

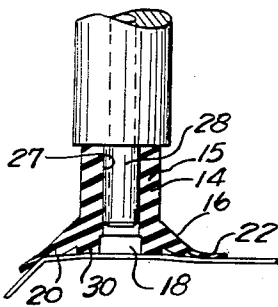
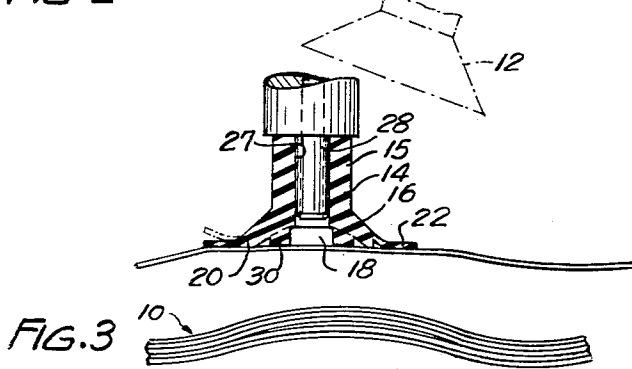
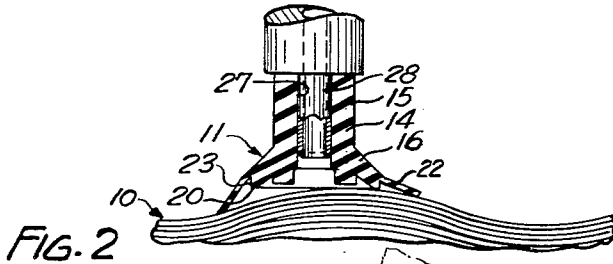
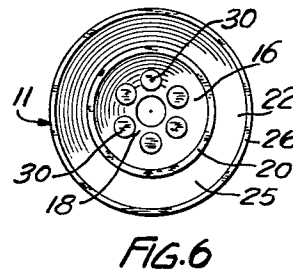
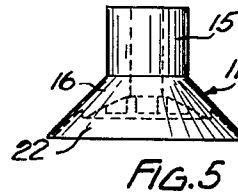
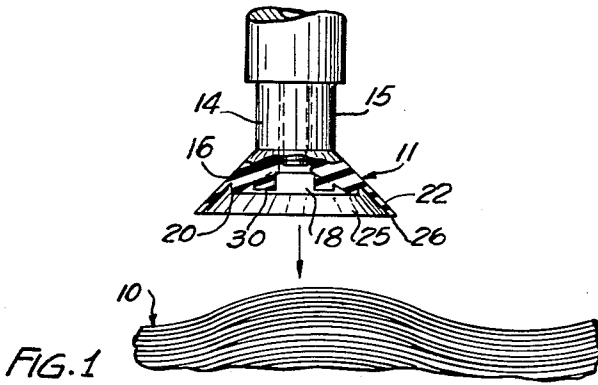
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SHEET-GRIPPING SUCKER

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SHEET-GRIPPING SUCKER

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The present invention relates to sheet-gripping suckers and, more particularly, to suckers which are adapted to take a sheet from the top of a pile and/or forward the sheet taken from the pile.

Sheet-gripping suckers are commonly utilized in sheet feeding and handling apparatus where cardboard and paper sheets are being fed or handled. Such suckers have a suction mouth which engages the sheet to be handled and have means for applying a vacuum thereto to effect a gripping of the sheet to be handled.

Sheet feeders commonly use such suckers to grip the top sheet of a pile to lift the sheet from the pile and forward it to a sheet handling machine. In certain conventional types of feeders, the sheet is picked up from the top of a pile by a pick-up sucker and is then transferred to a forwarding sucker which moves the sheet toward the sheet handling machine.

The suckers which have proved most satisfactory in feeders and other sheet handling machines have been rubber suckers or suckers made of similar resiliently flexible material. A rubber or resilient flexible sucker has the advantage of being able to conform to a sheet which is not lying in a single plane at the spot it is engaged by the sucker, or to a sheet which is lying in a single plane but which is angularly disposed to the mouth of the sucker. The top of a sheet pile often does not lie in a single plane and may be wavy, often due to the effect of moisture and humidity on the pile edges. Moreover, the sucker may be used to take a sheet held by another sucker and in a plane angularly disposed to the sucker. Rigid sucker materials, such as metal, cannot conform to the contour of such sheets. Moreover, if a portion of a gripped sheet is moved away from the sucker mouth, a resiliently flexible sucker may yield to reestablish contact between the sucker and the sheet. In the case of a rigid sucker, such as a metal sucker, contact cannot be re-established.

In view of the problems involved in making a rigid sucker conform to a sheet which is not lying in a plane or which is in a plane not square with the sucker, metal suckers have been provided with rubber skirts which engage the sheet to be handled and which perform the primary holding function of the sucker. In the absence of such a skirt, the metal sucker has little holding power and is not satisfactory for use. Consequently, in effect, the metal sucker is converted to a sucker formed of resilient or flexible material. In converted metal suckers the rubber skirts have been formed by flat rubber washers which are forced over the metal sucker and these washers occasionally have a tendency to turn on themselves to extend inwardly from the sucker mouth rather than outwardly to form a skirt.

One problem with converted metal suckers and suckers made entirely of resiliently flexible material is that the paper and the cardboard handled by the suckers is highly abrasive and the material of the suckers will wear quickly resulting in a short life for suckers when used in sheet handling equipment making it necessary to constantly replace the suckers. In order to obtain the longest possible life, the suckers are made as heavy as is consistent with their function of picking up and feeding a sheet. However, it will be realized that the flexibility of the

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sheet-gripping sucker and its ability to conform is dependent, at least in part, upon the thickness of the material forming the sucker and, as a result, a compromise has had to be effected between the need for a longer life and the need for flexibility, since the sucker must be sufficiently flexible to conform to sheets being taken.

Another problem involved in handling sheets with a sheet-gripping sucker is that creasing or bending of the sheet at the sucker will tend to break the seal. In picking up the sheet, it is advantageous to have a wide sucker mouth to provide a large gripping area to effect a gripping of the sheet and a picking up of the sheet with the sucker. After the sheet has been picked up and gripped by the sucker, it is not necessary that the gripping area of the sucker be as large as when initially taking the sheet and, in fact, a large gripping area after the sheet is taken means that the sheet is more likely to be lost by a bending of the sheet which causes the breaking of the seal between the sucker and the sheet. Accordingly, at this time, it is desirable that the gripping area be the minimum which is consistent with the force necessary to hold and possibly advance the sheet.

Another problem, which occurs when the mouth of the sucker is made extremely flexible so as to facilitate the conforming of the sucker to sheets which do not lie in a plane or which are disposed angularly with respect to the sucker, is that the thin skirt of the sucker forming the suction mouth readily doubles upon itself if the sucker is advanced to forward the sheet. The sheet will have inertia which must be overcome and the initial forward movement of the sucker will cause the sucker to double on its thin skirt and perhaps break the seal between the skirt and the sheet. Consequently, problems are involved when a thin-skirted sucker is used to advance a sheet.

A principal object of the present invention is to provide a new and improved sheet-gripping sucker which has a thin resiliently flexible skirt that forms a first suction mouth for initially gripping and taking a sheet to be handled and a second suction mouth distinct from the first mouth and formed by a heavier portion which takes the bulk of the wear and any distorting forces acting on the sucker during the use of the sucker in picking up and handling sheets.

Another object of the present invention is to provide a new and improved sheet-gripping sucker molded of resiliently flexible material and having a heavy portion forming a suction mouth which is adapted to grip and hold the sheet and a thin flexible portion extending from the body to define a larger suction mouth readily adapted to conform to the sheet and which effects the initial gripping of the sheet and then releases when the first-mentioned suction mouth takes the sheet.

In accordance with the present invention, a molded sucker is provided which has a body of relatively heavy resiliently flexible material forming an inner suction mouth and an integrally molded skirt of very flexible material which extends outwardly from the suction mouth, with the skirt defining a second distinct outer, wide suction mouth which is adapted to initially engage the sheet and which will readily conform to sheets which are not lying in a plane or which are angularly disposed to the plane of the suction mouth to facilitate an initial gripping and taking of the sheet by the sucker. After the sheet has been gripped by the wide, relatively flexible mouth, the sheet will be moved, by the vacuum applied to the sucker, into engagement with the smaller relatively rigid mouth and securely held thereby and the flexible wider mouth normally will lose its grip on the sheet. To facili-

tate this latter action, the sucker is formed so that the inner mouth has a rim forming a seat which engages the sheet and is disposed in a plane parallel to the plane of the sheet. In the preferred embodiment, the flexible skirt forming the wider mouth joins the body forming the smaller mouth at a line of juncture inwardly from the edge of the body defining the smaller mouth on the external side of the body so that there is an abutment or shoulder between the line of juncture of the skirt and the rim or seat of the smaller suction mouth. The release of the wider suction mouth upon the gripping of the smaller suction mouth minimizes the danger that the sheet will be lost by bending which effects a breaking of the vacuum in the sucker and the sucker will not double on the skirt if it is advanced to advance the sheet.

In addition to the above advantages, experience has shown that a sucker constructed as above described will have a life of as great as five times that of a sucker constructed in the conventional manner. Analyses of experimental suckers show that when the sucker is constructed as described, practically all of the wear of the sucker is concentrated at the heavier smaller mouth and that the thin flexible skirt will have a long life. Consequently, the present invention provides a molded sucker having a thin flexible skirt which is adapted to conform to the configuration of sheets being handled, but yet will have a long life. The long life of the thin flexible skirt appears to be produced because of the fact that the larger mouth defined by the thin skirt releases its hold on the paper when the smaller, more rigid suction mouth grips the sheet and, consequently, any relative movement between the sucker and the sheet does not effect a wearing of the relatively thin flexible skirt but wears primarily at the heavier, smaller suction mouth of the sucker.

Further objects and advantages of the present invention will be apparent from the following detailed description of the preferred embodiment thereof made with reference to the accompanying drawings, in which:

FIG. 1 shows a sucker constructed in accordance with the present invention being utilized in apparatus for taking sheets from the top of an irregular pile with parts of the sucker being cut away;

FIG. 2 illustrates the engagement of the sucker of FIG. 1 with the top of the pile;

FIG. 3 shows the sucker of FIG. 1 after it has taken a sheet from the top of the pile and lifted the same;

FIG. 4 is illustrative of a condition which might be encountered after the sucker takes the sheet;

FIG. 5 is an elevational view of the sucker shown in FIG. 1; and

FIG. 6 is a bottom plan view of the sucker shown in FIG. 5.

Referring to the drawings, FIG. 1 shows a sucker 11 which in the embodiment of FIG. 1 is used to take the top sheet from a pile of sheets 10. The sucker when so used may be a part of conventional sheet feeding mechanism. It will be understood that there are usually two sheet pick-up suckers in conventional sheet feeding mechanisms and that the pick-up suckers 11 may take the sheet from the top of the pile and transfer it to forwarding means including a forwarding sucker 12, shown in dotted lines in FIG. 3, commonly used to advance the sheet, or the pick-up sucker may also do the advancing of the sheet after it is taken from the pile. The forwarding sucker 12 may be a duplicate of the sucker 11. When the pick-up suckers transfer the sheet to forwarding suckers, the axes of the forwarding suckers will generally be disposed at an angle to the plane of the sheet such as illustrated by the position of sucker 12 in FIG. 3.

The top of the pile 10 is shown as having waves or variations therein as is often the case with piles of paper or cardboard sheets. Piles of paper or cardboard sheets are affected by humidity and moisture and the illustrated wavy condition often results. A sucker 11 must, therefore, if it is to be capable for use as either a pick-up sucker

or as a forwarding sucker be capable of conforming to the surface of a sheet which does not lie in a plane as well as to a sheet which lies in a plane that is not perpendicular to the axis of the sucker.

In accordance with the present invention, the sheet-gripping sucker 11 is integrally molded from a resiliently flexible material, such as rubber or polyurethane, and has a body 14 which comprises a stem or tubular portion 15 and a frusto-conical suction head 16 at one end of the tubular portion 15, the lower end as the sucker is viewed in FIG. 1. The head 16, in the illustrated embodiment, is circular in cross section and the underside thereof is disc-shaped or concave to provide a suction mouth 18 which is concentric with the axis of the stem 15 and which has a circular peripheral sealing edge or rim 20 provided by an annular surface concentric with the axis of the stem and being in a plane perpendicular to the axis. The rim or edge 20 will seat against the sheet being handled to form an air seal.

The head 16 also has, as an integral part thereof, a thin flexible skirt 22, which extends from a line of juncture with the head 16 which is disposed inwardly of the head from the sealing edge 20 so as to provide a shoulder 23 extending inwardly of the sucker between the sealing edge 20 and the line of juncture of the skirt 22 and forming a groove in the sucker extending around the edge 20. The skirt 22 extends outwardly from the head 16 to form a continuation of the frusto-conical configuration of the head and to define a second circular suction mouth 25 concentric with the axis of the stem 15 and of larger diameter than the suction mouth defined by the circular edge 20, the suction mouth 18 being disposed within the suction mouth 25 defined by the skirt and located inwardly of the plane of the outer edge 26 of the suction mouth 25.

The body 14 has a central passageway 27 therethrough which is coaxial with the stem 15 and the head 16 and which opens into the underside of the head 16 so that vacuum can be established in the suction mouths 18, 25 through the passageway 27. The passageway 27 receives a tube 28 which is connected to a source of vacuum and which is reciprocated and translated in a conventional manner to effect the desired movements of the sucker.

When the sucker is displaced from a sheet, the parts of the sucker will have the relative positions illustrated in FIG. 1. When the tube 28 is moved down to move the sucker into engagement with the top sheet on the pile 10, the skirt 22 will first engage the top sheet of the pile and will readily conform to the sheet even though the sheet is wavy at this point or is disposed in a plane that is not perpendicular to the axis of the sucker, or both. Vacuum is applied as the sucker is moved into engagement with the top sheet of the pile, and a seal will be effected which will make the sucker effective to lift the sheet as the tube 28 is moved upwardly to retract the sucker. When the skirt 22 grips the sheet and effects a taking of the sheet, the sheet will be pulled upwardly by the vacuum to be gripped by the suction mouth 18 as is shown in FIG. 3. The sealing edge 20 seals and effects a seal for the applied vacuum and the skirt 22 will actually lose its grip on the sheet, since sheet material is ordinarily porous, and the skirt can be moved, as indicated in dotted lines in FIG. 3, without breaking the vacuum in the sucker and the grip of the mouth 18. When the sucker is a double-acting sucker which reverses movement when the sucker seals on a sheet, the reversal will occur when the skirt 22 seals, thus preventing pounding of the pile by the heavy portion of the sucker on the downward stroke. Such pounding causes air to be squeezed out from between the sheets and often results in picking up two sheets, which ultimately results in a press trip-off when the sucker is part of a feeder for a press. The proper operation of the sucker appears to require two distinct suction mouths as provided by the shoulder 23 which is actually part of a groove in the sucker ad-

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jacent the edge 20. In other words, if the skirt merely formed a continuation of the inside surface of the suction mouth 18, the sucker would not function in the same manner. It appears that without distinct mouths, the skirt 22 would not release after transfer of the sheet to the suction mouth 18, at least not to the extent that the outer portion of the skirt could be raised without affecting the grip in the sheet. Consequently, it appears that it is necessary for the proper operation of the sucker to have the shoulder 23.

In view of the fact that the thin skirt 22 effects a release of the sheet, the sucker 11 can also be used as a forwarding sucker without danger of the skirt 22 doubling over as the sucker is advanced, which would allow the head proper to move over the skirt and perhaps to break the vacuum. This is common in conventional suckers if the skirt is made too thin. Tests have shown that the skirt 22 in the described sucker will not be particularly subject to wear because of the abrasive nature of paper and cardboard and that the wear will occur on the heavier portion of the body at the peripheral edge 20. Since the head of the sucker forming the suction mouth 18 and peripheral edge 20 does not have to be sufficiently flexible to conform to the configuration of the sheet or the plane of the sheet when it is not perpendicular to the axis of the sucker, this part of the head is preferably made relatively heavy so that considerable wear may occur before it is necessary to discard the sucker. Additionally, the heavier construction of the body and suction mouth 18 causes the suckers to resist flexing due to normal forces exerted in the direction of the plane of the sealing edge 20. Such forces are caused, for example, by sheet inertia when forwarding the sheets, or by the transverse stretching of a sheet along its rear edge when the lifting suckers transfer the sheet to the forwarding suckers. It appears that the wear occurs at the suction mouth 18 because of the probability that the skirt 22 releases its grip on the sheet so that if movement occurs between the sucker 11 and the sheet when the sheet is gripped, the skirt 22 is not in gripping relationship with the sheet so that the movement does not take place under a condition where the skirt and sheet are being pressed together.

In accordance with the preferred embodiment, the underside of the head 16 is provided with a plurality of circular projections 30 which are arranged in circularly spaced relationship around the opening of the passageway 27 into the suction mouth 18. The projections preferably extend slightly short of the peripheral edge 20 of the suction mouth 18 and form stops to prevent the sheet from being distorted too greatly by being drawn upwardly into the opening of the passageway 27 into the underside of the head 16.

It will also be noted that when the skirt 22 releases, the area of the sheet gripped by the sucker is reduced. Once the sheet is taken, it is not necessary to have as large an area as is desirable when initially taking the sheet. The reduction in area of the sucker mouth has the advantage that it provides less area where bending of the sheet at the suction mouth might break the vacuum. For example, as shown in FIG. 4, if bending of the sheet occurs after the suction mouth 18 has gripped the sheet, it will have no effect if it occurs in the area of the skirt since the skirt 22 is not gripping. Attention is directed to the fact that when the suction mouth 18 takes the sheet, the vacuum source is effectively disconnected from the suction mouth 25 defined by the skirt 22 and the vacuum in the suction mouth 18 does not, therefore, depend upon the maintaining of vacuum under the skirt 22. If, however, the skirt 22 had maintained its grip on the sheet, the suction would be broken and the sheet would be dropped. A further advantage of the described sucker is that if the suction mouth 18 loses its grip, the skirt 22 will tend to regrip the sucker and may prevent the losing of the sheet where it would otherwise occur.

It can now be seen that the present invention has pro-

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vided a new and improved sucker which provides a secure grip on the sheet and which is readily conformable to any configuration or plane of the sheet being taken, but, yet, will have a life many times greater than any of the known suckers and will have sufficient body to properly function as a forwarding sucker.

The preferred embodiment of the present invention has been described in considerable detail but it is hereby our intention to cover all constructions, arrangements, and modifications which fall within the ability of those skilled in the art and within the scope and spirit of the present invention.

Having described our invention, we claim:

1. In a sheet separating apparatus including a movable sucker for gripping and handling a sheet of paper-like material with the sucker being subjected to forces acting laterally on the sucker during the handling operation, said sucker comprising a body having a portion defining an inner suction mouth facing outwardly from said body and having a sheet-gripping rim which lies in a first plane, said inner mouth being constructed to have substantial resistance to flexing due to forces exerted along said plane during the handling of said sheet by said sucker, a second portion on said body defining an outer outwardly facing suction mouth of larger diameter than the first mouth, said outer mouth having a sheet-gripping rim in a plane parallel to and offset from said first plane outwardly from said body beyond the rim of said inner mouth, means for placing a vacuum source in communication with said inner mouth through said body and to said outer mouth through said inner mouth whereby vacuum is supplied solely to said inner mouth when the rim thereof seals onto a sheet causing said outer mouth to release its grip on said sheet, said outer mouth comprising a thin resiliently flexible skirt readily conformable with the sheet contacted thereby and collapsible to lie in the first plane upon application of a vacuum to said mouths, said inner mouth being formed of substantially heavier material than said outer mouth.

2. In a sheet separating apparatus including a sucker for gripping and handling a sheet of paper-like material with the sucker being subjected to forces acting laterally on the sucker and between the sucker and sheet during handling, said sucker comprising a body having a portion defining an inner suction mouth facing outwardly from said body and having a sheet-gripping rim which lies in a first plane, said inner mouth being constructed to have substantial resistance to flexing due to normal forces exerted along said plane during the handling of said sheet by said sucker, a second portion on said body defining an outer outwardly facing suction mouth of larger diameter than the first mouth disposed about said inner mouth, said outer mouth having a sheet-gripping rim in a plane parallel to and offset from said first plane outwardly from the body beyond said first plane, means for placing a vacuum source in communication with said inner mouth through said body and to said outer mouth through said inner mouth whereby vacuum is supplied solely to said inner mouth when the rim thereof seals onto a sheet causing said outer mouth to release its grip on said sheet, said outer mouth comprising a thin resiliently flexible skirt easily conformable with the sheet contacted thereby and collapsible to lie in the first plane upon application of a vacuum to said mouths and said inner mouth being comprised of material substantially heavier than said outer mouth, said sucker having an annular groove adjacent the outer edge of the rim of the inner mouth extending around the latter and providing a distinct separation of said mouths.

3. The method of handling a sheet comprising engaging the sheet with a sucker having a first suction mouth formed by a thin resiliently flexible material through a second suction mouth of heavier material than said first suction mouth, establishing a vacuum in said second suction mouth by drawing air from the first suction mouth through

the second suction mouth to cause said first suction mouth to grip the sheet, to distort, and to move the sheet into engagement with the second suction mouth to seal against the second suction mouth and break the vacuum being drawn on the first suction mouth to effect a release of the latter, and re-establishing the vacuum in the first suction mouth in the event the seal is broken in the second suction mouth during the handling of the sheet.

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