June 4, 1935. J. P. REMINGTON 2,003,698

METHOD OF AND APPARATUS FOR SEPARATING SHEETS FROM STACKS THEREOF

Filed Feb. 20, 1932 2 Sheets-Sheet 1

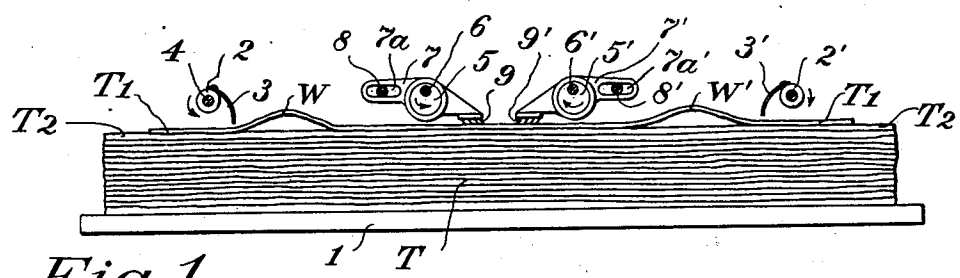


Fig. 1.

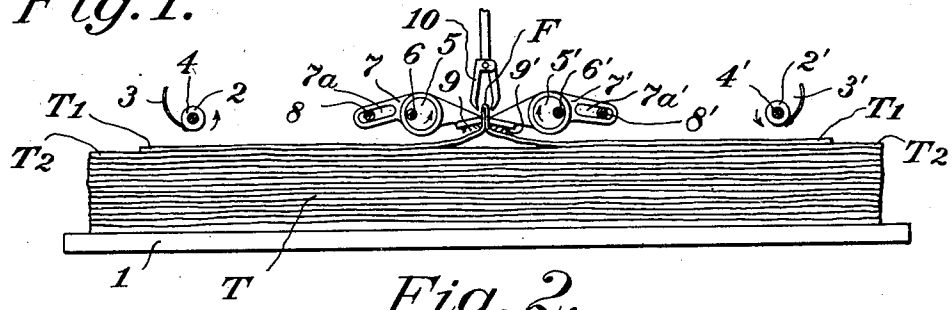


Fig. 2.

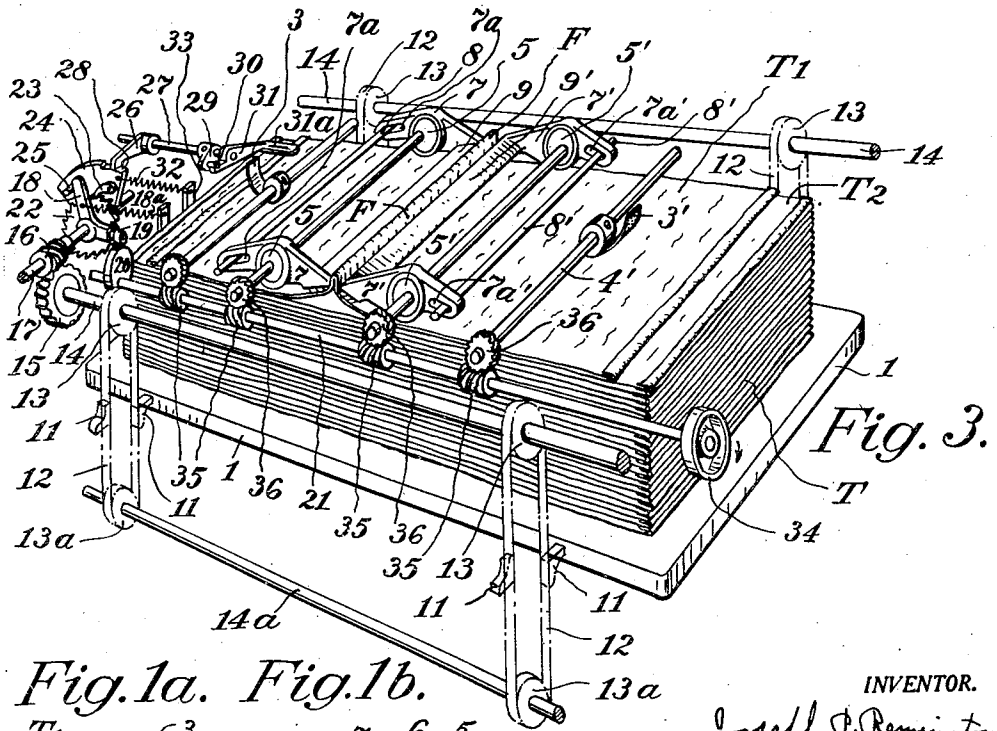
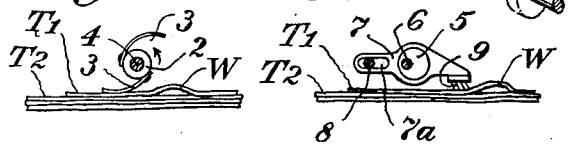


Fig. 3.

Fig. 1a. Fig. 1b.



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METHOD OF AND APPARATUS FOR SEPARATING SHEETS FROM STACKS THEREOF

Filed Feb. 20, 1932 2 Sheets-Sheet 2

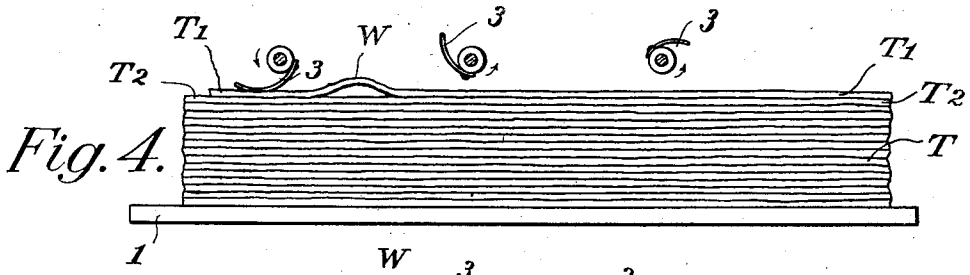


Fig. 4.

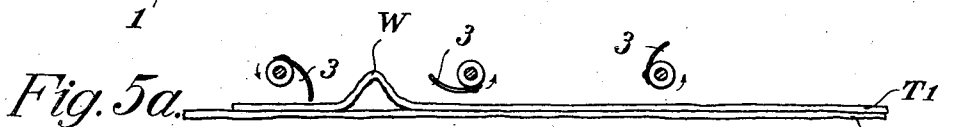


Fig. 5a.



Fig. 5b.

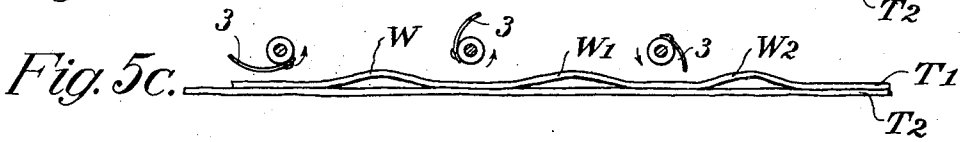


Fig. 5c.

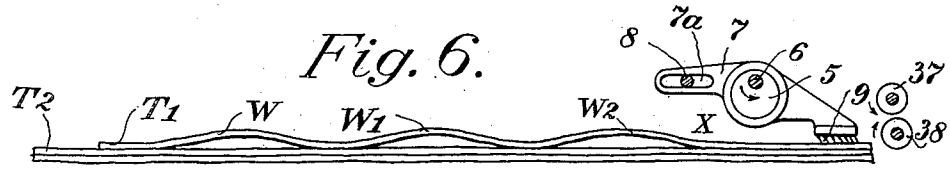


Fig. 6.



Fig. 7.



Fig. 8.

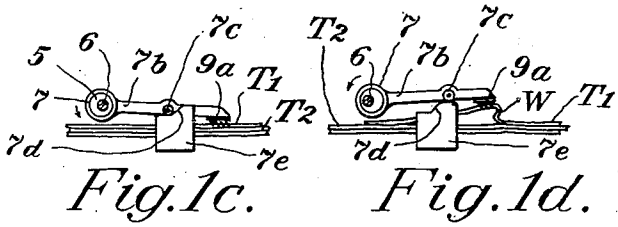


Fig. 1c.

Fig. 1d.

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UNITED STATES PATENT OFFICE

2,003,698

METHOD OF AND APPARATUS FOR SEPARATING SHEETS FROM STACKS THEREOF

Joseph P. Remington, Philadelphia, Pa., assignor to Stokes and Smith Company, Philadelphia, Pa., a corporation of Pennsylvania

Application February 20, 1932, Serial No. 594,194

24 Claims. (Cl. 271—25)

My invention relates to a method of and apparatus for separating sheets, one at a time, from a pile or stack thereof, particularly when the sheets are of material which is limp, or having little or no rigidity or elasticity, as in the case of cloth, paper and the like, having such characteristics that neighboring sheets thereof adhere to each other or exhibit considerable resistance, due to friction or the like, to movement of a sheet away from or flatwise along the surface of its immediate neighbor in the stack.

In accordance with my invention the separation of sheets of material of the character aforesaid, one at a time from a stack, is effected by reducing or eliminating in one or more areas or regions simultaneously or in succession, by equal or unequal movements of the top sheet with respect to the neighboring sheet, the adhesion or cohesion of the top sheet to or with the immediately adjacent sheet in the stack, or by reducing the friction between the top sheet and its immediate neighbor in the stack, and simultaneously, or preferably thereafter, taking hold of the top sheet and by movement in any suitable direction or directions with respect to the stack removing the top sheet without substantial disturbance of its neighbor.

Further in accordance with my invention the stack of sheets, of material of the character aforesaid, is elevated as sheets are removed in succession from the top thereof, with maintenance of a substantially constant top level of the stack.

It has been found in practice that sheets, of material of the character above mentioned, cannot be satisfactorily separated and fed from a stack (as may sheets of paper or other material which, though flexible or pliable, are smooth or more or less rigid or elastic) because sheets of limp or cloth-like material act quite differently due to their physical properties, causing adhesion, cohesion or friction between neighboring sheets. For example, a sheet of cloth, such as a towel, napkin or other flatwork of cloth, does not readily slide one upon its neighbor; the sheets, because of their limpness and surface structure adhere or cling to each other at their contacting surfaces which mutually interlock or so frictionally engage that in attempting to remove one sheet from or drag it along the surface of its neighbor causes the latter and even other sheets adjacent thereto to roll back upon itself or themselves, or so otherwise behave as to render it difficult to insure that always one, but never more than one, piece or sheet at a time is picked up or removed from the stack.

In accordance with my invention, however, as above indicated, by suitably reducing or eliminating the interfacial adhesion or friction between the top sheet and its immediate neighbor in the stack, the top pieces or sheets may be removed one at a time in succession, and in rapid sequence if desired, without disturbance of the adjacent sheet or sheets; the step of so reducing or eliminating the interfacial adhesion or friction preferably wholly precedes the step of lifting or dragging the top sheet from the stack, though the first of said steps may be initiated before and continue during a suitable portion of or throughout the second step to the time of substantially final separation of the top sheet from its immediate neighbor in the stack.

Stacked sheets or pieces of cloth or other limp material of the character above referred to, may be described as to their adhesion or friction at their engaging faces as "felting" together; and the adhesion or friction between adjacent sheets is the more pronounced if the sheets for a considerable time have been in contact with each other in the stack. The adhesion or friction between sheets makes it difficult to draw the top sheet across the top surface of the remainder of the pack or stack without sometimes also drawing with it the second sheet or rolling back the edges of one or more sheets; this difficulty is encountered especially in attempting suddenly or quickly to remove or lift the top sheet from the stack.

Whether a single sheet or two sheets is or are at one time removed from the stack depends upon the extent of friction or adhesion between the top and the second sheet as compared with the friction or adhesion between the second and third sheets of the stack, as may be shown by placing a piece of smooth or glazed paper between the second and third sheets, in which case, on attempting to remove the first sheet alone from the stack very frequently the second sheet will come with it, or at least be rumpled or disturbed in its position which is just as undesirable; while the third sheet will not be picked up because the intervening paper reduces or eliminates adhesion or friction between the second and third sheets.

In accordance with one aspect of my invention the friction or adhesion between the top sheet and its immediate neighbor in the stack is sufficiently overcome, reduced or eliminated by picking up and/or moving the top sheet, a little at

a time, and if desired simultaneously or successively and to equal or unequal extents at a plurality of places or regions within the borders of the sheet, off from, over or along the surface of the second or neighboring sheet, without disturbing the adhesion or friction between the second and third sheets, which during the removal of the top sheet assists by preventing disturbance, deformation or rumpling of the second sheet. In consequence, when the top sheet is picked up and transported, the second sheet remains undisturbed or maintains its flat formation, because there still exists maximum or sufficient adhesion or friction between the second and third sheets to hold the second sheet smoothly in place.

It accordingly will be appreciated that my invention is distinguished from the use of mechanical means such as blades, or pneumatic means, such as compressed air, applied between the sheets to separate the top from the adjacent sheet because, instead of interposing separating means or medium between the top and second sheets, only the upper or exposed surface of the top sheet is operated upon.

A stack or pile of sheets of cloth or other generally like limp material yields or is to some extent elastic or compressible in the direction of depth of the pile or stack. In consequence, height indicators or feelers, which selectively operate or fail to operate in control of elevation of the stack, as commonly used in paper feeding, are inadequate, because even small variation in pressure of the indicator or feeler on a stack of sheets of cloth or other limp material indents the indicator or feeler into the top surface of the stack to a distance greater or less than the thickness of one sheet, and so causes undesirable or irregular stack elevation. In accordance with my invention, however, a counterbalanced feeler or height indicator of invariable or constant weight is employed, and so disposed or designed that the force required to operate the more or less robust or heavy mechanism for elevating the stack does not react upon or affect the indicator or feeler to vary its pressure on the top of the stack from a substantially constant magnitude.

My method or apparatus is utilizable alone, or in association with or as a part of methods or systems, including those disclosed in my copending applications Serial No. 510,084, filed January 21, 1931, Serial No. 583,439, filed December 28, 1931, and Serial No. 596,774, filed March 4, 1932.

For an understanding of my method, and for an illustration of some of the various forms my apparatus may take, reference is had to the accompanying drawings, in which:

Fig. 1 is a fragmentary side elevational view, parts in section of a stack of sheets of limp material on the elevator feed table, showing the top sheet partially separated from its neighbor;

Fig. 1*a* illustrates a modification of the adhesion-reducing device;

Fig. 1*b* illustrates a further modified form of adhesion-reducing device;

Fig. 1*c* illustrates a further modification of the adhesion-reducing device;

Fig. 1*d* illustrates a later stage of operation of the structure shown in Fig. 1*c*;

Fig. 2 is a view similar to Fig. 1 illustrating a later stage of the operation;

Fig. 3 is a perspective view of a system for removing sheets one at a time from a stack, in association with stack elevating means and control therefor;

Fig. 4 is a fragmentary side elevational view illustrating a modified method and structure for reducing or eliminating the adhesion or friction between the top sheet and its immediate neighbor in the stack;

Figs. 5*a*, 5*b* and 5*c* are illustrative of successive stages in the operation shown by Fig. 4;

Figs. 6 and 7 are fragmentary side elevational views illustrating successive stages of operation in removing a top sheet from a stack;

Fig. 8 is a fragmentary side elevational view illustrating a modification in the mode of removal of a top sheet from a stack.

For brevity hereinafter, the stacked sheets will be referred to as towels, a generic term including towels, napkins, flat piece laundry work, and other sheets of cloth, felt paper or other limp material having the characteristics hereinbefore referred to.

Referring to Fig. 1, the towels T are shown disposed in a stack or pile upon the support or table 1 which, as hereinafter described more particularly in connection with Fig. 3, is elevated as the height of the stack diminishes.

To break up or reduce the adhesion between the top towel T1 and its immediate neighbor T2 is provided any suitable number of devices 2, 2', rotating continuously or intermittently, or equivalent devices, which may be termed "peelers", suitably disposed in one or more places or regions within the borders of the towel T1, generally producing therein ripples or waves, such as W, W'. The devices 2, 2' may be of any suitable character for the purpose, and in the example illustrated comprise sheet or leaf springs 3, 3' secured at their inner ends tangentially to collars secured upon the shafts 4, 4', rotating in the directions indicated by the arrows. The backs or towel engaging surfaces of the members 3, 3' are suitably roughened, as by application thereto of emery cloth, carding cloth, or equivalent means, whereby the members 3, 3' in their rotation brush or whip the exposed surface of the towel T1 drawing opposite ends thereof longitudinally along the upper surface of the second towel T2, thereby generally forming the aforesaid self-sustaining waves or ripples W, W', more or less pronounced, and so or in any event breaking up or diminishing the adhesion or friction between the towels T1 and T2.

Located in any suitable position, and in the example illustrated in Figs. 1 and 2 between the devices 2, 2', are the eccentrics 5, 5', rotating continuously or intermittently, or equivalent mechanism such as cranks or cams, secured upon and rotated by the shafts 6, 6', rotating in the directions of the arrows, imparting to the eccentric strap members 7, 7', movements having components parallel with and toward and away from the towel T1, the strap members 7, 7' having for the purpose slots 7*a* and 7*a'* by which the strap members are hung upon and guided or confined by the shafts or rods 8, 8' extending through the slots. The other ends of the strap members 7, 7' carry carding cloth 9, 9', or any equivalent means or material, adapted to engage the surface of and move the towel T1. The carding cloths 9, 9' are shown in Fig. 1 as having been brought into engagement with the top towel, and in their continued movement they approach each other and rise from towel T1, as indicated in Fig. 2, taking up the ripples or waves W, W', and moving at least a portion of towel T1 with respect to its neighbor T2, producing the fold or tent F, Fig. 2, which is gripped or taken hold of by any suitable means generically represented by the gripping

members 10 for thereafter removing, dragging or lifting the towel T1 form the stack and transporting it to any suitable destination as for example to feed rolls of mechanism for further folding the towel T1 into smaller compass. The gripping members 10 close and open, and carry the towel away from the stack, in timed relation to the adhesion-breaking devices.

The devices 3, 3', or equivalents, and the devices 9, 9', or equivalents, operate in timed relation to each other whether they move continuously or intermittently.

Assuming the rolls 4, 4' and 6, 6' rotate at the same speeds or angular velocities, as in the case illustrated by Fig. 3, and because the members 3, 3' are suitably angularly displaced upon their shafts from the corresponding positions of the eccentrics 5, 5' upon their shafts 6, 6', the members 3, 3' first engage the towel T1 and break or reduce the adhesion or friction between it and the towel T2 before the members 9, 9' engage towel T1, taking up the slack as represented by the ripples or waves W, W', and fold or crease the towel at F', raising it at that region at the same time to position sufficiently removed from the second towel T2 to prevent the towel-holding or gripping and transporting structure 10 from picking up the second towel T2.

While the first step, that performed by the members 3, 3', is preferably completed or substantially completed before initiation of the second step of the operation performed by the members 9, 9', it will be understood that by otherwise relatively disposing the members 3, 3' angularly with respect to the eccentrics 5, 5', the first step, at least begun before initiation of the second step, may to suitable extent either partially or wholly overlap or coincide with the second step. In general, however, it is preferred that the first step be completed or substantially completed before initiation of the second step of the two-step operation of breaking or reducing the adhesion or friction between towels T1 and T2 and folding or creasing the towel T1 as at F, Fig. 2; and it is preferred that the first step be completed or substantially completed by the time the mechanism 10 starts to strip or remove towel T1 from the stack.

While by their relations indicated in Fig. 1, the members 3 and 3' perform their adhesion-breaking operations substantially simultaneously, they may perform their functions dis-simultaneously, so long as over a sufficient portion of the towel T1 its adhesion to its neighbor T2 is sufficiently broken or reduced to permit the second step operations of folding, taking hold of and removing the towel T1.

Breaking a part of the total adhesion or friction between the towels T1 and T2, besides that effected by the members 3, 3', is effected by the members 9, 9' as part of the second stage or step above described; the members 3, 3' break up or reduce the adhesion sufficiently to allow the remainder to be broken up or reduced by the members 9, 9', making it safe to continue breaking the adhesion or friction on enough of the remainder of the towel T1 without danger of picking up the second towel T2.

Referring to Fig. 3, the stack elevating table 1 is raised short distances from time to time, or step-by-step, by the lugs or table-supporting elements 11 secured to the belts or chains 12 passing over the pulleys or sprockets 13, secured upon and rotated by the shafts 14, driven in unison by gearing not shown, and passing over the idler pulleys or sprockets 13a.

Secured upon shaft 14 is the worm wheel 15 meshing with and driven from time to time by the worm 16 secured upon shaft 17. While the worm 16 may drive the wheel 15, the latter, under the influence of the weight of the table 1 and the stack T is not able to rotate the worm 16 and so influence the elevator control or reverse the elevator movement. Mounted loosely upon the shaft 17 is a bell crank 18 carrying on its one arm a roller or follower 19 held in engagement with the eccentric 20, secured upon the drive shaft 21, by a spring 18a. With a ratchet wheel 22, with its one face adjacent an arm of the bell crank 18, secured upon the shaft 17 for rotating the latter from time to time, coacts a pawl 23 pivoted upon the plate member 24, loosely mounted on shaft 17, and disposed adjacent the ratchet wheel 22; a spring 32 attached to plate 24 and to post 33 biases the plate 24 toward the right. A pin 25 carried by the plate 24 coacts with the other arm of the bell crank lever 18. A latch or detent 26 is secured upon the shaft 27 in position to engage the edge of plate 24 or in a notch or depression 28 therein. An arm or crank 29 secured upon the shaft 27 carries a pin 30 adapted in its lower position to engage one end of the lever arm 31 loosely journalled upon the shaft 27, and provided with the laterally extending indicator or feeler element 31a resting upon the top of the stack T. The arm 31 and member 31a have such excess weight on that side of axis of shaft 27 at which member 31a is disposed, as to force the pin 30 upwardly, upon descent of feeler member 31a upon withdrawal of a towel or towels from the stack, thereby lifting the latch 26 from the notch 28, permitting spring 32 to rotate plate 24 toward the right when the upper member of the bell crank level 18 has been moved toward the right upon descent of the cam 22, thereby causing the pawl 23 to engage the ratchet wheel 22 in a new position, whereby, upon the next ascent of the cam 20, the upper arm of the bell crank 18 will rotate toward the left, rotating shaft 17, worm 16, gear 15, shafts 14 and pulleys or sprocket wheels 13 to cause upward movement of the lugs or abutment 11, thereby elevating the top of the stack.

If the increment of elevation so effected is sufficient to restore the top of the stack to the proper level with relation to the adhesion breaking and towel removing devices, the parts resume their position indicated in Fig. 3 until upon further removal of one or more towels feeler member 31a again descends sufficiently to initiate a further increment of elevation of the stack. Ordinarily a single incremental movement of the shaft 17, as above described, will suffice to restore the top of the stack to desired level; if for any reason such movement should not be sufficient, one or more further incremental movements will be imparted by the next rotation or rotations of the cam or eccentric 20.

The plate 24 and detent 26 serve to lock the stack elevating mechanism when the pressure between the feeler 31a and the stack overcomes the weight of and lifts the feeler system, comprising the feeler 31a and its carrier 31, thereby permitting detent 26 to enter notch 28, and so render the stack elevating mechanism inoperative.

The described control of the stack elevating mechanism is such that there is no reaction therefrom upon members 31 and 31a, and ac-

cordingly the feeler member 31a will not be indented or pressed into the top of the stack. It is characteristic of the control that no pressure except that of the weight of the arm 30 and member 31a is or can be exerted upon the stack. In consequence the height indicator or feeler 31a moves through only the range corresponding with the thickness of one or more towels removed, affording nice or substantially exact control of stack elevation, which would not be the case if the elevating mechanism reacted to press feeler 31a into the yielding or elastic stock.

The shaft 21 is rotated at substantially constant speed by its driving pulley or gear 34. Beside driving the aforesaid cam or eccentric 20 for stack elevation, the shaft 21 rotates the spiral gears 35 meshing with and driving the spiral gears 36 secured upon the shafts 4, 6, 6' and 4' to rotate them for the purposes and with the results above described.

The stack elevating mechanism and its control above described have in practice been found satisfactory and reliable, even when the towels or sheets constituting the stack as a whole are of different thicknesses due to varying degrees of shrinkage corresponding with their prior histories.

While reference has been made more particularly to elevation of sticks of towels or sheets of cloth of such nature that the stack is more or less yielding in the direction of its depth, it will be understood that my system of stack elevation and control therefor are generally applicable to all cases where the stack is so substantially compressible, including the case where the sheets are of paper, particularly embossed paper.

It will be understood that various modifications in the above described method and apparatus are comprehended within my invention; for example, some of the further modifications are illustrated by Figs. 4 to 8 inclusive.

In Fig. 4 a series of any suitable number of members 3 or equivalent are provided for breaking the adhesion or friction between the top towel T1 and its immediate neighbor T2. These members 3 are angularly displaced with respect to each other, whereby they operate at different regions in succession upon the towel T1. Furthermore, as indicated, the members 3 may be of different lengths, and in the example illustrated decrease in length from left toward the right whereby the left hand member 3 effects greater movement of the towel T1 with respect to towel T2, the middle member 3 produces a second and lesser movement, and the right hand member 3 produces the least and last movement.

Figs. 5a, 5b and 5c show the several members 3 of Fig. 4 in three successive positions subsequent to their relative positions indicated in Fig. 4. The action is such for example that the left hand member 3 in Fig. 4 has begun to form a wave or ripple W which is at its maximum in Fig. 5a. Thereafter, as indicated in Fig. 5b, the middle member 3 has produced the second wave or ripple W1, without wholly flattening the first ripple or wave W. In Fig. 5c the third and shortest member 3 has reduced the ripple or wave W1 and produced the third ripple W2. The result is that a plurality of ripples are effected in succession, the first being reduced by the formation of the second, and the second reduced by the formation of the third. There results, therefore, a breaking of the adhesion or friction between the top towel T1 and its neighbor T2 in different regions or areas in succession. The towel T1 may then be dragged, lifted or otherwise removed from its neighbor T2 and the stack as a whole with assurance that only the top towel T1 will be removed from the stack and without disturbance of its neighbor T2 which still adheres to the next towel beneath.

As indicated in Figs. 6, 7 and 8 the mechanism, comprising the carding cloth or equivalent member 9, is positioned to the right of the several members 3 and operates adjacent one edge of the towel T1. In Fig. 6 the member 9 is in engagement with the towel T1 beginning to lift it to position indicated in Fig. 7 for moving it toward the right for delivery to the feed rolls 37, 38, of any suitable mechanism for further operating upon the towel, as for example for further folding it into smaller compass.

In Fig. 6, the ripples or waves W, W1, W2 have been produced as described in Figs. 4 to 5c inclusive, with resultant breaking or reduction of the adhesion or friction between towel T1 and its neighbor T2 up to a region generally indicated by X, assuring that the member 9 or equivalent may then operate to remove the towel T1 and deliver it to some other position.

As indicated in Fig. 8, in lieu of the carding cloth 9 or equivalent there may be used a mechanism 10 of the character above described for grasping the crease or fold F and so removing the towel T1 from the stack by movement in any suitable direction or directions, the friction or adhesion having been broken up as in the immediately preceding figures up to the region X.

While throughout the various figures of the drawings the adhesion-reducing devices have been illustrated as comprising single spring members 3 in or for each area or zone, it shall be understood that as illustrated in Fig. 1a any suitable number of blades or springs 3 may be employed. By a structure of this character successive adhesion-breaking forces are applied in each region or zone of the top sheet. In this example, each of the several members 3 imparts a wiping or a sliding movement of the top sheet upon its neighbor. In order that none of the elements 3 shall engage the second sheet T2, their shaft 4 is located such distance from the end of the stack that the total movement of the top sheet T1 imparted by the several members 3 will not uncover the second sheet T2 sufficiently to expose it to the action of a member 3.

Referring to Fig. 1b, there is illustrated a type of adhesion-reducing device generally corresponding with a like device utilized, as illustrated in Fig. 1, for both reducing adhesion and lifting the topmost sheet T1 clear of its neighbor. Here again the structure comprises an eccentric 5 secured upon and rotated by its shaft 6 to impart to the strap 7, having as before the slot 7a' receiving the shaft 8, a movement having components parallel to the top of the stack and away from the stack thereby causing the carding cloth 9 or equivalent to engage the exposed surface of the top towel T1 and move it flatwise along the surface of the towel T2 producing a ripple or wave W, thereafter separating the uppermost towel and moving it away from the stack, and returning to repeat the same cycle of operations upon the next sheet.

It shall be understood that the devices illustrated in Fig. 1b may be used in lieu of those of the character illustrated in the other figures, including Fig. 1a, utilizing roughened springs 3 or the like.

Referring to Figs. 1c and 1d, there is shown a further modification, for reducing adhesion between the top towel and its neighbor, which may be utilized in lieu of any of the devices for like purposes shown in any of the other figures hereof. In this case carding cloth or equivalent 9a is carried upon an eccentric rod 7b terminating at the left in the eccentric strap 7 within which is the eccentric 5 secured upon and rotated by its shaft 6. At a suitable position upon the rod 7b is disposed a roller or cam follower 7c adapted to ride upon the cam surface 7d constituting an edge of the member 7e.

The carding cloth 9a first moves from left toward the right, substantially parallel to the top of the stack so long as the follower 7c is upon the left hand horizontal portion of the cam surface 7d, thereby sliding the top towel T1 upon its neighbor T2 sufficiently to set the wires or teeth of the carding cloth 9a into the towel T1. In continuing the stroke as effected by the eccentric 5, the follower rides up upon the inclined portion of the cam surface 7b thereby imparting to the cloth 9a a movement having components both parallel to and away from the stack; later the follower 7c rides upon the right hand horizontal portion of the cam surface 7d to its final position, indicated in 1d, by which time there has been formed in the top towel a ripple or wave W which persists after further movement of 9a on its return stroke from engagement with the sheet T1.

While hereinbefore for purposes of description towels, napkins or other sheets of limp cloth have been more particularly referred to, it will be understood that my method and apparatus are utilizable also for removing one at a time from a stack sheets of other limp materials, exhibiting interfacial cohesion, adhesion or friction of the character hereinbefore referred to, as may be the case with some classes of paper, skins, felt, leather, rugs, carpets and the like.

For brevity in the appended claims, the term "limp" is employed generically to include the characteristics of cloth, paper and other materials which are limp, filmsy or the like causing adhesion, cohesion or friction of the character hereinbefore described; and the term "adhesion" is employed generically to include adhesion, cohesion, friction or such other interfacial action which, unless reduced or broken, would prevent separation of a single sheet at a time from a stack without disturbing the adjacent sheet or sheets.

What I claim is:

1. A method of separating one sheet at a time from a stack of limp sheets, which comprises reducing the adhesion between the top sheet and its neighboring sheet beginning adjacent an end of the top sheet and progressing in zones toward the other end of said top sheet, and adjacent said other end picking up and removing the top sheet from the stack, without substantial disturbance of said neighboring sheet.

2. A method of reducing the adhesion between a top sheet and its neighboring sheet in a stack of limp sheets, which comprises producing a ripple in the top sheet, and in a different area reducing said ripple by producing a further ripple in said top sheet.

3. A method of reducing the adhesion between a top sheet and its neighboring sheet in a stack of limp sheets, which comprises moving the top sheet to an extent to produce a ripple therein, and in another region producing movement of the top sheet of lesser extent to reduce said ripple and produce another ripple therein.

4. Means for separating one sheet at a time from a stack of limp sheets comprising means for reducing the adhesion between the top sheet and its neighboring sheet successively in different areas of the top sheet, and means for removing the top sheet from the stack.

5. Means for separating one sheet at a time from a stack of limp sheets comprising means for imparting movements of different extents in different areas of the top sheet to reduce the adhesion between the top sheet and its neighboring sheet, and means for removing the top sheet from the stack.

6. Means for separating one sheet at a time from a stack of limp sheets comprising means for imparting movements of different extents in succession in different areas of said top sheet to reduce the adhesion between the top sheet and its neighboring sheet, and means for removing the top sheet from the stack.

7. Means for separating one sheet at a time from a stack of limp sheets comprising means reducing the adhesion between the top sheet and its neighboring sheet in separated zones, and means between said zones for removing the top sheet from the stack.

8. Means for separating one sheet at a time from a stack of limp sheets comprising means reducing the adhesion between the top sheet and its neighboring sheet in separated zones, means for producing a fold in the top sheet between said zones, and means for engaging said fold to remove the top sheet from the stack.

9. Means for separating one sheet at a time from a stack of limp sheets comprising means in each of different zones extending between one end of said top sheet and its opposite end for reducing the adhesion between said top sheet and its neighboring sheet, and means adjacent one end of said top sheet for removing it from said stack.

10. Apparatus for reducing adhesion between limp sheets of a stack comprising means for producing a ripple in the top sheet, means in an adjacent zone for reducing said ripple and producing a further ripple in the top sheet.

11. A method of separating one sheet at a time from a stack of cloth sheets which comprises drawing the end sheet toward the center of the stack without exertion of appreciable pressure thereon to reduce the adhesion between it and the neighboring sheet, and thereafter removing the sheet from the stack.

12. A method of separating one sheet at a time from a stack of cloth sheets which comprises penetrating a portion of the end sheet and drawing it thereby toward the center of the stack to reduce the adhesion between it and the neighboring sheet, and thereafter removing the sheet from the stack.

13. Means for separating one sheet at a time from a stack of cloth sheets comprising structure for penetrating the upper face of the top sheet of the stack, means for moving said structure toward the center of the stack to draw said top sheet along the sheet below and reduce the adhesion therebetween, and means for thereafter removing the sheet from the stack.

14. Means for separating one sheet at a time from a stack of cloth sheets comprising movable structure for penetrating the upper face of the top sheet of the stack having a component of motion parallel to and toward the center of the

top of the stack and a component of motion upwardly from the stack for reducing the adhesion between the top sheet and the neighboring sheet, and means for thereafter removing the top sheet.

15. Means for separating one sheet at a time from a stack of cloth sheets comprising movable structure for penetrating the upper face of the top sheet of the stack, and means for moving said structure substantially parallel to the top of the stack and toward the center thereof to draw a portion of the top sheet along the neighboring sheet and for thereafter moving said structure upwardly from the top of the stack to release said top sheet, and means for thereafter removing the top sheet.

16. A method of separating one sheet at a time from a stack of limp sheets, which comprises lightly whipping the top surface of the top sheet of the stack to reduce the adhesion between it and the adjacent sheet and to form a self-sustaining ripple, and thereafter removing the sheet from the stack without substantially disturbing said adjacent sheet.

17. A method of separating one sheet at a time from a stack of limp sheets, which comprises lightly whipping the top surface of the top sheet of the stack successively in different areas to produce a plurality of self-sustaining ripples, and thereafter removing the sheet from the stack without substantially disturbing the adjacent sheet.

18. A method of separating one sheet at a time from a stack of limp sheets, which comprises lightly whipping the top surface of the top sheet of the stack to reduce the adhesion between it and the adjacent sheet and to form a self-sustaining ripple, thereafter sliding the top sheet to produce a tent fold taking up the slack produced by the ripple, and grasping the fold to remove the sheet from the stack without substantial disturbance of said adjacent sheet.

19. A method of separating one sheet at a time from a stack of limp sheets, which comprises lightly whipping the top surface of the top sheet of the stack to reduce the adhesion between it and the adjacent sheet and to form a self-sustaining ripple and thereafter grasping said ripple to remove the sheet from the stack without substantial disturbance of said adjacent sheet.

20. A method of separating one sheet at a time from a stack of limp sheets, which comprises lightly whipping the top surface of the top sheet of the stack successively in different areas to produce a plurality of self-sustaining ripples, and grasping one of the ripples to remove the sheet from the stack without substantial disturbance of the adjacent sheet.

21. Means for separating one sheet at a time from a stack of cloth sheets comprising rotating flexible structure for lightly whipping the top surface of the top sheet of the stack to reduce the adhesion to the adjacent sheet, and means for thereafter removing the top sheet.

22. Means for separating one sheet at a time from a stack of cloth sheets comprising a plurality of rotating flexible members for whipping the top surface of the stack to produce a plurality of self-sustaining ripples, and means for thereafter removing the top sheet.

23. Means for separating one sheet at a time from a stack of cloth sheets comprising a plurality of rotating flexible members for whipping the top surface of the stack to produce a plurality of self-sustaining ripples, means for sliding the top sheet to produce a tent fold by taking up the slack produced by ripples on opposite sides thereof, and means for thereafter grasping said fold to remove the sheet from the stack without substantial disturbance of said adjacent sheet.

24. Means for separating one sheet at a time from a stack of cloth sheets comprising rotatable structure for lightly whipping the top surface of the top sheet of the stack to ripple it, means for thereafter removing the top sheet, and means for elevating the stack to maintain the top thereof in predetermined position with respect to said rotatable structure.

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