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[50] Field of Search..... 235/61.63,
61.11, 61.111; 339/17, 18; 200/46

[56] References Cited
UNITED STATES PATENTS
2,111,118 3/1938 Lake 235/61.6X
2,286,812 6/1942 Keefe 235/61.6X

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[54] SENSOR FOR PUNCHED CARDS
10 Claims, 9 Drawing Figs.

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200/46, 339/18
[51] Int. Cl..... G06k 7/06,
H01h 43/08, H01r 25/00, H01r 29/00

ABSTRACT: A sensor for punched cards and the like providing arrays of self-cleaning contacts of high reliability economically fabricated from standardized modular components. Contact combs having a linear set of bifurcated contact fingers are interleaved with spacers to form a planar array of contact pairs.

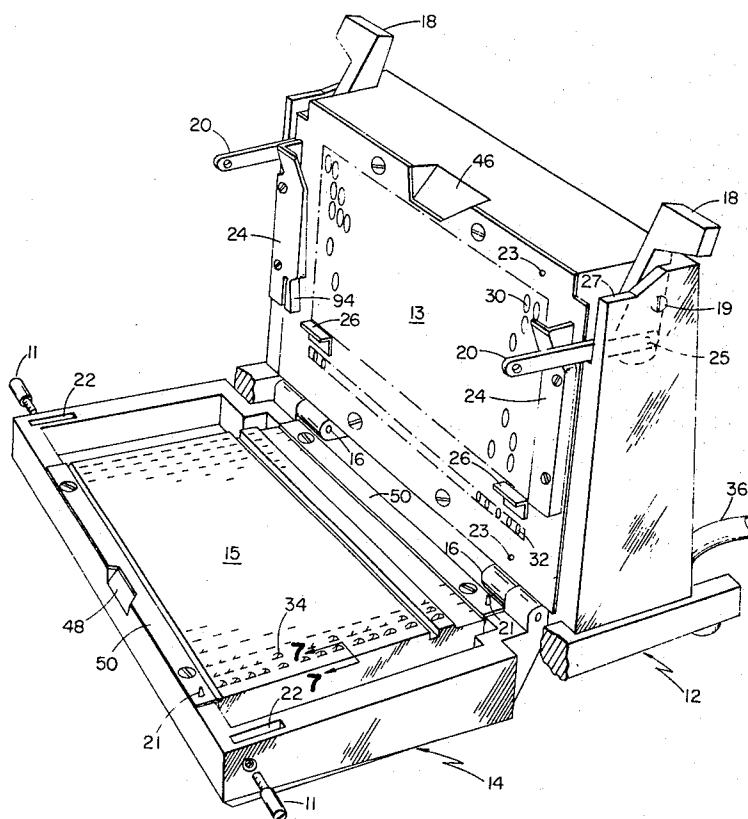


FIG 1

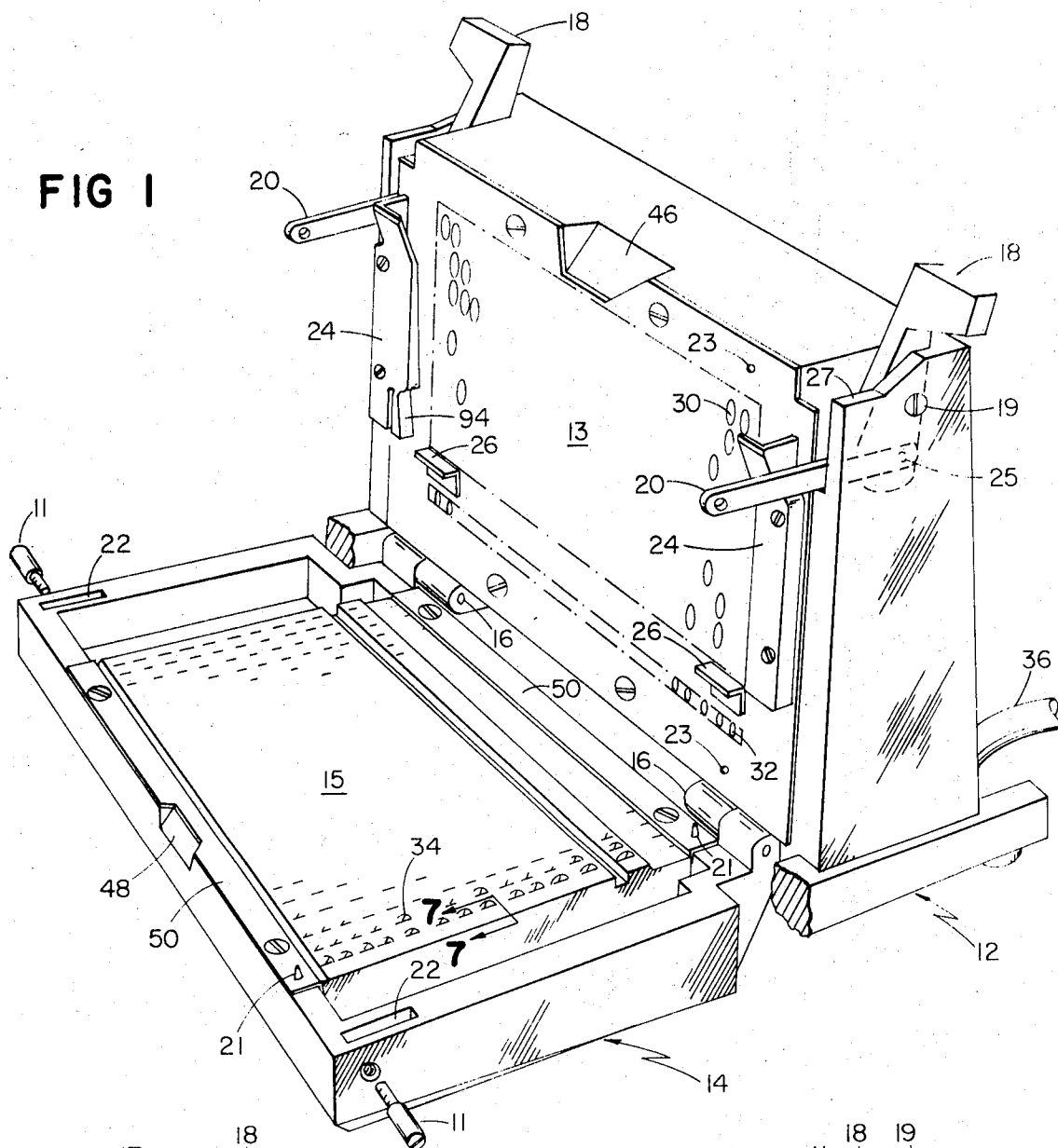


FIG 2

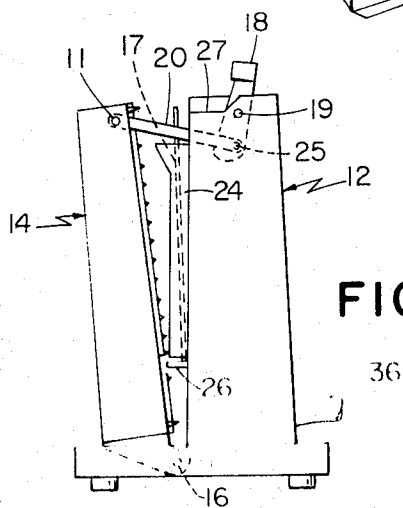


FIG 3

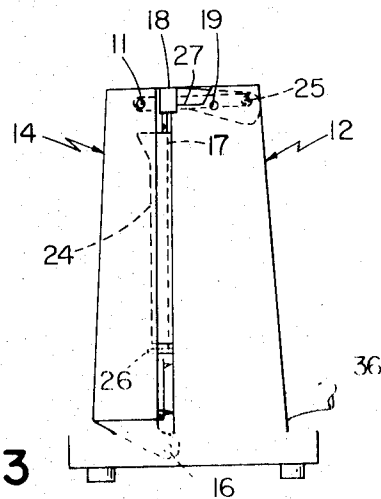


FIG 4

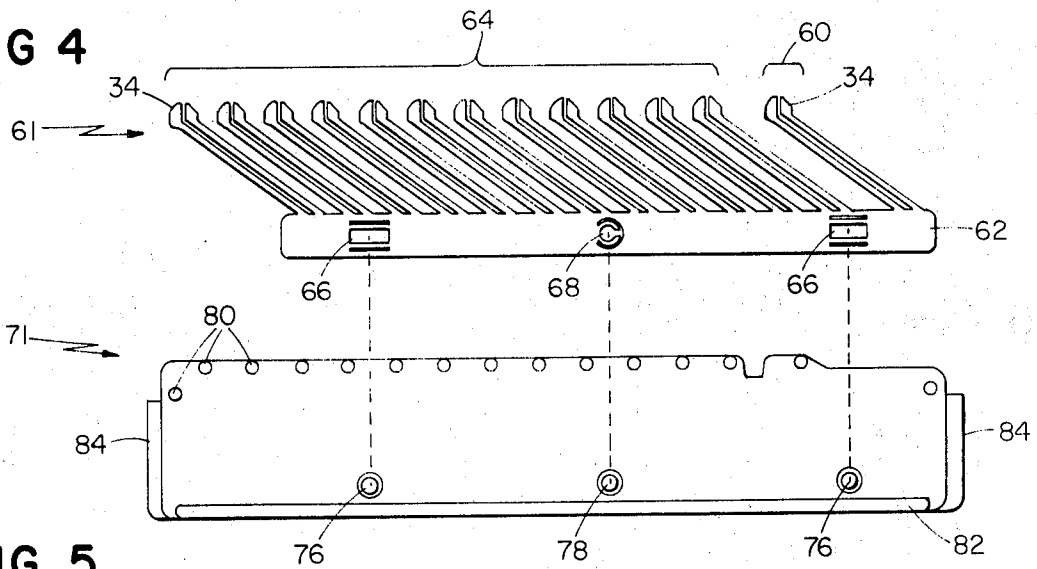


FIG 5

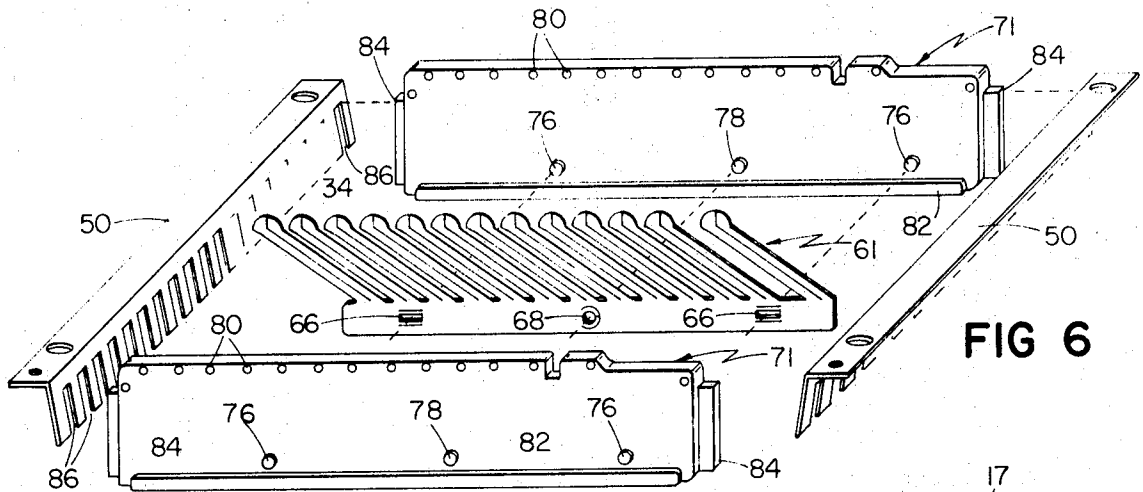


FIG 6

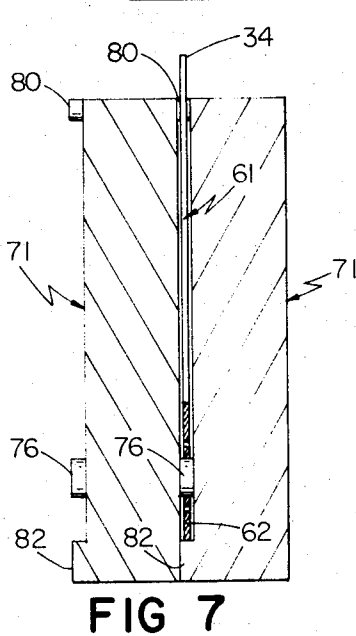


FIG 8

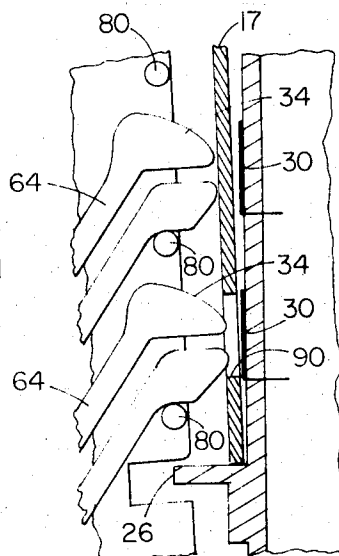
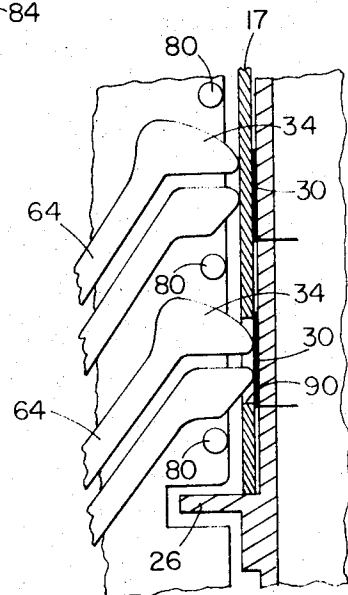


FIG 9



SENSOR FOR PUNCHED CARDS

PUNCHED RECORD SENSOR

This invention relates to an improvement in punched record sensors, particularly those such as may be used, for example, for reading manually punched preperforated cards positioned at a fixed location between a plane array of fixed contacts and a cooperating plane array of movable contacts. calculators).

Manually punched preperforated cards have a predetermined set of hole locations scored or perforated to permit manual punching with the point of a pencil or similar implement. While often more convenient than standard unperforated cards requiring the use of a key-punch (for instance, for point-of-use programming of small computers or electronic calculators), preperforated cards generally yield rougher holes than standard unperforated key-punched cards. Small projections of paper or "whiskers" often are left protruding from the edges of the holes where the chaff is punched out of the preperforated cards.

Of limited reliability under even the best of conditions, single contact points are, when used with preperforated cards, subject to an even greater rate of error. There is an appreciable risk that a fragment of unseparated paper fiber, dust, or other foreign matter will lodge at the single point of contact thus interfering with contact continuity and producing a data error.

Under certain conditions contact brushes formed from small sheaves of fine wires offer a way of obtaining better reliability than that which can be had from a single contact point. However, under adverse operating conditions contact brushes may become bent or clogged with particles of foreign matter. Furthermore, such brushes are relatively expensive to manufacture and install. A number of wires must be shaped and joined to form each single brush and the angle and position at which the brush is joined to the contact array is of critical importance.

The present invention produces contact arrays having better reliability than can be obtained from arrays of contact brushes. The increased reliability is not purchased at the cost of increased complexity and expense of manufacture. On the contrary, contact arrays produced in accordance with the invention are less costly to manufacture and install than comparable arrays of single-point spring-actuated contacts.

It is a primary object of the invention to provide an unusually reliable contact array which may be inexpensively fabricated from standardized modular components. Another object is to provide a method of assembly and installation of inexpensive low-tolerance components which automatically ensures precise alignment of each contact pair in the array with the corresponding hole position of the punched record. Yet another object is to provide movable contacts which move both normal to the plane of a fixed punched record and tangential thereto, and which are thus, to a large extent, self-cleaning.

In a preferred embodiment of the invention there is featured one or more contact combs each formed from a single strip of relatively thin sheet metal. Each contact comb has a number of resilient bifurcated contact fingers extending outwardly at substantially equal acute angles from a common base member. Cooperating spacers interleaved between adjacent contact combs locate the combs relative to each other and to the punched record.

Other objects, features and advantages will appear from the following description of a preferred embodiment of the invention taken together with the attached drawings thereof in which:

FIG 1 is a perspective view of a typical card reader incorporating the invention;

FIG 2 is an end view of the same card reader in position for insertion or withdrawal of a punched card;

FIG 3 is another end view of the same card reader in position for card readout;

FIG 4 is a side elevation of a contact comb;

FIG 5 is a side elevation of a spacer;

FIG 6 is an assembly drawing showing a contact comb, two adjacent spacers, and two spacer locating racks in perspective prior to assembly;

FIG 7 is a cross-sectional view of a contact comb and the two adjacent spacers taken along the plane of section line 7-7 of FIG 1;

FIG 8 is a greatly enlarged diagrammatic view of two bifurcated contact fingers in proximity to a punched card (with the card reader partially closed);

FIG 9 is a similar view showing the same elements with the card reader completely closed (in position for reading the card).

A perspective view of a typical card reader embodying the invention as shown in FIG 1. To more clearly show its internal parts, the reader is shown in an open maintenance position (made possible by removal of pivot screws 11) rather than in one of its two normal operating positions. End views of the same card reader in the two operating positions are shown in FIG 2 and FIG 3. To permit insertion of a punched card into the reader the two hinged halves or leaves of the reader 12 and 14 can be slightly separated as shown in FIG 2. The position for card readout is shown in FIG 3.

The leaf of the reader designated 12 is provided with an array of fixed contacts (e.g. 30) on its inner surface 13; the leaf designated 14 is provided with a cooperating array of movable contacts (e.g. 34) on its inner surface 15. Fixed-contact leaf 12 is hinged to movable contact leaf 14 at hinges 16. The two leaves are further joined by two overcenter toggle release and locking mechanisms each having an operating lever 18 pivoted at operating-lever pivot 19 to actuate connecting bar 20. Connecting bar 20 is attached to operating lever 18 at middle pivot 25 and to slot 22 by connecting-bar pivot screw 11. The toggle mechanism controls the angular separation of the two leaves as best shown in FIGS. 2 and 3. When the reader is in the open position shown in FIG 2, middle pivot 25 is below the line joining connecting-bar pivot 11 and operating-lever pivot 19. It will readily be seen that when the operating lever is rotated about operating-lever pivot 19, middle pivot 25 moves upward and to the right as viewed in FIG 2 until reaching the point where it lies on the extension of the line between pivot 11 and pivot 19; at that point the two leaves are brought together to the maximum extent and the card reader will be closed very slightly more than is shown in FIG 3. The movable contact array on inner surface 15 is then slightly compressed and movable contact pairs 34 exert a force on fixed contact leaf 12 tending to bias the two leaves of the reader toward a more open position. Operating lever 18 is then rotated by a small additional angle thus raising middle pivot 25 above the extension of the line between pivot 11 and pivot 19. This will collapse and lock the toggle in an upward direction. The reader is then held in the closed position of FIG 3; the opening bias of contact pairs 34 locks operating lever 18 against stop ledge 27 until the operating lever is rotated to the FIG 2 position to reopen the reader leaves.

With the reader in open position as shown in FIG 2 a single punched card 17 may be inserted in side guides 24 until the lower edge of the card comes to rest on positioning stops 26. (The side guides are preferably molded of a high-lubricity material such as Delrin and one of them may be provided with an integral leaf spring 94 to hold the best reference end of the punched card in the correct lateral position.) Operating levers 18 are then rotated to close the reader to the FIG 3 readout position. Hinges 16 and toggle linkage pivots 19 are preferably adjustable. This permits the closed position separation between each of the four corners of the fixed and movable contact leaves to be precisely and independently adjusted for optimum contact performance. Correct alignment of leaves 12 and 14 in the plane of surfaces 13 and 15 is ensured by tapered key 21 and cooperating socket 23.

The inner or working surface 13 of fixed-contact leaf 12 may be inexpensively fabricated from an etched circuit card. Each punch location of the punched card to be sensed corresponds to a small oval contact area 30 on the etched card.

The portion of surface 13 above positioning stops 26 is provided with 40 vertical columns of 12 such contacts each. An additional horizontal row 32 of 40 "common" contacts is located below the positioning stops.

The inner surface 15 of movable-contact leaf 14 is provided with 520 pairs of movable contacts 34 also arranged in 40 columns of 13 contacts each. Each pair of movable contacts 34 is precisely located to cooperate with a corresponding fixed contact 30. Operation and structure of the movable contact array will be described in greater detail in conjunction with the associated figures, FIG 4 through FIG 9.

A counter, which may be located either within the card reader or externally, counts the column numbers from 1 to 40. The output of the counter is decoded to select the particular vertical column corresponding to the current count and the corresponding fixed contact in the "common" row is energized. Since the 13 movable contact pairs in each given column are interconnected through a very low resistance contact comb all of the movable contacts in the given column are energized. Current is passed through to the fixed contact points 30 in those specific horizontal rows of the selected column corresponding to the punched locations of card 17 (in the selected column). At those locations where the card is not punched, the movable contacts are, of course, prevented from making contact with the corresponding fixed contacts. The 40 fixed contacts in each of the 12 horizontal rows of fixed contacts above the stops 26 are bussed to a common output line. Output signals consequently appear on some of the 12 output lines corresponding to the 12 horizontal rows, signals being present on output lines corresponding to those rows where the card is punched in the selected column and not present on output lines corresponding to rows where it is not punched. When the counter is stepped, the next column is selected, and the fixed contact in the "common" row of that column is energized. In this manner the card reader can rapidly scan all punch locations of a given punched card and readout its contents in 40 sequential steps of 12 signals each. After the reading of a card is completed, the operating levers 18 are returned to the open position shown in FIG 2 and the edge of the card may be grasped at notches 46 and 48 to remove the card from the reader.

The construction and control of one practical form of card reader that has been used with the punched record sensor of the invention is described above. It will, of course, be understood that other readers and alternate methods of control also may be employed without departing from the principles of the invention claimed.

The movable contact array at inner surface 15 of leaf 14 contains 40 identical contact combs 61 one of which is shown in side elevation in FIG 4. These contact combs are positioned between 41 identical spacers (see FIG 5). The spacers are in turn positioned between spacer locating racks 50 as is best seen in FIG 6.

The contact comb 61 shown in FIG 4 is stamped from a single strip of heat treated full-hard beryllium copper 0.007 inches thick. The comb includes 13 bifurcated contact fingers each extending outwardly from a common base member 61 at an acute angle of about 35°. The tips of each contact finger are widened to provide a pair of contact surfaces 34 having appreciable stiffness and resistance to twisting or bending. Only the tips of contact pairs 34 are visible in FIG 1; the rest of the contact fingers and the base member 62 are below the edges of the adjacent spacers.

Contact finger 60 carries the "common" movable contact pair; the remaining 12 contact fingers 64 sense the 12 card punch locations in a single vertical column of the punched card 17. The two halves of each bifurcated contact finger are 0.030 inches wide and the space between the halves is 0.0125 inches. Each finger is about one-inch in length. The 12 card-sensing contact fingers 64 are separated from each other by 0.250 inches, and this dimension should preferably be accurate to ± 0.001 inch to ensure that the fingers are aligned with the holes in the card and the corresponding fixed contacts 30.

Indexing slits 66 locate and hold the contact comb in the proper vertical position and indexing hole 68 locates and holds the contact comb in the proper horizontal position with respect to the adjacent spacers.

The spacer 71 shown in side elevation in FIG 5 is molded from glass-filled phenolic thermosetting plastic. Its overall thickness is about 0.174 inches. Locating studs 76 and 78 project about 0.012 inches above the surface of the spacer and are each surrounded by a small annular indentation 80. Stud 76 are positioned to mate with indexing slits 66 and stud 78 is positioned to mate with indexing hole 68 of the adjacent contact comb. The bottom of the comb rides on ridge 82 which also projects about 0.012 inches from the surface of the spacer. Fourteen limit-stop studs 80 project the same distance and are used to limit the deflection of the adjacent contact comb's contact fingers. The obverse side of the spacer is flat and has no projections. Tenons 84 at the ends of the spacer fit into cooperating notches 86 in spacer locating racks 50 as shown in FIG 6.

FIG 7 is a sectional view of a single contact comb 61 and the two adjacent spacers 71 taken along the line 7-7 of FIG 1. Although the thickness of contact comb 61 is only 0.007 inches, the inner surfaces of the two adjacent spacers 71 are spaced apart by approximately the thickness of ridge 82 and studs 76, 78, and 80 (about 0.012 inches), so that the contact fingers are free to move between the spacers (within the constraints imposed by the limit stop studs 80) when deflected by the fixed contacts 30 or the punched card 17.

The spacer locating racks 50 ensure that the separation between adjacent contact combs is precisely equal to that between adjacent columns of punch locations in the punched card 17. This avoids any problem of cumulative error due to normal variation in the nominal 0.174 inch thickness of the plastic spacers. Because the tolerance of the individual spacers can be relatively low it is possible to utilize relatively inexpensive techniques of fabrication, thus lowering the cost of constructing a contact array of given size.

In operation, the reader is first opened to the position shown in FIG 2. A punched card is inserted between side guides 24 until the long lower edge of the card rests upon positioning stops 26. Operating levers 18 are then rotated to close the card reader to the position shown in FIG 3. This causes the contact surfaces of the contact pairs 34 of the movable contact array to be pressed against the card and so to sense the 480 punch locations of the card.

The sensing operation is detailed in FIG 8 and FIG 9, FIG 8 shows two of the bifurcated contact fingers 64 just beginning to touch the card surface (as the reader nears the closed position of FIG 3). The lower contact finger is adjacent to a hole 90 in the card 17, the upper to an unpunched card punch location. The contact pairs 34 protrude only about 0.060 inches beyond the surface of spacers 71 and only the widened end portions of the contact fingers are exposed; these are stiff enough to resist bending or twisting. The thinner and more readily deformed portions of the contact fingers are constrained and protected by the closely adjacent surfaces of spacers 71.

With the contact fingers undeflected as shown in FIG 8, the lower surfaces of the contact pairs rest against limit stop studs 80. These studs protect the contact fingers from the accidental deformation that might otherwise occur should the edge of a bent or damaged card be inadvertently forced down upon the upper surface of a contact pair during card insertion.

In FIG 9 the card reader is completely closed to the FIG 3 position and ready for readout. The contact pair 34 at the end of the lower contact finger shown in FIG 9 has penetrated hole 90 of card 17 and is making firm contact with the corresponding fixed contact 30. The upper contact pair 34 is prevented from contacting its corresponding fixed contact 30 by the presence of the intervening unpunched material of card 17.

As the closure of the card reader is completed the contact fingers move from the position shown in FIG 8 to that shown in FIG 9. Fixed contacts 30 and card 17 exert pressure on con-

tact pairs 34 causing the contact fingers to be deflected both normal to the card surface (to the left in FIG 9) and tangential to the card surface (upward in FIG 9). The normal deflection is about 0.025 to 0.030 inches; the tangential deflection is about 0.015 inches. The tangential deflection raises the lower surfaces of the contact pairs clear of limit stop studs 80 and results in a sliding contact rather than a mere pressing contact through hole 90 to fixed contact 30. This sliding contact coupled with the redundancy inherent in there being two separate contact surfaces at the tip of each bifurcated contact finger results in extremely high reliability. The sliding motion helps to ensure that positive electrical contact is made through every hole of the punched card even through some of the holes may contain fibers of paper or other obstructions.

It may be that as the contact surfaces slide across the hole they tend to cut through small obstructions or perhaps to sweep them out of the way. Whatever the cause may be, it has been observed that the operational reliability of the contacts is far better when such sliding motion is present than when it is not, as, for example, in other punched record sensors where the contact action results only in contact motion normal to the surface of the punched record. The fact that the sliding motion is an automatic consequence of the motion of the movable contact leaf of the reader normal to the surface of the record renders the punched record sensor of the present invention well suited for use with relatively inexpensive card readers wherein the card remains fixed in a single position throughout sensing and readout, and particularly well suited for use with manually punched perforated cards.

Other embodiments will occur to those skilled in the art and are within the following claims.

We claim:

1. A contact comb of the type used for sensing punched records comprising a base member and a plurality of coplanar bifurcated contact fingers of resilient material extending outwardly from said base member at acute angles thereto each bifurcation of each of said contact fingers terminating in an electrical contact surface.

2. The contact comb of claim 1 wherein said base member and said contact fingers are integral portions of a unitary sheet of relatively thin metal.

3. The contact comb of claim 2 wherein a portion of each of said contact fingers distal from said base member and proximal to said contact surfaces is wider than the remainder of said contact fingers.

4. The contact comb of claim 1 wherein said base member is provided with a plurality of indexing apertures.

5. A movable contact array of the type used for sensing punched records comprising a plurality of spaced contact combs:

each of said contact combs comprising a base member and a plurality of coplanar bifurcated contact fingers of resilient material extending outwardly from said base member at acute angles thereto;

each bifurcation of each of said contact fingers terminating in an electrical contact surface; and

nonconducting spacers interposed between adjacent pairs of said contact combs.

6. The movable contact array of claim 5 wherein each of said spacers engages said base member of at least one of said contact combs adjacent to said spacer and is fixed at a predetermined spacing from adjacent spacers and from the contact fingers of adjacent contact combs whereby a predetermined separation is maintained between contact combs and free deflection of said contact fingers toward said base members is permitted.

7. The movable contact array of claim 5 wherein each of said spacers further comprises means for limiting the deflection of the contact fingers of at least one adjacent contact comb.

8. A punched record sensor comprising in combination the movable contact array of claim 5 and a fixed contact plate; said fixed contact plate comprising an array of fixed con-

tacts spaced from each other and each positioned to make electrical contact with the contact surfaces of a corresponding contact finger of said movable contact array.

9. The punched record sensor of claim 8 wherein:

said movable contact array and said fixed contact plate are mounted for movement relative to each other between a first open position and a second closed position;

said first open position providing a space between said movable contact array and said fixed contact plate in which a punched record can be interposed;

said second closed position permitting the contact surfaces of those contact fingers adjacent to punched locations of said punched record to make electrical contact with the corresponding fixed contacts of said fixed contact plate; and

movement from said first position to said second position causing the contact surfaces of said movable contact array to move toward said fixed contact plate until said contact fingers are deflected by contact with said fixed contacts or with the surface of said punched record and thereafter to move in a direction generally tangential to said fixed contacts whereby a sliding contact is achieved between each contact surface adjacent to a punched location of said punched record and the corresponding fixed contact of said fixed contact plate.

10. A punched record sensor comprising:

a first contact leaf and a second contact leaf one comprising a generally planar array of movable contacts and the other of fixed contacts, said first contact leaf being hingedly mounted to said second contact leaf for a limited range of swinging motion relative thereto, said range extending from a first open position wherein portions of said contact leaf remote from the hingeline are sufficiently separated to permit insertion of a punched record between said contact arrays to a second closed position wherein said array of movable contacts mates with said array of fixed contacts;

said array of movable contacts comprising a plurality of contact combs, each of said combs comprising a base member and a plurality of coplanar bifurcated contact fingers of resilient material extending outwardly from said base member at acute angles thereto, each bifurcation of each of said contact fingers terminating in an electrical contact surface and nonconducting spacers interposed between adjacent pairs of said contact combs, each of said spacers engaging said base member of at least one of said contact combs adjacent to said spacer and being fixed at a predetermined spacing from adjacent spacers and from the contact fingers of adjacent contact combs whereby a predetermined separation is maintained between contact combs and free deflection of said contact fingers toward said base members is permitted, each of said spacers comprising means for limiting the deflection of the contact fingers of at least one adjacent contact comb;

said array of fixed contacts comprising a plurality of fixed contacts spaced from each other and each positioned to make electrical contact with the contact surfaces of a corresponding contact finger of said array of movable contacts;

bias means operable in said second position to bias said contact leaves toward said first position; and

an overcenter toggle mechanism for controlling the arcuate position of said first leaf relative to said second leaf, comprising an operating lever pivotally mounted to said first leaf at a first pivot axis, a connecting bar pivotally mounted to said second leaf at a second pivot axis and pivotally mounted to said operating lever at a third pivot axis, said operating lever being rotatable to straighten said toggle mechanism to a position wherein said third axis lies on a line connecting said first axis and said second axis and being further rotatable to a limit stop to lock said toggle mechanism and to hold said leaves against said bias means in said second position.