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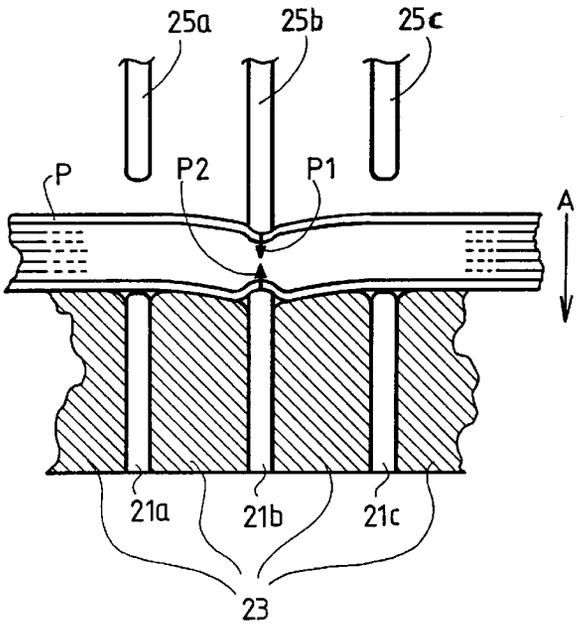
(54) Serial impact printer.

(57) A serial impact printer (1) having a movable print head (2) with a plurality of print wires (25a,25b,25c) and a platen (6) arranged oppositely to the print head (2), the platen (6) supporting a print medium (P) thereon and moving synchronously with the print head (2), the serial impact printer comprising : a plurality of projections (21a,21b,21c) formed on a projecting member (21) which is mounted on the platen (6), each of the projections having a top surface and being opposed to each of the print wires (25a,25b,25c), and a spacer (23) with an upper surface arranged near the projections, the spacer (23) being more deformable than the projections against impact power yielded by the print wires, and wherein printing is conducted on the print medium (P) while the print medium (P) is retained between the projection (21b) and the print wire (25b) impacted toward the projection (21b).

FIG. 5



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The present invention relates to a serial impact printer which conducts printing of characters and the like on a print medium by impacting thereon through print wires and more particularly to a serial impact printer having projections on a platen, each of the projections being opposed to each of print wires, so that the characters and the like can be clearly printed on print medium in which plural copyable sheets such as carbon copy papers are bound into one form.

Impact printers are utilized in simultaneous printing of characters and the like on copyable print sheets in which pressure sensitive sheets such as carbon copy papers are bound into one form. Thus, in such the impact printers, it is demanded that the characters and the like can be clearly printed on all of the copyable print sheets in case that print form in which plural copyable print sheets (for example, 10 sheets) are bound into one form is utilized.

However, in order to clearly print the characters and the like on all of the plural copyable print sheets, there are two problems as follows. That is to say, it is the first problem that, though it is more favorable to strongly drive the print wires to print the characters and the like with enough concentration onto the lowermost print sheet as same as the uppermost print sheet, open holes are formed on the uppermost print sheet by the print wires in case that impacting power of the print wires are unnecessarily strong. And it is the second problem that the characters and the like printed on the lowermost sheet are apt to fade because the impacting power transmitted to the print form is gradually dispersed according to that position of the print sheet becomes lower and lower.

Therefore, to dissolve the above problems, the inventors of the present invention proposed in United States Patent Application serial No. 07/997,077 a serial impact printer in which a platen is installed, the platen being arranged oppositely to a print head having print wires in a state that print sheets are inserted therebetween and the platen being movable parallel to the print head in synchronism with movement of the print head, and further projections are formed on the platen, each of the projections being opposed to each of the print wires.

And in such serial impact printer, when the print wires are driven to impact the print sheets, the print sheets are pressed between the print wires and the projections and thus the impact power of the print wires is concentrated within a small area without being dispersed. As a result, by utilizing the above serial impact printer, the characters and the like can be clearly printed on all of the print sheets if the print sheets, in which plural copyable print sheets are bound into one form, are used.

Next, the printing manner of the above serial impact printer will be described hereinafter referring to Fig. 25 of the accompanying drawings. In the serial impact printer, as shown in Fig.25, when a print wire 90b impacts a copyable print medium P, in which plural copyable sheets are bound into one form, pressure P1 is added to the print medium P and thus the print medium P is strongly moved to a direction indicated by an arrow A. Therefore, due to the pressure P1, pressure P2 is exerted to the print medium P from the opposite side by a projection 94b.

However, projections 94a, 94c, each having the same height as the projection 94b, are formed near both sides of the projection 94b and the projections 94a, 94c are contacted with the print medium P same as the projection 94b. Thus, when the print medium P is moved toward the direction indicated by the arrow A, pressures P3, P4 yielded by the projections 94a, 94c are exerted to the print medium P. As a result, there is a problem that unnecessary shades occur on the lower sheet in the print medium P which is made pressure sensitive because the print medium P is comprised copyable sheets such as carbon copy papers. In particular, in an impact printer having a construction that the platen is vibrated by piezoelectric member in order to increase print concentration, pressure is positively exerted to the print medium P from the side of the projections 94b, 94a, 94c. Therefore, there is tendency that unnecessary shades are formed on the lower sheet (especially on the lowermost sheet) in the print medium P.

According to one aspect of the present invention there may be provided a serial impact printer having a movable print head with a plurality of print wires and a platen arranged oppositely to the print head, the platen supporting a print medium thereon and moving synchronously with the print head, the serial impact printer comprising:

a plurality of projections formed on a projecting member which is mounted on the platen, each of the projections having a top surface and being opposed to each of the print wires,

a spacer with an upper surface arranged near the projections, the spacer being more deformable than the projections against impact power yielded by the print wires, and

wherein printing is conducted on the print medium while the print medium is retained between the projection and the print wire impacted toward the projection.

In the thus constructed printer, when printing of characters and the like is conducted on the print medium, the print wires in the print head are impacted to the print medium. And such printing is done while the print medium is retained between the projection and the print wire.

At that time, impact power yielded by the print wire is concentrated in a small area, where the print wire and the projection are opposed with each other, without being dispersed and thereby the characters and the like can be clearly printed on the area impacted by the print wire.

And the spacer arranged near the projections supports the print medium when impacted by the print wire and thus the spacer prevents another projections from exerting strong pressure to the print medium. Here, since the spacer is more deformable than the projections and supports the print medium on a wider area than the projections, the spacer exerts only a very weak Pressure to the print medium.

As a result, when the impact power of the print wires are exerted to the print medium the pressure reacted to the impact power is oppositely exerted to the print medium by the projections and thereby the characters and the like can be clearly printed on all of the copyable sheets even if the print medium in which a plurality of copyable sheets are bound into one form is utilized.

And the spacer disperses the impact power from the print wires and the pressure yielded from the projection opposed to the print wires which are not impacted is very weak. Therefore, it can hinder unnecessary shades from being formed on the copyable sheets existing lower position in the print medium. As a result, in particular, the characters and the like can be clearly printed with high printing quality on the print medium in which a plurality of copyable sheets are bound into one form.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for purpose of illustration only and not intended as a definition of the limits of the invention.

The invention will be more clearly understood from the following description, given by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of main part in a serial impact printer according to the first embodiment,
Fig. 2 is a sectional view of main part in the serial impact printer according to the first embodiment,
Fig. 3 is a plan view of a platen installed in the serial impact printer according to the first embodiment,
Fig. 4 is a sectional view of main part in the platen installed in the serial impact printer according to the first embodiment,
Fig. 5 is a schematic view to explain printing manner by the serial impact printer according to the first embodiment,
Fig. 6 is a sectional view of main part in the platen according to the second embodiment,
Fig. 7 is a schematic view to explain printing manner by the serial impact printer according to the second embodiment,
Fig. 8 is a sectional view of main part in the platen according to the third embodiment,
Fig. 9 is a schematic view to explain printing manner by the serial impact printer according to the third embodiment,
Fig. 10 is a sectional view of main part in the platen according to the fourth embodiment,
Fig. 11 is a schematic view to explain printing manner by the serial impact printer according to the fourth embodiment,
Fig. 12 is a sectional view of main part in the platen according to the fifth embodiment,
Fig. 13 is a schematic view to explain printing manner by the serial impact printer according to the fifth embodiment,
Fig. 14 is a schematic view to show the first modification of a spacer,
Fig. 15 is a schematic view to show the second modification of the spacer,
Fig. 16 is a schematic view to show the third modification of the spacer,
Fig. 17 is a schematic view to show the fourth modification of the spacer,
Fig. 18 is a schematic view to show the fifth modification of the spacer,
Fig. 19 is a schematic view to show the sixth modification of the spacer,
Fig. 20 is a schematic view to show the seventh modification of the spacer,
Fig. 21 is a schematic view to show the eighth modification of the spacer,
Fig. 22 is a schematic view to show the ninth modification of the spacer,
Fig. 23 is a schematic view to show the tenth modification of the spacer,
Fig. 24 is a schematic view to show the eleventh modification of the spacer, and
Fig. 25 is a schematic view to explain printing manner by a previous impact printer.

A detailed description of the first embodiment embodying the present invention will be given referring to the accompanying drawings. As shown in Fig. 1, in a serial impact printer 1, a print head 2 is mounted on a head carriage 5 movably supported through both a main guide bar 3 and a sub guide bar 4, the guide bars 3, 4 being fixed to side frames (not shown) of the printer 1. Thus, the print head 2 can be reciprocally moved along axial directions of the guide bars 3, 4 while being retained at a position opposing a print position on a print medium P inserted between the print head 2 and a platen 6. Here, in the print medium P, a plurality of copyable sheets are bound into one form. On the other hand, the platen 6 is supported to a plate spring 7 which is mounted in a frame 8 and the frame 8 is mounted on a platen carriage 11 which is movably supported through both a main guide bar 9 and a sub guide bar 10. Thereby, the platen 6 can be reciprocally moved along axial directions of the guide bars 9, 10 while being opposed to the print medium P existing between the platen 6 and the print head 2. Here, the guide bars 3, 4 and the guide

bars 9, 10 are arranged so that each of the guide bars 3, 4, 9 and 10 is made parallel with each other.

The head carriage 5 mounting the print head 2 thereon and the platen carriage 11 mounting the platen 6 thereon are fixed to a timing belt 12, 13 respectively so that both the head carriage 5 and the platen carriage 11 are moved synchronously with each other. The timing belt 12 is equipped between a pair of rollers 15 (one of the rollers 15 is shown in Fig. 1) which are fixed to driving shafts 14 (one of the shafts 14 is shown in Fig. 1) extended to a direction normal to the axial direction of the guide bar 3. And similarly, the timing belt 13 is equipped between a pair of rollers 16 (one of the rollers 16 is shown in Fig. 1 and the roller 16 has the same diameter of the roller 15) which are fixed to the driving shaft 14 extended to a direction normal to the axial direction of the guide bar 9. Based on the above construction, the print head 2 and the platen 6 are made movable to the same direction while being retained in a state that the print head 2 and the platen 6 are constantly opposed with each other. Here, the driving shaft 14 is connected to a wellknown driving mechanism driven by a driving motor (not shown) so that the head carriage 5 and the platen carriage 11 are synchronously moved through the rollers 15, 16 and the timing belts 12, 13. And a pair of sheet feed rollers 17a, 17b are positioned at an upstream position of sheet feed direction and a pair of sheet feed rollers 18a, 18b are positioned at a downstream position of the sheet feed direction so that the print medium P is fed from lower position to upper position in Fig. 2.

To the print head 2, a flexible printed circuit film 19 is connected and thereby print data is transmitted to the print head 2 from a control device (not shown) so that the print head 2 prints the characters and the like onto the print medium P according to the print data transmitted from the control device.

Here, in the print head 2, a plurality of print units are radially arranged and each of the print units has a print wire to impact the print medium P, a piezoelectric member to drive the print wire and a force transmitting mechanism to transmit displacement of the piezoelectric member to the print wire after enlarging the displacement. Since such construction of the print unit is wellknown, explanation thereof is omitted.

In Fig. 3, a piezoelectric member 20 is arranged on the lower surface of the plate spring 7 (the lower surface is opposite side of the upper surface on which the platen 6 is mounted). The thus piezoelectric member 20 is constructed to conduct vibrating motion toward the platen 6 in response to alternating current in a frequency range of several kHz - ultrasonic.

Further, in the printer 1, a wellknown control circuit in which thickness and quality of the print medium P is detected by a sensor and it is judged based on signal from the sensor whether vibration is to be given to the platen 6 through the piezoelectric member 20, is arranged. Here, for instance, the control circuit judges that the vibration is to be given to the platen 6 if a print format in which a plurality of copyable sheets such as the carbon copy papers are bound into one form is used as the print medium P, and the alternating current is input to the piezoelectric member 20.

Next, a detailed description of the platen 6 will be given referring to Fig. 4. As shown in Fig. 4, on a surface of the platen 6 opposite to the print head 2, a projecting member 21 is embedded. The projecting member 21 has a plurality of projections 21a, 21b, 21c, each of which has the same diameter as that of top portion of the print wire. Here, three projections 21a, 21b and 21c are shown in Fig.4 to easily understand. And each of the projections 21a, 21b and 21c is opposed to each of the print wires in the print head 2 with a relation of 1:1.

As materials forming the projecting member 21, it is desirable the materials having enough hardness and durability such as sintered hard alloy, tungsten, ceramic zirconia and the projecting member 21 is made of the above material separately from the platen 6. And the projecting member 21 is fixed onto the surface of the platen 6 made of stainless steel to embed in a recess formed on the surface of the platen 6 and to adhere therein.

And as shown in Fig. 4, a spacer 23 is fixed onto the surface of the platen 6 so that the spacer 23 surrounds each of the projections 21a, 21b and 21c and the upper surface of the spacer 23 has a height substantially same as the height of the projections 21a, 21b and 21c. As materials forming the spacer 23, it is desirable the materials, which act as cushion, made of synthesized polymer having softness and deformability. For instance, it is desirable urethane, silicon rubber, foamed rubber, as the spacer 23. The thus spacer 23 is adhered onto the surface of the platen 6 through adhesive.

Next, operation of the printer 1 constructed according to the above will be described hereinafter. As explained in Fig. 2, the print medium P is fed to a predetermined print position through the sheet feed rollers 17a, 17b and the sheet feed rollers 18a, 18b from the lower position to the upper position along the sheet feed direction. And the print wires in the print head 2 controlled based on the print data transmitted from the control device impact the print medium P fed to the print position through a ink ribbon IR. Thereby, the characters and the like are printed on the print medium P.

Here, in case that the print medium P is the print form in which the plural carbon copy papers are bound into one form, the uppermost sheet (the first sheet) is printed through the ink ribbon IR and on the other hand, the second sheet and the other sheets under the second sheet are copied by impact power of the print wires.

Further, if it is judged by the control circuit that the vibration is necessary to be given to the platen 6 when printing is conducted, alternating current is input to the piezoelectric member 20. Thereby, the piezoelectric member 20 is vibrated toward the platen 6 and the platen 6 is vibrated through the plate spring 7. At that time, the frequency of the vibration is suitably set so that the vibration of one time to several times is given to the platen 6 while the print wires are contacted to the print medium P.

And the drive shaft 14 is rotated by the drive motor (not shown) in synchronism with signal transmission of the print data from a host computer (not shown) and thus the rollers 15, 16 are rotated according to the rotation of the drive shaft 14. As a result, the head carriage 5 mounting the print head 2 thereon is moved along the print surface of the print medium P by the timing belt 12 and at the same time, following to movement of the head carriage 5, the platen carriage 11 mounting the platen 6 thereon is moved along the hinder surface of the print medium P by the timing belt 13. Here, moving speed of both the head carriage 5 and the platen carriage 11 is exactly same because the roller 15 has the same diameter as that of the roller 16.

Therefore, the platen 6 is moved along the hinder surface of the print medium P while the vibration is given thereto by the piezoelectric member 20, in synchronism with that the print head 2 is moved along the print surface of the print medium P. And after one line printing is conducted, the print medium P is fed toward upper direction by a predetermined amount through the sheet feed rollers 17a, 17b, 18a and 18b.

Next, interactive action of the projections 21a, 21b, 21c and the spacer 23 will be described hereinafter. As shown in Fig. 5, in case that the print wire 25b impacts the print medium P (in which the plural carbon copy papers are bound into one form),the pressure P1 is added to the print medium P and thereby the print medium P is strongly moved to a direction A so that the print wire 25b becomes a pressing point.

At that time, the spacer 23 is deformed as shown in Fig. 5 and is recessed around the projection 21b opposed to the print wire 25b. On the other hand, since the projection 21b is not easily deformed, the pressure P2 is exerted to the print medium P from the projection 21b. Therefore, pressure for printing is concentrated on a small area between the print wire 25b and the projection 21b and thus the characters and the like are clearly printed on the print medium P. Further, since pressure occurring in printing is dispersed and absorbed based on that the spacer 23 is softly deformed, the characters and the like are not printed on the second sheet and the other sheets under the uppermost sheet in the print medium P due to the pressure from the spacer 23. And though the projections 21a, 21c, having the same height as that of the projection 21b, are positioned near both sides of the projection 21b, these projections 21a, 21c are surrounded by the spacer 23. Therefore, the projections 21a, 21c does not so strongly press the print medium P. As a result, unnecessary shades are not formed on the second sheet and the other sheets under the uppermost sheet in the print medium P.

As detailedly mentioned above, in the serial impact printer 1 according to the first embodiment, the impact power by the print wires is exerted to the print surface of the print medium P when printing is conducted and the pressure opposing to the impact pressure from the print wires is exerted to the hinder surface of the print medium P from the platen 6 by the projections. And further, the vibrating power of the platen 6 may be exerted to the hinder surface of the print medium P if necessary. Therefore, the characters and the like can be clearly printed onto all of the copyable sheets in the print medium P in case that the print form in which a plurality of copyable sheets are bound into one form is used.

In addition to the above, the spacer 23 acts as the cushion which softly disperses the impact power of the print wires and thus the pressure yielded by the projections opposed to the print wires not used for printing is not so strong. Therefore, it can prevent unnecessary shades from being formed on the second copyable sheet and the other copyable sheets under the uppermost sheet.

As mentioned above, in the serial impact printer 1, though it can prevent unnecessary shades from being formed by the projections positioned near the projection to which the impact power is exerted by the print wire, there is possibility that concentration of the impact power exerted from the print wires is mitigated by the spacer 23 and thus print clearness is inferior in comparison with a case that printing is conducted without the spacer 23. Therefore, in order to improve this point, the second through the fifth embodiments will be described hereinafter.

At first, the second embodiment will be described. Here, the serial impact printer according to the second embodiment essentially has the same construction as the serial impact printer 1 of the first embodiment except for construction of the platen 6. Therefore, only the construction of the platen 6 different from that of the first embodiment will be described in the following.

In the serial impact printer of the second embodiment, as shown in Fig. 6, a soft spacer 31 made of the synthesized polymer is arranged on the surface of the platen 6 so that the spacer 31 surrounds each of the projections 21a, 21b and 21c. And top portion in each of the projections 21a, 21b and 21c is slightly projected from the surface of the spacer 31. Here, projecting length of each top portion is set about 0.3 mm.

The above constructed platen 6 acts as follows. As shown in Fig. 7, in case that the print wire 25b im-

pacts the print medium P (in which the plural carbon copy papers are bound into one form), the pressure P1 is exerted to the print medium P and thereby the print medium P is strongly moved to a direction A so that the print wire 25b becomes a pressing point.

Here, in the second embodiment, the top portion of the print wire 21b is slightly projected from the surface of the spacer 31. Therefore, at the time that impact printing is conducted, the impact power exerted from the print wire 25b is not absorbed by the spacer 31 and thus the projection 21b is sunk into the print medium P in comparison with the first embodiment (see Fig. 5). As a result, the characters and the like can be more clearly printed on the print medium than the first embodiment.

Further, the print medium P is contacted with the surface of the spacer 31 around the projection 21b and movement of the print medium P toward the direction A is mitigated. Therefore, the print medium P is not impacted to the other projections 21a and 21c. As a result, it can prevent unnecessary shades from being printed on the second copyable sheet and the other copyable sheets under the uppermost sheet in the print medium P by the projections 21a and 21c. And since the spacer 31 is softly deformed to disperse the pressure yielded by the print wire 25b and the projection 21b, the copyable sheets are not colored by the pressure from the spacer 31.

Here, the length of the top portion in each of the projections 21a, 21b and 21c is desirably set in a range of 0.1 mm - 0.3 mm because the spacer 31 cannot satisfactorily act as the cushion if the length of the top portion is unnecessarily long. And such length is suitably selected in taking the impact power of the print wires and the distance between the projections into consideration.

According to the above constructed serial impact printer of the second embodiment, it can prevent unnecessary shades from being formed on the second copyable sheet and the other copyable sheets under the uppermost sheet. Additionally, at the time that the print medium P is impacted by the print wires, the print medium P does not contact to the surface of the spacer 31 and thus the impact power is not mitigated at that time. Therefore, the characters and the like can be more clearly printed on all of the copyable sheets in the print medium P than the first embodiment.

Next, the third embodiment will be described hereinafter. In the third embodiment, as shown in Fig. 8, a soft spacer 33 made of the synthesized polymer is arranged on the surface of the platen 6 so that the spacer 33 surrounds each of the projections 21a, 21b and 21c. And similar to the second embodiment, top portion in each of the projections 21a, 21b and 21c is slightly projected from the surface of the spacer 33. Here, projecting length of each top portion is set about 0.3 mm. Further, on the surface of the spacer 33, a plurality of projected portions 35a, 35b, 35c and 35d are formed into one body. Each of the projected portions 35a, 35b, 35c and 35d is positioned between the projections 21a, 21b and 21c.

The above constructed platen 6 acts as follows. As shown in Fig. 9, in case that the print wire 25b impacts the print medium P (in which the plural carbon copy papers are bound into one form), the pressure P1 is exerted to the print medium P and thereby the print medium P is strongly moved to a direction A so that the print wire 25b becomes a pressing point. And also in the third embodiment, since the top portion in each of the projections 21a, 21b and 21c is slightly projected from the surface of the spacer 33, the characters and the like can be clearly printed on all of the copyable sheets in the print medium P as in the second embodiment.

And the print medium P is supported by the projected portions 35b and 35c formed on the spacer 33 at areas separated from the projection 21b and thus the movement of the print medium P toward the direction A is mitigated. As a result, it can prevent unnecessary shades from being formed on the second copyable sheet and the other copyable sheets under the uppermost sheet in the print medium P. Here, since the spacer 33 is softly deformed to disperse the pressure yielded by the print wire 25b and the projection 21b, the copyable sheets are not colored by the pressure from the projected portions 35a and 35c of the spacer 31.

Next, the fourth embodiment will be described hereinafter. In the fourth embodiment, as shown in Fig. 10, a soft spacer 37 made of the synthesized polymer is arranged on the surface of the platen 6 so that the spacer 37 surrounds each of the projections 21a, 21b and 21c. And similar to the first embodiment, the surface of the spacer 37 is substantially coincided with the top surfaces of the projections 21a, 21b and 21c. Further, in the spacer 37, taper portions 39 are formed near the projections 21a, 21b and 21c.

The above constructed platen 6 acts as follows. As shown in Fig. 11, in case that the print wire 25b impacts the print medium P (in which the plural carbon copy papers are bound into one form), the pressure P1 is exerted to the print medium P and thereby the print medium P is strongly moved to a direction A so that the print wire 25b becomes a pressing point. And also in the fourth embodiment, since the taper portions are formed near the projection 21b, at the time that impact printing is conducted, the impact power exerted from the print wire 25b is not absorbed by the spacer 37 and thus the projection 21b is sunk into the print medium P in comparison with the first embodiment (see Fig. 5). As a result, the characters and the like can be more clearly printed on the print medium P than the first embodiment.

And the print medium P is supported by the spacer 37 at an area separated from the projection

21b and thus the movement of the print medium P toward the direction A is mitigated. As a result, it can prevent unnecessary shades from being formed on the second copyable sheet and the other copyable sheets under the uppermost sheet in the print medium P. Here, since the spacer 37 is softly deformed to disperse the pressure yielded by the print wire 25b and the projection 21b, the copyable sheets are not colored by the pressure from the spacer 37.

Next, the fifth embodiment will be described hereinafter. As mentioned above, in the first through the fourth embodiments, the projections 21a, 21b and 21c of the projecting member 21 are arranged on the platen 6 with the same space therebetween. On the other hand, it is conceivable a case that the print wires are not arranged with the same space therebetween in the print head of the serial impact printer. In that case, therefore, it is necessary to ununiformly arrange the projections according to the print wires in order to arrange the projections against the print wires with a relationship of 1:1. In such case, it is desirable to construct the platen 6 according to the fifth embodiment.

In the fifth embodiment, as shown in Fig. 12, each of the projections 21a, 21b and 21c is ununiformly arranged on the projecting member 21 so that the space between the projections 21a, 21b and the space between the projection 21b, 21c are different with each other. And a spacer 41 is arranged at the left side of the projection 21b on the surface of the platen 6 and the another spacer 43 is arranged at the right side of th projection 21b on the surface of the platen 6. The spacers 41 and 43 are made of the soft synthesized polymer and the spacer 43 has more hardness and less deformability than the spacer 41.

The above constructed platen 6 acts as follows. As shown in Fig. 13, in case that the print wire 25b impacts the print medium P (in which the plural carbon copy papers are bound into one form), the pressure P1 is exerted to the print medium P and thereby the print medium P is strongly moved to a direction A so that the print wire 25b becomes a pressing point. At this time, the print medium P is strongly pressed to the projection 21b and thereby the pressure P2 is exerted to the print medium P from the projection 21b. As a result, the pressure for printing is concentrated on a small area between the print wire 25b and the projection 21b and the characters and the like can be clearly printed on the print medium P.

By the way, it is generally understood that unnecessary shades are apt to be formed by the projections existing near the impacted projection if the space between the projections is narrow. That is to say, for example, when the projection 21b is impacted by the print wire 25b, the stronger pressure is yielded by the projection 21c than the projection 21a and thus unnecessary shades is apt to be formed by the projection 21c.

To dissolve this point, in the fifth embodiment, the spacer 43 with less deformability is arranged on a narrow area which is sectioned by the projections 21b and 21c. As a result, the projection 21c is not easily pressed to the print medium P based on that the spacer 43 is not easily deformed and therefore it can prevent unnecessary shades from being formed in spite of the spaces between the projections.

As mentioned above, in the serial impact printer of the fifth embodiment utilizing the above constructed platen 6, it can prevent unnecessary shades from being formed on the second copyable sheet and the other copyable sheet under the uppermost sheet in the print medium P. In particular, since the spacer 43 with less deformability is arranged on the narrow area sectioned by the projections 21b and 21c, it can prevent unnecessary shades from being formed on the copyable sheets in the print medium P.

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 can be made therein without departing from the scope of the invention as defined by the appended claims.

For instance, as the spacer arranged around the projections, various spacers other than the spacer made of the synthesized polymer can be adopted.

As shown in Fig. 14, a thin metallic plate spring 51 which covers the projecting member 21 except for the projections, may be arranged in the platen 6 as the spacer. Taking into consideration that the spacer is continuously contacted to and frictioned with the print medium P, abrasion resistance of the spacer is eminently improved by utilizing the metallic plate spring 51 in comparison with the case that the spacer is made of the synthesized polymer.

Further, as shown in Fig. 15, it may be conceivable that the plate spring 51 is used together with a cushion member 53 made of the synthesized polymer, the cushion member 53 being arranged under the plate spring 51 between the projections. And the plate spring 51 covers the projecting member 21 except for the projections and peripheral portion of the plate spring 51 is engaged in a recess formed in the platen 6. Based on such construction, the plate spring 51 is reinforced by the cushion member 53 against the impact pressure exerted thereon and thereby the thin metallic plate having a small spring constant and more deformability can be used. As a result, the plate spring 51 in Fig. 15 can absorb the impact pressure because it softly deforms, in comparison with the construction shown in Fig. 14 in which only the plate spring 51 is arranged. And also the abrasion resistance thereof is eminently improved in comparison with the spacer made of the synthesized polymer.

And further, as shown in Fig. 16, a thin metallic plate 55 may be positioned on the cushion member 53

so as to cover the projecting member 21 except for the projections. And the cushion member 53 is positioned between the projecting member 21 and the metallic plate 55 in an area surrounded by the projections of the projecting member 21. In this case, peripheral portion of the metallic plate 55 is adhered onto the platen 6 and therefore such metallic plate 55 can operate with the same action of the plate spring 51 shown in Fig. 15. Here, treatment may be done on the surface of the cushion member 53 so that the abrasion resistance of the metallic plate 55 is improved.

And as shown in Fig. 17, two of the cushion members 53 may be arranged over the peripheral portion of the projecting member 21 and may support the metallic plate 55 at the peripheral portion thereof from the under surface. Further, as shown in Fig. 18, the metallic plate 55 may be entirely supported by the cushion member 53 from the under surface.

And further, as shown in Fig. 19, in case that both the peripheral portions of the metallic plate 55 and the cushion member 53 are engaged in a recess formed in the platen 6, both the metallic plate 55 and the cushion member 53 can be mounted in the platen 6 without adhering thereof. Here, as shown in Fig.20, in case that only the cushion member 53 is used as the spacer, the peripheral portion thereof can be engaged in the recess of the platen 6.

Further, as shown in Fig. 21, even if the cushion member 53 is partially arranged on the projecting member 21, the cushion member 53 can effectively support the impacted print medium P by the print wire. Here, in the construction shown in Fig. 21, the cushion member 53 does not surround the projections.

And in order to partially arrange the spacer on the projecting member 21, the spacer 23 may be partially embedded into openings, which are perforated at the center position and the peripheral positions separate from the center position in the projecting member 21 on which a plurality of projections are arranged in a lozenge shape, as shown in Fig. 22. By using this construction, the projecting member 21 and the spacer 23 can be easily combined without adhering thereamong. Here, only the spacer 23 in the center opening or only the spacers 23 in the peripheral openings can be utilized.

Further, as shown in Fig. 23, the spacer 23 having a plurality of cylindrical portions may be utilized. And the cylindrical portions 23 are inserted into openings formed in the projecting member 21 from the hinder surface of the base portion 22. By this construction, the projecting member 21 and the spacers 23 can be easily combined.

And as shown in Fig. 24, the spacer 23 with a contacting portion 24 having a wedge shape, the contacting portion 24 being contacted with the print medium P, may be used. And such contact portion 24 is inserted into openings formed in the projecting member 21. By making the contacting portion 24 the wedge shape as shown in Fig. 24, the print medium P can be smoothly guided into the printer without being stopped by the projections when the print medium P is fed into the printer. Additionally, the relationship between the spacer and the projections is suitably determined based on the distance between the projections and the molderbility of the spacer.

Claims

1. A serial impact printer (1) having a movable print head (2) with a plurality of print wires (25a,25b,25c) and a platen (6) arranged opposite to the print head, the platen being arranged to a print medium (P) thereon and to move synchronously with the print head, the serial impact printer comprising:

   a plurality of projections (21a,21b,21c) formed on a projecting member (21) which is mounted on the platen (6), each of the projections (21a,21b,21c) having a top surface and being opposed to a respective print wire (25a,25b,25c),

   a spacer (23) with a surface adjacent the projections (21a,21b,21c), the deformability of the spacer relative to that of the adjacent projections (21a,21b,21c) being such that when, in use, a printing medium (P) is supported on the platen (6) between the projections (21a,21b,21c) and the print wires (25a,25b,25c) and a print wire (25b) impacts its respective projection (21b), the spacer (23) deforms against the impact more than the projection.

2. The serial impact printer according to claim 1, wherein the print medium has a plurality of copyable sheets which are bound into one form.

3. The serial impact printer according to claim 1 or 2 further comprising:

   a movable head carriage (5) mounting the print head (2) thereon, and

   a platen carriage (11) mounting the platen (6) thereon, the platen carriage (11) being movable synchronously with the head carriage (5).

4. The serial impact printer according to claim 3, further comprising:

   a frame (8) mounted on the platen carriage (11), and

   a plate spring (7) with two surfaces installed in the frame (8), the platen (6) being supported on one surface of the plate spring (7).

5. The serial impact printer according to claim 4, further comprising a piezoelectric member (20)

which is arranged on the other surface of the plate spring (7), the piezoelectric member (20) vibrating the platen (6) through the plate spring (7).

6. The serial impact printer according to any preceding claim wherein the projecting member (21) is made of material such as sintered hard alloy, tungsten and ceramic zirconia.

7. The serial impact printer according to any preceding claim wherein the spacer (23) is arranged on the platen (6) so that the spacer (23) surrounds the projections (21a,21b,21c) and the upper surface of the spacer (23) substantially coincides with the top surface of each of the projections (21a,21b,21c).

8. The serial impact printer according to any one of claims 1 to 6 wherein the projections (21a,21b,21c) are slightly projected from the upper surface of the spacer (31).

9. The serial impact printer according to claim 8, wherein the projections (21a,21b,21c) are projected from the upper surface of the spacer (31) by an amount in a range of 0.1 mm - 0.3 mm.

10. The serial impact printer according to claim 8 or 9 further comprising a plurality of portions (35a,35b,35c,35d) projected from the upper surface of the spacer (33), each of the portions being positioned between the projections (21a,21b,21c).

11. The serial impact printer according to claim 7, further comprising a taper portion (39) formed near each of the projections (21a,21b,21c).

12. The serial impact printer according to any preceding claim wherein the spacer (23) comprises a cushion member having softness and deformability.

13. The serial impact printer according to claim 12 wherein the cushion member (23) is made of synthesized polymer such as urethane, silicon rubber and foamed rubber.

14. The serial impact printer according to any preceding claim wherein the projections (21a,21b,21c) are ununiformly formed on the projecting member (21) so that at least a first space (43) and a second space (41) wider than the first space (43) are arranged between the projections (21a,21b,21c) and the spacer (41,43) comprises at least a first spacer (43) and a second spacer (41) wider that the first spacer (43) and wherein the first spacer (43) is arranged in the first space (43) and the second spacer (41) is arranged in the second space (41).

15. The serial impact printer according to claim 14, wherein the first spacer (43) is harder and less deformable than the second spacer (41).

16. The serial impact printer according to any one of claims 1 to 7 wherein the spacer comprises a metallic plate spring (51) which covers the projecting member (21) except for the projections.

17. The serial impact printer according to any one of claims 1 to 7 wherein the spacer comprises a plate spring (51) engaged in the platen (6) so as to position over the projecting member (21) except for the projections and a cushion member (53) positioned between the plate spring (51) and the projecting member (21).

18. The serial impact printer according to any one of claims 1 to 7 wherein the spacer comprises a metallic plate (59) and a cushion member (53) positioned between the metallic plate (51) and the platen (6) at peripheral portion of the metallic plate (55).

19. The serial impact printer according to any one of claims 1 to 7 wherein the spacer comprises a metallic plate (55) and a cushion member (53) positioned between the metallic plate (55) and the platen (6) to entirely support the metallic plate (55).

20. The serial impact printer according to any one of claims 1 to 7 wherein the spacer comprises a metallic plate (55) with a peripheral portion and a cushion member (53) with a peripheral portion, both the peripheral portions of the metallic plate (55) and the cushion member (53) being engaged in the platen (6).

21. The serial impact printer according to any one of claims 1 to 7 wherein the spacer comprises a cushion member (53) with a peripheral portion, the cushion member (53) being mounted on the platen (6) by engaging the peripheral portion in the platen (6).

22. The serial impact printer according to any one of claims 1 to 7 wherein the spacer comprises a cushion member (53) and the cushion member partially arranged on the projecting member (21).

23. The serial impact printer according to any one of claims 1 to 15 wherein the spacer comprises a cushion member (23) made of synthesized polymer and the projecting member (21) has a plural-

ity of openings formed therein and wherein a plurality of parts of the cushion member (23) is embedded in the openings.

24. The serial impact printer according to any one of claims 1 to 15 wherein the spacer comprises a cushion member (23) having a plurality of cylindrical portions and the projecting member (21) has a plurality of openings formed therein and wherein the cylindrical portions are inserted in the openings.

25. The serial impact printer according to any one of claims 1 to 15 wherein the spacer comprises a cushion member (23) having a contact portion (24) with a wedge shape contacted with the print medium and the projecting member (21) has a opening to insert the contact portion (24) therein.

26. The serial impact printer according to any one of claims 1 to 7 wherein the spacer comprises a metallic plate (51) which is adhered onto the platen (6) at peripheral portion thereof so as to cover the projecting member (21) except for the projections and a cushion member (53) which is positioned between the projecting member (21) and the metallic plate (51) in an area surrounded by the projections.

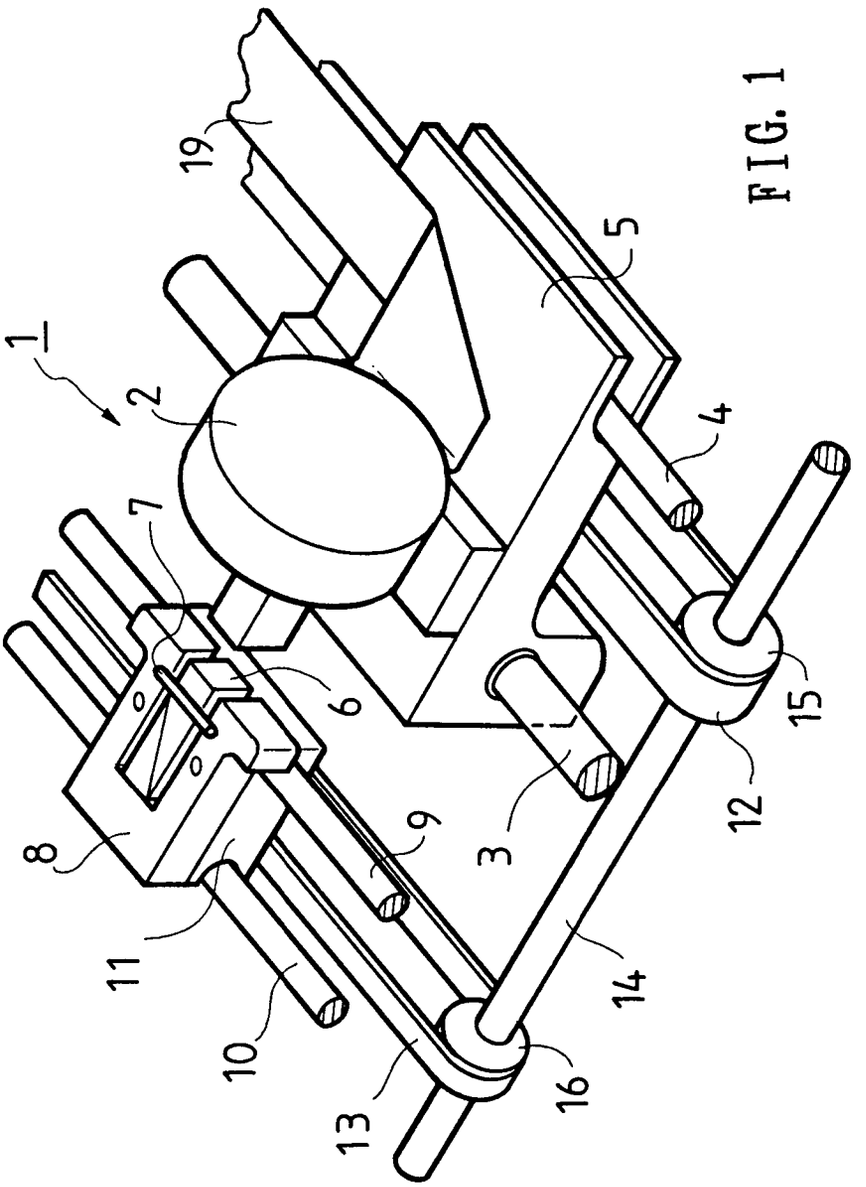


FIG. 1

FIG. 2

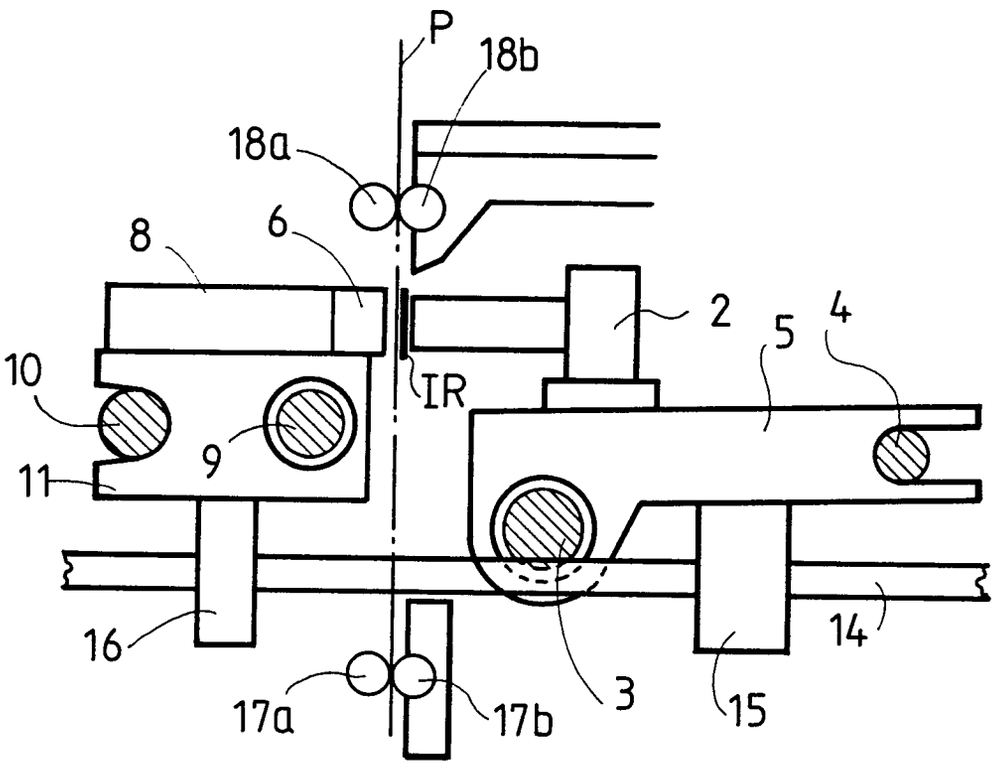


FIG. 3

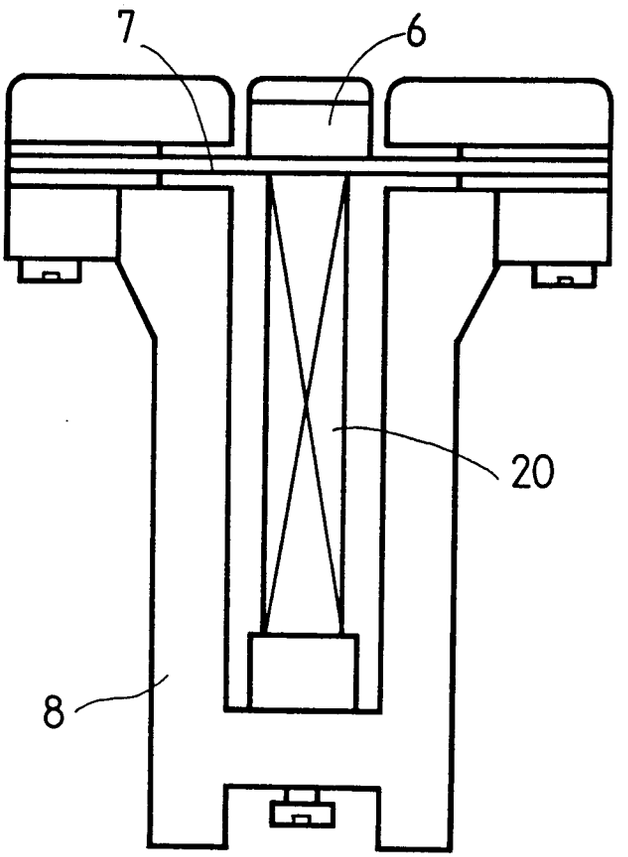


FIG. 4

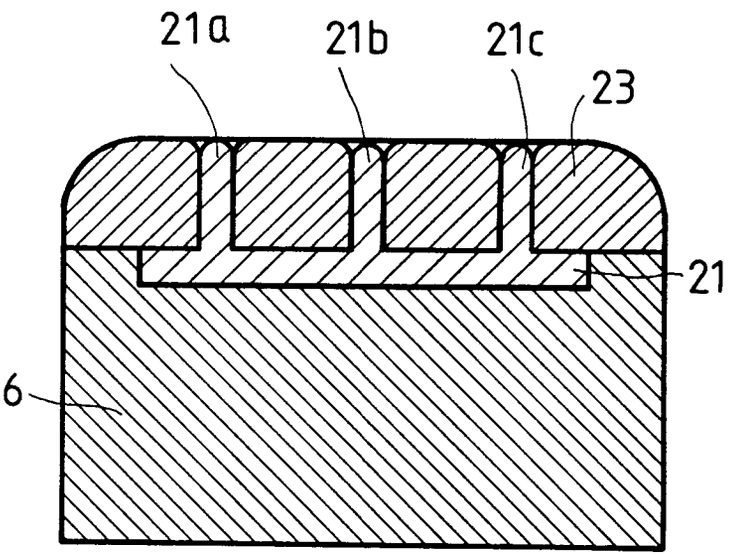


FIG. 5

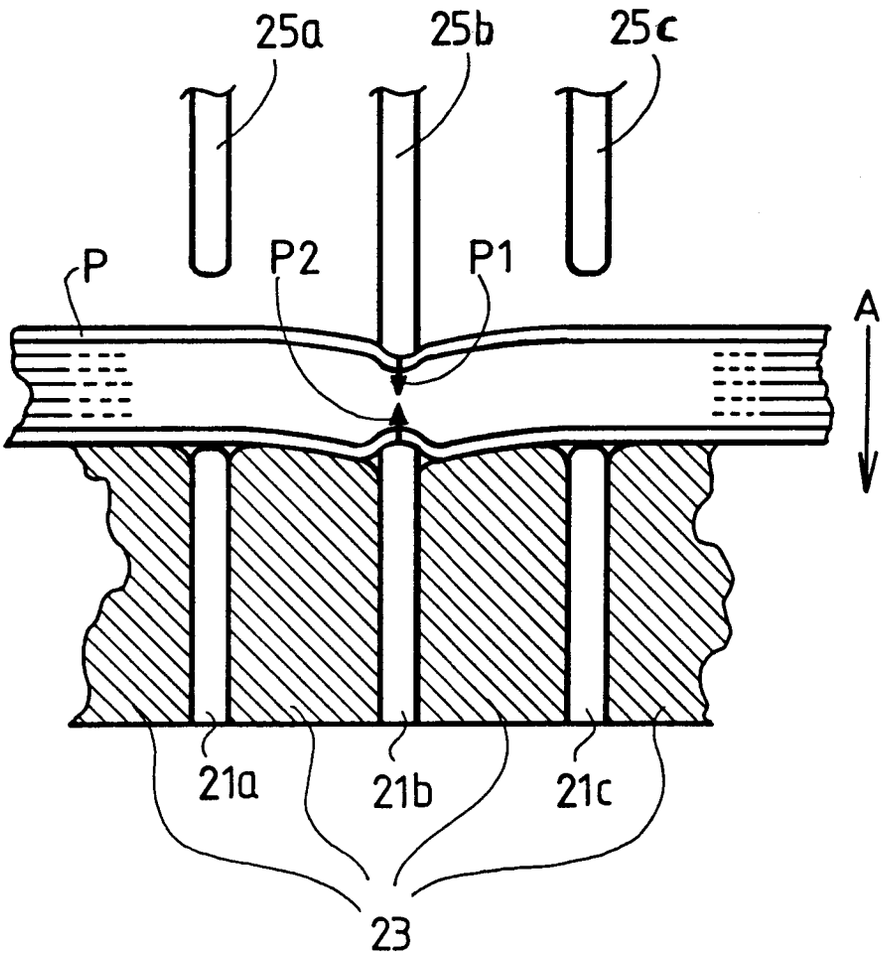


FIG. 6

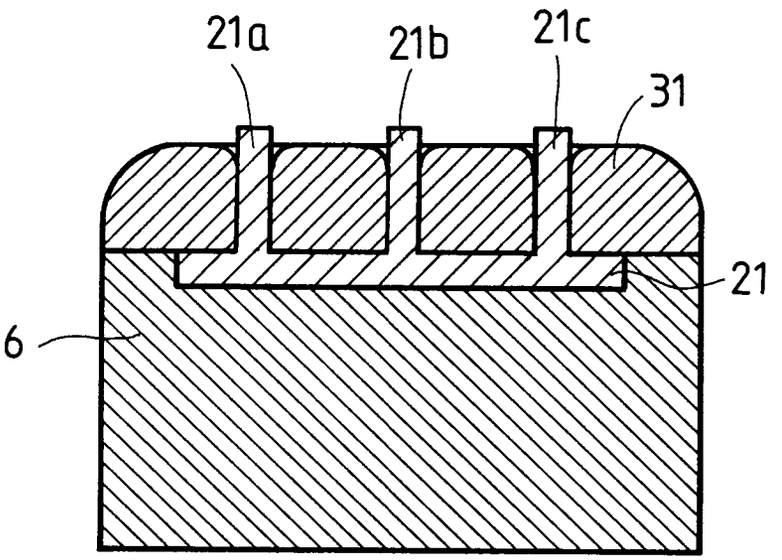


FIG. 7

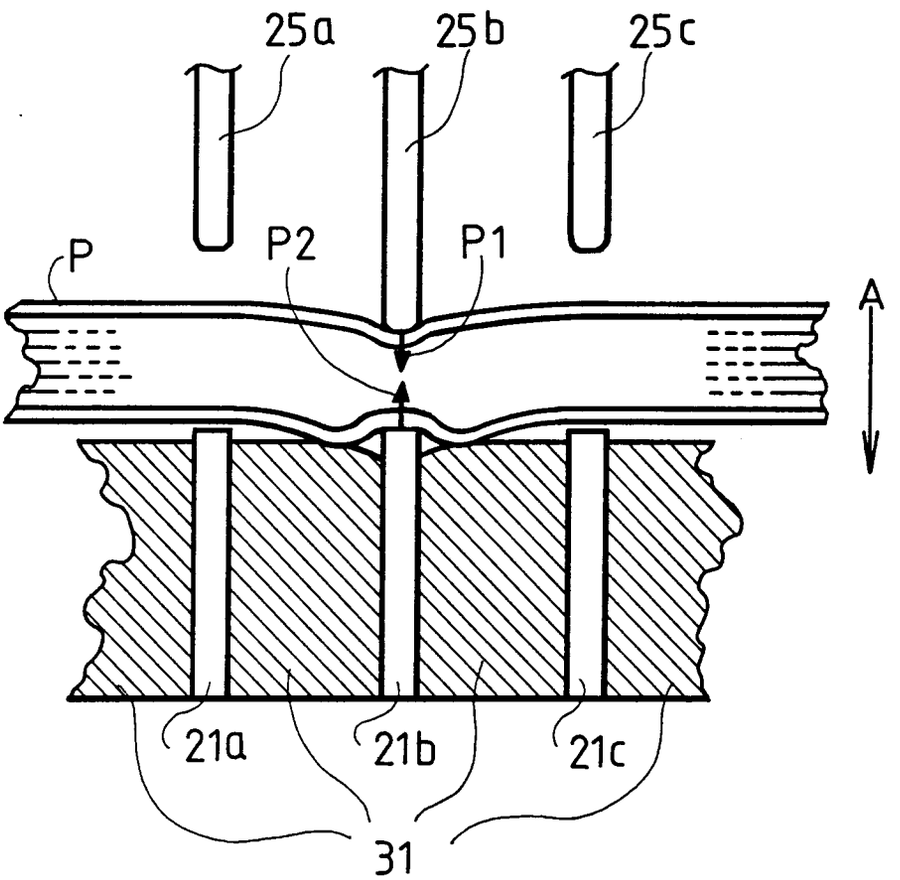


FIG. 8

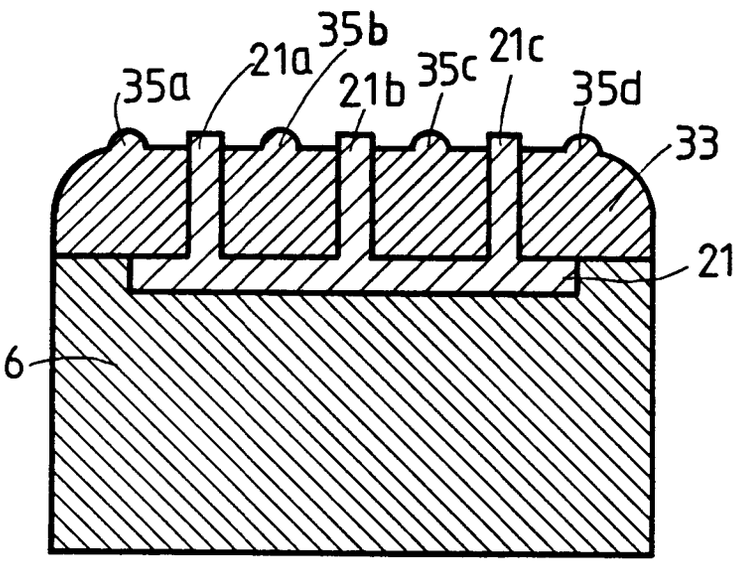
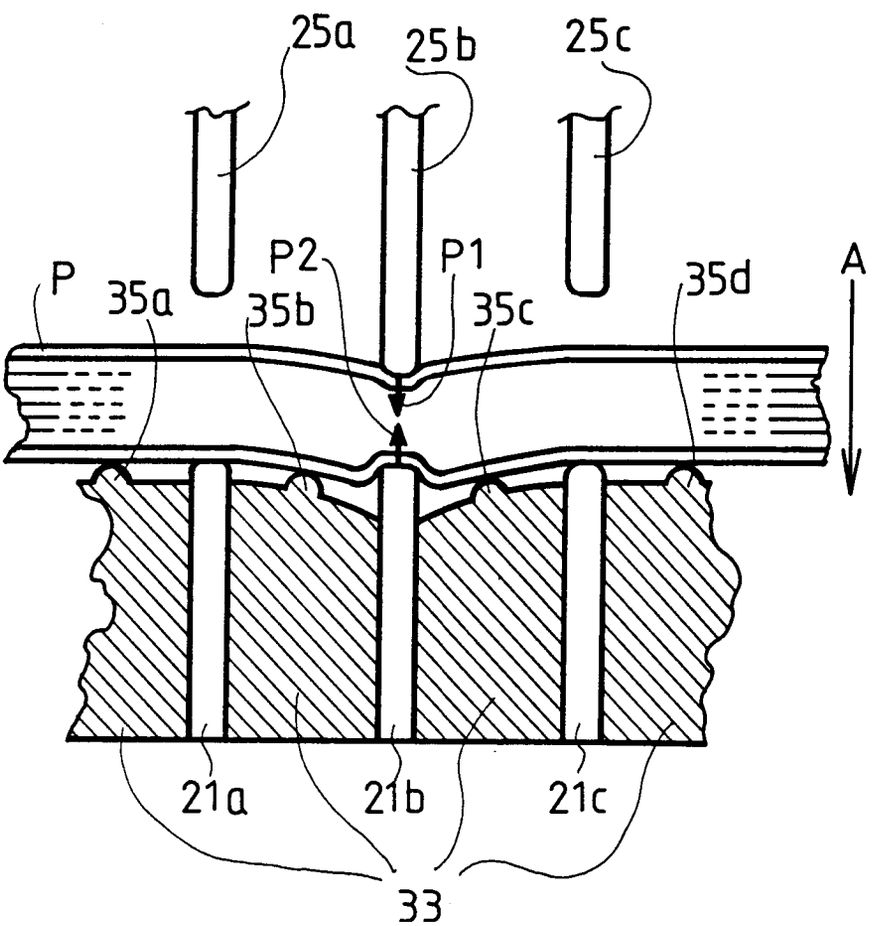


FIG. 9



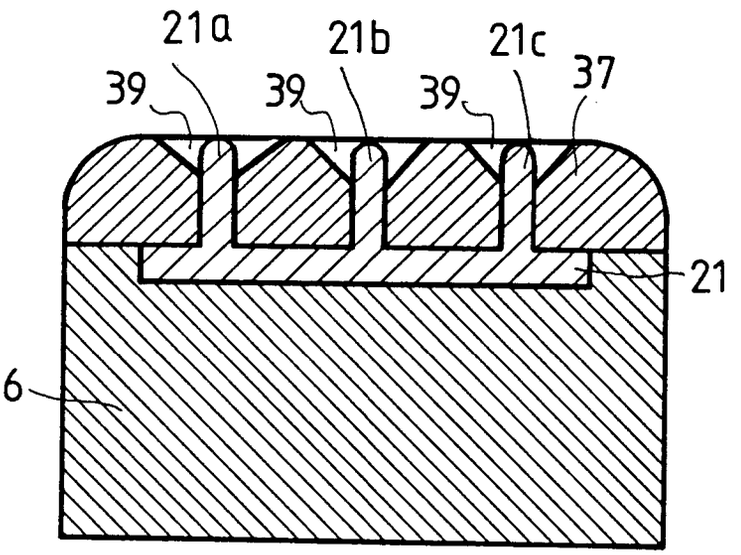
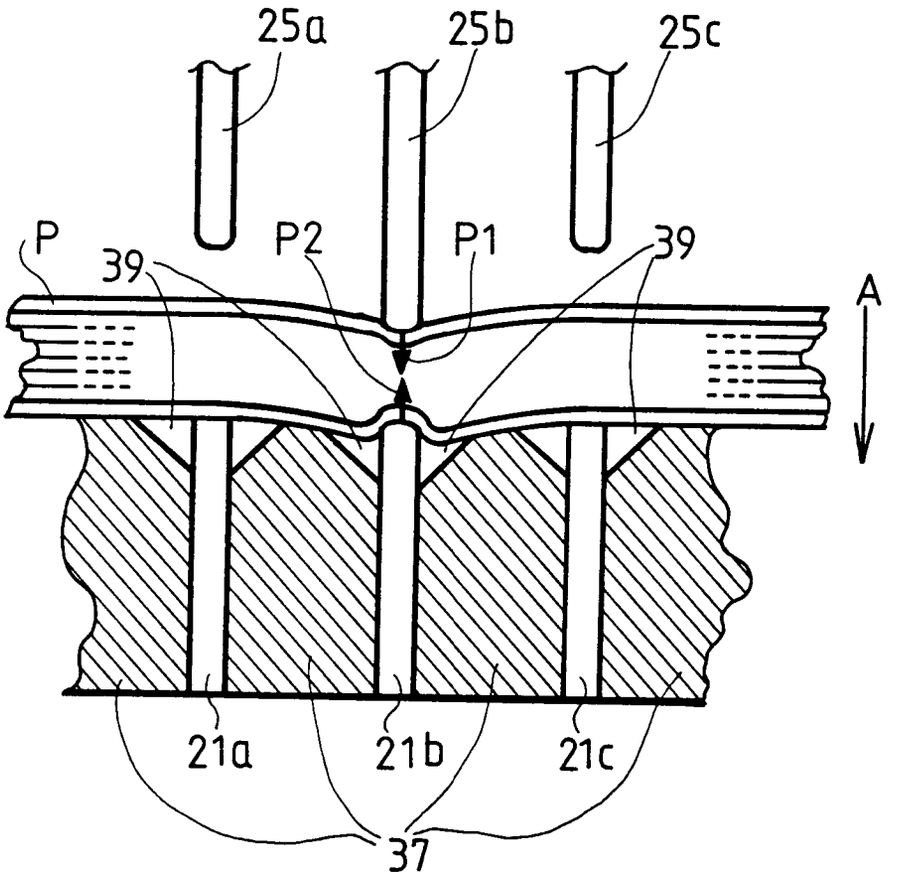


FIG. 10

FIG. 11



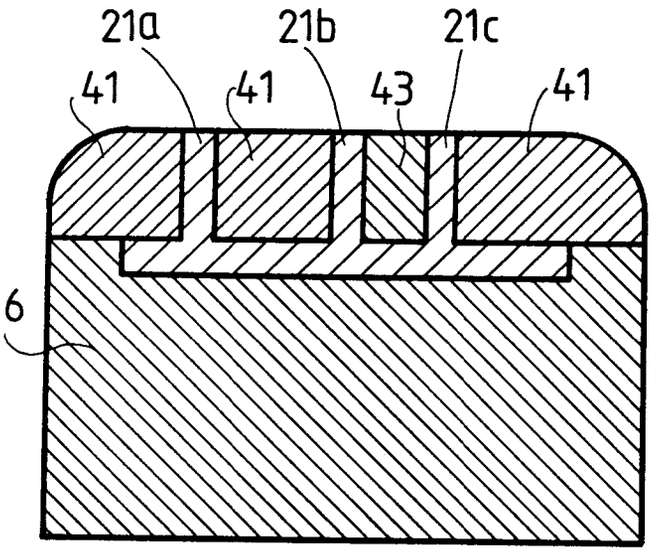


FIG. 12

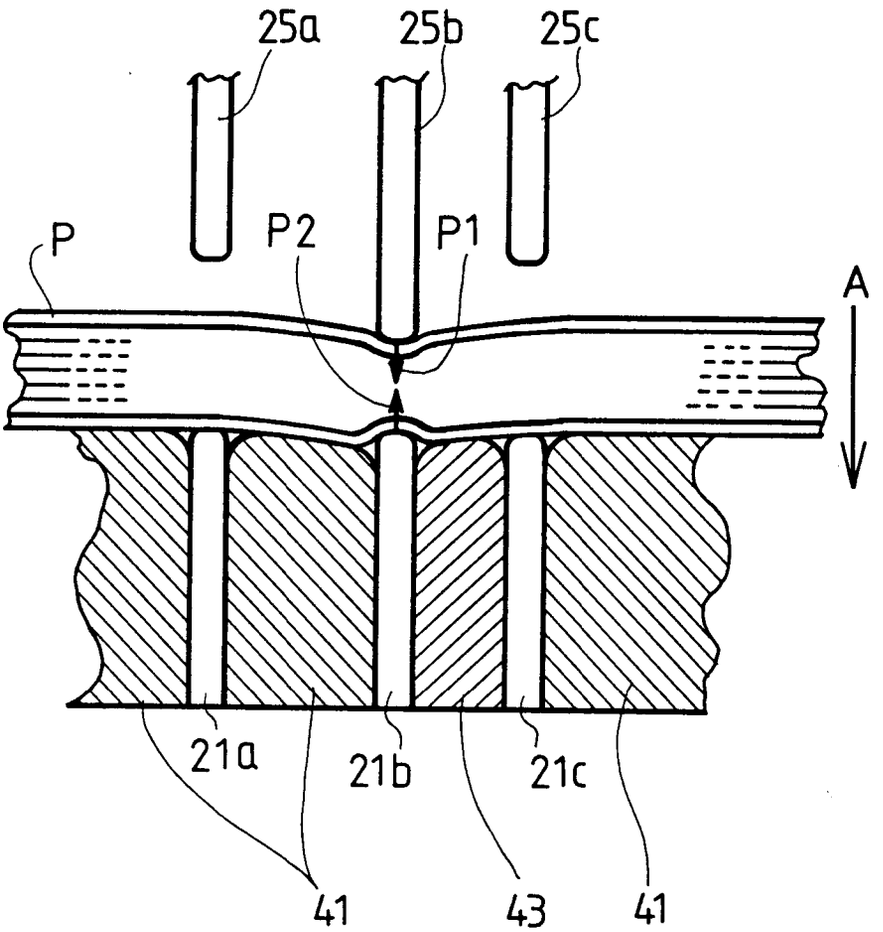


FIG. 13

FIG. 14

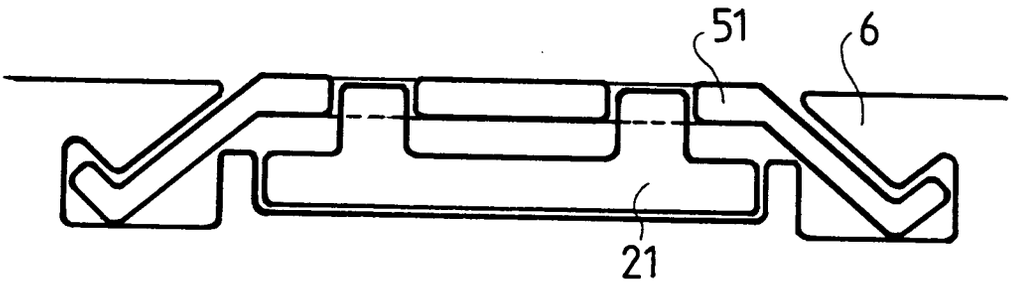


FIG. 15

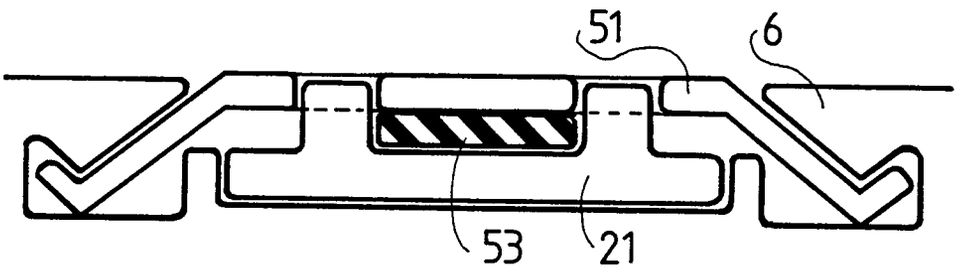


FIG. 16

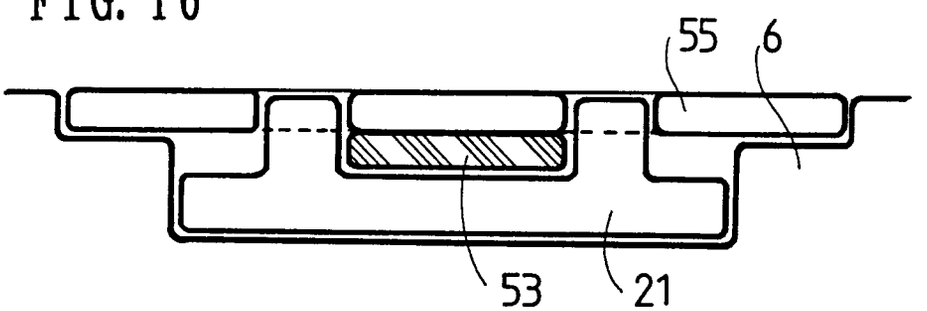


FIG. 17

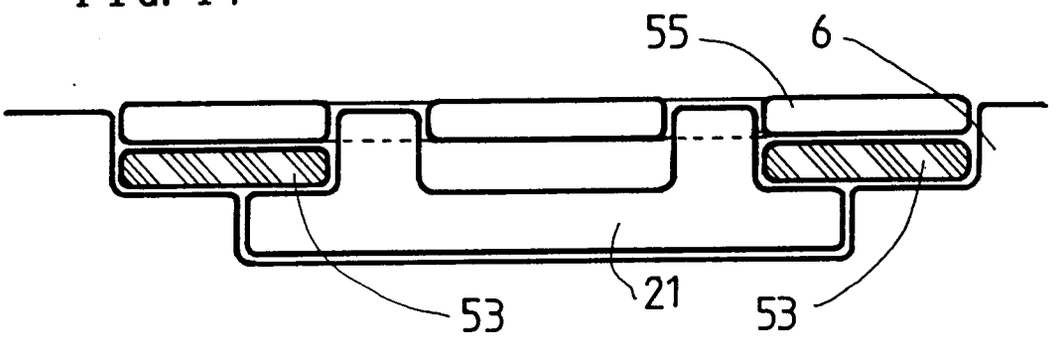


FIG. 18

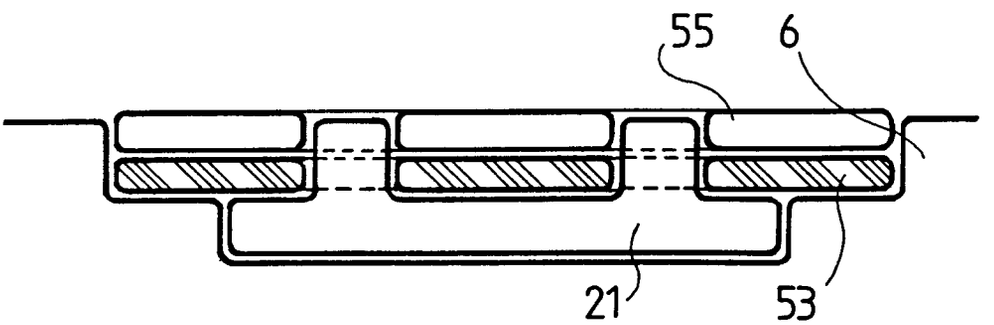


FIG. 19

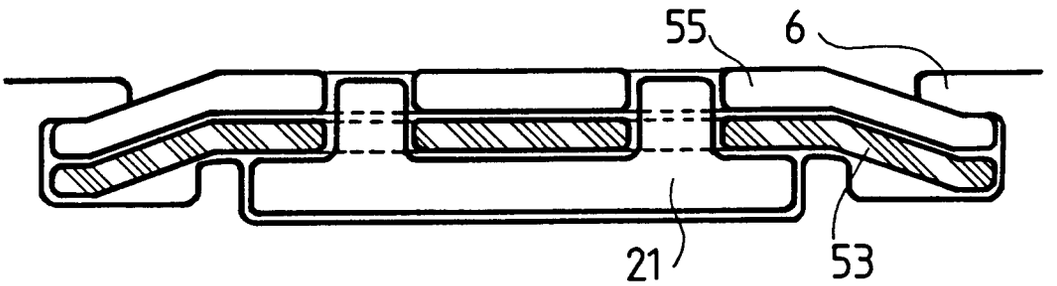


FIG. 20

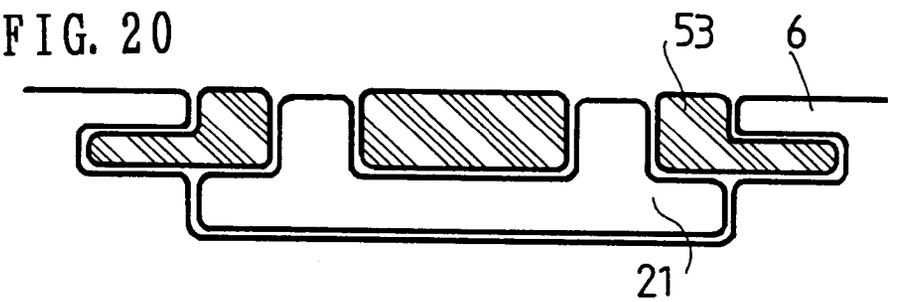
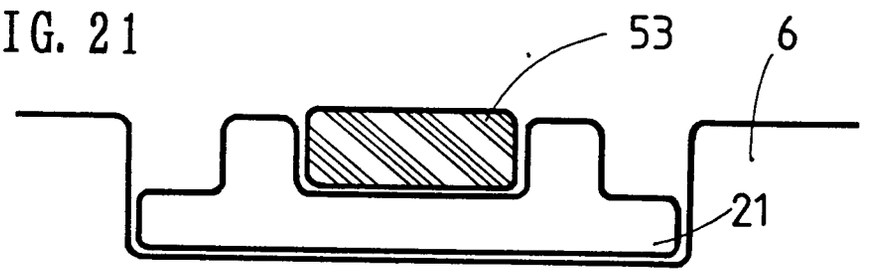


FIG. 21



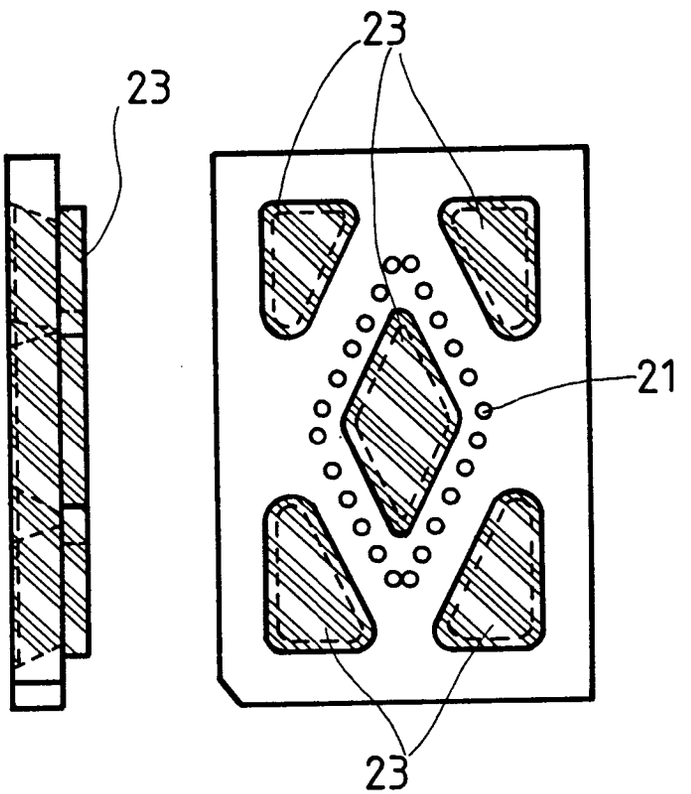


FIG. 22

FIG. 23

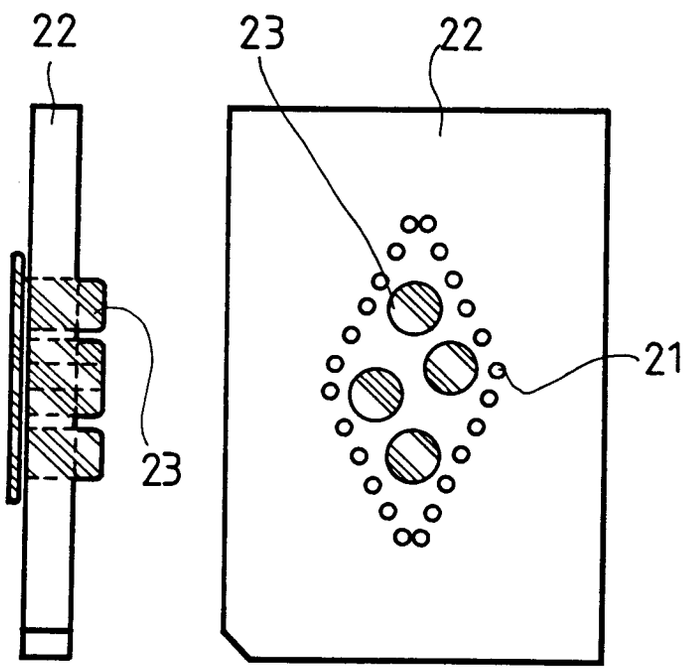


FIG. 24

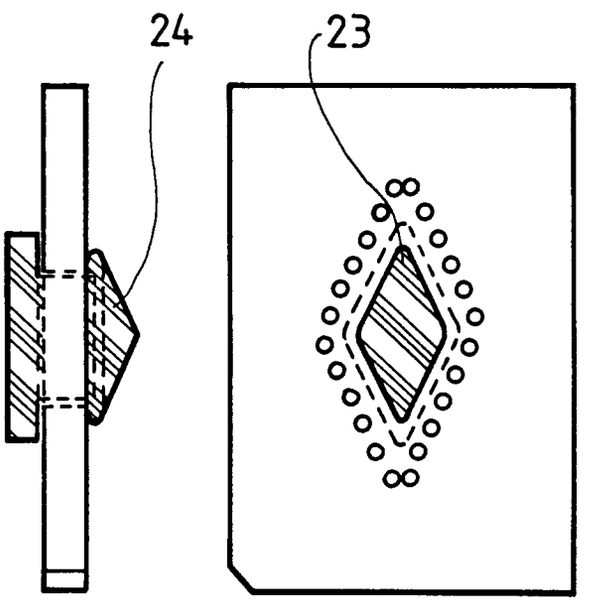


FIG. 25