Dec. 21, 1965 O. D. JOHNSON ETAL 3,224,671

ROTARY PUNCHING DEVICE

Filed Oct. 30, 1963 2 Sheets-Sheet 1

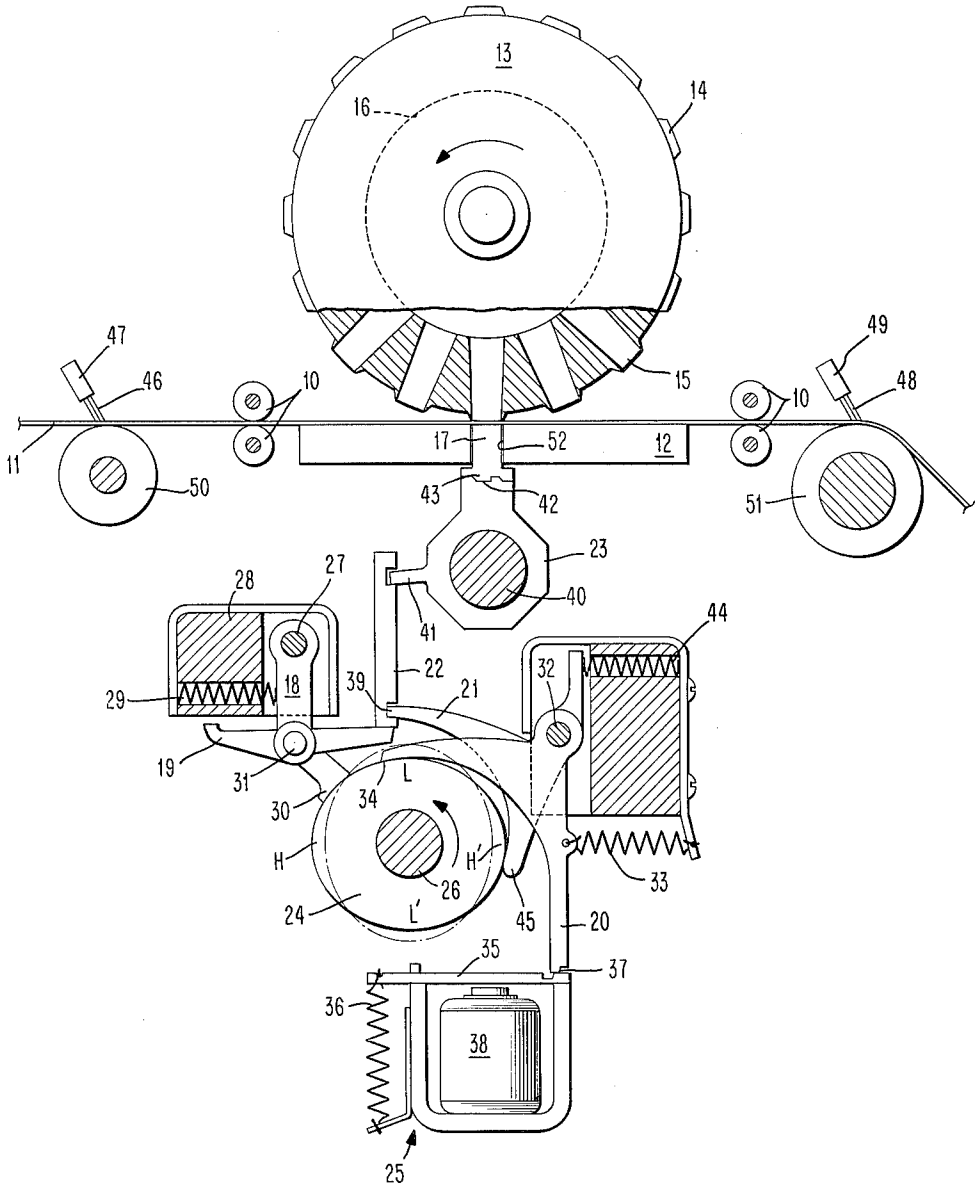

FIG. 1

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Filed Oct. 30, 1963 2 Sheets-Sheet 2

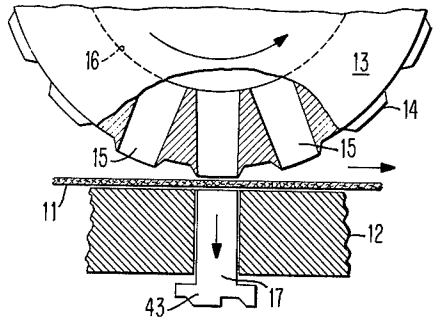

FIG. 2

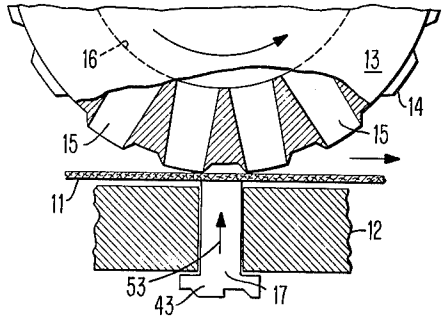

FIG. 3

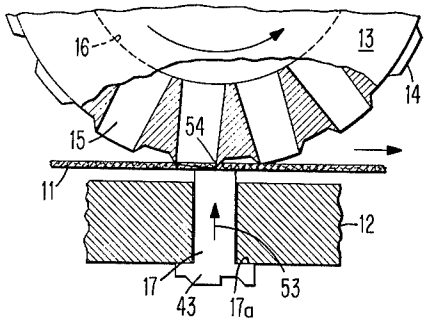

FIG. 4

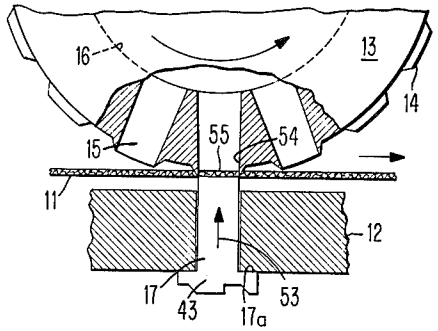

FIG. 5

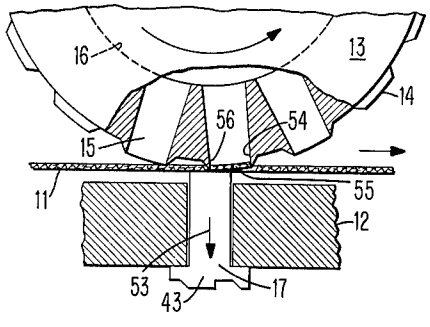

FIG. 6

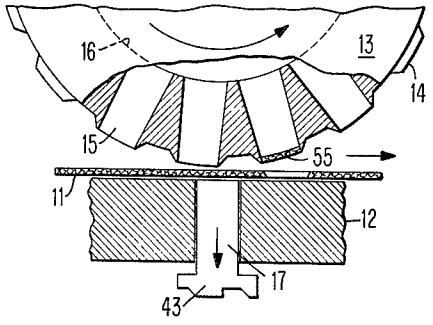

FIG. 7

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3,224,671

ROTARY PUNCHING DEVICE

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Filed Oct. 30, 1963, Ser. No. 320,177
12 Claims. (Cl. 234—50)

This invention relates to a rotary punching device and more particularly to a rotary selective punching device having hollow punching elements and which is specially adapted for high speed operation.

There are a number of punching devices presently in use for selectively perforating record cards and the like which are employed in record controlled statistical machines. Heretofore, such devices have made use of general punch mechanism designed which have been known for some time. For example, one common punch format makes use of solid punch elements which are selectively reciprocated into and out of mating holes in a stationary die. In devices of this type, the cards or material to be punched are fed with an intermittent motion, thus greatly reducing the speed of punching. Also, the mating of the punch and die elements is critical and problems also exist in timing of punch selection. Additional problems are also raised due to the fact that the punching load is carried by the selecting mechanism of the punch which directly operates punch interposers or the like. Rotary punches have been used where punch elements on a rotary carrier are directed under control of a selection mechanism into and out of mating holes in a rotating die or a swinging die. The speed of punching was somewhat increased but the problems of mating the punch and die elements as well as loading the punch selection mechanism remained and limited the improvement of operation. Also known in the art is the use of rotary punches wherein the punch elements on a rotary carrier cooperate with a solid rotating backup roll to effect punching. However, these punches are used to perform repetitive gang punching type of operations and no means is provided to carry out automatic high speed selective punching operations. The punch elements are detachably secured on the rotating carrier and when it is desired to change the format of punching, the punch elements have to be manually rearranged.

To overcome the above problems and satisfactorily meet the increased output that present day business demands, the present invention provides an improved and vastly superior rotary selective punching device which is not only adapted for extremely high speed operation but which also eliminates the use of mating punch and die elements and also eliminates the need for having the selection mechanism carry the punch loading. The present punch makes use of the principle of severing material through the use of a hollow punch and a solid anvil. The embodiment of this principle in an "on the fly" punch is worthy of note since it becomes unnecessary to provide any incrementing drive to the card, thus reducing the complexity and cost of the document transport itself with attendant increase in registration control. The preferred form of rotary selective punching device comprises a plurality of hollow punches mounted around the circumference of a hollow cylinder which rotates on a hollow axle through which the punched chips may be drawn by a vacuum. The cylinder is driven in synchronism with the cards or material to be punched but the surface contact is at a very low pressure to avoid marking the material. A row of movable anvils, one for each desired punching position, is placed in a line parallel to the axis of the cylinder. Each of these anvils is normally resting in a retracted position, but may be selectively cammed

toward the axis of the cylinder by an electromechanical selection or punch control mechanism. In the selected position, the anvil supports the cardstock against the moving hollow punch to shear a chip, forming the hole. The actual punching is to within .0002 inch which fractures the stock fiber sufficiently to completely sever the chad. For other types of material, a different relationship between punch and anvil may be used for most effective punching action. No mating die holes are needed for the punches and hence no close registration problem is presented. Also, there is no metal to metal contact which greatly prolongs the life of the punches. A further advantage of the present design is that the selection mechanism oprates the anvils and not the punches and hence it dos not have to carry the load of forcing the punches through the card-stock as in prior devices. The movement of the selected anvil is completed before the selected punch element starts passing through the cardstock.

Accordingly, a principal object of the present invention is to provide high speed rotary selective punching device.

A further object of the present invention is to provide a high speed rotary selective punching device wherein the punching load is not provided or carried by the selection mechanism.

A further object of the present invention is to provide a high speed rotary selective punching device wherein there is no mating of punch and die elements and therefore, the timing of the selection is not critical.

A still further object of the present invention is to provide a high speed rotary selective punching device wherein a backup member can be preselected or prepositioned in anticipation of the punching action.

A still further object of the present invention is to provide a rotary selective punching device wherein the operating elements have greater simplicity and where the restrictions on size and shape of the selection system are greatly relieved.

A further objective of the present invention is to provide a rotary selective punching device having an arrangement of hollow punch elements and soil anvil backup members which cooperate to punch the material to within .0002 inch which fractures stock fiber to completely sever a chad with no tolerance problem and no metal to metal contact.

Another object of the present invention is to provide a rotary selective punching device wherein the location of the hole is not dependent on precise timing of the selection device.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a schematic elevation view of a punching machine embodying the principles of the present invention.

FIGS. 2 through 7 are schematic views showing progressively the action of selective punching in the machine of FIG. 1.

As shown in FIG. 1, the improved machine illustrated therein comprises briefly means, such as feed rolls **10**, for moving cardstock **11** continuously along a card feed path defined by support plate **12** and in a direction from left to right, as viewed in this figure, relative to a continuously rotating punch carrying cylinder **13**. Any suitable drive mechanism may be provided for rolls **10** and cylinder **13** so that the cylinder is driven in synchronism with the material or cards to be punched. It will be understood that by providing additional feed rolls individual record cards may be continuously fed past the cylinder and punched in the same fashion as a continuous

strip of material. Disposed around the surface of the cylinder are a plurality of punching elements **14** shaped and spaced so as to provide all combination of the desired hole configurations in the end product. Each punch element has a thru hole **15** which communicates with a hollow shaft **16** of the punch cylinder to provide for the removal of the punched chips by suitable vacuum means.

Positioned adjacent the punching cylinder is a single row or bank of movable solid anvil members **17**, only one of which is shown. This bank preferably comprises a number of anvils **17** equal to the number of columns (rather than rows) provided on the record card (for example, 80 anvils for a conventional 80-column, 12 row card), so that the cards will be punched in parallel (that is, row by row). A conventional 80-column, 12 row card having 960 punching positions is fully shown and described in U.S. Patent 1,928,209 which issued to A. W. Mills on September 26, 1933. When punching in parallel, cylinder **13** may be provided, for example, with 12 rows of 80 punch elements **14** or 960 punch elements to cover all possible punching positions on the conventional 80-column record card and each one of the 80 anvils **17** will be provided with its individual selection mechanism, only one of which is shown in FIG. 1. It will be noted that cylinder **13** is shown as having 16 rows of punch elements. The reason for this is that in the preferred embodiment of the invention, parallel punching is carried out on a 16 cycle point machine. It requires 12 cycle points of machine operation to punch the 12 rows and there are 4 cycle points of machine operation between the last row on one record card and the first row of the following record card. The 4 extra rows of punch elements would not be used during parallel punching of individual record cards. Of course, all 16 rows may be used when punching a continuous strip of record material. It will be understood that punching may be carried out column by column on a serial sequence. Machines designed to punch column by column would be equipped with 960 punches and 12 anvil mechanisms and the punch cylinder driven to match the card or web transport speed.

When parallel punching, it will be understood that more or less than 16 rows of punch elements may be used. In fact it is highly desirable to use more than 16 rows, such as for example 17 rows, to set up a hunting condition wherein the punching pattern will be variably distributed over the punch elements. This reduces the number of times that each punch element is used and materially decreases the wear of the punches. Additionally, the punch cylinder size can be any integral number of punch spacings, the punch spacings being preferably ¼ inch.

The anvils **17** pass through the support plate **12** and are reciprocated to allow either full clearance for the record material **11** or confinement of the material between a punch element **14** and a selected anvil **17** to produce a hole. Operation of each anvil **17** is independently controlled by a corresponding selection mechanism including an element or lever **18**, interposer **19**, interposer lever **20**, restoring lever **21**, operating element **22**, anvil cam **23** and rotary cam **24**, each of identical configuration, and a preferably electrical controlled holding means **26**.

The anvil selection mechanism shown in FIG. 1 comprises the cams **24** which are mounted side-by-side and keyed to, and constantly rotated counterclockwise by, a driven shaft **26** journaled in the side frames; however, it preferred, a single cam roll may be used instead of 80 transversely spaced cams. Each cam **24** has a cam surface defined by two lobes of identical and symmetrical configuration such that their respective low points L, L' are diametrically opposite each other and arranged 90° to their respective diametrically opposite high point H, H'.

Each lever **18** is rockably fulcrumed on a pin **27** carried on a fixed support member **28**. A spring **29** is anchored to support **28** and connected to one arm of lever **18**. Spring **29** biases lever **18** clockwise about pin **27** to bias a follower **30**, which is carried at the outer end of the other arm of said lever, into contact with cam **24**. Each interposer **19** is pivotally connected by a pin **31** to said other arm of the corresponding lever **18** at a point intermedaite pin **27** and follower **30**. Each interposer **19** is laterally confined with slight clearance between the operating element **22** and the top of the corresponding interposer lever **20** to assure that the interposer **19** will be constrained to move generally transversely of the axis of element **22** as lever **18** rocks on pin **27**.

Each interposer lever **20** is rockably supported on a fixed fulcrum pin **32** and biased counterclockwise about said pin by a suitably anchored spring **33** to bias one end of the interposer lever into contact with the corresponding cam **24**. However, the holding means **25** normally latches interposer lever **20** in a normal position in which the follower end **34** of the lever is held effectively disengaged from cam **24** and said follower end will abut the free end of the interposer **19** for applying thereto a force which acts through pin **31** and lever **18** to also hold interposer **19** disengaged from the cam.

Each holding means **25** preferably comprises an armature **35** that normally is biased toward lever **20** by a spring **36** so that it can interlockingly engage a shoulder **37** provided at the end of the lever. When a corresponding magnet **38** is energized, it will attract the associated armature **35** and thus free the lever **20** so that it will be rocked by spring **33** and carry follower end **34** into contact with cam **24**.

Each restoring lever **21** is preferably in the form of a bell crank rockably supported at its knee of pin **32**. A hook-like end **39** of one arm of lever **21** projects into a notch in the side of the corresponding operating element **22** to provide an interlocking type connection between said element and the corresponding anvil **17**. The anvil cams **23** are rockably mounted on a fixed shaft **40** and each cam has a projection **41** which extends into a notch in the side of the corresponding element **22**. Each cam **23** is provided with an irregular camming surface **42** which coacts with a mating complementary surface **43** on the corresponding anvil **17** to effect reciprocal motion of the anvil. A light spring **44** biases the lever **21** clockwise about pin **32** to hold the follower end **45** of the lever against the surface of cam **24**. It will be noted that the high points on cam **24** act through lever **21** to allow the anvil to drop to a retracted position and the spring **44** is merely strong enough to maintain the follower end **45** of the lever against the surface of cam **24**.

Energization of each magnet **38** may be controlled selectively in any desired manner. For example, when punching individual cards the various magnets **38** may be energized either by the brushes **46** of sensing station **47** or the brushes **48** of sensing station **49**. Station **47** is used if information sensed from one card is to be sent to a calculator (not shown) to compute results to be punched in that card or the preceding card; whereas station **49** is used if information sensed from a preceding card is to be punched in a subsequent card.

Each of these brushes **46** or **48**, as the case may be, complete a corresponding electrical circuit when they detect perforations in a card as it moves between the brushes and respective contact rolls **50**, **51**; it is to be noted, however, that each such circuit is opened by a circuit breaker cam in the manner well known to those familiar with this art during the card point cycles that the brushes wipe the spaces between successive cards in order to prevent undesired energization of the control magnets **38** at such time.

To effect a punching operation a selected magnet **38** is energized and its armature **35** will unlatch the corresponding interposer lever **20**. In its normal non-punching

position, the follower end 34 of lever 20 will abut against a mating surface on the end of the corresponding interposer 19 and will remain in this raised position clear of cam 24. However, when unlatched by magnet 38 the interposer lever 20 will pivot counterclockwise due to spring 33 until the follower end 34 contacts the surface of cam 24 and interposer 19 will slide in between the bottom of operating element 22 and the top of the follower end 34, as shown in FIG. 1. As cam 24 approaches the position shown in dotted outline in FIG. 1 where either of the high points H or H' come under the follower end 34, the corresponding operating element 22 will be cammed upward causing the related anvil cam 23 interlocked therewith to be rotated clockwise a sufficient amount so that the camming surface 42 thereon will coact against the camming surface 43 on the anvil 17 to raise the anvil through an opening 52 in support plate 12 and against the cardstock 11. As will be described in more detail, the supporting of the cardstock by the selected anvil against the action of one of the punching elements 14 on the punch cylinder will effectively cause a hole to be formed in a selected position on the card.

As the follower end 34 of interposer lever 20 reaches the upward limit of its travel, the shoulder 37 on the other end of lever 20 will be engaged in the notch in the spring-biased armature, since magnet 38 will now be deenergized, and lever 20 will be latched in its upper normal position. Following this action, one of the high spots on cam 24 will come under the follower 30 of lever 18 causing the lever to pivot clockwise about pin 27 so that interposer 19 will be moved toward the left, as viewed in FIG. 1, a sufficient amount to just clear the end of follower 34 of interposer lever 20. As this action is completed, the diametrically opposite high spot on cam 24 will coact with the follower end of restoring lever 21 to pivot this lever counterclockwise about pin 32. When lever 21 pivots counterclockwise, the related operating element 22, interlocked therewith, is pulled downward to its normal position and during this movement element 22 moves the end of interposer 19 down into abutting alignment with the end of follower 34. Also the related anvil cam 23 is rotated back counterclockwise to allow anvil 17 to drop down and seat in its normal retracted position. The selection mechanism is now in position for another cycle of operation.

FIGS. 2 through 7 show progressively the action of selective punching in a preferred embodiment of the present invention which may use the anvil selection mechanism above described and shown in FIG. 1. In FIG. 2, the anvil 17 is shown held in its normal retracted position. The punches 14 and cardstock 11 move by without interference and no punchng occurs. When it is desired to produce a hole in the cardstock 11 approaching the punching position, the selection mechanism is energized to apply an upward force 53 to the selected anvil 17 and, as shown in FIG. 3, this force is timed to occur after the preceding punch element 14 has passed over the anvil. As shown in FIG. 4, force 53 lifts the anvil 17 and cardstock 11 fully into position before the leading edge 54 of the selected punch 14 has passed through the area of maximum restriction. In FIG. 5, the anvil 17 is held in its raised position while the selected punch 14 passes fully over it. The shouldered portion 17*a* on the anvil strikes the support member 12 limiting the upward travel of the anvil and card so that the selected punch 14 passes through the cardstock 11 which is supported by the anvil to within .0002 inch which fractures the stock fiber sufficiently to form the chip 55. Referring to FIG. 6, as the trailing edge 56 of the selected punch moves past the punching position the force 53 on the anvil 17 is reversed. The chip 55 has been fully cut from the remaining cardstock material. In FIG. 7, the anvil 17 is back in its fully retracted position allowing the nonselected punches 14 and cardstock material to pass without interference. The cut chip 55 is retained in the punch element 14 until mechanically forced into the thru-hole 15 by the pressure of later chips. A suitable source of vacuum may be connected to the thru-holes 15 to remove the cut chips from the punch cylinder 13.

The present invention makes available a significant speed increase for selective punching whereby machines may be operated in the order of 16,000 cycles per minute to punch 1000 record cards per minute and much higher speeds are expected. The increase in speed is also accompanied by a greater reliability of operation since no mating of punches and die holes is involved.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A high speed rotary punching device for punching record material and the like comprising in combination:
   - a rotatable punching cylinder;
   - a plurality of punch elements carried by said cylinder;
   - a support member for supporting the material to be punched out of the path of said punch elements;
   - a plurality of reciprocable backup members positioned in said support member; and
   - means selectively operable to actuate selected backup members to move said material into the path of certain of said punch elements to carry out a selective punching operation.

2. A high speed rotary punching device for punching record material and the like comprising in combination:
   - a rotatable punching cylinder;
   - a plurality of hollow punch elements carried by said cylinder;
   - a support member for supporting the material to be punched out of the path of said punch elements;
   - a plurality of reciprocable solid backup members positioned in said support member; and
   - means selectively operable to actuate selected backup members to move said material into the path of certain of said punch elements to carry out a selective punching operation.

3. A high speed rotary punching device for punching continuously fed record material and the like comprising in combination:
   - a punching cylinder rotatable in synchronism with the record material to be punched;
   - a plurality of hollow punch elements carried by said cylinder;
   - a support member for supporting said record material;
   - a plurality of movable solid anvils positioned in said support member, said anvils normally resting in a retracted position and out of the path of said record material; and
   - means selectively operable to cam a selected anvil toward said record material and punching cylinder, said selected anvil moving the record material into the path of the hollow punch elements and supporting the record material against the action of one of said rotating hollow punch elements to shear a chip and form a hole.

4. A high speed rotary punching device as defined in claim 3 and including means for automatically retracting said selected anvil out of the path of the record material after the formation of said hole.

5. A high speed rotary punching device as defined in claim 3 and including means for limiting the extent of movement of the anvils toward the punching cylinder so that the punch elements will not move completely through the record material but will fracture the material sufficiently to completely sever the chips without contacting the anvils.

6. A high speed rotary punching device for punching continuously fed record cards comprising in combination:

a punching cylinder rotatable in synchronism with the record cards to be punched;

a plurality of hollow punch elements mounted around the circumference of said cylinder;

a support member along which said record cards are fed;

a row of movable solid anvils positioned in said support member and in a line parallel to the axis of said cylinder, said anvils normally resting in a retracted position and out of the path of said record cards; and

means selectively operable to cam a selected anvil toward a record card and said punching cylinder, said selected anvil moving the record material into the path of the hollow punch elements and supporting the record card against the action of one of said rotating hollow punch elements to shear a chip and form a hole.

7. A high speed rotary punching device as defined in claim 6 and including means for controlling the limit of travel of said anvils whereby said punching elements and anvils coact when selected to cut the record cards to within the order of .0002 inch which fractures the cardstock sufficiently to completely sever a chip.

8. A high speed rotary punching device for punching continuously fed record cards comprising in combination:

a punching cylinder rotatable in synchronism with the record cards to be punched;

parallel rows and columns of hollow punch elements mounted around the circumference of said cylinder, there being one punch element provided for each punching position on a record card;

a support member along which said record cards are fed;

a row of movable solid anvils positioned in said support member and in a line parallel to the axis of said cylinder to provide one anvil in alignment with each of said parallel columns of punch elements, said anvils normally resting in a retracted position and out of the path of said record cards; and

means associated with each anvil and selectively operable to cam selected anvils toward a record card and said punching cylinder, said selected anvils moving the record card into the path of the hollow punch elements and supporting the record card against selected ones of said rotating hollow punch elements to shear chips and form holes in selected positions on said record card.

9. A high speed rotary punching device as defined in claim 8 and including selection means for effecting operation of said cam means whereby the camming of each selected anvil is timed to occur prior to the time that the leading edge of a selected punch element in the row of elements in alignment with the selected anvil passes over said selected anvil.

10. A high speed rotary punching device for punching continuously fed record material and the like comprising in combination:

a punching cylinder rotatable in synchronism with the record material to be punched;

a plurality of hollow punch elements carried by said cylinder;

a support member for supporting said record material;

a plurality of movable solid anvils positioned in said support member, said anvils normally resting in a retracted position and out of the path of said record material; and

means selectively operable to cam a selected anvil toward said record material and punching cylinder, said selected anvil moving the record material into the path of the hollow punch elements and being prepositioned to support the record material against the action of one of said rotating hollow punch elements prior to the time that said punch element contacts the supported material to shear a chip and form a hole.

11. A high speed rotary punching device for punching continuously fed record cards having parallel rows and parallel columns of punching positions which comprises in combination:

a punching cylinder rotatable in synchronism with the record cards to be punched;

parallel rows and parallel columns of hollow punch elements mounted on said cylinder and corresponding to the punching positions on said record cards, said rows of elements extending around the circumference of the cylinder with said columns of elements extending axially along the cylinder;

a support member along which said record cards are fed;

a row of movable solid anvils positioned in said support member and in a line parallel to the axis of said cylinder to provide one anvil in alignment with each of said parallel columns of punch elements, said anvils normally resting in a retracted position and out of the path of said record cards; and

means associated with each anvil and selectively operable to cam selected anvils towards a record card and said punching cylinder, said selected anvils moving the record card into the path of the hollow punch elements and supporting the record card against selected ones of said rotating hollow punch elements to shear chips and form holes in selected positions on said record card.

12. A high speed rotary punching device as defined in claim 11 wherein more parallel rows of punch elements are provided around the cylinder than there are parallel rows of punching positions on the record cards to enable punching patterns to be variably distributed over the punch elements.

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