March 28, 1967 R. G. WILLIAMSON ETAL 3,311,297

SELECTIVE PUNCHING MECHANISM

Filed April 6, 1965 2 Sheets-Sheet 1

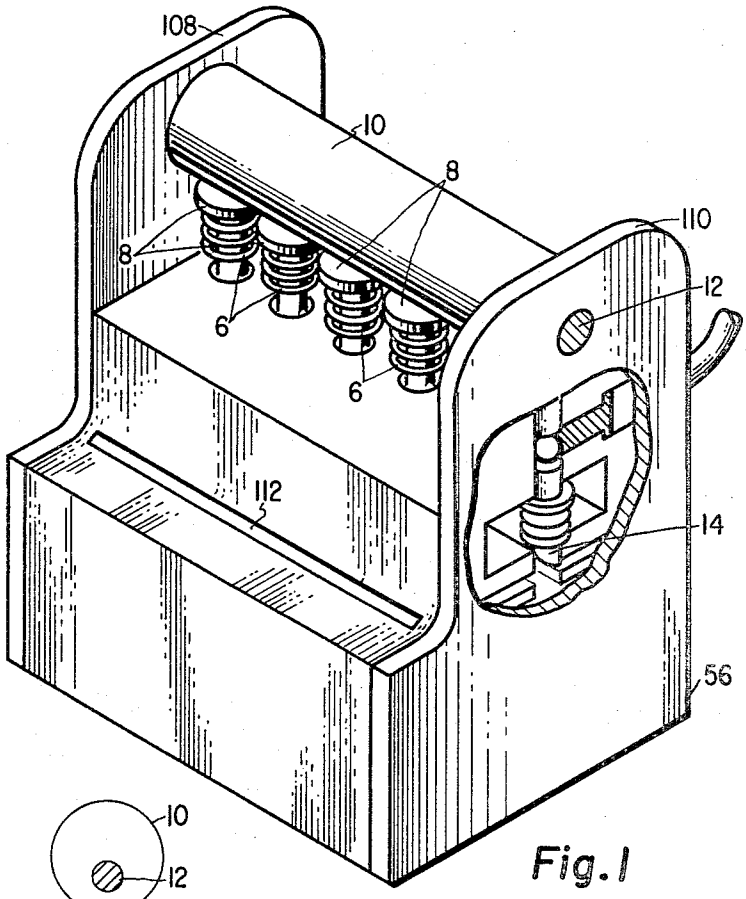

Fig. 1

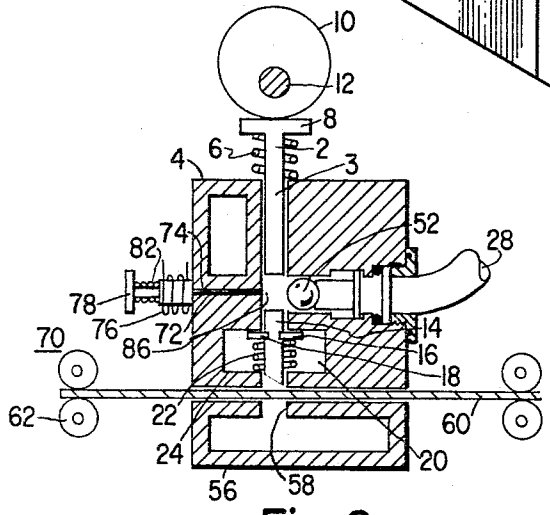

Fig. 2

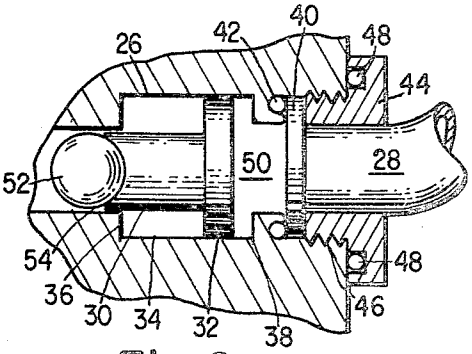

Fig. 2a

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Fig. 3

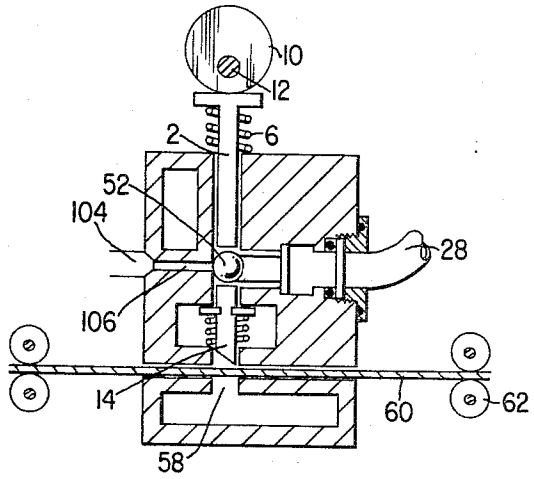
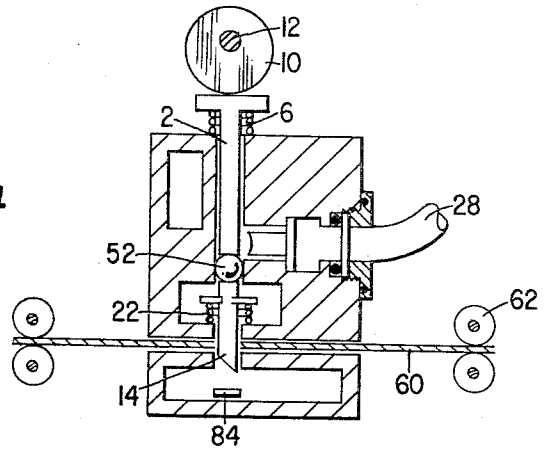


Fig. 4



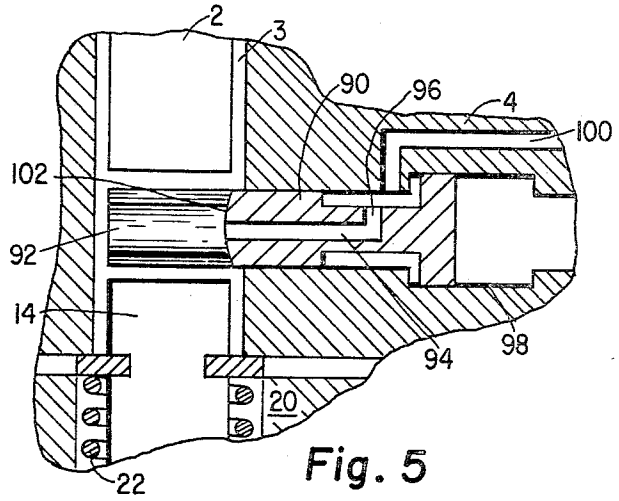


Fig. 5

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3,311,297

SELECTIVE PUNCHING MECHANISM

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This invention relates to selective punching mechanisms and more particularly to a punching mechanism wherein the punch is driven by a cyclically operated drive means through a selectively operated interposer.

Many present day punching mechanisms have the individual punches thereof selectively operated by means of the selective insertion, between a punch and a cyclically operated drive means, of a connecting member called an interposer. Mechanical arrangements for inserting an interposer between the punch and the punch drive member generally have the drawbacks of being noisy, slow, and susceptible to serious vibration problems. Those mechanical insertion devices which have been considered to be "high-speed" have not been suitable for heavy duty punching mechanisms. This is because they have a relatively short insertion stroke whereby the interposer is not fully inserted between the punch and the punch drive.

Electrically inserted interposers are generally faster and quieter than mechanical insertion mechanisms. The electrical devices, however, are still limited to a short insertion stroke hence they too are unsuitable for heavy duty punches.

In some instances pneumatic or hydraulically driven interposers have been both fast and silent as well as providing a long stroke capability. This, then, is the present state of the art. For an interposer to be either pneumatically or hydraulically driven the entire punching mechanism must provide a fluid tight system. This, of course, necessitates low manufacturing tolerances which result in high production costs.

It is a principal object of this invention, therefore, to provide a punching mechanism with all the advantages of one having a fluid actuated interposer but which does not require a fluid-tight punch and punch-drive housing.

An additional object is to provide a punching mechanism having a high speed and long stroke interposer capability and still having a relatively simple punch and punch drive mechanism.

A further object of the invention is to provide a punching mechanism wherein the punching loads are not required to be transmitted by means of pivots or flexures.

A further object of the invention is to provide a high speed punch that has an extremely simple actuating and restoring mechanism for the interposers.

In modern day data processing equipment there is a great need for high speed, silent, heavy duty punches. The data processing machines, however, have many types of auxiliary power systems. That is, some employ vacuum lines for one purpose or another, other machines have hydraulically driven actuators, and still others use air pressure to accomplish certain machine functions. It is a further object of this invention, therefore, to provide a punching mechanism that is adaptable to either hydraulic, pneumatic, or vacuum operated equipment.

This invention has a typical application in the type of punching mechanism in which a punch drive means is cyclically operated. Motion of the punch drive, however, is only transmitted to a punching member when an interposer is inserted between the drive and the punch. In accordance with the principle of the invention the interposer is inserted by means of an interposer drive member. A means is provided for causing the interposer to adhere

to its drive member when the punch drive is in a neutral or non-drive position. The interposer drive member is selectively driven by a fluid means whereby it is capable of a long stroke. With this structure the interposer itself is isolated from the fluid drive source from whence it derives its insertion force. When it is desired that a punching operation take place the fluid driving means is selected to drive the interposer drive member; the drive member, to which the interposer is adhered, inserts the interposer between the punch drive and the punch member; the next punch cycle of the punch drive forces the interposer to disengage from the interposer drive and force the punch member to undergo a punching stroke. A punch return means then forces the punch and interposer back to a neutral position where the interposer once again adheres to the interposer drive. The interposer drive and interposer may then be withdrawn from the punching mechanism, whereupon a subsequent similar punching operation may take place.

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

In the drawings:

FIG. 1 is a perspective view of a plural punch mechanism with a portion of a side thereof broken away;

FIG. 2 is a sectional view of the punching mechanism shown in FIG. 1 taken on a plane through the center of one of the punch mechanisms at time during a punch cycle when the punch drive is in a neutral position and the interposer is withdrawn;

FIG. 2*a* is a cutaway portion of FIG. 2 showing the area around the interposer drive in more detail.

FIG. 3 is similar to FIG. 2 at a time during a punch cycle when the punch drive is in a neutral position and the interposer is inserted;

FIG. 4 is also similar to FIG. 2 but at a time during the punch cycle when the punch drive, interposer, and punch itself are undergoing a punching stroke;

FIG. 5 is an enlarged portion of FIG. 2 which has been broken out to show an alternative means for causing the interposer to adhere to the interposer drive member.

One embodiment of the invention will now be briefly described with reference to FIGS. 2 and 2*a* of the accompanying drawings. A punch drive member **2** has one end thereof slidably inserted in a punch guide channel **3** of a punching block **4**. A spring **6** is restrained between the punching block and a head **8** located on the other end of the punch drive member **2** and urges the punch drive member upwardly into engagement with a cam **10** mounted on a shaft **12** and which is driven by a means not shown. Also slidably located within the punch guide channel **3** and directly below the punch drive member **2** is a punch **14**. A retaining ring **16** is mounted about the punch **14** in a groove **18**. A punch retainer channel **20**, in the lower part of the punch block **4**, surrounds the punch **14** and accommodates a spring **22** which embraces the punch. The spring **22** is restrained between a lower surface **24** of the punch channel and the lower surface of the retainer ring **18** thereby urging the punch **14** in an upward direction.

On the right side of the punch block **4** is an interposer channel **26** extending from a fluid entry tube **28** into the punching channel **3**. An interposer drive member **30** is slidable within the interposer channel **26**. A limit cap **32** is integral with the interposer drive member **30** and extends into a limiting groove **34**. Hence, sliding motion of the interposer drive member is limited by motion of the cap **32** as it strikes ends **36** and **38** of the limiting groove **34**. A flange **40** of the fluid tube **28** is pressed

against O ring 42 by a threaded cap 44 which is screwed into a tapped counter bore 46. The cap is also sealed against the side of the punch block by an O ring 48. The opposing surfaces of the interposer channel 26 and the interposer drive member 30 as well as the cap 38 are ground to provide a fluid seal between fluid chamber 50 and a spherical interposer 52.

In the embodiment shown in FIGS. 2, 2*a*, 3, and 4 the spherical interposer 52 is of a paramagnetic material and the end portion 54 of the interposer drive member 30 is permanently magnetic. Hence, the interposer adheres to the interposer drive member by means of the magnetic forces between the two.

A die block 56 has a die opening 58 located directly below the punch 14. An article to be punched 60, such as a unit record card or a tape is driven by rollers 62 between the punch block 4 and the die block 56 so that downward motion of the punch 14 against the force of the spring 22 will cause a hole to be punched in the article 60.

On the left hand side of the punch block in FIG. 2 is an optional interposer restore mechanism 70. In the embodiment thereof shown in FIG. 2, an armature has one end 72 thereof extending into an interposer restore channel 74, and the other end thereof extending through a solenoid 76 and terminating in a head portion 78. When current is applied to the leads of the solenoid the head of the armature overcomes a spring 82 and the other end of the armature is extended slightly into the punching channel 3.

Having described the structure of one embodiment of the punching mechanism of the invention a punching operation cycle will now be described with reference to FIGS. 2, 2*a*, 3, and 4.

A cam shaft 12 is driven by a means not shown so that cam 10 cyclically forces the punch drive member 2, against the force of spring 6, into the punch guide channel 3. As shown in FIG. 2, the motion of the punch drive member will not have any effect upon punch 14. Rollers 62 are operated in synchronism with the cam shaft drive means so that an article to be punched 60 has predetermined portions thereof between the die opening 58 and the punch 14 as the punch drive member approaches the lower portion of its stroke.

If it is desired to punch a hole in one of the predetermined locations on the article 60 the interposer 52 is selectively inserted between the punch drive member and the punch as shown in FIG. 3.

In order to insert the interposer between the punch drive member and the punch, fluid pressure is selectively applied to the fluid entry means 28. Mechanisms for selectively applying fluid pressure to an entry tube such as 28 are well known in the art and therefore will not be further described herein. It should be noted, however, that the selective application of fluid pressure should be in synchronism with the cam shaft drive means and the article feed rollers 62.

At the time when fluid pressure is applied to fluid chamber 50 the interposer drive and the interposer are in the positions shown in FIGS. 2 and 2*a*. The interposer adheres to the surface 54 of the interposer drive means by virtue of the magnetic forces therebetween. Preferably, because of the fluid seal between the limit cap 32 and the limiting groove 34 none of the fluid from chamber 50 is permitted into the portion of the interposer channel 26 occupied by the spherical interposer. Once the pressure is fully applied to the chamber 50 the interposer drive member 30 moves to the left in FIG. 2 until the limit cap 32 abuts the end 36 of the limiting groove 34 as shown in FIG. 3. At this time the spherical interposer is fully in position between the punch drive member and the punch.

During the next revolution of the cam 10 the punch drive member is driven downwardly (FIG. 4) compressing spring 6 and removing the spherical interposer 52 from its magnetic adherence to the interposer drive member 30. As the interposer is driven downwardly in FIG. 4 it in turn drives the punch downwardly compressing the spring 22 and causing a punched segment 84 to be removed from the punched article 60.

As the cam continues its revolution the springs 22 and 6 force the punch interposer, and punch drive members respectively upwardly as shown in FIG. 3. When in this position the interposer is once again magnetically attracted to the interposer drive member and adheres thereto. At this time a relatively negative hydraulic pressure is applied to the chamber 50 whereby the interposer drive member and the interposer move to the right in FIG. 3 until the limit cap strikes the end of the limiting groove at which time the entire cycle is completed and the mechanism is returned to the starting position of FIG. 2.

If the optional interposer restore mechanism 70 is employed, the solenoid 76 is timed to be briefly energized when the interposer is returned to its neutral position after the punching stroke. In this manner the armature moves to the right in FIG. 1 and nudges the interposer into engagement with the interposer drive member. So long as a relatively small spherical interposer is used, there is little likelihood that the interposer will require this aid in adhering to the interposer drive member. However, as will be described shortly, when a larger cylindrical interposer is used, this feature takes on added importance.

From the above description of a preferred embodiment of the invention it can be seen that the long stroke capabilities of hydraulic actuation have been obtained while at the same time the need for a fluid tight punching chamber has been eliminated. This results in a silent, high speed, heavy duty punching mechanism having much lower fabrication costs than hydraulically actuated punches of the prior art. It will also be appreciated that repairs and maintenance of the punching unit can be accomplished without the necessity for draining and subsequently bleeding a hydraulic system. It will similarly be understood by those skilled in the art that any fluid system, such as a pneumatic system for example, could be used in place of the hydraulic system herein described.

Having described the structure and operation of a preferred embodiment of the invention an alternative embodiment of a means for causing the interposer to adhere to the interposer drive member will now be described with reference to FIG. 5. The structure of FIG. 5 is in all respects similar to that of FIGS. 2, 3, and 4 except for the structural and coactive relationships between an interposer drive member 90 and a cylindrical interposer 92. The interposer drive member has an axial bore 94 running for part of its depth and is connected by a cross bore 95 to a circumferential groove 98. The groove 98 is connected to a vacuum channel 100 extending through the punch block 4 to a vacuum source not shown. As the interposer drive member is driven back and forth, in the manner described above, the groove 98, and hence bores 94 and 96 are continually connected to the vacuum. The vacuum at the end 102 of the interposer drive member sucks the interposer 92 into adherence with the interposer drive member. In this manner the interposer drive selectively inserts the interposer into the punching chamber as shown in FIG. 5 and also withdraws the interposer from the punching chamber after the punch drive member returns to its neutral position upon completion of a punching stroke.

The interposer used in FIG. 5 is cylindrical rather than spherical as previously described. The spherical interposer provides only point contact between the punch drive member 2 and the punch 14. While this is generally suitable for most punching needs it is sometimes desirable for very heavy duty punching operations to have greater than a point contact. The cylindrical interposer 92, shown in FIG. 5, provides a line contact between the punch drive member 2 and the punch 14. This not only provides a

greater contact area and hence has better wear characteristics, but also provides less opportunity for any canting of the punch drive and punch members. In this manner the machining tolerances of the punching elements may be even greater.

In the event that a cylindrical interposer is used it may be desirable to assist it into an adhering position with the interposer drive member after it is returned to its neutral position upon completion of a punching cycle. One means for assisting the interposer into its adhering position is shown, and has already been described in connection with FIGURE 2. That type of interposer restorer is little more than the old type of electrically actuated interposer. That is, to assist the interposer into its adhering position an electrically controlled armature is used to nudge the interposer to the right in FIG. 2. Because the stroke of the armature need be only very slight its force is strong enough and its motion rapid enough to accomplish this limited function.

Another embodiment of a means for assisting the interposer into its adhering position is shown in FIG. 3. Therein, air is supplied through tube **104** into a channel **106** in the punch block of FIG. 3. Again, although this assisting force is not satisfactory for use in inserting and withdrawing the interposer itself, it is adequate to perform the limited requirements placed upon it in the embodiment just described.

The invention as described thus far has been shown as being embodied only in a single punching element. The invention is not limited thereto, however, but may be employed with equal utility when plural punches are used as shown in FIG. 1. Therein, the shaft **12** is journalled in end housings **108, 110**. As the cam **10** rotates the heads **8** are cyclically driven downwardly against the forces of the springs **6**. As an article to be punched is driven through slot **112** it passes under the punch **14** and over the die block **56**. Depending upon which of the interposers **52** are inserted by the means described above, selected portions of the article will be punched.

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

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a selective punching mechanism having a punching member movable within a guide means and a cyclically operated punch drive means for transmitting motion to said punching member through a selectively inserted interposer so that said punching member moves from a neutral position to a punching position when said interposer member is inserted between said punch drive means and said punching member, the combination comprising:

an interposer drive member;

a fluid drive means for driving said interposer drive member from a first position to a second position and back to said first position when said punching member is in said neutral position;

an interposer member located in the path of said interposer drive member and movable with said interposer drive means, said interposer drive member being adapted to insert said interposer between said punching member and said punch drive means when said punch member is in said neutral position;

and means for causing an adherence between said interposing member and said interposer drive member that is sufficient to cause said interposer member to follow said interposer drive member back to said first position but insufficient to resist motion of said punch drive means as it moves from said neutral position to said punching position.

2. The device described in claim **1** wherein said fluid drive means is pneumatic.

3. The device described in claim **1** wherein said fluid drive means is hydraulic.

4. In a selecitve punching mechanism having a punching member movable within a guide means and a cyclically operated punch drive means for transmitting motion to said punching member through a selectively inserted interposer so that said punching member moves from a neutral position to a punching position when said interposer member is inserted between said punch drive means and said punching member, the combination comprising:

a magnetic interposer drive member;

a fluid drive means for driving said interposer drive member from a first position to a second position and back to said first position when said punching member is in said neutral position;

a paramagnetic interposer member located in the path of said interposer drive member and movable with said interposer drive means, said interposer drive member being adapted to insert said interposer between said punching member and said punch drive means when said punching member is in said neutral position;

whereby the magnetic forces between said interposer drive member and said paramagnetic interposer cause said interposer to adhere to said drive member.

5. In a selective punching mechanism having a punching member movable within a guide means and a cyclically operated punch drive means for transmitting motion to said punching member through a selectively inserted interposer so that the punching member moves from a neutral position to a punching position when said interposer member is inserted between said punch drive means and said punching member, the combination comprising:

an interposer drive member;

a fluid drive means for driving said interposer drive member from a first position to a second position and back to said first position when said punching member is in said neutral position;

an interposer member located in the path of said interposer drive member and movable with said interposer drive means, said interposer drive means being adapted to insert said interposer between said punching member and said punch drive means when said punching member is in said neutral position;

a vacuum supply means;

and means for continually connecting said vacuum supply means to the end of said interposer drive member nearest to said interposer as said interposer drive member moves from said first to said second position whereby said vacuum adheres said interposer to said interposer drive member when said punch drive means is in said neutral position.

6. The device described on claim **4** wherein said interposer is spherical.

7. The device described in claim **5** wherein said interposer is spherical.

8. The device described in claim **4** wherein said interposer is cylindrical.

9. The device described in claim **5** wherein said interposer is cylindrical.

10. In a selective punching mechanism having a plurality of punching members each movable within a guide means and cyclically operated punch drive means for transmitting motion to said punching members through related selectively inserted interposers, wherein said punching members are moved from a neutral position to a punching position when a related interposer member is inserted between the punch drive means and said related punching member, the combination comprising:

an interposer drive member associated with each of said interposers;

a fluid drive means for selectively driving selected ones of said interposer drive members from a first position

to a second position and back to said first position when the punching members are in said neutral position;

an interposer member located in the path of each of said interposer drive members and movable with the associated interposer drive member, said interposer drive member being adapted to insert the selected interposer between the related punching member and said punch drive means when the related punching member is in said neutral position;

and means for causing an adherence between each of said interposing members and the associated interposer drive members that is sufficient to cause said interposing member to follow the associated interposer drive member back to said first position but insufficient to resist motion of said punch drive means as it moves from said neutral position to said punching position.

11. The device described in claim **10** wherein said fluid drive means is pneumatic.

12. The device described in claim **10** wherein said fluid drive means is hydraulic.

13. The device of claim **10** wherein said interposer drive members are magnetic and said interposers are paramagnetic whereby the magnetic forces between said interposer drive members and said paramagnetic interposer cause said interposers to adhere to said drive members.

14. The device of claim **13** wherein said interposers are spherical.

15. The device of claim **13** wherein said interposers are cylindrical.

16. The device of claim **10** including a vacuum supply means; and means for continually connecting said vacuum supply means to the ends of said interposer drive members nearest to said interposers as said interposer drive members move from said first to said second positions, whereby said vacuum tends to cause said interposers to adhere to said interposer drive members when said punch drive members are in said neutral position.

17. The device of claim **16** wherein said interposers are spherical.

18. The device of claim **16** wherein said interposers are cylindrical.

19. In a selective punching mechanism having a punching member movable within a guide means and a cylically operated punch drive means for transmitting motion to said punching member through a selectively inserted interposer so that said punching member moves from a neutral position to a punching position when said interposer member is inserted between said punch drive means and said punching member, the combination comprising:

an interposer drive member;

a fluid drive means for driving said interposer drive member from a first position to a second position and back to said first position when said punching member is in said neutral position;

an interposer member located in the path of said interposer drive member and movable with said interposer drive means, said interposer drive member being adapted to insert said interposer between said punching member and said punch drive means when said punch member is in said neutral position;

means for causing an adherence between said interposing member and said interposer drive member that

is sufficient to cause said interposer member to follow said interposer drive member back to said first position but insufficient to resist motion of said drive means as it moves from said neutral position to said punching position;

and means operative when said interposer is returned to said neutral position from said punching position for urging said interposer towards said interposer drive means, whereby the adherance between the interposer and the interposer drive member is aided.

20. A selective punching mechanism comprising:

a punch block;

a die block located adjacent to said punch block;

a guide means extending from said punch block into said die block;

a punch drive member movable within said guide means;

a punch located in said guide means substantially coaxially with said punch drive member and adapted to have the punching end thereof moved into the die block portion of said guide means;

means for cyclically driving said punch drive means from a neutral position to a punching position;

means urging said punch drive member towards said neutral position;

an interposer drive member;

a fluid drive means adapted to drive said interposer drive member from a first position to a second position and back to said first position when said punch drive member is in said neutral position;

an interposer member located in the path of said interposer drive member and movable with said interposer drive member, said interposer drive member being adapted to insert said interposer between said punch drive means and said punch member when said punch drive means and said punch member are in said neutral position;

means urging said punch member towards said neutral position, said last named means being overcome by said punch drive means when said interposer is inserted between it and said punch drive means, said punch thereby undergoing a punching stroke by being driven through said guide means from the punch block into said die block, said means urging said punch and said punch drive member into said neutral position being operative to return said interposer to said neutral position after said punching stroke;

and means for causing said interposer to adhere to said interposer drive member so that the adherence is sufficient to cause said interposer member to follow said interposer drive member back to said first position, but insufficient to resist motion of said punch drive means as it moves from said neutral position to said punching position.

21. The apparatus of claim **20** including means for urging said interposer from said neutral position towards said interposer drive means.

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