Nov. 23, 1965 EIICHI HORI ETAL 3,219,340

APPARATUS FOR SEPARATING AND CONVEYING CARDS OR THE LIKE BY MEANS OF AN AIR STREAM

Filed Sept. 5, 1962 2 Sheets-Sheet 1

Fig. 1

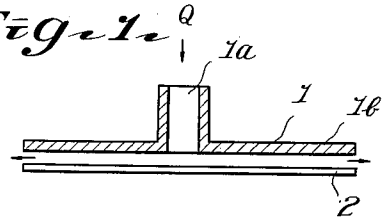

Fig. 2

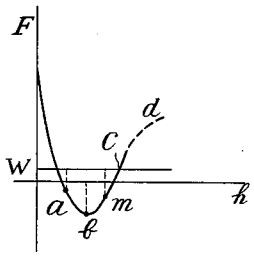

Fig. 3

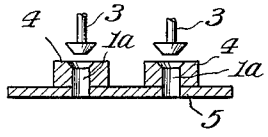

Fig. 4

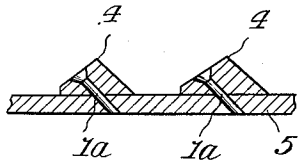

Fig. 5

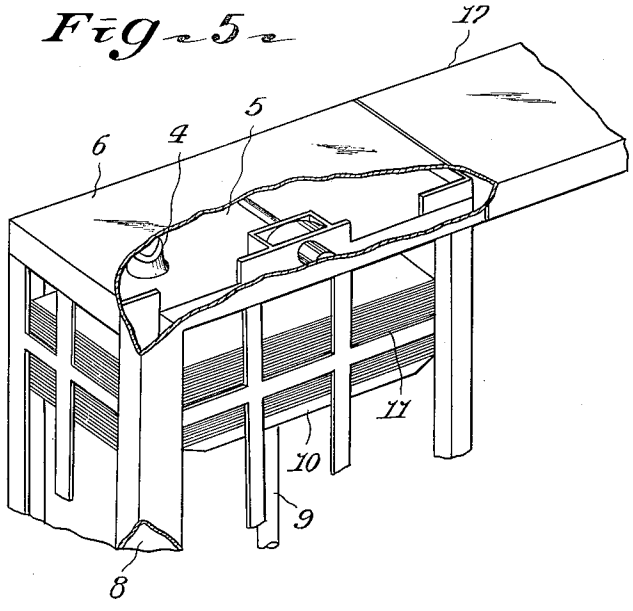

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Fig. 6

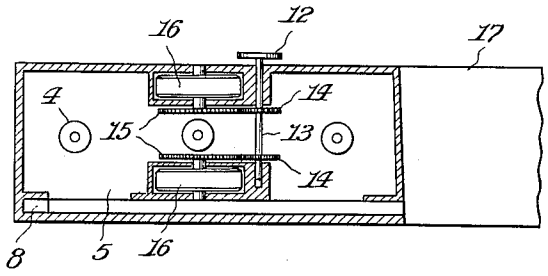
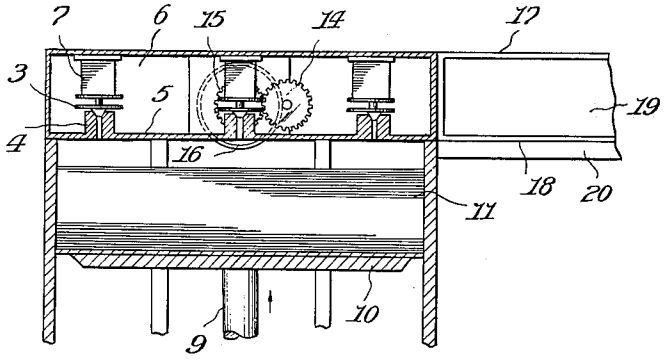


Fig. 7



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APPARATUS FOR SEPARATING AND CONVEYING CARDS OR THE LIKE BY MEANS OF AN AIR STREAM

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2 Claims. (Cl. 271—11)

This invention relates to an apparatus for handling cards, and more particularly it concerns an apparatus in which cards or the like to be handled are separted and conveyed by means of an air stream.

In business machines, for instance, it is often required to pick up, one by one, a considerable number of cards which have piled up and to convey them at high speed into various machines or apparatuses such as those for sorting, reading, typewriting, etc. Among the conventional systems which have been proposed for such requirements, there is a vacuum suction pickup type, but the maximum handling speed obtainable in this type has not exceeded 2000 sheets per minute.

It is an object of the present invention to provide an apparatus which is entirely free from the ideas heretofore prevailing and is absolutely new and unique, whereby cards or the like may be handled at a great speed.

More specifically, it is an object of this invention to provide an apparatus for separating and conveying cards by means of an air stream, which comprises means for separating each card from its group by utilizing the low positive pressure due to the jet stream of air caused to be ejected over the cards perpendicularly or with an appropriate angle.

The nature and details of the invention, as well as the manner in which the foregoing objects thereof may best be achieved, will now be described in detail, with reference to the accompanying illustrations in which like parts are designated by like reference numerals, and in which:

FIG. 1 is an elevational view, in section, showing an air jet nozzle and a thin flate plate disposed in the vicinity thereof;

FIG. 2 is a characteristic curve showing the relation between the force acting on a card and the gap between the parts in the state shown in FIG. 1;

FIGS. 3 and 4 are elevational views, in section, showing embodiments of jet nozzles according to the invention;

FIG. 5 is a fragmentary perspective view showing an embodiment of the apparatus according to the present invention;

FIG. 6 is a plan view, partly in section, showing a horizontal section of the apparatus shown in FIG. 5; and

FIG. 7 is a side elevational view showing a vertical section of the apparatus shown in FIG. 5.

In general, when a jet of air is impinged, from a jet nozzle 1_a provided near the center of a flange **1** having an appropriate size, against a thin flat plate **2** previously arranged in parallel with the flange **1** of said jet nozzle 1_a, it is well known that an external force will act on the thin plate **2** to urge it toward the surface of the flange **1** if such factors as the dimensions of the said jet nozzle 1_a and the flange and the volumetric rate of air flow Q satisfy certain conditions. Now, denoting the gap between the opposed surfaces of the flange **1** and thin plate **2** by *h*, the magnitude of external force by F, defining the direction from the side of jet nozzle 1_a to the side of the thin plate **2** as being positive, and denoting the weight of the plate **2** itself by W, the relation between the external force F and the gap length *h* may be represented by a curve as shown in FIG. 2.

By appropriately determining the various factors such as the rate of air flow Q, etc., it is possible to establish the points where the suction force on the thin plate **2** toward the flange surface 1_b is in a state of equilibrium with the weight W of the thin plate **2**, these points being shown as *a* and *m* respectively in the FIG. 2. Now, by setting said conditions other than gap length *h* so that said point may exist on the curve, ejecting an air stream from the jet nozzle 1_a which is perpendicular to the flange surface 1_b, and causing the thin plate **2** to approach gradually the flange surface 1_b, vertically from below, the state of affairs will be shifted in the order *d-c-m-b-a-*. In this case, after passing the point *m* where the weight of thin plate **2** and the force acting on said plate **2** and flange **1** is balanced, the thin plate **2** is attracted towards the flange surface 1_b with a force $(F+w)$ and is again balanced at the point *a* in the same figure where $W+F=0$.

As will be clear from the above description, during the interval between the points *m—b*, the available force tending to displace hte thin plate **2** toward the flange surface 1_b starts from 0 and increases to its maximum at *b* and balances again at point *a*. When the gap between the flange surface 1_b and the thin plate **2** is further decreased from point *a*, a positive force acts on the thin plate **2**, tending to return the parts to the condition of the point *a*. When the gap *h* between the flange surface 1_b and thin plate **2** tends to increase beyond the point *a* on the curve shown in FIG. 2, the force directed toward the flange surface acts on the thin plate **2**, as is obvious from the same figure. It follows that the thin plate is in a stable condition without contacting with flange surface if it is in the condition of the points shown in FIG. 2.

The present invention, which is based on this principle described above, will now be explained in detail with reference to the accompanying drawings.

In FIG. 3 which shows the essential parts of the separating means of the present invention, one valve mechanism or a plurality of valve mechanisms each of which comprises a valve **3** and valve seat **4** are provided on a flat plate **5**. The valves are operated electrically or mechanically to pass and shut off the air current flowing to the underside of the flange surface 1_b through the jet nozzle 1_a. The thin plate **5**, which is equipped with this valve mechanism, is installed at an air chamber **6** to which air is introduced through a duct **8** as shown in FIG. 5 from an air source such as a blower. As shown in FIGS. 6 and 7, the cards **11** to be handled are piled up on a platform **10** supported by a bar **9**, while a magnet coil **7** connected with a detector for detecting the uppermost position of said cards and a group of rollers **16** are provided at a part of the aforesaid air chamber **6**. Said rollers **16** are diven by power transmitted from a power source (not shown), through a speed control mechanism (also not shown) and gear **12**, then through a shaft **13** and gears **14** and **15**. Further, the said separator is provided at one side thereof with a duct, which is formed by an air chamber **19**, in which a plate **18** constitutes one surface thereof and is arranged in the same horizontal plane with plate **5** having the jet nozzle 1_a, and by side plates **20** secured on both sides of the said duct. The air admitted into said air chamber **19** is also supplied from the air source in the same manner as that of said separator. Thus, when the bar **9** starts to rise, driven through the speed control mechanism by appropriate power, the cards stacked on the platform **10** also rise gradually, and when their uppermost surface reaches to a predetermined height relative to the plate **5**, the valve **3** is raised from its seat **4** by the operation of the magnet coil **7** and the power source of the rollers **16**, and a jet stream from the jet nozzle **1**, passing through the valve seat **4** and the plate **5** from the air chamber, is produced and impinges upon the uppermost surface of the cards. At this moment,

the card situated on the top of the cards **11** is immediately separated and lifted according to the afore-stated principle and contacts the peripheral surface of the roller mounted under the lower surface of the plate **5** at a predetermined distance. As said rollers **16** are rotated to shift the card coming into contact therewith in the horizontal direction by the torque transmitted through the speed control mechanism from the power source, the card contacted is detached from the undersurface of the plate **5**, and is directed towards the duct **17**. In this manner, the cards, which have been stacked up, are sucked up and delivered sheet by sheet, and the final operation for the last card is detected by a separately provided detector, whereupon the bar **9** is lowered immediately, and at the same time, the operation of the magnet coils **7** is stopped, whereby the valve **3** is caused to resume its original state, thereby cutting off the jet stream. Simultaneously, the rotation of rollers **16** is stopped. The card feeder with the bar **9**, is one embodiment of the present invention, and the cutting-off of the jet stream and stopping of the rotation of rollers are not always necessary if other continuous card feeders are employed.

The speed of rotation of the rollers **16** and the elevating velocity of the bar **9** for lifting the cards are interconnected with the upper limit controller and are automatically controlled so as to maintain the height of the top surface of the cards always constant.

Although in the foregoing description, the angle between the horizontal plane of the plate **5** and the central axis of the jet nozzle 1_a is assumed to be a right angle, it is possible also to adopt any suitable angle between the central axis of the jet nozzle 1_a and the plate **5**. In this case, the jet stream has the action of maintaining the card at a constant gap from the plate **18** and the action of providing the card with a velocity component in the direction of travel, so that the velocity of the card can be adjusted if the conditions of the jet current and the nozzle angle of the jet nozzles are suitably determined.

As is clear from the above description, the characteristic of the present invention is that, instead of using suction for separating the cards in apparatuses of this kind conventionally employed, the apparatus according to the present invention obtains the same effect by means of a stream of jet air ejecting against the card. Consequently, according to the invention, separating and conveying of cards may be performed consistently by air current with almost no contact of the cards with the solid surfaces of the apparatus. Accordingly, fewer moving parts than in the conventional apparatus are required, and the apparatus is simple in construction and reliable in its action of separating and conveying because of its principle and has high speed of operation. Thus, the appparatus according to the present invention has substantial worth in industrial applications.

Although this invention has been described with respect to a few embodiments thereof, it is not to be so limited as changes and modifications may be made therein which are within the full intended scope of the invention, as defined by the appended claim.

What is claimed is:

1. A device for separating and conveying cards from a stack of piled cards which comprises, in combination, a flat plate opposite the uppermost surface of said stack; a nozzle for ejecting and directing an air stream toward said uppermost surface, penetrating said flat plate; and rollers disposed on said flat plate and facing the upper surface of said stack, said rollers being adapted to contact a card separated from said stack due to low positive pressure created by the air stream ejected from said nozzle and to rotate simultaneously so as to transfer the lifted card in a horizontal direction.

2. A device for separating and conveying cards from a stack of piled cards which comprises, in combination, a flat plate opposite the uppermost surface of said stack; a nozzle which opens through a portion of said flat plate for ejecting and directing an air stream toward said uppermost surface; and rollers disposed on said flat plate and facing the upper surface of said stack, said rollers being adapted to contact a card separated from said stack due to positive low pressure created by the air stream ejected from said nozzle and to rotate simultaneously to convey the lifted card in a horizontal direction.

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