July 2, 1963 W. F. BRADBURY 3,096,015

BALL PERFORATOR

Filed Jan. 27, 1960 3 Sheets-Sheet 1

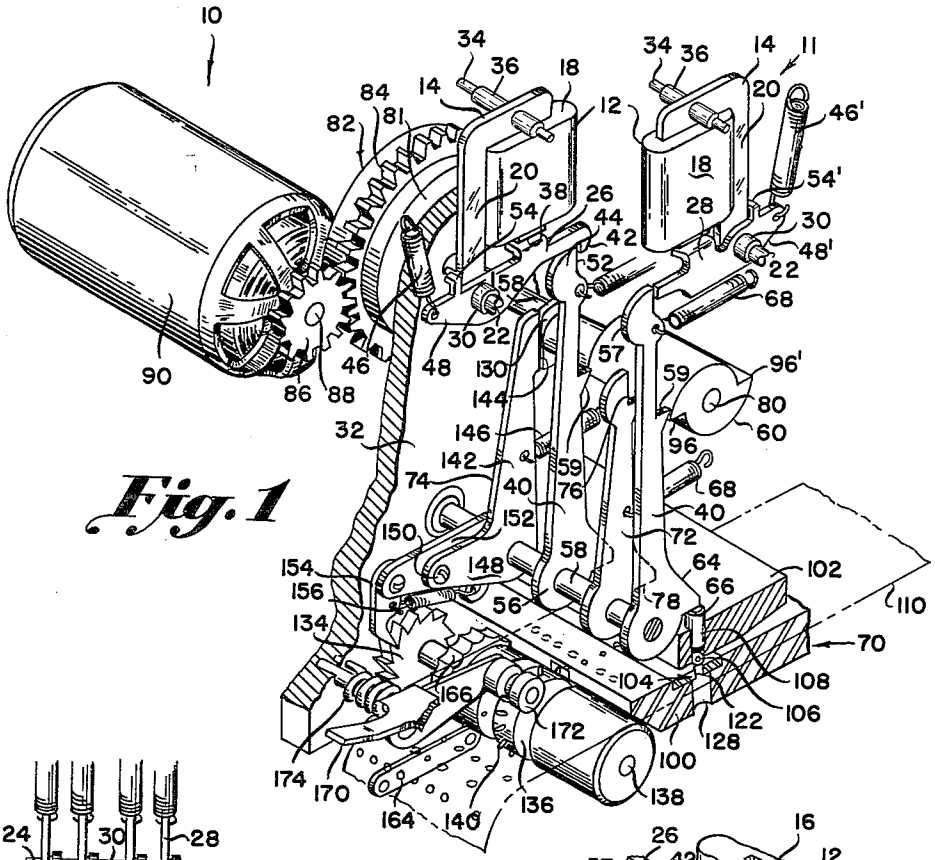


Fig. 1

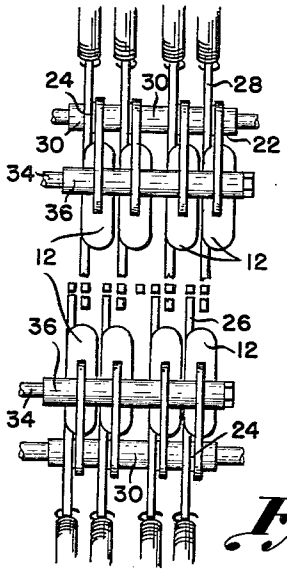


Fig. 2

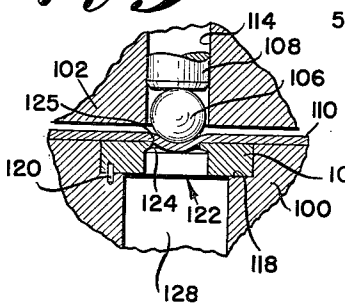


Fig. 3

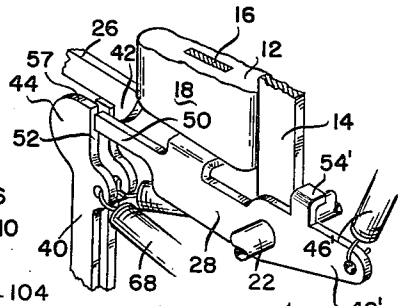


Fig. 4

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BALL PERFORATOR

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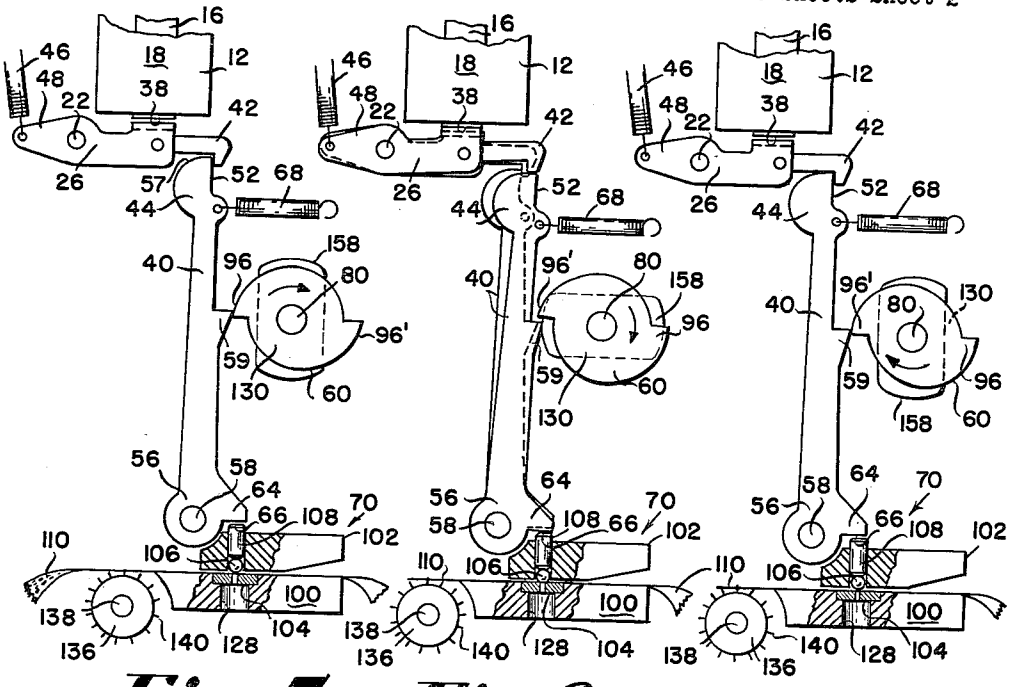



Fig. 5 Fig. 6 Fig. 7

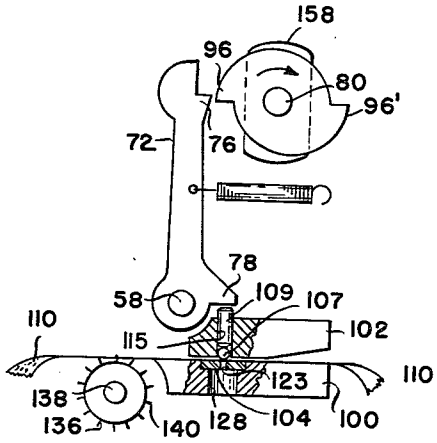



Fig. 8

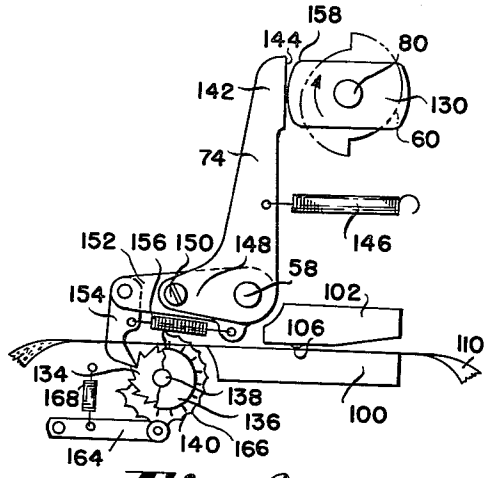



Fig. 9

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BALL PERFORATOR

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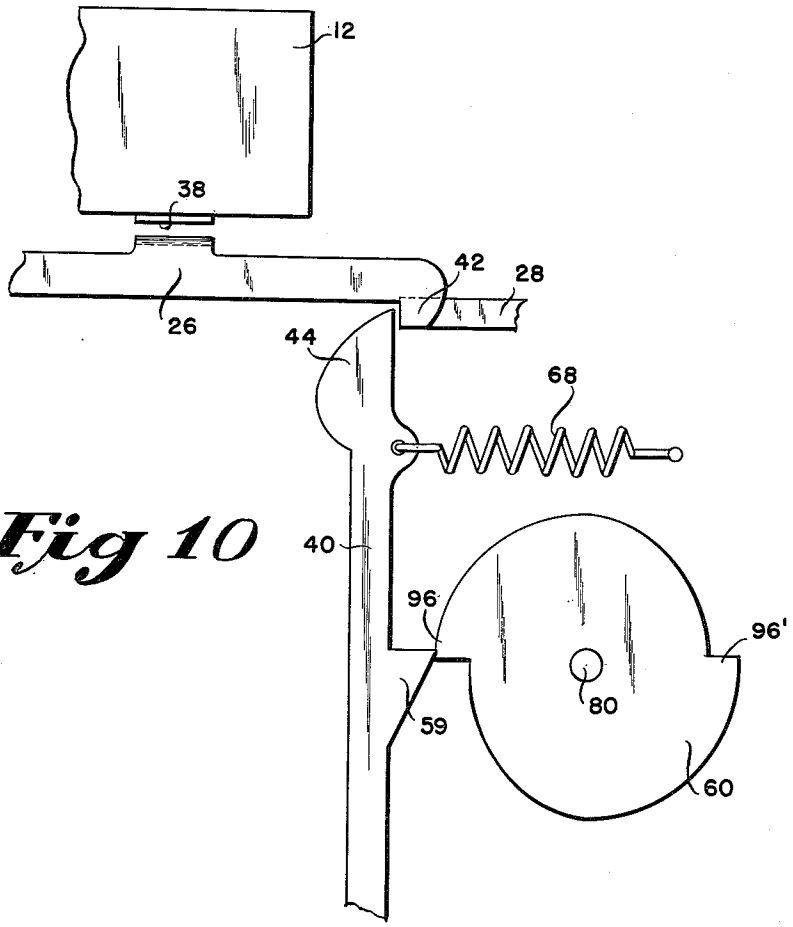



Fig 10

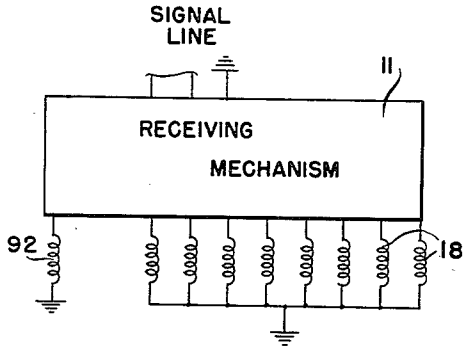



Fig 11

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United States Patent Office 3,096,015 Patented July 2, 1963



3,096,015

# BALL PERFORATOR

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Filed Jan. 27, 1960, Ser. No. 4,916
20 Claims. (Cl. 234—107)

This invention relates to a high speed perforator using ball type punches and adapted to punch on tape or other record media, coded or uncoded data, from high speed systems such as calculators, business machines, computers and telegraphic systems.

For some time interested segments of industry have been experimenting with code punching devices in an effort to produce a simplified machine capable of attaining very high speeds and at the same time realizing an extensive reduction in manufacturing costs. Many perforators in use today frequently employ highly complicated cam elements, involved linkage arrangements and close tolerance punch and die systems. Such arrangements in most cases place limits on the operation speed and always create high manufacturing costs due to complex and critical machining problems.

The use of electro-magnets as punch selection control components in punching mechanisms is well known. Also, the use of the steel ball as a punching medium is known but not widely utilized. However, the combined association of these two mechanisms creates a structural and functional perforating and control mechanism not previously known.

In the present invention, a series of punch actuating levers are mechanically retained, against a biasing force, by correlated action between a cycle cam and a series of individual punch lever latch members constituting pivoted armatures associated with individual selector electro-magnets.

When the selected electro-magnets are energized by electric impulses of a received coded signal combination, their armatures (the punch lever latching members) move upward, unblocking the path of movement of selected punch levers, enabling them to pivot under spring bias, when released by the cycle cam, to perform the punching operation. An instant after the punching operation has been performed, the selected punch levers are returned to the reset or start position by cam means ready for the next code signal combination which will set the cycle in motion once again.

As will be noted, no specific receiving circuit for the selector magnets is shown inasmuch as any well known mechanical or electronic receiving apparatus can be used to energize the selector magnets, and too, the receiving circuitry actually does not form a per se part of the subject matter of the present invention.

Accordingly, a principal object of this invention is the provision of a multiple punch ball type perforator capable of very high speeds.

Another object is to provide a high speed punching apparatus with a plurality of selector magnets which, when energized by code signals, retain any unselected code punch levers throughout the punching cycle and permit release of the selected punch levers allowing them to accomplish a punching cycle.

A further object resides in the provision of a high speed punching apparatus with a plurality of closely adjacent side by side punches and a plurality of similarly shaped code punch levers, all interchangeable (except for the feed hole punch lever and the tape feed lever). Identical selecting levers permit not only ease of interchangeability but enable lower production and maintenance costs as well.

Another object in connection with the preceding object resides in the provision of identical impact transfer members also interchangeable (except for the feed hole punch impact transfer member which is smaller in diameter). Still another object in connection with the two preceding objects is the provision of relatively inexpensive identical steel balls used to actually punch the holes. These, too, are interchangeable (excluding again the feed hole punching ball which is slightly smaller in diameter).



Further novel features and other objects of this invention will become apparent from the following detailed description, discussion and the appended claims taken in conjunction with the accompanying drawings showing a preferred structure and embodiment, in which:

FIGURE 1 is a fragmentary perspective of punching mechanism in accord with the principles of this invention, illustrating only two of the eight sets of electro-magnets and armature latches; code punch levers, an impact transfer member and a steel punching ball. Also shown is the feed hole punch lever and the tape feed lever. The remaining sets, various bearings, spring anchors and fixed support structure are not necessary for an understanding of the invention and are omitted to enable clarity of disclosure.

FIGURE 2 is a somewhat schematic top view illustrating the compact electro-magnet arrangement, associated armature latch levers (some of which are partially broken away) and the upper tips of the code levers;

FIGURE 3 is an enlarged detail section through the punch and die assembly illustrating the relationship between the steel punch ball and the die cutting hole;

FIGURE 4 is a detailed perspective view showing the upper ends of the code levers, an electro-magnet and the different shapes of the ends of right and left hand armature latch levers;

FIGURES 5, 6 and 7 represent operational front elevation views of the code punching apparatus, FIGURE 5 illustrating the code punch levers in the unselected or latched position an instant before a code group signal has been received by the electro-magnets, FIGURE 6 illustrating one selected lever performing the actual punching of the code hole in a tape while an unselected lever is held in a non-punching position, instantly after the code group signal has been received by the electro-magnets, the cam being in the first one quarter of its revolution, and FIGURE 7 illustrating the code punch levers in the "reset" position an instant after the reset cam has cammed the selected punch levers counter-clockwise causing them to again be latched by the electro-magnet armature-latches, the cam having completed one half of a complete revolution;

FIGURE 8 is a front elevation of the feed hole punching mechanism, showing its shorter punch lever and its relationship to the reset cam;

FIGURE 9 is a front elevation of the tape feed lever an instant after it has been positively shifted by a lobe of the feed cam and the associated feed pawl has engaged the feed ratchet and sprocket to perform a tape feeding operation;

FIGURE 10 is an enlarged front elevation view of the code levers, latches and cam to show relative shapes and cooperative positions; and

FIGURE 11 is a diagrammatic representation of the electrical connections between a receiving mechanism to a signal line and to the start and punch selector electro-magnets of the reperforator.

The exemplary mechanism used herein to describe an operative embodiment of the present invention is an eight-code tape perforator having eight code punch levers, one feed punch lever and a punch and die group arrangement with eight ball type code punches and one ball type feed punch. An electro-magnet with an armature latch is provided for each of the code punch levers. More or less sets of punch levers and associated punches and

magnets can be utilized in accord with a desired punching operation.

Referring to the drawings for a specific description, FIGURE 1 illustrates the basic components of a telegraphic message receiving tape perforator 10, parts being broken away and only two sets of eight sets of code hole punching components being shown. The manner of arranging compact organization of eight sets of code hole punching components to obtain a standardized lateral spacing between adjacent holes in a coded tape is illustrated by the top plan view of FIGURE 2.

Reperforator 10 is to be used with a plurality of electric circuits which provide paths for a simultaneous, coded electric signal combination. To this end, a receiving mechanism 11 of a suitable type, shown in block diagram in FIGURE 11, can be used to receive a sequential coded electrical signal combination and transform it to a code combination of simultaneous electrical signals through plural circuits to the control components of the reperforator 10.

The selector mechanism 11 imparts a start impulse signal either simultaneously with the sending of the code group impulses or after a very slight delay. Various electro-magnets in the reperforator 10 are energized by the impulse signals to initiate and control reperforator action.

Reperforator 10 includes a plurality of punch selecting electro-magnets 12, each of which has a U-shaped flat bridge 14 of magnetizable material arranged in vertical planar form, the two arms 16 and 20 of the U-bridge being projected downwardly. One arm 16 of bridge 14 serves as the magnet core and carries a relatively flat winding coil 18 as depicted in FIGURE 2. The second bridge arm 20 is somewhat longer than arm 16 and is apertured and mounted on a shaft 22 made of a non-magnetizable material. Pivotally mounted on shaft 22 and preferably separated from its associated bridge arm by a washer 24 (FIGURE 2) of magnetizable material is a lever shaped armature member 26 or 28 also made of magnetizable material to provide a continuous magnetic flux path from the apertured end of bridge arm 20 into armature 26 or 28.

Each electro-magnet bridge 14 and its associated armature member 26 or 28 is maintained in a specific spaced apart relationship on the shaft 22 by suitable dielectric spacer sleeves 30 and the electro-magnet mounting shafts 22 are secured in the reperforator frame structure which is represented by vertical wall 32. A further non-magnetizable shaft 34 extends through each bridge 14 of each set of bridges, is secured in frame 32 and carries dielectric spacer sleeves 36 to help maintain the proper position and spacing between adjacent bridges. All electromagnets, being mounted with their arms 16 and 20 in vertical disposition, include downwardly facing pole faces 38 on core arms 16.

Armature members 26 and 28 are disposed to cooperate with and will serve to latch associated, selected punch operating levers 40, equal in number to the number of selector magnets 12. Each of levers 40 is identical in construction. Because of the structural nature of the punch operating levers 40 and their mounting as a single group, the armatures 26 of the left hand group of selector magnets 12 have different shaped latching ends than do the armatures 28 of the right hand group of selector magnets, hence the use of different reference numerals for the armatures of the two groups. Each of the left hand armatures 26 includes a hooked finger 42 which extends horizontally from the armature pole face over the upper end 44 of an associated punch lever 40. A biasing spring 46, anchored to fixed structure (not shown) connects to a short arm 48 on armature 26 to pivotally bias the associated armature toward a latching position away from its selector magnet pole face. Each of the right hand armatures 28 includes an abutment finger 50 which extends horizontally from the armature pole face to a position adjacent the upper end 44' of an associated punch lever and an individual biasing spring 46' anchored to fixed structure (not shown) connects to a short arm 48' on armature 28 to pivotally bias the associated armature toward a latching position away from its selector magnet pole face.

All punch operating levers 40, which will be next described, have their upper ends 44 biased toward the right, as viewed in FIGURES 1 and 4–7, and each lever end 44 has a right hand vertical latching face 52. In the start condition of the machine 10 (FIGURE 1) none of the selecting magnets 12 is energized and all punch operating levers 40 will be held in a non-selected position against their spring bias by a rotatable cam 60. Also at such stage of operation, all armatures 26 and 28 are biased to a pivotal position away from their associated magnet pole faces. These conditions permit the hooked ends 42 of left hand armatures 26 to be disposed in latching position in front of the latching faces 52 of their associated punch operating levers 40 and the abutment fingers 50 of right hand armatures 28 to be disposed in latching position in front of the latching faces 52 of their associated punch operating levers 40. A mechanical limit stop determines the spring biased latching position of the armatures and, as shown, such a stop can take the form of a bent abutment lug 54 on the armature arms 48 to engage the back edge of bridge arms 20. The enlarged FIGURE 10 illustrates the latching positions of the two different shapes of armatures and it will be seen that in a start position the latching fingers of the armatures 26 and 28 are spaced from the latching faces on the ends of the punch operating levers 40 by a slight clearance, approximating .005" to .010". Thus a selector magnet 12, when energized, need only be strong enough to lift the associated armature against its biasing spring force and will not have to overcome any friction of an actual latching engagement between the fingers 42 and 50 and the punch operating lever faces 52.

When any selecting magnet 12 is energized, its associated armature 26 or 28 will pivot toward the magnet pole face and lift the latching finger 42 or 50 to a position above and out of the path of possible movement of the upper end 44 of punch operating levers 40.

Each punch operating lever 40 is a long flat lever with an apertured lower end 56 and having its upper end 44 shaped with a flat latching face 52, as aforedescribed, on one side edge and a curved camming face 57 on the other side to enable ease in resetting movement. A mounting rod 58, secured in the machine frame wall 32, extends through the apertured ends 56 of all punch operating levers to pivotally mount such levers as a group below their associated selector magnet latching armatures 26 and 28. Suitable spacers on the rod 58 maintain proper spacing between levers 40 and other levers, to be described. At an intermediate position on each lever 40, and on the same side edge as the latching face 52, is a cam follower 59 which cooperates with the aforementioned cam 60, in accomplishing punch lever operating and resetting movements. A toe extension 64 adjacent the lower end of each lever 40 on the same side as the cam follower 59 has a bottom impact surface 66 and constitutes and will be referred to as a hammer. The hammers 64 of all punch operating levers 40 are aligned in a fore and aft arrangement and are spaced above the upper side of a punch and die assembly 70, each punch operating lever 40 having a strong biasing spring 68 connected between the lever and a fixed anchor on the machine frame to urge the levers 40 in a clockwise direction (FIGURE 1).

Lever mounting rod 58 pivotally carries at least two additional levers, a feed hole punch lever 72 approximately centered in the group of operating levers 40 and a tape feed lever 74 located at the rear of the group of punch operating levers 40 (see FIGURE 1) and to be

later specifically described. The feed hole punch lever 72 is similar to the punch operating levers 40 in that it includes an apertured lower end, a cam follower 76 and a toe extension hammer 78 shaped identically to the corresponding parts of the punch operating levers; however, the feed hole punch lever 72 differs from a code punch lever in that it terminates just above its cam follower 76 and does not have a latching end.

With reference now to FIGURES 1 and 10, the aforementioned cycle cam 60 is non-rotatably fixed on a rotatable cam shaft 80 which is journalled in the machine frame wall 32 and projects forwardly under the right hand group of selector magnets 12. The rear end of cam shaft 80 is secured to the driven member 81 of a friction clutch 82, the driving member of which has a gear tooth periphery 84 meshed with a spur gear 86 secured on the end of the drive shaft 88 of an electric motor 90. During machine operation, motor 90 will be operating to continuously rotate the clutch driving member gear 84 at a desired speed. The driven member 81 of the clutch is mechanically blocked by a latching means (not shown) which is magnetically released to permit rotation of the cam shaft 80 upon energization of an electro-magnet coil 92 (see FIGURE 11) by a start signal impulse from the reperforator receiving mechanism 11. The clutch driven member 81 and hence the cam shaft 80 is blocked and the blocking means relatched after a rotation of 180°. Detail structure of a suitable multiple step clutch can be found in copending application Serial No. 748,019, now Patent No. 3,051,377 wherein a six step clutch blocking means and resetting latch means is described.

Cam 60 is a double lobe, axially elongate, external cam having its camming surfaces rotatable in a path adjacent to and common to all of the punch operating levers 40 and feed punch lever 72. In other words, identical camming action can be imparted by cam 60 to all punch operating levers, dependent, of course, upon whether they have been selected for punching operation, during one half revolution of the cam shaft, the same camming action then being repeated throughout the remaining 180° extent, during the next cam cycle. The machine start position, at which time cam 60 is stationary, is depicted in FIGURES 1 and 10 wherein it will be seen that a high dwell 96 of cam 60 is engaged with the cam followers 59 of all punch operating levers 40 and with the cam follower 76 of feed punch operating lever 72 to mechanically maintain all of the levers 40 and 72 in a counterclockwise direction against spring bias. In this condition all of the punch operating levers 40 are mechanically held by cam 60 beyond a latched position, resulting in the aforedescribed .005" to .010" clearance between the lever latching faces 52 and the armature latching fingers 42 and 50.

The aforedescribed relationship of components, upon the machine's receiving an electrical code impulse combination plus a start signal impulse from the selector mechanism, will result in energization of selected ones of the punch selector magnets 12 and of the start magnet 92. Such energized selector magnets 12 will raise their associated armatures 26 and/or 28 away from a position of potential latching or blocking engagement with the ends 44 of associated punch levers 40. Any electro-magnet 12 which does not receive an energizing electrical impulse from selector 11, of course, will not attract and raise its associated armature 26 (and/or 28) which thus will remain in a position capable of latching respective associated punch operating levers 40 when the cam 60 rotates away from start position.

Simultaneously with the raising of selected armatures, the driven member 81 of the slipping friction clutch 82 is magnetically released and is driven by clutch 82 in a clockwise direction motion through gears 84 and 86 connected to motor 90 to rotate cam shaft 80 and cam 60. Cam 60, rotating clockwise, shifts its high dwell 96 out of interference with the protruding points on the selecting lever cam followers 59 thereby allowing the selected punch levers to rotate clockwise under bias by springs 68. The abrupt nature of the high dwell cutoff provides a snap rotation of the selected punch levers 40 to create an impact through the lever hammer heads 64 on associated punching components now to be described.

The punch and die assembly 70 utilizes steel balls for punches rather than the conventional matched cylindrical punch and cylindrical die of prior art reperforators. Assembly 70 consists of a lower die plate 100, upper guide plate 102, steel die insert 104, steel balls 106 and 107 and impact transfer members 108 and 109. The die plate 100 and guide plate 102 are secured in a conventional manner (not shown) to the machine frame to provide a horizontal tape guide slot through which the message tape 110 is stepped by feed mechanism to be hereinafter described.

Upper guide plate 102 has formed therein a fore and aft aligned row of vertical punch guide holes 114 and 115 vertically disposed below the hammers 64 and 78 of punch operating levers 40 and feed punch operating lever 72. Within each guide hole 114 is a close but freely fitted one of the punch balls 106 and a close but freely fitted one of the cylindrical steel impact transfer members 108. Guide hole 115 is for the tape feed hole punch ball 107 and impact transfer member 109, hence the hole, with the ball and impact transfer member, is smaller in diameter than the corresponding code hole punching components.

As seen in FIGURES 1 and 5–8, the upper ends of the impact transfer members project above the upper surface of the guide plate 102 and in the machine start position (FIGURES 5, 7 and 8) are spaced with a slight clearance just below the hammers 64 and 78 of the punch levers 40 and 72. A tape 110 passing through the die assembly slot acts in a camming manner on the curved surfaces of the balls and will hold the small lightweight punch balls and their associated impact members in what might effectively be termed a floating disposition within their guide holes under the hammer ends of the punch operating levers.

A portion of the die plate 100 immediately below the guide holes 114 and 115 has an elongate fore and aft recess 118 within which is located the die insert 104 having its upper surface coextensive with the upper surface of the die plate 100. Die insert 104 can be accurately located within recess 118 by locator pins, such as pin 120 (FIGURE 3), and is secured by means such as screws (not shown). A fore and aft aligned set of vertically disposed die holes 122 and 123 are provided through the die insert 104 in respective vertical coaxial alignment with the associated guide holes 114 and 115 in the guide plate 102 and die hole 123, being for the feed hole ball punch 107, is smaller than die holes 122. A description of one die hole 122 will suffice for all die holes.

The cutting edge 125 of a die hole 122 is a sharp circular edge formed by the flat upper surface of the steel die insert and a short extent 124 of cylindrical vertical wall at the upper end of hole 122. Below the short extent 124 of the vertical wall the hole 122 is enlarged to permit ready escape of the tape punchings or "chad" which fall through larger through openings 128 in the die plate 100 below the die insert 104. A conventional chad drawer or chad removal device (not shown) will enable disposal of chad falling through the die plate 100.

Die holes 122 and 123 are sufficiently smaller in diameter than their associated steel punch balls 106 and 107 so the balls will not enter the holes a distance sufficient to enable the balls to bind within the hole cutting edges. When a tape 110 is disposed between the ball punch 106 and die hole 122, an impact (e.g., an approximately 25 pound punch blow has been utilized, approximately 12 pounds of which is used, with a standard thickness message tape, to push the ball the final .004 inch to punch the hole) by an associated punch lever 40 on the impact transfer member 108 will cause the impact force from the punch lever to push the steel ball 106 down against the die hole circular cutting edge 125 which cuts a clean

perforation in the tape 110. FIGURE 3 illustrates the ball as it starts the actual perforating of the tape.

Tape feed occurs approximately midway of a cycle of punch and reset operation and is occasioned by a double lobed tape feed lever cam 130 rigidly secured on cam shaft 80 to rotate with the punch cam 60. Feed cam 130 shifts the aforementioned tape feed lever 74 which operates a tape feed ratchet 134 to index a tape feed sprocket 136 one feed step during each punch operation cycle.

Feed ratchet 134 and feed sprocket 136 are non-rotatably secured on a shaft 138 which is journalled in the machine frame with its axis of rotation parallel and normal to the tape feed path at the exit side of the die plate 100. Peripheral pins 140 on the feed sprocket 136 engage the tape feed holes in the tape 110 just past the exit edge of the die plate 100. The tape feed lever 74, as described, is pivoted on the same rod 58 as the punch operating levers and has two arms, one upstanding arm 142 having an anvil end 144 serving as a cam follower riding on the tape feed cam 130. A feed lever biasing spring 146 connects to arm 142 and to a frame anchor (not shown) to urge the feed lever 74 into engagement with cam 130.

The lower feed lever arm 148 extends horizontally over the feed ratchet 134 and is adjustably fastened by an eccentric screw 150 to a pawl carrier link 152 which has one end fitted on rod 58 adjacent the feed lever 74. The link 152 is, in effect, an extension of the lower horizontal feed lever arm 148 and at its free end pivotally mounts a depending pawl 154 which is resiliently urged into engagement with the teeth of the feed ratchet 134 by a pawl biasing spring 156. Positive clockwise rotation of the tape feed lever 74 by the feed cam 130 will shift the pawl 154 downwardly to move the tape feed ratchet 134 and the tape feed sprocket 136 one step (one tape feed space). When the high dwell 158 of feed cam 130 rotates out of engagement with the feed lever anvil end 144, the feed lever biasing spring 146 urges feed lever 74 clockwise to shift the pawl back over the ratchet teeth to a position in engagement with the next tooth on the feed ratchet 134. The eccentric screw 150 enables a fine adjustment to the feed pawl drive engagement stroke to assure that the feed step does not begin until punch lever pressure on the impact transfer levers 108 is released by initiation of punch lever reset movement.

To assure a precise and crisp stepping of tape 110 a detent 164 held against a detent wheel 166 non-rotatably secured on the feed sprocket shaft 138 by spring 168 is utilized. Also, to assure that the tape 110 is cleanly stepped and that no slipping occurs between the pins 140 on the feed sprocket 136 and the tape 110, a lever 170 and grooved pressure roller 172 arrangement is used and held against the tape 110 by a spring 174. This keeps the tape 110 tightly against the feed sprocket 136 and allows pins 140 to perform their stepping feed functions properly on the tape.

*Operation*

When the selected punch selector electro-magnets 12 simultaneously energized by an incoming code signal group, the corresponding armature latch levers 26 and/or 28 are pulled upward by a magnetic force, thereby unblocking the top portion 44 of the selected punch operating levers 40. Approximately simultaneously with selector magnet energization the start magnet 92 is energized to unblock and permit drive engagement of the friction clutch 82 to start rotation of cam shaft 80. When the high dwell 96 of cam 60, which is holding all operating levers 40 in reset position, rotates away from engagement with the cam followers 59 of the punch operating levers 40 and feed hole punch lever 72, any code punch operating lever 40 which is not blocked by an unselected armature selector lever 26 and/or 28 will be snapped clockwise by the springs 68. This snap action causes the code operating lever hammers 64 of the selected levers 40 to strike the associated floating impact transfer members 108 housed in guide plate 102 which in turn engage the associated floating steel punch balls 106, 107 causing the lever force to push the balls down through the tape 110 against the associated die cutting edges 125, thereby punching the proper code holes in tape 110. By utilizing non-biased floating impact members rather than spring biased members, there is no bias spring force to overcome during punching.

Simultaneously with code hole punch lever operation, cam 60 also operates the feed hole punch lever 72 which, having no electro-magnet or any other selecting device, is non-selective and therefore performs its punching operation once during each cycle of operation, i.e., once for every one-half rotation of dual cam 60. All punching operations and essentially complete lever reset movements occur during a one-quarter revolution of cam 60 from start positions, as will be apparent from the shape of cam 60 in FIGURE 10 wherein the major portion of the cam rise between low and high dwell occurs within the 90° after the drop-off from the high dwell.

The feed hole punch lever 72, like the code hole punch levers 40, is biased by one of the springs 68 in a clockwise direction and it, too, punches and is essentially reset in the first quarter of a revolution of cam 60.

As cam 60 continues its clockwise rotation, the second sloping rise engages the followers 59 on operating levers 40, camming them CCW until the top portions 44 of the code levers 40 are once again in position (accomplished this time by the second high dwell 96') to be latched or blocked by any unselected armature latches 26 and/or 28 of the now de-energized selector magnets 12. The punch operating levers 40 at this stage are again in reset position and the feed hole punch lever 72 is again ready to operate.

As will now be seen in consecutive FIGURES 5, 6 and 7, cam 60 during one cycle of operation passes through one-half (180°) of a complete (360°) revolution from the unselected position (FIGURE 5) to the selected punching position (FIGURE 6) and finally to the code lever reset position (FIGURE 7).

After the code punching and feed hole punching members have completed their punch and initial reset operation, approximately 45° of cam rotation, cam 60, of course, continues to rotate clockwise to complete a 180° rotation. During the intermediate portion of the (180°) operation cycle the tape feed lever 74 is shifted CCW to cause pawl 154, which is held against the tape feed ratchet 134 by spring 156, to move downward engaging a tooth of the tape feed ratchet 134 and indexing the ratchet 134 one position. The tape feed sprocket 136, rotated in conjunction with the ratchet 134, is thus indexed one position by the tape feeding mechanism to step the tape one space.

During the last one-quarter revolution of the operating cycle the tape feed mechanism will be reset as the lobe 158 of cam 130 clears the tape feed lever 72. This causes the lever 72 to move clockwise again, pulling the pawl 154 upward, causing it to ride over a tooth in the tape feed ratchet 134, thus positioning the pawl 154 for the next tape feeding operation.

An instant later the next incoming code signal group is received and the selector magnets 12 are again energized, thus sending the machine through another punching and tape feeding cycle.

The foregoing discloses and describes an improved ball type perforator proposed to be utilized in particular in telegraphic code type reperforators, and also adapted for other similar perforating operations wherein coded electrical signal combinations are received and, through a novel selecting mechanism, transferred into coded perforations on a message tape. The perforator utilizes ball punch and impact transfer punching components of small mass, requiring no retract biasing springs and thereby

enabling rapid punching without waste force necessary to overcome an opposing spring force on punch components.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A multiple hole perforator machine comprising: a plurality of selectively operable ball type punch and die means; hammer means, at least equal in number to said punch means, individual to each punch means and adapted to impart momentary impact punching forces to associated punch means during a cycle of machine operation; power means for operating said hammer means; and a plurality of two position operable means adapted in one direction to engage and block the hammer operation of, and selectively operable to the second position to unblock and permit operation of, selected hammer means enabling such selected hammer means to impart said momentary impact punching forces to associated punch means.

2. A multiple hole perforator machine comprising: a plurality of selectively operable ball type punch and die means; hammer means, at least equal in number to said punch means, individual to each punch means and adapted to impart momentary impact punching forces to associated punch means during a cycle of machine operation; power means for operating said hammer means; and operable means comprising a plurality of electro-magnets with spring-biased armature levers adapted, when the magnets are de-energized, to be positioned to engage and block the hammer operation of associated hammer means, and selectively operable upon energization of associated magnets to a position which unblocks and thereby permits operation of associated selected hammer means, enabling such selected hammer means to impart said momentary impact punching forces to associated punch means.

3. A record medium perforator adapted to punch holes in a flat, thin record medium comprising: perforating means consisting of multiple punch means and correlated multiple die means; means adapted to engage and feed the record medium through said perforating means; a plurality of operating means, for associated said punch means, spring biased in a direction to engage and drive by an impact force a portion of said punch means through the record medium against associated said die means; means maintaining said punch operating means against spring bias in a position out of engagement with associated said punch means; means including said maintaining means for selectively releasing the punch operating means; means for replacing said punch operating means to a position out of engagement with said punch means; means operable subsequent to release of said punch operating means to operate said record medium feed means; and means comprisng the structural shape of the punching portion of said punch means and the body of said record medium, operative upon a feed movement of the record medium after punching, to return the punching portion of said selected operated punch means to a pre-punching position.

4. A record medium perforator adapted to punch holes in a record medium comprising: perforating means consisting of multiple punch means and correlated multiple die means; means adapted to engage and feed the record medium through said perforating means; a plurality of individual operating means, for associated said punch means, spring biased in a direction to engage and drive a portion of said punch means through the record medium against associated said die means; means comprising a cyclically operated rotatable cam with a high dwell for engaging and maintaining said punch operating means against spring bias and out of engagement with associated said punch means, punching control means including selectively actuatable devices for selectively blocking and unblocking punch operation of said individual operating means and a sharp cam surface drop from said high dwell for cyclically releasing the punch operating means, and further cam surface means on said cam for replacing said punch operating means to a position out of engagement with said punch means; and means operable between release and replacement of said punch operating means to operate said record medium feed means for feeding said record medium relative to the perforating means.

5. A record medium perforator adapted to punch holes in a flat, thin record medium comprising: perforating means consisting of multiple punch means and correlated multiple die means; means adapted to engage and feed the record medium through said perforating means; a plurality of operating means, for associated said punch means, spring biased in a direction to engage and drive a portion of said punch means through the record medium against associated said die means; means comprising a cyclically operated rotatable cam with a high dwell for engaging and maintaining said punch operating means against spring bias and out of engagement with associated said punch means, punching control means including a sharp cam surface drop from said high dwell for selectively releasing the punch operating means, and further cam surface means on said cam for engaging and replacing said punch operating means to a position out of engagement with said punch means; means operable subsequent to release of said punch operating means to operate said record medium feed means; and means comprising the structural shape of the punching portion of said punch means and the body of said record medium, operative upon a feed movement of said record medium after punching, to return the punching portion of said selected operated punch means to a pre-punching position.

6. A record medium perforator as defined in claim 5, wherein said means for selectively releasing the punch operating means further comprises a plurality of selectively energizable electro-magnets with armature latch devices for blocking spring biased punching operation of individual associated punch operating means excepting when an associated electro-magnet is energized.

7. A record medium perforator adapted to punch holes in a flat, thin record medium comprising: perforating means consisting of multiple steel ball and impact transfer member punch means and correlated multiple circular hole die means; means adapted to engage and feed the record medium through said perforating means; a plurality of operating hammers for impacting impact transfer members of associated said punch means, springs biasing said hammers in a direction to drive said steel balls through the record medium against the circular edges of associated said die means; means maintaining said punch operating hammers against spring bias in a position out of engagement with associated said impact members; means including said maintaining means for selectively releasing the punch operating hammers; means for replacing said punch operating hammers to a position out of engagement with said impact members; means operable subsequent to release and during initial replacement movement of said punch operating hammers to operate said record medium feed means; and means comprising the curved surface of said steel balls and the body of said record medium, operative upon a feed movement of said record medium after punching, to return the steel balls and associated impact members of said selected operated punch means to a pre-punching position.

8. A perforating apparatus comprising: a die means having a plurality of circular die holes provided therein and a flat upper surface enabling a thin flat record medium to be passed over said die means; a punch guide device disposed above said die means including a plurality of

vertical punch guide means aligned above each die hole; a steel ball punch disposed for vertical shifting movement within each of said guide means in coaxial alignment with its associated die hole; an impact transfer means freely slidably disposed in each said guide means above the associated said punch; feed means adapted to cooperate with a record medium and laterally shift the record medium between said die means and said guide device; a plurality of pivotally mounted, spring biased punch operating levers mounted for independent operation above associated said impact transfer means; each of said operating levers having an impact device thereon adapted to engage an associated impact transfer means and force said transfer means and steel ball punch down into engagement with the edge of the associated circular die hole; a plurality of shiftable latch devices, each of which is adapted to engage an associated said punch operating lever to retain said punch operating lever against spring bias out of engagement with the associated impact transfer means; operating devices for each of said latch devices adapted to be selectively actuated to selectively shift said latch devices to permit the associated said punch operating levers to be operatively shifted under spring bias to accomplish a punching operation; and power means maintaining said punch operating levers in a cocked position against spring bias for cyclically enabling movement of said levers under spring bias, operating said feed means, and resetting said punch operating levers to cocked position.

9. A perforating apparatus as defined in claim 8, wherein said operating devices are selectively energizable electro-magnets and said shiftable latch devices comprise spring biased pivoted lever-type armatures on each of said electro-magnets shiftable against spring bias upon energization of an associated electro-magnet.

10. A perforating apparatus as defined in claim 9, wherein all of said punch operating levers associated with said electro-magnets are identical, a common shaft pivotally mounts all punch operating levers, all punch operating levers are urged under spring bias in a common direction, and each of said punch operating levers associated with said electro-magnets has a latching face at the free end which is adapted to engage and cause the lever to be latched by the associated latch lever armature of a non-selected, de-energized electro-magnet whenever said power means is cyclically operated to enable movement of said punch operating levers under the force of spring bias.

11. A perforating apparatus as defined in claim 10, wherein said punch selecting levers are closely spaced in side by side relationship, said electro-magnets include flat bridges and flat coil windings and are arranged in two laterally spaced apart groups above the latching ends of said punch operating levers, one of said groups being disposed on one side of said punch operating levers and the other of said groups being disposed on the opposite side of said punch operating levers, the armature latch levers of one group of electro-magnets having hooked latching ends to engage the associated latching face of said punch operating levers, and the armature latch levers of the other group of electro-magnets having blocking abutment fingers adapted to be disposed immediately in the path of movement in front of the latching faces of associated punch operating levers.

12. A perforating apparatus as defined in claim 9 constituting a message tape code perforator wherein: the record medium is a tape; one set of said circular die holes, punch guide means, steel ball punches and impact transfer means constitutes a tape feed hole punch and die; the remaining sets of die holes, punch guide means, steel ball punches and impact transfer means constitute code hole punch and die sets; each punch and die set has associated therewith a said spring biased punch operating lever; and only said code hole punch and die sets have associated therewith a shiftable latch device and an associated selectively actuatable operating device whereby the punch operating lever will be operated during each cycle of machine operation to cause its said associated punch and die set to punch a feed hole in the tape.

13. A high speed multiple punching apparatus with a plurality of individual hole punch and die sets, means to operate selected punch and die sets comprising an individual hammer device for each said set, power means for engaging and enabling operation of all hammer devices through a cycle consisting of means providing a powered rapid operating movement of selected hammer devices to impart a sharp momentary impact forces to an associated punch of a punch and die set and means resetting all hammer devices to cocked position, and a plurality of selectively operable shiftable latch means adapted, when not shifted, to be engaged by associated said hammer devices to prevent hammer device operation upon snap release by said power means, and when operatively shifted, to permit full snap release of any associated hammer device.

14. A record medium perforator adapted to punch holes in a record medium comprising: perforating means consisting of multiple punch means and correlated multiple die means; means adapted to engage and feed the record medium through said perforating means; a plurality of individual operating means, for associated said punch means, spring biased in a direction to engage and drive a portion of said punch means through the record medium against associated said die means; means comprising a cyclically operable rotatable cam with a high dwell for engaging and maintaining said punch operating means against spring bias and out of engagement with associated said punch means, punching control means including selectively actuatable devices for selectively blocking and unblocking punch operations of said individual operating means, and a sharp cam surface drop from said high dwell for cyclically releasing the punch operating means, and further cam surface means on said cam for replacing said punch operating means to a position out of engagement with said punch means.

15. A record medium perforator adapted to punch holes in a flat, thin record medium comprising: perforating means consisting of multiple steel ball and impact transfer member punch means and correlated multiple circular hole die means; means adapted to engage and feed the record medium through said perforating means; a plurality of operating hammers for impact transfer members of associated said punch means, springs biasing said hammers in a direction to drive said steel ball through the record medium against the circular edges of associated said die means; means maintaining said punch operating hammers against spring bias in a position out of engagement with associated said impact members; means including said maintaining means for selectively releasing the punch operating hammer; means for replacing said punch operating hammers to a position out of engagement with said impact hammers; and means comprising the curve surface of said steel balls and the bodies of said record medium, operative upon a feed movement of said record medium after punching, to return the steel balls and associated impact members of said selected operating punch means to a pre-punching position.

16. A multiple hole perforator machine comprising: a plurality of selectively operable ball type punch means and die means; spring-biased hammer means including a plurality of pivoted levers at least equal in number to said punch means, each lever having a hammer portion adapted to be shifted by the bias force of its spring means to engage and impart a momentary punching impact force to an associated punch means during a cycle of machine operation; power means including a motor driven shaft, a cyclically actuated rotatable cam shaft, means including a blockable friction clutch connecting said motor shaft to said cam shaft for starting and stopping said cam shaft, and a cam non-rotatably secured on said cam shaft, said cam being shaped to engage and maintain all ham-

mer levers out of punching disposition against spring bias while said friction clutch is blocked from transmitting rotation to said cam shaft, then to simultaneously enable all hammer levers to be shifted under spring bias toward a punch actuating position and then to reset all hammer levers to their inactive position when rotated through a cycle of operation; operable means adapted to engage and prevent operation of, and selectively operable to permit operation of, selected hammer levers enabling such selected hammer levers to impact said momentary impact punching forces to associated punch means, said operable means, when not selectively operated, being disposed to prevent full movement of associated hammer levers to a punch operating position; and means to coordinate actuation of said cltuch means and selected ones of said operable means responsive to receipt of signal information.

17. A high speed multiple punch perforating apparatus with a plurality of individual separably operable hole punch and die sets; means to operate selected punch and die sets comprising an individual hammer for each punch device shiftable between a reset position and a position for impacting the punch of each said set, power means for operating all hammer devices through a cycle consisting of a plurality of selectively operable means enabling powered impact movement of associated hammer devices, and means providing a return of all hammer devices to reset position, said powered impact movement of a hammer device forcing the associated punch and die set into a punching condition; and means comprising the punch portions of any impact operated punch and die set, the perforation edge of a perforated record medium and record medium feed means for shifting the punch portions of any impact operated punch and die set away from engagement with its associated die portion.

18. A multiple punch record medium perforator adapted to punch holes in a flat, thin record medium comprising: perforating means consisting of a plurality of individual, separately operable steel ball and impact transfer member punch means and correlated multiple hole die means with circular edge formations; means adapted to engage and feed a record medium through said perforating means; a plurality of selectively operable spring biased punch operating means for impacting impact transfer members of associated said punch means in a direction to drive said steel balls through a record medium against the circular edge formation of associated said die means, said punch operating means being normally maintained in a position out of engagement with associated said impact members; means including portions of each of said plurality of spring biased punch operating means enabling replacement of all said punch operating means to a position out of engagement with said transfer members and means comprising the steel ball punch portion of any impact operated punch means, the associated perforated edge of the perforated flat thin record medium and said record medium feed means for shifting the steel balls of any impact operated punch means away from engagement with its associated die means.

19. A multiple punch perforator capable of perforating a record with data items in columns transverse to record movement, said record being adapted to be moved past a perforating station, comprising: a frame; a pair of spaced members mounted on said frame and forming a channel through which said record is moved columnwise; a plurality of elements, each having at least a hemispherical portion, and each mounted within a first of said members for reciprocal movement in a straight path to move said hemi-spherical portion into and out of contact with the other member; means, including said hemispherical portions of said elements and said record, enabling said elements to be moved in said straight path out of contact with said other member by unperforated portions of said record as said record passes through said channel; a plurality of impact imparting means for selectively driving said elements and an unperforated portion of a record in said channel into contact with said other member including a plurality of solenoids operatively, individually associated with respective ones of said plurality of impact means; and means on said other member cooperating with said selectively driven elements to effect a line of contact disposed on a true circle whereby the record therebetween is perforated.

20. A perforating apparatus comprising: a die means having a plurality of die holes having circular form edges provided therein and a flat upper surface enabling a thin flat record medium to be passed over said die means; a punch guide device disposed above said die means including a plurality of vertical punch guide means aligned above each die hole; a steel ball punch disposed for vertical shifting movement within each of said guide means in coaxial alignment with its associated die hole; an impact transfer means mounted for shifting movement in said guide means above the associated said steel ball punch; feed means adapted to cooperate with a record medium and laterally shift the record medium between said die means and said guide device; a plurality of spring biased punch operating members mounted for independent operation above associated said impact transfer means; each of said operating members having an impact device thereon adapted to move and impact an associated impact transfer means and force said transfer means and steel ball punch down into engagement with the edge of the associated circular die hole; operating means comprising said spring biased members and associated selectively energizable electro-magnets enabling each of said operating members to be selectively actuated to selectively rapidly shift said punch operating members to accomplish a punching operation and resetting said punch operating levers to cocked position; all of said punch operating members associated with said electro-magnets being identical and all punch operating members being urged under spring bias in a common direction.

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