

June 6, 1950

F. M. CARROLL ET AL
PNEUMATIC RECORD SENSING DEVICE

2,510,552

Filed Jan. 29, 1948

4 Sheets-Sheet 1

FIG. 1

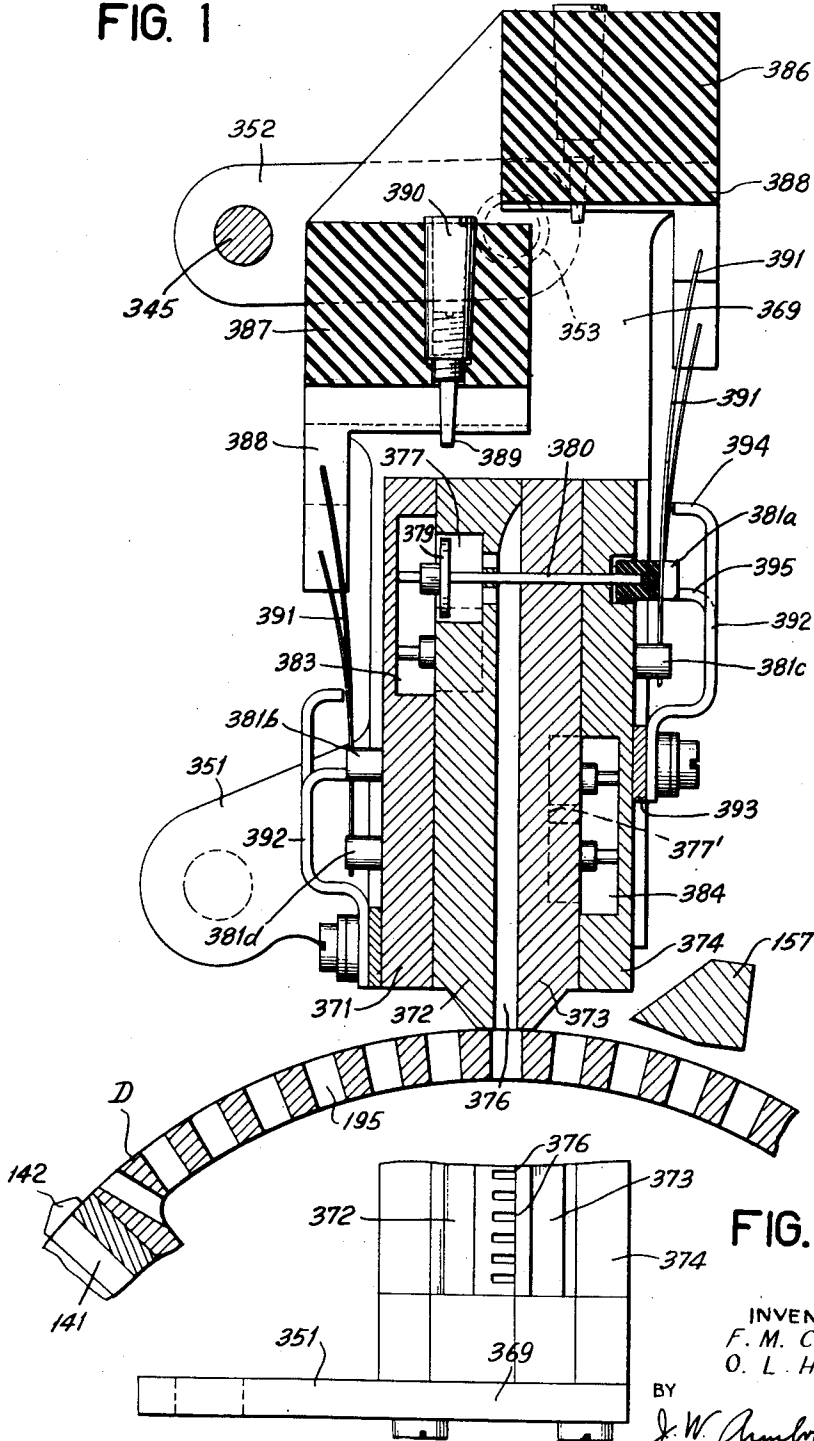


FIG. 2

INVENTORS
F. M. Carroll
O. L. Hibbard

BY
J. W. Ambrose
ATTORNEY

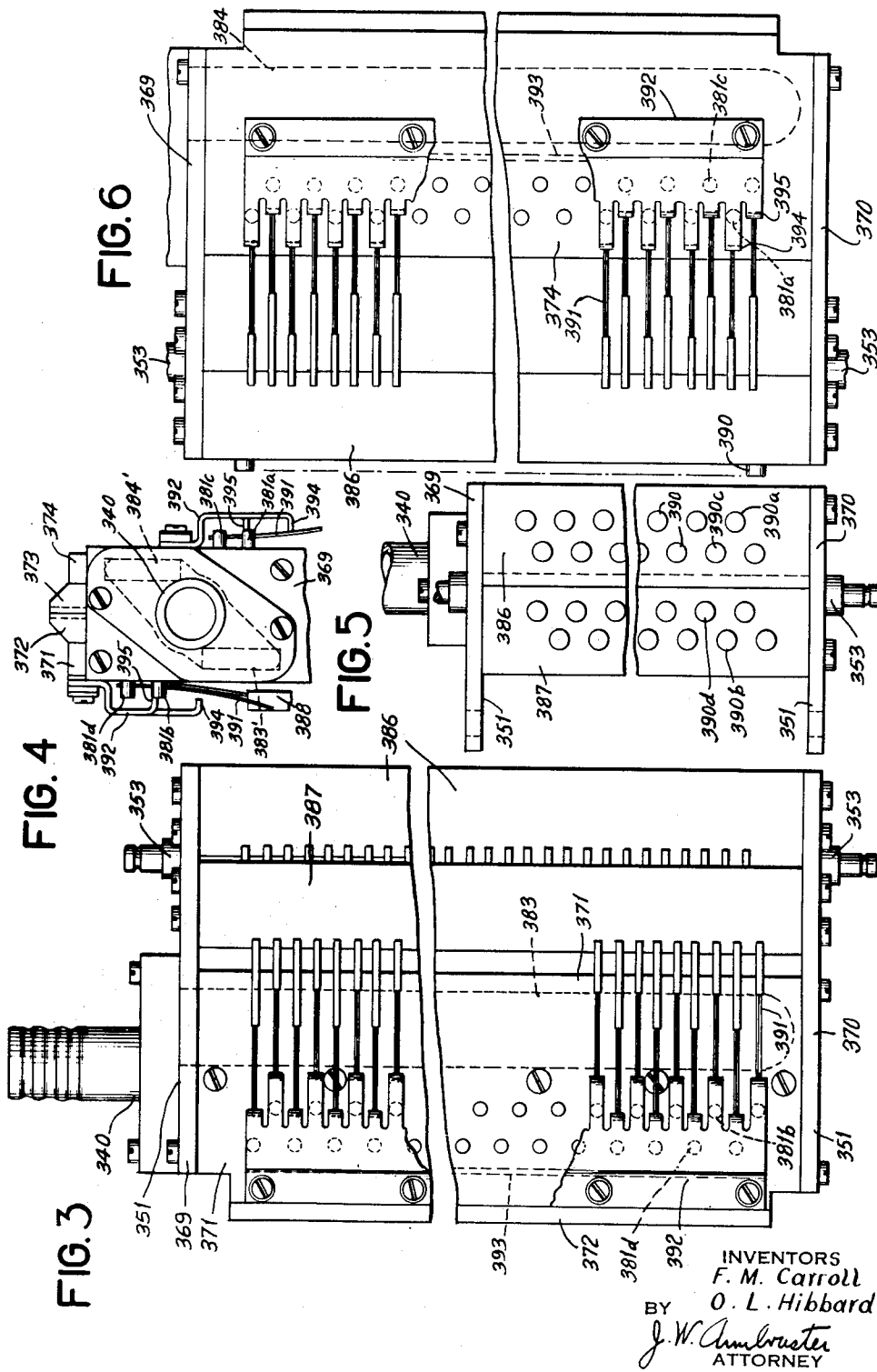
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FIG. 7

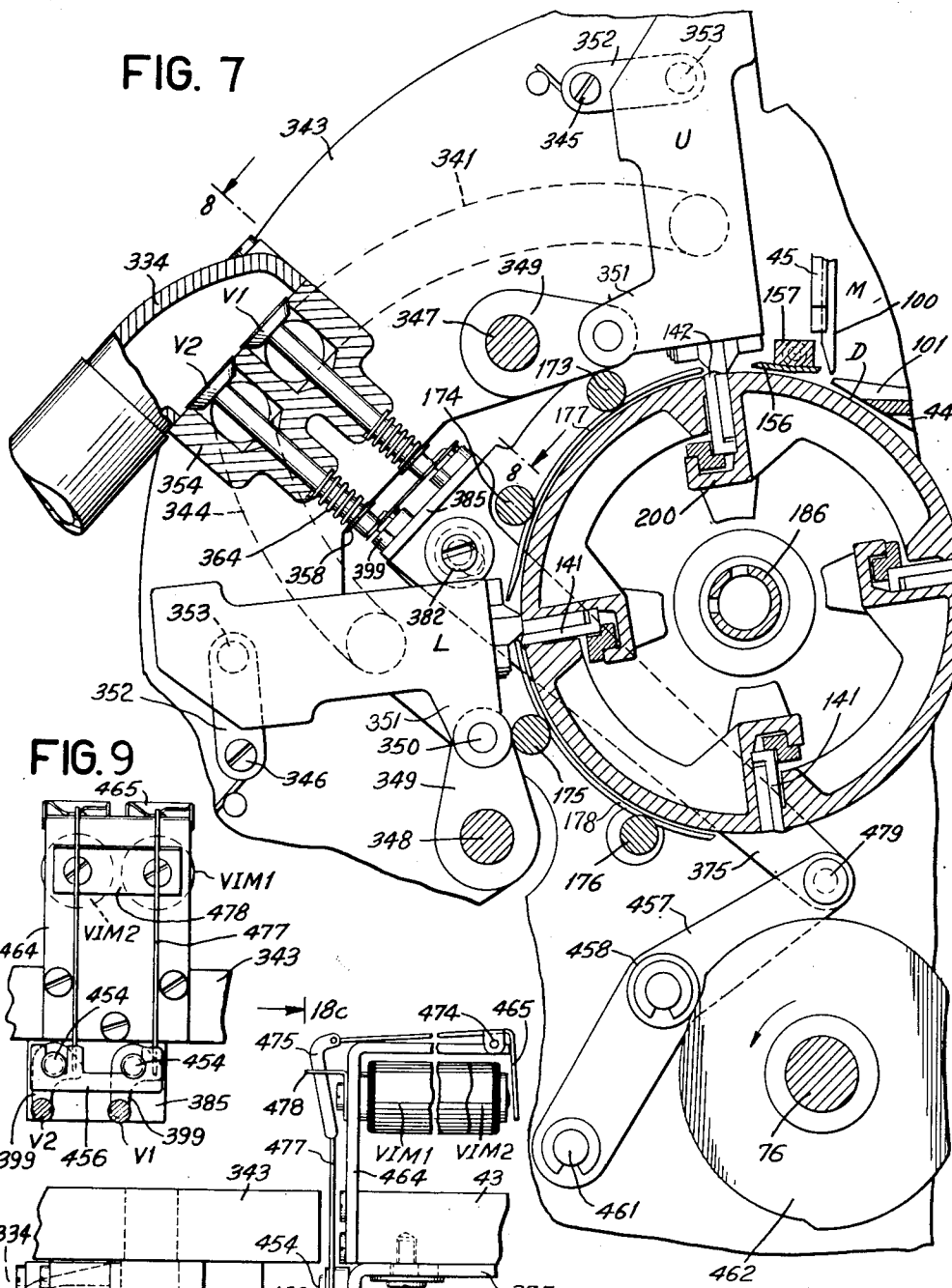


FIG. 9

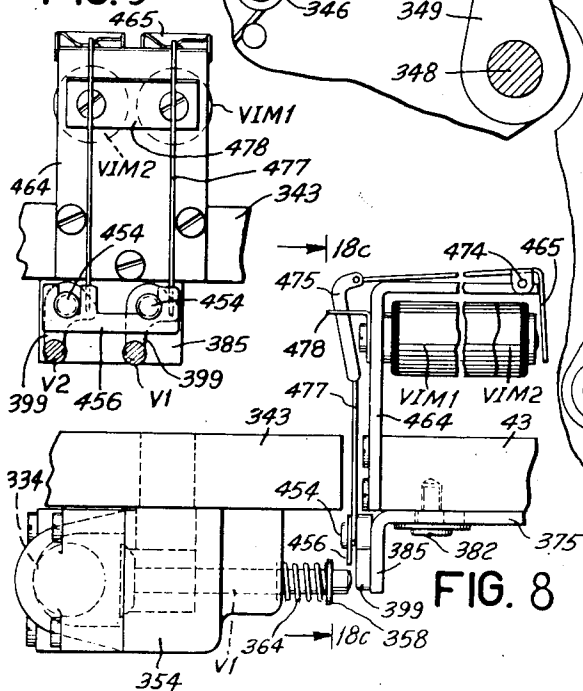


FIG. 8

INVENTORS
F. M. Carroll
O. L. Hibbard
BY *J. W. Ambrauer*
ATTORNEY

June 6, 1950

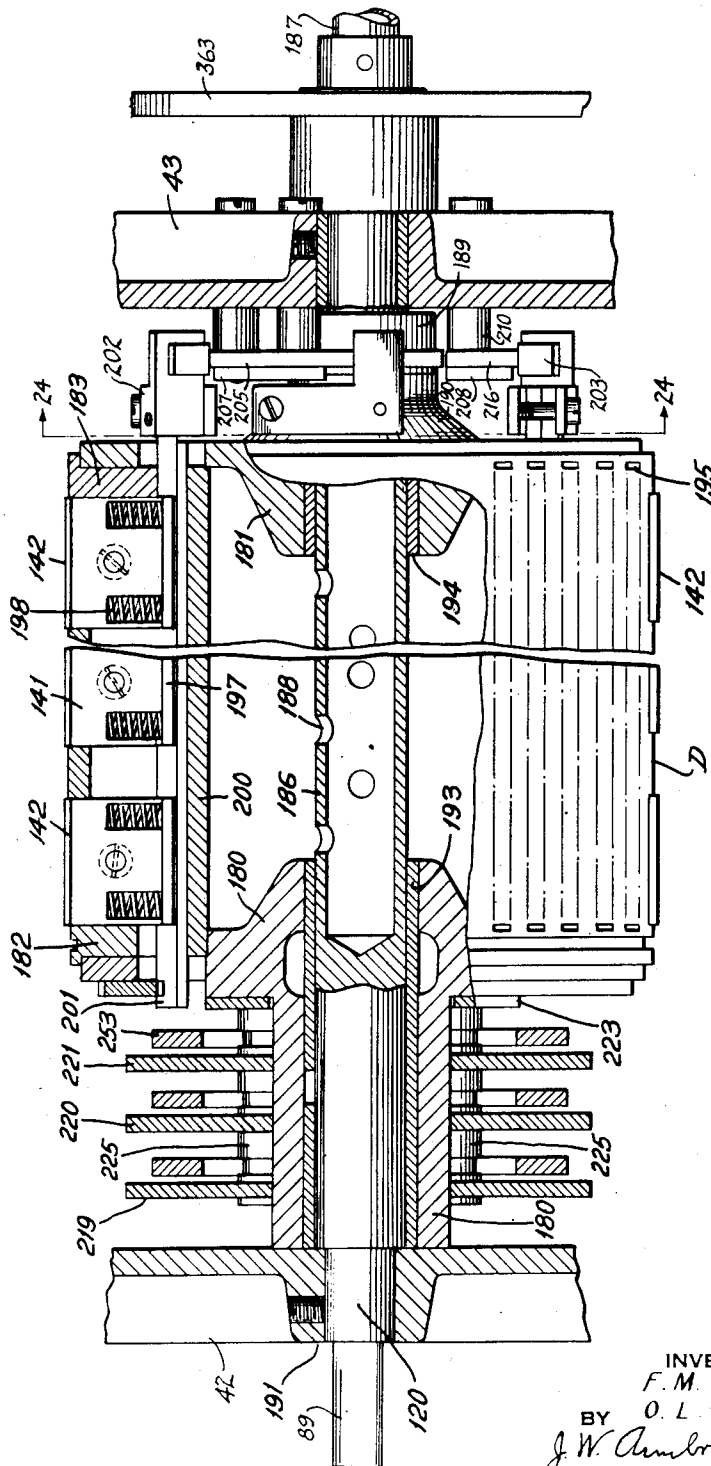
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4 Sheets-Sheet 4

FIG. 10



INVENTORS
F. M. Carroll
O. L. Hibbard
BY *J. W. Ambrose*
ATTORNEY

UNITED STATES PATENT OFFICE

2,510,552

PNEUMATIC RECORD SENSING DEVICE

Fred M. Carroll, Binghamton, and Oscar L. Hibbard, Johnson City, N. Y., assignors to International Business Machines Corporation, New York, N. Y., a corporation of New York

Application January 29, 1948, Serial No. 5,134

16 Claims. (Cl. 235—61.11)

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2

This application is a continuation in part of our copending case Serial No. 686,636, filed July 27, 1946.

This invention relates to record feeding and analyzing devices and more particularly to an advanced form of pneumatic sensing device for cooperation with perforated tabulating cards to repeatedly sense the same or different fields of perforated data in one of such cards.

An object of the invention is to provide improved pneumatic sensing devices for cooperation with perforated records, thereby making it possible to sense such records without the usual contact therewith incidental to the use of feeler pins or electrical sensing brushes. The object is to construct the pneumatic controls with pressure and a forwardly directed vacuum action rather than a suction action, and thereby cause the lint, dirt, and other loose matter to be blown away from the sensing unit and card and directed into an exhaust opening away from all the sensing mechanism. Thus, the action produced is dual in a combined cleaning and reading operation.

The pneumatic action of the disclosed devices with air pressure in a direction toward an exhaust port and away from the pneumatic unit exercises a useful scavenging action to clean the card at the same time that it is sensed.

Another object of the invention is to provide a compact pneumatic sensing device for cooperation with perforated record material. The sensing unit is designed to be fitted in a limited space by having a double tiered arrangement of pressure chambers with a staggered array of cylinders and pistons. This design makes it possible to have a large number of closely spaced air ports arranged side by side in a single line, and yet extending from such ports are a series of cylinder openings and pistons of substantial size leading to the air chambers and tubes for supplying the pistons with the activating air pressure and enabling a substantial electrical reading device to make contact under control of the pistons. The piston or plunger is arranged to have comparatively large clearance in the surrounding cylinder walls leading to the port opening directly above the perforated record material. The air pressure behind and in front of the piston is equalized as long as the advancing record material appears imperforate under the air opening. However, as soon as a data representing perforation appears under the opening, the air on the record side of the piston escapes, creating a low pressure area or vacuum under the piston head, thus causing the air on the intake side

of the piston head to exert enough pressure to cause it to move toward the sensing port. This motion is communicated to a flexed contact wire or blade which is then brought into electrical contact with a common conducting bar.

Another object of the invention is to provide pneumatic sensing devices wherein the moving parts for establishing electrical contact are so small and light that they have a rapid operating cycle and fast restoration movement in order that they will sense code perforations in adjacent index positions appearing in rapid succession under the air ports.

Another object of the invention is the provision of a hollow record holder to carry the record under analyzing devices, as shown, the holder is a hollow drum wherein the lint, dirt, paper threads, etc. from the record may be blown off and exhausted to leave the record and the sensing area free from such matter as is likely to impair the proper actuation of the sensing devices.

Fig. 1 is an enlarged sectional elevation view through one pneumatic sensing unit.

Fig. 2 is an enlarged bottom view showing the air openings.

Fig. 3 is a side view of a pneumatic sensing unit.

Fig. 4 is an end view of a pneumatic sensing unit showing the air intake port.

Fig. 5 is a plan view of a pneumatic sensing unit.

Fig. 6 is a side view of a sensing unit showing the side opposite that shown in Fig. 3.

Fig. 7 is a sectional elevation view taken through the air valves which admit the compressed air to the two sensing units.

Fig. 8 is a projected plan view of the two air valves and the magnet controlled interposer operator therefor.

Fig. 9 is a projected plan view of the two valve operating interposers shown with the valves removed.

Fig. 10 is a sectional elevation view taken through the middle of the card feed drum.

The invention is disclosed as embodied in an alphabet printing tabulator of the kind shown generally in United States Patents 2,079,418 and 2,199,547. These machines are controlled by perforated record cards and the purpose is to accumulate separately the amounts represented by groups of the records and also print bill forms or other accounting records. Heretofore, a plurality of perforated cards, one for each address line and one for each item, were needed to print a record such as a bill. Now, instead of using several separate cards for the related data, all may be represented on one card and in different fields

of said card and detected successively by passing the card repeatedly under pneumatic sensing means.

The air is driven through a filter by a pump and directed into an air pressure supply tank, and from there it passes two control valves V1, V2, Fig. 7, and along two hose branches into two pneumatic sensing units U and L. These units correspond generally in position and purpose with the usual double line of electrical sensing brushes UB and LB found in most tabulators and here replaced by the pneumatic units. Each unit has a row of air openings or ports which are aligned with the columns of data perforation positions of the record cards. The two sensing units are supported on an arcuate rockable frame which can be moved back for inspection, but is normally held with the two lines of ports over the periphery of a hollow perforated drum D. A pile of cards are placed in the magazine M from which they are picked off one at a time and transferred to the drum D. The drum has clips for holding the card thereon for about 180° of the drum movement, during which time the card is passed under the upper unit U and then under the lower unit L before being transferred to a stacker drum.

Upon the appearance of a card perforation under an air port (at a time determined by the location which is indicative of a particular letter or number value), air is allowed to escape into the drum D and, in so doing, a piston in unit U or L closes related contacts. Unit U is used as a control station for special heading card detection and group number control, while unit L has its contacts in series with add and print control devices. The air blown into drum D with lint and dirt is expelled through an exhaust pipe or hose leading away from central tube 186.

Cards with more than one field of data indicia have a special digit perforation which is sensed as the card passes under the ports of the upper sensing unit U. Later, as the same card passes under the lower sensing unit L, devices under control of the special perforation reverse the motion of the drum D and rock it back and forth a number of times determined by the magnitude of the digit.

The card guides

Although the front end of each record card assembled on the sensing drum D is held thereon by the grippers, the other portions of the card are free and would tend to spring outward and abut against various mechanisms near the periphery of the drum. To eliminate such card contact outside the drum area, a pair of arcuate card guides are provided to confine the card path to a narrow arcuate space concentric with the periphery of the drum. Two guides 177 and 178, Fig. 7, are proportioned to cover the areas between the upper and lower sensing station, and the area between the lower sensing station and stacking control means respectively. Guide 177 is fixed to a pair of rods 173 and 174 extending across the space between the two side frames. The second guide 178 is mounted in a similar fashion between a pair of rods 175 and 176 borne by the side frames.

The card carrying drum

Drum D is a hollow cylinder, the ends of which are closed by heavy annular rings 180 and 181 (Fig. 10), secured to flanges just inside the ends of the drum. The two rings are seated on the long perforated tube 186 which extends through

and is affixed to both side frames 42 and 43, the left end being solid and having an extending portion 89 beyond the outer surface of frame 42, and the right end extending beyond frame 43 to hold a hollow elbow 187 to which is assembled the hose or exhaust tube to carry off the lint, dirt, etc., blown through the perforations 188 in the tube 186.

The tube 186 is held in position axially by means of a collar 189 held thereon by a set screw between frame 43 and a hub 190 on ring 181. The left end of tube 186 passes through a bushing 191 on frame 42. Formed on the left end of the tube is a bearing shoulder 120 out of which extends the shaft 89 used as the picker clutch shaft. However, movement of drum D is independent of the movement of clutch shaft 89. Tube 186 is held fixed and the drum rotates thereon by means of bearing rings 193 and 194 fixed to the inner openings of end pieces 180 and 181.

The periphery of the drum D is divided into four arcuate segments, i. e., four areas between the sets of grippers 141 (Fig. 7). In each of these areas, the drum is perforated with columns and rows of openings, each of which corresponds to an index point on the record card. Since the card taken for purposes of illustration is the ordinary card, alphabet data is represented by a twelve hole code. To correspond with the spacing of the card indicia representations, each of the four drum areas is perforated with eighty columns of holes 195 (Fig. 1) with twelve regularly spaced holes in each column. In other words, between sets of card grippers on drum D there are twelve holes 195 in an arcuate formation, and horizontally displaced across the drum are eighty such formations. These drum perforations are so placed with respect to the set of grippers 141 which precedes them in the counterclockwise direction that they match the location of all the card perforation positions. Therefore, while a card is on the drum, underlying each of the card perforation positions is a drum opening to allow free passage of air under pressure through the card indicia perforations. On the other hand, all imperforate card index points cover all the other drum openings and prevent air from being blown through them.

The card gripper operating mechanism

It is already mentioned that the sensing drum D contains four sets of card grippers 141, Fig. 7, which are equally spaced around the drum to grasp the cards as they are issued successively out of the magazine M. Reference to the broken sectional view (Fig. 10) shows three of the five grippers arranged across the drum in each set. Each gripper is rectangular in formation and projects upward through a rectangular opening in the periphery of the drum, said five openings being slightly smaller than the heads 142 of the grippers. The lower part of each gripper 141 is formed with a foot 197 which acts as a pressing point for one end of a pressure spring 198, the other end of which contacts with the inside of the drum.

All five grippers of a set are supported within an L-shaped formation 200 extending across the inside of the drum D and providing sliding surfaces for guiding the reciprocating movements of the five grippers 141. Extending across the entire drum and projecting through openings in the end rings 180 and 181 of the drum is an operating bar 201 which is seen in Fig. 7 to be shaped in the form of a Z with a lower extension under-

lying all five grippers 141 of one set. It is through operation of the bar and this extension that the grippers are lifted in unison to receive a record card out of the magazine. Bar 201 is also formed with an upper stopping projection which abuts against a shoulder on the angular formation 200. The bar is confined between the abutting lug of formation 200 and the sides of the grippers 141, but it is free for radial movement away from the center of the drum, and it is with such movement that the grippers are operated.

The four operating bars 201 are operated successively in two of the positions assumed by the sensing drum as it rotates in card feeding operation. The one gripper operating position is that provided for reception of cards as they come out of the magazine, and the other gripper operating position is that encountered after sensing is completed under the two sensing units and the card is about to be put in the stacker.

Card feed drum rotating mechanisms

The card feed drum D is rotated and oscillated by means of pawls engaging notched disks or ratchet wheels attached thereto. Certain of the pawls operate to rotate the drum in the forward card feed direction as long as ordinary detail cards are presented. Other pawl mechanism is provided to reverse the direction of the drum movement and oscillate it a selected number of times for heading or cross footing card control to read several selected number of fields of data or repeatedly sense one field on each card. The reverse pawl mechanism is under control of a special heading digit perforation which is also by virtue of its value a cycle control perforation for selecting a predetermined number of drum reversal operations, the number of reversals needed depending on the number of fields of information to be recorded or added.

In Fig. 10, it is seen that attached to the left end of drum D is a set of three spaced ratchet disks or wheels 219, 220 and 221. Disk 220 is used for the reversal movement and the other two disks are used for initial and terminal forward feed movement.

Sensing unit supports

The sensing units U and L are mounted on a swinging frame which can be tipped back so that about one-half the periphery of drum D may be exposed for cleaning and inspection.

Both main side frames 42 and 43 are formed with upwardly extending ears for holding the sensing unit frame. Facing these ears and held thereto by a shaft is an ear (not shown) on a rockable frame member 343 which is a right side frame for the sensing units. Frame 343 and the companion frame on the left side are mounted in the same fashion on the main side frames 42 and 43.

When the frames are rocked to the home position wherein the sensing units are effective, a flat portion of each frame rests on a shelf formed near the tops of the side frames. The sensing unit frames are locked in place by a pair of latches pivoted on the outer faces of the frames. With the sensing units in the exposed position, access is also given to the surface of drum D, so that all parts related to the sensing operation can be inspected, cleaned and adjusted.

Reference to Fig. 7 shows that both pneumatic sensing units U and L are shaped generally as rectangular bars of about the same length as drum D and they are placed between the side

frames to correspond with the axial position of the drum. Since both units U and L are similarly constructed and mounted in the rockable frame, description of either one applies to the other.

Attached to the right of unit U is a hollow hose fitting 340, Fig. 3, for receiving the flexible hose 341, Fig. 7, which conveys the air under pressure from a pump to the sensing unit.

The sensing units are suspended within the rockable frame 342, 343 by parallel links which can be operated to raise the units before the gripper heads 142 pass underneath them. Normally, the sensing units are lowered into contact with the card surface which is moving in an arcuate path. A virtual air seal is provided between the air port openings and the contacting card surface. However, while passing beyond the index points near the margin of the card at the bottom, and over to the edge of the next card where the grippers engage it, it is not necessary to preserve the seal because the sensing air pressure is not then applied and therefore the units may be lifted to provide clearance for the gripper heads.

Extending across the rockable frame (Fig. 7) is a pair of suspending shafts 345 and 346 and a pair of operating shafts 347 and 348 for controlling the lifting of the units U and L. Attached to shafts 347, 348 are pairs of arms 349 carrying rods 350 which are also encircled by ears 351 extending from the sensing units. Pivoted on the shafts 345, 346 are the ends of a pair of links 352 which at the other ends encircle shouldered studs 353 extending from the side walls of the sensing units. A coil spring is wrapped around shaft 345 and confined by a collar thereon. The spring is wound to exert rotary force and is caught on the top of link 352 to urge it and unit U downward in a clockwise direction about shaft 345. A similar spring is assembled on shaft 346 to urge unit L downward.

With pairs of links 352 and arms 349 as the supporting means, each sensing unit is mounted for movement radially with respect to the center of drum D. Springs tend to hold the units inward in constant contact with the card surface. Adjustably secured to shafts 350 are pairs of eccentric collars in contact with the fixed support rods 173 and 175 near the inner ends of the two sensing units. These collars determine the exact inner positions of the units and the degree of closeness the units have with, or the required pressure upon, the card surface. By turning the eccentric collars and fastening them in selected angular positions, the inner ends of the sensing units can be positioned as desired on or above the card to eliminate excessive air leakage. An air pressure of from 3 to 10 pounds may be used with 6# as a desirable value.

Although the springs tend to hold the sensing units in the effective card reading position, a positive disengaging means is provided to lift the units together for a portion of each cycle. Since the units are spaced exactly at a 90° interval circumferentially of drum D, which is also the interval from card to card thereon, an action for lifting one unit for clearance of the gripper heads may be taken simultaneously with the lifting of the other unit.

The pneumatic sensing units

Each of the sensing devices U and L may be considered as a unit, for it is removable for replacement and inspection. Units U and L are similar construction so that the description which

follows applies to either structure. The purpose of the pneumatic unit is to direct separate jets of compressed air, one jet for each card column (80 in the disclosed embodiment) against the index point positions of a moving card. In all the imperforate positions of the card, the air is confined and ineffective. However, as soon as a data representing perforation appears under a jet, the air escapes therethrough to pull with a vacuum action on a piston in the stream of the air. Connected to the piston are contact closing devices for sensing an electrical impulse which is timed to correspond with the data value which is determined by the position of the perforation in the card column. In the case of alphabetic data, two perforations are placed in code positions in a single column to represent a letter, and two differentially timed impulses are initiated by the same pneumatic sensing controls.

Figs. 1-6 show various views of a pneumatic unit. A number of bars extend the full length of the unit and are assembled between side plates 369 and 370 which are formed with the supporting ears 351 and carry studs 353 for supporting links 352.

A set of four metal bars 371-374 are fastened between the end plates 369 and 370. These bars are accurately machined and fitted closely together with air tight joints because they are formed with tubes, cylinders and air chambers for carrying and confining air under pressure. The one central bar 372 is formed with a set of eighty grooves which, when the bars 372 and 373 are assembled face to face, are blocked off to provide eighty rectangular port openings 376 (Fig. 2) corresponding in size and spacing to the arrangement of columns of data perforations on the card. There is a port 376 for each column of index points on the card, and the unit is located to match the ports with the card columns as they appear directly above the sets of openings 195 in the drum D carrying the card. The lower ends of bars 372 and 373 are beveled down to a smooth blunt end designed to ride on the surface of passing cards.

The top of each rectangular tube or port 376 (Fig. 1) is blocked off and sealed because the groove of which it is composed does not extend to the top of bar 372.

Leading off from each of the vertical tubes 376 is a horizontal cylindrical opening 377 with constricted holes between the two. There are forty such openings 377 in bar 372 and they are arranged in two rows and staggered in position along said rows. A similar number of cylindrical openings 377' are cut into bar 373 where they are also arranged staggered in two rows.

In each of the eighty openings 377, 377' is a piston comprising a disk-shaped piston head 379 and a long rigid piston rod 380 fastened thereto. Attached to the ends of the rods 380 are insulation buttons 381a, 381b, 381c and 381d, which are designated differently to distinguish the rows and tiers of pistons and the order in which they are arranged across the unit. It is apparent from the positions of buttons 381a-381d that not only are the pistons arranged in four rows but the rows are divided into two tiers wherein the pistons are reversed in position, so that the buttons 381a and 381c of the two top rows of pistons project at the right, and the buttons 381b and 381d of the two bottom rows of pistons project from the left of the unit. Rods 380 slide in holes in the bars to guide the pistons.

With the pistons arranged as shown, it is pos-

sible to make the working parts of substantial size and durable formation while leading to the port openings 376 which are necessarily of restricted size and close formation as determined by the card index point and column proportions.

Behind the upper tier of pistons is an air inlet chamber 383 and there is a similar chamber 384 behind the lower two rows of pistons. Chamber 383 is formed by cutting a wide groove almost the entire length of bar 371, one end being sealed and that is the end near the side plate 370 (Fig. 3). The other end of chamber 383 is not sealed, because plate 369 (Fig. 4) is formed with a rectangular opening 383' leading into the trapezium-shaped inlet hose fitting 340 which is clamped to plate 369. The other chamber 384 is formed in a similar fashion in bar 374 and coincides with a hole 384' in plate 369 to communicate with the inner opening of the air hose fitting 340.

In chamber 383 (Fig. 1) there extends a shouldered end of the piston assembly. This end abuts against the side wall of the chamber and acts as a limiting stop for the piston 379 which is spring urged toward the left to the home position as shown.

Piston 379 is not fitted closely in the cylinder 377 but instead has considerable clearance so that the air is allowed to flow from chamber 383 to cylinder 377 and build up equalizing pressure in front of the piston quite rapidly after the piston is actuated. In the normal condition of the parts, with piston 379 positioned as shown, air under substantially equal pressure is present in chamber 383, behind the piston in cylinder 377, in front of the piston, and all the way down tube 376 to the port obstructed by the surface of a card. Should there be a slight leak of pressure at the port due to an imperfect seal with the card surface, such a drop in pressure would not be sufficiently abrupt to cause piston actuation. However, when a data representing card perforation appears under port 376, there is a sudden release of the air under pressure through tube 376, the card and a drum opening 195.

The air in cylinder 377 and tube 376 in front of piston 379 is free to move while the air in chamber 383 behind the piston is restricted in movement by the presence of the piston. The result is that the air escaping through the card perforation causes a lowering of the pressure in front of the piston amounting to a vacuum or partial vacuum in the cylinder 377. For a moment this condition exists until the air behind the piston tries to fill the lower pressure area and in so doing moves the piston and the connected rod 380 toward the right.

As explained hereinafter, a contact establishing spring presses against the right end of the piston assembly, and it is this spring pressure which is overcome by the air under pressure. Movement of the piston to the right is of sufficient duration to establish contact before the air passing around the clearance between the piston and the cylinder wall reaches the lower end of tube 376 and abuts against the card surface and tends to equalize the air pressure before and behind the piston. When such a point of equilibrium in pressure is about to be reached and before it is reached, the spring urging the piston assembly to the left becomes effective to restore the piston and at the same time break the contact which is established by movement toward the right.

It is necessary for the actuation of the piston and the resulting electrical contact to be extremely rapid, because there are instances when

two perforations in a card column are found directly adjacent each other, and separate impulses must be created by successive actuation of the piston under control of the two perforations appearing one right after the other on the rotating drum under the pneumatic port. For this reason it is important that the size or area of the tube 376, the holes leading from the cylinder 377 into the tube 376 and the clearance between the piston 379 and the walls of cylinder 377 be so proportioned that the right amount of time is allowed to elapse between the actuation of the piston by the vacuum condition and the rapid resumption of pressure equilibrium which follows thereafter. It was found by experiment that the proportions between the area of the rectangular tube opening 376 and the clearance area around the piston 379 should be approximately as 3 is to 1. This proportion presupposes that there is sufficient opening between the cylinder and the tube to allow free escape of the air under pressure. The area of the piston head 379 is about 15 times the area of the port opening 376. The area of piston clearance is substantial so that, when multiplied by 12, it is about equal to the average volume of the air port chamber between the piston and the card. It will be noted that the advantage lies not only in the rapid initiation of an impulse upon the appearance of a card perforation but also the rapid recovery of the impulse creating facilities, so that rapid operations may continue under high speed conditions.

Now that the operation of the piston has been explained with reference to the action of the air pressure thereon, it is believed well to point out how such actuation is converted into the initiation of electrical impulses which are timed by virtue of the positions of the related perforations in the card on the drum. Since the adding and printing devices of the machine are synchronized with the operation of the drum, the resulting impulses are effective to control accumulation of the amounts sensed on the record card and the recording of numerical and alphabetic data also analyzed thereon.

Extending across the top of the electrical sensing unit is a pair of square insulation bars 386 and 387 fastened between the side plates 369 and 370. These two bars are assembled at different levels, the upper one to cooperate with contacts controlled by the upper tier of pistons and the lower one to have association with the other half of the pistons found on the lower level. The bottom portion of each insulation bar is slotted at regular intervals in forty places to receive and hold a like number of L-shaped transmission plates 388. The vertical extension of these plates 388 are not of similar length but are seen to have two different sizes, the short length extensions being interspersed with the longer extensions and the former provided for the upper row of pistons of each tier. In contact with the horizontal member of each L plate 388 is the pointed end 389 of a vertical terminal 390 projecting upward with plug openings at the upper surfaces of bars 386 and 387.

In Fig. 5 it is seen that these wiring terminals 390 are arranged in a staggered formation across the tops of the two insulation bars. They act as receivers for plug tips on wires leading from the control mechanism of the tabulator. Terminals 390 are formed hollow to receive the tips and establish contact therewith.

Extending downwardly from each terminal

plate 388 is a leaf spring 391 which at its lower end fits into a notch cut vertically in the button 381a fastened to the end of the piston rod 380. Leaf spring 391 is tensioned to press the piston assembly toward the left into the normal position, wherein the left end of the assembly abuts against the left wall of chamber 383. The plates 388 formed with the long vertical extensions also carry similar leaf springs 391 in the shape of a bent wire which cooperates with the other row of buttons 381c fastened to the second row of pistons in the upper tier. The plates 388 projecting from the left bar 287 are similarly provided with leaf springs 391 cooperating with the buttons 381b and 381d on the lower tier of pistons.

Associated with the forty leaf springs 391 at the right is a common contact bar 392 fastened to plate 374 but separated therefrom by an insulation strip 393. This bar is formed with a series of upper and lower prongs 394 and 395 extending inwardly toward the sides of the leaf springs 391 but normally separated therefrom. Electrical contact is established between the leaf spring 391 and prong 394 whenever the piston 379 is shifted to the right by change of air pressure attending the detection of the presence of a card perforation. The impulse path flows through bar 392 out to prong 394 against the abutting leaf spring 391 up into the terminal plate 388 and through plug socket 390 to the control wiring.

In order to explain the arrangement of the pistons and connected contact springs more fully, certain of the terminals 390 (Fig. 5) are further designated 390a—390d to point out that the successive denominational or columnar orders of the sensing device alternate from side to side of the unit as well as being staggered in arrangement on each side. It is seen that the terminal 390a is on the right side while the next terminal (i. e. next with reference to longitudinal distribution), terminal 390b, is on the left side, and the other two terminals 390c and 390d also alternate from right to left. It is explained hereinbefore that the buttons 381a—381d also alternate from side to side as well as from tier to tier. Now the effect of such arrangement may be studied with reference to the electrical connections between spring wires or contact blades 391 and the prongs 394 and 395 on the common contact bars 392. The spaced and staggered buttons 381a and 381c (Fig. 6) in the upper tier are seen to extend from the right wall and operate wires to contact with prongs 394 and 395, respectively. Similarly, the spaced and staggered buttons 381b and 381d (Fig. 3) in the lower tier are found to extend from the left bar 371 and operate wires 391 to contact with the long and short prongs, respectively. From the foregoing it may be gathered that the electrical contact devices are made in sturdier proportions and with greater clearances due to the piston arrangement in staggered rows and alternating tiers.

The pressure control valves

It is shown in Fig. 7 that a pair of control valves is provided between the compressed air supply and the upper and lower sensing units U and L. These valves cut off the compressed air at times when there are no cards at the sensing stations.

A more detailed showing of the valves and the operating mechanism therefor is given in Figs. 7, 8 and 9. Valve VI is seen to cover the opening to the tube that leads from the main air pressure inlet 334 to the separate duct or tube 341 which is

connected to the upper sensing unit U and conducts the air under pressure to the chambers 333 and 334 in the unit housing. The other valve V2 is seen to be positioned to close the valve opening of a cylinder which is the connector between the main air entry space 334 and the separate tube 344 that leads to the air chambers in the lower sensing unit L.

Valves V1 and V2 are seated in a casing 354 secured to the rockable frame 343. The stems of the valves extend below the casing 354 (Fig. 7) and have formed thereon collars 358 against which press the ends of coil compression springs 364 tending to keep the valves closed.

The lower ends of the valve stems are poised above a pair of bell cranks 399 pivoted on studs 454 extending from a shelf 385 formed on a slide 375 attached with a screw and slot connection 382 to the main slide frame 43. Slide 375 is articulated at 479 on the top of an operating arm 457 which is pivoted at 461 on the main frame and carrying a roller 458 cooperating with a cam 462 fixed to shaft 76.

Early in each cycle, cam 462 rocks arm 467 in a counterclockwise direction and the arm then pushes slide 375 to the left so that the cranks 399 thereon press against the ends of the valve stems and lift valves V1 and V2. In Fig. 9 it is seen that the long arms of cranks 399 are normally directly under the stems of the valves and in position to operate them as timed by cam 462 to agree with the perforation positions on the cards, said valves being closed at times other than the index point sensing time.

Cranks 399 are used as interposers for disabling the valve lifting action and thereby cutting off the air pressure supply to one or both sensing units for one or more complete cycles. This control is exercised under control of card levers for detecting the absence of cards at the sensing stations and thereby closing contacts to energize magnets for rocking cranks 399 to prevent valve operation when cards are missing.

In Fig. 9 it is seen that, if a crank 399 is rocked about 30° in a counterclockwise direction, the long arm will be moved out of abutting relation with the end of the valve stem. Then, even though slide 375 reciprocates the cranks axially, the one which has been rocked fails to operate the related valve. The magnets for rocking the interposer cranks are about to be described.

Attached to frame 43 (Fig. 8) is a bracket 464 carrying a pair of magnets VIM1 and VIM2, the former being controlled by the upper card lever and the latter by the lower card lever. Associated with the magnets (Fig. 8) is a pair of armatures 465 pivoted at 474 on bracket 464. A horizontal armature lever extends to the left and is articulated with the flat end 475 of a call rod 477, the lower end of which is bent to project into a hole in the short arm of crank 399. Ends 475 are guided by a notched bracket 478 and the lower ends are confined by a retaining strip 456 which is forced into grooves of studs 454 and serves to hold the cranks 399 down on the pivots with just enough room between the bottom of strip 456 and the top faces of the cranks for the ends of wires 477 to move freely to operate the cranks.

When a magnet is energized due to the absence of a record at the related sensing station, armature lever 465 (Fig. 8) is rocked clockwise and wire 477 is pulled upward to rock the crank 399 counterclockwise (Fig. 9) and move the long arm thereof away from the end of the valve stem. Then, when the slide 375 is shifted upward, it is

ineffective to cause lifting of the related valve with the result that no air under pressure is supplied to the sensing unit having no card on which to work.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention therefore to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In an accounting machine controlled by perforated records, a pneumatic record sensing unit comprising a body structure with a plurality of closely spaced port openings cooperating with said record perforations, said structure having separate cylinders at an angle to each of said openings and connected therewith, a piston in each of said cylinders, said structure having an air chamber leading into all of said cylinders, means for supplying air under pressure to said chamber, and electrical contact devices operated by said pistons when they move due to the escape of air from related ports through said record perforations.

2. A pneumatic sensing unit comprising a body structure with a plurality of rectangular port openings spaced in a single row at regular intervals, said structure having a series of cylinders in a staggered formation and connected to said openings, each cylinder communicating with a related port opening, said structure also having an air chamber leading into all of said cylinders, means for putting air under pressure into said chamber, a piston in each of said cylinders, and electrical contact devices operated by said pistons when they move due to escape of air from related ports.

3. A pneumatic sensing unit comprising a frame with a plurality of air port openings arranged at spaced intervals, said structure also having a series of cylinders each of which is in communication with a related port opening, means for compressing air in said cylinders, a piston in each of said cylinders, a piston rod extending from each of said pistons and extending through said frame to the outside, and electrical contact devices operated by said extending piston rods.

4. The invention set forth in claim 3, wherein said electrical contact devices comprise a series of individual terminal plates, each of which carries a flexible contact member, said member being in cooperation with one of said piston rods and a common contact bar also on the outside of said frame, said bar having a portion normally separated from said flexible members, whereby operation of any of said pistons causes movement of the related flexible member into contact with said common bar.

5. The invention set forth in claim 3, further characterized by the fact that a substantial amount of clearance is provided between said piston and the walls of the surrounding cylinder, the proportion of said clearance area to said port opening being as 1 is to 3, whereby said piston is restored quickly upon the escape of air from the port opening.

6. The invention set forth in claim 3, further characterized by the fact that the area of the piston is substantially larger than the port open-

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ing, the ratio being approximately as 15 is to 1, whereby escape of air through a port opening causes rapid actuation of the piston and connected electrical devices.

7. A pneumatic sensing unit comprising a frame with a plurality of air port openings spaced at intervals, said structure having a plurality of tiers of cylinders at an angle to said openings, each cylinder communicating with a related port opening, means connected with said frame for placing air under pressure into said cylinders, a piston in each of said cylinders and electrical devices operated by said pistons upon the escape-ment of air from the port openings.

8. The invention set forth in claim 7, further characterized by the fact that the different tiers of said cylinders are arranged on opposite sides of said frame and in opposite directions to the port openings arranged in a single centralized row.

9. The invention set forth in claim 7, characterized by the fact that said different tiers are arranged at different levels on opposite sides of said frame and project from the centralized port openings in different directions and at different heights from the openings thereof.

10. The invention set forth in claim 7, further characterized by the fact that said tiers each comprise a plurality of staggered rows of cylinders, said tiers being arranged not only on opposite sides of said frame but also at different levels, whereby the row of port openings communicate with cylinders on both sides of the frame at different levels or tiers and rows of cylinders arranged in staggered formation within the tiers.

11. The invention set forth in claim 7, characterized by the fact that the cylinders in said plurality of tiers are arranged in a staggered formation therein and said tiers are placed on opposite sides of said frame at different levels and further characterized by the fact that the port openings are connected thereto alternately with one port opening communicating with a cylinder in one tier and the next port opening communicating with a cylinder in the other tier.

12. The invention set forth in claim 7, characterized by the provision of four rows of cylinders arranged in two tiers, the two rows of cylinders in each tier being arranged in a staggered formation therein, said tiers being arranged with the cylinders on opposite sides of said frame and at different levels therein, said port openings communicating with said four rows of cylinders alternately with respect to the different tiers and rows, whereby a space is provided for each cylinder opening four times that of the space provided for each port opening.

13. A pneumatic sensing unit having a frame composed of four rectangular bars connected to form a single unit, one of the inner or centralized pair of said bars being formed with a series of

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facing grooves to form a row of port openings, said centralized pair of bars also being formed with a plurality of tiers of circular openings arranged in staggered formation at right angles to said port opening grooves and communicating therewith to furnish individual cylinders for the port openings, the two outer pairs of bars being formed with inner longitudinal grooves comprising air chambers communicating with all cylinders, means for supplying air to said chambers, pistons in said cylinders, and electrical devices operated by said pistons when air is allowed to escape through any of said port openings.

14. The invention set forth in claim 3, characterized by the fact that the electrical contact devices include a flexible member in cooperation with said piston rod to force an extending end of said piston into an abutting relation with a wall of said frame, whereby the electrical contact device serves a dual purpose in restoring said piston and establishing contact.

15. In a machine controlled by perforated paper sheets, a pneumatic sensing unit contacting the surface of said sheets, means for advancing said sheets with respect to said sensing unit, said sensing unit comprising a frame structure formed with a plurality of port openings ending directly on the surface of said sheet, said frame also formed with a plurality of cylinders each communicating with one of said port openings, a piston in each of said cylinders, an air chamber in said frame, means for supplying air under pressure to said chamber and in said cylinders behind said pistons so that the appearance of the perforation causes the escape of air and the movement of a related piston toward the port opening, electrical contact devices operated by movement of the pistons whereby the movement of the air away from the pistons and contact devices causes the removal of lint and dirt in a direction away from the mechanism.

16. The invention set forth in claim 3, further characterized by the substantial area of clearance provided between the piston and the cylinder, said clearance area multiplied by 12 being equal to the average volume of the port space between the piston and the air port opening.

FRED M. CARROLL.
OSCAR L. HIBBARD.

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