United States Patent [19]

Shindo

[11] **3,826,485**

[45] **July 30, 1974**

[54] **APPARATUS FOR SUCKING UP AND LIFTING THE UPPERMOST SHEET MATERIAL FROM A STACK OF SUCH SHEET MATERIALS**

[75] Inventor: **Masashi Shindo,** Saitama-ken, Japan

[73] Assignee: **Pilot Man-Nen Hitsu Kabushiki Kaisha,** Tokyo, Japan

[22] Filed: **Feb. 9, 1973**

[21] Appl. No.: **330,975**

[30] **Foreign Application Priority Data**

July 10, 1972 Japan 47-068802

[52] **U.S. Cl.** ..... **271/106,** 214/1 BT, 214/8.5 D, 294/65

[51] **Int. Cl.** **B65g 59/04**

[58] **Field of Search** ..... 214/1 BT, 8.5 D; 294/64 R, 294/65; 271/91, 100, 106

[56] **References Cited**

UNITED STATES PATENTS

3,322,301	5/1967	Bliss	271/106 X
3,411,640	11/1968	Wallis	214/1 BT X
3,673,759	7/1972	Ayres	271/91 X

Primary Examiner—Robert J. Spar
Assistant Examiner—George F. Abraham
Attorney, Agent, or Firm—Eliot S. Gerber

[57] **ABSTRACT**

A sheet material is sucked at one end and at an intermediate portion between the central portion and the other end thereof, wherein said one end of the sheet material is lifted initially while the sheet material is pressed downwardly at a portion between the sucked portions to cause the sheet material to have a bend between the sucked portions.

3 Claims, 8 Drawing Figures

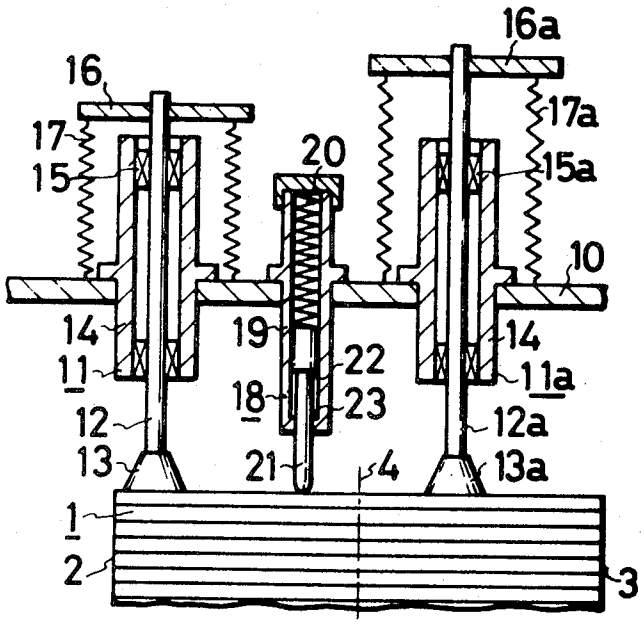


FIG. 1

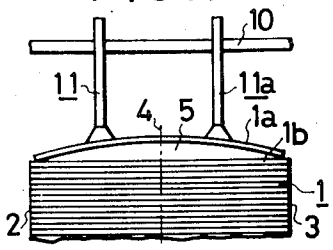


FIG. 2

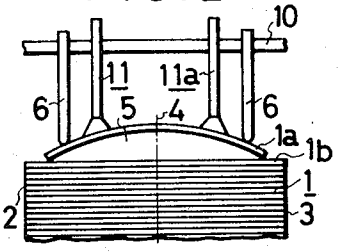


FIG. 3

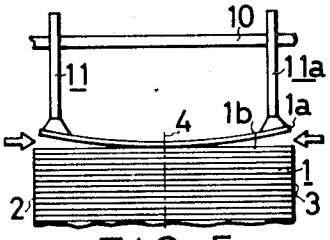


FIG. 4

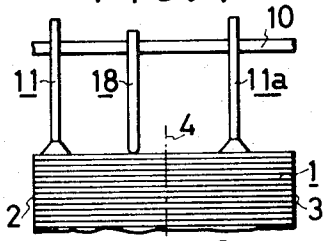


FIG. 5

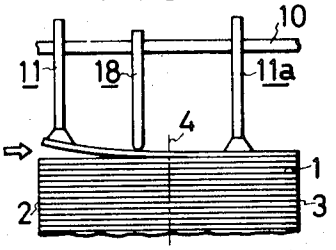


FIG. 6

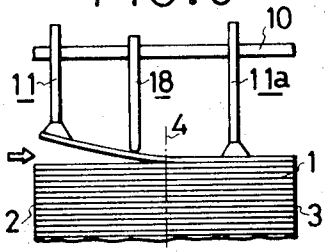


FIG. 7

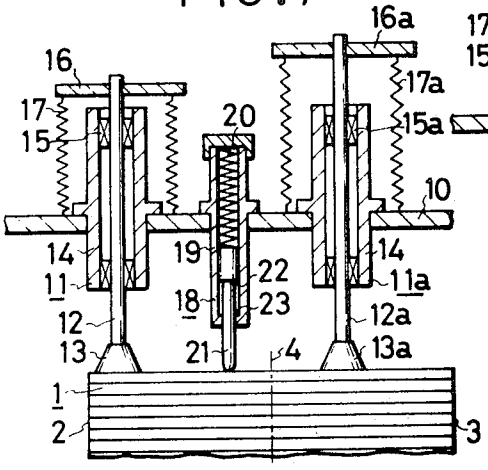
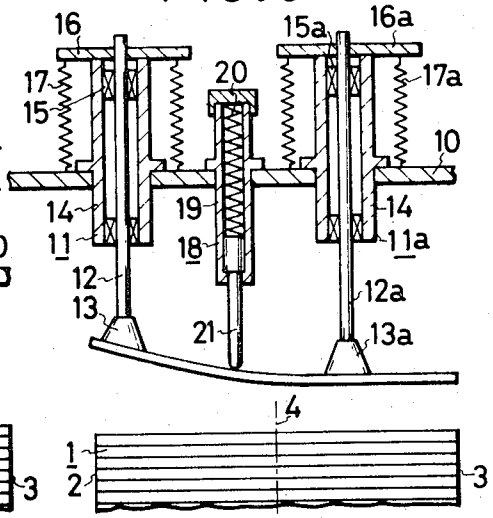


FIG. 8



APPARATUS FOR SUCKING UP AND LIFTING THE UPPERMOST SHEET MATERIAL FROM A STACK OF SUCH SHEET MATERIALS

The present invention relates to method and apparatus for sucking up and lifting the uppermost one of stacked sheet materials and transferring the lifted sheet material to another predetermined place.

In the field of transferring thin sheet materials, such as thin plastic sheets, one after another from a stack of the sheet materials to another predetermined place, there has been known a method in which the uppermost one of stacked sheet materials is subjected to suction force so that the uppermost sheet material is peeled off the other sheet materials and then transferred. Usually, this method is carried out by simultaneously lowering a plurality of suction means at the bottom ends of hollow rods into contact with the uppermost one of stacked sheet materials. Because of the pressure applied to the stacked sheet materials such as by the weight of the suction means, the sheet materials tend to be adhered to each other.

If the uppermost one of such adhered stacked sheet materials is subjected to suction force a plurality of suction means and if the latter and simultaneously lifted up, there takes place a tendency in which the second sheet or the second and third sheet materials are lifted together with the uppermost sheet material due to vacuum pressure. The nearer to the central area of the sheet material are the points on the sheet material at which the suction means contact the same, the greater the tendency.

Several methods and apparatuses have heretofore been proposed in order to eliminate the above difficulty, but all have many shortcomings and fail to provide satisfactory, quick and reliable peeling and transferring operations which have been demanded long time.

It is an object of the present invention to provide a method of quickly and reliably peeling and transferring sheet materials one after another from the top of a stack of such sheet materials and an apparatus for performing the method.

It is another object of the present invention to provide a method of quickly and reliably peeling and transferring uppermost sheet material from a stack of such sheet materials without causing a second sheet material of the stack to be scratched and an apparatus for performing the method.

It is further object of the present invention to provide an apparatus for peeling and transferring sheet materials from a stack of such sheet materials which has a simplified construction and is inexpensive.

According to one aspect of the present invention, there is provided a method of sucking up and lifting the uppermost sheet material from a stack of such sheet materials and transferring the lifted sheet material to another predetermined place, wherein the top surface of the uppermost sheet material is subjected to suction force at one end thereof and at an intermediate portion between the central portion and the other end of said sheet material; thereafter said one end of said sheet material is lifted while said sheet material is pressed downwardly at a portion between the sucked portions of the sheet material to cause the sheet material to have a bend between the sucked portions so that the sheet material is peeled off lower sheet materials; then the sucked portion of the uppermost sheet material between the other end and the central portion is lifted to separate the uppermost sheet material from the lower ones; and finally the separated sheet material is moved upwardly.

According to another aspect of the present invention, there is provided an apparatus for sucking up the uppermost one of a plurality of stacked sheet materials comprising at least first and second suction means each provided at the lower end thereof with a suction member, said first suction means being disposed above one end of the stacked sheet materials while said second suction means is disposed above the intermediate portion between the other end of the stacked sheet materials and the central portion of the stack, at least one pressure means for applying pressure upon said sheet material, said pressure means being disposed between said two suction means, and means for driving said suction means operative to first move said first suction means upwardly to partially lift up said pressure means by the sucked sheet material and then upwardly move said second suction means.

The above and other objects, features and advantages of the present invention will be made apparent by the following description with reference to the accompanying drawings, in which:

FIGS. **1** to **3** diagrammatically illustrate heretofore known methods of sucking up and peeling sheet materials one after another from a stack of the sheet materials;

FIGS. **4** to **6** diagrammatically illustrate the method of sucking up and peeling sheet materials one after another from a stack of the sheet materials according to the present invention; and

FIGS. **7** and **8** are schematic views of an embodiment of the apparatus for sucking up and peeling sheet materials one after another from a stack of the sheet materials according to the present invention.

Before the present invention is described with reference to FIGS. **4** to **8** of the drawings, the prior art will be discussed with reference to FIGS. **1** to **3**.

With a heretofore known method of sucking up and peeling sheet material one after another from a stack **1** of the sheet materials shown in FIG. **1**, suction means **11** and **11***a* are operated to suck the uppermost one **1***a* of the stack of sheet materials at substantially the central portions of the left and right sections sectionalized by a center line **4**. Simultaneously, the suction means **11** and **11***a* are lifted together with the sucked sheet material **1**a by means of a support structure **10**. At this time, the central portion of the sucked sheet material goes up first so that a partially vacuumed space **5** is formed under the central area of the uppermost sheet material **1***a*. Hanged ends **2** and **3** at the opposite sides of the sucked sheet material **1**a substantially block the natural supply of air into the space **5**. This tends to disadvantageously cause a second sheet material **1***b* to be lifted up together with the uppermost one **1***a*.

In an attempt to eliminate the disadvantage, retaining rods **6** are used, as shown in FIG. **2**, to hold down the stack **1** at its end portions until the uppermost sheet material, which is sucked by the suction means **11** and **11***a* at the portions inwardly of the retaining rods **6**, is completely separated off the second sheet material **1***b*. In this case, the uppermost sheet material when lifted up has sliding movement with respect to the second

sheet material 1*b* so that both sheet materials may be scratched.

If the suction means **11** and **11***a* are operated to suck the opposite ends of the uppermost sheet material **1***a* and, at the same time, moved upwardly, as shown in FIG. **3**, the ends of the sheet material 1a are first lifted up to cause a relatively good natural air supply inwardly of the opposite ends of the sheet as indicated by arrows, with a result that the tendency that the second sheet material **1***b* is also lifted upwardly is reduced. However, if the sucking means are moved upwardly at a higher speed, the natural air supply is insufficient to prevent the second sheet material **1***b* from being lifted together with the uppermost sheet material. Thus, it is difficult to carry out the operation at a rate greater than a certain rate. In order to eliminate the diffuculty, therefore, a procedure is employed that the air supply is relied upon not only natural air supply but also jets of compressed air or the like so as to ensure that the uppermost sheet material **1***a* only is lifted up. This procedure, however, needs an additional installation for the air jet. Moreover, there may be a case where the uppermost **1***a* and the second sheet materials **1***b* are adhered together by virtue of electrostatic force etc. In such a case, air jet is insufficient to assure complete separation of the uppermost sheet material **1***a* from the second one **1***b*.

The method of sucking up and peeling sheet materials one after another from a stack of the sheet material according to the present invention will be described with reference to FIGS. **4** to **6**. A suction means **11** is disposed above one end **2** of a stack **1** of sheet materials. Another suction means **11***a* is disposed above the intermediate portion between the other end **3** of the stack **1** and center line **4** thereof. A pressure means **18** is provided at intermediate portion between the suction means **11** and **11***a*. The pressure means **18** and the suction means **11** and **11***a* are operable by an upper support structure so as to be moved up and down in a predetermined timed relationship.

In the first position shown in FIG. **4**, the suction means **11** and **11***a* are operated to suck the uppermost sheet material **1***a* while the pressure means **18** is forced down against the stack **1** with a constant pressure.

In the second position shown in FIG. **5**, the right hand suction means **11***a* positioned between the end **3** of the stack **1** and the center line **4** thereof is maintained in its lower position, whereas the suction means **11** adjacent the other end **2** of the stack **1** is moved upwardly with the pressure means **18** being forced down against the uppermost sheet material 1a with substantially the same pressure force as in the position of FIG. **4**. Air is naturally supplied inwardly as shown by an arrow. There takes place little case where the second sheet material **1***b* is lifted up together with the uppermost sheet material **1***a*. Of course, if the sucking up and lifting operation is continuously carried out at a high speed, there occurs a case wherein the natural air supply is insufficient to insure that the second sheet material **1***b* is prevented from being lifted up together with the uppermost sheet material. However, since the pressure means **18** holds down the second sheet material **1***b* to cause the same to have a resistance against deformation, it is almost assured that, the second sheet material **1***b* is separated from the uppermost sheet material. In addition, even if the uppermost and the second sheet materials **1***a* and **1***b* are adhered to each other by electrostatic force etc., it is almost assured that the second sheet material **1***b* is separated from the uppermost one **1***a* by the resistance against deformation.

The left hand suction means **11** is further moved upwardly with the right hand suction means **11***a* being maintained in its lower position to hold down the uppermost sheet material **1***a*. The pressure means **18** is moved upwardly due to the moving up of the left hand suction means **11**, as shown in FIG. **6**, to such a level as to cause the uppermost sheet material to be arcuately bent upwardly at its left end portion. Thus, even if the second sheet material **1***b* tends to be lifted up together with the uppermost sheet material **1***a*, the increase in the resistance of the second sheet material **1***b* against deformation and the lapse of time in the process from the position shown in FIG. **5** to that shown in FIG. **6** ensure sufficient natural air supply to cause the end of the second sheet material to be completely separated from the end **2** of the uppermost sheet material. In addition, even if the uppermost and the second sheet materials **1***a* and **1***b* are maintained in not completely separated position as shown in FIG. **5** by electrostatic force etc., the increase in the resistance against deformation ensures complete separation of the second sheet material from the uppermost one in the position shown in FIG. **6**.

Then, the right hand suction means **11***a* is moved up to support the sheet material **1***a* by both suction means **11** and **11***a*. The upper support structure **10** is laterally moved to a predetermined place in which the suction force is removed from the suction means **11** and **11***a* to allow the sheet material 1a to drop.

As described above, the uppermost sheet material **1***a* is lifted in such a manner that one end thereof is turned up to improve natural air supply. This is combined with the utilization of the resistance of the second sheet material **1***b* against deformation to ensure complete separation of the uppermost sheet material **1***a* from the second one **1***b* so that the second sheet material **1***b* is prevented from otherwise being scratched and that the uppermost sheet material **1***a* only is positively lifted up.

A description will be made with respect to the apparatus for performing the above-described method by referring to FIGS. **7** and **8**. The apparatus includes a support structure **10** which is movable upwardly and downwardly to peeling off and lifting up a sheet material from a stack of sheet materials **1** and which is also movable to convey or transfer the lifted sheet material. The support structure **10** is provided with at least a pair of suction means **11** and **11***a* and a pressure means **18**. The first suction means **11** shown at the left hand portion in FIGS. **7** and **8** is supported from the support structure **10** above the left end portion **2** of the stack of the sheet materials **1** while the second suction means **11***a* shown at the right hand portion in FIGS. **7** and **8** is supported from the support structure **10** above the intermediate area of the stack between the right end **3** and the central area **4** of the stack. The pressure means **18** is mounted on the support structure between both suction means **11** and **11***a*. The suction means **11** and **11***a* comprise hollow support tubes **12**, **12***a* and suction members **13**, **13***a* mounted on the bottom ends thereof, respectively. The hollow support tubes **12** and **12***a* vertically slidably extend through vertically elongated guide tubes **14** and **14***a*, respectively, and are guided by guide members **15** and **15***a* disposed within the guide tubes. The hollow support tube **12** of the first suction

means **11** is somewhat shorter than the hollow support tube **12***a* of the second suction means **11***a*, as seen in FIG. **7.** The hollow support tubes **12** and **12***a* have stop plates **16** and **16***a* secured to the upper end portions of the support tubes, respectively. Preferably, tension springs **17** and **17***a* are provided to extend between the stop plates **16, 16***a* and the support structure **10,** respectively.

The pressure means **18** provided between the first and second suction means **11** and **11***a* comprises a tubular member **19** fixedly secured to the support structure **10,** a spring **20** mounted in the tubular member under compression and a pressure member **21** biased downwardly by the compression spring **20.** The pressure member **21** has a downwardly directed shoulder **22** adapted to be engaged by an inner shoulder **23** on the lower end of the tubular member for limiting the downward movement of the pressure member **21.**

The stop plates **16** and **16***a* are fixedly secured to the upper end portions of the hollow support tubes **12** and **12***a* at such levels that, when the first and second suction members **13** and **13***a* and the pressure member **21** are in their lifted positions shown in FIG. **8,** the first suction member **13** is at a higher level than the other and the line joining the bottom ends of the members **13, 21** and **13***a* is generally arcuate.

FIG. **8** illustrates the upper support structure in its lifted position wherein a sheet material **1a** is shown as being sucked up. The support structure, after having transferred the sheet material **1a** to another predetermined place, will be moved downwardly to suck up the next sheet material from the stack. The position of the upper support structure before the downward movement is the same as the position in FIG. **8** in which there is not the sheet material **1***a*. This position is followed by successive steps of operation which will be described hereunder.

The suction members **13** and **13***a* are moved downwardly by their hollow support tubes **12** and **12***a*. The lowermost levels of the suction members **13** and **13***a* are determined by the engagement of the stop plates **16** and **16***a* secured to the hollow support tubes **12** and **12***a* with the top ends of the guide tubes **14** and **14***a*, respectively. The pressure member **21** is always biased downwardly by the spring **20.** The level of the bottom end of the pressure member **21** is determined by the cooperation of the shoulder **22** on the pressure member **21** with the shoulder on the tubular member **19** for guiding the pressure member. In the illustrated embodiment of the invention, the arrangement is such that the suction member **13** of the first suction means **11** is disposed at the highest level and this level is followed by the bottom end of the pressure member **21** and the suction member **13***a* of the second suction means **11***a* in the mentioned order and the suction member **13,** the bottom end of the pressure member **21** and the suction member **13***a* are positioned on an arcuate line, as described hereinabove.

From the position described, the upper support structure **10** is moved downwardly so as to suck the stacked sheet materials. The lowermost second suction member **13***a* is first brought into contact with the uppermost sheet material **1***a* of the stack and is stopped while the upper support structure still continues its downward movement. This is allowed by the relative sliding movement of the hollow support tube **12***a* with respect to the guide tube **14***a*, with a result that the stop plate **16***a* is spaced from the top of the guide tube **14***a*.

The continued downward movement of the upper structure **10** then causes the bottom end of the pressure member **21** to contact the top of the stack of sheet material. The support structure further continues its downward movement to bring the first suction member **13** into contact with the top of the stack. The support structure is further moved downwardly an appropriate distance and, thereafter, is stopped. The pressure member **21** is already stopped as described above, but, this does not interfere with the downward movement of the upper support structure **10** as the pressure member **21** has a relative sliding movement with respect to the guide tube **19** in such a manner that the spring **20** is pressed between the pressure member **21** and the guide tube **19.** Similarly, the stoppage of the first suction member **13** by contact with top of the stack of sheet materials does not interfere the downward movement of the support structure **10** because the hollow support tube **12** has a relative sliding movement with respect to the guide tube **14.**

FIG. **7** illustrates a position in which, after the first suction member **13** has been brought into contact with the sheet material **1a**, the support structure **10** has been moved downwardly an appropriate distance and then stopped. In this position, the suction means **13** and **13***a* will be actuated by any conventional means such as vaccum pump or the like so as to suck the sheet material **1a.** Then, the upper support structure **10** will be moved upwardly to cause the top of the guide tube **14** to abut against the stop plate **16** with a result that the suction member **13** is moved upwardly lifting up the left end portion of the sheet material **1a** in the manner and with the advantage previously described with reference to the illustration in FIG. **5.**

The support structure **10** is further moved upwardly to cause the shoulder **23** on the guide tube **19** of the pressure member **21** to be cooperated with the shoulder **22** thereon so that the pressure member **21** is moved upwardly together with the support structure **10** in the manner and with the advantage previously discussed in connection with the illustration in FIG. **6.**

The upper support structure **10** continues its upward movement to move the suction member **11***a* upwardly for lifting up the right end of the sheet material **1***a*, with a result that the sheet material **1a** is completely peeled off the second sheet material **1b** and is lifted up by the suction members **13** and **13***a*. The upper support structure **10** is further moved upwardly until it is stopped at a predetermined level, as shown in FIG. **8.**

Thereafter, the upper support structure **10** will be moved laterally or horizontally to transfer the lifted sheet material **1a** toward another predetermined place. When the support structure **10** reaches the other predetermined place, the suction members **13** and **13***a* will be deenergized to release the sheet material **1***a* so that the same is released from the suction members **13** and **13***a* so as to be placed on the pre-determined place.

Then, a description will be made with respect to the functional advantage of the springs **17** and **17***a*. Since the suction members **13** and **13***a* are mounted for upward and downward movement by means of the hollow support tubes **12** and **12***a*, respectively, the springs **17** and **17***a* are not required by the suction members for their operation for the intended purpose. However, the suction means **11** and **11***a* would be required to be

moved downwardly solely by their gravity if the springs **17** and **17***a* were not provided. In addition, the suction members **13** and **13***a* may fail to have intimate contact with the top surface of the uppermost sheet material of the stack if the stack has a somewhat corrugated or curved top surface. The springs **17** and **17***a* assures that the suction members **13** and **13***a* are positively moved down and urged into intimate contact with the top surface of the uppermost sheet material **1***a* of the stack so that the suction members **13** and **13***a*, when energized, are operative to suck up the sheet material **1***a*.

The advantage of the spring **20** for the pressure means **18** will be discussed hereunder. After the sheet material **1**a has been sucked by the suction members **13** and **13***a*, the support structure **10** is moved upwardly to first of all lift up the suction member **13** for turning up the left end of the sheet material **1***a*, as previously described with reference to FIG. **5**. At this time, it is required that the pressure member **21** holds down the sheet material **1**a in order to assure complete separation thereof from the second sheet material **1**b until the pressure member is lifted by the upper support structure. In a case where the uppermost sheet material **1**a has a great resistance against deformation, there will be a possibility that the pressure member is lifted by the uppermost sheet material due to its resistance against deformation with a resultant decrease in the efficiency of the peeling-off operation. The spring **20** within the guide tube **19** positively enables the pressure member **21** to overcome such resistance against deformation for completely eliminate the discussed possibility so as to increase the efficiency of the peeling-off operation.

Although the present invention has been described with reference to the illustrated embodiment, it is to be understood that the invention is not limited to the illustrated embodiment and the apparatus of the invention may have any other form that is operative to turn up one end of the uppermost sheet material of a stack of sheet material from the second sheet material of the stack. For example, the upward and downward movement of the suction members can be obtained from pivotal motion of pivotally mounted levers. This is also true with the case of the pressure member.

In addition, the described embodiment has its suction members **13** and **13***a* and the bottom end of the pressure member **21** mounted on the support structure so that they are positioned on an arcuate line in order to turn up one ends of successive stacked sheet materials. This arrangement is merely employed as a means to utilize the upward movement of single upper support structure **10** and is not required if the three members **13, 13***a* and **21** are actuated by separate upwardly and downwardly driving sources. Namely, if the procedure is carried out in such a manner that the suction member **13** is first moved upwardly by its own drive source, then the pressure member **21** is moved upwardly by its own drive source and thereafter the suction member **13***a* is moved upwardly by its own drive source, the procedure results in the same operation and function as those obtainable from the described embodiment.

Preferably, more than three suction members may be used in order to assure that a sucked sheet material is levelled. In such a case, the suction members are positioned such that they are divided into a first group including the first suction member **13** and a second group including the second member **13***a*. It is most preferred that the first group includes more than one suction members disposed along one end **2** of the stack of the sheet material **1** so as to turn up successive sheet materials at this end. The limitation to the second group of suction members is not so severe as the limitation to the first group but it is preferred that the second group includes more than one suction members disposed in an appropriate area between the center line **4** of the stack of sheet materials **1** and the end **3** of the stack.

The invention is not limited to the use of a single pressure means and a plurality of such pressure means may be used.

Moreover, the stacked sheet materials have been described and illustrated as being turned up at their left ends. The arrangement of the described and illustrated components of the apparatus, however, may be so modified that the sheet materials are turned up at their right ends.

Since the apparatus of the present invention is based on the described principle, the apparatus does not require any cooperable installation and is operative to peel off and lift up only an uppermost sheet material in such a manner that the apparatus does not cause any defect such as scratch in the sheet materials. The apparatus is also capable of transferring the lifted sheet material to another predetermined place. Thus, the apparatus is suited for use with an automatic sheet feeding apparatus.

What is claimed is:

1. An apparatus for sucking up the uppermost one of a plurality of stacked sheet materials comprising at least first and second suction means each provided at the lower end thereof with a suction member, said first suction means being disposed above one end of the stacked sheet materials while said second suction means is disposed above the intermediate portion between the other end of the stacked sheet materials and the central portion of the stack, at least one pressure means for applying pressure upon said sheet material, said pressure means being disposed between said two suction means, and means for driving said suction means operative to first move said first suction means upwardly to partially lift up said pressure means by the sucked sheet material and then upwardly move said second suction means, wherein each of said suction means comprises a shaft provided at its bottom end with said suction member, said shaft being slidably extended through guide means secured to an upwardly and downwardly movable support structure and having a stop member secured to the upper end portion thereof, the shaft of said first suction means having a length smaller than that of the shaft of said second suction means.

2. An apparatus as defined in claim **1**, wherein said pressure means is positioned between said first and second suction means and is supported from said support structure, said pressure means having a projection always biased downwardly by a spring, said projection having its bottom end positioned at a level lower than the suction member of said first suction means and higher than the suction member of said second suction means when said support structure is in its lifted position.

3. An apparatus as defined in claim **1**, wherein a tension spring extends between each stop member and said support structure.

* * * * *