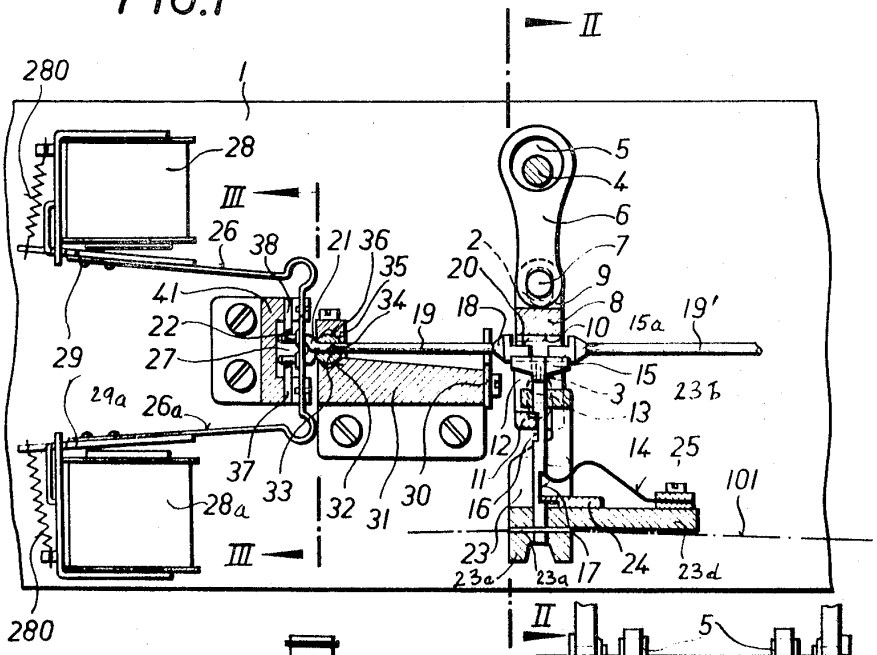
June 23, 1970 H. BEHRENS 3,516,601

PUNCHING APPARATUS

Filed Dec. 11, 1967 3 Sheets-Sheet 1

FIG. 1



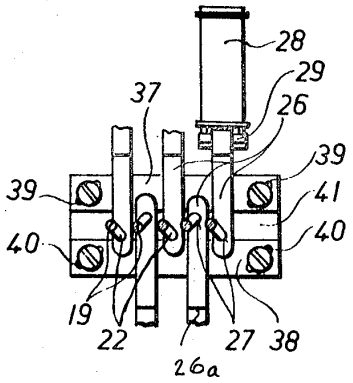


FIG. 3

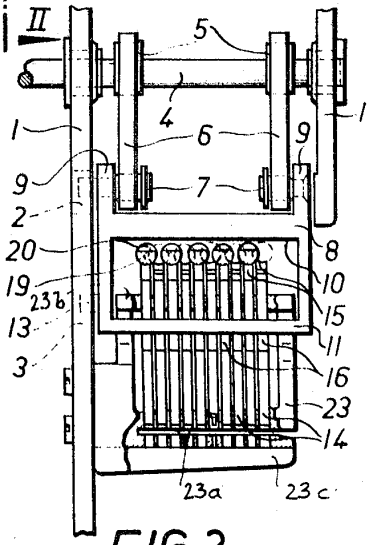


FIG. 2

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PUNCHING APPARATUS

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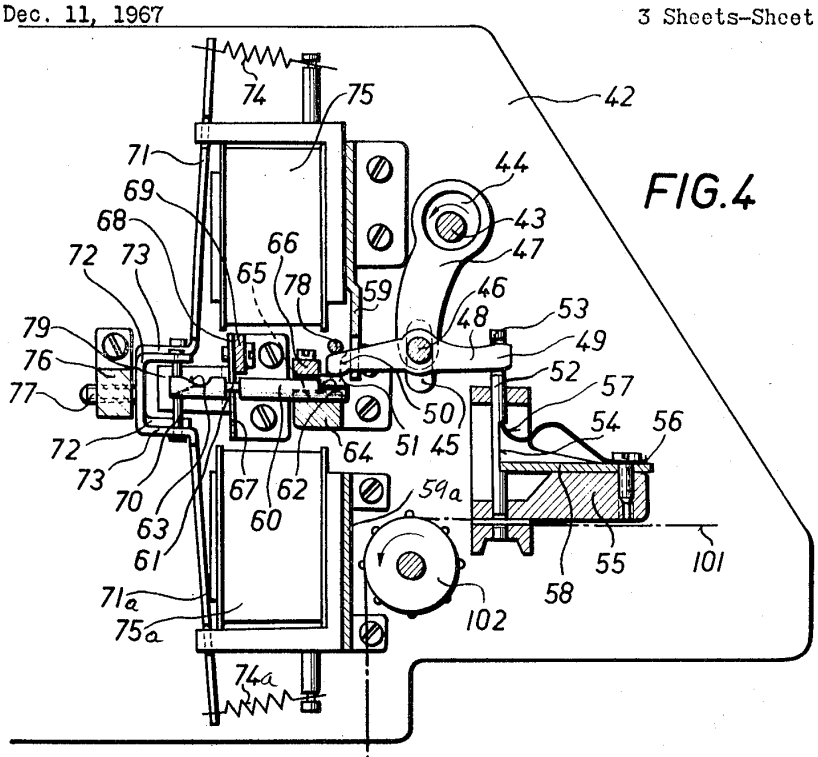

FIG. 4

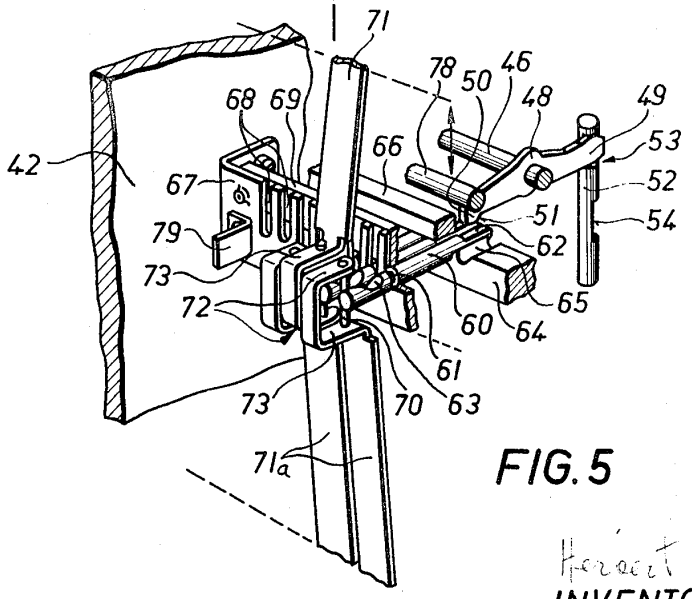

FIG. 5

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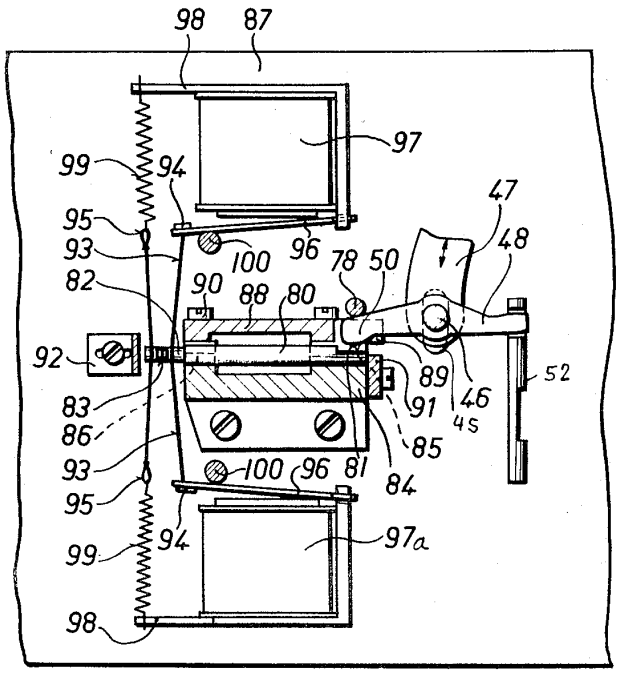
FIG.6



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PUNCHING APPARATUS

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Claims priority, application Germany, Dec. 13, 1966, O 12,142
Int. Cl. B26f 1/04
U.S. Cl. 234—115 23 Claims

ABSTRACT OF THE DISCLOSURE

A reciprocating drive means is coupled with selected punches by coupling members which are turnable about axes perpendicular to the direction of reciprocation of the drive means. Each coupling member has a coupling portion whose cross section is non-circular and has a greater dimension and a smaller dimension. When the greater dimension is located in the path of movement of the drive means or a coupling lever thereon, during a working stroke force is transmitted to selected punches, but when the smaller dimension is effective, the drive means or coupling lever does not touch the coupling member so that no force is transmitted to the non-selected punches during a working stroke. Electromagnetic selector means turn the coupling members during the return stroke of the drive means.

BACKGROUND OF THE INVENTION

Punching apparatus is known in which a reciprocating drive means is coupled to selected punches by coupling members. The German Auslegeschrift 1,208,104 discloses a punching apparatus in which coupling members have cylindrical end portions flattened at one end along a chord, and which are operated by electromagnetic means to move in longitudinal direction between an operative position located in the path of movement of reciprocating drive means, and an inoperative position. It is necessary that the drive means performs a longer stroke than required for the operation of the punches so that the coupling member can be returned to the inoperative position and then again advanced to the operative coupling position, if again selected. A very short time period remains for the coupling function of the coupling members, so that the selecting electromagnets must either be very large, or provided with special core sheets permitting rapid demagnetization. Nevertheless, the operating speeds of the known punching apparatus cannot exceed a certain limit.

SUMMARY OF THE INVENTION

It is one object of the invention to overcome the disadvantages of known punching apparatus, and to provide a punching apparatus which operates reliably at very high speed.

Another object of the invention is to provide a punching apparatus which produces little noise during operation, and has comparatively small movable masses which can be rapidly accelerated by small electromagnets.

Another object of the invention is to move coupling members having a small inertia in the direction of movement between inoperative and operative positions so as to be operable by small electromagnets at high speed for increasing the operating speed of the punching apparatus.

With these objects in view, the present invention provides turnable coupling members which are permanently located in the path along which force is transmitted from the reciprocating drive means to the punches. However, the coupling members are turnable between an inoperative position in which they transmit no force, and a coupling position in which they transmit force from the drive means to the punches. The turning of the coupling members between the inoperative and coupling positions is preferably effected by electromagnets energized in accordance with a program by conventional control means.

As compared with the prior art in which the coupling members are moved in axial direction between inoperative and coupling positions, the turning of the coupling members according to the present invention requires a far lesser electromagnetic energy.

In accordance with the invention, the coupling members have a non-circular cross section whose greater dimension is located in the path along which force is transmitted when the respective coupling member is placed by the selector magnets in the coupling position. The coupling members which are associated with non-selected punches are held in the inoperative position in which the smaller dimension is located in the path of force transmission, so that the drive means performs an idle stroke without touching the coupling member. The turning movement of the coupling members between the inoperative and coupling positions is synchronized with the reciprocation of drive means so that the drive means immediately engages the coupling member when starting its working stroke so that noisy impacts of the drive means on the coupling members are avoided. It is neither necessary to stop the drive means, nor to operate the drive means in partly idle strokes longer than required for the actuation of the punches.

It is a particular advantage of the invention that the entire time period during which the drive means performs the return stroke, can be used for turning a selected coupling member from its inoperative position to the coupling position so that the respective coupling member is ready to be engaged by the reciprocating drive means when the same starts its working stroke. In the same manner, a previously selected coupling member can be turned from its coupling position to its inoperative position during the return stroke of the drive means. Consequently, a comparatively long time is available for the coupling operation and for the reaction of the armature of the selecting electromagnets upon receipt of an energizing impulse. The setting of the coupling members can start as soon as the common drive means starts its return stroke, and when the return stroke has been completed, the coupling members are already set for the following working stroke during which the punches are operated. The time available for turning the coupling members from the coupling position to the inoperative position, is even greater than the time required for turning the coupling members from the inoperative position to the coupling position. Since the time of the entire return stroke is used for setting the coupling members in accordance with the program determined selection, the speed at which punching operations follow each other can be substantially increased as compared to the prior art.

A punching apparatus according to the invention comprises reciprocating drive means; a set of punches movable between a position of rest and a punching position; a set of force transmitting means, each including a coupling member having a non-circular cross section and being mounted for angular movement about the axis of the cross section between a normal inoperative position, and a force transmitting position in which the greater dimension of the non-circular cross section is effective to transmit force from the drive means to the respective correlated punch; and a set of selector means, preferably including electromagnets, respectively correlated with the punches and connected with said coupling members for turning selected coupling members to the force transmitting position so that the respective punches are operated by the drive means.

In one embodiment of the invention, the coupling means comprises a coupling lever mounted on the drive

means for pivotal movement and having one end connected with the respective punch and the other end located opposite the coupling member. Supporting means support the non-circular portions of the coupling members for angular movement between the inoperative and coupling positions. The ends of the coupling levers are reciprocated by the drive means toward and away from the coupling portions and the supporting means to and from an end position. In this end position, the ends of the coupling levers are spaced a predetermined distance from the supporting means, which distance is greater than the dimension of the cross section supported by the supporting means in the inoperative position of the coupling members, and smaller than the greater dimension which is supported by the supporting means in the coupling position of the coupling members so that force is transmitted from the drive means through the coupling levers and coupling members to selected punches only when the respective selected coupling members are placed in the coupling position.

In another embodiment of the invention, the coupling portions of the coupling members rest on the respective correlated punches, and the drive means is reciprocable to and from an end position spaced a predetermined distance from the punches. This distance is greater than the dimension of the cross section supported by the punches in the inoperative position of the coupling members and smaller than the greater dimension of the cross section which is supported by the punches in the coupling position of the coupling members. Consequently, force is transmitted from the drive means through the coupling portions of selected coupling members to the punches only when selected coupling members are placed in the coupling position.

Preferably, the coupling portion of a coupling member has a cross section bounded by circular line extending over more than 180° and by a chord, the smaller dimension of the cross section being located perpendicularly to the chord and the greater dimension extending along a diameter of the circular line. The coupling member is advantageously turned an angle of 90° between its inoperative and coupling positions.

The selector means comprise a set of electromagnets respectively associated with the punches, and each having an armature connected by transmission means to a corresponding coupling member so that movement of the armature causes turning of the respective coupling member between the inoperative and coupling positions.

In contrast to prior art constructions, coupling members either rest on the correlated punches, or on supporting means, and do not reciprocate with the drive means. The coupling members are preferably cylindrical rods having the coupling portions at one end, and having the other end formed with a screw surface cooperating with a stud on the armature of the respective selector electromagnet. In a modified construction, the rods are provided with a helical groove for guiding several windings of a cord or rope whose ends are connected to the armature of a selector electromagnet and to a return spring.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevation, partially in vertical section, illustrating an embodiment of the invention;

FIG. 2 is a fragmentary front elevation, partially in section along line II—II in FIG. 1;

FIG. 3 is a fragmentary front elevation, partially in section along line III—III in FIG. 1;

FIG. 4 is a fragmentary side elevation, partially in vertical section, illustrating another embodiment of the invention;

FIG. 5 is a fragmentary perspective rear view of the embodiment of FIG. 4; and

FIG. 6 is a fragmentary side elevation, partially in vertical section, illustrating a modification of the embodiment of FIGS. 4 and 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to the embodiment illustrated in FIGS. 1 to 3, the supporting means of the apparatus include vertical walls **1** carrying bearings in which a shaft **4** is supported for rotation. Two circular eccentric members **5** are fixed on shaft **4** and drive connecting rods **6** which carry pins **7** guided in vertical guide slots **2** and **3** in walls **1** and passing through bores in lateral portions **9** of a rectangular frame **8** which is constrained by pins **7** and guide slots **2** and **3** to reciprocate in a vertical plane when driven by connecting rods **6** during rotation of shaft **4**. Frame **8** has an upper transverse portion **10** and a lower transverse portion **11** between the lateral parts **9** so that rectangular opening **12** is formed in frame **8**. As will be explained hereinafter in greater detail, frame **8** is a drive means which performs a downward working stroke and an upward return stroke, so that the transverse portion **10** is effective to move punches **14** downward in a punching stroke.

Punches **14** are arranged in a row and mounted for movement between a higher position of rest and a lower punching position in a stationary frame **23** which is arranged below frame **8**. Frame **23** is fixed to a wall **1** and has in its lower portion a slot **23***a* for the insertion and passage of the record carrier **101**, such as a punch card.

As best seen in FIG. 1, a transverse portion **23***b* of frame **23** is located in the proximity of the lower frame portion **11** of frame **8**. Punches **14** are guided in bores of the transverse portion **23***b* and in the lower portion **23***c* of frame **23**.

The upper ends of punches **14** have abutment portions **15** projecting forward and rearward from the plane in which the row of punches **14** is located. Coupling portions **18** of coupling members **19** are located in recesses **15***a* of abutment **15**.

Punches **14** have higher rectangular cutouts **16**, and lower rectangular cutouts **17**. A return spring **25** has one end abutting the upper shoulder of each cutout **17**, and another end secured to portion **23***d* of frame **23**. Springs **25** urge the respective punches to rise to the position of rest in which the lower ends of the punches are located above slot **23***a*. A stop bar **24**, secured to frame portion **23***d*, limits the upward movement of the row of punches under the action of springs **25**.

The upper shoulder of each cutout **16** in punches **14** cooperates with the transverse portion **11** and abuts the same, or is located slightly above the same, in the upper position of the punches which the same assume under the action of springs **25**. During the upward return stroke of reciprocable frame **8**, the transverse portion **11** assures the movement of all punches **14** from the punching position to the higher position into which they are also urged by springs **25**.

Coupling members **19** and **19'** have coupling portions **18** resting in curved guide recesses **15***a* provided in abutment portions **15** of alternate punches **14**. Each coupling member **18** has a partly frustoconical and partly cylindrical attaching portion, and a coupling portion resting on an abutment portion **15** and located under the transverse portion **10** of reciprocable frame **8**. The cross section of the coupling portion is non-circular and bounded by a circular line extending over an angle of more than 180°, and by a straight chord **20**, as best seen in FIG. 2.

Consequently, each coupling portion is part cylindrical and has a flat face parallel to the lower face of the transverse portion **10** of frame **8** when a respective coupling member is in the inoperative position. When a coupling member is turned to its operative position, its greater dimension, corresponding to the diameter of the cylindrical peripheral surface is located in a vertical plane directly adjacent the lower face of transverse portion **10** in the upper retracted end position of reciprocable frame **8** shown in FIGS. 1 and 2 in which the coupling portions **18** are shown in the inoperative position.

The shape of the guide recesses **15***a* is cylindrical corresponding to the cylindrical surfaces of the coupling portions **18** so that the same can be easily turned. The rods **19** and **19'** are cylindrical and each rod **19** and **19'** has at the other end a crank portion **22** shown only for the coupling members **19** in FIGS. 1 and 3, but not illustrated for coupling members **19'**. The elements of the construction shown in the left portion of FIG. 1 are duplicated on the right side of frames **8** and **23**, but not illustrated in FIG. 1 for the sake of simplicity.

As shown only on the left side of FIG. 1, each crank portion **22** is inserted into a corresponding bore **27** in a vertical leaf spring portion of an angular leaf spring **26** or **26***a* which are respectively secured to the armatures **29**, **29***a* of electromagnets **28**, **28***a* which are under the influence of springs **280** which, as long as electromagnetic means **28**, **28***a* are not energized, hold the armatures **29**, **29***a*, springs **26**, **26***a*, and cranks **22** in such a position that the respective coupling members **18** are in the inoperative position shown in FIG. 1 in which the flat face **20** is parallel to the lower surface of the upper transverse member **10** of frame **8**. The rods **19** are mounted in vertical slots of a comb-shaped guide plate **30** which is secured to a support **31** which extends along the row of punches **14**.

A cover plate **34** is detachably attached to the other side of support **31**, and the confronting faces are provided with recesses **32** and **36**, respectively in which balls **33** are mounted for turning movement, each ball having a bore **34** in which the respective rod **19** is guided. Consequently, each rod **19** can turn about its longitudinal axis between inoperative and coupling positions, and can pivot with a respective ball **33** in a vertical plane when following the movement of the reciprocating frame **8** in the coupling position.

Stop bars **37** and **38**, see FIGS. 1 and 3, are adjustably mounted on a fixed support **41** by means of screws passing through slanted slots **39** and **40**. When stop bars **37** and **38** are adjusted, and raised or lowered while being laterally shifted, crank portions **22** of rods **19** abut the stop bars in angular end positions by which the angular position of the respective coupling portion **18** is determined. The stroke of armature **29** or **29***a* is selected so that the crank portions **22** are under the tension of springs **280** when abutting stop bars **37** and **38**.

Upon energization of an electromagnet **28**, **28***a* the respective coupling member is turned to the coupling position, and upon deenergization, the respective coupling member is returned by spring **280** to its inoperative position. However, instead of springs **280**, electromagnetic means may be provided for returning the coupling members to the inoperative position.

As is particularly apparent from FIG. 3, the positioning of the rows of electromagnets **28** and **28***a* in two rows located at different levels provides a space corresponding to the width of two springs **26**, **26***a* for each electromagnet **28**, whereas if all electromagnets **28** would be arranged in one row, the width of an electromagnetic means **28** would have to correspond to the width of one spring **26**, and to the corresponding spacing of rods **19**. The spacing of rod **19** is already twice the spacing of punches **14**, since alternate punches **14** cooperate with coupling portions **18** connected with rods **19** and **19'**, respectively, alternate rods **19'** being operated by electromagnets provided in a higher and a lower row, as described with reference to the electromagnets **28**, **28***a* by which the rods **19** are operated.

When one of the selector electromagnets **28**, **28***a*, or of the electromagnets, not shown, on the other side of the punches, is energized, the armature is attracted against the action of spring **280**, and respective spring **26** is displaced and acts on the respective crank portion **22** to turn respective rod **19** an angle of substantially 90° so that the greater dimension of coupling member **19** is in the vertical position and effective. When reciprocable frame **8** is in its highest position, as shown in FIGS. 1 and 2, transverse bar **10** is spaced by a gap from the abutments **15**. The vertical height of this gap is equal to the greatest dimension of the cross section of coupling portion **18** which is the diameter of the cylindrical portion thereof. When shaft **4** turns 180°, transverse portion **10** assumes a lower position and is spaced a smaller distance from abutments **15**, which smaller distance is greater than the smaller dimension of the coupling portion which is determined by the flat face **20**.

When a coupling portion **18** is turned by the respective selector electromagnet **28** or **28***a* into its coupling position in which a portion of its cylindrical surface is in contact with the lower surface of the transverse portion **10**, downward movement of frame **8** from its upper end position is directly transmitted through coupling member **18** to abutment portion **15** of the respective punch which is moved downward to the punching position passing through slot **23***a* for punching the record carrier **101**. Since the greater dimension of coupling portion **18** is equal to the gap between frame portion **10** and abutment **15**, there is no noise-creating impact of portion **10** on the coupling portion.

When a punch is not to be selected for a punching operation, the respective electromagnet **28** is not energized, and coupling portion **18** remains in the inoperative position shown in FIGS. 1 and 2. Downward movement of frame **8** will not bring the lower surface of transverse portion **10** into contact with the flat face **20**, since the smaller dimension of coupling portion **18** is less than the gap between abutments **15** and transverse portion **10** in the lowest position of frame **8**. Consequently, the downward stroke of frame **8** is idle, and the motion and force is not transmitted to the respective punch which remains in its position of rest held by spring **25**.

If a selected punch **14** has been moved downward due to the transmission of force from frame portion **10** through coupling portion **18** to abutment portion **15**, it is pulled upward to its position of rest by the lower transverse portion **11** of frame **8** which engages the upper shoulder of cutout **16**.

The lower surface of transverse portion **10** of frame **8** may be provided with curved recesses corresponding to recesses **15***a* to assure an even better guidance of coupling portions **18**.

Due to the fact that four rows of electromagnets are provided for operating the coupling members, four times as much space is available for each electromagnet as compared with an arrangement in which all electromagnets are arranged in a row.

It is advantageous to make the bearing balls **33** of a synthetic plastic material whereby the noise is further reduced.

During punching operations, shaft **4** is continuously rotated, and frame **8** continuously reciprocates. As long as coupling portions **18** are in the illustrated inoperative position, no force can be transmitted from frame **8**, which constitutes a drive means, to the punches.

The selector electromagnets **28**, **28***a* are energized by electric impulses in accordance with a program and generated in synchronism with the reciprocating movement of the drive means **8**. An electric impulse representing the command "punch" is supplied to the respective electromagnet **28** early enough so that the angular movement of

the coupling members 19, 18 starts already when frame 8 is still in its lower end position. The entire time period during which frame 8 performs its return stroke can be used for setting the coupling members 18, 19 as required for the following punching operation occurring during the following downward working stroke of frame 8. During the upward return stroke of frame 8, a coupling member 18, 19 which was in its coupling position, is turned by the action of the respective spring 280 to its inoperative position, if required by the program. A coupling member in the inoperative position during a working stroke of frame 8, is turned by the action of the selector electromagnet 28 to its coupling position during the return stroke of frame 8. In other words, the time period required for the return stroke of the drive means is fully used for setting the apparatus to perform the next following punching operation during the following working stroke of the drive means.

It is an advantage of the invention that only those coupling members 18, 19 perform a working stroke with the reciprocating frame 18 which are required for operating a selected punch. The other coupling members 18 and 19 do not participate in the working stroke of frame 8 since they are in the inoperative position in which they are not engaged by portion 10 of frame 8. Consequently, the mass which has to be moved by the reciprocating drive means is reduced as compared with constructions of the prior art in which all coupling members participate in the working stroke. Wear of the parts, and the noise produced during operation is reduced by this feature of the invention.

Punches 14 which are not selected and therefore not operated are held during the working stroke in the higher position of rest by springs 25 so that the lower shoulders of cutouts 17 in punches 14 abut the stop bar 24. Stop bar 24 also prevents a turning of punches 14 so that the curved recesses 15*a* always register with the corresponding cylindrical surface portions of coupling portions 18.

In the second embodiment illustrated in FIGS. 4 and 5, the reciprocating drive means is not a frame, but a shaft 46 reciprocating by a pair of connecting rods 47 which are driven by a pair of eccentric members 44 secured to a motor driven shaft 43 mounted in side walls 42 of the apparatus. The ends of the reciprocating shaft 46 are guided in elongated vertical guide slots in walls 42 so that shaft 46 reciprocates in a vertical plane when shaft 43 rotates. A set of punches 52 is guided for vertical movement in bores of stationary supporting means 55. Punches 52 have openings 53 therethrough into which the ends of a correlated series of coupling levers project. Each punch 52 has a cutout 54 whose upper shoulder is engaged by a spring 57 urging the punch to its highest inoperative position, while the lower shoulder of cutout 54 abuts a common stop plate 58 which limits upward movement of all punches. Springs 57 are portions of a comb-shaped spring 56 which is secured by screws to supporting means 55. Transporting sprocket means 102 transport a record carrier sheet through a slot in supporting means 5 so that punches 52, when moved downward to a punching position, perforate the record carrier.

The other ends of coupling levers 48 are guided in vertical slots of a comb-shaped guide plate 59 which is secured to the side walls 42. When shaft 46 is raised to its highest position by eccentric members 44, the ends of coupling levers 48 abut a stop bar 78 which extends between the sidewalls 42.

A supporting beam 64 also extends between the side walls and has an upper surface formed with curved recesses 65 in which coupling members 60 are mounted for turning movement. Each coupling member 60 has a coupling portion whose cross section is non-circular, and more particularly partly bounded by a circular line, and partly bounded by a flat surface extending along a chord, as explained with reference to FIGS. 1 to 3. Coupling members 60 are turnable between a coupling position, and the illustrated inoperative position in which the flat surface 62 is in horizontal position and located under the surface of the drive portion 51 of a correlated coupling lever 48. When a selected coupling member 60 is turned 90° or more to the coupling position, the greater dimension of the coupling portion is effective, and since the surface 51 of each coupling lever 48 is spaced from the upper surface of abutment beam 64 a distance which is equal to the diameter of the part-cylindrical coupling portion, the gap between each surface 51 and abutment beam 64 which forms in the highest position of reciprocating shaft 46, is completely filled by the coupling portion of the respective coupling member 60 when the same is in its coupling position. It is preferred that in the upper end position of shaft 46, the coupling levers 48 do not actually abut the stop bar 78, but are slightly spaced from the same. A transverse beam 66 is secured to transverse beam 64 and provided with curved recesses corresponding to recesses 65 for guiding the cylindrical main portion of coupling members 60.

Each coupling member 60 has an annular groove 61 located in vertical slots of a comb-shaped guide plate 67 which is secured to the lateral walls 42. The upper ends of slots 68 are closed by a transverse bar 69.

Each coupling member has at the free end thereof, a helical screw face 61. An actuator pin 70 is mounted on the legs 72 and 73 of a U-shaped portion of alternating higher and lower armatures 71 and 71*a* of electromagnets 75 and 75*a*. Each actuator pin 70 engages the screw face of one coupling member 60 and the cylindrical surface of the adjacent coupling member 60. When the respective armature 71 or 71*a* is attracted, the pins 70 are moved substantially in axial direction of the coupling member 60, having the effect of a nut, so that the respective coupling member 60 is turned between the inoperative position shown in FIG. 4 and an operative position in which the full diameter of the coupling portion is effective to couple coupling lever 48 with coupling member 60.

Return springs 74 and 74*a* connect armatures 71 and 71*a* with stationary parts of selector electromagnets 75 and 75*a*. Two rows of selector electromagnets 75 and 75*a* are mounted on transverse supporting plates 59 and 59*a* so that the width of each electromagnet corresponds to the width taken up by two coupling levers 48 and two punches 52.

A transverse supporting bar 76 has threaded bores receiving adjusting screws 77 which respectively cooperate with the armatures 71 and 71*a* for exactly adjusting the position of each armature.

At the end of transverse guide plate 67, an abutment plate 79, best seen in FIG. 5, is provided for guiding the last actuator pin 70.

During operation of the apparatus illustrated in FIGS. 4 and 5, shaft 43 continuously rotates so that drive means 46 is reciprocated in vertical direction. Since punches 52 are held by springs 57 in the upper position, end portions 49 of coupling levers 48 cannot move downward as long as coupling members 60 are in the illustrated inoperative position, and the other end portions 50 of coupling levers 48 move freely downward since the smaller dimension of the coupling portion is located in a vertical plane and consequently effective.

The gap between the flat surface 62 and the lower surface of the respective end portion 50 is greater than the downward movement of end portion 50 during the downward stroke of reciprocating shaft 46. Consequently, no substantial force is transmitted by coupling levers 48 to punches 52, which remain in the higher position due to the action of springs 57. During this idling operation, coupling levers 48 rock about a pivot axis defined by end portions 49 and openings 53 in punches 52 without engagement between end portions 50 and flat faces 62 of coupling members 60.

When, in accordance with a program, energizing impulses are transmitted to the electromagnets **75** or **75***a* which are associated with punches selected for a punching operation, the respective armatures **71** or **71***a* are attracted, so that the respective actuator pins **70** move in axial direction of coupling members **60**, and since the actuator pins engage the helical screw faces **63**, the respective coupling members **60** turn an angle of substantially 90° to a position in which the cylindrical part of the coupling portion fills the gap between surface **51** of end portion **50** of the respective coupling lever **48** so that the respective end portions **50** are rigidly supported by the coupling members **60** and support **64** so that the downwardly working stroke of reciprocating shaft **46** causes the respective coupling levers **48** to pivot about an axis defined by end portions **50** and coupling members **60**, while end portions **49** move downward and force punches **52** downward to the punching position against the action of springs **57**.

When eccentric members **44** and connecting arms **47** move reciprocating shaft **46** upward in a return stroke, the end portions **50** abut the abutment bar **78** so that the respective coupling levers **48** swing about the same while the end portions **49** move upwards and raise the punches which were actuated. Springs **57** raise the punches slightly higher so that end portions **50** slightly separate from abutment bar **78**, and in this position, stop bar **58** prevents further upward movement of the punches. When the electric impulse energizing the respective electromagnets **75** or **75***a* is terminated, springs **74** move armatures **71**, **71***a* to the released position illustrated in FIG. 4, so that each actuator pin **70**, acting on the helical screw face **63**, turns the respective coupling member **60** back to its inoperative position illustrated in FIG. 4. The energizing impulses are terminated when reciprocating shaft **46** arrives in its lower end position after a working stroke, so that coupling members **60** are turned to the inoperative position while the punches **52** are raised by coupling levers **48** during the return stroke of shaft **46**.

It is preferred that the helical screw faces **63** have at the ends thereof short straight face portions so that the pressure exerted by actuator pins **71** does not produce a turning moment on the coupling members **60** when the same are in the inoperative or in the coupling end position.

The diameter of the actuator pin is selected so that each actuator pin is in contact with a helical screw surface **63** of a coupling member **60**, and with a cylindrical surface portion of the adjacent coupling member **60** whereby the helical screw surfaces **63** fully abut the respective actuator pin **70**. The last actuator pin **70**, not shown, on the left of the row as viewed in FIG. 5, abuts the abutment plate **79**.

While return springs **74** are illustrated for returning armatures **71**, **71***a*, and for turning the coupling members to the inoperative position, it is possible to substitute electromagnets for springs **74**. Magnetic flip-flops may be used for this purpose.

The embodiment illustrated in FIG. 6 is a modification of the embodiment illustrated in FIGS. 4 and 5, and the punches **52** are operated under the control of a reciprocating shaft **46**, coupling levers **48**, and coupling members **80**, as described above.

Coupling members **80** have a cylindrical portion mounted in recesses **85** and **86** in a transverse support **84**. A cover plate **88** secured by screws **90** retains coupling members **80**. Each coupling member has a coupling portion with a flat surface **81** and a part cylindrical surface, as described above. The coupling portions cooperate with the end portions **50** which are guided in vertical slots **89** of cover plate **88**. The upward movement of end portions **50** is limited by an abutment bar **78**. A drive shaft, carrying eccentric members, not shown, and connecting arms **74** is mounted in walls **87** and reciprocates shaft **46** which is guided in slots **45** of walls **87**.

Each coupling member **80** has at the other end thereof a reduced cylindrical portion **82** formed with a helical groove whose cross section is preferably wadge-shaped. A rope or cord **93** has one end **94** secured to the armature **96** of each electrical magnet **97**, and another end connected with the return spring **99** which is secured to an arm **98** of an electromagnet **97**.

The central portion of each rope or cord **93** is laid in several loops into the helical groove **83**. An abutment plate **92** secured to walls **87** blocks axial movement of the coupling members **80**. The helical groove **83** has at least three turns receiving three loops of cord **93**. Cord **93** are preferably made of synthetic fibers, and transmits the motion of armature **96** to coupling members **80**. When an armature **96** is attracted, the respective coupling member is turned 90° so that the respective coupling portion turns to the coupling position in which the cylindrical part of the coupling portion rigidly supports the free ends **50** of coupling levers **48** so that during reciprocation of shaft **46**, coupling levers **48** pivot about a fulcrum provided by end portions **50**, coupling members **80** and abutment bar **78**.

Due to the fact that each cord **93** has several loops, a slipping of the coupling members in the loops is prevented. Return springs **99** hold cord **93** in a tensioned condition, and since each end **94** is secured to an armature **96**, the respective armature is pulled by spring **99** to the release position abutting a stop bar **100** when the electromagnet **97** is deenergized. As explained above, the deenergization takes place when the reciprocating shaft **46** has completed its working stroke, so that the coupling members are turned back to the inoperative position during the return stroke of reciprocating shaft **46** if they were previously turned to the coupling position for actuation of the respective associated punches.

On the other hand, if during a punching operation a punch remains inoperative and its coupling members are in the inoperative position shown in FIG. 6, the electromagnet **97** is energized when the reciprocating shaft **46** arrives after a working stroke in its lower end position so that coupling member **80** is turned to its operative coupling position during the return stroke of shaft **46**, or even slightly earlier during the end of the working stroke.

The electromagnets **97** and **97***a* are arranged in two staggered rows in order to save space, as explained above. Preferably, each cord **93** is secured at **94** to the armature of an electromagnet of one row, while its other end **95** is secured to a spring **99** connected with an electromagnet of the other row. For example, the cord **93** secured to armature **96** of electromagnet **97** is secured to spring **99** of electromagnet **97***a*. The two rope end portions exert a symmetrical pull on coupling member **80**, whereas if the end of the cord is secured to the return spring **99** of the same electromagnet to which the end **94** is connected, the force of spring **99** would tend to transversely displace coupling members **80** and press the same into recesses **85**, thereby increasing the friction opposing turning movement of coupling members **80**.

From the above description of several embodiments of the invention, it will become apparent that the present invention provides for each punch, force transmitting means including a coupling member **19**, **18**, **60**, **80** having a non-circular cross section bounded by a flat face **20**, **62**, **81**, and by a cylindrical surface so that the cross section has a smaller dimension and a greater dimension. Each coupling member is mounted for angular movement about the axis of the cross section between a normal inoperative position in which the smaller dimension of the cross section is effective so that no force is transmitted between the drive means **8**, **46** and the respective correlated punch **14**, **52**, and a force transmitting coupling position in which the greater dimension of the cross section, namely the diameter of the cylindrical surface of the coupling portion, is effective to transmit force from the drive means **8**, **46** to the respective correlated punch.

Electromagnets **28**, **75**, **97** are a set of selector means respectively correlated with the punches and connected with the coupling members **19**, **18**, **60**, and **80** for turning selected coupling members to the force transmitting coupling position.

In the embodiment of FIG. 1, the coupling members directly connect the reciprocating drive means **8** with the punches **14**. In the embodiments of FIGS. 4 to 6, the force transmitting means includes coupling levers **48** and coupling members **60**, **80** for connecting the reciprocating drive means **46** with the punches.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of punching apparatus differing from the types described above.

While the invention has been illustrated and described as embodied in a punching apparatus in which reciprocating drive means are connected with the punches by turnable coupling members having a non-circular cross section, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

I claim:

1. Punching apparatus comprising, in combination, drive means reciprocable in a working stroke and in a return stroke between a retracted position and an advanced position; supporting means; a set of punch means, each punch means being mounted on said supporting means for movement between an inoperative position and a punching position; a set of force transmitting means respectively correlated with said punch means, each force transmitting means including a coupling member having a coupling portion with a cross section bounded by a circular line extending over more than 180° and less than 360°, and by another line connecting the ends of said circular line and having a center spaced from the center of said circular line a distance which is less than the radius of said circular line so that said coupling portion has a greater dimension equal to the diameter of said circular line, and a smaller dimension, each coupling member being mounted for angular movement about the axis of said cross section between a force transmitting position in which the greater dimension is operative so that said coupling portion transmits force from said drive means to the respective correlated punch means during a working stroke, and an inoperative position in which the smaller dimension is effective to prevent transmission of force from said drive means to the respective punch means; and a set of selector means respectively correlated with said punching means and respectively connected with said coupling members for turning selected coupling members 90° during said return stroke between said positions of the same.

2. Punching apparatus as claimed in claim **1** wherein said drive means is reciprocable along a path; and wherein said axes of said coupling members are perpendicular to said path.

3. Punching apparatus as claimed in claim **1** wherein said selector means hold said coupling members in said force transmitting coupling position while said drive means moves in said working stroke, and turn said coupling members from said coupling position to said inoperative position, and selected coupling members also to said coupling position during said return stroke; and wherein said strokes have such a length that said punch means are placed in said inoperative position and in said punching position when said drive means arrives in said end positions, respectively.

4. Punching apparatus as claimed in claim **3** wherein said selector means turn selected coupling members from said coupling position to said inoperative position, and from said inoperative position to said coupling position during a time period equal to the time period during which said drive means makes said return stroke.

5. Punching apparatus as claimed in claim **1** wherein each said coupling portion of said coupling members has a cross section bounded by said circular line and by a chord, said cross section having said smaller dimension perpendicularly to said chord, and said greater dimension extending along a diameter of said circular line.

6. A punching apparatus as claimed in claim **1** wherein said set of punch means includes a row of punches located in a plane; wherein each of said coupling members includes a rod and a coupling portion at the end of said rod; wherein the rods of alternate coupling portions project in opposite direction from said plane; and wherein said rods are respectively connected to said selector means.

7. Punching apparatus as claimed in claim **1** and including abutment means for blocking axial movement of said coupling members.

8. Punching apparatus comprising, in combination, drive means reciprocable in a working stroke and in a return stroke of predetermined length between a retracted position and an advanced position; supporting means; a set of punch means, each punch means being mounted on said supporting means for movement between an inoperative position and a punching position, and being spaced in said inoperative position a selected distance from said drive means in said retracted position; a set of force-transmitting means respectively correlated with said punch means, each force-transmitting means including a coupling member having a coupling portion with a non-circular cross-section having first peripheral portions located from each other at a greater distance which is equal to said selected distance and offset second peripheral portions located from each other at a smaller distance which is less than the difference between said selected distance and said length of said strokes, and being mounted for angular movement about an axis which is located substantially halfway between said first peripheral portions between a force-transmitting position, in which said first peripheral portions are located in the path of said drive means between said drive means and the respective correlated punch means so that said coupling portion is engaged by said drive means during said working stroke and transmits force to said punch means, and an inoperative position in which said second peripheral portions are located between said drive means and the respective correlated punch means so that said coupling portion remains spaced from said drive means during said working stroke and in said advanced position; and a set of selector means respectively correlated with said punch means and respectively connected with said coupling members for turning selected coupling members between said positions of the same during said return stroke.

9. An apparatus according to claim **8** wherein each of said coupling members includes a rod and said coupling portion at one end of said rod, said rod having at the other end thereof a crank arm; and wherein each selector means includes an electromagnet having a movable armature including a leaf spring formed with a bore receiving said crank arm so that movement of said armature between attracted and released position causes turning movement of said coupling member between said inoperative and coupling positions.

10. A punching apparatus as claimed in claim **9** wherein said supporting means comprise a comb-shaped guide plate having slots for guiding said rods, and balls mounted for turning movement and having a bore through which said rods pass.

11. A punching apparatus as claimed in claim 8 wherein said supporting means include walls having parallel vertical guide slots; and wherein said drive means includes a reciprocating member having end portions guided in said slots, and means for reciprocating said member.

12. A punching apparatus as claimed in claim 8 wherein said supporting means include a support member having a slot for a record carrier and a row of bores for guiding said punch means; wherein each punch means includes a punch having at least one cutout bounded by two shoulders, a stop bar engaging one of said shoulders of each punch, and spring means engaging the other shoulders of each punch for urging the same to said inoperative position in which further movement is stopped by said stop bar.

13. Punching apparatus as claimed in claim 8 wherein said punching means include punches each of which has a punching end and another end formed with an abutment; wherein said coupling portions are disposed on said abutment; and wherein said reciprocating drive means includes a frame having a first transverse member located above said coupling portions, and a second transverse member for engaging said punches so that in said force transmitting coupling position of said coupling members, the respective punches are moved in a punching stroke during a working stroke of said frame, while said punches are retracted to said inoperative position by said second transverse member during the return stroke of said reciprocating frame.

14. Punching apparatus as claimed in claim 8 wherein said supporting means include a stationary frame having a horizontal portion for guiding said punches and being located between said first and second transverse portions of said reciprocating frame.

15. Punching apparatus as claimed in claim 8 wherein each coupling portion has a cross section bounded by a circular line extending over more than 180° and less than 360° whose diameter equals said greater distance, and by another line whose center is spaced from the center of said circular line a distance which is less than the radius of said circular line; and wherein said coupling member is turned by said selector means 90° between said inoperative and coupling positions.

16. Punching apparatus comprising, in combination, reciprocating drive means; supporting means; a set of punch means, each punch means being mounted on said supporting means for movement between an inoperative position and a punching position; a set of force-transmitting means respectively correlated with said punch means, each force transmitting means including a coupling member having a coupling portion with a non-circular cross section having a smaller dimension and a greater dimension, and being mounted for angular movement about the axis of said cross section between a normal inoperative position in which said smaller dimension is effective so that no force is transmitted between said drive means and the respective correlated punch means, and a force transmitting coupling position in which the greater dimension of said non-circular cross section is effective to transmit force from said drive means to the respective correlated punch means, each of said coupling members having said coupling portion at one end thereof, and having at the other end thereof, a cylindrical end portion formed with a helical screw face; and a set of selector means respectively correlated with said punch means and respectively connected with said coupling members for turning selected coupling members to said force transmitting coupling position so that the respective punch means are operated by said drive means to move to said punching position, each selector means includes an actuating member movable in the direction of said axis and abutting said helical screw face so that movement of said actuating member causes turning of said coupling member between said inoperative and force transmitting coupling positions.

17. Punching apparatus as claimed in claim 16 wherein each of said coupling members has straight axially extending faces at the ends of said helical screw faces so that no turning movement is exerted by said actuating members on said coupling members in said inoperative and coupling positions.

18. Punching apparatus as claimed in claim 17 wherein said supporting means include supporting members having curved recesses for turnably supporting said coupling members for angular movement about said axis; wherein each coupling member has an annular groove; and wherein said supporting means include a comb-shaped member having slots engaging said annular grooves of said coupling members, and a bar closing said slots.

19. Punching apparatus as claimed in claim 16 wherein said actuating members are actuating pins, each actuating pin being located between two coupling members and abutting said helical screw face of one of said two coupling members and also the other coupling member; wherein said coupling members are arranged in a row; and wherein said supporting means comprise an abutment member located at the end of said row of coupling members in such a position that said actuator pin which abuts said helical screw face of the last coupling member of said row, also abuts said abutment member.

20. Punching apparatus comprising, in combination, reciprocable drive means; supporting means having an abutment portion; a set of punch means, each punch means being mounted on said supporting means for movement between an inoperative position and a punching position; a set of force-transmitting means respectively correlated with said punch means, each force-transmitting means including a coupling lever mounted on said drive means for pivotal movement and having one portion connected with the respective punch means, and a drive portion driven by said drive means in a working stroke and a return stroke of predetermined length toward and away from said abutment portion of said supporting means between a retracted position and an advanced position, and being spaced in said retracted position a selected distance from said abutment portion, and a coupling member having a coupling portion with a non-circular cross-section having first peripheral portions located from each other at a greater distance which is equal to said selected distance and offset second peripheral portions located from each other at a smaller distance which is less than the distance between said selected distance and said length of said stroke of said drive portion, and being mounted for turning movement about an axis which is located substantially halfway between said first peripheral portions between a force-transmitting position, in which said first peripheral portions are located between said drive portions and the respective correlated punch means so that said coupling portion is engaged by said drive means during said working stroke and transmits force to said punch means, and an inoperative position in which said second peripheral portions are located between said drive portion and said abutment portion so that said coupling portion remains spaced from said drive portion during said working stroke and in said advanced position; and a set of selector means respectively correlated with said punch means and respectively connected with said coupling members for turning the same between said positions of the same during said return stroke.

21. Punching apparatus as claimed in claim 20 wherein said set of selector means includes a row of electromagnets having movable armatures; and comprising a supporting bar extending over said armature members and supporting a row of adjusting screws for adjusting the positions of said armature members independently of each other.

22. Punching apparatus as claimed in claim 20 wherein each coupling portion has a cross section bounded by a circular line extending over more than 180° and less than 360° whose diameter equals said greater distance, and by

another line whose center is spaced from the center of said circular line a distance which is less than the radius of said circular line; and wherein said coupling member is turned by said selector means 90° between said inoperative and coupling positions.

23. Punching apparatus comprising, in combination, reciprocating drive means; supporting means; a set of punch means, each punch means being mounted on said supporting means for movement between an inoperative position and a punching position; a set of force-transmitting means respectively correlated with said punch means, each force transmitting means including a coupling member having a coupling portion with a noncircular cross-section having a smaller dimension and a greater dimension, and being mounted for angular movement about the axis of said cross section between a normal inoperative position in which said smaller dimension is effective so that no force is transmitted between said drive means and the respective correlated punch means, and a force transmitting coupling position in which the greater dimension of said non-circular cross section is effective to transmit force from said drive means to the respective correlated punch means, said coupling members being cylindrical rods having at one end said coupling portion, said coupling

portion having a flat face extending along a chord of said cylindrical coupling member, said coupling member having at the other end thereof a helical groove; and a set of selector means respectively correlated with said punch means and respectively connected with said coupling members for turning selected coupling members to said force transmitting coupling position so that the respective punch means are operated by said drive means to move to said punching position, each selector means including a movable member and a spring biased cord having a plurality of loops located in said helical groove so that movement of said movable member causes turning movement of said coupling member between said inoperative and coupling positions.

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