to 18 and 44, in particular, there is shown a preferred embodiment for effecting lateral folds in the product produced by the above-described apparatus. More particularly, the product as it comes off the above-described apparatus has the configuration shown in FIG. 5. The apparatus now to be described carries out the folding operations shown in FIG. 6 to produce the product shown in FIG. 1.

The belts 442 serve to remove the folded material from roller H. Located beneath roller H are three separate endless belts designated by reference numerals 600, 601 and 620 (see FIG. 44 and FIG. 7). There belts are passed on a roller 603 mounted to the frame of the apparatus. Belt 600 is relatively short and passes over roller 604 just after the discharge of the folded material from roller H as will be seen in FIG. 7.

A pair of closely spaced rotatable rolls 605 and 606 are vertically mounted in the direction of advancement of the belts. These rolls act on the belts 601 and 602 to divert the belts towards each other. When the belt 601 and 602 pass between the rollers 605 and 606 they are juxtaposed as shown in FIG. 14.

Operating in conjunction with the steps involved in this stage is a folding finger 607 mounted by means of a bracket 608 (shown in FIG. 7) connected to the frame of the apparatus. This finger is spaced above the belts 601 and 602 with the folded material adapted to pass beneath the finger 607.

When the longitudinally folded product is transposed from roller H unto the belts 600, 601, and 602, it has its full lateral width with the exception of the edge portions which have been folded inwardly in the initial folding operation. The width of the belts 601 and 602 are such that they support respective portions of the lateral width of the product. As the product advances on these belts and passes roller 604 (where the belt 600 ends), the portion of the product which is supported by belt 600 extends past the remaining belt 601 and 602. As the belts 601 and 602 converge towards each other, in juxtaposition, the portions which are supported by these belts are folded inwardly towards each other. However, as will be seen, the portion of the product which had been supported by belt 600 hangs freely beyond belt 601.

In advance of rollers 605 and 606, a supporting finger 610 is provided to support the free portion of the material (FIG. 14) and to prevent the free portion from becoming entangled with components of the apparatus.

Endless belt 602, following disengagement between roller 605 and 606 is maintained in a vertical direction and is passed between rollers 611 and 612, whereafter it is passed over roller 614 in a horizontal direction. Belt 601, after passing between rollers 605 and 606, is diverted from a vertical direction to an angle as shown in FIG. 15. By virtue of the fact that belt 602 remains in a vertical direction while belt 601 diverges away from belt 602 lying in an angled position, the partially folded material lies on belt 601 as can be seen from FIG. 15.

At this point, a further endless belt is introduced designated by reference numeral 620 and passing about pulley 624 and 622, as will be seen from FIG. 8c.

In advance of pulley 622, a pair of further vertical rotatable rollers 630 and 631, between which belts 601 and 620 pass, cause the belts to converge towards a vertical direction and finally into a vertical position folding the already folded two portions of the product towards the free portion of the product, as they pass between the rollers 630 and 631. In order to guide the partially folded material, a further guiding finger 633 is included, mounted by suitable means before reaching the rollers 630 and 631. Thus, the free lateral portion of the material engages belt 620 with the finger 633 forcing the partially folded material downwardly, whereby it assumes the configuration shown in FIG. 16. In this manner, when the belt 601 and 620 pass between the rollers 630 and 631, a product folded in three equal portions is obtained. The configuration at this point is illustrated in FIG. 17 and FIGS. 1 and 6.

Belt **620** terminates shortly after passing between rollers **630** and **631** passing around a vertically oriented roller **634**. The subsequent passing of this belt will be described hereinafter.

Belt **601** after passing between roller **630** and **631** passes over a horizontal pulley **640**, and thereafter descends (FIG. 8*c*) to pass over pulley **642**. As will be seen from FIG. 7*a* and **17**, the belt **601** lies in a vertical plane between roller **630** and **631** and thereafter lowers to a horizontal plane at the discharge end of the apparatus. Operating in conjunction with belt **601**, is a further guiding finger **643** (FIG. **18**) which serves to retain the folded material in juxtaposition with belt **601**; finger **643** being mounted by suitable means to the frame of the apparatus.

As will be seen from FIG. 8*c*, a guide **645** runs parallel to the belt **601** as the belt descends between pulleys **640** and **642**. This serves to prevent the folded product from prematurely falling from the belt **601**. At the discharge end of the apparatus, the folded material is then fed to a stacking station by any suitable means. As will be seen from FIG. 8*c*, this may include a reciprocating plate **647** which by itself does not form part of this invention. The plate **647** may be operated by suitable cam means **648**.

The system of rotating the belts will be described in greater detail; reference being made particularly to FIGS. 7*a*, 8*a*, and 8*c*.

The main drive system of the apparatus, previously described, includes rotation of a shaft **503**—a further sprocket **675'** is mounted on the shaft **503** driving a chain **677** which in turn drives a sprocket **684** mounted on a shaft **679**.

The chain **680** is tensioned by means of a tensioning device **683**. Shaft **679** mounts a further sprocket **678** which in turn drives a further chain **685**. As will be seen from FIG. 8*c*, this chain drives a sprocket **686**, a further sprocket **687** and sprocket **688** to complete the run of the chain. Auxiliary sprocket **689** provides support for the chain **685** during its run.

The main sprocket **687** is mounted to a shaft **690** on which rigidly mounted drums **691** (which could be a single drum) are located. The drums in turn provide the turning power for the various endless belts.

Reference numeral **692** designates the bracket mounting means for the shaft **690**, which brackets **692** are connected to the frame of the apparatus.

Throughout the paths of the various endless belts certain fixed guides are included to guide the belts in the proper plane of travel. These guides are indicated generally by reference numeral **695**, and include a mounted bracket **696** connected to the frame of the apparatus, the bracket **696** journaling a rotatable roller **697**.

In order to provide the proper tension for the endless belts, tensioning devices are also included which consist of a bracket **700** mounted to the frame of the apparatus, a rotatable roller **701** journaled on the bracket and an adjustable screw device **702** for slackening or tightening of the roller **701**.

The use of the adjustable tensioning devices permits the desired amount of tension to be placed on the endless belts used in transporting and folding the material to the various folding stages so as to maintain the alignment of the product in order to avoid irregular folds occurring.

In the drawings, with respect to the description concerning the lateral folding mechanism, the drums that are mounted on shaft **690** may be mounted independently if desired, thereby permitting each to be varied with regard to the relative speed to the common drum, thus providing for correction of off-folding as they travel down the belt section.

It will be understood that various modifications cab be made to the above described apparatus without departing from the scope of the invention. Thus, for example, as previously mentioned, the lateral folding portions may be optional depending on the type of product described. If included, the lateral folding components may be employed as described in the drawings or may be included in the apparatus prior to transverse folding by the first and second rotary means.

While the apparatus has been described with respect to the first and second rotary means whereby a sheet product may be transversely folded into a number of transverse folds, it will be readily understood that more transverse folds may be provided for by repeating the number of rotary folding means with transverse means between the rotary folding means. Thus, by way of example, if it were desired to provide an additional transverse fold in the product to increase the number of plies over that shown with respect to the drawings, an additional transverse drum may be provided following the second rotary means, which additional transverse drum operates in conjunction with a third rotary means similar to the second rotary means.

In an apparatus of the type described, various components may be made adjustable in respect to each other and their particular operation. For example, the vacuum chambers of the first and second rotary means and the transverse means may be adjustably mounted in their respective drums whereby the positioning of the vacuum may vary by rotating the vacuum chamber with respect to the surface of the drum. The various components which are adjustable include this feature for design tolerances and for transfer speed allowances when running at higher or lower speeds.

With the apparatus of the present invention, it has been proven that articles such as surgical sponges, for example, can be produced at a rate twice or several times that which is capable of being produced on existing "in-line" machinery.

What is claimed is:

1. An apparatus for folding a sheet of flexible material comprising:
- feeding means,
- first rotary means for receiving said sheet fed by said feeding means, and for rotating it about a fixed axis, said first rotary means including
  - means for retaining said sheet in juxtaposition therewith, and leading and trailing folding means for folding leading and trailing portions of said sheet into juxtaposition with said sheet,
- means for rotating said first rotary means about said axis,
- means for actuating said leading and trailing folding means as said first rotary means rotates,
- transfer means for receiving said sheet from said first rotary means after said leading and trailing folding means have folded the leading and trailing folded portions of said sheet,
- second rotary means operating in conjunction with said transfer means whereby said transfer means is effective to present said sheet to said second rotary means from said first rotary means,
- means for rotating said second rotary means about a fixed axis,
- said second rotary means having means for retaining said folded sheet in juxtaposition therewith, and folding means for folding at least one portion of said sheet in overlapping relationship to the remainder of said sheet,
- and means for operating said apparatus in a time related sequence whereby when said sheet is fed to said first rotary means, the leading and trailing portions of said sheet are folded onto the sheet during rotation of the first rotary means by said means for rotating it and thereafter the transfer means transfers the folded sheet from the first rotary means to the second rotary means with the folding means of the second rotary means subsequently folding at least one further portion of the sheet while the means for rotating the second rotary means rotates it.

2. An apparatus for folding a sheet of flexible material to form a folded sheet product comprising means for feeding a web of material from a supply thereof, metering means for metering a predetermined length of said web, means for severing a metered portion of said web to form a sheet blank, first rotary means for receiving said sheet and rotating said sheet about a fixed axis, said first rotary means including means for retaining said sheet in juxtaposition with said rotary means, means for rotating said rotary means about said axis, and lead-

ing and trailing folding means for folding a portion of the leading and a portion of the trailing portions of said sheet into juxtaposition with the main body of said sheet, and means for actuating said folding means as said first rotary means rotates, second rotary means for receiving and retaining said folded sheet in juxtaposition therewith, means for rotating said second rotary means about a fixed axis, transfer means for transferring the folded sheet from said first rotary means to said second rotary means, said second rotary means having folding means, said last-mentioned folding means including means for transversely folding said folded sheet upon itself to form a multiple folded sheet product, and means for operating said metering means, said cutting means, said first and second rotary means, each of said folding means and said transfer means in time related sequence whereby said metering means meters a predetermined amount of web material, said cutting means severs said predetermined amount of material and each of said folding means folds portions of said sheet into juxtaposition with the main body of said sheet.

3. An apparatus of claim 2 wherein said apparatus includes means for creating a source of humidity, said means for feeding a web of material being adapted to pass said web through said source of humidity.

4. An apparatus of claim 2, wherein there is included means for feeding at least two separate webs of sheet material, and guiding means adapted to combine the webs of material into a single continuous length of juxtaposed material.

5. An apparatus for folding a sheet of flexible material to form a folded sheet product comprising means for feeding a web of material from a supply thereof, metering means for metering a predetermined amount of said material, rotary cutting means for severing a metered length of said web to form a sheet blank, first rotary means comprising a rotatable drum for receiving said cut sheet and rotating said sheet about a fixed axis, said first rotary means including means for retaining said sheet in juxtaposition with said drum, leading and trailing folding means for folding the leading and trailing edges of said sheet into juxtaposition with the main body of said sheet, said first rotary means further including gripping means for gripping said sheet while said sheet rotates about said axis, second rotary means comprising a rotatable drum, means for rotating said second rotary means about a fixed axis, transfer means comprising a rotatable drum, means for rotating said transfer means about a fixed axis for receiving a folded sheet from said first rotary means and for transferring the folded sheet to said second rotary means, said second rotary means including means for retaining a folded sheet in juxtaposition therewith, folding means associated with said second rotary means for folding a portion of said sheet into juxtaposition with the balance of said sheet, and means for operating said rotary means, said cutting means, said feed means, all of said folding means and said transfer means in time-related sequence whereby said metering means meters a predetermined amount of web material, said cutting means severs said predetermined amount of material, said folding means folds the leading and trailing edges of said sheet into juxtaposition with the main body of said sheet and said third folding means folds the sheet material in sequence.

6. An apparatus as defined in claim 1 which includes first pressing means for pressing a folded sheet produced by said first rotary means, said pressing means operating in conjunction with said transfer means.

7. An apparatus as defined in claim 1, wherein said apparatus includes pressing means adapted to press a folded sheet produced by said second rotary means.

8. An apparatus as defined in claim 1, wherein said apparatus includes first pressing means adapted to press a folded sheet produced by said first rotary means and said pressing means operating in conjunction with said transfer drum, said apparatus further including second pressing means for pressing a folded sheet produced by said second rotary means.

9. An apparatus as defined in claim 1, wherein said apparatus includes first pressing means comprising a rotatable roller, means for rotating said roller in time relationship to the transfer drum, said apparatus further including second pressing means for pressing a folded sheet produced by said second rotary means and comprising a pair of rotatable rollers, means for rotating said rollers in timed relationship, one of said rollers including means for receiving a folded sheet produced by said second rotary means, and means for retaining the folded sheet in juxtaposition with said one roller.

10. An apparatus as defined in claim 1, wherein said apparatus includes means for supplying a continuous length of web material to said feeding means, means for cutting a predetermined amount of said web, and means for presenting cut portions of said web to said first rotary means.

11. An apparatus as defined in claim 1, wherein said apparatus includes means for feeding a continuous length of web material, cutting means subsequent to said feeding means to cut a predetermined amount of said material to form individual sheets, said cutting means comprising a rotatable roller having a first cooperating cutting component, means for rotating said rotatable roller, said roller being spaced from said first rotary means and rotating in time-related sequence therewith, second cooperating cutting means mounted on said first rotary means whereby said first and second cooperating cutting components operate to cut a predetermined amount of said web material into individual sheets with said first rotary means assuming control of the cut sheets.

12. An apparatus as defined in claim 11, wherein said first and second cutting components comprise cooperating cutting blades, each cutting blade being mounted in one of said rotatable cutting rollers and said first rotary means.

13. An apparatus as defined in claim 12, wherein said rotating cutting roller and said first rotary means include a plurality of cooperating cutting blades, each pair of cooperating cutting blades being adapted to meet in operating relationship upon rotation of said cutting roller and said first rotary means.

14. An apparatus as defined in claim 11, wherein said cooperating cutting components comprise at least one cutting blade mounted on said rotating cutting roller and at least one rigid cutting surface on said first rotary means.

15. An apparatus as defined in claim 1, including positioning means subsequent to said feeding means in the feeding direction of said web material, said positioning means including means for receiving said web material as said web material is advanced by said feed means, means for directing said web material to said first rotary means and means for intermittently halting the forward movement of said web material to said first rotary means.

16. An apparatus as defined in claim 1, including positioning means in advance of said feeding means in the feeding direction of said web material, said positioning apparatus including means for receiving said web material as said web material is advanced by said feed means, means for directing said web material to said first rotary means and means for intermittently halting the forward movement of said web material to said first rotary means, said means for intermittently halting said web comprising at least one rotatable arm over which said web material passes in the feeding direction of said web material to said first rotary means, means for displacing said arm in a direction opposed to the feeding direction of said web material at a speed and to an extent sufficient to substantially halt movement of said web to said first rotary means, and means for operating said last-mentioned means for displacing said arm in time-related sequence to the rotation of said first rotary means whereby said web material is intermittently fed in predetermined amounts of said first rotary means.

17. An apparatus as defined in claim 1, wherein said feed means comprises means for receiving and advancing a web of sheet material from a supply thereof, said means including a pair of spaced-apart rollers, at least one of said rollers having drive means for rotating said roller to advance said web at a predetermined speed.

18. An apparatus as defined in claim 1, wherein said apparatus includes means folding the free side edges of a sheet or web of material.

An apparatus as defined in claim 1, wherein said apparatus includes means for folding the free side edges of a web of sheet material as said web is being advanced in the feeding direction thereof, said means for folding said side edges including means for downwardly tucking a portion of the side edges of said web and placing said portions into juxtaposition with the main body of said web.

20. An apparatus as defined in claim 1, wherein said transfer means comprises a rotatable drum mounted between said first and second rotary means, means for rotating said transfer drum in time-related sequence to the rotation of said first and second rotary means.

21. An apparatus as defined in claim 1, wherein said transfer means comprises a rotatable drum, means for rotating said drum about a fixed axis in a direction reversed to the direction of rotation of said first and second rotary means, said transfer drum including a source of vacuum adapted to retain a folded sheet transferred from said first rotary means to said transfer drum.

22. An apparatus as defined in claim 1, wherein said transfer means comprises a rotatable drum, means for rotating said drum about a fixed axis in a direction reversed to the direction of rotation of said first and second rotary means, said transfer drum including a source of vacuum adapted to retain a folded sheet transferred from said first rotary means to said transfer drum, said transfer drum further including means for causing removal of said vacuum at a predetermined point in the rotation of said transfer drum whereby said second rotary means assumes control of the folded sheet from said transfer drum, and means for aiding transfer of said folded sheet from said transfer drum to said second rotary means comprising a source of pressurized air adapted to displace said folded sheet from said transfer drum.

23. An apparatus, as defined in claim 1, wherein said apparatus includes supplementary transfer means operating in conjunction with said first transfer means, said supplementary transfer means comprising a rotatable roller located between said transfer roller and said second rotary means and being adapted to retain a portion of a folded sheet under positive control when said sheet is being transferred from said transfer means to said second rotary means.

24. An apparatus as defined in claim 1, wherein said first rotary means comprises a rotatable drum rotatable about a fixed axis, said means for retaining said sheet in juxtaposition with said drum comprising a source of vacuum in said drum acting on said sheet to retain said sheet in juxtaposition with said drum, and means for removing said vacuum at a point during rotation of said drum whereby a folded sheet on said drum may be transferred to said transfer means.

25. An apparatus as defined in claim 1, wherein said first rotary comprises a rotatable drum rotatable about a fixed axis, said means for retaining said sheet in juxtaposition with said drum comprising a source of vacuum in said drum acting on said sheet to retain said sheet in juxtaposition with said drum, and means for removing said vacuum at a point during rotation of said drum whereby a folded sheet on said drum may be transferred to said transfer means, said drum further including first gripping means adapted to receive and retain a portion of said sheet in juxtaposition with said drum together with said vacuum means, and second cooperating tucking means operating in conjunction with said gripping means to place a portion of said sheet in operative relationship to said gripping means.

26. An apparatus, as defined in claim 1, wherein said means for folding the leading and trailing portions of said sheet into juxtaposition with said sheet comprises a pair of spaced-apart folded bars mounted beneath the surface of said rotary means, and means for causing said bars to operate through a forward and return stroke to lift a portion of said sheet in juxtaposition with said rotary means onto the main body of the sheet.

27. An apparatus as defined in claim 1, wherein said second rotary means comprises a rotatable drum, said means for retaining said folded sheet in juxtaposition with said second rotary means comprising a source of vacuum in said drum, and means for removing said vacuum at a predetermined point of rotation of said drum.

28. An apparatus as defined in claim 1, wherein said second rotary means comprises a rotatable drum, said means for retaining said folded sheet in juxtaposition with said second rotary means comprising a source of vacuum in said drum, and means for removing said vacuum at a predetermined point on rotation of said drum, said second rotary means further including a source of pressurized air operative to lift a folded sheet on said second rotary means, after said vacuum has been removed, to remove a folded sheet from said second rotary means, said second rotary means further including gripping means adapted to cooperate with said vacuum means in retaining said sheet in juxtaposition with said second rotary means, said gripping means operating in conjunction with tucking means located on said transfer roller whereby said tucking means is effective to place a portion of said sheet into gripping engagement with said gripping means when said sheet is being transferred from said transfer roller to said second rotary means, and means for releasing said sheet from engagement with said gripping means when said vacuum is removed.

29. An apparatus as defined in claim 1, wherein the folding means of said second rotary means comprises first cooperating gripping means on said second rotary means, second cooperating complimentary means on said transfer means adapted to place a portion of the folded sheet at said transfer means into gripping engagement with said first gripping means of said second rotary means, said transfer means having means for rotating said transfer means about a fixed axis in a first direction, said means for rotating said second rotary means being adapted to rotate said second rotary means in a direction opposite to that of the rotating of said transfer means, whereby a portion of the sheet product transferred from said transfer means of said second rotary means is folded onto a further portion of the sheet.

30. An apparatus of claim 1, wherein said apparatus includes means for receiving a folded product from said second rotary means and for discharging said product therefrom.

31. An apparatus as defined in claim 1, wherein said apparatus includes discharge means comprising a rotatable roller, means for rotating said roller in timed relationship to said second rotary means, said second rotary means including means for displacing a folded product thereon into operative relationship with said discharge roller and means associated with said discharge roller for retaining said folded product in juxtaposition therewith, said discharge roller including means for removing said folded product therefrom at a predetermined point upon rotation of said discharge roller.

32. An apparatus as defined in claim 1, wherein said apparatus includes a further rotatable roller operating in timed relationship to said second rotary means, said further roller comprising a rotatable drum, means associated with said rotatable drum for receiving and retaining a product associated with said second rotary means, a pressing roller spaced from said further rotatable roller, means for retaining said pressing roller in timed relationship to the rotation of said further roller, a discharge roller, said discharge roller being mounted in spaced relationship to said further roller and being adapted to receive a folded product from said further roller, means for rotating said discharge roller in relationship to said further roller, and means for retaining a folded product in juxtaposition with said discharge roller.

33. An apparatus of claim 1, wherein said apparatus includes means for subjecting said sheet or web to a source of humidity.

34. An apparatus as defined in claim 1, said apparatus including additional folding means for laterally folding the product, said additional folding means including means for dividing the product into at least two lateral portions, and means for placing the lateral portions into juxtaposition with each other.

35. An apparatus as defined in claim 34, wherein means for laterally folding a product is located after said second rotary means.

36. An apparatus as defined in claim 34, wherein the apparatus includes a discharge roller, said means for laterally folding a product operating in conjunction with said discharge roller.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,640,522 Dated Feb. 8, 1972

Inventor(s) Peter Oelmann & Peter Weisshuhn

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Abstract, line 3, "rate" should read ---rates----.

In Column 1, line 14, "Granz" should read ---Ganz---.

In Column 6, line 24, "required" should read --- requires---.

In Column 15, line 13, "or" should read --- of---.

In Column 19, line 68, "cab" should read ---can---.

In Column 21, line 53, "feed" should read --- feeding---.

In Column 22, line 66, "of" should read ---to---.

Signed and sealed this 25th day of July 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents