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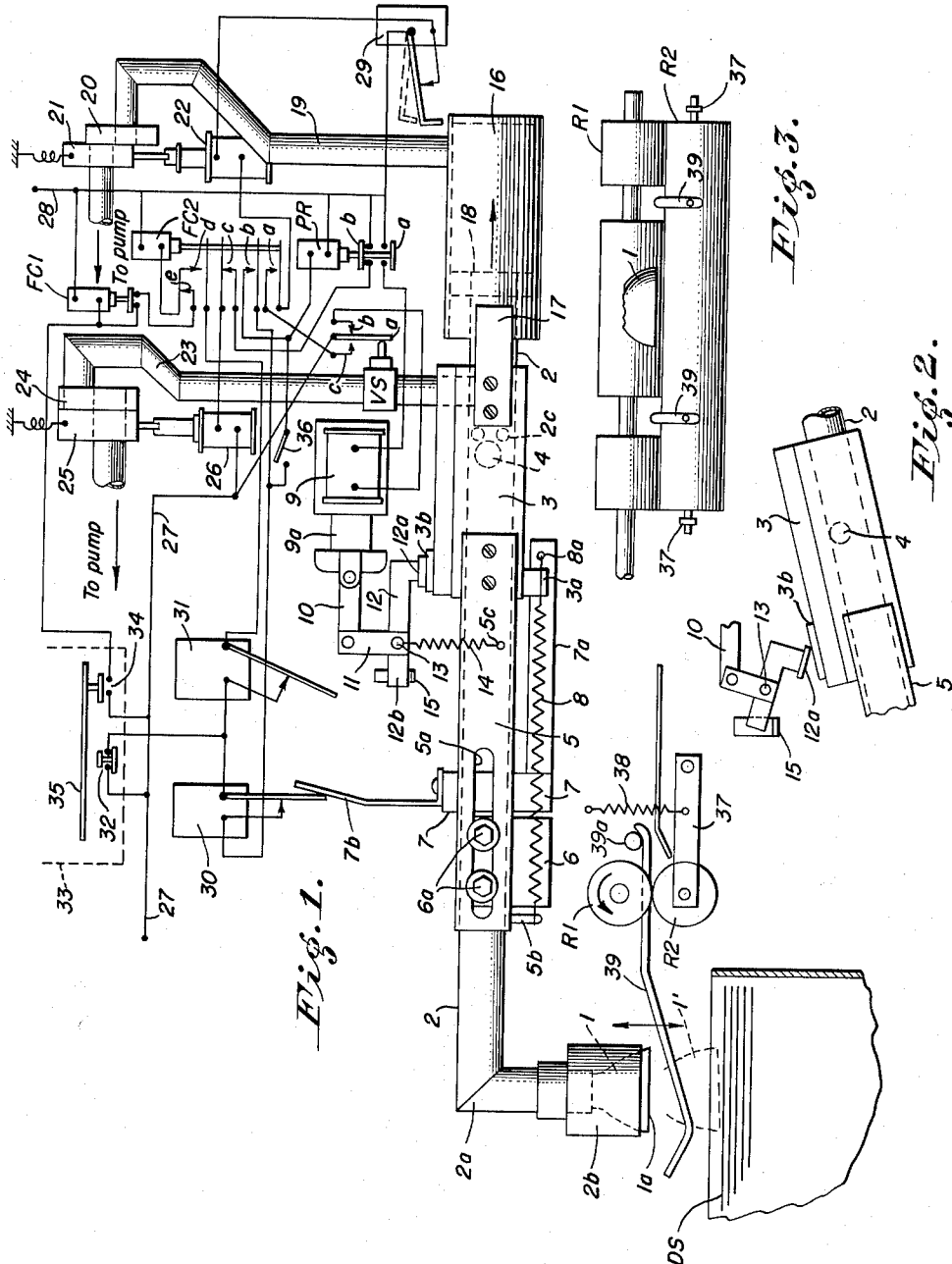
R. L. SWARTZ ETAL

3,201,114

DOCUMENT FEEDER AND CONTROL SYSTEM

Filed May 11, 1961

2 Sheets-Sheet 1



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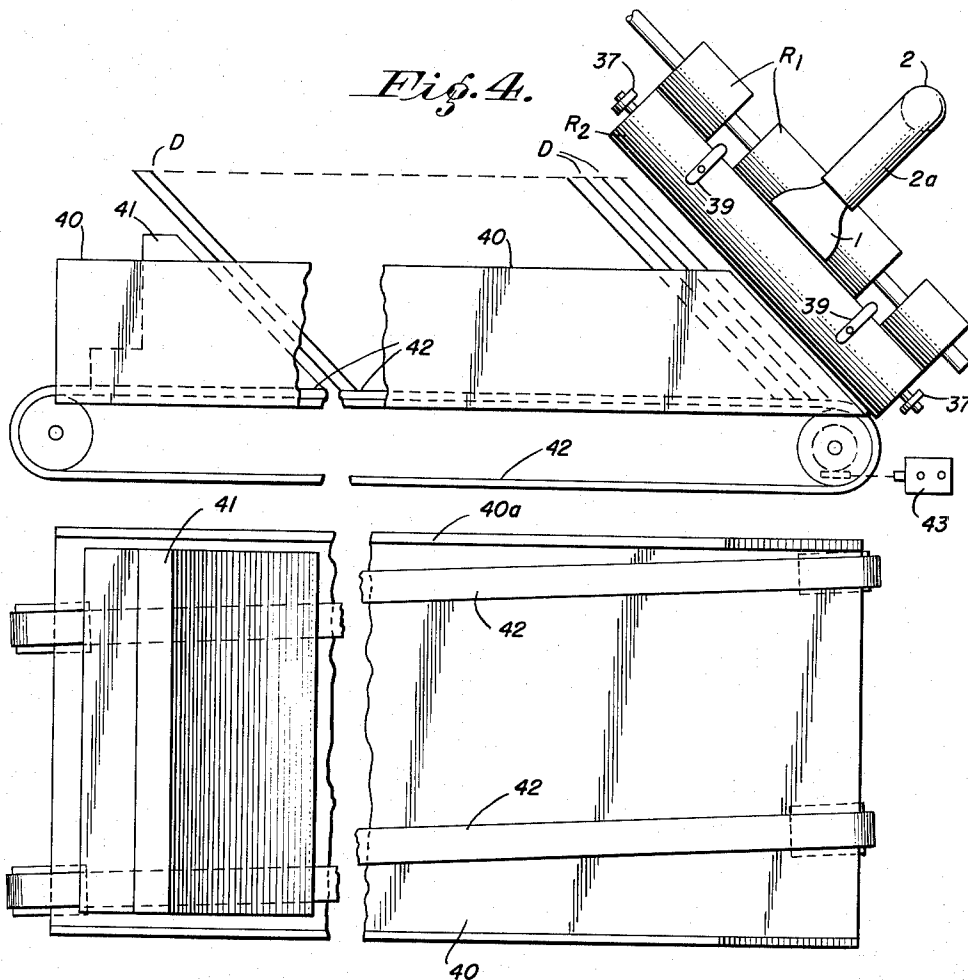
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DOCUMENT FEEDER AND CONTROL SYSTEM
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This invention relates to a device or machine for feeding documents, one at a time, from a stack of documents to a location adjacent the stack where they are delivered for further use.

The term "documents" as used herein refers to sheet-like articles generally, such as checks, vouchers, receipts, paper money, and the like, including envelopes which may contain sheet material. Our invention is especially useful for sorting mail.

While not limited to such use, this invention is especially useful in document sorting machines of the type disclosed in U.S. Letters Patent 2,707,569 issued to LeRoy J. Benson, and in our copending application Serial No. 686,745, filed September 27, 1957, now Patent No. 2,984,481. Machines of this type include a bin for receiving a stack of documents to be sorted, the stack being supported upon a vertically movable bottom or platform in the bin, a feeding device for removing the top document from the stack and feeding the document to a conveying guideway adjacent the stack, a keyboard arranged adjacent the stack and having a number of key-controlled devices for selecting and operating any one of a number of tiltable gates arranged at spaced stations along the length of the guideway and for simultaneously operating the feed device to move the uppermost document into the conveying guideway. As the document is conveyed along the guideway and reaches the selected station, the tilted gate at the selected station will deflect the document downward into a suitable storage bin.

Our present invention is also useful in sorting machines where the documents or sheet-like articles are supported on one edge in a horizontal stack within a supply receptacle which is provided in the bottom wall thereof with conveyor belts or chains. Examples of such horizontal stack arrangements provided with endless conveyor belts or chains in the bottom wall thereof are shown in U.S. Patents to Cadden 1,442,126 and Davidson 2,089,946. The present invention embodies improvements over these prior arrangements.

The present invention is concerned with the arrangement for feeding the documents from the top of the stack or the face of the stack, into the delivery guideway and involves improvements over the arrangement disclosed in our copending application Serial No. 686,745, filed September 27, 1957, now Patent No. 2,984,481.

The feeding arrangement of this invention involves the use of a suction cup or nozzle for picking up the face document (the document at the top of the stack) and transferring it to a delivery station adjacent the stack.

An object of the invention is to improve the arrangement for mounting and operating the suction cup.

Another object is to provide simple and effective means for preventing two or more documents from being fed or removed from the top of the stack during any one operating cycle.

Another object is to devise an improved stack conveyor arrangement for feeding a horizontal stack of documents to the pick-up position of the suction cup and to insure proper alignment of the leading edges of the documents at the pick-up station.

Still another object is to devise a novel control system for effecting operation of the different elements of the feeder in proper sequence in each operating cycle.

A preferred embodiment of the document feeder and its

control system is described herein in connection with the accompanying drawings in which:

FIGURE 1 is a side elevational view of the feeder in diagrammatic representation, as applied to the feeding of documents from a vertical stack, together with a diagrammatic showing of the control system;

FIGURE 2 is a fragmentary view of part of FIGURE 1 showing the suction cup mounting depressed into the pick-up position;

FIGURE 3 is an end view of some of the elements shown in FIGURE 1 as seen from the left side of FIGURE 1;

FIGURE 4 is a view similar to FIGURE 3 but showing the feeder adapted to feed documents from a horizontal stack of documents; and,

FIGURE 5 is a plan view of the supply receptacle and conveyor for the arrangement shown in FIGURE 4.

In the embodiment illustrated in the drawing, a suction cup 1 is supported at the end of a supporting stem in the form of a suction tube 2 which is arranged to slide lengthwise in a bore formed in a bearing block 3, the cup 1 being supported on the lower end of tube section 2a arranged at right angles to the main section 2 as shown in the drawing. The cup supporting stem, tube 2, is normally held in a horizontal position with its axis parallel to the direction in which documents are to be removed from the stack DS. As shown, the cup 1 normally is held in an elevated position above the top of the stack and with the plane of its mouth at the proper elevation to pass between two feed rollers R1 and R2 at the entrance to a delivery trackway located at the right side of the stack.

The bearing block 3 is mounted on a fixed support to be tilted about a transverse axis 4 to shift the suction cup 1 from its normal position shown in solid lines, to the pick-up position 1' shown in dotted lines, where it engages the top of the stack DS. Pick-up cup 1 is made of flexible material, such as rubber, or plastic material, and it may be surrounded by a protective casing in the form of a rigid shell 2b supported from tube section 2a, the mouth of the cup extending below the shell as shown at 1a.

A rigid bar 5 is attached to the bearing block 3 and extends forward parallel to the suction tube 2 and at one side thereof. Bar 5 is slotted at 5a near the outer end thereof, and a stop element 6 is adjustably clamped to the bar 5 between the tube 2 and the bar by means of clamping screws 6a passing through the slot 5a. A stop member 7 is secured to the suction tube 2 and limits the lengthwise movement of tube 2 by engagement with the adjustable stop 6 in one direction and with the end of block 3 in the other direction. The suction cup 1 is maintained in its extended position shown in FIGURE 1 by a tension spring 8 attached at one end to a pin 5b carried by the bar 5 at its outer end, the other end of spring 8 being attached to a pin 8a carried by a rigid bar 7a mounted on stop 7 and extending parallel with the bar 5, the pin 8a extending laterally from bar 7a to a point below bar 5. The bar 7a has a sliding fit in a slot formed in lug 3a extending down from block 3. This prevents tube 2 from rotating about its axis and thereby holds cup 1 against such rotation.

The suction tube 2 and its mounting is rotated about the axis 4 from the horizontal position shown in FIGURE 1 to the lower position of the cup 1 by means of a solenoid 9 mounted on a fixed part of the machine frame and having a plunger 9a connected through a link 10 to one arm 11 of a bell-crank lever having another arm 12, the lever 11-12 being pivoted on a horizontal pin 13 supported by the fixed frame. When the solenoid 9 is energized the plunger 9a moves inwardly and rotates the lever 11-12 clockwise to depress the left end of the bearing block 3 in the manner shown in FIGURE 2. The right end of

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arm 12 is provided with a shoe 12a which has sliding engagement with a wear plate 3b mounted on the block 3. A tension spring 14 is connected to the bar 5 at the point 5c and is connected to a fixed part of the frame above the point 5a such as the pin 13. Spring 14 normally holds the suction tube 2 and its support in the position shown in FIGURE 1. Upward movement of the support is arrested by engagement of the arm extension 12b with a lug 15 extending underneath the portion 12b from a fixed part of the frame. As shown in FIG. 2, the lever 12 is not secured to the block 3, but has only sliding contact therewith, so that contact between these two parts will be interrupted if the inertia of the moving parts (tube 2 and its mounting) is sufficient to overcome the pull of spring 14.

A cylinder 16 is mounted in axial alignment with the bore in the block 3 by means of a bar connection 17 secured to the rear end of block 3 and holding the cylinder 16 in spaced relation with the rear end of the block 3. The left end of cylinder 16 is open and the right end closed. The suction tube 2 extends out of the rear end of block 3, into the open end of cylinder 16 and is attached to a piston 18 operating within the cylinder 16, so that when a vacuum is established in the right end of cylinder 16 the tube 2 and the suction cup 1 is moved to the right. The right end of cylinder 16 is connected to a suitable vacuum pump by way of flexible tube or conduit 19, cut-off valve being interposed in the connection to control the times at which a vacuum is applied and removed. The valve is shown diagrammatically and comprises a fixed block 20 having an aperture forming a portion of the conduit 19 and a movable block 21 having face-to-face sliding contact with block 20 and having an aperture forming part of the conduit 19. The aperture in block 21 normally is spring biased out of registry with the aperture in block 20, so that the vacuum connection is interrupted. A solenoid 22 is connected to shift block 21 so that its aperture is in registry with that in block 20 to establish the connection from the vacuum pump to the cylinder 16.

The bore within block 3 is larger than the outside diameter of suction tube 2 and the tube is supported at the center of the bore by an annular bearing piece at each end of the bore, thus providing an annular chamber surrounding the tube 2 within block 3. A vacuum connection from a vacuum pump is established to this annular chamber by a second flexible conduit 23 connected to an opening in the block 3 communicating with the annular chamber surrounding the tube 2. Conduit 23 is provided with a control valve like that in conduit 19 and formed of a fixed block 24 and a movable block 25 controlled by a solenoid 26. The valve 24-25 normally establishes a connection between the pump and the annular chamber when the solenoid is deenergized, and this connection is interrupted when the solenoid is energized. Suction is applied to cup 1 through tube 2 by means of one or more holes 2c formed in the wall of tube 2 at a location within the annular chamber of block 3 when the tube 2 is in its extended position. These suction holes are located so that they move out of block 3 into the space between block 3 and cylinder 16 when the tube 2 is at or near the end of its feeding stroke. This admits ambient air to tube 2, thereby removing the suction on cup 1 and releasing the document from the cup.

A vacuum responsive switch VS is connected in conduit 23 and is provided with an armature (a) which normally engages contact (b) to energize a circuit to solenoid 9 and which responds to a certain magnitude of vacuum in the conduit 23 to deenergize solenoid 9 and energize solenoid 22 through a circuit to be described below.

The solenoid 9 is controlled by a pickup relay PR which in turn is controlled by two feed control relays FC1 and FC2. Solenoid 9 is energized from supply conductor 27 leading to armature (a) of a vacuum switch VS, through the normally closed contact (b) of this switch, through the coil of solenoid 9 and through normally open contact

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PR-a of pickup relay PR and back to supply conductor 23 leading to the other side of the supply source. Energization of pickup relay PR closes its contact PR-a and energizes solenoid 9 to move the cup 1 downwardly into pickup position.

The energizing circuit for feed solenoid 22 is completed from supply conductor 28 through the normally closed limit switch 29 having an operating arm extending into the path of a part of the suction cup support, in this case the cylinder 16, to be opened when the suction cup is moved downwardly into pickup position. The circuit continues from switch 29 through the winding of solenoid 22, through contact FC2-a of relay FC2, through contact VS-c of vacuum switch VS when closed, and from the tongue (a) of switch VS back to the supply conductor 27. Thus solenoid 22 cannot be operated except when a vacuum is effective in the conduit 23 and therefore in the suction cup 1.

The circuit for energizing solenoid 26 extends from supply conductor 27 through the winding of the solenoid, through contact FC2-c of relay FC2, and through the normally closed contact PR-b of pickup relay PR and back to supply conductor 23. It may be noted that solenoid 26 normally is energized to cut off the vacuum connection to pickup cup 1.

The energizing circuit of pickup relay PR extends from supply conductor 28 through the relay winding, through the normally open contact FC2-b of relay FC2, and through the normally open contact of limit switch 30, through the normally closed contact of a key switch 32 mounted in the keyboard 33, and back to supply line 27. The normally open limit switch 30 is held in closed position by a finger 7b carried by the stop 7 mounted on the tube 2, when the tube is in its extended position as shown in FIGURE 1. Switch 30 is opened when the tube 2 moves in the feeding direction, and at the end of its feeding movement the finger 7b opens the normally closed limit switch 31.

The energizing circuit for relay FC1 extends from supply conductor 27 through a normally open key contact 34 mounted within the keyboard and being operated by any key which effects final selection. This universal action of contact 34 is represented by the operating bar 35 extending entirely across the keyboard. From contact 34 the circuit of relay FC1 continues through the winding of the relay to support conductor 28.

The initial energizing circuit for relay FC2 is completed from supply conductor 27 through key contact 34, through the normally closed contact of relay FC1 through the normally closed contact FC2-e of relay FC2, and through the relay winding to supply conductor 28. Upon operation of relay FC2, a holding circuit for the relay is completed from conductor 28 through the relay winding, through contact FC2-d of the relay, through the normally closed contact of limit switch 31, and through release key contact 32 back to supply conductor 27. This holding circuit is completed at contact (d) of relay FC2 before contact (e) is opened. Opening of the initial energizing circuit of relay FC2 by opening of the contacts of relay FC-1 prevents subsequent feeding operation before selection by the operator.

Operation of the feeder through a complete cycle will now be described, it being understood that the feeder as shown in FIGURE 1 is in its normal state and ready to be driven through a cycle initiated by the closing of key contact 34.

Closing of key contact 34 energizes relays FC1 and FC2 in parallel, opening all normally closed contacts of these relays and closing all normally open contacts. Opening of contact FC2-c on relay FC2 deenergizes solenoid 26 which allows return of valve part 25 to a position to apply vacuum to the suction cup. Relay FC2 will be held in operated position by the closing of a holding circuit at contact FC2-d and will hold this circuit closed through the normally closed contact of retract switch 31

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until the circuit is disturbed. Closing of contact (b) of relay FC2 energizes pickup relay PR through extend switch 30 which is wired normally open, but is held closed by the finder 7b in the extended position of the suction cup 1 and tube 2. Operation of the pickup relay PR energizes the pickup solenoid 9 which causes the suction cup mounting to rotate about the axis 4 to lower the cup from its normal or retracted position to its depressed or pickup position. The tilting of cylinder 16 opens the normally closed feed safety switch 29 to break the circuit to feed valve solenoid 22 while feed stem or tube 2 is away from its normal (horizontal) position. When the pickup head is in this down position, the suction cup engages the top or face document of the stack. The soft material of the cup conforms partly to the surface of the document and suction in the cup draws it up and seals the mouth of the cup. When the pressure in conduit 23 reaches approximately 6" vacuum, the vacuum switch VS is forced in by atmospheric pressure, changing the position of the switch to open the power circuit to pickup solenoid 9 causing the pickup head to return to its normal or horizontal position and lifting the top or face document from the stack. The changing of switch VS also closes the power circuit to feed valve solenoid 22 which, on operation, opens the valve 20-21 to create a vacuum in cylinder 16. The piston 18 is forced by atmospheric pressure to move to the right and carrying tube 2 and cup 1 along with it. The leading edge of the document carried by the cup is directed between the two feed rolls R1 and R2, and, substantially simultaneously, the suction on cup 1 is relieved when holes 2c in tube 2 move out of the rear end of block 3. Near the end of the feed stroke, switch operating lever 7b engages the arm of retract switch 31, and opens this normally closed switch, breaking the circuit to feed control relay FC2, which causes return of all controls to normal positions. All components are then ready for another cycle of operation which occurs upon the closing of key contact 34.

The suction control valve 24-25 is not essential where operating cycles are repeated in rapid succession, but this valve is desirable for the purpose of preventing serious loss in vacuum in the pumping system during the time when the pickup head is being returned to extend position and during times when the machine is idling.

Another optional feature is the provision of a cycle selector switch 36 connected to bypass the normally open contact FC2-b in the energizing circuit of the pickup relay PR. This switch determines the position of the feed head between selections. With switch 36 open, operation of key 32 effects "full" cycle operation as described above where the pickup head moves from its normal position, picks up a document, feeds it towards the feed rollers R1-R2, and returns to its normal position. By closing switch 36 the automatic operation is varied so that upon the return stroke of the pickup head, the head automatically picks up another document and then returns to its normal position and remains there until the next selection by the operator.

Full cycle operation should be used where the documents are thick and heavy enough to require excessive time for the supply conveyor to advance the stack into proper position for a subsequent pickup operation. Since full cycle operation is slower than the three-quarter cycle operation, the three-quarter cycle operation is used whenever possible.

The vacuum release key switch 32 is provided on the keyboard for optional isolation of the feed head from the vacuum system. The energizing circuits for the feed control relay FC2 and the pickup relay PR are completed through the normally closed contacts of the vacuum release key switch 32. Opening of these contacts will de-energize both of these relays and effect closing of contact FC2-c on relay FC2 and the closing of contact b on pickup relay PR which will energize solenoid 26 to

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shift the valve part 25 to the position cutting off the connection from the vacuum pump to the suction tube 2.

The document introduced between feed rolls R1 and R2 is delivered by these rolls for further handling by other apparatus, such as a guideway provided with gates spaced along the length thereof which control the distribution of the documents to different storage bins, one example being shown in the Benson patent referred to above. Feed roll R1 is driven continuously from a suitable source and roll R2 is an idler pressure roller bearing against roll R1. For this purpose roll R2 may be supported at each end upon a pivoted arm 37 which is urged toward the roll R1 by biasing spring 38. This arrangement is effective in feeding documents of various thicknesses.

The feed roll R1 preferably is formed in three sections which are spaced apart axially, and a pair of fingers 39 formed of stiff wire are supported at their rear ends by a transverse rod 39a fixed to the machine frame and extend forwardly through the gaps between the center section of the roll and the two outer sections. The fingers 39 extend forward from the rod 39a above the level of the plane of contact between rolls R1 and R2 to a point in front of these rolls and then are inclined downwardly beneath the cup 1 and then upwardly for a short distance beyond the cup.

In moving from its normal position to pickup position, the cup 1 passes downwardly between the fingers 39 to the pickup position, and when it returns to the normal position shown in FIGURE 1, with the document adhering to the cup, the fingers 39 effect transverse buckling of the document which is effective in dislodging another document which may be adhering to the lower face of the document carried by the cup. As the cup moves from its normal position in the feeding direction, the buckling of the document becomes less and less due to the shape of fingers 39, so that the buckling does not interfere with the leading edge of the document being introduced between rolls R1 and R2.

It will be understood that the vertical stack of documents shown in FIGURE 1 is supported in a suitable receptacle, and the top of the stack is maintained at a predetermined level below the fingers 39 by apparatus well known in the art, see, for example, the Benson patent referred to above.

FIGURE 4 is an end view of certain feeder parts, as in FIGURE 3, and showing how the feeder is arranged to operate in connection with a horizontal stack of documents. In this arrangement, the documents are supported within a flat tray 40 extending horizontally and at right angles to the feeding axis of the feeder. Thus the feeding axis of the feeder in FIGURE 4 is normal to the plane of the paper and the longitudinal axis of the tray 40 is parallel with the plane of the paper. As shown in FIGURE 4 the documents D are supported on edge from the bottom of the tray 40, and they are inclined at an angle of about 45° to the bottom of the tray, the rear or bottom end of the stack being supported by a follower element 41 having a forward face which is inclined about 45° to the horizontal. The horizontal stack of documents is conveyed towards the feeder by means of a pair of endless conveyor elements 42 mounted in the bottom of the tray and serving to support the lower edges of the documents. These endless conveyors may take the form of endless belts as shown in the Davidson Patent 2,089,946 or as endless chains as shown in the Cadden Patent 1,442,126. These two conveyors are driven by a suitable motor 43 to convey the horizontal stack towards the feeder. The follower 41 has frictional engagement with the conveyor elements and moves along with the stack. At the forward end of the tray the feeder is tilted at a 45° angle so that the pickup cup 1 faces the top or face document at the front end or top of the stack. As explained above, a suitable sensing finger and control circuit may be provided to control the operation of the conveyor motor

to maintain the front end of the stack at the proper position for operation of the feeder.

For the purpose of maintaining the documents in the stack with their leading edges aligned in the same plane, the endless conveyor elements 42 are arranged inclined to the side walls of the tray 40. As shown in FIGURE 5, the conveyor elements 42 are arranged at an angle to the side walls such that the rear ends of the conveyor elements are at a greater distance from the side wall 40a than the forward ends of the conveyor. By this arrangement the documents are shifted laterally towards the side wall 40a as the stack is moved forward.

We claim:

1. A device for transferring documents one at a time from the top of a stack of documents to a discharge station adjacent said stack comprising, a suction cup, an elongated stem carrying said cup at one end thereof, mounting means supporting said stem for pivotal movement about a transverse axis and for longitudinal sliding movement of the stem, resilient means acting on said stem for holding said cup in a normal position elevated above the top of said stack, resilient means acting on said stem to hold said stem at one end of its longitudinal movement with said cup positioned to pick up the face document of the stack, motive means connected to the other end of said stem for effecting longitudinal movement of said stem in the desired direction of transfer of documents from the stack, means for establishing a vacuum within said cup upon downward movement of said cup, and means for interrupting the vacuum connection upon completion of the axial movement of said stem from the normal position of said cup to the discharge position.

2. A device according to claim 1 wherein said stem comprises a suction tube connected to said cup, and said mounting means comprises a bearing block having a bore receiving said tube and providing an annular space surrounding the tube within the block, a vacuum connection communicating with said annular space, and at least one coupling hole in the wall of said tube connecting the bore of the tube with said annular space.

3. A device according to claim 2 wherein said coupling hole is positioned to move out of said bearing block and be exposed to the atmosphere at the end of the feeding movement of said stem.

4. A device according to claim 1 wherein said motive means comprises a cylinder mounted in axial alignment

with the rear end of said stem and having a piston connected with said stem, and a source of differential pressure connected with said piston for effecting transfer movement of said stem.

5. A device according to claim 1 and including a pair of cooperating feed rollers located at said discharge station and having contact with each other substantially in the plane of the mouth of said cup, a pair of resilient fingers extending from said feed rolls on opposite sides of said cup, said fingers being mounted to a fixed support adjacent said feed rolls and extending towards said cup for a distance at an elevation above said plane, and then being inclined towards the face document, and having end portions inclined away from said document at a point between the face document and the mouth of the cup, said cup, in moving to pickup position, passing below said fingers to pick up the face document, and said fingers operating upon return of said cup to its normal position to cause transverse buckling of said document.

6. A device for transferring documents one at a time from a first station to a discharge station comprising, a suction cup, means mounting said suction cup for movement from said first station to said discharge station, a connection for applying vacuum pressure to said cup to hold a document against the mouth of said cup, normally inactive transfer means for effecting movement of the cup from said first station to said discharge station, and means responsive to vacuum pressure applied to said cup and being operative when said pressure reaches a predetermined value for energizing said transfer means, whereby said transfer means is operated only when a document is carried by said cup and remains inoperative when a document is not carried by said cup.

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