

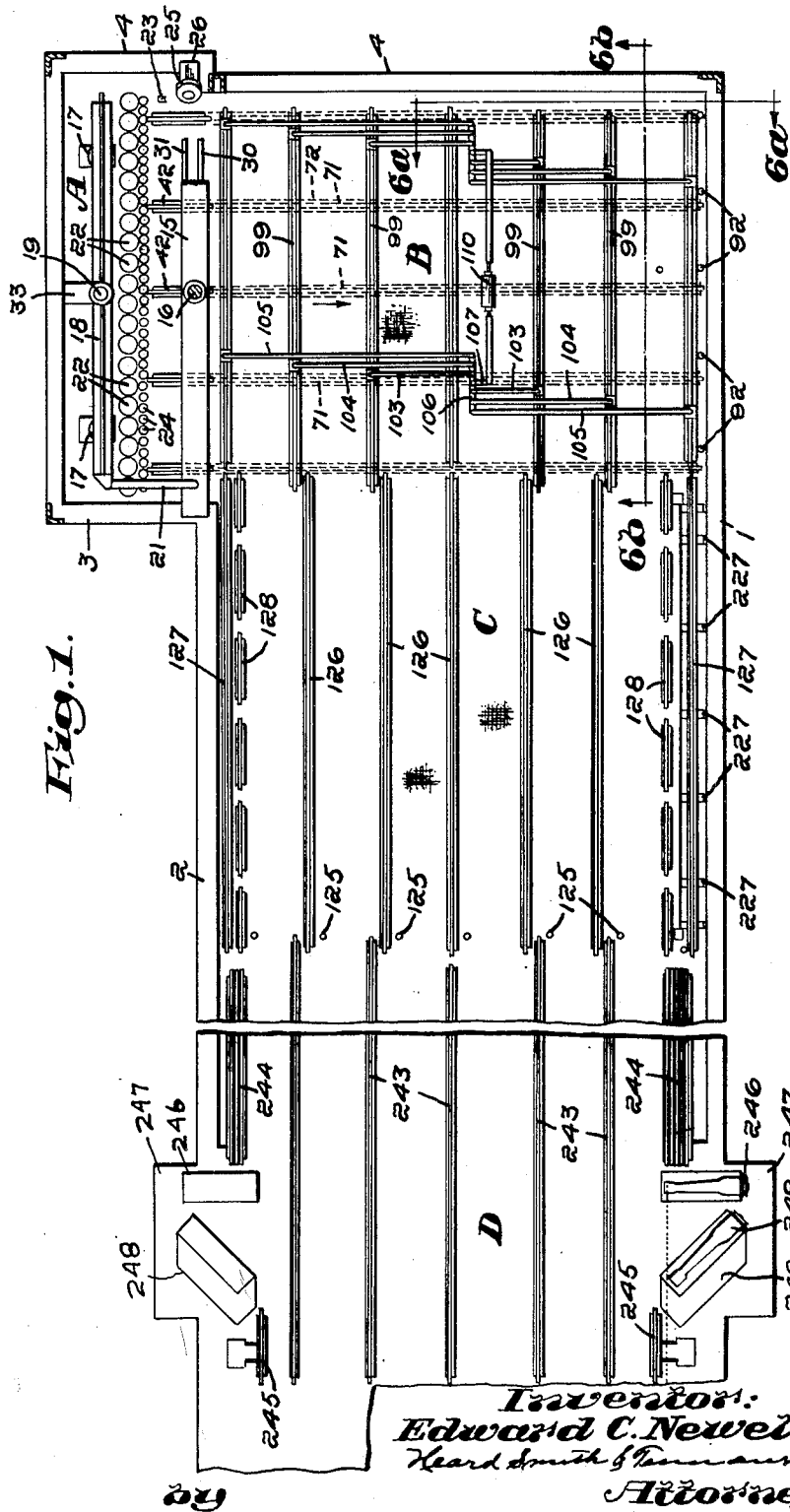
March 27, 1951

E. C. NEWELL  
METHOD AND APPARATUS FOR AUTOMATICALLY  
MAKING RECTANGULAR SHEETS OF FABRIC

2,546,831

Filed June 21, 1947

18 Sheets-Sheet 1



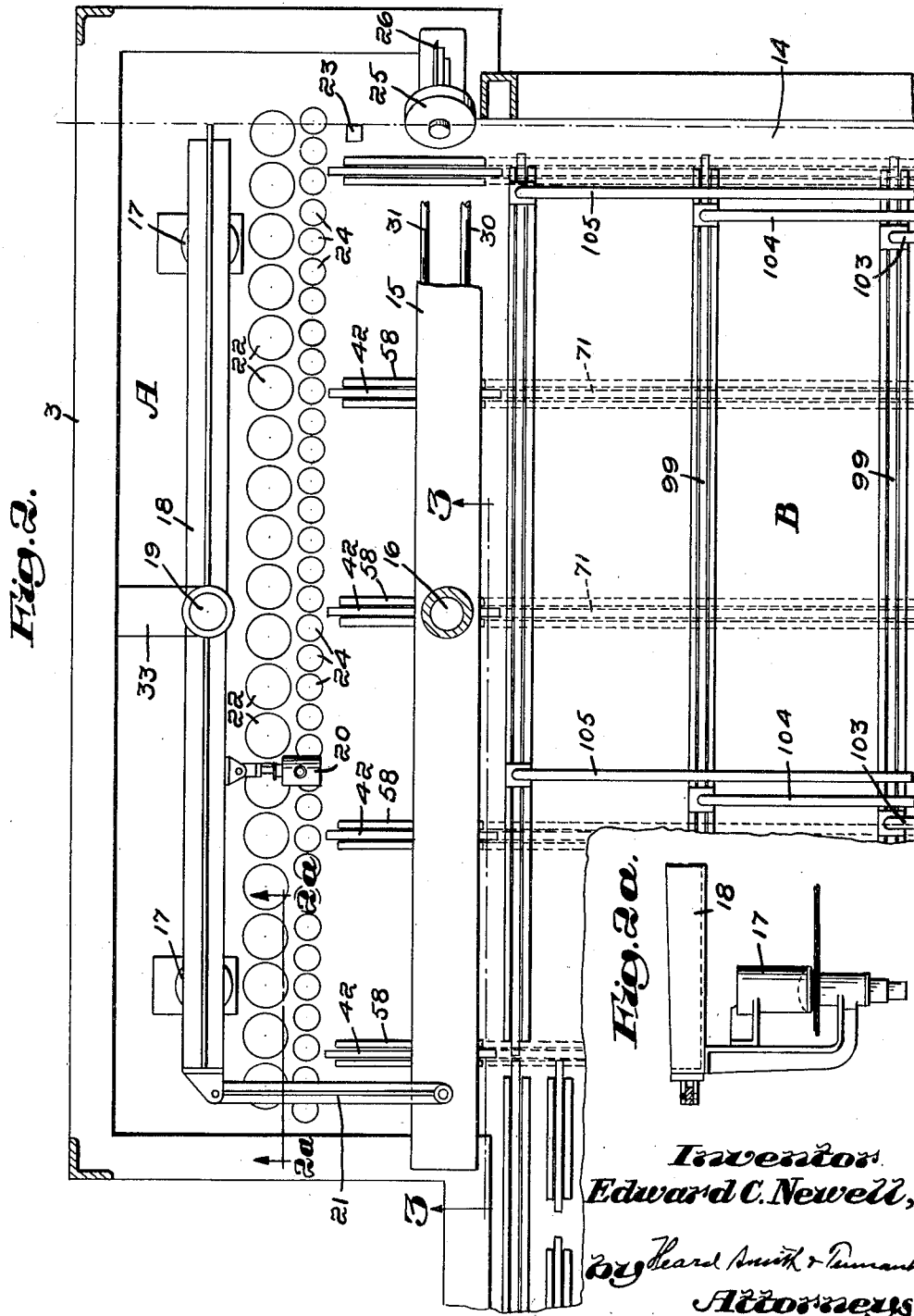
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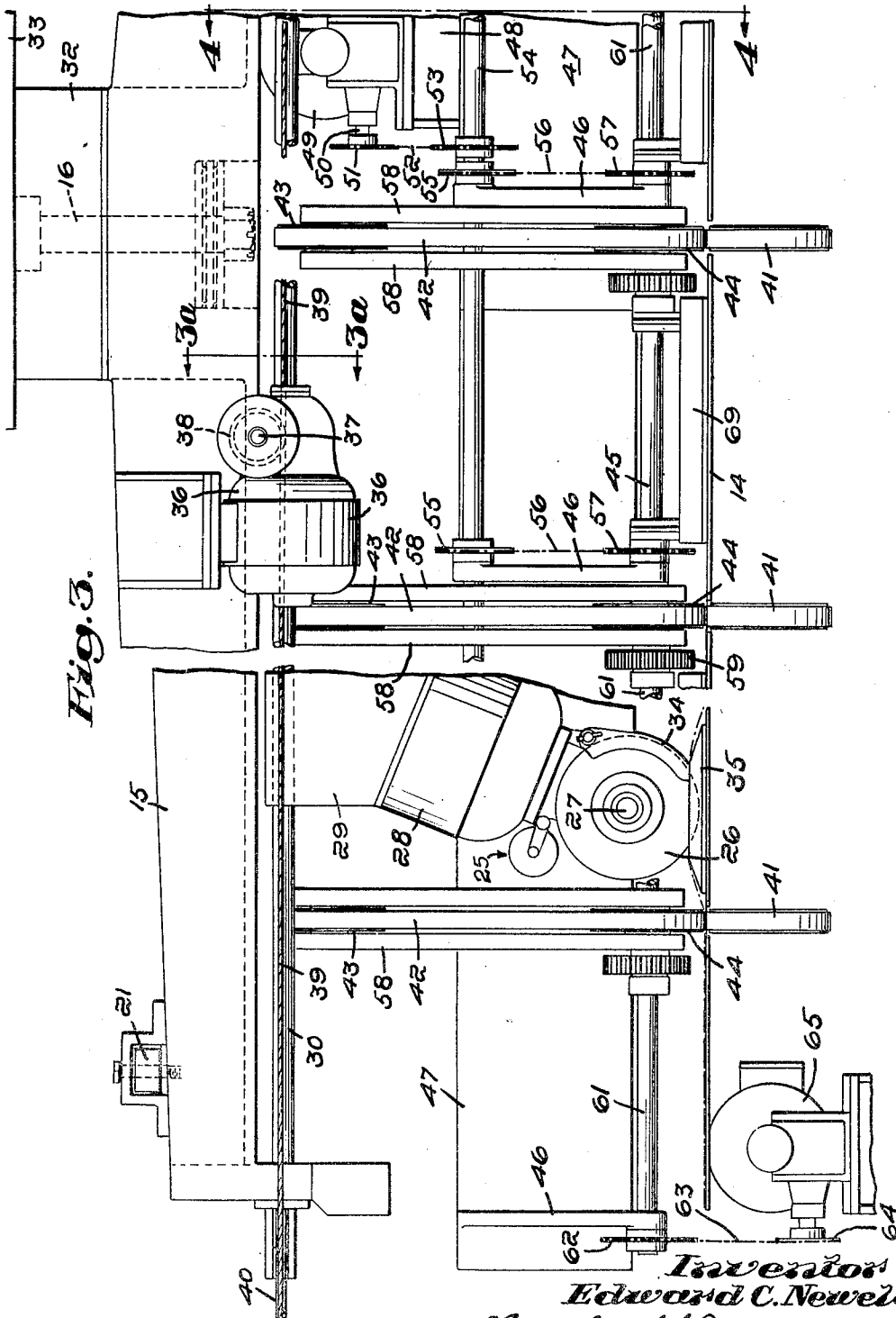
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Fig. 3.



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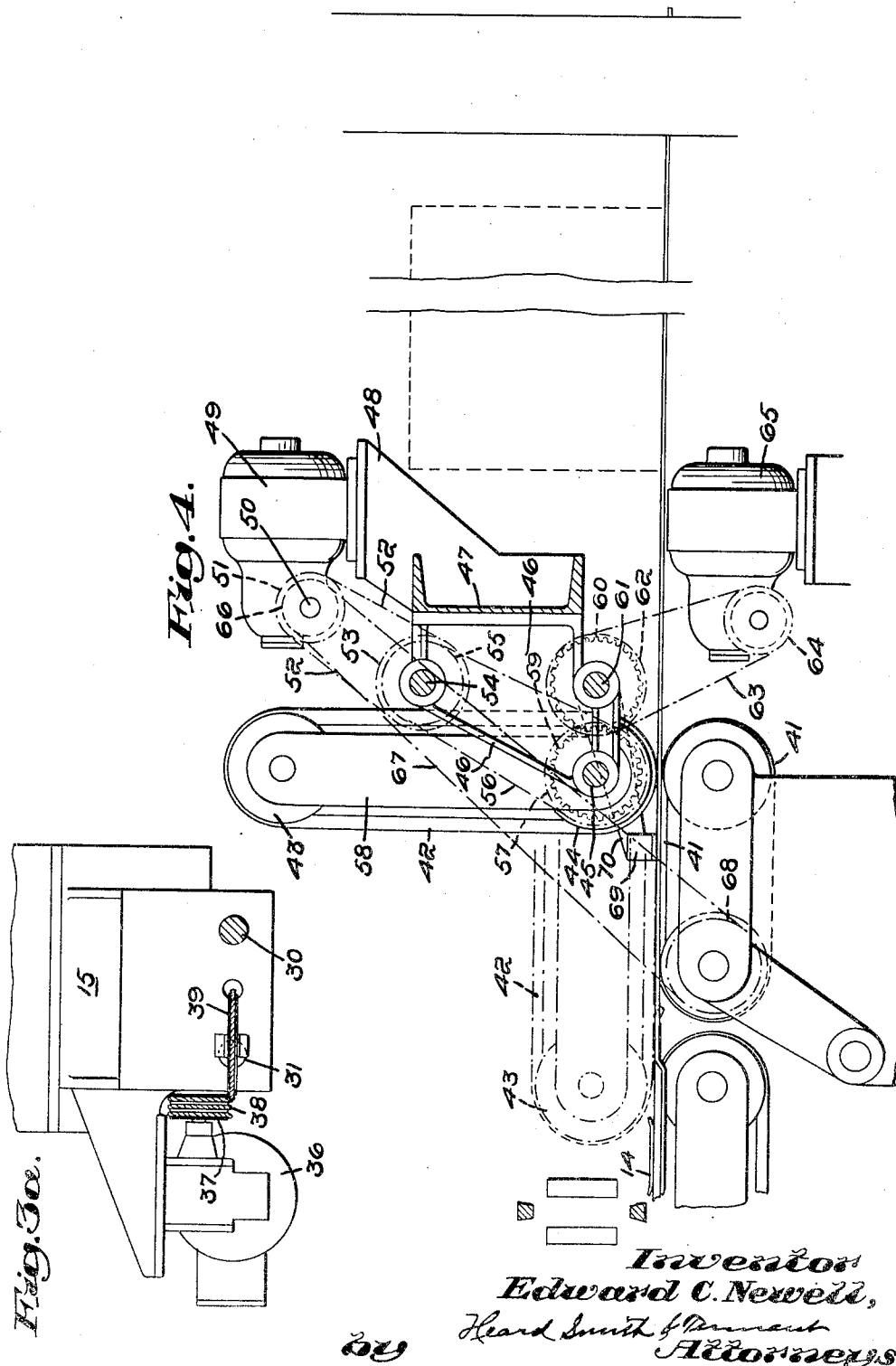
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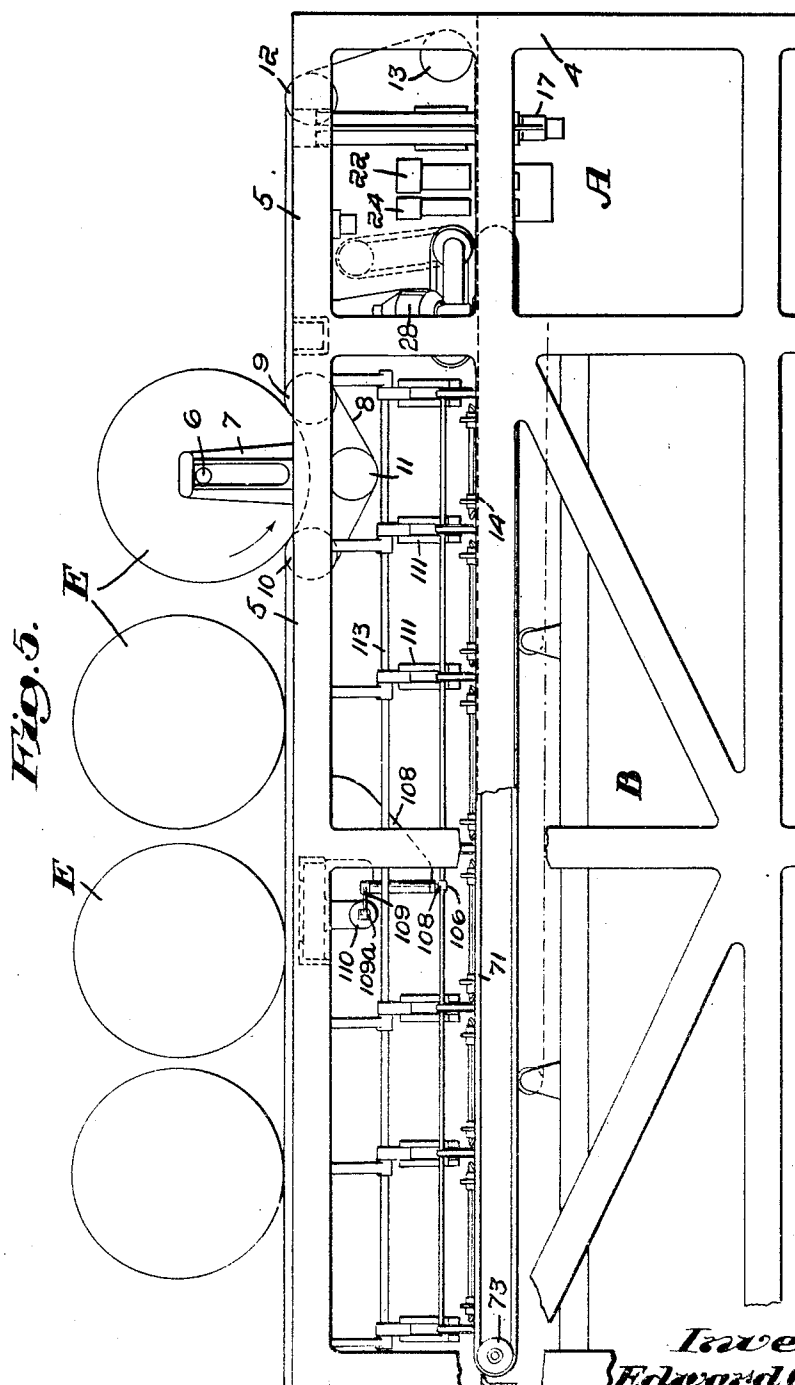
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Filed June 21, 1947

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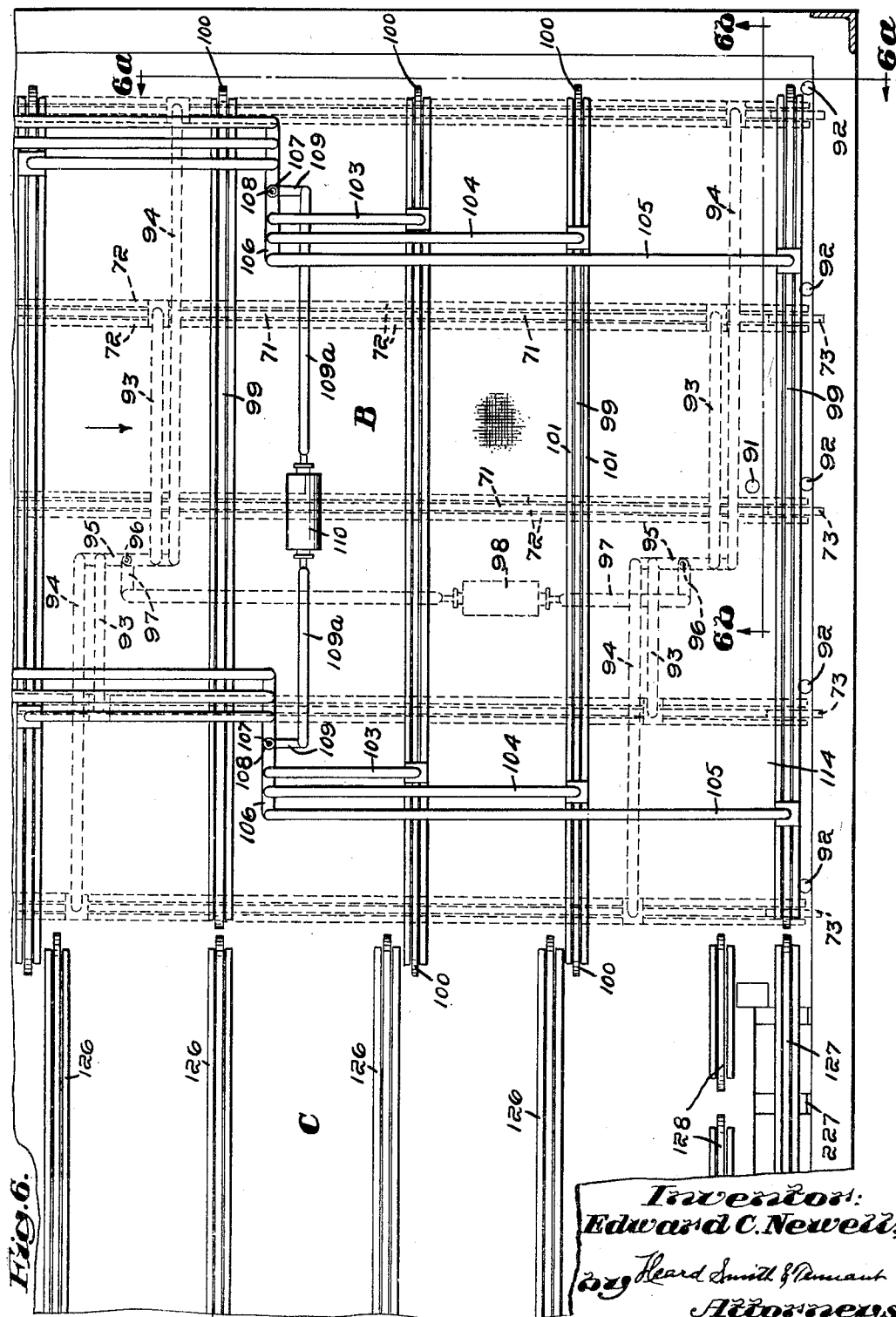
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**2,546,831**



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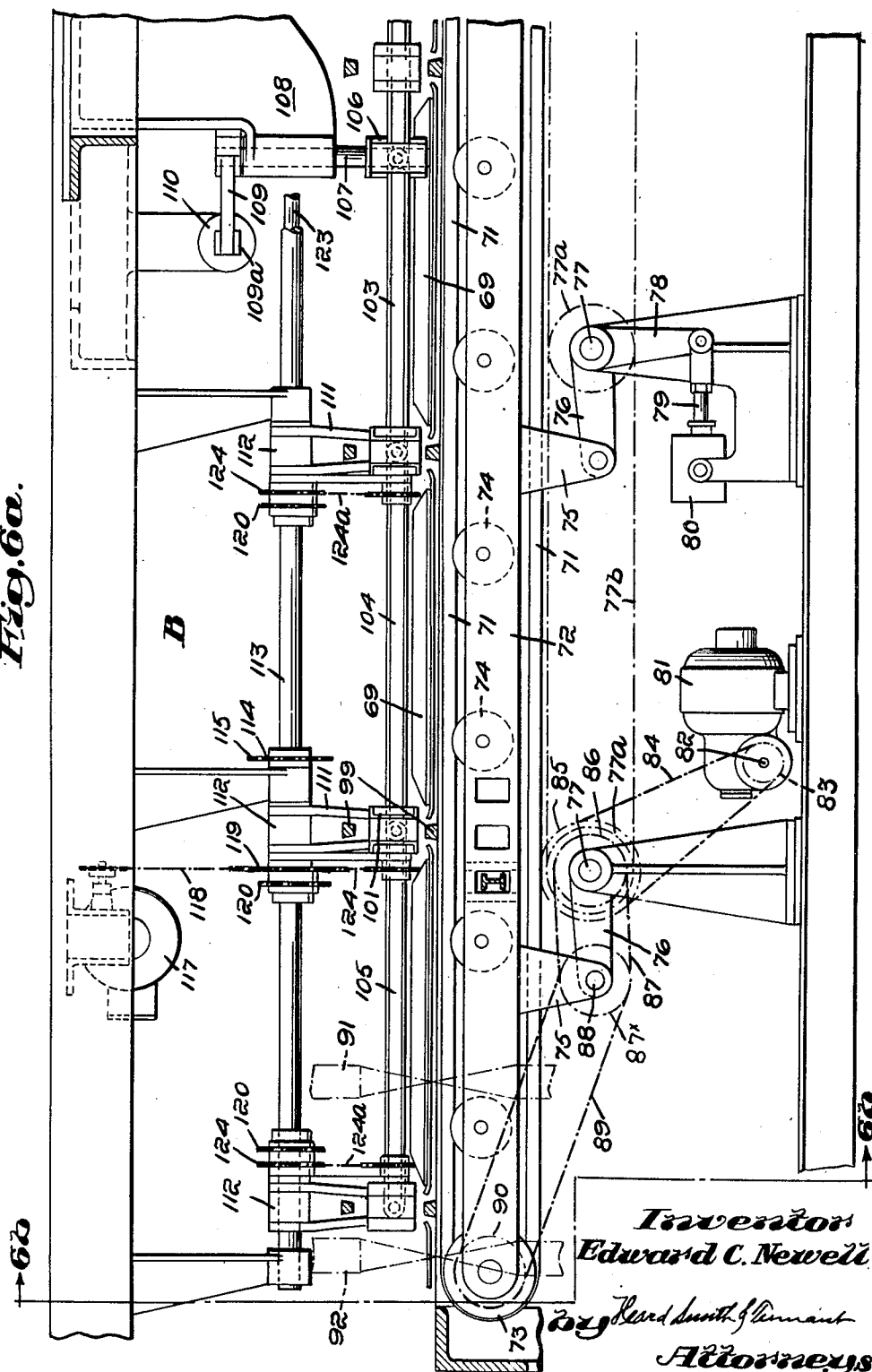
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Fig. 6a.



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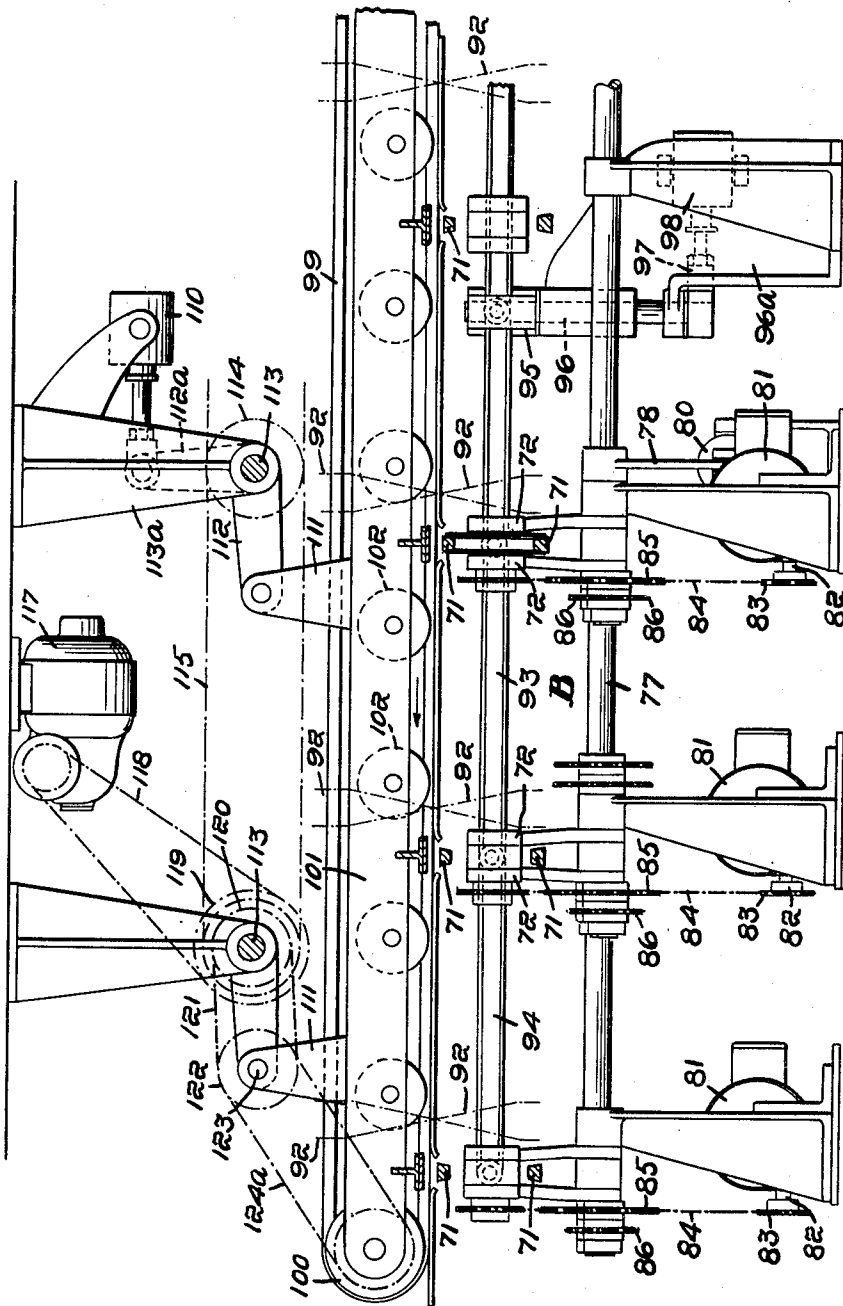
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Fig. 6b.



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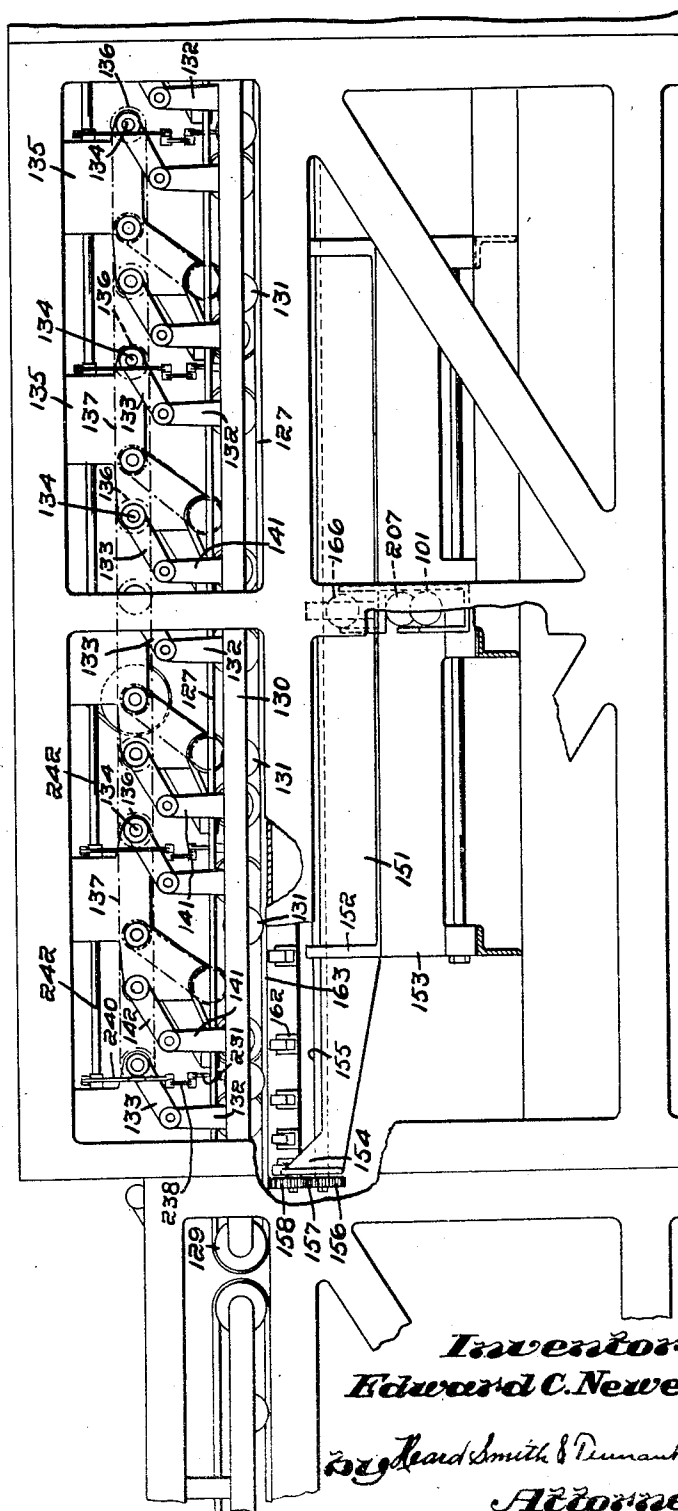
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Fig. 8.



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*Fig. 7a.*

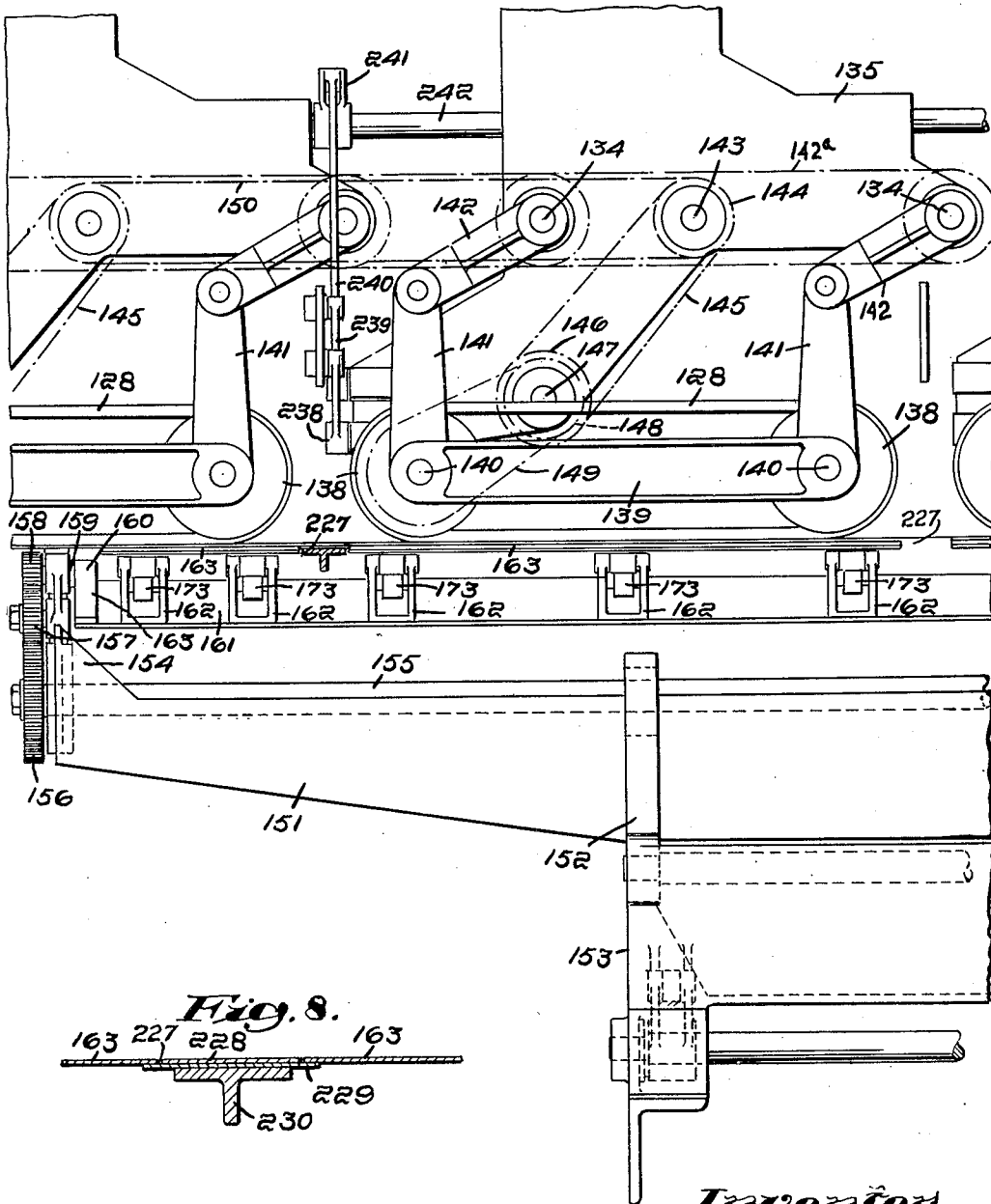
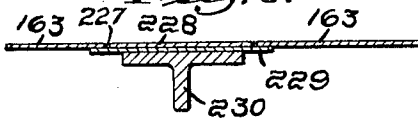


*Fig. 8.*



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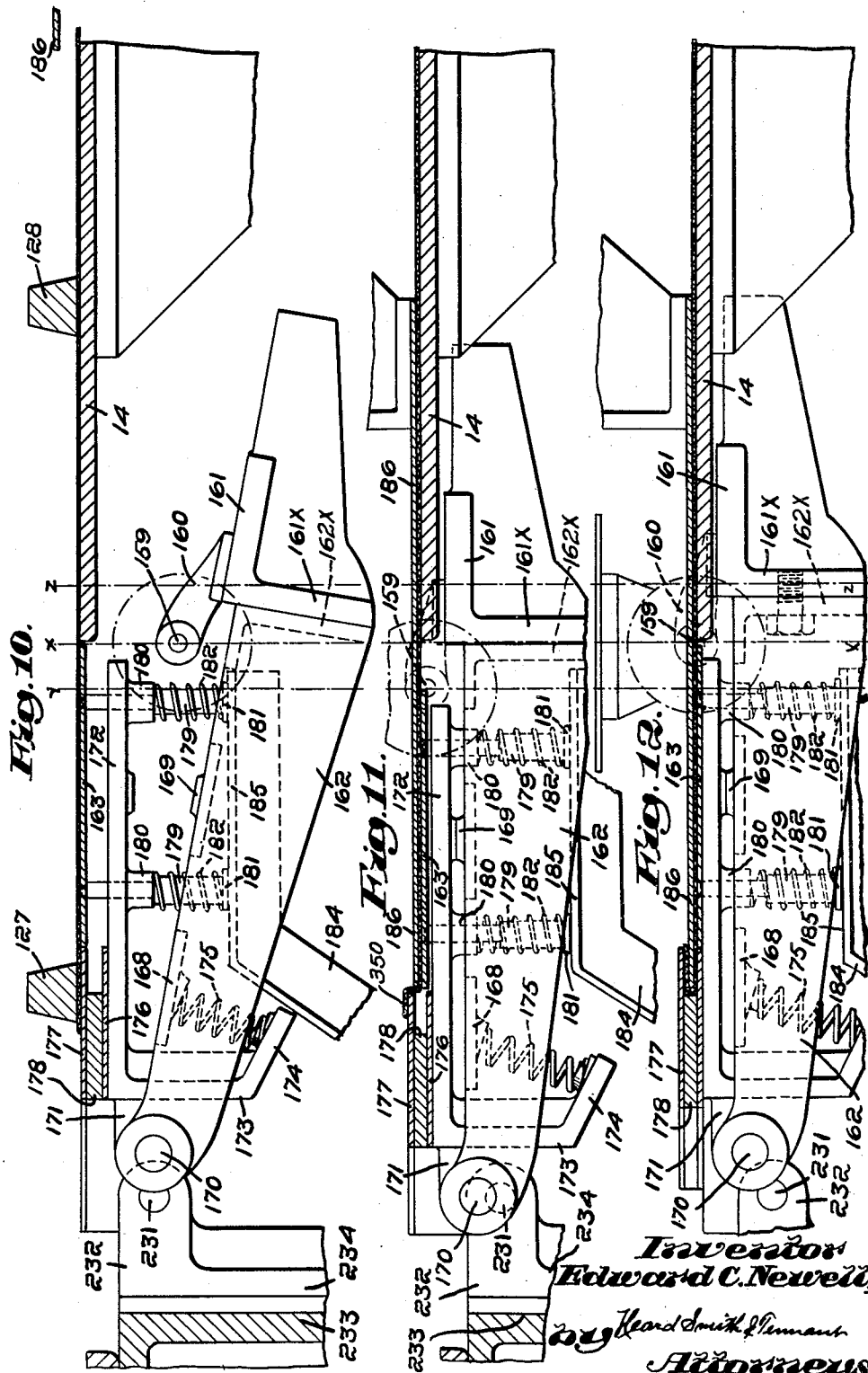
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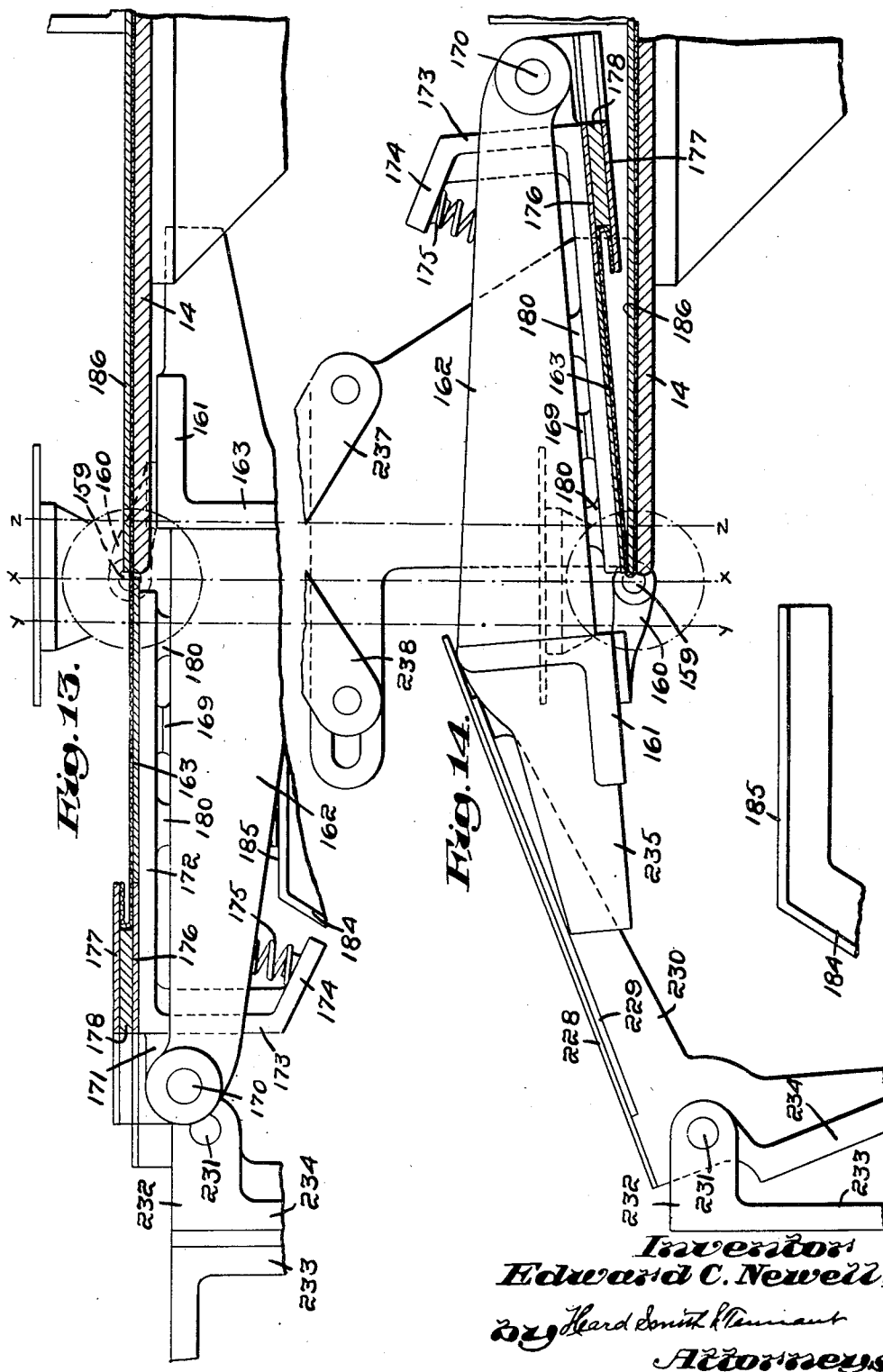
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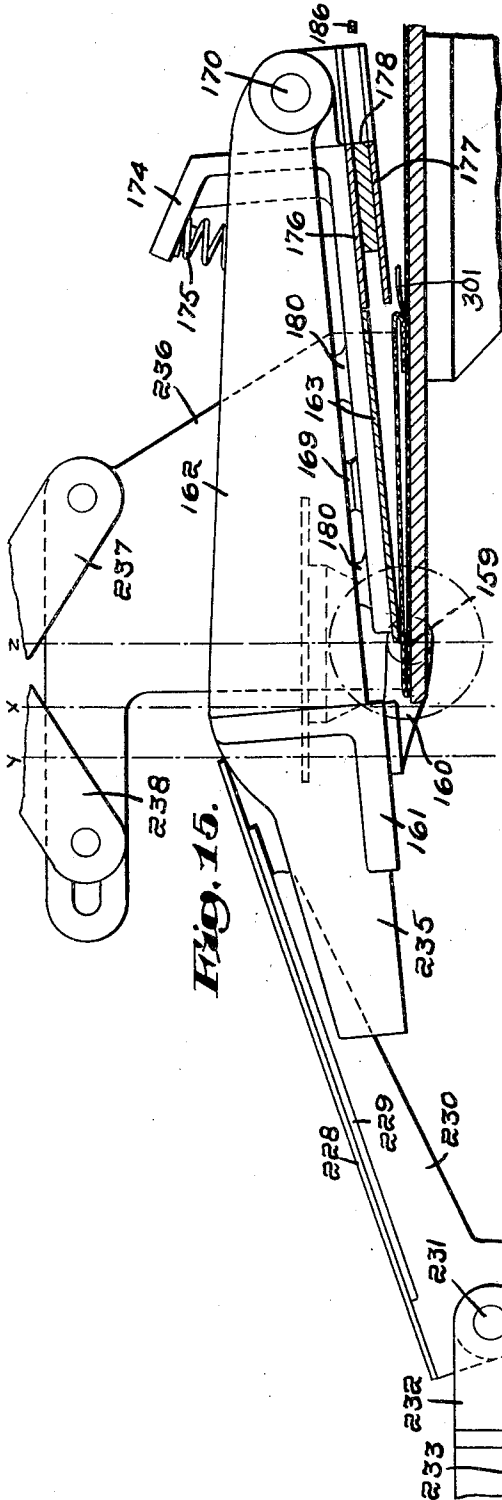


Fig. 15.

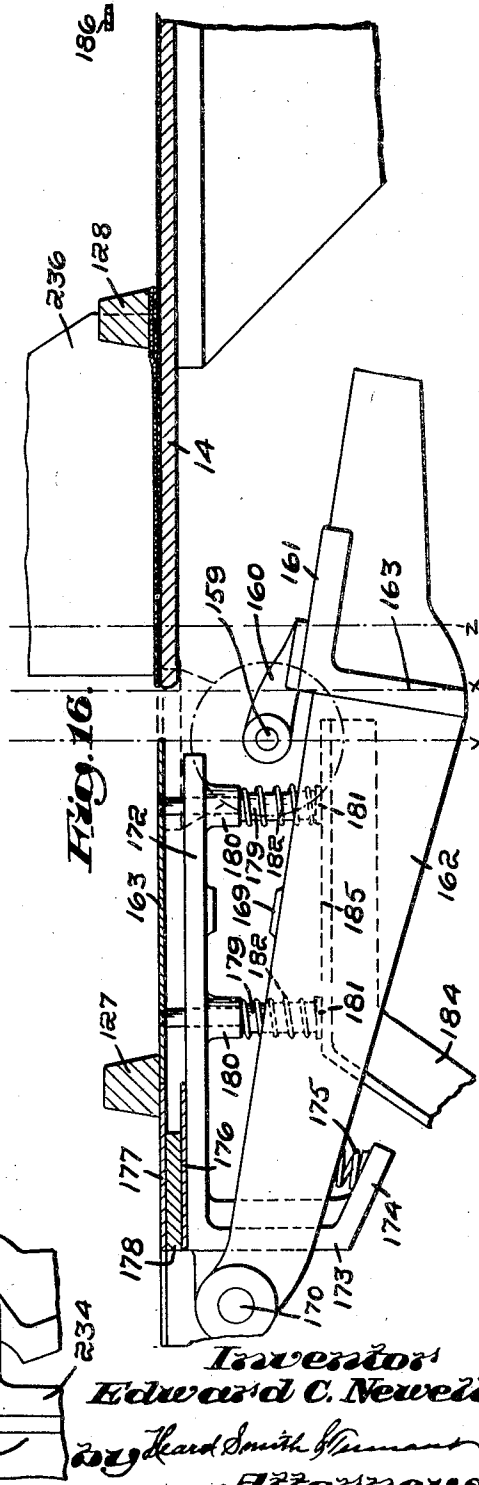


Fig. 16.

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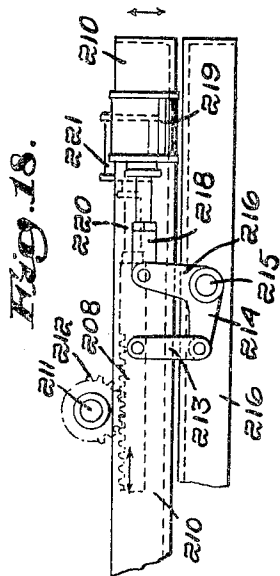
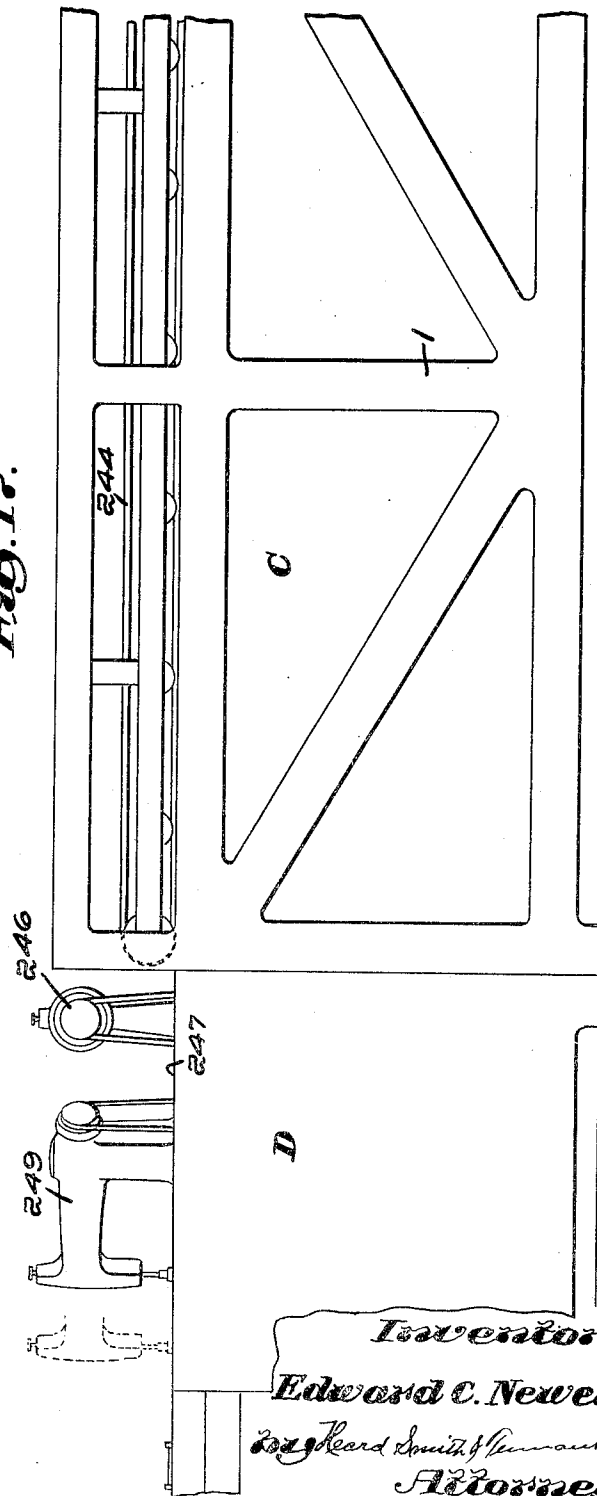


**Fig. 18.**



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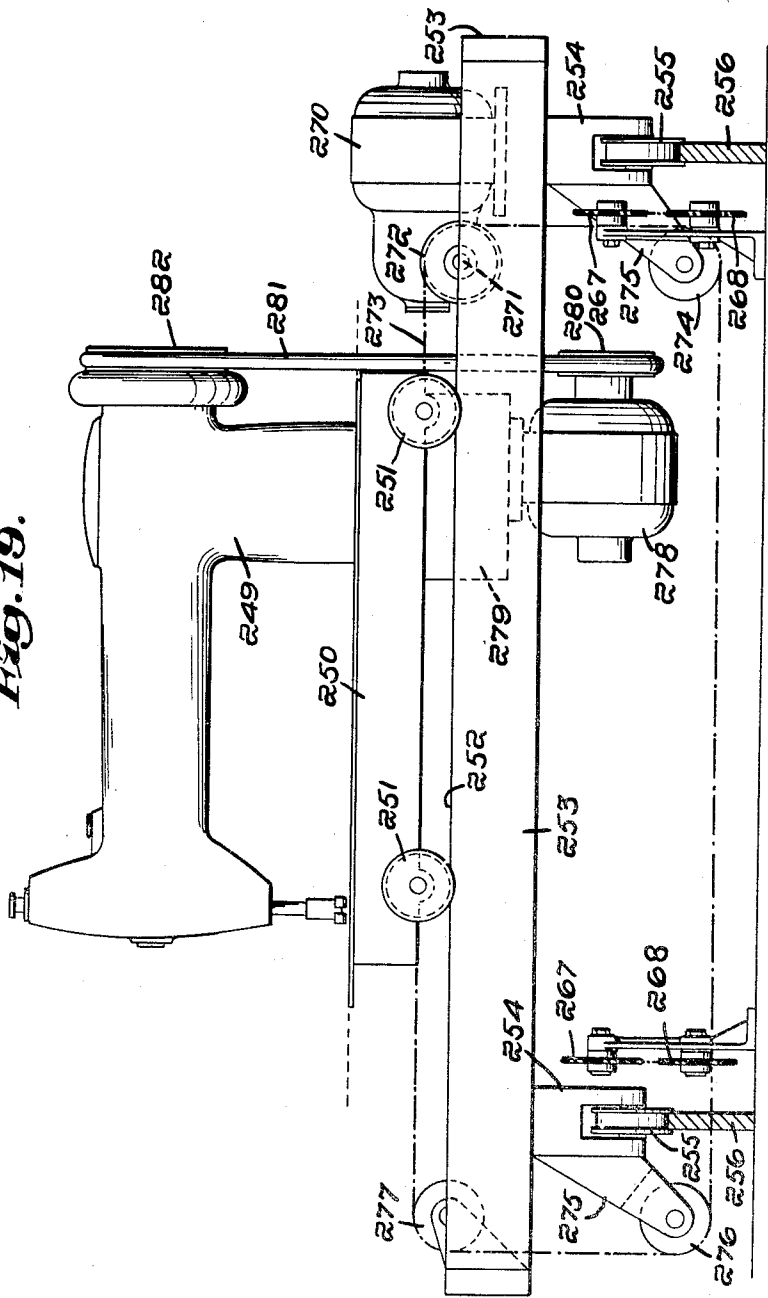
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Fig. 19.



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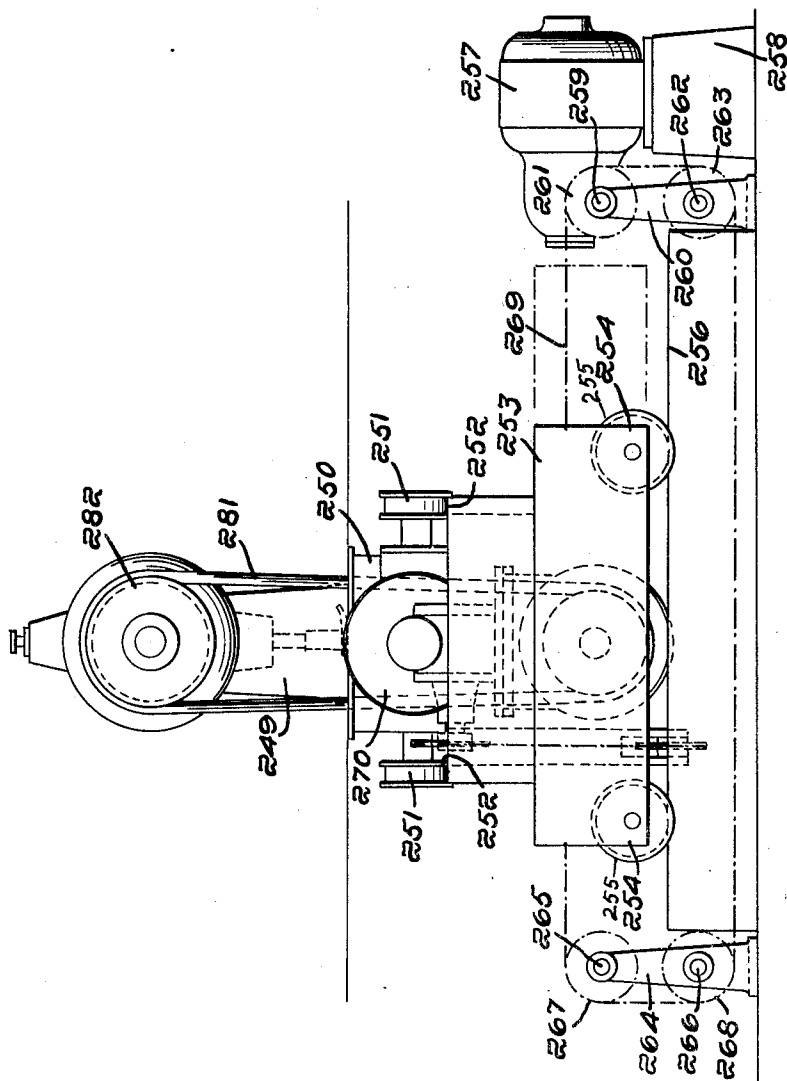
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Fig. 20.



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*Fig. 21.*

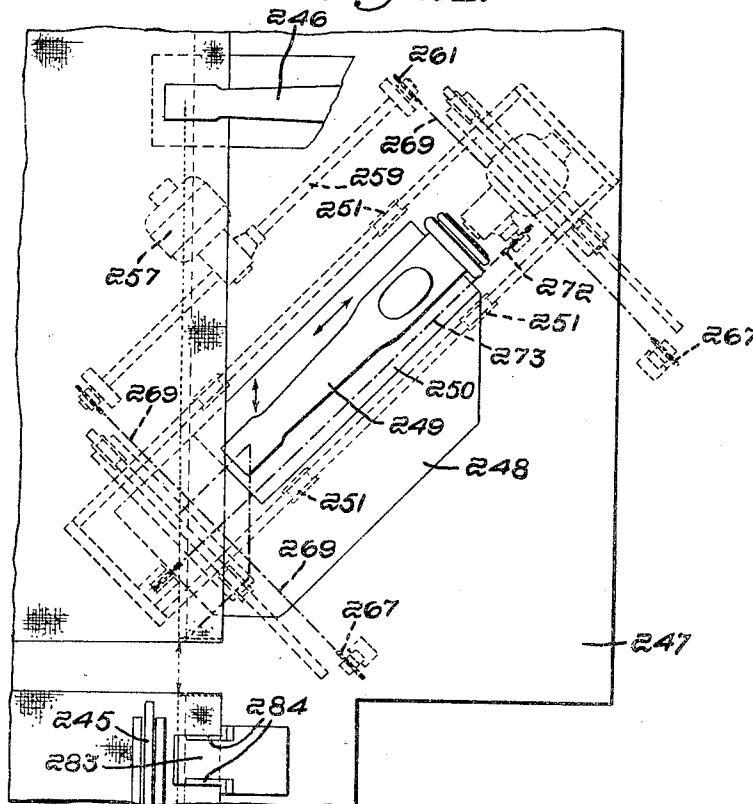
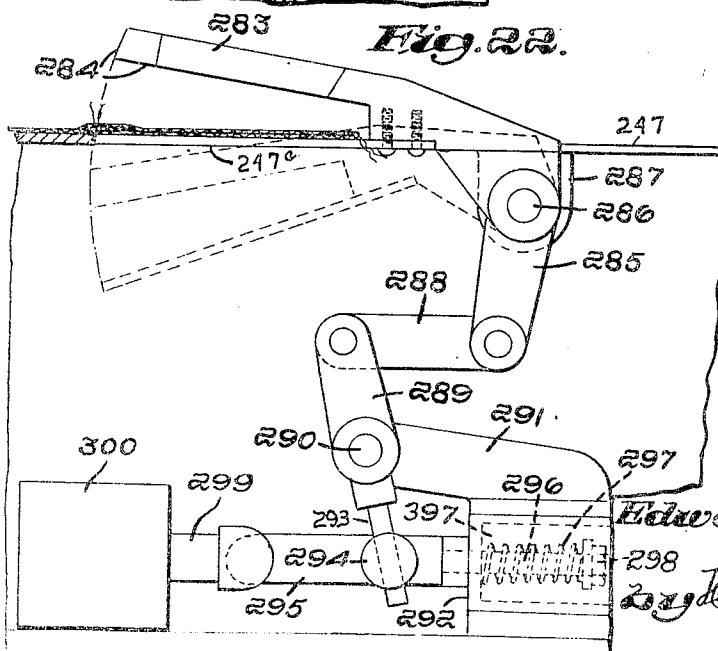


*Fig. 22.*



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## UNITED STATES PATENT OFFICE

2,546,831

## METHOD AND APPARATUS FOR AUTOMATICALLY MAKING RECTANGULAR SHEETS OF FABRIC

Edward C. Newell, Derry Village, N. H.

Application June 21, 1947, Serial No. 756,244

21 Claims. (Cl. 112—2)

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This invention relates to a method and apparatus for automatically making in sequence from a bolt of flexible sheet material of predetermined width rectangular articles severed from the sheet material and hemmed at their respective severed ends.

More particularly the invention relates to a method and apparatus for automatically making in sequence from a continuous web of woven fabric strictly rectangular bed sheets or other rectangular articles severed from the web of fabric with the severed ends thereof hemmed without manual handling, even though the web is skewed.

The terms "accurately rectangular" and/or "strictly rectangular" are used herein as defining a construction conforming to a commercial standard of accuracy and not necessarily to mathematical accuracy.

Usual methods of making rectangular bed sheets and like rectangular articles of fabric comprise tearing the web of cloth transversely along a weft thread into suitable lengths for the sheet or other article, folding the section torn from the cloth, piling such sections on hand trucks by which they are transported to suitable benches in proximity to sewing machines, taking the sheets individually from the pile, unfolding them, sewing hems along the torn edges thereof when the hems are of different width by separate hemstitching sewing machines, cutting the threads at the end of the sewing operation, then inspecting the sheets or other articles, selecting and marking the imperfect ones as rejects, again piling the sheets which pass inspection upon trucks for transportation to pressing machines, and finally folding and packaging the articles. During the production of sheets and other articles in this manner they become wrinkled and frequently soiled and therefore require laundering and pressing.

In order to minimize wrinkling of the sheets apparatus has heretofore been employed in which sheets are draped upon movable supports adapted to transport the sheets to manually controlled stitching mechanism for hemming the respective severed ends of the sheets, but in any case several manual operations have been required.

The general object of the present invention is to provide a method and apparatus by means of which accurately rectangular sheets and other articles are successively produced from a bolt of suitable material, the severed ends hemmed, the ends of the hems closed, and the sheets or other articles delivered without manual handling ready to be folded and packaged.

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The method of the present invention comprises automatically intermittently forwarding the web of material, from a bolt thereof, in the direction of its length in a horizontal plane, inspecting the traveling web and upon discovery of a removable blemish applying to the portion of the web containing it indicia denoting such blemish, examining the traveling web for flaws, and upon discovery of a flaw automatically severing the flaw-containing portion transversely of the web and discharging such portion, forwarding and measuring the web of perfect material, measuring a section thereof corresponding to the desired length of the sheet or other article to be hemmed, severing the web, perpendicular to the longitudinal edges of the sheet or other article, to insure accurate rectangularity thereof, transporting the measured and severed section laterally to hem-folding position, arresting it in such position, and simultaneously first folding the cut marginal end edges upon the body of said section, then folding hems of desired width upon the body of the section with the marginal infolded edge portions therebetween, and permanently securing the hems thus folded to the body of the section and discharging the finished article.

The method of making strictly rectangular bed sheets and other articles of woven fabric also comprises severing the web along a weft thread irrespective of its angular relation to the longitudinally extending warp threads, straightening the sheet to true rectangular form, spreading the sheet-forming section laterally and longitudinally to remove wrinkles therefrom, and after the folding of the hems forwarding it in the direction of the weft thread, stitching the hems longitudinally and the ends of the hems laterally to close the ends thereof, and cutting the threads connecting successive sections closely adjacent to the ends of the respective hems.

A further object of the invention is to provide suitable apparatus for performing the method above described in which one of the objects is to provide means for automatically inspecting the web of fabric throughout its width as it is drawn from a bolt, preferably in the form of a roll, having means operable upon detection of blemishes, such as soiled spots, to apply to the section of the sheet containing the same means indicative of the necessity of laundering or other treatment.

Another object of the invention is to provide automatically operated means for severing the web transversely along a weft thread irrespective of the angular relation thereof relatively to the

longitudinal weft threads if the weft threads are in skewed relation thereto.

A further object of the invention is to provide means for examining the traveling web to determine imperfections such as faults or flaws in the weave of the fabric which warrant its rejection, and means operable thereby to arrest the web to sever the section containing the imperfection therefrom and to discharge the same.

Another object of the invention is to provide mechanism for automatically measuring from the leading edge of the web to the severing means a distance equal to that required to produce a hemmed sheet of predetermined length, and severing the sheet at the end of said distance along a weft thread.

Another object of the invention is to provide means for straightening the severed section of the web both longitudinally and laterally to true rectangular form.

Another object of the invention is to provide means for transferring the section of fabric, thus straightened, laterally in the direction of the weft to suitable mechanism, operable simultaneously, for folding both of the cut ends of the web to form thereupon hems, which desirably are of different widths.

A further object of the invention is to provide means for advancing the section of the web in the direction of the wefts thereof and fixedly securing the folded hem portions upon the body of said section.

Another object of the invention is to provide means for automatically stitching, during said forwarding movement, the longitudinal edges of the hems to the body portion of the sheet, together with means for stitching the open ends of the hems to the body of the sheet during the traveling movement thereof.

Another object of the invention is to provide mechanism for severing the stitching threads connecting adjacent ends of successive sheets closely to the respective ends of the sheets thereby to produce a complete hemmed sheet.

Another object of the invention is to provide alternative means for automatically cementing the hems to the body of the sheet in place of stitching above described.

Another object of the invention is to provide an apparatus for performing the method above described in which the timing of the operations of the respective mechanisms are controlled and co-ordinated by suitable photoelectric mechanisms of a usual commercial type such as may be obtained from the General Electric Company, Photoswitch, Incorporated, or other manufacturers of such photoelectric apparatus and which need not be illustrated.

These and other objects and features of the invention will more fully appear from the following description and the accompanying drawings and will be particularly pointed out in the claims.

A suitable apparatus thus controlled by photoelectric means for making bed sheets and like articles is illustrated in the accompanying drawings, in which,

Fig. 1 is a general diagrammatic plan view illustrating essential portions of the associated mechanisms for inspecting a traveling web of fabric as it is fed from a cylindrical bolt, mechanism for measuring and straightening the severed sections, means for delivering the straightened section to the hem-folding mechanism, the mechanism for stitching and closing the hems, and

means for severing the threads connecting successive sheets;

Fig. 2 is an enlarged detail plan view of the mechanism for inspecting and examining the traveling web, the cutter mechanism for severing the sheet transversely, the means for positioning the cutter mechanism in parallelism with the weft thread, and a portion of the mechanisms for forwarding the web;

Fig. 2-a is an enlarged detail view of one of the weft-following photoelectric eyes showing where the web passes through the latter to cause the cutter to follow a weft thread;

Fig. 3 is an enlarged detail sectional view of the cutting mechanism on line 3-3 Fig. 2, viewed in the direction indicated by the arrow; Fig. 3-a is a detail vertical sectional view on line 3a-3a Fig. 3;

Fig. 4 is an enlarged detail sectional view on line 4-4 Fig. 3, viewed in the direction of the arrow;

Fig. 5 is an end elevation of the construction shown in Fig. 1, illustrating the manner in which a cylindrical bolt of material is supported on the frame of the machine and diagrammatically illustrating the inspection and examining photoelectric mechanism, the cutting mechanism, and mechanism for forwarding the web and the mechanism for straightening laterally the severed portion of said section;

Fig. 6 is an enlarged detail diagrammatic plan view of the mechanism for forwarding and measuring a section of the web of desired length, the photoelectric mechanism for arresting the web and severing the measured section therefrom, the mechanism for spreading it laterally and longitudinally, and a portion of the mechanism for forwarding the severed section to folding mechanism;

Fig. 6a is an enlarged detail vertical sectional view on line 6a-6a Fig. 6 showing in elevation the lower endless belt mechanism for forwarding the web of material to measuring position and the means for raising and lowering the same and also showing mainly in elevation and partly in vertical section the upper endless belt mechanism extending transversely thereof, the means for spreading the web longitudinally after it is severed, and the means for actuating the upper endless belt;

Fig. 6b is an enlarged detail vertical sectional view on line 6b-6b and Figure 6 particularly illustrating the individual mechanisms for driving the respective lower forwarding belts and the means for actuating the same to spread the web laterally;

Fig. 7 is a side elevation of the hem folding and part of the hem completing portion of the machine, a portion of the frame being broken away to show the mechanism for supporting and actuating the folder mechanism, and also illustrating the endless belt forwarding mechanism for positioning the severed sheet forming section in folding position;

Fig. 7a is an enlarged detail view of one end portion of the hem folding mechanism showing in section a plate for supporting a sheet between adjacent short forwarding belts;

Fig. 8 is an enlarged detail view of the sheet-supporting plate shown in Fig. 7a;

Fig. 9 is an enlarged detail vertical sectional view of one of the folder mechanisms and the mechanism for actuating the same, the folder mechanism being shown in initial position preparatory to the hem folding operation and illus-

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trating also the mechanism for raising and lowering the folder mechanism and moving the same laterally;

Fig. 10 is an enlarged detail view of the folder mechanism in the position illustrated in Fig. 9 showing the position of the parts as the sheet is being fed into folding position;

Fig. 11 is a similar enlarged detail vertical sectional view showing the folding mechanism positioned to offset the marginal edge preparatory to the folding of said marginal edge;

Fig. 12 is a similar enlarged detail vertical section illustrating the position of the parts upon the completion of the edge fold;

Fig. 13 is a similar enlarged detail vertical sectional view illustrating the completed edge fold with the hold-down plate withdrawn and positioned preparatory to the making of the hem fold;

Fig. 14 is a similar enlarged detail vertical sectional view illustrating the position of the folding mechanism as the hem is being folded about the hold-down plate;

Fig. 15 is a similar enlarged detail vertical sectional view showing the position of the folding mechanism when the hold-down plate is withdrawn; and disengaged from the marginal fold;

Fig. 16 is a similar enlarged detail vertical sectional view showing the position of the mechanism when the folder is restored to horizontal position preparatory to being returned to normal position shown in Fig. 10;

Fig. 17 is a side elevation of the frame and forwarding belts for advancing the sheet-forming section and illustrating also the sewing machines for stitching the hems longitudinally and for stitching the ends of the hem;

Fig. 18 is an enlarged detail elevation of the mechanism for raising and lowering the hold-down plate and the mechanism for moving the hold-down plate to folding positions as illustrated in Fig. 9 and in detail in Figs. 10-16;

Fig. 19 is a side elevation of the motor driven traveling sewing machine for closing the ends of the hems and the mechanism for actuating the same to move the sewing machine longitudinally in an angular direction relatively to the direction of movement of the hem-folded section of the material;

Fig. 20 is a rear end view of the traveling hem-closing sewing machine and the mechanism for actuating it shown in Fig. 19;

Fig. 21 is a detail diagrammatic plan view illustrating the relative positions of the sewing machines for stitching the hem longitudinally and the traveling sewing machine for closing the ends of the hems during the forwarding movement of the hem sections, and also illustrating the position of the thread cutting mechanism for severing the threads connecting the adjacent ends of successive sheets; and,

Fig. 22 is an enlarged vertical detail view partially in vertical section of the thread cutting mechanism.

Suitable apparatus for performing the method above described as illustrated in the drawings for the manufacture of bed sheets and like articles comprises a series of cooperating mechanisms the operations of which are co-ordinated in properly timed relation by photoelectric mechanisms including electric eyes and means operable thereby to co-ordinate the operation of said mechanism in properly timed relation to produce from a continuous sheet of material accurately rectangular bed sheets or the like completely

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hemmed along the edges of the sheet-forming section and delivered in smooth form ready to be ironed, if desired, and folded for storage or transportation.

In order to facilitate an understanding of the sequence of the mechanisms illustrated in the drawings and their operation automatically to produce accurately rectangular hemmed sheets and like articles the general description thereof is as follows, it being understood that the photoelectric mechanism for controlling and coordinating the operation of the respective mechanisms is not illustrated as such mechanisms may be of usual types obtainable in the open market.

The sheet forming and hemming apparatus of the present invention comprises automatically operable means for intermittently advancing a web of suitably woven cloth, of a predetermined width corresponding to the desired width of the sheets to be made, from a preferably cylindrical bolt thereof, automatically inspecting the advancing cloth for blemishes, such as soiled or stained areas for laundering or other treatment, again automatically examining the cloth for imperfections which warrant rejection of the section containing the same, automatically severing such section along a weft thread irrespective of its angle relatively to the longitudinal direction of movement of the cloth, automatically measuring a section of cloth which passes inspection of sufficient length to make sheets of predetermined length, automatically severing the section from the web, then straightening the section laterally and longitudinally to true rectangular form, then transferring the sheet section laterally in the direction of the weft to hem-folding mechanism adapted simultaneously to fold hems on both cut edges of the sheet, thereupon advancing the hem-folded sheet through suitable mechanism for permanently securing the hem upon the body of the sheet including the closing of the open end of the hem.

A preferred series of mechanisms for performing the system above described, as illustrated in the drawings, comprises means for supporting a cylindrical bolt of suitable woven cloth, means for advancing the web of cloth from the bolt upon a flat smooth table, and mechanisms respectively controlled by photoelectric devices for performing successive operations upon the web and the sections thereof forming the sheet. Inasmuch as photoelectric devices and mechanisms controlled and operated thereby are well known in the art the photoelectric devices are graphically illustrated in the accompanying drawings and only such mechanisms shown as are particularly adapted to the system of the present invention.

The cloth thus supported upon the table first passes lengthwise through the field of photoelectric means which actuate mechanism automatically to position a pivotally mounted weft follower in alinement with the weft threads of the fabric, whether perpendicular to or at an angle to the direction of longitudinal movement of the web of cloth. The traveling web of cloth is then automatically inspected by a series of narrowly spaced photoelectric cells extending transversely of and perpendicular to the direction of movement of the web which upon discovery of a blemish or blemishes, such as removable soiled spots or stains, causes the actuation of mechanisms for applying to the cloth, preferably adjacent the selvage edge thereof, removable indicia indicating the necessity of laundering or other cleaning.

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The traveling web of cloth is also inspected by another series of photoelectric cells which are located in proximity to the former inspection cells and are adapted to detect imperfections in the cloth which warrant the rejection of the section containing the imperfections.

Upon such detection means controlled by said photoelectric cells arrest the cloth-forwarding mechanism after it has advanced such distance as to include the predetermined area and thereupon actuate cutter mechanism which is connected to and movable in parallelism with the web follower to sever the imperfect section from the web. Where the severed section is shorter than the required length of the sheet the severed portion is moved forwardly until it is ejected from the system before further operations are performed upon the web.

The mechanism for forwarding the web longitudinally preferably comprises a series of normally parallel belts which underlie the cloth and extend in the direction of movement thereof, with means for spreading the belts relatively to a central vertical plane.

The web which passes inspection is carried by these belts until the leading edge thereof intercepts the ray of a measuring photoelectric cell located in said central vertical plane at a distance from said web-severing means equal to the length of a section of the web required to form a sheet of desired length. The forwarding movement is then arrested and the knife actuated under the control of said measuring cell to sever the web along a web thread in the manner heretofore described. The forwarding mechanism is then resumed until the leading edge of the severed section intercepts the rays of a series of photoelectric cells positioned at right angles to the direction of movement of the web. Each of the forwarding belts is individually controlled by the respective cells, each of which arrests its belt in response to the interception of the ray thereof. As soon as the leading edge of the cloth is stopped mechanism is operated to spread the belts from the longitudinal central plane of the web laterally to take out any wrinkles extending longitudinally of the cloth. Means are also provided for taking out wrinkles which extend laterally of the severed section of the web. This comprises a series of upper belts which overlie the cloth and extend transversely at right angles to the direction of movement of the severed section and are provided with means for spreading the same laterally from a transverse plane centrally of said series. When the web of cloth is arrested as aforesaid the upper belts are brought down into contact with the upper side of the cloth and the lower belts lowered out of contact with the cloth by means controlled by said photoelectric eye mechanisms and the upper belts spread relatively to the transverse central plane thereby taking out any cross wrinkles which may have been caused by the straightening mechanism.

As soon as this operation is completed mechanism for driving the upper belts is started and the cloth is forwarded to folding position in the direction of the web threads by series of upper belts which form practically a continuation of the upper cloth spreading belts and which carry the severed section to folding position where it is stopped by photoelectric mechanism the rays of which are intercepted by the leading end of the severed section. The mechanism for forwarding the sheets to folding position comprises not only continuous belts but also series of short belts lo-

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cated adjacent to the outer continuous belts. The outside continuous belts and the series of short belts adjacent thereto are movable up and down to permit the folding mechanism to function.

The folding mechanism comprises folding plates which extend the full length of the edges of the severed section and means are provided for first folding over the marginal portion of a cut edge against the upper surface of the sheet and thereupon to fold the hem over and down upon the face of the sheet.

After the cut edges have been thus hem-folded the upper belts are actuated to move the sheet out of folding position into and through mechanisms for permanently securing the hem to the body of the sheet, thereby to complete the hemming of the sheet.

Suitable alternative means are provided for thus securing the hem to the body of the sheet, one of which comprises stitching mechanism operable during the continued advancing of the severed sheet sections in the direction of its width through the fields of sewing machines which stitch the inner edges of the hem to the body of the sheet and through the fields of movable sewing machines which travel at a suitable angle to the direction of movement of the sheet to close the ends of the hems.

In this construction a series of suitably driven upper belts in substantial alignment with the belts which advance the sheet to folding position engage the upper surface of the sheets and are actuated to move the sheet out of folding position to the sewing mechanism at a comparatively high speed, thereby to position the trailing edge of the foremost sheet a short distance in advance of the leading edge of the next sheet, whereupon the speed of such belts is slowed down to the stitching speed of the sewing machines.

The hem stitching mechanism comprises a stationary sewing machine which stitches the inner folded edge of the hem as it advances in the direction of the web threads and supplemental traveling sewing machines are provided for closing the ends of the hems. The traveling sewing machines are positioned in such manner as to travel in angular relation to the ends of the traveling sheet a sufficient distance to stitch the ends of the hem, and the rate of traveling movement of the supplemental machines is coordinated to the speed of the advancing movement of the sheet in such manner as to sew the ends of the hems at right angles to the direction of movement of the sheet.

The threads of the sewing machines for stitching the hems longitudinally are continuous from one sheet to another and means are provided for severing these threads in close proximity to the trailing and leading edges of the respective sheets thus united and also for severing the threads of the hem-closing sewing machines, all in proximity to the respective trailing and leading edges thereof. Such mechanism may comprise a pivotally mounted blade or blades operable in timed relation to the advancing movement of the respective sheets to sever all of the threads in close proximity to the respective ends of the sheet.

In order to identify the sheets with respect to the source of manufacture and size of the sheets suitable means may be provided for inserting labels bearing such information into the folded hem of the sheet in advance of the stitching mechanism.

An alternative means for securing the folded end to the body of the sheet comprises means for

continuously inserting between the folded hem and the body of the sheet a strip of adhesively coated material or a flat band of a thermoplastic substance as the sheet travels from folding position by the forwarding mechanism heretofore described, and applying heat thereto by suitable means such as a "Singer Electric Bonding Machine."

For convenience in describing the several interrelated and mutually cooperating mechanisms for performing the series of operations above described the several sections of the apparatus will be hereinafter designated respectively as:

- A. Inspection and cutting section;
- B. Measuring and spreading section including lateral sheet-transferring means;
- C. Hem-folding section;
- D. Hem completing section.

The machine illustrated in the accompanying drawings comprises suitable side frames 1 and 2, the side frame 2 having an offset portion 3 forming the inspection and cutting section A, and end frames 4 which are mounted upon a suitable base therebeneath and support the various mechanisms employed in the system above described. The upper rail 5 of the end frame 4 and a complementary rail parallel thereto connecting the side frames 1 and 2 Fig. 5 may be employed to support a plurality of bolts E of cloth in the form of rolls. Suitable means are provided for supporting and driving one of the rolls to advance progressively the web of cloth therefrom. In the construction shown in Fig. 5 the shaft 6 of the roll E is slidably mounted in guideways in vertical standards 7 extending upwardly from the top rail of the end frame 4 and the companion rail. As illustrated herein the roll E from which the web is delivered rests upon and is supported upon the upper lead of a belt 8 which passes over suitably spaced rolls 9 and 10 and around a tension roll 11.

By reason of this construction the web can be delivered from the roll at a uniform speed irrespective of the diameter of the roll as the web is being unwound. The web, which will hereinafter be designated as "W," passes horizontally from the roll over a guide roll 12, thence downwardly around a guide roll 13, and is delivered upon the top of a horizontal flat smooth table 14 which covers the entire area within the frame and serves to support the cloth during all of the sheet forming operations, said table having slots to receive the feeding belts hereinafter referred to.

The web of cloth passing upon the table is carried beneath a suitable cutting mechanism 15 which extends transversely of the direction of movement of the web and is mounted on a preferably central vertical pivot 16 upon which it can be swung in a horizontal plane.

Suitable means are provided for positioning the cutter in such manner as to sever the web of cloth transversely along a weft thread irrespective of the angularity of the weft thread relative to the longitudinally extending warp threads. As illustrated herein the progressively traveling web moves through the light beams of a plurality of preferably to suitably spaced photoelectric means such as photoelectric eyes 17 and means, which may be defined as a weft follower, controlled and operated by said electric eyes is adapted to be positioned in parallelism with the wefts and to position the cutting means in alinement with the weft threads although the latter may be

askew in either direction with respect to the warp threads.

The mechanism for positioning the weft follower and the cutting mechanism is actuated and controlled by mechanism similar to the weft straightening mechanism of the General Electric Co., and that manufactured by the Winsor & Jerauld Mfg. Co. of Providence, R. I., which comprises means operable when a skew is presented to spaced photoelectric mechanisms in a traveling web of fabric the frequency of light interruptions in the respective beams of light become unequal and a comparison of the magnitude and direction of these frequencies becomes a measure of the magnitude and the direction of skew means are employed controllably to actuate a solenoid or a suitable motor to position the weft follower in parallelism with the skewed weft threads and thereby to position the cutting mechanism in parallelism with the skewed weft threads.

Any other suitable commercial photoelectric means may be provided for accomplishing this purpose. As illustrated in the drawings Figs. 1 and 2 a weft follower 18, which extends transversely of the direction of movement of the web, is centrally mounted upon a vertical pivot 19 and is adapted to be actuated by suitable mechanism such as a solenoid 20 flexibly connected to the weft follower and controlled by the photoelectric devices 17 in such manner as to position the weft follower in alinement with the weft threads of the cloth at all times. In the construction illustrated the pivots 16 and 19 of the weft follower and cutting mechanism are in alinement with the longitudinal center of the web and a link 21 which connects the weft follower and cutting mechanism causes the cutting mechanism at all times to be in alinement with the weft threads.

Suitable electrically operable means controlled by photoelectric means are employed for arresting the forwarding movement of the web of cloth at predetermined times as hereinafter described and for actuating the cutting mechanism to sever a portion or section of the cloth along the weft thread. By reason of such operation the selvages of each section of the web will be of exactly equal length so that a sheet or other article formed from the severed section may be straightened to strictly rectangular contour.

One of the objects of the invention is to provide means for inspecting the web of material with respect to soiled spots, blemishes, etc., which do not require rejection of the section upon which they occur. In the present invention such inspection is produced by a series of narrowly spaced photoelectric devices 22 which are positioned transversely of the direction of movement of the web throughout its width and which are adapted upon discovery of such a removable blemish to cause the actuation of suitable printing or other mechanism to apply to the sheet, preferably adjacent its edge, a stamp 23 or other indicia calling attention to the defect.

A further object of the invention is to provide means for detecting a flaw or fault in the cloth which would prevent the production of a perfect sheet. This is accomplished in the present invention by the provision of a supplemental series of photoelectric devices 24 extending horizontally across the web perpendicular to the direction of movement thereof and means operable thereby upon detection of a fault or flaw in the cloth such, for example, as an imperfect weave, to arrest the forward movement of the web after it has advanced sufficiently to position

the faulty section beyond the cutter and thereupon to actuate the cutting mechanism.

In explanation of the operation of the mechanisms above described it is well known that photoelectric cells have the ability to respond to changes in the intensity of light beams. In the present construction the series 22 of photoelectric mechanisms is so constructed as to react to minor changes in the intensity of the light beams therefrom which are interrupted by spots of dirt, grease, stains, and other removable blemishes, and that means such as a Selsyn motor is operated thereby to actuate a stamp or other means to apply to the section of the web which embodies such a removable blemish thereby to call attention thereto and the necessity of cleansing, whereas the supplemental series 24 of photoelectric mechanisms are such as not to react to such minimum changes in intensity of the beams of light from the respective cells but to require full intensity of the beam passing through a flaw in the web, such as a space in the weave, or a tear, to cause the operation of a Selsyn motor to actuate mechanisms temporarily to arrest the web and thereupon to actuate the cutter to sever the flaw-containing section from the web.

Any suitable or usual standard device now available for delaying mechanical reaction of a part after the receipt of a signal may be used to control the mechanism that arrests the movement of the web after the faulty section has been carried beyond the cutter.

The mechanism for thus causing a predetermined forwarding movement of the cloth after detection of the fault and the operation of the cutting mechanism under the control of the photoelectric devices 24 may be of a usual commercial character and need not therefore be illustrated.

Any suitable cutting mechanism for severing the cloth along a weft thread when positioned by the photoelectric devices 47 above described may be employed. A preferred cutting mechanism which is illustrated in the drawings comprises an electrically operated traveling rotary cutter which is caused to traverse along the weft thread when the cutting mechanism 15 is positioned as above described. The traveling cutter 25, which is graphically illustrated in Figs. 1 and 5 and in detail in Figs. 3 and 4 inclusive, comprises a rotatable cutting disk 26 which is mounted upon a horizontal countershaft 27 driven by an electric motor 28 which is supported upon a bracket 29 which is slidably mounted upon parallel bars 30 and 31 which extend longitudinally of the pivotally mounted frame 15 of the cutting mechanism. The frame 15 of the cutting mechanism as shown in Fig. 3 is pivotally mounted upon the vertical bolt 16 which extends downwardly from a block 32 secured to or formed integral with an overhead beam 33 Fig. 3 which is mounted upon the offset portions 3 of the side frame. The frame of the motor 28 has adjustably secured to it a downwardly extending arm 34 the lower end of which is connected to a foot member 35 having front and rear inclined portions adapted to travel beneath the web W of cloth and raise it into the path of the cutting disk 26 the edge of which rotates in a slot in the foot 35.

Suitable means are provided for causing the motor bracket 29 and the motor carried thereby to move longitudinally of the supporting bars 30 and 31. In the preferred construction illustrated a reversible motor 36 which is suspended from

the frame 15 of the cutter mechanism drives a countershaft 37 of a drum 38 around which several turns of an endless cord 39 are wound. The cord 39 passes around suitable sheaves 40 mounted upon the ends of the frame 15. The bracket 29 which supports the cutter is fixedly secured to the cord 39. The operation of the reversible motor 36 to traverse the cutter and the motor 25 are each controlled by mechanism operable by the photoelectric devices 24 in coordination with the mechanism which arrests the forward movement of the web after it has advanced a predetermined distance beyond the cutting field as heretofore described.

The mechanism for advancing the web toward and beyond cutting position comprises a series of suitably spaced parallel lower endless frictional belts 41 the upper leads of which extend through suitable slots in the table 14 and engage the under surface of the cloth and a complementary series of upper frictional endless belts 42, immediately above the respective lower belts, which engage the upper surface of the cloth but are adapted to be swung from horizontal to substantially vertical position out of the path of the traversing cutter. This mechanism is illustrated in detail in Figs. 3 and 4 in each of which the upper belts are illustrated as swung to vertical position out of the path of the cutting mechanism. Each of the endless upper belts 42 is mounted upon sheaves 43 and 44 the lower sheave 44 being fixedly secured to a shaft 45 which is mounted in brackets 46 which is secured to the face of a horizontal cross beam 47 suitably mounted upon the offset end frames 3 and the complementary parallel frame not shown. Another bracket 48 which is mounted upon the cross beam 47 supports an electric motor 49 which drives a countershaft 50 upon which is mounted a sprocket wheel 51 which drives a sprocket chain 52 which in turn drives a sprocket wheel 55 fixedly secured upon the shaft 54 which extends longitudinally of the offset portion 3 of the main frame and is journaled in the end frame 4 and the companion offset portion 3 of the main frame.

The shaft 54 is also journaled in suitably spaced brackets 46 which are mounted upon the cross beam 47 and is provided with a series of sprockets 55 which drive sprocket chains 56 which in turn actuate sprockets 57 fixedly secured to the shaft 45 upon which the driving pulleys 44 for the several frictional belts 42 are secured.

The other pulleys 43 around which the respective frictional belts 42 pass are journaled between the free ends of frames 58 comprising parallel bars which are pivotally mounted on the shaft 45 so that the frames and frictional belts can be swung from the horizontal cloth engaging position shown in dotted lines in Fig. 4 to upright position as shown in full lines in Figs. 3 and 4 out of the path of the traversing cutting mechanism.

Each of the frames 58 has fixedly secured to it a gear 59 which meshes with a gear 60 secured to a rock shaft 61 which is also journaled in bearings in the respective brackets 46 and extends in parallelism with the shaft 45. The rock shaft 61 has secured to it, preferably adjacent the end thereof, a sprocket 62 which is driven by a sprocket chain 63 by a sprocket 64 upon the shaft of a reversible motor 65 as shown in Figs. 3 and 4.

Desirably the lower feed belt 41, which co-operates with the upper feed belt 42, in forwarding the web of cloth, is also driven by the motor

49 which drives the upper feed belt 42. As shown in Fig. 4 a sprocket wheel 66, which is secured to the countershaft 50 of the motor 49, drives a sprocket chain 67 which in turn drives a sprocket wheel 68 on the shaft upon which one of the driving shafts for the lower frictional feed belt is mounted.

The operation of the motors which advance the web of cloth and under the control of the photoelectric mechanism arrest the operation of the motors when the cloth is advanced a predetermined distance and operation of the motors 49 and 65 are so controlled and synchronized by said photoelectric mechanism that when the feeding mechanism is arrested the motor 65 will be actuated to rotate the shaft 61 and its gear 60 in a direction to swing the frames 58 and the upper belts carried thereby to upright position as shown in Figs. 3 and 4 out of the path of the traversing cutting mechanism.

When the upper feed belts are thus raised from engagement with the web it is desirable that means shall be provided to hold down the web upon the table 14 during the cutting operation to insure accuracy of cut along the weft thread.

In the construction illustrated this is accomplished by providing hold-down bars 69 intermediate of the respective upper belts and of sufficient length effectively to clamp down the web throughout the greater portion of the distance between the upper belts 42 when the latter are swung to upright position. The hold-down bars 69 are mounted upon or integral with the ends of rigid arms 70 the opposite ends of which are fixedly secured to the rock shaft 61 which is actuated by the reversible motor 65. It is obvious therefore that when the rock shaft 61 is rotated in a direction to cause the gears 60 and 59 to swing the upper belts to upright position the hold-down bars will be swung downwardly to clamp the work upon the table and will be retained in such clamping relation until the upper belts are swung downwardly to horizontal feeding position during which movement the hold-down bars will be swung upwardly out of engagement with the web and therefore will not interfere with the feeding movement of the upper and lower feeding belts 41 and 42.

The mechanisms above described which are comprised in section "A" of the system may be and are actuated by suitable motors of well known types which are respectively controlled in properly timed relation to that of the cutting mechanism to insure the severance of the web along the weft thread and thereby to provide a sheet forming section in the form of a parallelogram the selvages of which are parallel and the severed ends of which are likewise parallel. The sheet forming section thus produced is adapted upon further manipulation if necessary by mechanism hereinafter described to provide a sheet of true rectangular form.

When the web of cloth has thus been inspected and thus severed along a weft thread it is advanced into the section "B", measuring and spreading section, and carried forward therein by suitable feeding mechanism which discharges the severed faulty section from the sheet forming section, if such section has been severed, and continues to advance the web a predetermined distance corresponding to the desired length of the sheet until such forward movement is arrested by means actuated by photoelectric means which also control the cutting mechanism to sever the web along a weft thread thereby pro-

viding a sheet forming section of predetermined length.

#### Section "B"—Measuring and spreading section

The mechanism for continuing the advancing movement of the web from the inspection and cutting section A to the measuring and spreading section B comprises a series of lower endless frictional belts 71 which extend longitudinally of said sections in alinement with the upper leads of the lower endless belts 41 of section A. These lower belts, which are illustrated in dotted lines in Figs. 1, 2 and 6 of the drawings as beneath the web of cloth, are mounted in frames having parallel bars 72 between which the frictional belts 71 extend longitudinally with the upper leads of the belts 71 projecting sufficiently above the table 14 to engage the under face of the web W of cloth. The slots in the table are of sufficient width to permit a limited lateral bodily movement of the belts for the purpose of stretching the sheet forming section laterally after it has been severed from the web as hereinafter more fully described. Each of the belts 71 passes over suitable sheaves 73 at the ends of the frame members 72 and each of the belts is driven by an independent electric motor the operation of which is controlled by photoelectric mechanism.

Means are provided for driving and raising and lowering the lower forwarding belts of section B. As illustrated in detail in Figs. 6a and 6b the lower belts 71, which are mounted on the sheaves 73, are journaled in the ends of the parallel frame bars 72, and are supported at preferably uniform intervals by idle rollers 74. The frame 72 is provided at suitably spaced intervals with downwardly extending brackets 75 which are pivotally mounted on arms 76 of suitably spaced parallel rock shafts 77 which are provided with sprockets 77a rotated in unison by a sprocket chain 77b. One of the rock shafts 77 is provided with an arm 78 which is pivotally connected to the horizontal piston 79 of an hydraulic cylinder 80 the introduction of liquid into which is controlled through suitable photoelectric mechanism in such manner as to cause the actuation of the bell crank lever to raise and lower the lower endless belts into engagement with the under face of the web during the forward movement thereof and to depress it when the forward movement is arrested. The endless belts 71 may be driven in any suitable manner as, for example, by a motor 81 the operation of which is controlled by the photoelectric mechanism and which drives a countershaft 82 provided with a sprocket 83 which drives a sprocket chain 84 which in turn drives a sprocket wheel 85 which is rotatably mounted upon the rock shaft 77. The sprocket 85 is connected to another sprocket 86 on said shaft which in turn drives a chain 87 and sprocket 87x which is fixedly secured to the shaft 88 upon the end of one of the bell crank arms. A similar sprocket on the shaft 88 drives a sprocket chain 89 which in turn drives a sprocket 90 upon the shaft of the sheave 73 at one end of the frame member 72.

Inasmuch as the operations of the motor 81 and of the hydraulically operated mechanism for actuating the bell crank levers are controlled by photoelectric mechanism as above described the forwarding movement of the lower frictional belts may be discontinued when the web has advanced a predetermined distance and the lower belts thereupon depressed out of engagement with the web in timed relation thereto. Conversely the

lower belts may be raised into engagement with the web and the forwarding movement of the belts resumed under the control of the photoelectric mechanism.

The means for measuring the predetermined length of the web to sever from the web a sheet forming section of a length corresponding to that required for a sheet of predetermined length comprises a photoelectric device such as a photoelectric eye 94 which is located midway of the width of the web at a distance from the path of the cutter equal to the length of the desired sheet forming section. The photoelectric eye 94 controls mechanism for arresting the forwarding movements of the several frictional belts above described and also controls the operation of a cutting mechanism when the advancing movement of the web has been arrested thereby to sever from the web a sheet forming section of predetermined length.

When the section of the web has thus been severed from the sheet the forwarding mechanism is again actuated to advance the sheet until the leading edge of the sheet intercepts the rays of suitable photoelectric devices 92 which are located in proximity to the ends of the respective lower forwarding belts 71. Each of the photoelectric devices 92 controls the operation of the motor 81 for one of the lower forwarding belts so that the forwarding movement of each belt is arrested as soon as the leading edge of the portion of the web which is engaged by the belt intercepts the ray of the photoelectric device associated therewith. When the forwarding movement of each of the lower belts is thus arrested the leading edge is positioned precisely at right angles to the longitudinal axis of the sheet forming section. If the webs of the sheet forming section are somewhat askew with respect to the perpendicularity to the warp threads and the web is somewhat narrowed during the feeding movement means are provided for spreading the lower feeding belts laterally with respect to the central longitudinal axis of the sheet forming section. Such spreading of the web laterally is accomplished by the following construction as shown in Figs. 6, 6a and 6b. The respective frame members 72 of each of the lower belts, except those of the central belt, are connected at a short distance from each end by links 93 and 94 of successively greater lengths to an evenner bar 95 rigidly connected to vertical shafts 96 which are rotatably and slidably journaled in stands 95a and provided at their lower ends respectively with rigid arms 97 which are pivotally connected to extensions of the plungers of hydraulic cylinders 98 which are actuated by fluid pressure under the control of photoelectric mechanisms operable when the predetermined length of web has been measured and a sheet forming section severed therefrom to actuate the piston rods and arms 97 and evenner 95 to cause the links 93 and 94 to move the respective belt frames to which they are attached laterally away from the central belt and thereby stretch the sheet forming section sufficiently to take out lateral wrinkles which may have been formed during the forwarding movement of the web by the respective individually driven lower belts, it being understood that the links 94 are successively connected to the evenner 95 at a greater distance from its pivotal point than the links 93 so that the outermost belts are moved a proportionately greater distance than the intermediate belts.

A similar series of suitably spaced upper belts

are superposed over the sheet forming section of section B at right angles to the belts 71 and are provided with means for raising them out of engagement with the sheet forming section during the forwarding movement of the web and for lowering them into engagement with the sheet forming section after it has been arrested and stretched lengthwise as above described and then lowered into engagement with the sheet forming section after the lower belts 71 have been depressed out of engagement therewith.

Means are provided for spreading the outer belts relatively to the central belt when the belts are lowered into engagement with the sheet forming section to stretch the sheet forming section laterally sufficiently to take out longitudinal wrinkles and means are thereupon provided for transferring the sheet forming section laterally in the direction of the weft threads to sheet folding position.

The upper frictional belts 99 of section B are, as shown in Figs. 6, 6a, 6b, mounted upon sheaves 100 at the ends of parallel frame bars 101, the lower leads of the frictional belts 99 which engage the cloth desirably being held against it by a series of idle rolls 102 mounted in the side frames 101. The frames 101 of the upper belts, with the exception of the central belt of the series, are adapted to be spread laterally from the central upper belt by mechanism similar to that above described with respect to the lower series of belts 71 and as shown in Fig. 6 comprises links 103, 104, and 105, of progressively greater lengths extending in opposite directions to the end portions of evenners 106 located, substantially midway of the width of section B, to the end portions of the respective frames 101 in which the upper feeding belts 99 are mounted. Each of the evenners is fixedly secured to a vertical shaft 107 which is slidably journaled in a bracket 108 suspended from the superstructure of the machine, as shown in Figs. 5 and 6a. The upper end of the shaft 107 is feathered to a laterally extending arm 109 which is pivotally connected to a rod 109a forming an extension of the piston of an hydraulic cylinder 110 which is suspended from the superstructure as shown in Fig. 6a.

The operation of the hydraulic cylinder is controlled by photoelectric mechanism operable after the sheet forming section has been measured, arrested and stretched, as above described, to supply fluid under pressure to the cylinders or cause the pistons thereof so to actuate the evenner 106 and the links 103, 104, 105, to spread and thereby take out wrinkles extending lengthwise of the sheet forming section.

Any suitable mechanism may be employed to raise and lower the upper belts. As illustrated in Fig. 6b each of the frames 101 which support the upper belts 99 is provided with a series of upwardly extending rigid arms 111 which are respectively pivotally connected to arms 112 of rock shafts 113 journaled in brackets 113a suspended from the superstructure of the machine, as shown in Fig. 6b. Sprockets 114, which are fixedly secured to the respective rock shafts, are all engaged by a sprocket chain 115, thereby to cause all the rock shafts to be actuated in unison to raise and lower the belts from and into engagement with the sheet forming section.

One of the rock shafts 113 is provided with an upwardly extending rigid arm 112a which with the shaft 113 and arm 112 forms a bell crank. The upper end of the arm 112a is pivotally connected to the piston rod of the hydraulic cylinder

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110 which desirably is pivotally mounted upon the bracket 113a which supports the bell crank rock shaft.

Liquid under pressure is supplied to the cylinder 110 under the control of suitable photoelectric mechanism (not shown) to lower the upper belts 99 into engagement with the sheet forming section after the lower belts 71 have been lowered out of engagement with the sheet forming section. The upper belts are then spread by the mechanism heretofore described to straighten out wrinkles extending longitudinally of the sheet forming section.

When the sheet forming section has been thus freed of wrinkles means are provided for actuating the upper belts 99 to transport the sheet forming section laterally in the direction of the wefts thereof to the hem-folding section C. This is accomplished as shown in Figs. 6a and 6b by a motor 117 which is mounted upon the superstructure of the machine and is provided with a countershaft having a sprocket which drives a sprocket chain 118 which in turn drives a sprocket 119 which is rotatably mounted upon another rock shaft 113. The sprocket 119 has fixedly secured to it a series of sprockets 120 each of which drives a sprocket chain 121 which in turn passes around a sprocket 122 which is fixedly secured to a shaft 123 which is rotatably journaled in like upwardly extending arms 111 of the frames of all the upper belts. The shaft 123 which, as shown in Figs. 6a and 6b, is located in the same horizontal plane as the work shaft 113, is provided with a series of sprocket wheels 124 which are driven by sprocket chains 121. The sprocket wheels 124 drive sprocket chains 124a which drive the respective pulleys 100 and thereby drive the upper belts 99 in unison.

Suitable photoelectric mechanism is provided for controlling the operation of the motor 117 to cause the upper belts 99 to transfer the sheet forming section from the measuring and spreading section B toward the hem holding section C.

The sheet forming section is thereupon engaged by sets of parallel frictional upper belts which extend in substantial alignment with the upper belts 99 throughout the length of the folding section C and transfer the sheet folding section in the same direction until the then leading edge of the sheet section intercepts the rays of photoelectric cells 125 located in proximity to the ends of the respective belts, as diagrammatically illustrated in Fig. 1. The photoelectric mechanism actuates suitable means for then arresting the sheet forming section in proper position relatively to means for folding hems upon the cut ends of the sheet forming section. The belts which forward the sheet forming section of cloth comprise a series of continuous inner belts 126 and continuous outer belts 127 which extend throughout the length of the hem folding section C and series of short intermediate belts 128, which are located in proximity to the belts 127.

In order to permit the folding over of the hems means are provided for raising the respective continuous outer belts 127 and the respective series of short belts 128 out of the path of the folding mechanism. The relative position of the belts 99 of section B and 129 of section C is shown in Figs. 1 and 6 and the mechanism for raising and lowering the belts 127 and 128 are illustrated in Fig. 7 and portions thereof in enlarged detail in Fig. 7a. The outer continuous belts 127 are as shown in Fig. 7 mounted upon

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sheaves 129 between parallel bars 130 of the character heretofore described, one of the sheaves 129 being driven by a suitable electric motor under the control of photoelectric mechanism. A series of presser rolls 131 spaced at suitable spaced intervals are journaled in the bars 130 and engage the lower lead of the endless belt 127 and serve to clamp the cloth thereby firmly upon the smooth surface of the table. The bars 130 are provided at intervals with pairs of upwardly extending rigid arms 132 which are pivotally connected at their upper ends to parallel links 133 which are respectively rigidly connected to rock shafts 134 at the ends of brackets 135 which are secured to the side frames of the machine. Each of the rock shafts 134 is provided with a sprocket 136 and a sprocket chain or chains 137 which engages all of the sprockets 136 and are actuated by a suitable reversible motor which serves simultaneously to rotate the rock shafts 134 to raise and lower the side bars 130 and the outer belts 127 carried thereby out of the path of the hem folding mechanism hereinafter described.

The short belts 128 of the respective series of short belts are similarly raised and lowered. As illustrated in Fig. 7—a the short frictional belts 128 are mounted upon sheaves 138 which are journaled between a pair of side bars 139. The shaft 140 at each end of the side bars 139 has pivotally secured to it an upwardly extending link 141 which is pivotally connected at its upper end to an arm 142 driven by an endless chain 142a of the rock shafts 134 above described which are provided with the arms 133 for raising the outer endless belt 127.

Suitable means are provided for driving the short belts 128. As illustrated in Fig. 7—a shafts 143, which extend across the machine, are mounted in the brackets 135 and are each provided with a sprocket 144 which drives a sprocket chain 145 which in turn drives a sprocket 146 upon a countershaft 147 which in turn is provided with a sprocket 148 which drives a sprocket chain 149 upon the shaft 140 to which one of the sheaves 138 is fixedly secured. The shafts 143 are provided with suitable sprockets which are driven by a sprocket chain 150 from a suitable electrically controlled motor (not shown) which is synchronized with the motor which drives the outer belt 127 and is electrically controlled in such manner by the photoelectric device 125 as to arrest the advancing movement of the sheet forming section and thereupon to raise the feeding belts 127 and 128 out of the path of the folding mechanism.

Mechanism is provided for folding the hems upon both cut edges of the sheet forming section and inasmuch as these folding mechanisms are in duplicate on opposite sides of the machine only one side is illustrated. When the cut edges are folded inwardly upon the body of the sheet the overall length of the sheet forming section will be shortened by the fold so that the outer endless feeding belts will not engage the sheet and the shorter belts are therefore employed to engage the folded hem and forward the hem folded sheet to the stitching mechanism hereinafter to be described, it being understood that the inner belts 126 remain thereafter in engagement with the cloth at all times and that the series of short belts 128 are driven in synchronism therewith when the hem folded sheet forming section is forwarded to the mechanism which permanently secures the folded hem to the body of the sheet.

*The folding mechanism*

In order to fold hems simultaneously on both cut edges for the squared sheet forming section which has been forwarded to the sheet folding section C of the machine and which lies flat on the table like means are provided for first folding narrow marginal portions of both cut edges of the sheet upon the body of the sheet, then folding the hem at a suitable distance from the folded marginal edges upon the body of the sheet with the folded marginal portions therebetween. Inasmuch as the mechanism for thus simultaneously folding both hems are the same only one is illustrated herein. The preferred mechanism for accomplishing this purpose comprises a folding assemblage which underlies the cut edge portions of the sheet and is movable vertically and laterally thereof and provided with means adapted in cooperation with a reciprocable hold-down plate to fold the cut marginal edge portions and thereafter to be pivotally moved about an axis located at a distance from the folded edge of the marginal portion equal to the desired width of the hem to fold the hem upon the body of the sheet with the marginal fold therebetween. The mechanisms and the series of movements thereof to accomplish this purpose are illustrated in Figs. 7 to 16 inclusive. Figs. 7 and 9 show the position of the various parts prior to and at the beginning of the folding cycle and illustrate the mechanism for raising and lowering the folding members, the means for reciprocating them laterally to fold the narrow marginal edge and the means for pivotally moving them to fold the hem upon the body of the sheet.

The folding assembly as shown in Figs. 7, 7-a, 8 and 9 comprises a rigid folder supporting beam or frame 151 which extends throughout the length of the hem folding section C of the machine and is normally positioned in the vertical plane of the main fold line. The supporting frame is mounted for vertical upward and downward movement in ways 152 extending upwardly from widely spaced ends of a stand 153 which is located centrally of the length of the frame 151 and is bodily movable laterally of the machine to position the folding mechanism for successive marginal and hem-folding operations.

For clearness of disclosure the stand is shown mainly in end elevation in Fig. 9. The folder supporting frame 151 is provided at its ends with upward extensions 154 in which are journaled the shafts of a vertical train of gears, for rotating the folder mechanism from the horizontal position, in which it underlies the cut edge portion of the sheet forming section, through approximately an angle of 180° to fold the hem upon the body of the sheet. This mechanism comprises a rock shaft 155 which extends throughout the length of the folding section C of the machine and is journaled at its ends in said extensions 154. It is provided at each end with spur gears 156 which engage idle pinions 157 on stud shafts journaled in said extensions 154. The idle pinions 157 in turn engage gears 158 on the ends of shaft 159 which is journaled in the upward extensions 154 of the supporting frame 151. The shaft 159 is provided at suitable intervals with arms 160 which are welded or otherwise fixedly secured to a bar 161 preferably in the form of an angle bar which extends throughout the length of the folding section C.

The bar 161 has a downwardly extending flange 161a to which is bolted complementary down-

wardly extending end flanges 162a of suitably spaced series of pairs of arms 162 (Figs. 7 and 7a) which support a yieldable folder main plate 163 in the manner hereinafter described. The gears 156 on the rock shaft 155 are provided with twice as many teeth as the gears 158 on the shaft 159 so that a revolution of the rock shaft through 90° will rotate the shaft 159, the bar 161 with its arms 162 and the yieldable folder plate 163 mounted thereon 180° about the axis of the shaft 159 to produce the main hem fold.

In order to rotate the folding mechanism about the axis of the shaft 159 to form the main hem fold the rock shaft 155 is provided centrally of its length with a rigid arm 164 which is pivotally connected to the piston rod 165 of an hydraulic cylinder 166 which is mounted on a bracket 167 extending laterally from the frame 151. The supply of fluid to the cylinder 166 is controlled by photoelectric means which is suitably coordinated with other photoelectric means for controlling other operations of the machine in a manner well known in the art and need not therefore be illustrated.

Suitable means are provided for normally retaining the main folder plate 163 flush with the table 14 when the sheet forming section is moved to folding position. In the preferred construction illustrated the upper portions of each pair of arms 162 are connected by spaced webs 169 and 169 (Figs. 10-13) forming abutments and are connected at their fore ends by pivots 170 upon which ends yieldable folder plate supporting brackets 171 are pivotally mounted.

Each of the folder plate supporting brackets comprises a flat section 172 which extends lengthwise of the arms 162 and is provided in proximity to the pivot 170 with a downward extension 173 which lies between the arms 162 and is provided at its lower end with an inwardly inclined flange 174. A coiled spring 175, which is interposed between the flange 174 and the abutment 169 of the arms 162, normally tends to force the plate 172 into engagement with the abutment 169 on the arms 162 and hold it in contact with the abutment 169.

The folder supporting brackets 171 have mounted on the outer ends of the flat section 172 parallel thin plates 176 and 177 with a spacer 178 therebetween with the edges of the plates 176 and 177 extending inwardly therebeyond a distance equal to the width of the marginal fold.

The yieldable main folder plate 163, which extends the full length of the folder section C, is mounted upon the upper ends of a pair of series of parallel vertical pins 179 which extend downwardly through bosses 180 on the flat section 172 of the bracket and are provided at their lower ends with enlarged heads 181 and coiled springs 182 interposed between the heads 181 of the pins and the bosses 180 tend to force the main folder plate 163 downwardly into engagement with the flat sections 172 of the supporting bracket.

When the folder supporting frame 151 is in lowered position as shown in Figs. 9 and 10, the arms 160 on the pivotal shaft 159 hold the arms 162 upon the ends of which the folder supporting brackets are mounted in upwardly and outwardly inclined position as shown in Figs. 9 and 10. Means however are provided for positioning the main folder plate 163 normally flush with the surface of the sheet supporting table 14. As illustrated in Figs. 9 and 10 brackets 184 mounted on the side frames of the machine have inwardly and upwardly inclined legs provided with flat

horizontal floor plate sections 185 which underlie the heads 181 of the pins 179 and are so positioned as to compress the springs 182 when the arms 162 are in lowered position and force the pins 179 and the main folder plate 163 upwardly into the plane of the sheet supporting table 14 and the upper thin plate 177 of the folder plate supporting bracket, thereby relieving the pressure of the spring 175 which tends to force the plate 172 into engagement with the abutments 189 on the arms 162 as shown in Fig. 10. The main folder plate 163 is thus held flush with the table 14 when the sheet forming section is moved into hem-folding position in section C of the machine with the outer feeding belts 127 engaging the marginal cut edge portion of the sheet folding section and holding it down on the upper thin plate 177 of the folder plate supporting bracket, as shown in Figs. 9 and 10. When the folding mechanism is thus positioned the vertical plane of the axes 155 and 159 of the gears is in coincidence with the main hem fold line as indicated by the dot and dash line X—X Fig. 10.

In order to fold the narrow marginal portion of the sheet forming section a thin hold-down plate 186 is advanced by mechanism hereinafter described, until its outer edge coincides with the marginal fold line. The stand 153 and the vertically movable folder supporting frame and the folding assembly are then moved bodily outwardly a distance equal to the width of the marginal fold and then moved upwardly a distance corresponding to the space between the plates 176 and 177 on the folder plate supporting bracket so that the vertical plane of the axes 155 and 159 of the gears is positioned as indicated by the dot and dash line Y—Y Fig. 11. These movements are accomplished as follows:

The main stand 153 which supports the folding assembly is, as shown in Fig. 9, slidably mounted on suitable ways in base members 187 which are fixedly secured to transverse girders 188 of the main frame of the machine. The stand 153, which is of generally L-shaped construction, has pivotally connected to its lower horizontal portion near said ways a horizontal link 189 the opposite end of which is detachably coupled to the piston rod 190 of an hydraulic motor 191 which is pivotally mounted on a bracket 192 which is fixedly secured to a plate 193 rigid with said base members 187.

A vertical link or links 194 pivotally connected respectively to the links 189 centrally of its width and to the base member 187 desirably may be provided to guide the longitudinal movement of the piston and link 189.

Suitable means for supplying liquid under pressure to the hydraulic cylinder are provided to move the stand 153 and are controlled by photoelectric means of a well known type in proper coordination with other operations of the machine and are not therefore illustrated.

Means are provided for locking the stand in the respective positions to which it is moved during the hem-folding cycle. As shown in Fig. 9 a toggle lock is provided comprising a vertical latch 195 mounted in a suitable guide in the base adapted to selectively engage one of suitable recesses 196, 197 or 198, in the under face of the stand 153, the latch 195 being raised and lowered by a toggle 199 which is connected by a link 200 to an electrically controlled solenoid 201 to hold the latch in locking position by engagement of the latch 195 with the notch 196 when the stand is in normal position or to lock it in other posi-

tions of adjustment by engagement with the notch 197 or 198.

### *The marginal folding*

When the sheet forming section has been moved to folding position and the hold-down plate 186 positioned as aforesaid the latch 195 is disengaged from the notch 196 and the hydraulic cylinder is actuated to move the stand outwardly until the axis of the shaft 159 is positioned at the dot and dash line Y—Y Fig. 11. The latch 195 is then caused to engage the notch 197 and lock the folding mechanism in the position shown in Fig. 11. At this time the hold-down plate extends over the sheet forming section and rests on the main folder plate to the marginal foldline as above described. The outer feeding belts 127 are then raised as above described while the inner short belts remain in engagement with the body of the sheet and hold it firmly on the table 14. The folding assembly is then raised bodily to the position shown in Fig. 11 by the following mechanism as illustrated in Fig. 9.

Vertical links 202, which are pivotally connected at their upper ends to the folder supporting frame 151, are pivotally connected at their lower ends to the arms 203 of the bell crank shaft 204 which is journaled in the stand 153, and the other arms 205 of the bell crank are pivotally connected to the piston rod 206 of the hydraulic cylinder 207 which is pivotally mounted on the stand 153. After the folding assembly has been moved outwardly, as heretofore described, and the feeding belts raised the marginal portion 350 of the sheet (see Fig. 11) which extends beyond the edge of the hold-down plate overlies the upper plate 177 on the main folder plate supporting bracket 171 with the main folder plate 163 in the plane of the table 14.

The hydraulic cylinder 207 is then actuated thereby causing its piston 206 to swing the bell crank arms 205 and 204 in a direction to raise the link 202 and main frame 151 and the folding assembly carried thereby until the lower plate 176 of the main folder supporting bracket is flush with the surface of the table 14. In the meantime the upward movement of the folding assembly permits expansion of the springs 182 surrounding the pins 179 and thereby depresses the main folder plate 163 into the plane of the table 14, as shown in Figs. 11 and 12, the sheet being at all times maintained horizontal by the hold-down plate 186 except that the marginal portion overlies the edge of the upper thin plate, as shown in Fig. 11. In order to fold the marginal edge upon the body of the sheet the latch 195 is withdrawn from the notch 197 by the solenoid 201 and the hydraulic cylinder actuated to move the folding assembly inwardly, thus causing the marginal portion to be wrapped around the edge of the hold-down plate 186, as shown in Fig. 12, thus completing the marginal fold.

Suitable means are provided for actuating the hold-down plate 186 to position the edge thereof at marginal fold line position and to withdraw it to permit main hem-folding operation. As illustrated herein the ends of the hold-down plate (one of which is shown in Fig. 9), are fixedly secured adjacent the rear edge thereof to upwardly and inwardly inclined arms 207 the upper ends of which are rigidly secured to longitudinally movable racks 208 which slide in ways 209 in parallel side members 210 (one of which is shown in Figs. 9 and 13) of a vertically movable frame

which extends transversely of section C of the machine.

In order to maintain equal and uniform movements of the racks a shaft 211, which is journaled in aligned bearings in the side members, has rigidly secured to it gears 212 which engage the respective racks, thereby insuring accurate position of the edge of the hold-down plate at the marginal fold line.

Suitable means are provided for raising the rack supporting frame slightly to remove the hold down plate from engagement with the sheet during its movement to and from marginal folding position and thus avoiding wrinkling of the sheet. As illustrated in Fig. 9 the side members 210 are pivotally mounted on suitably spaced vertical links 213 which are pivotally connected at their lower ends on horizontal arms 214 of bell crank levers, the shafts 215 of which are journaled in parallel girders 216 underlying the respective side members 210 of the frame. The vertical arms 217 are pivotally connected to horizontal connecting rods 218 which are connected at their other ends to piston rods of hydraulic cylinders 219, as shown in Fig. 18. The supply of liquid under pressure is controlled by suitable photoelectric mechanism coordinated with other controlling mechanisms to raise and lower the hold down plate as required.

Suitable means are provided for reciprocating the racks to move the hold down plate to and from marginal folding position. As illustrated in Fig. 18 racks 230 are connected at one end to the piston rods 220 of hydraulic cylinders 221 which are mounted on the vertically movable frame members 210 and the supply of liquid thereto is controlled by photoelectric means coordinated with other controlling mechanisms. In order to retain the hold down plate accurately in marginal and hem-folding positions the rack 238 has upward extensions 222—223 adapted when the rack is advanced to marginal and main hem folding positions respectively to be engaged by the arm 224 of a toggle lock 225 which is controlled by a solenoid 226.

#### *The main hem-folding operation*

When the marginal hem fold has been completed, as shown in Fig. 12, the hold down plate is withdrawn until its edge coincides with the main fold line as shown in Fig. 13 preparatory to the folding of the main hem. When the main hem is to be folded the inner series of feeding and hold down belts have to be raised far enough to permit the bracket 171 and the main folder plate thereon to be swung 180° about the axis of the shafts 159 which then is positioned in the plane indicated by the dot and dash line X—X, thereby to fold the main hem around the edge of the hold down plate 186. In order to hold down the main hem when thus folded and to permit the withdrawal of the hold down plate, the main folder plate 163 is provided with a series of recesses 227 between adjacent ends of the short feeder belts as shown in Figs. 1, 7a and 8. These recesses are normally filled by plates 228 which are superposed on wider plates 229 the edge portions of which underlie the main folder plate and are secured to horizontal upper surfaces of webbed L-shaped supports 230, as shown in Figs. 3, 14, 15. The supports 230 are mounted on pivots 231 in brackets 232 secured to the side frames having flat downwardly extending surfaces 233 adapted to be engaged by flat downwardly extending surfaces 234 on the supports and thereby

maintain the upper surface of the recess filling plates 228 flush with the upper surface of the main folder plate 163.

The main folder plate supporting angle bar 161 is provided with members 235 which underlie the ends of the supports and serve to tilt them upwardly when the main folder plate is rotated to fold the main hem as shown in Figs. 14 and 15, and to permit them to return to horizontal position when the main folder plate is restored to normal position.

Suitable presser feet cooperate with the supports to hold down the folded main hem until the feeding belts 128 are lowered to engage it as will hereinafter be described.

#### *The folding of the main hem*

After the folding of the marginal portions of the sheet has been completed, the hold-down plate withdrawn to position its edge at the main fold line and the main folder plate bracket retracted until the pivotal axis of the shaft 159 is positioned in the vertical plane X—X of the fold line as shown in Fig. 13, the gear shafts 159 and the folder plate supporting bracket mounted thereon are rotated through 180° by the train of gears 156, 157 and 158 by the hydraulic cylinder 166 the piston 165 of which acts through the arm 164 of the rock shaft 155 and its gear 156 in the manner above described. The main hem is thus folded about the edge of the hold-down plate to the position shown in Fig. 14 with the marginal fold confined between the plates 176 and 177 on the folder plate supporting bracket.

In order to free the marginal fold, the stand 153 and the folder supporting bracket 171 carried thereby is moved rearwardly by the hydraulic cylinder 191 until the pivotal axis of the shafts 159 is positioned in the plane indicated by the dot and dash line Z—Z as shown in Fig. 15, so that the main hem fold lies on the body of the sheet with the marginal fold therebetween. Means are provided for holding down the hem thus folded until it is engaged by the shorter feeding belts 128. The mechanism for accomplishing this purpose as illustrated herein comprises a series of presser feet 236 which are respectively located between the adjacent ends of the short feeding belts 128 and directly over the respective recesses 227 in the main folder plate 163 and the supports 230 therebeneath, Figs. 7, 7a, and 9.

The presser feet 236 are mounted upon the lower ends of arms 237 and 238, lazy tongs 239 which are actuated by vertical links 240 the upper ends of which are pivotally connected to arms 241 of a rock shaft 242 the ends of which are journaled in members of the side frames.

Suitable means, preferably controlled by photoelectric means, are provided for actuating the rock shaft to lower the presser feet at the completion of the main hem-folding operation. After the presser feet have thus engaged the folded hem the hold-down plate 186 is withdrawn from the marginal fold and the stand 153 is then moved outwardly until the pivotal axis of the shafts 159 is positioned in the vertical plane indicated by the dot and dash line Y—Y Fig. 16. The train of gears 156, 157 and 158 are then rotated in the reverse direction by the hydraulic cylinder 166 to position the main folder plate 163 in the plane of the table 14, as shown in Fig. 16. The stand 153 is then moved inwardly by the hydraulic cylinder 191 thereby restoring the folding mechanism to the normal position shown in

Fig. 9. When the folding assembly has thus been restored to normal position the series of short feeding belts 128 are lowered into engagement with the folded hems by the mechanism heretofore described and the rock shaft 242 actuated to raise the presser feet and thereby free the sheet so that it may be advanced to mechanism for permanently securing the folded hems to the body of the sheet and thereby automatically finishing the sheet.

The present invention comprises means for finishing the hemmed sheet either by stitching the infolded marginal edges of the hems longitudinally to the body of the sheet as the hems are moved through the fields of stationary sewing machines, then closing the ends of the hems by longitudinally and transversely movable sewing machines, and finally automatically severing the stitching threads close to the ends of the hem, or alternatively securing the folded hems to the body of the sheet by suitable adhesive, preferably in the form of adhesive tape, progressively inserted as the hemmed edges of the sheet travel through adhesive-applying mechanism.

The mechanisms for stitching the hems in the manner above described are illustrated diagrammatically in Figs. 1 and 17, and in detail in Figs. 19 to 22 inclusive. The alternative mechanism for adhesively securing the hems to the body of the sheet is hereinafter more fully described.

The hem finishing section D of the machine is a continuation of the hem-folding section and is provided with means for forwarding the hem-folded sheet from the hem-folding section C, through the fields of the mechanisms for securing the folded hems permanently to the body of the sheet in section D. The forwarding mechanism comprises a series of traveling belts 243 of rubber or other frictional material which preferably are in alignment with or slightly offset from the respective inner belts 126 of the folding section and extend in the same direction to the delivery end thereof and a plurality or gang of outer belts 244 in alignment with the belts 128 sufficient in number to cover the respective hems and insure uniform movement thereof with the body of the sheet to the hem finishing mechanism. Other series or gang of outer belts 245 are located beyond the hem finishing mechanism and terminate at the end of section D as shown in Fig. 1.

Where hem stitching mechanism is employed, as shown in Figs. 1, 17, 19, 20 and 21, the hems are presented by the belts 244 to the feeding mechanism of stationary motor driven sewing machines 246 the stitch-forming mechanism of which is so positioned as to sew a line of longitudinal stitching through the edge of the infolded margins and the body of the sheet therebeneath throughout the length of the hems. Each sewing machine desirably is mounted on a stand 247 the table of which is flush with the main table 14 of the machine.

In order to close the ends of the hem traveling sewing machines are positioned beyond the stationary sewing machines and are moved transversely of the direction of feed at such angular relation thereto and at such speed that the resultant direction is perpendicular to the edge of the folded hem and said longitudinal line of stitching.

As illustrated in Figs. 1 and 21 the table of the stand is provided with a suitable generally rectangular aperture 248 through which the traveling sewing machine 249 extends and is moved

longitudinally and transversely of the direction of feed of the sheet. The traveling sewing machine is fixedly mounted on an upper carriage 250 the wheels 251 of which are mounted on parallel rails 252 of a lower carriage 253 having downwardly extending legs 254 (Fig. 19) in which are journaled wheels 255 which are mounted on rails 256 of a base frame which is secured to the floor. The base rails extend in the direction of feed of the sheet and the rails 252 on the lower carriage which support the upper sewing machine carriage extend at right angles thereto, as shown in Figs. 19 and 20.

The lower carriage is reciprocated in the direction of the forwarding movement of the sheet by a motor 257 which is mounted on a suitable pier 258 extending upwardly from the floor. The motor shaft desirably drives a worm gear on a horizontal shaft 259 which is journaled in the upper ends of stands 260 which are mounted on the floor. The shaft 259 is provided with a sprocket wheel 261. Another shaft 262, which is mounted in the stands 260 beneath the shaft 259, is provided with companion sprocket wheels 263 directly beneath the sprocket wheels. Other stands 264 which are mounted on the floor at the opposite end of the base frame have journaled in them suitably spaced shafts 265 and 266 having sprocket wheels 267 and 268 complementary respectively to the sprocket wheels 261 and 263. Parallel sprocket chains 269 which are fastened at their ends to opposite ends of the lower carriage 253 pass from one end of the carriage 253 over the driven sprockets 261, thence downwardly around the sprockets 263, thence around the companion sprockets 268 and 267 to the other end of the carriage 253. The upper carriage is driven by similar mechanism in a direction perpendicular to the direction of the movement of the sheet by an upper reversible motor 270 which is mounted on the lower carriage 253 as shown in Fig. 19 in which the motor shaft drives a horizontal shaft 271 which is provided with sprocket wheels 272 which engage sprocket chains 273 which are anchored at their respective ends to the upper carriage 250 and pass over the driven sprocket wheels 272, thence downwardly around the lower sprocket wheels 274 the shafts of which are journaled in arms 275 extending angularly downward from the legs 254 of the lower carriage 253. The sprocket chains then extend horizontally beneath and upwardly around complementary sprocket wheels 276, the shafts of which are journaled in like arms 275 extending downwardly from the other legs 275 of the lower carriage. The sprocket chains then extend upwardly around upper sprocket wheels complementary to the driven sprocket wheels 277 and thence to the other end of the carriage.

The stitch forming mechanism of the traveling sewing machine is driven by an electric motor 278 which is suspended upon a mounting 279 depending from the upper carriage beneath the sewing machine standard. The shaft of the motor is provided with a pulley 280 which drives an endless belt 281 which passes around and drives the pulley 282 on the main shaft of the sewing machine 249 and actuates the stitching mechanism thereof in the usual manner.

The operation of the motors 257, 270 and 278 are respectively controlled by photoelectric mechanisms in such manner as properly to coordinate the rate of longitudinal movement of the lower carriage and the rate of transverse movement of the upper carriage to the rate of advancing move-

ment of the sheet and to control the operation of the sewing machine in such manner as to stitch the open ends of the hems permanently in closed position. At the completion of the hem folding operation the series of short feeding belts 123 are depressed into engagement with the sheet and they together with the central feeding belts 126 are actuated to advance the hem-folded sheet from section C by a suitable motor to the hem-stitching section.

As the sheets are thus forwarded the feeding belts of section D, which are driven by a suitable variable speed motor, continue the forwarding movement. When the hem-folded sheets have been fully delivered from the hem folding section C the speed of the variable speed motor is temporarily increased to space the foremost sheet slightly from the next sheet which is at the same time advanced into the hem folding section C in order that the threads of the stitching mechanism which connect adjacent ends of successive sheets will be exposed as shown in Fig. 21 in position to be severed. The variable speed motor is then slowed down in such manner as to advance the sheet at the same rate of speed as that of the longitudinal hem-stitching machines by suitable controlling mechanism of a usual type. After completion of the stitching which closes the hems at the leading edge of the foremost sheet of a series, the traveling sewing machine is retracted by the reversible motor and is withheld in such position until the end of the hem of the trailing edge of the sheet reaches the beginning of its path of traverse. The lower carriage 253 is then moved by its motor 257 transversely of the direction of movement of the sheet so that the sewing machine 249 will stitch and close the end of the hem at the trailing edge. Upon completion of this stitching the lower carriage 253 is quickly withdrawn and again advanced so that the sewing machine will stitch and close the end of the hem at the leading edge of the next sheet.

Upon further feeding movement of the sheet the gap between the trailing edge of an advanced sheet and the leading edge of the next sheet of the series will be positioned in the field of cutting mechanism for severing the threads connecting the successive sheets. In order to bridge the gap between the ledger blades in the table top 247 with which the cutter blades 284 cooperate a flat plate 247a adapted to close this gap is so mounted upon the cutter 283 that when the cutter blades are raised it will support the traveling material as it passes beneath the cutter blades. The thread cutting mechanism is actuated in synchronized relation to the rate of travel of the sheets simultaneously to sever the threads connecting successive sheets in close proximity to the edges of the adjacent ends thereof.

While any suitable thread cutting mechanism may be employed the thread cutting mechanism illustrated herein comprises a cutter 283 of inverted U-shaped cross section having vertical cutter blades 284 spaced apart a distance slightly less than the width of the space between the trailing edge of an advanced sheet and the leading edge of the next sheet of the series. The cutter 283 has a downwardly offset arm 285 which extends through the table of the stand 247 and is journaled on a shaft 286 which is mounted in bosses 287 extending downwardly from the table of the stand. The cutter normally is held upwardly in an angular direction so that its blades are well above the table, which is provided with

suitable ledgers with which the respective cutters cooperate to sever the threads.

Suitable means are provided for actuating the cutters. As shown in Fig. 22 a horizontal link 282, which is pivotally connected at one end to the ends of the cutter arm 285 is pivotally connected at its other end to the upper end of a lever 289 which is fulcrumed on a shaft 290 in the inclined arm 291 of a hollow stand 292 which is mounted on the floor. The lever 289 is provided with a cylindrical extension 293 which is slidably mounted in a rotatable member 294 which is pivotally mounted on a horizontal bar 295 having a cylindrical end portion 296 extending into a recess 297 in said stand 292. A coiled spring 297, which surrounds the cylindrical end 296 and is interposed between the wall of the recess 297 in said stand 292 and a nut 298 on said cylindrical end 296 normally acts through said lever mechanism to hold the cutter in upraised position. The other end of the bar 295 is pivotally connected to the armature 299 of a solenoid 300 which is energized in suitably timed relation to the positioning of the gap between the trailing and leading edges of successive sheets in the field of the cutter to sever all sewing threads closely adjacent the trailing and leading ends of the sheet.

After the threads are thus severed the completed foremost sheet is forwarded by the belts 245 to suitable folding and stacking mechanism of a usual character, which need not be illustrated.

An alternative method for hemming sheets of woven fabric comprises inserting between the folded hem and the body of the sheet a thin layer of cementitious, preferably thermoplastic, material and then subjecting the superimposed layers to heat of such temperature as to cause permanent adhesion of the infolded marginal edge to the body of the sheet, and preferably also a sufficient portion of the hem, to the body of the sheet to effect substantial closure of the end of the hem.

This may be accomplished by providing in proximity to the delivery end of the sheet forwarding belts 244 means such as an upright bar having a laterally extending foot provided with an arcuate surface positioned beneath the infolded edge of the hem adapted to raise or turn upwardly the folded hem portion of the traveling sheet away from the body of the sheet and progressively depositing a thin strip of thermoplastic material beneath the normal position of the raised or upturned portion, thereupon restoring the raised or upturned hem to normal position and preferably pressing the same upon the body of the sheet and thereupon bonding the hem to the body of the sheet by suitable heating and pressing means such as the commercial high frequency current electric bonding machines manufactured and sold by the Singer Sewing Machine Company.

In such case the bonding mechanisms may be substituted for the sewing machines 246 above described, which stitch the edges of the hem longitudinally to the body of the traveling sheet, and the traveling sewing machines for closing the ends of the hem omitted or rendered inactive.

The sections of the bonding strips which intervene between adjacent ends of the hems of successive sheets, instead of the threads uniting said ends heretofore described, may then be severed by suitable cutting means such as that

shown in Figs. 21 and 22 and heretofore described.

If desired means may be provided for inserting portions of suitable labels 301 between the end portion of the hem and body of the sheet during the folding of the hem upon the body of the sheet, as indicated in Fig. 15.

It will be understood that the particular mechanism shown and described herein for performing the method of successively making bed sheets from a bolt of woven fabric is illustrative and not restrictive of the scope of the following claims, and that such changes or modifications may be made within the knowledge of those skilled in the art as will accomplish the purpose of the invention herein defined.

It will also be understood that by varying the size and position of the mechanisms, the invention may be employed for hemming other rectangular articles such as table cloths, towels, etc. severed in the manner above described from a bolt of suitable material.

It will further be understood that rectangular articles made of sheets of or embodying thermoplastic material may be severed from a bolt thereof and the cut edges hem-folded and bonded by suitable means such as the commercial Singer bonding machines in the manner above described in which case the mechanism for positioning the cutter in the direction of a weft thread, the mechanism for straightening the severed section to rectangular form and the means for inserting a strip of thermoplastic material between the hem-folded edge of the article forming section may be rendered inoperative.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is:

1. A method of automatically making in sequence from a web of flexible woven sheet material formed of interwoven warp threads and weft threads with the warp threads extending longitudinally of the web strictly rectangular articles hemmed at their respective ends, which method comprises intermittently forwarding the sheet in a horizontal plane in the direction of its length, severing therefrom along the line of a weft thread successive article forming sections of predetermined length causing said sections if distorted to assume strictly rectangular form, forwarding each severed section laterally in the same plane to hem-folding position, arresting it when in folding position, simultaneously folding narrow marginal portions throughout the entire length of the respective severed end edges upon the body of said section while said section is at rest, simultaneously folding throughout the entire length of each end of each section a hem of desired width upon the body of said section with the marginal portions therebetween, permanently securing the hem thus folded to the body of said section and finally delivering the finished article.

2. A method of automatically making in sequence from a web of flexible woven sheet material formed of interwoven warp threads and weft threads with the warp threads running lengthwise of the web strictly rectangular articles hemmed at their respective ends which comprises intermittently forwarding the sheet in a horizontal plane in the direction of its length, severing therefrom along the line of a weft thread successive article forming sections of predetermined length causing said sections if distorted to assume strictly rectangular form, forwarding

each severed section laterally in the same plane to hem-folding position, arresting it when in folding position, simultaneously folding narrow marginal portions throughout the entire length of the respective severed end edges upon the body of said section, simultaneously folding upon the body of said section throughout the entire length of each end thereof a hem of desired width with the corresponding marginal portion therebetween, forwarding the hem-folded section in said lateral direction, permanently securing the folded hem to the body of the sheet during its movement in said direction, and finally delivering the finished article.

3. Steps in the method of automatically making commercially perfect rectangular articles from a bolt of suitable fabric which comprises forwarding the web thereof lengthwise in a predetermined path, photoelectrically examining the traveling web throughout its width and upon discovery of a flaw in said web automatically transversely severing the flaw-containing section from the web along the line of a weft thread, discharging the flaw-containing section from said path and thereafter resuming the forwarding of the web.

4. Steps in the method of automatically making in sequence from a bolt of woven fabric strictly rectangular articles hemmed at their respective ends comprising intermittently forwarding the web of fabric from said bolt a predetermined distance equal to the length of the article, photoelectrically scanning the traveling web throughout its width, automatically arresting the web, cutting the web transversely along a weft thread irrespective of the direction thereof relatively to the longitudinal warp threads when the web has been forwarded said predetermined distance to provide an article forming section the longitudinal edges of which are of equal length, resuming the forwarding of the article forming section, and photoelectrically arresting the forwarding movement of transverse portions of the web when the leading edge thereof is perpendicular to the direction of the advancing movement of the web to produce a strictly rectangular web-forming section.

5. Steps in the method of automatically making in sequence from a bolt of woven fabric strictly rectangular articles as defined in claim 4 which comprises spreading of the article-forming sections longitudinally to remove transverse wrinkles therefrom.

6. Steps in the method of automatically making in sequence from a bolt of a woven fabric strictly rectangular articles as defined in claim 4, spreading the article-forming section laterally to remove longitudinal wrinkles therefrom and to straighten the section to true rectangular form.

7. Steps in the method of automatically making in sequence from a bolt of woven fabric strictly rectangular articles as defined in claim 4, comprising folding the narrow marginal portion of the severed edge upon the body of the article-forming section and folding the hem upon the body portion with the narrow marginal portion therebetween, forwarding the hem-folded section from folded position in the direction of the hem folds and during such forwarding movement stitching the hem and infolded edge sections longitudinally to the body of said section and in also suitably timed relation stitching the respective ends of the hem to the body thereof by closing the hems and severing all stitching

threads closely adjacent to the respective ends of the hem.

8. A method of automatically making in sequence from a bolt of woven fabric rectangular articles hemmed at their respective ends which comprises intermittently forwarding the sheet in the direction of its length over a flat smooth table, photoelectrically inspecting the sheet throughout its width and upon discovery of a removable blemish automatically applying to the portion of the sheet containing it a removable indicia denoting such blemish, photoelectrically positioning cutting means to sever the sheet along a weft thread, photoelectrically examining the traveling web and upon discovery of a flaw in the material automatically severing and ejecting the flaw-containing portion, forwarding the inspected and examined web, and photoelectrically measuring a predetermined length corresponding to the width of the article to be produced, straightening the severed section to strictly rectangular form, spreading the sheet forming section longitudinally and laterally to remove wrinkles therefrom, forwarding the section laterally in the direction of its width to hem-folding position, simultaneously infolding the marginal cut edges of said section throughout their length upon the body of said section, folding hems of desired uniform width along said cut edges upon the body of the section with the marginal folds therebetween, again forwarding the hem-folded section in said lateral direction, stitching the hem to the body of the sheet during said forwarding movement and in timed relation thereto, stitching the ends of the hem transversely to close the hem, finally cutting the stitching threads in close proximity to the ends of the hem and delivering the finished article.

9. Apparatus for successively making hemmed sheets and like articles from a bolt of suitably woven cloth comprising means for progressively forwarding the web of cloth longitudinally from the bolt upon a smooth flat table, cutting means for severing the web transversely photoelectric means in the path of said web and means, automatically operable thereby for positioning the path of the cutting means in parallelism with the weft threads of said web irrespective of the direction thereof relatively to that of the longitudinal warp threads photoelectric means suitably spaced a measured distance from said cutting means equal to the desired length of said article and means, automatically operable thereby to arrest the forwarding movement of the cloth when the leading edge thereof engages the beam of said photoelectric means and means operable by said photoelectric means to actuate said cutting means to sever the measured section of cloth from said web.

10. Apparatus for successively making hemmed sheets and like articles from a bolt of suitably woven cloth comprising means for progressively forwarding the web of cloth longitudinally from the bolt upon a smooth flat table, cutting means for severing the web transversely photoelectric means in the path of said web and means, automatically operable thereby for positioning the path of the cutting means in parallelism with the weft threads of said web irrespective of the direction thereof relatively to that of the longitudinal warp threads, photoelectric means for automatically measuring a length of the traveling web suitably spaced from the path of the cutting means a distance equal to that required to form

a sheet, and means automatically operable by said photoelectric means upon interception of the light beam thereof by the leading edge of said web to arrest the means for forwarding the web and to actuate said cutting means to sever a sheet-forming section from the web.

11. Apparatus for successively making hemmed sheets and like articles from a bolt of suitably woven cloth comprising means for progressively forwarding the web of cloth longitudinally from the bolt upon a smooth flat table, cutting means for severing the web transversely photoelectric means in the path of said web, automatically operable thereby for positioning the path of the cutting means in parallelism with the weft threads of said web irrespective of the direction thereof relatively to that of the longitudinal warp threads, photoelectric means, for automatically measuring a length of the traveling web suitably spaced from the path of the cutting means a distance equal to that required to form a sheet, means automatically operable by said photoelectric means upon interruption of the light beam thereof to arrest the means for forwarding the web and to actuate said cutting means to sever a sheet-forming section from the web, and means automatically operable to straighten the severed sheet-forming section longitudinally and laterally to cause it to assume an unwrinkled true rectangular form.

12. Apparatus for successively making hemmed sheets and like articles from a bolt of suitably woven cloth comprising means for progressively forwarding the web of cloth longitudinally from the bolt upon a smooth flat table, cutting means for severing the web transversely, automatically operable means for positioning the path of the cutting means in parallelism with the weft threads of said web irrespective of the direction thereof relatively to that of the longitudinal warp threads, means for automatically measuring a length of the traveling web from the path of the cutting means to the leading edge of the web equal to that required to form a sheet, means automatically operable thereupon to arrest the means for forwarding the web and to actuate said cutting means to sever a sheet-forming section from the web, means automatically operable to straighten the severed sheet-forming section longitudinally and laterally to cause it to assume an unwrinkled true rectangular form, means for forwarding the severed sheet-forming section laterally in the direction of the length of its wefts to hem-folding position, automatically operable means for arresting the sheet-forming section in hem-folding position, means for simultaneously infolding the marginal portions of the severed ends throughout the length thereof upon the body of the sheet, and means for simultaneously folding the infolded marginal portions and hem areas of predetermined width upon the body of the sheet, and automatically operable means for permanently securing the same to the body of the sheet.

13. Apparatus for successively making hemmed sheets and like articles from a bolt of suitably woven cloth comprising means for progressively forwarding the web of cloth longitudinally from the bolt upon a smooth flat table, cutting means for severing the web transversely, automatically operable means for positioning the path of the cutting means in parallelism with the weft threads of said web irrespective of the direction thereof relatively to that of the longitudinal warp threads, means for automatically measuring a

length of the traveling web from the path of the cutting means to the leading edge of the web equal to that required to form a sheet, means automatically operable thereupon to arrest the means for forwarding the web and to actuate said cutting means to sever a sheet-forming section from the web, means automatically operable to straighten the severed sheet-forming section longitudinally and laterally to cause it to assume an unwrinkled true rectangular form, means for forwarding the severed sheet-forming section laterally in the direction of the length of its wefts to hem-folding position, automatically operable means for arresting the sheet-forming section in hem-folding position, means for simultaneously infolding the marginal portions of the severed ends throughout the length thereof upon the body of the sheet, means for simultaneously folding the infolded marginal portions and hem areas of predetermined width upon the body of the sheet, means for advancing the hem-folded sheet in the direction of the weft threads, and means for sewing the hem and infolded edge portion thereof to the body of the sheet.

14. Apparatus for successively making hemmed sheets and like articles from a bolt of suitably woven cloth comprising means for progressively forwarding the web of cloth longitudinally from the bolt upon a smooth flat table, cutting means for severing the web transversely, automatically operable means for positioning the path of the cutting means in parallelism with the weft threads of said web irrespective of the direction thereof relatively to that of the longitudinal warp threads, means for automatically measuring a length of the traveling web from the path of the cutting means to the leading edge of the web equal to that required to form a sheet, means automatically operable thereupon to arrest the means for forwarding the web and to actuate said cutting means to sever a sheet-forming section from the web, means automatically operable to straighten the severed sheet-forming section longitudinally and laterally to cause it to assume an unwrinkled true rectangular form, means for forwarding the severed sheet-forming section laterally in the direction of the length of its wefts to hem-folding position, automatically operable means for arresting the sheet-forming section in hem-folding position, means for simultaneously infolding the marginal portions of the severed ends throughout the length thereof upon the body of the sheet, means for simultaneously folding the infolded marginal portions and hem areas of predetermined width upon the body of the sheet, sewing mechanism for stitching the hem and infolded edge portion thereof to the body of the sheet, means for advancing the hem-folded sheet to space the foremost sheet a predetermined distance from the next succeeding sheet, and means operable thereupon to advance the sheet in proper coordinated relation to the speed of the sewing mechanism.

15. Apparatus for successively making hemmed sheets and like articles from a bolt of suitably woven cloth comprising means for progressively forwarding the web of cloth longitudinally from the bolt upon a smooth flat table, cutting means for severing the web transversely, automatically operable means for positioning the path of the cutting means in parallelism with the weft threads of said web irrespective of the direction thereof relatively to that of the longitudinal warp threads, means for automatically measuring a length of the travelling web from the path

of the cutting means to the leading edge of the web equal to that required to form a sheet, means automatically operable thereupon to arrest the means for forwarding the web and to actuate said cutting means to sever a sheet-forming section from the web, means automatically operable to straighten the severed sheet-forming section longitudinally and laterally to cause it to assume an unwrinkled true rectangular form, means for forwarding the severed sheet-forming section laterally in the direction of the length of its wefts to hem-folding position, automatically operable means for arresting the sheet-forming section in hem-folding position, means for simultaneously infolding the marginal portions of the severed ends throughout the length thereof upon the body of the sheet, means for simultaneously folding the infolded marginal portions and hem areas of predetermined width upon the body of the sheet, sewing mechanism for stitching the hem and infolded edge portion thereof to the body of the sheet, means for advancing the folded sheet to space the foremost sheet a predetermined distance from the next succeeding folded sheet, means operable thereupon to advance the sheet in proper coordinated relation to the speed of the sewing mechanism, and means for sewing the respective ends of the hem to the body of the sheet during the advancing movement thereof.

16. Apparatus for successively making hemmed sheets and like articles from a bolt of suitably woven cloth comprising means for progressively forwarding the web of cloth longitudinally from the bolt upon a smooth flat table, cutting means for severing the web transversely, automatically operable means for positioning the path of the cutting means in parallelism with the weft threads of said web irrespective of the direction thereof relatively to that of the longitudinal warp threads, means for automatically measuring a length of the traveling web from the path of the cutting means to the leading edge of the web equal to that required to form a sheet, means automatically operable thereupon to arrest the means for forwarding the web and to actuate said cutting means to sever a sheet-forming section from the web, means automatically operable to straighten the severed sheet-forming section longitudinally and laterally to cause it to assume an unwrinkled true rectangular form, means for forwarding the severed sheet-forming section laterally in the direction of the length of its wefts to hem-folding position, automatically operable means for arresting the sheet-forming section in hem-folding position, means for simultaneously infolding the marginal portions of the severed ends throughout the length thereof upon the body of the sheet, means for simultaneously folding the infolded marginal portions and hem areas of predetermined width upon the body of the sheet, sewing mechanism for stitching the hem and infolded edge portion thereof to the body of the sheet, means for advancing the folded sheet to space the foremost sheet a predetermined distance from the next succeeding sheet, means operable thereupon to advance the sheet in proper coordinated relation to the speed of the sewing mechanism, means for sewing the respective ends of the hem to the body of the sheet during the advancing movement thereof, and automatically operable means for severing the threads connecting the spaced ends of adjacent sheets closely in proximity to the respective ends of the hems thereof.

17. Apparatus for automatically making

hemmed sheets and like articles from a bolt of suitably woven cloth comprising photoelectric means for detecting flaws in the traveling web, cutting means for severing the web transversely when the leading edge of the cloth is advanced a predetermined distance therebeyond, and means operable by said photoelectric means to actuate the cutting means to sever the faulty section from the web along the line of a weft thread.

18. Apparatus for automatically making hemmed sheets and like articles from a web of suitably woven cloth comprising photoelectric means for detecting flaws in the traveling web, cutting means for severing the web transversely when the leading edge of the cloth is advanced a predetermined distance therebeyond, means operable by said photoelectric means to actuate the cutting means to sever the faulty section from the web along the line of a weft thread, and means automatically operable upon completion of the operation of the cutting means to cause resumption of the web-forwarding means to discharge the faulty section and to continue the forwarding movement of the web.

19. Apparatus for making successively rectangular articles from a bolt of suitable sheet material which comprises means for forwarding the sheet in the direction of its length from said bolt along a flat supporting surface, cutting means extending transversely of said sheet, means for measuring a section of predetermined length from the path of the cutting means to the leading edge of the sheet and thereupon arresting said forwarding means, means operable by said arresting means for actuating the cutting means to sever the measured portion from the sheet, means for automatically transferring the severed section laterally perpendicular to the direction of said forwarding movement to hem-folding position, means for arresting said section therein, means for simultaneously folding hem portions upon the body of the sheet, means for advancing the hem-folded sheet section in the same lateral direction, and means for bonding the hem to the body of said section during the advancing movement thereof.

20. Apparatus for automatically making successively rectangular articles from a bolt of suitable material which comprises means for forwarding the sheet in the direction of its length from said bolt along a supporting flat surface, cutting means extending transversely of said sheet, photoelectric means for examining said traveling sheet, and means operable thereby upon detection of a fault to actuate said cutting means and to enable the faulty section to be discharged, photoelectric means for measuring a section of predetermined length from the leading edge of the sheet to the path of the cutting means and thereupon arresting said forwarding means, means operable by said arresting means for actuating the cutting means to sever the measured portion from the sheet, means for automatically transferring the severed section laterally perpendicular to the direction of said forwarding movement to hem-folding position, photoelectric

means for arresting said section in said position, means for simultaneously folding narrow marginal cut edge portions upon the body of the sheet and thereafter operable to fold the hems upon the body of the sheet with the marginal portions therebetween, and means for bonding the hem to the body of the sheet.

21. Apparatus for automatically making successively rectangular articles from a bolt of a suitable fabric which comprises forwarding the web of fabric in the direction of its length from said bolt along a flat supporting surface, cutting means extending transversely of said web, photoelectrically controlled means for positioning said cutting means in alignment with the weft thread of said material, photoelectric means preceding said cutting means for inspecting the sheet for removable blemishes and means operable thereby to apply to the blemish-containing section removable indicia thereof, photoelectric examining means located in proximity to said blemish-inspecting means and means operable thereby upon detection of a flaw to cause the cutting means to sever from the web the section containing said blemish or blemishes and enabling the forwarding means to discharge the faulty section, photoelectrically controlled means for measuring a predetermined length of said material from the path of said cutting means, a series of photoelectric means beyond and in proximity thereto extending perpendicularly to the direction of said forwarding movement, and means operable thereby upon interception of the light beams thereof by the leading edge of the web successively to arrest the forwarding movement of respective portions of the sheet thereby to straighten the web to true rectangular form, to arrest the web and thereupon to actuate said cutting means to sever the measured section from the sheet, means operable thereupon to transfer the sheet in the direction of the weft to hem-folding position, photoelectric means for arresting the section in said position, automatically operable means for simultaneously folding narrow portions of the cut edges upon the body of the sheet and thereafter to fold hems of predetermined width upon the body of the sheet with the marginal portions therebetween, and means for bonding the hem portions upon the body of the sheet.

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