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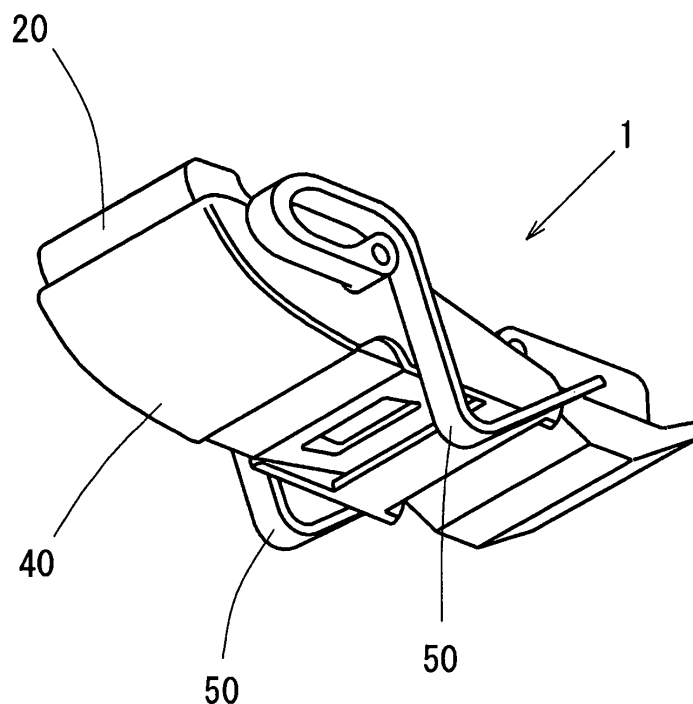
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(54) **Presser foot for sewing machine**

(57) A presser foot (1) for a sewing machine includes a main body (20) rotatably attached to a presser holder (2) via a pivot shaft (4) and having a needle receiving hole (33), and a restriction member (40) rotatably attached to the main body (20), wherein the restriction member

(40) includes a restriction portion (50), which protrudes downward from a bottom face (21) of the main body (20) to press a work material to thereby restrict a movement of the work material when a stepped portion (10) of the work material comes in contact with the presser foot (1).

FIG. 1



Description

TECHNICAL FIELD

[0001] This disclosure relates to a presser foot for a sewing machine, which presses a stepped portion of a work material for restricting an unexpected movement of the work material.

BACKGROUND DISCUSSION

[0002] As shown in Fig. 32, a known presser foot 60 for a sewing machine includes a bottom face 61 having a flat surface, a front presser portion 64, and a rear presser portion 67. A needle receiving hole 62 is formed in the center of the bottom face 61. The presser foot 60 is configured so that the bottom face 61 surely presses a work material (fabric) to thereby prevent the work material from moving vertically in conjunction with a vertical movement of a sewing needle (such vertical movement of the work material resembles a waving flag and therefore will be referred to as "flagging"). For example, as shown in Fig. 33, in the case of hemming jeans or sewing belt loops, when a stepped portion 10 of the fabric, which includes three, nine, and three folds, is sewn by the sewing machine, the front presser portion 64 is moved up on the stepped portion 10 via a rear end portion 63 of the bottom face 61 serving as a supporting point. Further, since a rotary pin 4 is arranged adjacent to the rear end portion 63, the rotary pin 4 is moved upward simultaneously when the front presser portion 64 is moved up on the stepped portion 10.

[0003] Thus, as illustrated in Fig. 34 and Fig. 35, a thickest portion of the stepped portion 10 is fed close to the rotary pin 4 and afterwards passes the rotary pin 4, i.e. the presser foot 60 is moved up on and down from the stepped portion 10. When the thickest portion of the stepped portion 10 is fed close to the rotary pin 4, the work material may be forcibly moved backward in the opposite direction of a feed direction of the work material because of a presser bar pressure and may not be appropriately fed because of a sudden upward movement of the rotary pin 4.

[0004] Further, as shown in Fig. 33, when the front presser portion 64 is in contact with the stepped portion 10, a space 68 having an approximately triangular shape is formed by an upper corner of the stepped portion 10, a lower end 66 of the stepped portion 10, and the rear presser portion 67. Under such condition, the work material in a space 68 is not surely pressed by the presser foot 60. Accordingly, when a sewing needle 6 penetrates through into the work material, thread loops may not be formed uniformly because the work material is not surely pressed by the presser foot 60. As a result, sewing defects such as skipped stitches occur. Such sewing defects may occur in a similar way as in the case where the presser foot 60 is moved down from the stepped portion 10 (see Fig. 35).

[0005] A known presser foot disclosed in JP1991-65570U (hereinafter referred to as Reference 1) includes a presser plate rotatably attached to a lower end of a presser holder via a pivot shaft. Recessed portions are formed at lateral sides of a bottom face of the presser plate so as to be positioned approximately directly below the pivot shaft.

[0006] Further, a presser foot for a sewing machine, disclosed in JP1996-141251A (hereinafter referred to as Reference 2) includes front and rear presser feet arranged in a feed direction of a work material. The front and rear presser feet are rotatably attached to a presser arm. A first coil spring is arranged between the front and rear presser feet and a second coil spring is arranged between the rear presser foot and the presser arm. When the front presser foot rotates in a direction departing from a bed surface, a biasing force is applied to the rear presser foot by the first coil spring so that the front presser foot is moved close to the bed surface.

[0007] Furthermore, a known fabric feed control apparatus for a sewing machine is disclosed in JP1993-161771A (hereinafter referred to as Reference 3). The fabric feed control apparatus includes a sensor detecting a stepped portion of a work material (fabric) when a front end or the stepped portion of the work material approaches a contact portion with a presser foot. When detecting the stepped portion, the sensor transmits a detection signal to a CPU. Afterwards, the CPU issues a command to reduce a pressure of the presser foot; thereby, a horizontal moving distance of feed dogs is increased.

[0008] The presser foot described in Reference 1 is more easily moved up on and down from a stepped portion of a work material by means of the recessed portions of the bottom face of the presser foot. However, when the length of the recessed portions is short in a feed direction of a work material, the presser foot is difficultly moved up on a stepped portion of the work material because of a flat portion of the bottom face of the presser foot. When the length of the recessed portion is long in the feed direction, a portion around a needle receiving hole is recessed. Accordingly, the presser foot may not prevent a fluttering movement of the work material. In addition, the presserfoot may not surely press the work material flatly and may not prevent the fluttering movement of the work material while the presser foot is moved up on and down from the stepped portion of the work material.

[0009] Moreover, according to the presser foot including the front and rear divided presser feet as described in Reference 2, when the work material is backstitched (reversely fed) in a condition where the front presser foot is moved down from the stepped portion, a rear end of the front presser foot is not moved up on the stepped portion again, therefore causing thread tangling. Further, when the presser foot is attached to the sewing machine, the front presser foot tilts downward, therefore causing a user to have difficulties feeding the work material under

the presser foot. Furthermore, the presser foot has a complicated configuration and includes more components, therefore increasing manufacturing costs of the presser foot.

[0010] In addition, according to the fabric feed control apparatus described in Reference 3, the sensor detects an inclination of the presser foot and transmits the detection signal to the CPU. Accordingly, the CPU processes the detection signal and outputs the processed detection signal to an actuator controlling the pressure of the presser foot and to an actuator controlling a fabric feed amount. As a result, a feeding condition is adjusted in order to easily feed the stepped portion of the work material. The fabric control apparatus includes such sensor and actuators and therefore is applied only to a very expensive sewing machine. Accordingly, the fabric control apparatus may not be applicable to various models of sewing machines.

[0011] A need thus exists for an inexpensive presser foot for a sewing machine, which prevents skipped stitches at a stepped portion of a work material, appropriately feeds the work material, and applies to various models of sewing machines.

SUMMARY

[0012] According to the invention there is provided a presser foot for a sewing machine according to claim 1 herein. The invention accordingly provides a presser foot for a sewing machine, comprising a main body capable of being pivotally attached to a presser holder of the sewing machine via a pivot shaft so as to press a work material being sewn by the sewing machine against a work bed of the sewing machine, the main body of the presser foot having:

a needle receiving hole and
a restriction member or work material control means pivotally attached to the main body and including a portion capable of protruding downwardly from a bottom face of the main body to press against a work material being sewn by the sewing machine even when the presser foot rides up and over a height discontinuity of a stepped portion of the work material being sewn.

[0013] For example, when the stepped portion is moved to a contact position with a front portion of the presser foot, the space having an approximately triangular shape is formed between the stepped portion and the presser foot (in an area where a sewing needle is moved downward). At this time, the restriction portion presses the work material to restrict the movement of the work material. Accordingly, thread loops are uniformly formed and skipped stitches are prevented. Such action of the restriction portion is effective when the presser foot is moved up on and down from the stepped portion. Further, the presser foot is formed by two types of components

such as the main body (for example, formed by die-cast portion of zinc alloy) and the restriction member including the restriction portion; therefore, materials and a manufacturing process of the presser foot are easily provided. Furthermore, when the presser foot is applied to the sewing machine, a body of the sewing machine does not require a special configuration. Accordingly, the presser foot may be applicable to conventional sewing machines and optionally provided thereto.

[0014] According to another aspect of the disclosure, the restriction member and the restriction member are formed with resin so as to form a single-piece member.

[0015] Accordingly, the restriction member is manufactured at low cost and easily attached to the presser foot.

[0016] According to further aspect of the disclosure, the restriction portion is an elastic member pressing the work material by means of an elastic force.

[0017] Accordingly, the restriction portion is the elastic member pressing the work material by means of the elastic force and therefore elastically biases the restriction member. Thus, the restriction member does not need a biasing member (for example, a compression coil spring) for protruding the restriction portion from the bottom face of the main body of the presser foot. As a result, the number of components for the presser foot is minimized.

[0018] According to still further aspect of the disclosure, at least two or more restriction portions are arranged at the restriction member so that the needle receiving hole is positioned between the restriction portions.

[0019] Accordingly, the movement of the work material around the needle receiving hole is restricted by two imaginary lines defined by the restriction portions (in the case of three or more restriction portions, an imaginary surface defined by the restriction portions); therefore, thread loops are uniformly formed and skipped stitches are inhibited.

[0020] According to another aspect of the disclosure, the restriction member includes a supplementary restriction member positioned in the needle receiving hole and holding the work material along a feed direction thereof.

[0021] Accordingly, the movement of the work material around the needle receiving hole 133 is prevented, therefore forming thread loops more effectively.

[0022] According to further aspect of the disclosure, wherein the bottom face of the main body has inclined portions and a deepest portion between the inclined portions is positioned further rearward than the pivot shaft in the feed direction.

[0023] Accordingly, for example, in the case where the stepped portion of a thick work material is sewn (in the case of hemming jeans), the inclination of the presser foot when the presser foot is moved up on the stepped portion is decreased, therefore reducing an upward movement of the pivot shaft transmitting a presser bar pressure to the work material. Further, even when the stepped portion is inserted directly under the pivot shaft,

the pivot shaft does not necessarily move upward so as to be higher than the thickness of the stepped portion of the work material and the work material is smoothly fed under the presser foot. Furthermore, the inclination of the presser foot allows the stepped portion to be pressed along shapes of the inclined portions. Accordingly, a rear portion of the bottom face, which is located rearward than the pivot shaft is easily moved up on the stepped portion. The upward movement of the pivot shaft gently varies; thereby, the presser foot is easily moved up on and down from the stepped portion. The inclined portions are formed so as to extend to the needle receiving hole. Accordingly, in the case of sewing a thin work material, a portion of the thin work material, which is positioned around the needle receiving hole may not be pressed by the main body of the presser foot. However, the main body is combined with the restriction member; thereby the portion of the thin work material around the needle receiving hole is pressed by the restriction member to inhibit skipped stitches accordingly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The foregoing and additional features and characteristics of this disclosure will become more apparent from the following detailed description considered with the reference to the accompanying drawings, wherein:

[0025] Fig. 1 is a perspective view of a presser foot for a sewing machine according to a first embodiment disclosed here;

[0026] Fig. 2A is a top view of a main body of the presser foot according to the first embodiment disclosed here;

[0027] Fig. 2B is a lateral view of the main body of the presser foot according to the first embodiment disclosed here;

[0028] Fig. 2C is a bottom view of the main body of the presser foot according to the first embodiment disclosed here;

[0029] Fig. 2D is a cross-sectional view of the main body of the presser foot according to the first embodiment, taken along the line 2D-2D of Fig. 2A;

[0030] Fig. 3A is a top view of a restriction member including plate springs according to the first embodiment disclosed here;

[0031] Fig. 3B is a lateral view of the restriction member according to the first embodiment disclosed here;

[0032] Fig. 3C is a bottom view of the restricting member according to the first embodiment disclosed here;

[0033] Fig. 3D is a cross-sectional view of the restriction member according to the first embodiment, taken along the line 3D-3D of Fig. 3A;

[0034] Fig. 4A is a top view of an assembled condition of the presser foot according to the first embodiment where the restricting member is attached to the main body;

[0035] Fig. 4B is a lateral view of the assembled condition of the presser foot according to the first embodiment;

[0036] Fig. 4C is a bottom view of the presser foot according to the first embodiment;

[0037] Fig. 4D is a cross-sectional view showing the assembled condition of the presser foot according to the first embodiment, taken along the line 4D-4D of Fig. 4A;

[0038] Fig. 5 is an explanation drawing showing a condition before a stepped portion of a work material is moved to a contact position with the presser foot according to the first embodiment;

[0039] Fig. 6 is an explanation drawing showing a condition where the presser foot according to the first embodiment starts being moved up on the stepped portion of the work material;

[0040] Fig. 7 is an explanation drawing showing a condition where the stepped portion of the work material is moved to a contact position with a front inclined portion of the presser foot according to the first embodiment;

[0041] Fig. 8 is an explanation drawing showing a condition where the stepped portion of the work material is further fed close to a rotary pin;

[0042] Fig. 9 is an explanation drawing showing a condition where the stepped portion of the work material is moved directly below the rotary pin;

[0043] Fig. 10 is an explanation drawing showing a condition where the stepped portion of the work material passes directly below the rotary pin;

[0044] Fig. 11 is an explanation drawing showing a condition where a terminal portion of the stepped portion of the work material is moved under the rotary pin;

[0045] Fig. 12 is an explanation drawing showing a condition where a rear inclined portion of the main body of the presser foot according to the first embodiment is moved down from the stepped portion of the work material;

[0046] Fig. 13 is an explanation drawing showing a condition where the rear inclined portion of the main body of the presser foot is in contact with the stepped portion of the work material;

[0047] Fig. 14 is an explanation drawing showing a condition after the presser foot according to the first embodiment is moved down from the stepped portion of the work material;

[0048] Fig. 15 is a perspective view of the presser foot according to a second embodiment disclosed here;

[0049] Fig. 16A is a top view of the main body of the presser foot according to the second embodiment disclosed here;

[0050] Fig. 16B is a lateral view of the main body of the presser foot according to the second embodiment disclosed here;

[0051] Fig. 16C is a bottom view of the main body of the presser foot according to the second embodiment disclosed here;

[0052] Fig. 16D is a cross-sectional view of the main body of the presser foot according to the second embodiment, taken along the line 16D-16D of Fig. 16A;

[0053] Fig. 17A is a top view of the restriction member according to the second embodiment disclosed here;

[0054] Fig. 17B is a lateral view of the restriction member according to the second embodiment;

[0055] Fig. 17C is a bottom view of the restriction member according to the second embodiment;

[0056] Fig. 17D is a cross-sectional view taken of the restriction member according to the second embodiment, taken along the line 17D-17D of Fig. 17A;

[0057] Fig. 18A is a top view of an assembled condition of the presser foot according to the second embodiment where the restriction member is attached to the main body;

[0058] Fig. 18B is a lateral view of the assembled condition of the presser foot according to the second embodiment;

[0059] Fig. 18C is a bottom view of the assembled condition of the presser foot according to the second embodiment;

[0060] Fig. 18D is a cross-sectional view of the presser foot according to the second embodiment, taken along the line 18D-18D of Fig. 18A;

[0061] Fig. 19 is an explanation drawing showing a condition before the stepped portion of the work material is moved to a contact position with the presser foot according to the second embodiment;

[0062] Fig. 20 is an explanation drawing showing a condition where the presser foot according to the second embodiment starts being moved up on the stepped portion of the work material;

[0063] Fig. 21 is an explanation drawing showing a condition where the stepped portion of the work material is moved to a contact position with the front inclined portion of the presser foot according to the second embodiment;

[0064] Fig. 22 is an explanation drawing showing a condition where the stepped portion of the work material is further fed close to the rotary pin;

[0065] Fig. 23 is an explanation drawing showing a condition where the stepped portion of the work material is moved directly below the rotary pin;

[0066] Fig. 24 is an explanation drawing showing a condition where the stepped portion of the work material passes directly below the rotary pin;

[0067] Fig. 25 is an explanation drawing showing a condition where the rear inclined portion of the main body of the presser foot according to the second embodiment is moved down from the stepped portion of the work material;

[0068] Fig. 26 is an explanation drawing showing a condition where the rear inclined portion of the main body of the presser foot according to the second embodiment is in contact with the stepped portion of the work material;

[0069] Fig. 27 is an explanation drawing showing a condition after the presser foot according to the second embodiment is moved down from the stepped portion of the work material;

[0070] Fig. 28 is an explanation drawing of a third embodiment that is an modified example of the second embodiment where a supplementary restriction member is

attached to the restriction member;

[0071] Fig. 29 is an explanation drawing showing a condition before the stepped portion of the work material is moved to a contact position with the presser foot according to the third embodiment;

[0072] Fig. 30 is an explanation drawing illustrating a condition where the stepped portion of the work material is moved to a contact position with the front inclined portion of the presser foot according to the third embodiment;

[0073] Fig. 31 is an explanation drawing illustrating a condition where the rear inclined portion of the main body of the presser foot according to the third embodiment is in contact with the stepped portion of the work material;

[0074] Fig. 32 is an perspective view of a known presser foot;

[0075] Fig. 33 is an explanation drawing showing a condition while the known presser foot is moved up on the stepped portion of the work material;

[0076] Fig. 34 is an explanation drawing showing a condition while the known presser foot is moved up on the stepped portion of the work material; and

[0077] Fig. 35 is an explanation drawing showing a condition while the known presser foot is moved down from the stepped portion of the work material.

DETAILED DESCRIPTION

[0078] A first embodiment of a presser foot 1 for a sewing machine disclosed here will be explained with reference to the attached drawings. In the following description, an up-and down direction is a vertical direction that coincides with a moving direction of a sewing needle 6. A front-and-rear direction corresponds to a feed direction of a work material in the sewing machine. Left and right sides in the attached drawings correspond to the front direction and the rear direction, respectively.

[0079] Fig. 1 is a perspective view of the presser foot 1 according to the first embodiment. The presser foot 1 includes a main body 20, a restriction member 40 for restricting a vertical movement of the work material, and two plate springs serving as restriction portions (elastic members) 50 attached to the restriction member 40. The vertical movement of the work material resembles a waving flag and therefore will be referred to as "flagging" hereinafter. Thus, the restriction member 40 is to be read as a flagging-preventing member 40.

[0080] Fig. 2A is a top view of the main body 20 of the presser foot 1. Fig. 2B is a lateral view of the main body 20. Fig. 2C is a bottom view of the main body 20. Fig. 2D is a cross-sectional view of the main body 20 taken along the line 2D-2D of Fig. 2A. A presser holder 2 transmitting a presser bar pressure of a presser bar spring to the main body 20 is arranged at the main body 2 (see Fig. 5). The presser holder 2 is fixed to a presser bar 3 that is vertically movable (see Fig. 5). The main body 20 of the presser foot 1 is movably attached to the presser holder 2 via a pivot pin (pivot shaft) 4.

[0081] As shown in Figs. 2A to 2D, a bottom face 21

of the main body 20 of the presser foot 1 includes flat faces 22, a front inclined portion (inclined portion) 23, and a rear inclined portion (inclined portion) 24. A deepest portion 25 between the front inclined portion 23 and the rear inclined portion 24 is positioned further rearward than the rotary pin 4. A needle receiving hole 33 is formed in the approximately center of the main body 20. The sewing needle 6 penetrates through the needle receiving hole 33. A first accommodating portion 27 and a second accommodating portion 28 are arranged in the bottom face 21. The first accommodating portion 27 accommodates a pass over portion 42 (see Fig. 3) of the restriction member 40 in accordance with a rotation of the restriction member 40 while the second accommodating portion 28 accommodates a pressing portion 41 (shown in Fig. 3) pressing the work material around the needle receiving hole 33, in accordance with the rotation of the restriction member 40. Thus, the bottom face 21 of the main body 20 of the presser foot 1 is flatly connected to either one of the pass over portion 42 and the pressing portion 41. Further, first and second recessed portions 31 and 32 are formed in the bottom face 21 for preventing the main body 20 from contacting a contact portion 5 of the presser holder 2. Holes 26 are formed in lateral faces of the main body 20. Shafts 43 of the restriction member 40 are inserted into the holes 26 of the main body 20. Furthermore, the rotary pin 4 is attached to the main body 20.

[0082] Fig. 3A is a top view of the restriction member 40 including the plate springs 50. Fig. 3B is a lateral view of the restriction member 40. Fig. 3C is a bottom view of the restriction member 40. Fig. 3D is a cross-sectional view of the restriction member 40 taken along the line 3D-3D of Fig. 3A. The restriction member 40 includes the pressing portion 41 and the pass over portion 42. The plate springs 50 are attached to lateral faces of the restriction member 40. The shafts 43 are arranged at inner portions of the lateral faces of the restriction member 40. The restriction member 40 and the plate springs 50 are formed with resin so as to form a single-piece member.

[0083] Fig. 4A is a top view of an assembly condition of the presser foot 1 in which the restriction member 40 is attached to the main body 20. Fig. 4B is a lateral view of the assembled condition of the presser foot 1. Fig. 4C is a bottom view of the assembled condition of the presser foot 1. Fig. 4D is a cross-sectional view of the assembled condition of the presser foot 1 taken along the line 4D-4D of Fig. 4A. The shafts 43 are fitted in the holes 26 to thereby movably attach the restriction member 40 to the main body 20.

[0084] Details of an operation of the presser foot 1 according to the first embodiment will be described with reference to Figs. 5 to 14 as follows.

[0085] Fig. 5 shows a condition before a stepped portion 10 of the work material is fed close to the presser foot 1. In Fig. 5, the presser foot 1 presses (three folds of the stepped portion of) the work material. An elastic force of the plate springs 50 of the restriction member 40 is set to be surely smaller than the presser bar pressure.

Accordingly, the plate springs 50 are elastically deformed and moved upward as seen in Fig. 5. Further, the pass over portion 42 is accommodated in the accommodating portion 27 of the main body 20 by the presser bar pressure. Furthermore, since the pass over portion 42 is pressed against the work material by the presser bar pressure, a portion of the work material, which is around the needle receiving hole 33, is pressed by the pressing portion 41 via the shafts 43. Such condition is seen similarly in the case of sewing a thin work material, therefore preventing skipped stitches.

[0086] Fig. 6 shows a condition where the presser foot 1 starts being moved up on the stepped portion 10. A space 11 having an approximate triangular shape is formed between the presser foot 1 and the work material. At this time, flagging of the work material is restricted by the elastic force (restoring force) of the plate springs 50 arranged at the restriction member 40 to thereby prevent a non-uniform formation of thread loops. Further, skipped stitches are prevented while the presser foot 1 is moved up on the stepped portion 10.

[0087] Fig. 7 shows a condition where the stepped portion 10 is moved to a contact position with the front inclined portion 23 of the presser foot 1. In this condition, an upper corner of the stepped portion 10 is in contact with the front inclined portion 23 of the main body 20 and the presser bar pressure is not applied to the pass over portion 42 of the restriction member 40. Further, the pressing portion 41 is accommodated in the second accommodating portion 28 of the main body 20 by the elastic force (restoring force) of the plate springs 50.

[0088] Fig. 8 shows a condition where the stepped portion 10 of the work material is further fed close to the rotary pin 4. In this condition, the presser bar pressure is stronger than the elastic force of the plate springs 50 and therefore elastically deforms the plate springs 50. At this time, an inclination α of the presser foot 1 is reduced by approximately 40 percent as compared with an inclination β of a known presser foot 60 (see Fig. 34). Further, a height h_1 of the rotary pin 4 from the work material is shorter by approximately 10 percent as compared with a height h_2 of the rotary pin 4 of the known presser foot 60 (see Fig. 34). Accordingly, a resistive force (acting in the opposite direction from the feed direction) of the rotary pin 4, occurring relative to the work material until the stepped portion 10 is moved directly below the rotary pin 4 is reduced and variations of a load of the presser bar pressure is reduced; therefore, the work material is smoothly fed to pass under the presser foot 1.

[0089] Fig. 9 shows a condition where the stepped portion 10 of the work material is moved directly below the rotary pin 4. In this condition, the presser bar pressure is applied to a whole area of the front inclined portion 23 of the main body 20 of the presser foot 1. Since the deepest portion 25 that is an inflexion point between the front inclined portion 23 and the rear inclined portion 24 of the main body 20 is located further rearward than the rotary pin 4, the condition shown in Fig. 9 is realized due to the

principle of leverage.

[0090] Fig. 10 shows a condition where the stepped portion 10 of the work material passes directly below the rotary pin 4. In this condition, the upper corner of the stepped portion 10 is in contact with the rear inclined portion 24 of the main body 20. At this time, the height of the rotary pin 4 varies but an amount of the variation is small; therefore, feeding of the work material is not inhibited.

[0091] Fig. 11 shows a terminal portion of the stepped portion 10 of the work material is moved approximately below the rotary pin 4. In this condition, the space 11 having the approximately triangular shape is formed between the stepped portion 10 and the presser foot 1 in the same manner as seen while the presser foot 1 is moved up on the stepped portion 10. In addition, flagging of the work material is restricted by the plate springs 50 of the restriction member 40; therefore, skipped stitches are inhibited.

[0092] Fig. 12 shows a condition before a rear end inclined portion 29 of the main body 20 of the presser foot 1 is moved down from the stepped portion 10 of the work material. In this condition, the presser foot 1 is moved down from the stepped portion 10 while flagging of the work material in the space 11 formed between the main body 20 and the stepped portion 10 is restricted by the plate springs 50 of the restriction member 40. At this time, the pressing portion 41 is not in contact with the stepped portion 10 and a load is not applied to the pressing portion 41. Further, the pass over portion 42 is accommodated in the first accommodating portion 27 of the main body 20 by the presser bar pressure. When the work material is backstitched (reversely fed) under the condition shown in Fig. 12, the presser foot 1 is easily moved up on and down from the stepped portion 10.

[0093] Fig. 13 shows a condition where the rear end inclined portion 29 of the main body 20 of the presser foot 1 is in contact with the stepped portion 10 of the work material. As seen in Fig. 35, a downwardly inclined angle of the known presser foot 60 is not sufficient for the presser foot 60 to press the work material. When feed dogs move lower than a needle plate surface, the stepped portion 10 is moved forcibly or suddenly in the feed direction by a rear end inclined portion 69 of the known presser foot 60 because of the presser bar pressure. Accordingly, a feed amount of the work material is increased. As a result, the sewing needle 6 may be bent by the forcible or sudden movement of the work material. Meanwhile, according to the presser foot 1 described in the first embodiment, a forwardly inclined angle of the main body 20 is increased by the receded portions 31 and 32 preventing the main body 20 from interfering with the contact portion 5 of the presser holder 2 arranged at the main body 20. Further, the work material is held by the presser bar pressure applied to the main body 20, via the pass over portion 42 of the restriction member 40. As a result, the work material is inhibited from being forcibly or suddenly moved in the feed direction.

[0094] Fig. 14 shows a condition after the presser foot 1 is moved down from the stepped portion 10 of the work material. In Fig. 14, the plate springs 50 of the restriction member 40 are elastically deformed and moved upward in the same manner as seen in Fig. 5. In this condition, the pass over portion 42 is accommodated in the first accommodating portion 27 by the presser bar pressure.

[0095] According to the press foot 1 of the first embodiment, the restriction member 40 is provided with the plate springs 50 protruding from the bottom face 21 of the main body 20. Accordingly, when the stepped portion 10 is moved to a contact position with a front portion of the presser foot 1, the space 11 having the approximately triangular shape is formed between the stepped portion 10 and the presser foot 1. At this time, the spring plates 50 press the work material to restrict the movement of the work material. Accordingly, thread loops are uniformly formed and skipped stitches are prevented. Such action of the spring plates 50 is effective when the presser foot 1 is moved up on and down from the stepped portion 10. Further, the presser foot 1 is formed by two types of components such as the main body 20 and the restriction member 40 including the plate springs 50; therefore, materials and a manufacturing process of the presser foot 1 are easily provided. Furthermore, when the presser foot 1 is applied to the sewing machine, a body of the sewing machine does not require a special configuration. Accordingly, the presser foot 1 may be applicable to conventional sewing machines and optionally provided thereto.

[0096] In addition, the restriction member 40 and the plate springs 50 are formed with the resin so as to form the single-piece member. Accordingly, the restriction member 40 is manufactured at low cost and easily attached to the presser foot 1.

[0097] Moreover, the spring member 50 is the elastic member pressing the work material by means of the elastic force and therefore elastically biases the restriction member 40. Thus, the restriction member 40 does not need a biasing member (for example, a compression coil spring) for protruding the spring plates 50 from the bottom face 21 of the main body 20 of the presser foot 1. As a result, the number of components for the presser foot 1 is minimized.

[0098] The plate springs 50 are arranged at the lateral faces of the restriction member 40 in a condition where the needle receiving hole 33 is positioned between the plate springs 50. Accordingly, the movement of the work material around the needle receiving hole 33 is restricted by two imaginary lines defined by the spring plates 50; therefore, thread loops are uniformly formed.

[0099] In addition, the bottom face 21 of the main body 20 of the presser foot 1 is configured so that the deepest portion 25 between the front inclined portion 23 and the rear inclined portion 24 is positioned further rearward than the rotary pin 4. Accordingly, for example, in the case where a stepped portion of a thick work material is sewn (in the case of hemming jeans), the inclination of

the presser foot 1 when the presser foot 1 is moved up on the stepped portion is decreased, therefore reducing an upward movement of the rotary pin 4 transmitting the presser bar pressure to the work material. Further, even when the stepped portion 10 is inserted directly under the rotary pin 4, the rotary pin 4 does not necessarily move upward due to the position of the deepest portion 25 so as to be higher than the thickness of the stepped portion 10 of the work material; therefore, the work material is smoothly fed under the presser foot 1. Furthermore, after the stepped portion 10 passes the rotary pin 4 in the feed direction, the inclination of the presser foot 1 allows the stepped portion 10 to be pressed along shapes of the front inclined portion 23 and the rear inclined portion 24. Accordingly, a rear portion of the bottom face 21, which is located further rearward than the rotary pin 4 is easily moved up on the stepped portion 10. The upward movement of the rotary pin 4 gently varies to thereby allow the presser foot 1 to easily move up on and down from the stepped portion 10. In addition, the front inclined portion 23 and the rear inclined portion 24 are formed so as to extend to the needle receiving hole 33. Accordingly, when a thin work material is sewn by the sewing machine, a portion of the thin work material, which is around the needle receiving hole 33 may not be pressed by the main body 20 of the presser foot 1. However, the main body 20 is combined with the restriction member 40; thereby the portion of the thin work material around the needle receiving hole 33 is pressed by the restriction member 40. As a result, skipped stitches are inhibited.

[0100] A second embodiment of a presser foot 101 for a sewing machine will be described as follows. Fig. 15A is a perspective view of the presser foot 101 seen from above. Fig. 15B is a perspective view of the presser foot 101 seen from below. The presser foot 101 mainly includes a main body 120, a restriction member 140 restricting flagging of a work material, compression coil springs 151 (see Fig. 18), and torsion coil springs 152 (see Fig. 18).

[0101] Fig. 16A is a top view of the main body 120 of the presser foot 101 according to the second embodiment. Fig. 16B is a lateral view of the main body 120. Fig. 16C is a bottom view of the main body 120. Fig. 16D is a cross-sectional view of the main body 120 taken along the line 16D-16D of Fig. 16A. A presser holder 102 transmitting the presser bar pressure of the presser bar spring to the main body 120 is arranged at the main body 120 (see in Fig. 19). The presser holder 102 is fixed to a presser bar 103 that is vertically movable (see Fig. 19). The main body 120 is movably attached to the presser holder 102 via a pivot pin (pivot shaft) 104.

[0102] A bottom face 121 of the main body 120 of the presser foot 101 includes a front flat face 122a, a rear flat face 122b, a front inclined portion (inclined portion) 123, and a rear inclined portion (inclined portion) 124. A virtual deepest portion 125a between the front inclined portion 123 and the rear inclined portion 124 is positioned

further rearward than the rotary pin 104. A needle receiving hole 133 is formed in the approximately center of the main body 120. A sewing needle 106 (see Fig. 19) penetrates through the needle receiving hole 133. An accommodating portion 128 is arranged in the bottom face 121. The accommodating portion 128 accommodates a restriction portion 141 (see Fig. 17) of the restriction member 140 (see Fig. 17). The restriction portion 141 is accommodated in the accommodating portion 128 in accordance with a rotation of the restriction member 140 so as to be flatly connected to the bottom face 121 of the main body 120 of the presser foot 101. Further, first and second recessed portions 131 and 132 preventing the main body 120 from contacting a contact portion 105 of the presser holder 102 are formed in the bottom face 121. Holes 126 are formed in lateral faces of the main body 120. Shafts 143 (see Fig. 17) of the restriction member 140 are inserted into the holes 126. Furthermore, recessed portions 156 therein retaining the compression coil springs 151 (see Fig. 18) and fitting grooves 157 therein retaining the torsion coil springs 152 (see Fig. 18) are arranged in the main body 20 of the presser foot 101.

[0103] Fig. 17A is a top view of the restriction member 140 including the restriction portion 141. Fig. 17B is a lateral view of the restriction member 140. Fig. 17C is a bottom view of the restriction member 140. Fig. 17D is a cross-sectional view of the restriction member 140 taken along the line 17D-17D of Fig. 17. The restriction member 140 includes the restriction portion 141, rotation restriction pins 142, and coil spring retaining portions 150. The shafts 143 are arranged at inner portions of lateral faces of the restriction member 140. A cross-section of the restriction member 140 is formed so as to conform to shapes of the front inclined portion 123 and the rear inclined portion 124 in a condition where the restriction member 140 is accommodated within the accommodating portion 128 of the main body 120. Under such condition, the virtual deepest portion 125a is set at the restriction member 141.

[0104] Fig. 18A is a top view of an assembly condition of the presser foot 101 in which the restriction member 140 is attached to the main body 120. Fig. 18B is a lateral view of the assembled condition of the presser foot 101. Fig. 18C is a bottom view of the assembled condition of the presser foot 101. Fig. 18D is a cross-sectional view of the assembled condition of the presser foot 101 taken along the line 18D-18D of Fig. 18A. The shafts 143 are fitted in the holes 126 to thereby movably attach the restriction member 140 to the main body 120 of the presser foot 101. Further, an allowable rotation range of the restriction member 140 is determined by the rotation restriction pins 142 and a restriction surface 127 of the main body 120. Furthermore, a load acting in a clockwise direction around the shaft 143 seen in Figs. 18B and 18D is consistently applied to the restriction member 140 by the compression coil springs 151. The clockwise direction corresponds to a direction in which the restriction portion 141 of the restriction member 140 protrudes

downward from the bottom face 121 of the main body 120 of the presser foot 101. Thus, flagging of the work material is prevented by the aforementioned action of the compression coil springs 151. In addition, a load to tilt the whole presser foot 101 rearwardly downward relative to a spring retaining surface 105a (see Fig. 19) around the rotary pin 104 is applied to the presser foot 101 by the torsion coil springs 152. Thus, a feeding failure (i.e. the work material is not fed appropriately) occurring when the presser foot 101 is not tilted rearwardly downward, is prevented in the case where the presser foot 101 is moved up on a stepped portion 110 of the work material. As a result, the presser foot 101 is easily moved up on the stepped portion 110.

[0105] Details of an operation of the presser foot 101 according to the second embodiment will be described as follows with reference to Figs. 19 to 28.

[0106] Fig. 19 shows a condition before the stepped portion 110 of the work material is moved to a contact position with the presser foot 101. In Fig. 19, the presser foot 101 presses (three folds of the stepped portion 110) of the work material. An elastic force (restoring force) of the compression coil springs 151 applying the load to the restriction member 140 is set to be surely smaller than the presser bar pressure. Accordingly, the compression coil springs 151 is not resistive to the presser bar pressure to thereby rotate the restriction member 140 around the shafts 143 in a counterclockwise direction and a portion of the work material, which is positioned around the needle receiving hole 133, is pressed by the front flat portion 122a, the rear flat portion 122b, and the restriction portion 141 of the restriction member 140. Such condition is seen similarly in the case of sewing a thin work material. Thus, the portion of the thin work material around the needle receiving hole 133 is pressed by the front flat portion 122a, the rear flat portion 122b, and the restriction portion 141 of the restriction member 140, therefore preventing skipped stitches.

[0107] Fig. 20 shows a condition where the presser foot 101 starts being moved up on the stepped portion 110. A space 111 having an approximate triangular shape is formed between the presser foot 101 and the work material. At this time, flagging of the work material is restricted by the restriction portion 141 of the restriction member 140 by the action of the compression coil springs 151. Accordingly, a non-uniform formation of thread loops and an occurrence of skipped stitches are prevented under a condition where the presser foot 101 is moved up on the stepped portion 110.

[0108] Fig. 21 shows a condition where the stepped portion 110 is moved to a contact position with the front inclined portion 123 of the presser foot 101. In this condition, an upper corner of the stepped portion 110 is in contact with the front inclined portion 123 of the main body 120 and the restriction member 140 is further rotated by the action of the compression coil springs 151 to prevent flagging of the work material by the restriction portion 141 accordingly. At this time, the restriction por-

tion 141 of the restriction member 140 fully protrudes downward from the bottom face 121 of the main body 120 of the presser foot 101. When a protrusion amount of the restriction portion 141 is excessively large, the restriction portion 141 may interfere with the sewing needle 106. The rotation restriction pins 142 are arranged at the restriction member 140. The rotation restriction pins 142 adjust the protrusion amount in contact with the restriction surface 127 arranged on the main body 120 of the presser foot 101 in order to prevent the interference between the restriction portion 141 and the sewing needle 106.

[0109] Fig. 22 shows a condition where the stepped portion 110 of the work material is further fed close to the rotary pin 104. In this condition, lower portions 153 of the lateral faces of the restriction member 140 move along the stepped portion 110; thereby the restriction member 140 is rotated around the shafts 143 in the counterclockwise direction and the restriction portion 141 is accommodated in the accommodating portion 128 of the main body 120. At this time, an inclination α of the presser foot 101 is reduced by approximately 40 percent as compared with the inclination β of the known presser foot 60 (see Fig. 34). Further, a height h_1 of the rotary pin 104 from the work material is shorter by approximately 10 percent as compared with the height h_2 of the rotary pin 4 of the known presser foot 60. Accordingly, a resistive force (acting in the opposite direction from the feed direction) of the rotary pin 104 relative to the work material, which occurs until the stepped portion 110 is moved directly below the rotary pin 104 is reduced and variations of a load of the presser bar pressure is reduced; thereby, the work material is smoothly fed under the presser foot 101.

[0110] Fig. 23 shows a condition where the stepped portion 110 of the work material is moved directly below the rotary pin 104. In this condition, the presser bar pressure is applied to a whole area of the front inclined portion 123 of the main body 120. Since the virtual deepest portion 125a that is an inflexion point between the front inclined portion 123 and the rear inclined portion 124 of the main body 120 is located further rearward than the rotary pin 104, the condition shown in Fig. 23 is realized due to the principle of leverage.

[0111] Fig. 24 shows a condition where the stepped portion 110 of the work material passes right below the rotary pin 104. In this condition, the upper corner of the stepped portion 110 is in contact with the rear inclined portion 124 of the main body 120. At this time, the height of the rotary pin 104 varies but an amount of the variation is small; therefore, feeding of the work material is not inhibited.

[0112] Fig. 25 shows a condition where the rear flat portion 122b of the main body 120 is moved down from the stepped portion 110 of the work material. The presser foot 101 is moved down from the stepped portion 110 while flagging of the work material in the space 111 having the approximately triangular shape formed between the stepped portion 110 and the main body 120 is re-

stricted by the restriction portion 141 of the restriction member 140. Accordingly, when the work material is backstitched (reversely fed) under such condition shown in Fig. 25, a rear end portion 155 of the restriction member 140 enables the presser foot 101 to be easily moved up on the stepped portion 110.

[0113] Fig. 26 shows a condition where a rear end inclined portion 129 of the main body 120 of the presser foot 101 is in contact with the stepped portion 110 of the work material. The known presser foot 60 illustrated in Fig. 32 does not securely press the work material because the downwardly inclined angle of the known presser foot 60 is not sufficient due to interference between a contact portion 2a of the presser holder 2 and the presser foot 60 as shown in Fig. 35. For example, when the feed dogs move lower than the needle plate surface, the stepped portion 10 is suddenly or forcibly moved in the feed direction by the rear end inclined portion 69 of the known presser foot 60 by means of the presser bar pressure; therefore, the feed amount of the work material is increased. As a result, the sewing needle 6 may be bent by the work material forcibly moved in the feed direction. Meanwhile, according to the presser foot 101 described in the second embodiment, a forwardly inclined angle of the main body 120 is increased by the receded portions 131 and 132 preventing the main body 120 from interfering with the contact portion 105 of the presser holder 102 arranged at the main body 120. Further, the work material is held by the presser bar pressure applied to a curved guide portion 154 (Fig. 16B and Fig. 16D) of the main body 120. As a result, the work material is inhibited from being forcefully fed in the feed direction.

[0114] Fig. 27 shows a condition after the presser foot 101 is moved down from the stepped portion 110 of the work material. In this condition, the work material is pressed by the restriction member 140 so that the portion of the work material around the needle receiving hole 133 is pressed by the front flat portion 122a, the rear flat portion 122b, and the restriction portion 141. Such condition is similarly seen in the case of sewing the thin work material. Thus, the portion of the thin work material around the needle receiving hole 133 is pressed by the front flat portion 122a, the rear flat portion 122b, and the restriction portion 141 of the restriction member 140, therefore preventing skipped stitches.

[0115] According to the press foot 101 of the second embodiment, the restriction member 140 is provided with the protruding portion 141 protruding downward from the bottom face 121 of the main body 120. Accordingly, when the stepped portion 110 is moved to a contact position with a front portion of the presser foot 101, the space 111 having the approximately triangular shape is formed between the stepped portion 110 and the presser foot 101. At this time, the restriction portion 141 presses the work material to thereby restrict the movement of the work material. Accordingly, thread loops are uniformly formed and skipped stitches are prevented. Such effect of the restriction portion 141 is seen when the presser foot 101

is moved up on and down from the stepped portion 110. Further, the presser foot 101 is formed by four types of components such as the main body 120, the restriction member 140 including the restriction portion 141, the compression coil spring 151, and the torsion coil spring 152 and materials and a manufacturing process of the presser foot 101 are easily provided. Furthermore, when the presser foot 101 is applied to the sewing machine, the body of the sewing machine does not require the special configuration. Accordingly, the presser foot 101 may be applicable to conventional sewing machines and optionally provided thereto.

[0116] In addition, the restriction member 140 and the restriction portion 141 are integrally molded with resin. Accordingly, the restriction member 140 is easily manufactured at low cost and easily attached to the presser foot 101.

[0117] Moreover, the bottom face 121 of the main body 120 of the presser foot 101 is configured so that the deepest portion 125a between the front inclined portion 123 and the rear inclined portion 124 is positioned further rearward than the rotary pin 104. Accordingly, for example, in the case where the stepped portion of the thick work material is sewn (in the case of hemming jeans), the inclination of the presser foot 101 when the presser foot 101 is moved up on the stepped portion is decreased, therefore reducing the upward movement of the rotary pin 104 transmitting the presser bar pressure to the work material. Further, even when the stepped portion 110 is inserted directly under the rotary pin 104, the rotary pin 104 does not necessarily move upward so as to be higher than the thickness of the stepped portion 110 of the work material and the work material is smoothly fed under the presser foot 101. Furthermore, the inclination of the presser foot 101 allows the stepped portion 110 to be pressed along shapes of the front inclined portion 123 and the rear inclined portion 124. Accordingly, a rear portion of the bottom face 121, which is located further rearward than the rotary pin 104 is easily moved up on the stepped portion 110. The upward movement of the rotary pin 104 gently varies; thereby, the presser foot 101 is easily moved up on and down from the stepped portion 110. The front inclined portion 123 and the rear inclined portion 124 are formed so as to extend to the needle receiving hole 133. Accordingly, in the case of sewing the thin work material, the portion of the thin work material around the needle receiving hole 133 may not be pressed by the main body 120 of the presser foot 101. However, the main body 120 is combined with the restriction member 140; thereby the portion of the thin work material around the needle receiving hole 133 is pressed by the restriction member 140 to inhibit skipped stitches accordingly.

[0118] Fig. 28A and Fig. 28B illustrate a third embodiment that is a modified example of the presser foot 101 according to the second embodiment. The presser foot 101 shown in Fig. 28A and Fig. 28B includes the restriction member 140 to which a supplementary restriction

member 158 is attached. The supplementary restriction member 158 has arm portions 158a and 158b positioned in the needle receiving hole 133 along the feed direction. Fig. 28A and Fig. 28B are top and lateral views, respectively, of the presser foot 101 according to the third embodiment.

Fig. 29 shows a condition where a flat portion of the work material is sewn. Fig. 30 shows a condition where the presser foot 101 according to the third embodiment is moved up on the stepped portion 110 of the work material. Fig. 31 shows a condition where the presser foot 101 according to the third embodiment is moved down from the stepped portion 110.

[0119] The supplementary restriction member 158 is attached to the restriction member 140 and thereby holds the work material in the needle receiving hole 133 along the feed direction. Accordingly, flagging of the work material is prevented right before the sewing needle 106 moves downward toward and into the needle receiving hole 133. As a result, thread loops are uniformly and effectively formed.

[0120] The principles, preferred embodiment and mode of operation of the present invention have been described in the foregoing specification. However, the invention which is intended to be protected is not to be construed as limited to the particular embodiments disclosed. Further, the embodiments described herein are to be regarded as illustrative rather than restrictive. Variations and changes may be made by others, and equivalents employed, without departing from the spirit of the present invention. Accordingly, it is expressly intended that all such variations, changes and equivalents which fall within the spirit and scope of the present invention as defined in the claims, be embraced thereby.

Claims

1. A presser foot (1) for a sewing machine, comprising:

a main body (20,120) rotatably attached to a presser holder (2,102) via a pivot shaft (4,104) and having a needle receiving hole (33,133); and
a restriction member (40,140) rotatably attached to the main body (20,120),
wherein the restriction member (40,140) includes a restriction portion (50,141), which protrudes downwardly from a bottom face (21,121) of the main body (20,120) to press a work material to thereby restrict a movement of the work material when a stepped portion (10) of the work material is in contact with the presser foot (1).

2. The presser foot (1) according to Claim 1, wherein the restriction member (40) and the restriction portion (50) are formed in one-piece resin member.

3. The presser foot (1) according to Claim 1 or 2, wherein the restriction portion (50) comprises an elastic member for elastically pressing against the work material.

4. The presser foot (1) according to any one of Claims 1 to 3, wherein the restriction portion (50) comprises a plurality of restriction portions (50) which are arranged at the restriction member (40) such that the needle receiving hole (33) is positioned between the restriction portions (50).

5. The presser foot (110) according to any one of Claims 1 to 4, wherein the restriction member (140) includes a supplementary restriction member (158) positioned in the needle receiving hole (133) and holding the work material along a feed direction thereof.

6. The presser foot (1, 110) according to any one of Claims 1 to 5, wherein the bottom face (21, 121) of the main body (20, 120) has inclined portions (23; 24, 123; 124) and a deepest portion (25, 125a) between the inclined portions (23; 24, 123; 124) is positioned further rearward than the pivot shaft (4, 104) in the feed direction.

FIG. 1

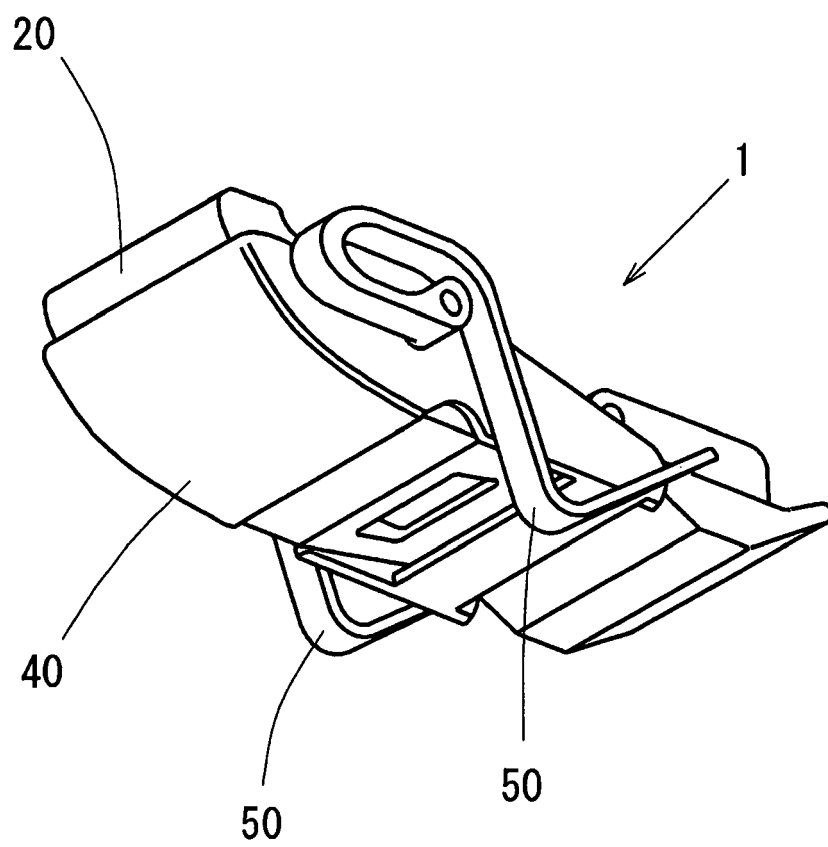


FIG. 2 A

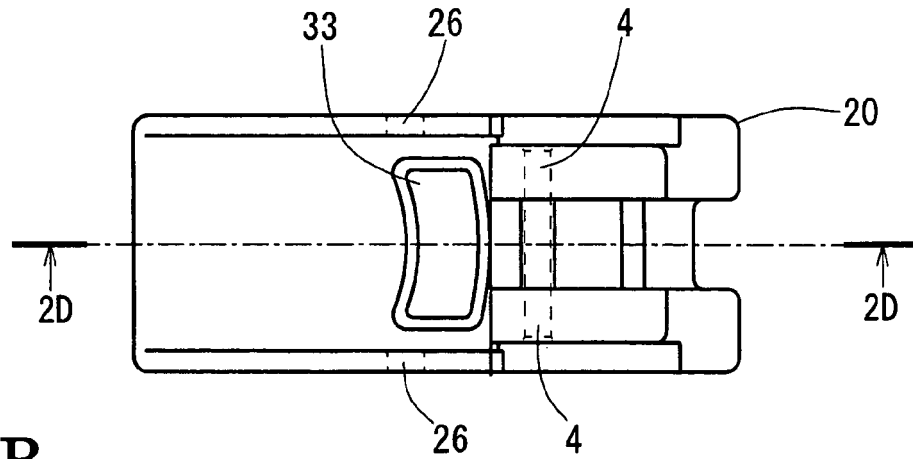


FIG. 2 B

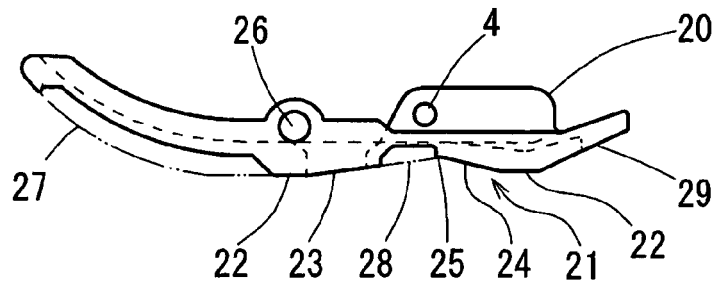


FIG. 2 C

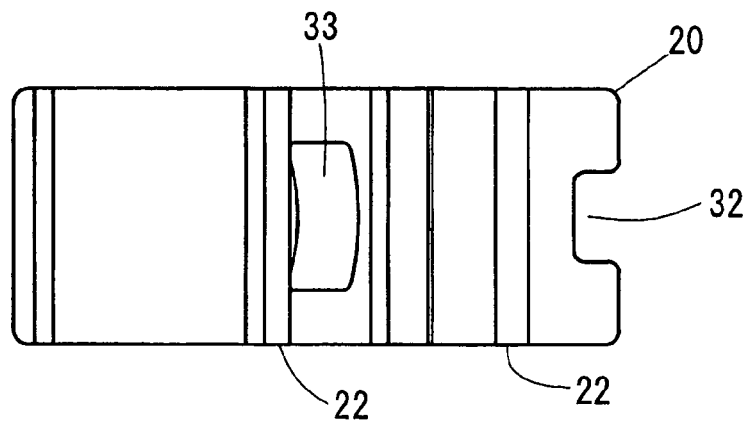


FIG. 2 D

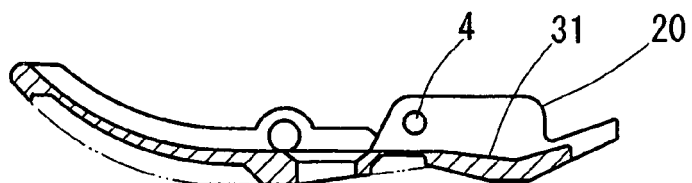


FIG. 3 A

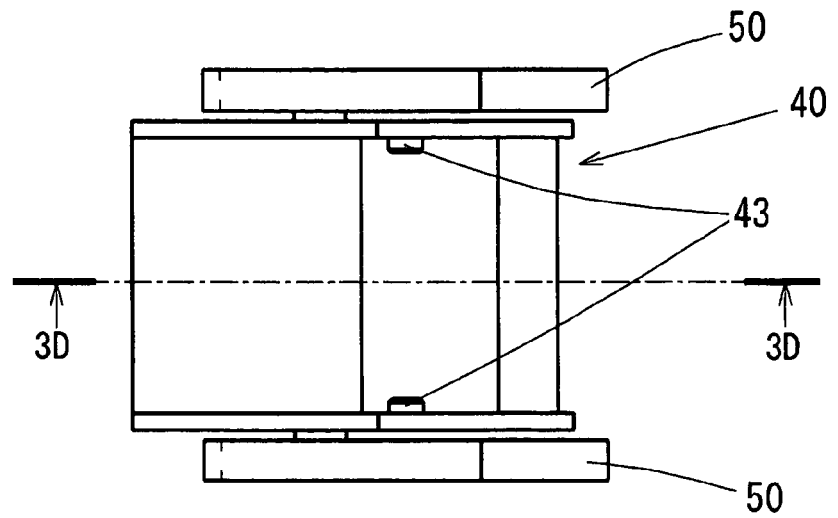


FIG. 3 B

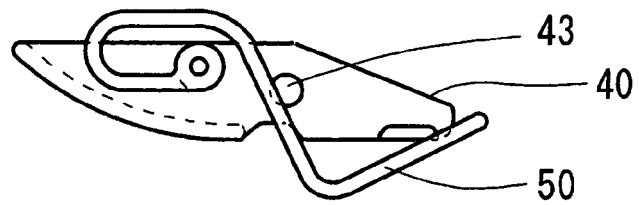


FIG. 3 C

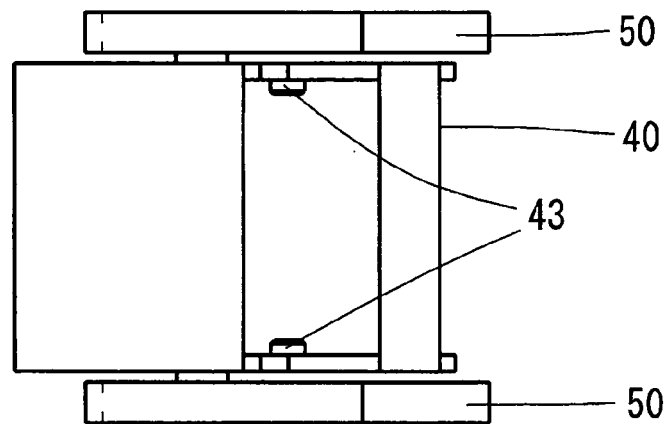


FIG. 3 D

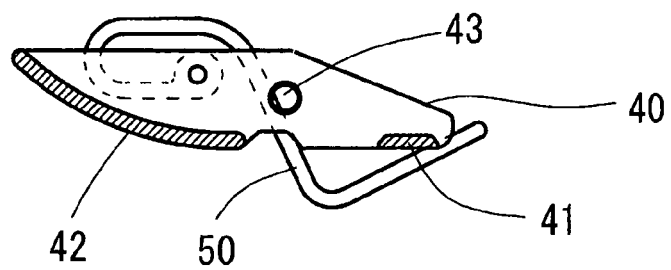


FIG. 4 A

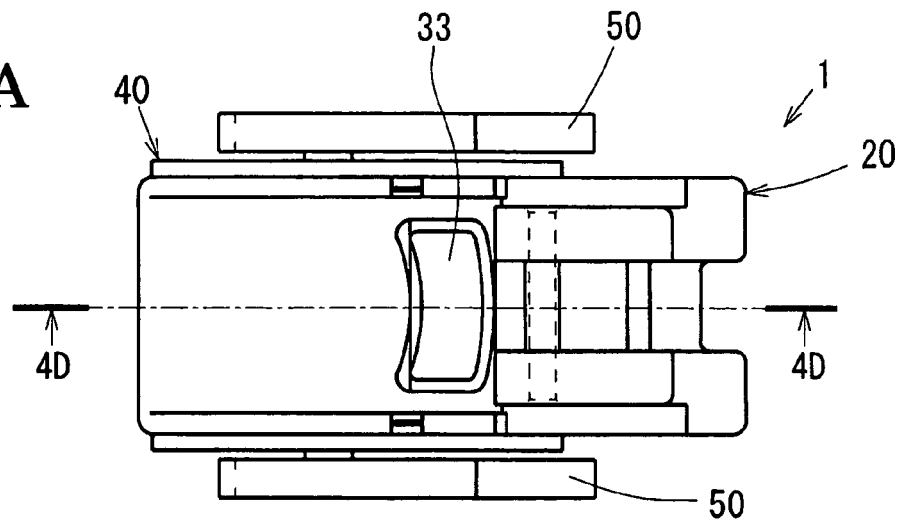


FIG. 4 B

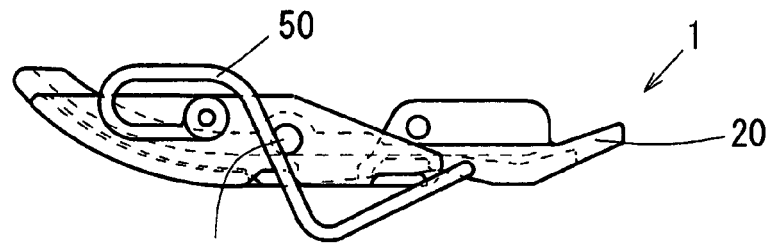


FIG. 4 C

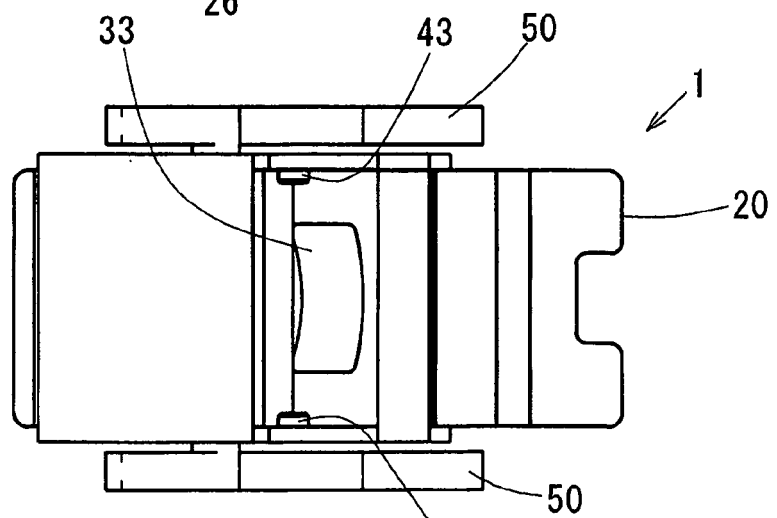


FIG. 4 D

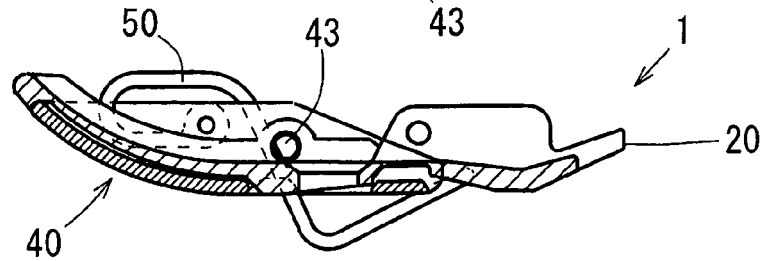


FIG. 5

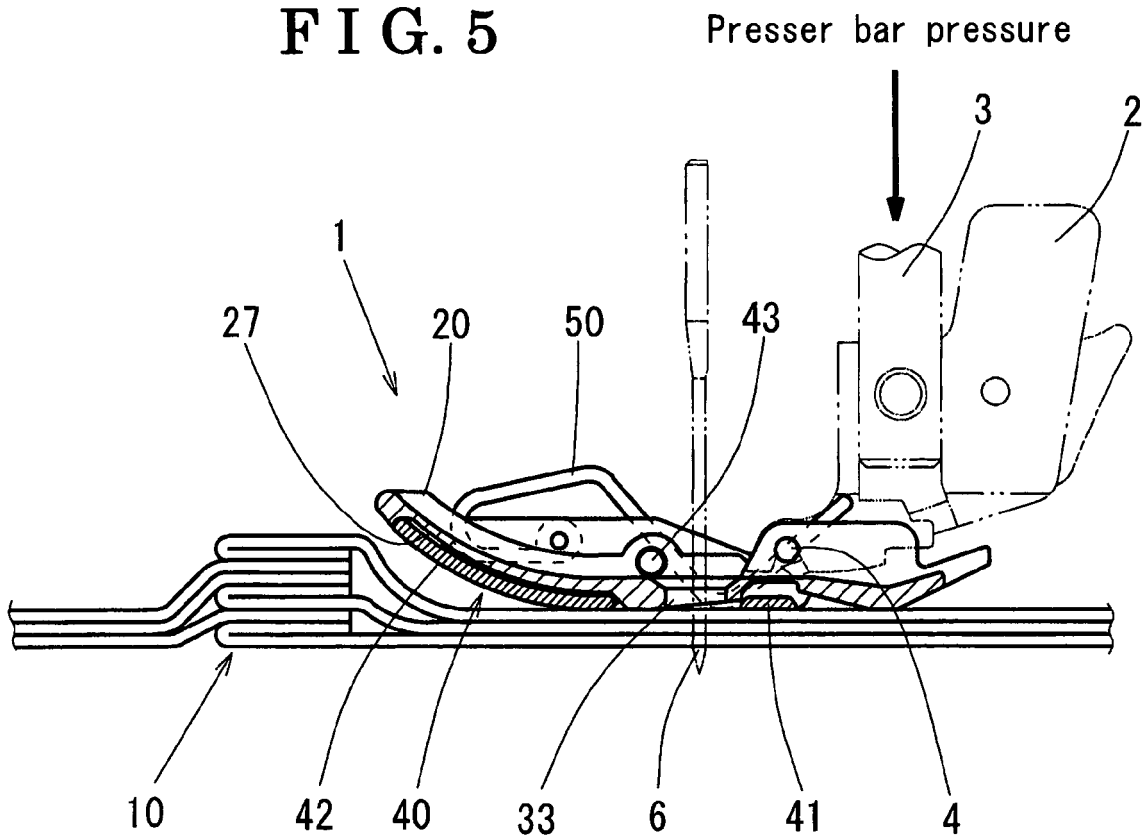


FIG. 6

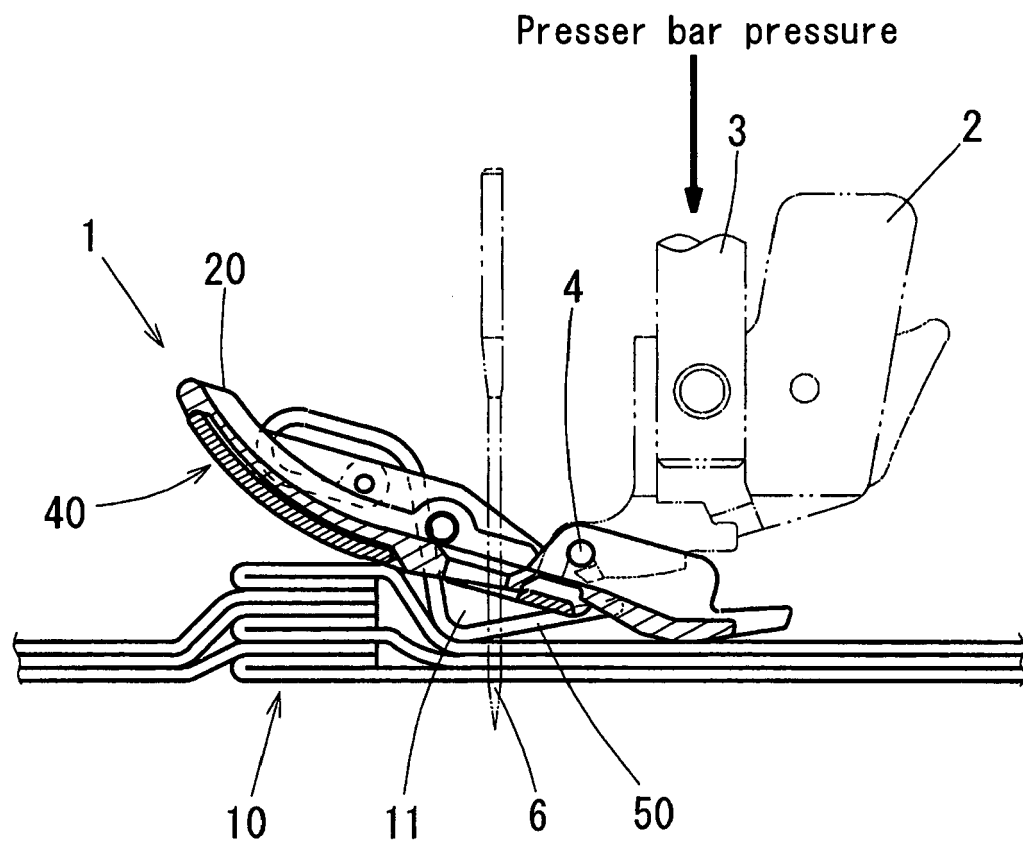


FIG. 7

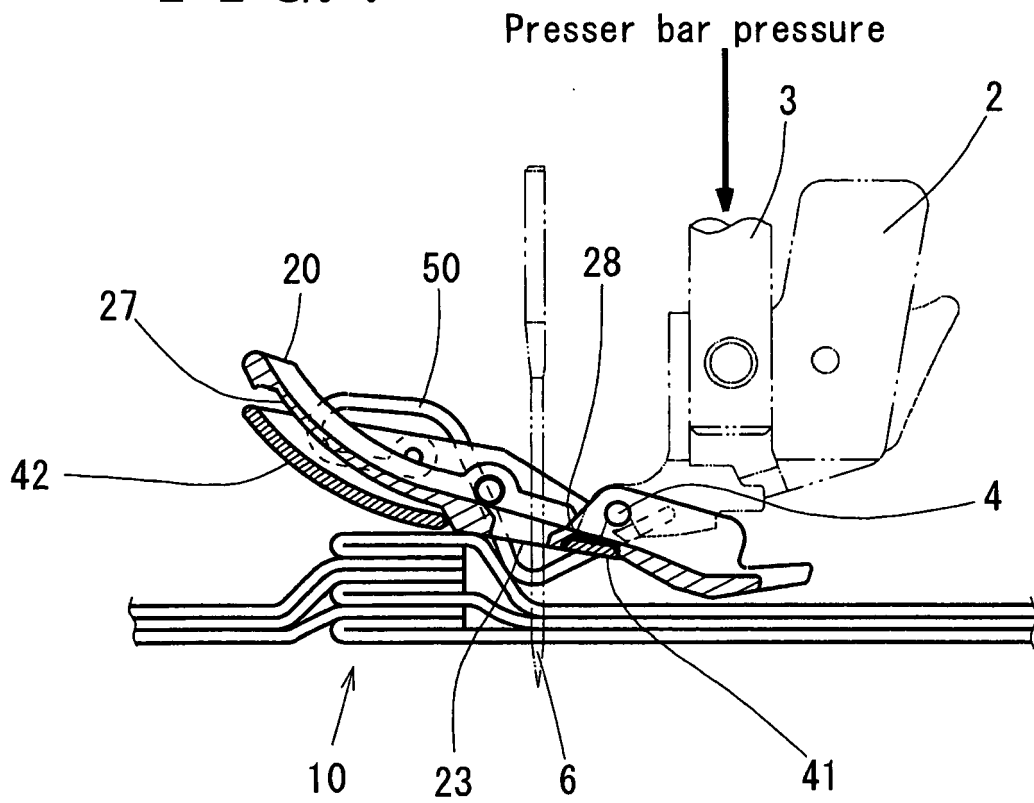


FIG. 8

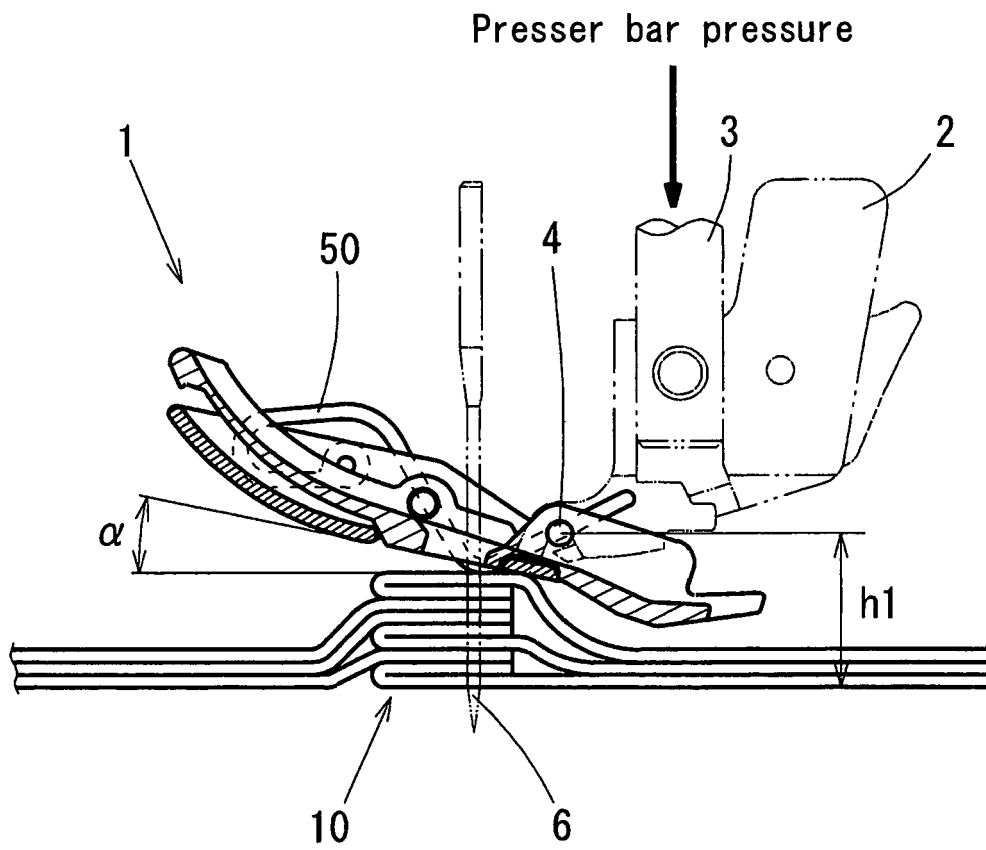


FIG. 9

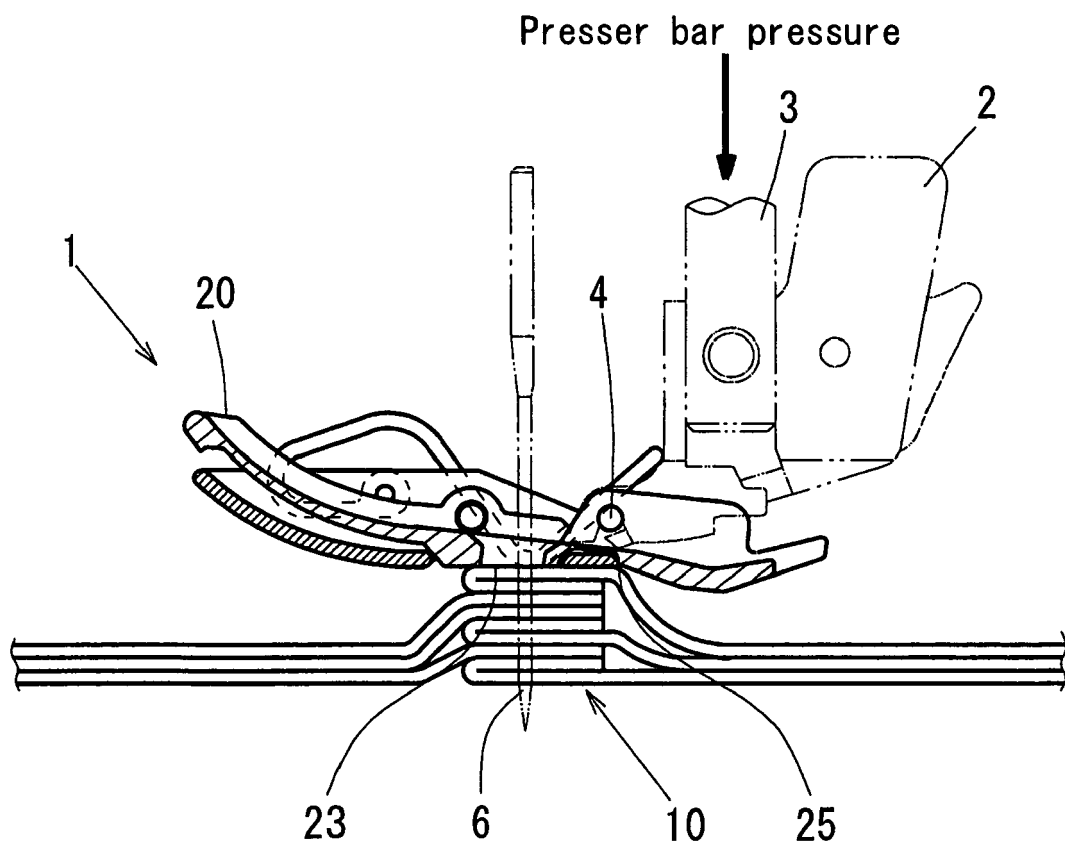


FIG. 10

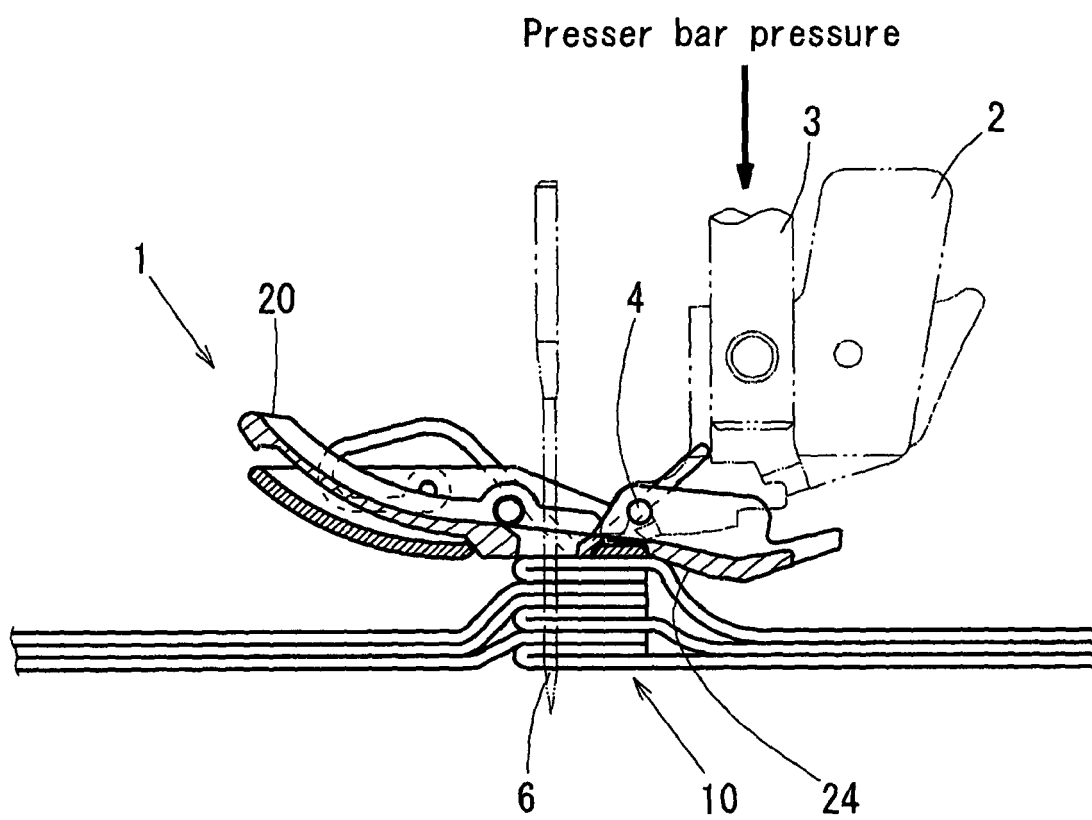


FIG. 11

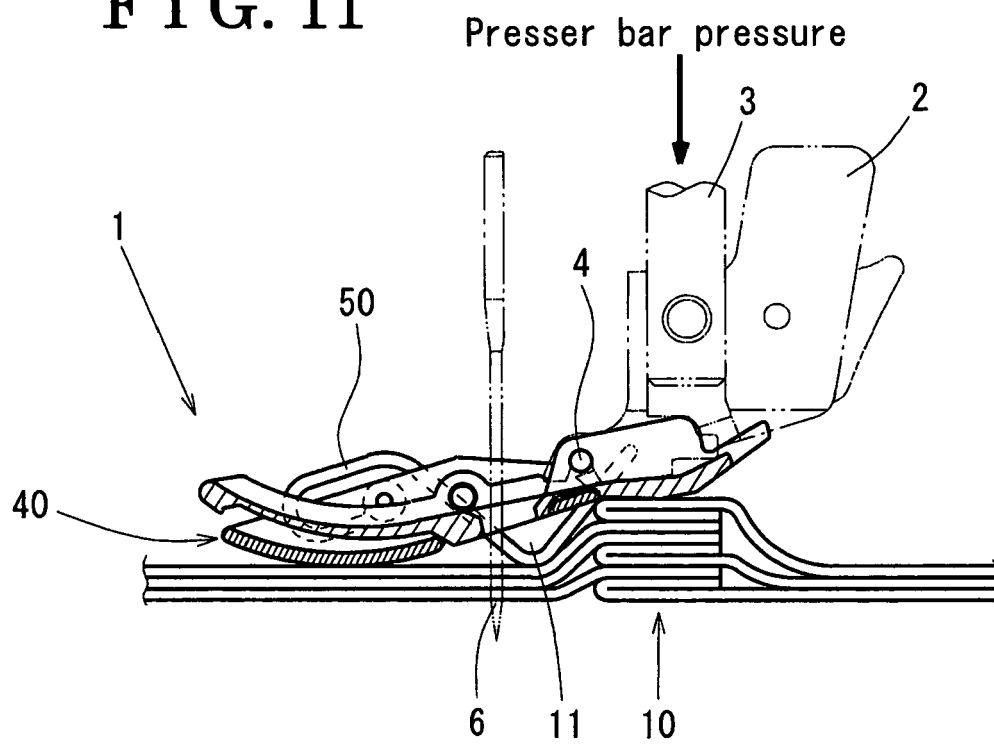


FIG. 12

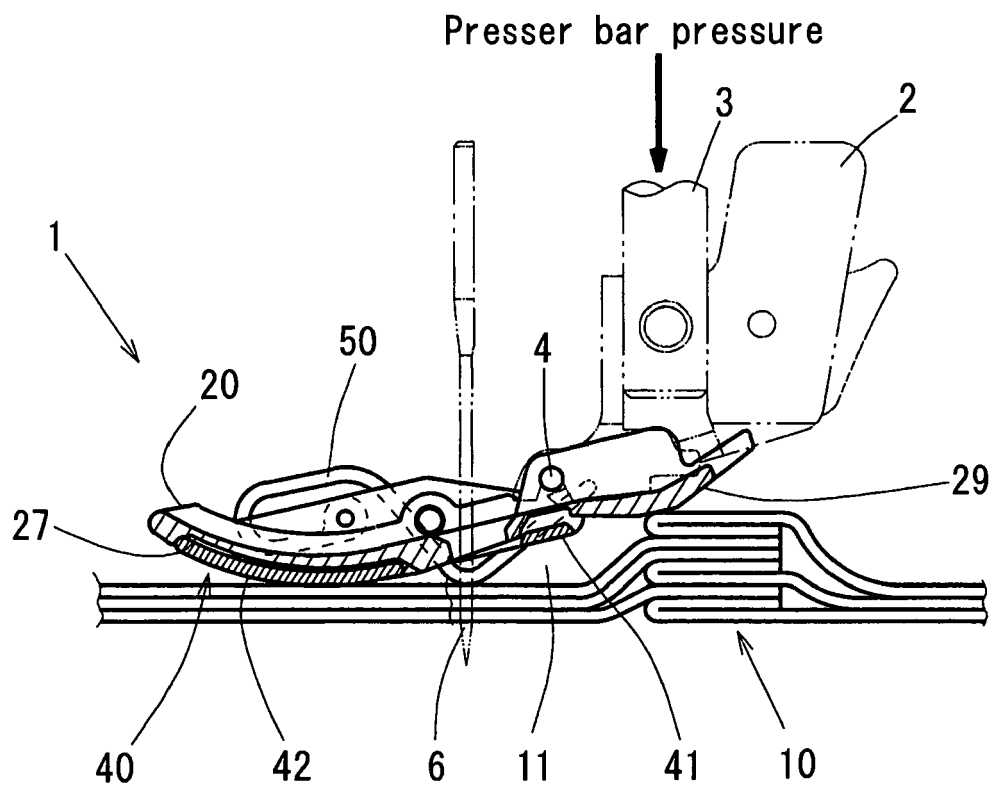


FIG. 13

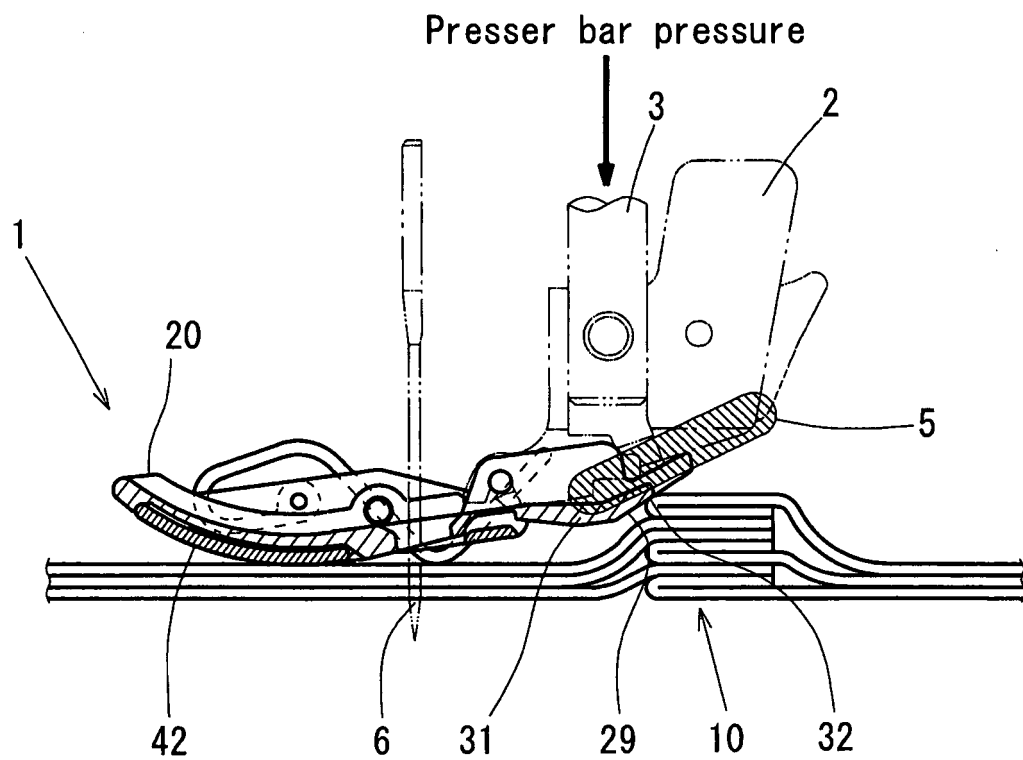


FIG. 14

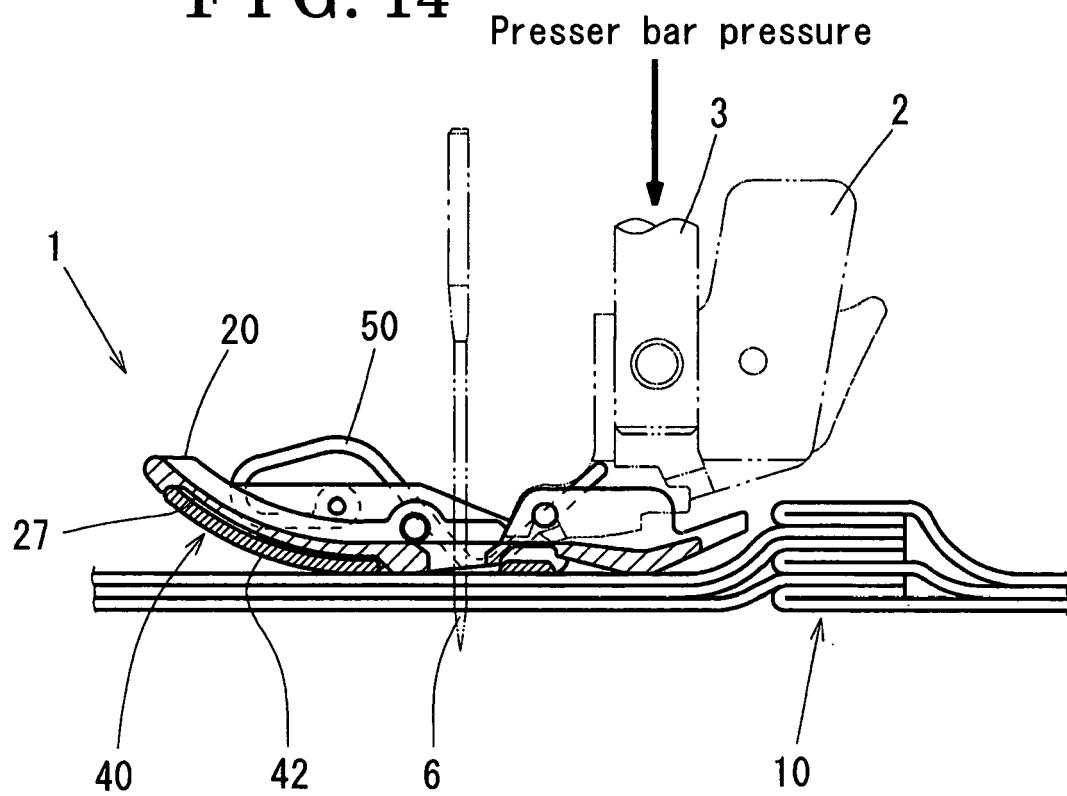


FIG. 15 A

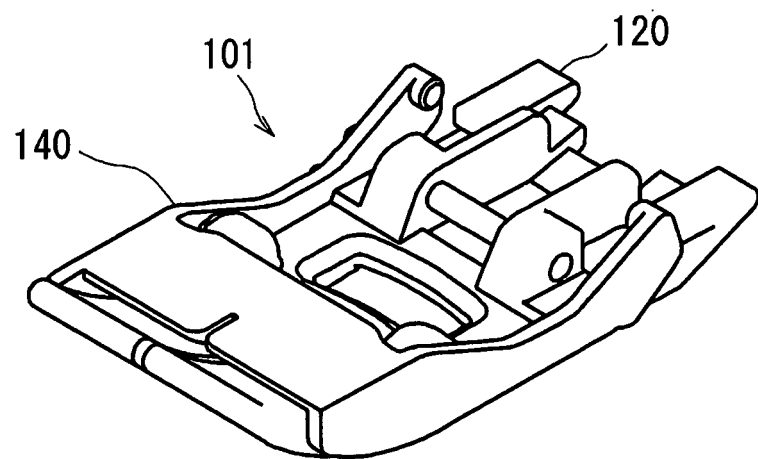


FIG. 15 B

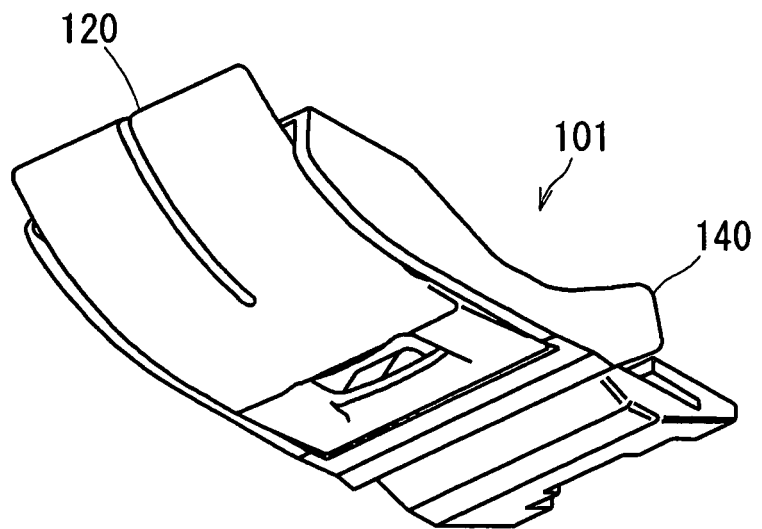


FIG. 16 A

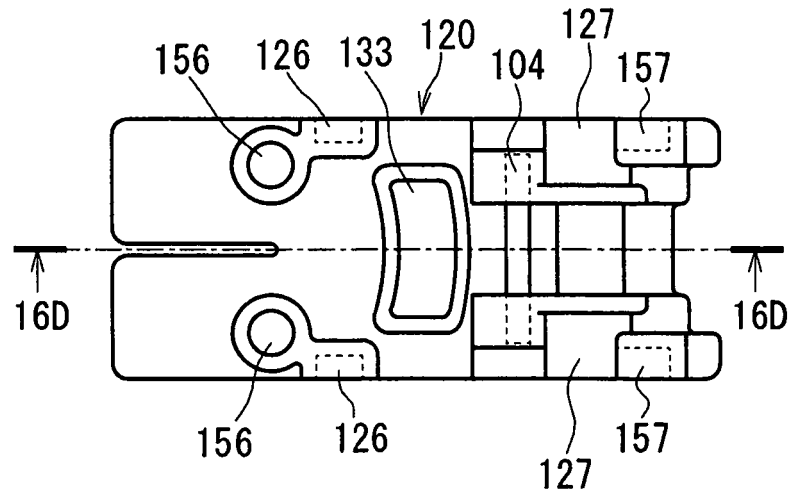


FIG. 16 B

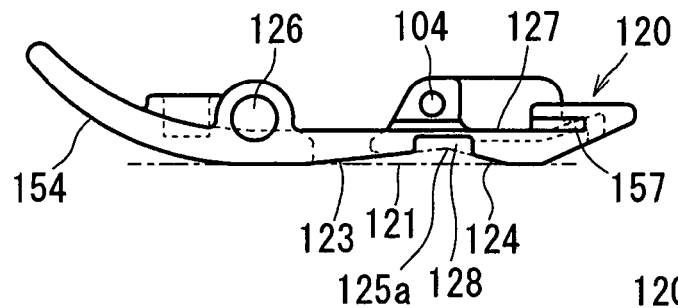


FIG. 16 C

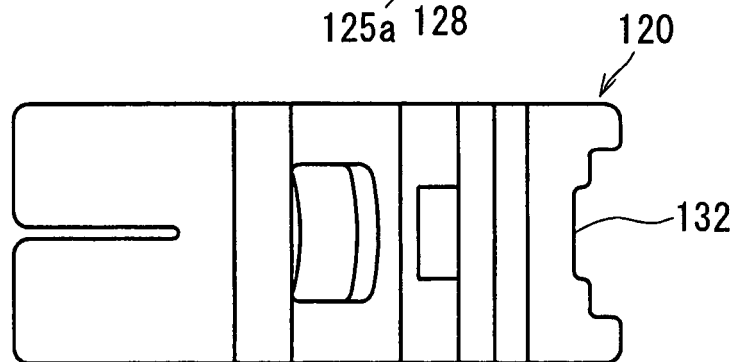


FIG. 16 D

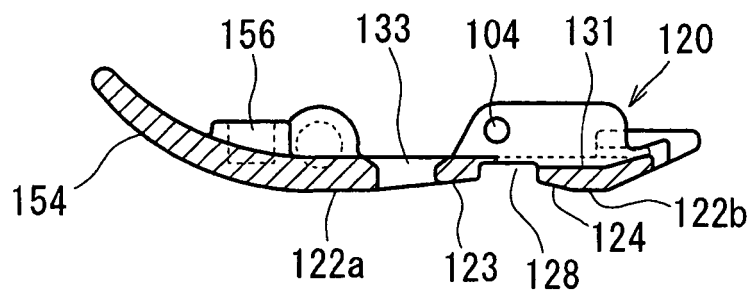


FIG. 17 A

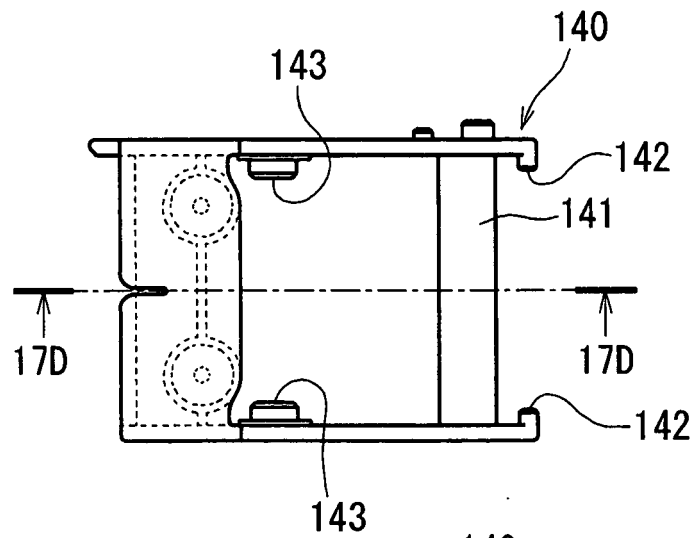


FIG. 17 B

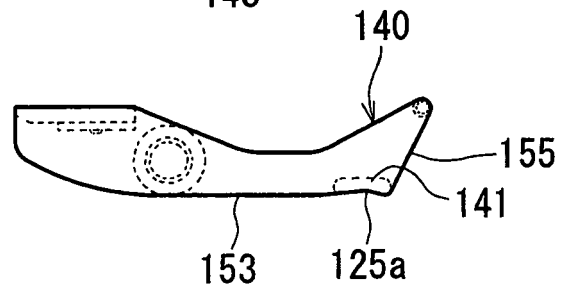


FIG. 17 C

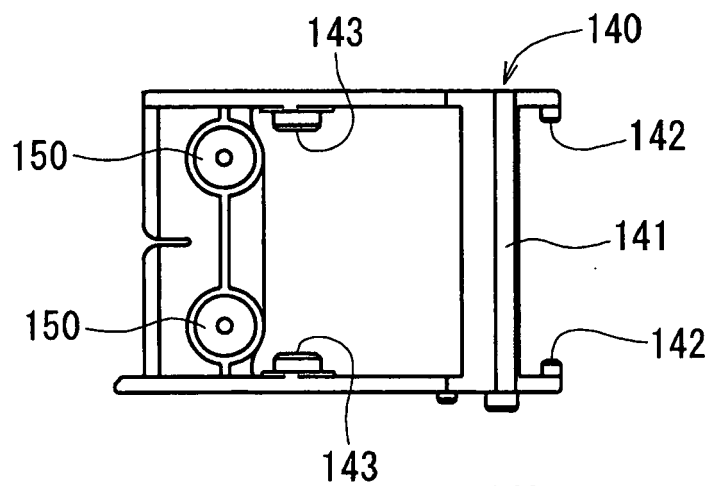


FIG. 17 D

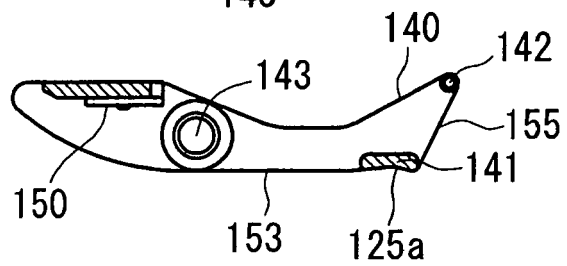


FIG. 18 A

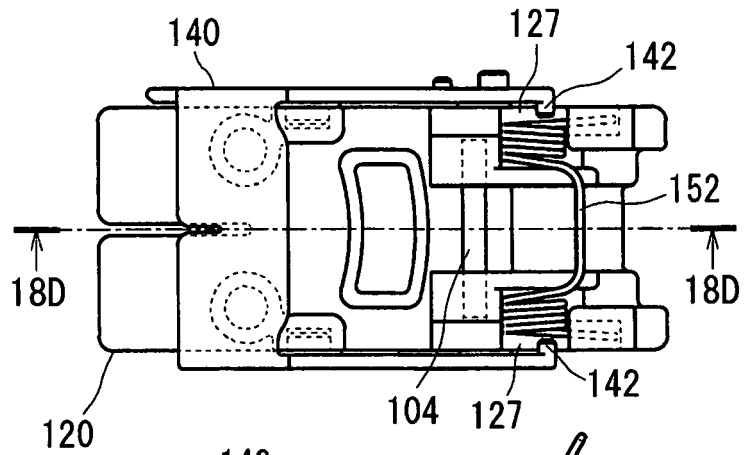


FIG. 18 B

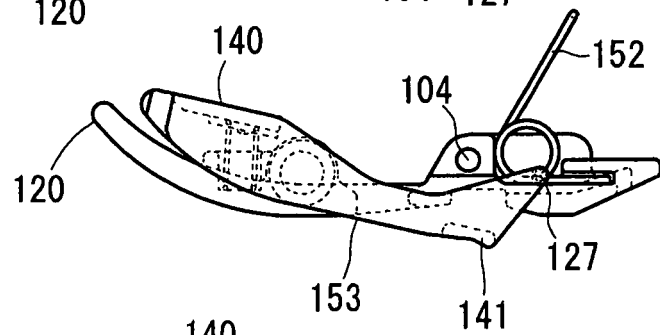


FIG. 18 C

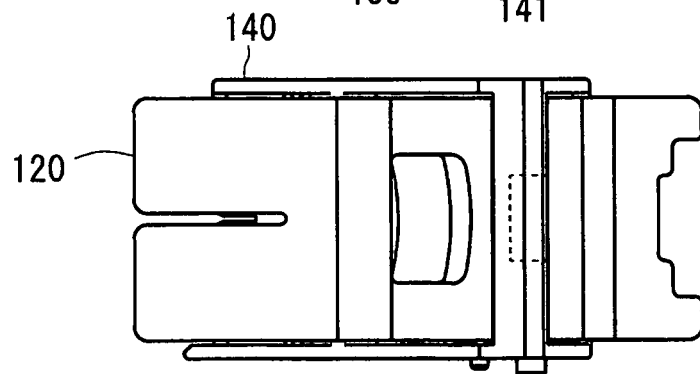


FIG. 18 D

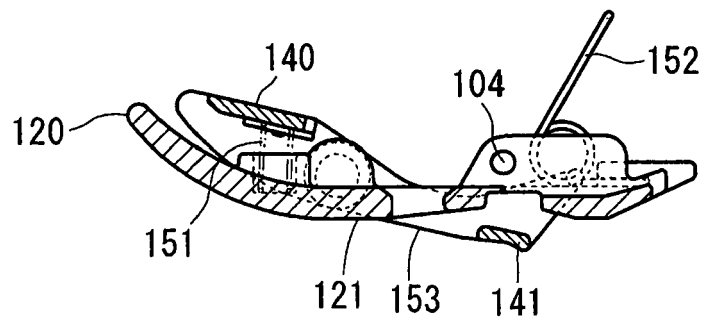


FIG. 19

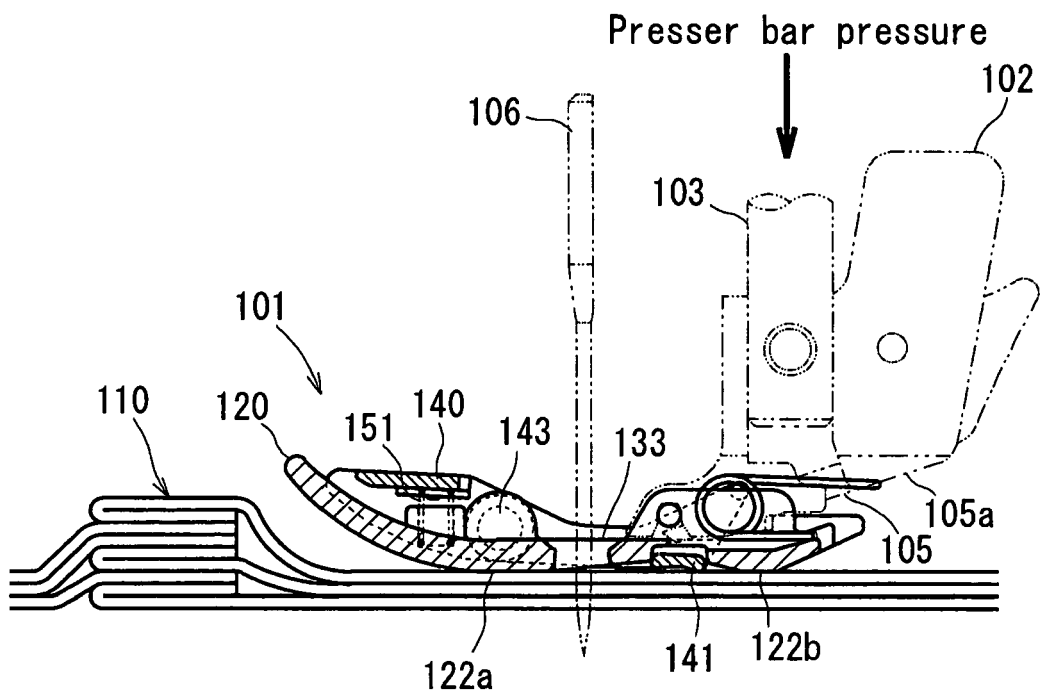


FIG. 20

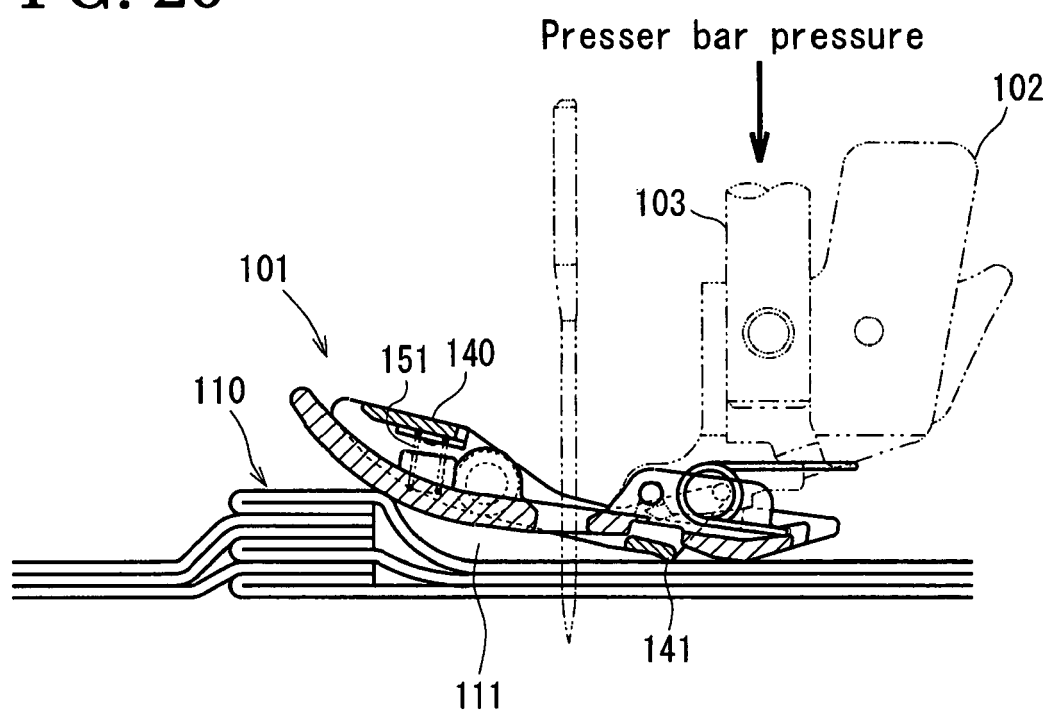


FIG. 21

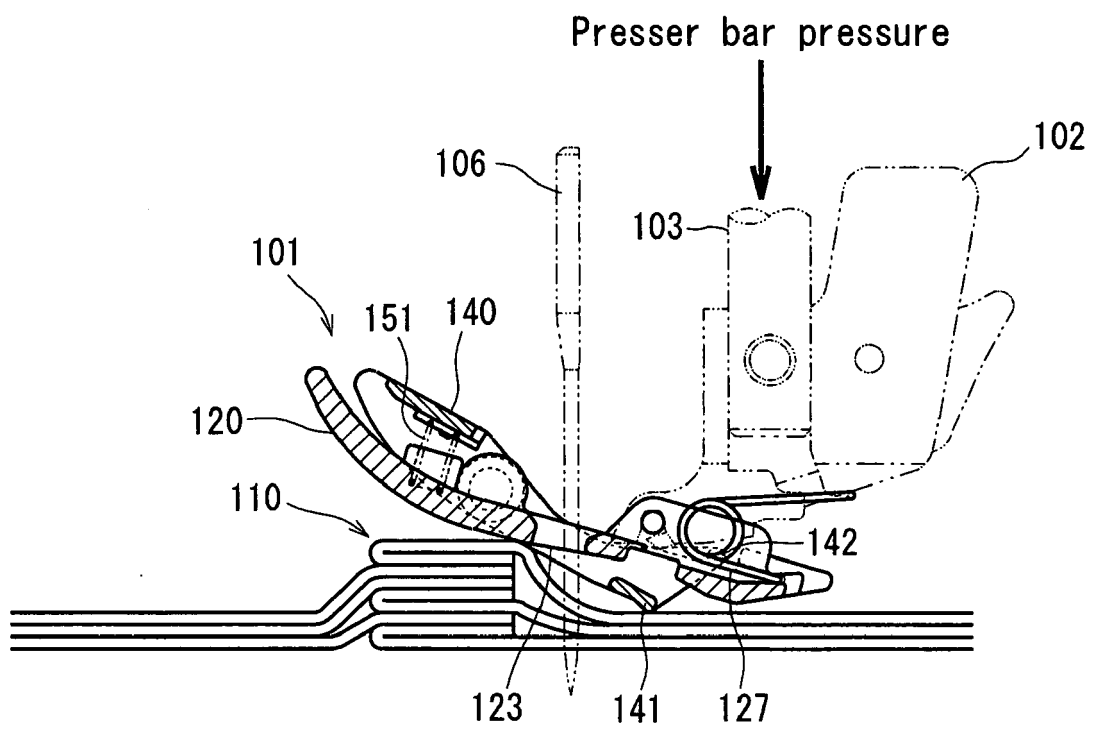


FIG. 22

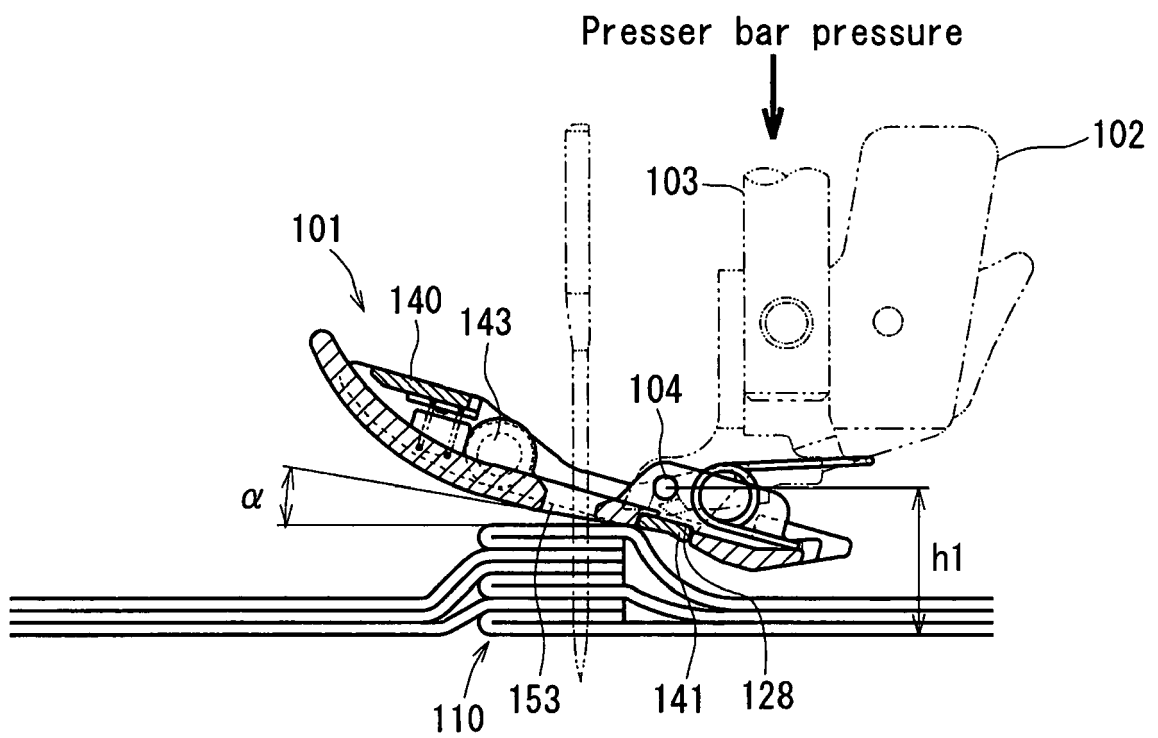


FIG. 23

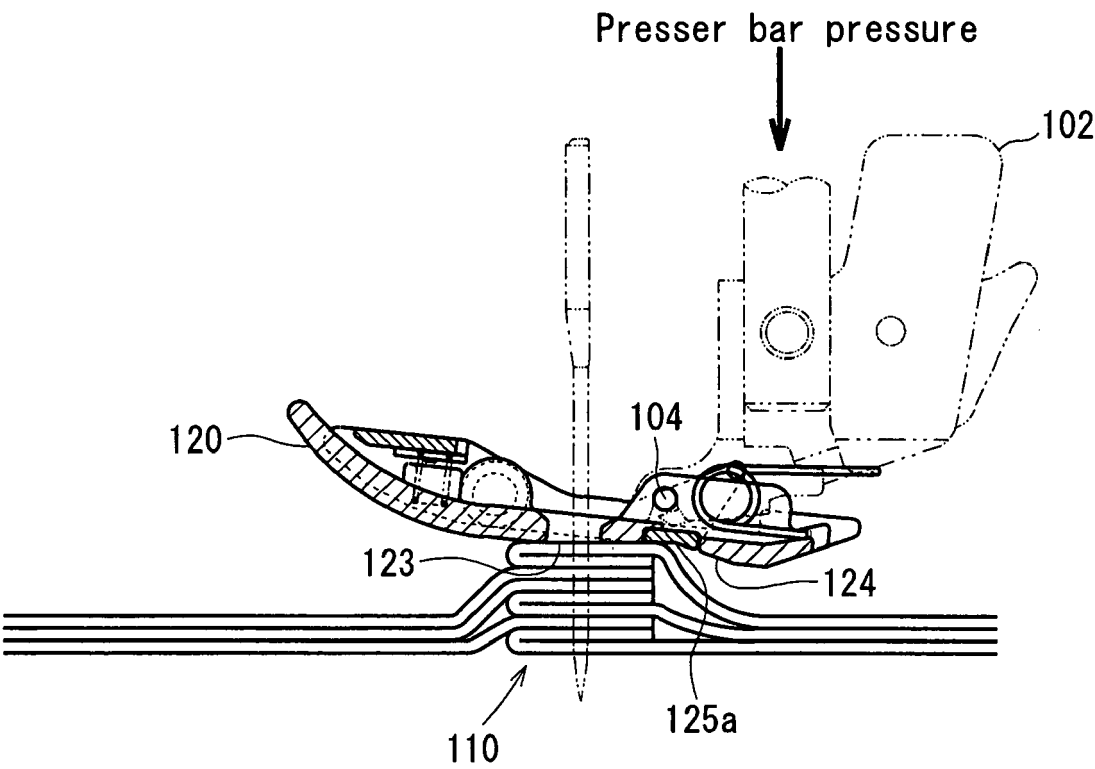


FIG. 24

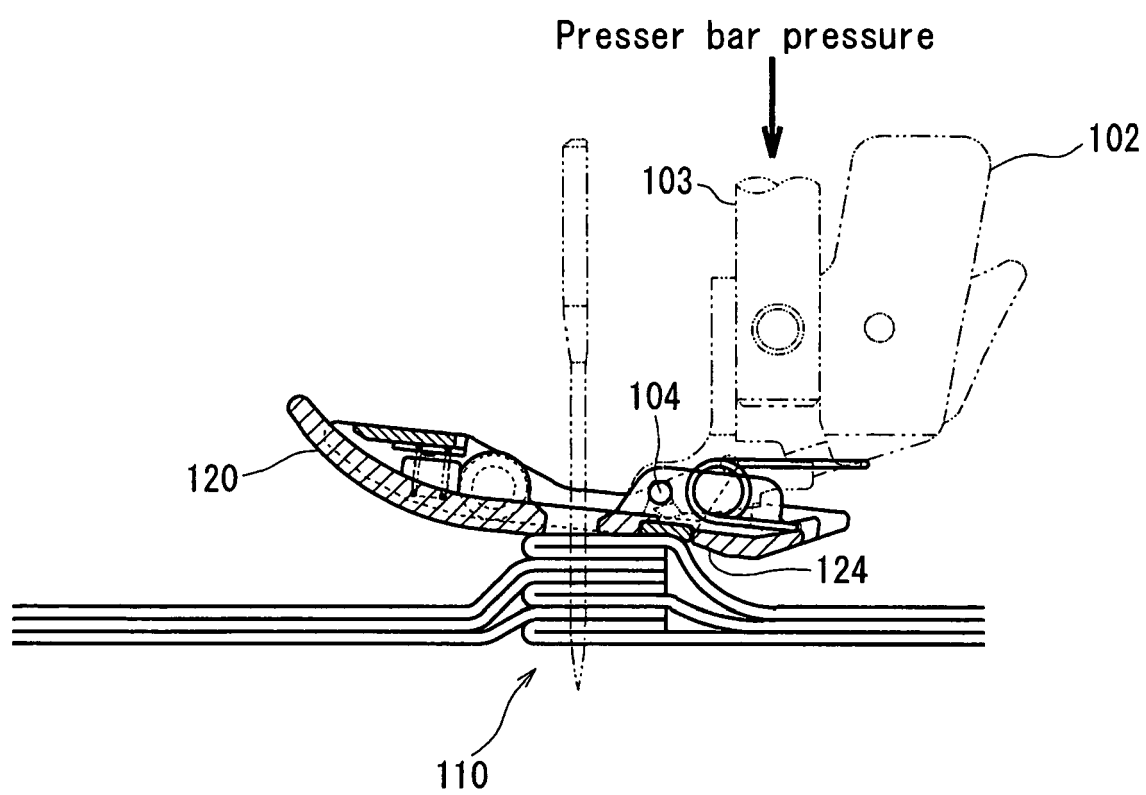


FIG. 25

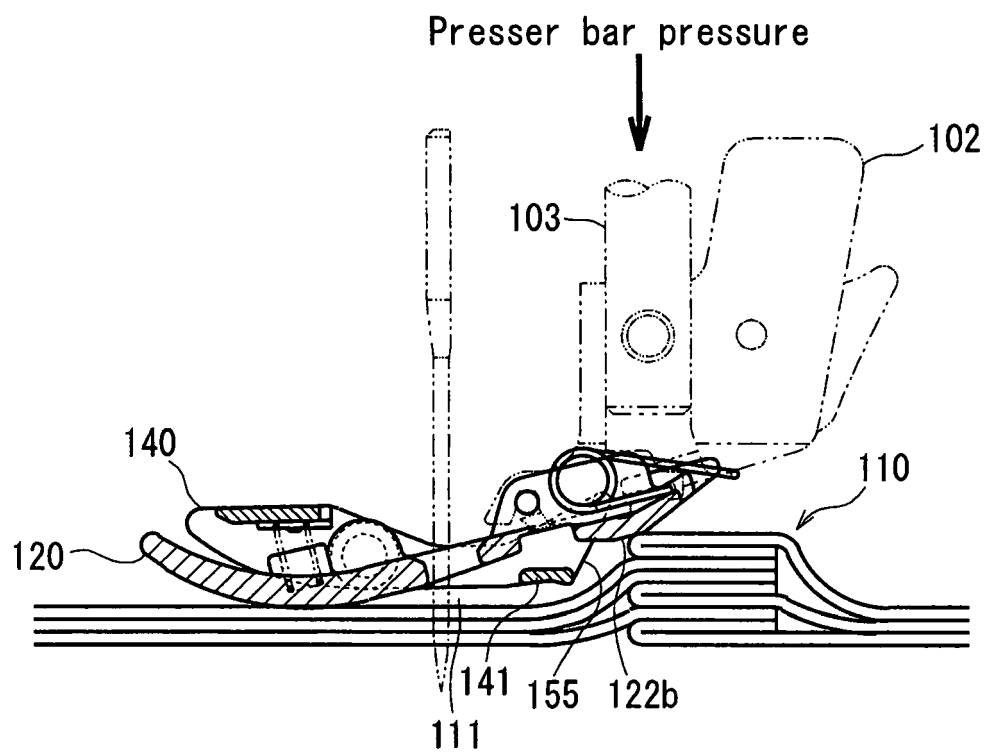


FIG. 26

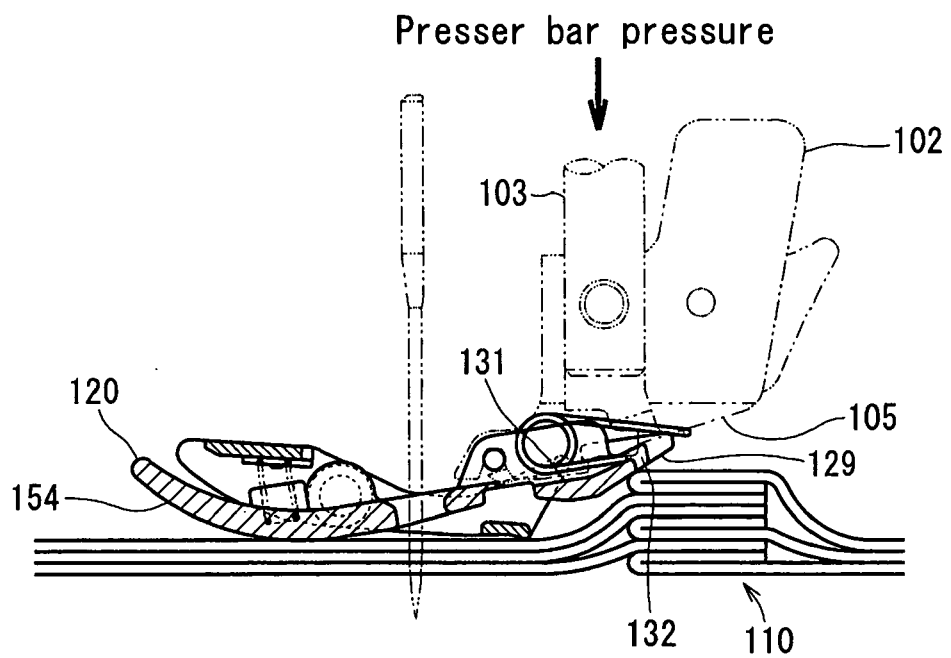


FIG. 27

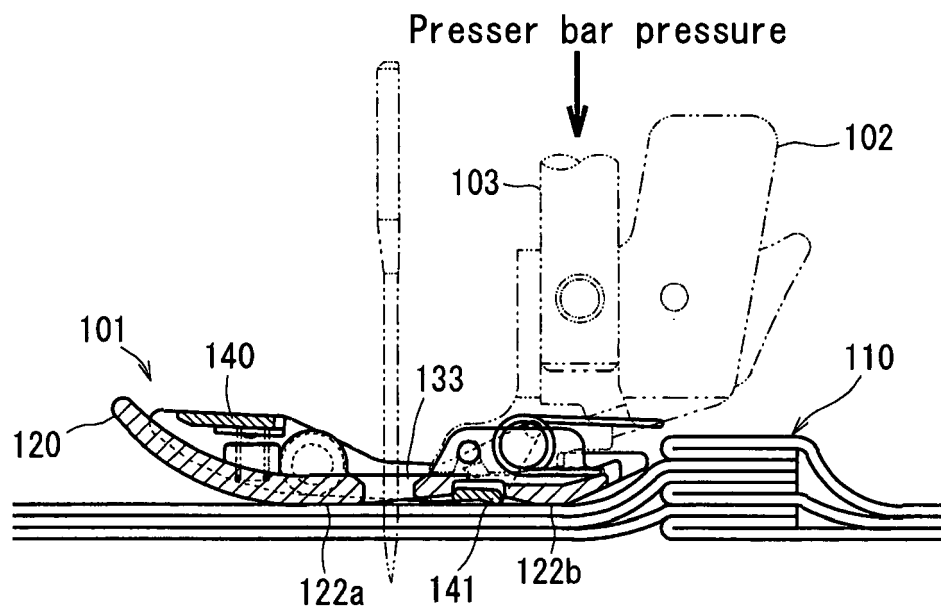


FIG. 28 A

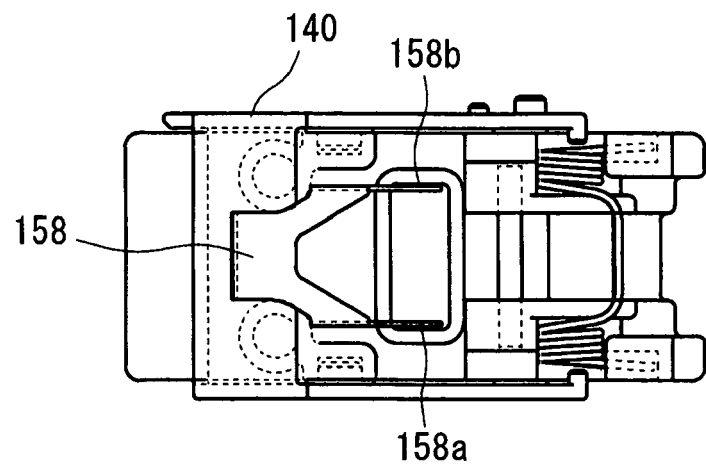


FIG. 28 B

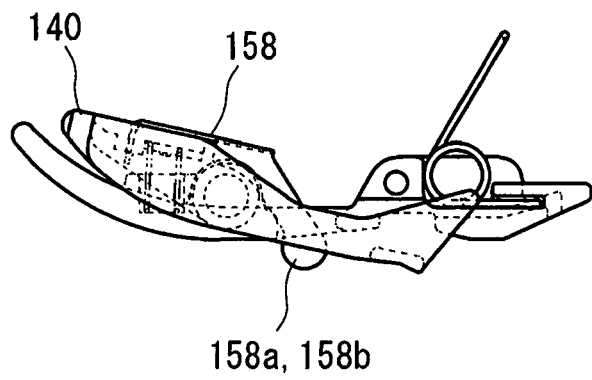


FIG. 29

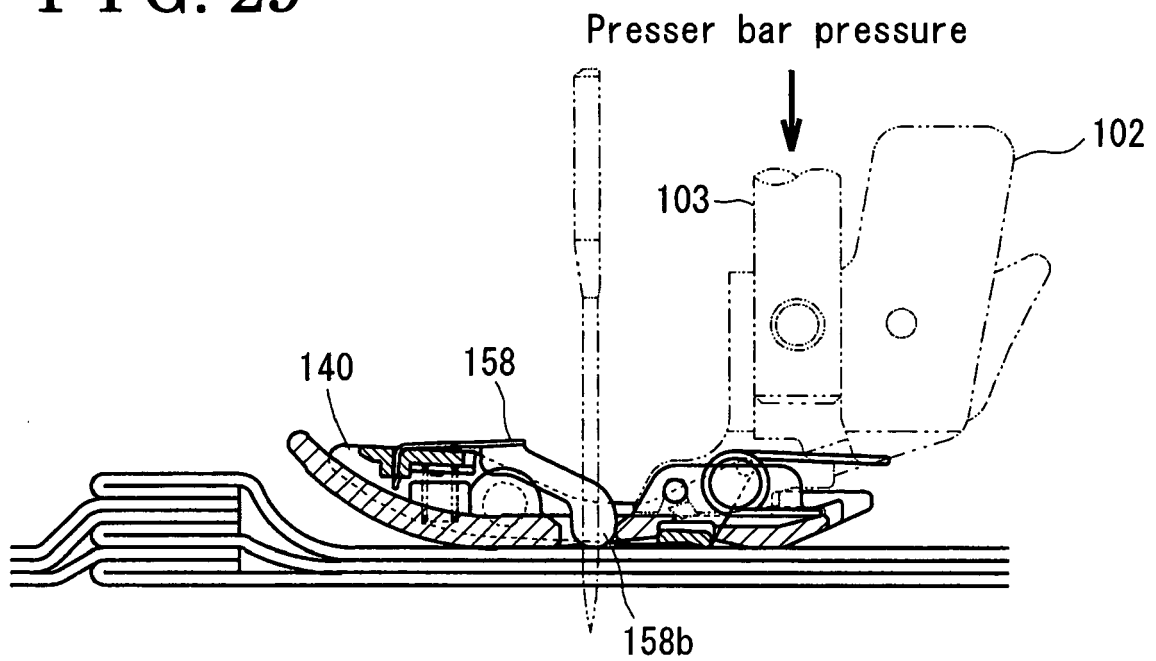


FIG. 30

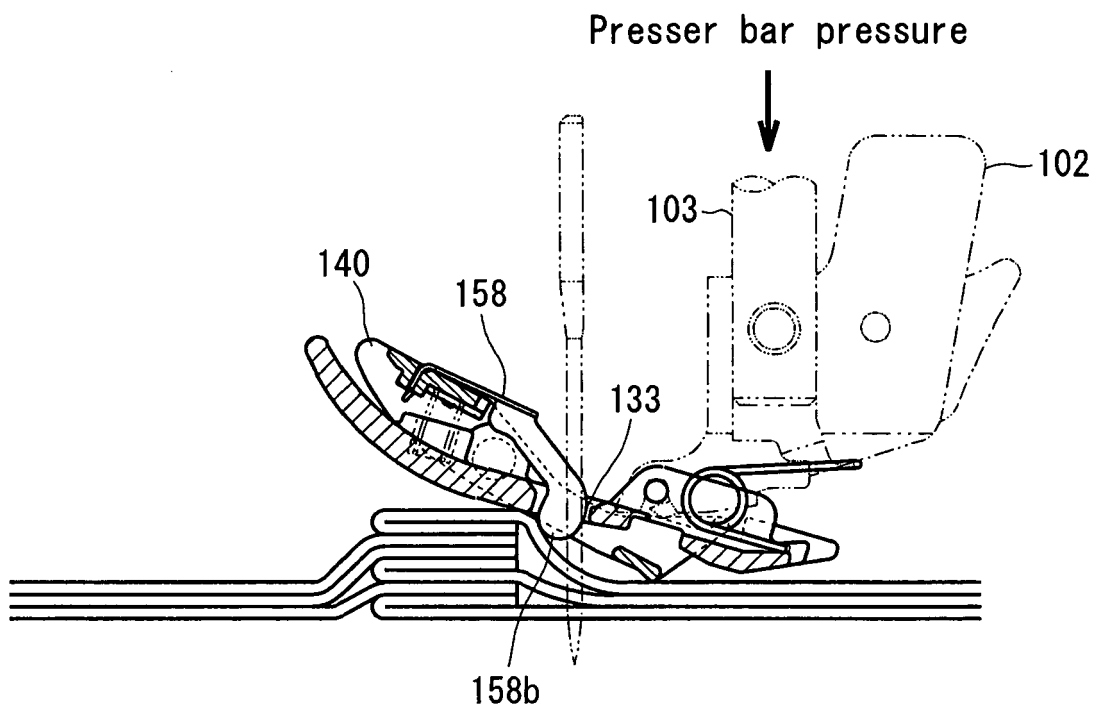
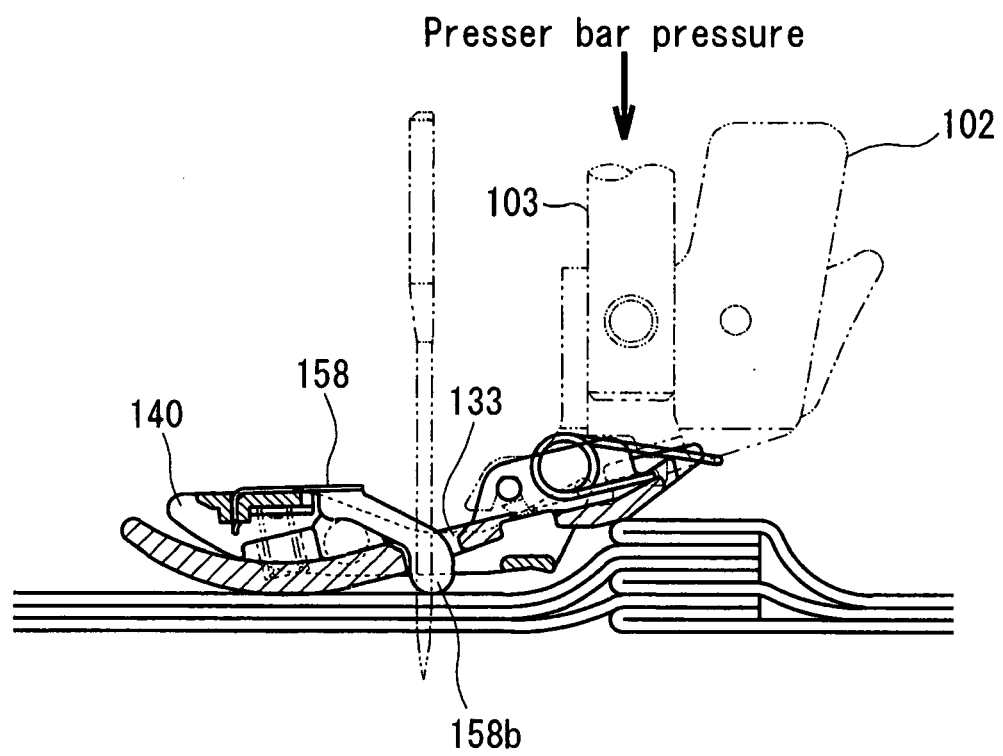


FIG. 31



F I G. 32 **Prior Art**

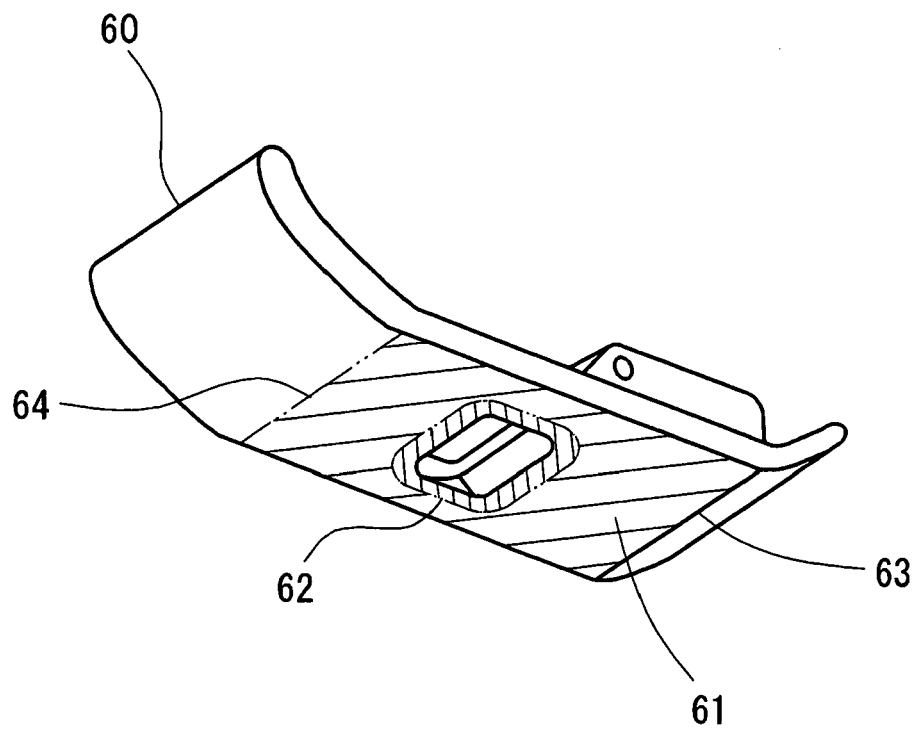
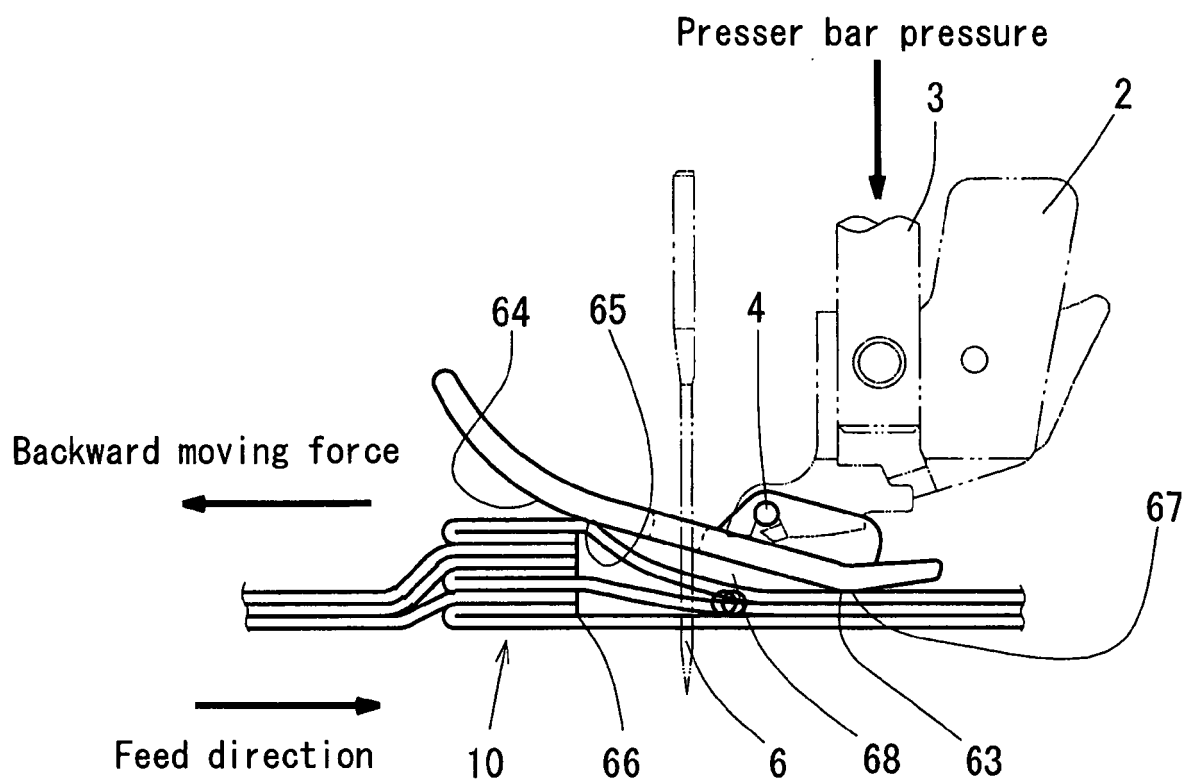


FIG. 33

Prior Art



F I G. 34 Prior Art

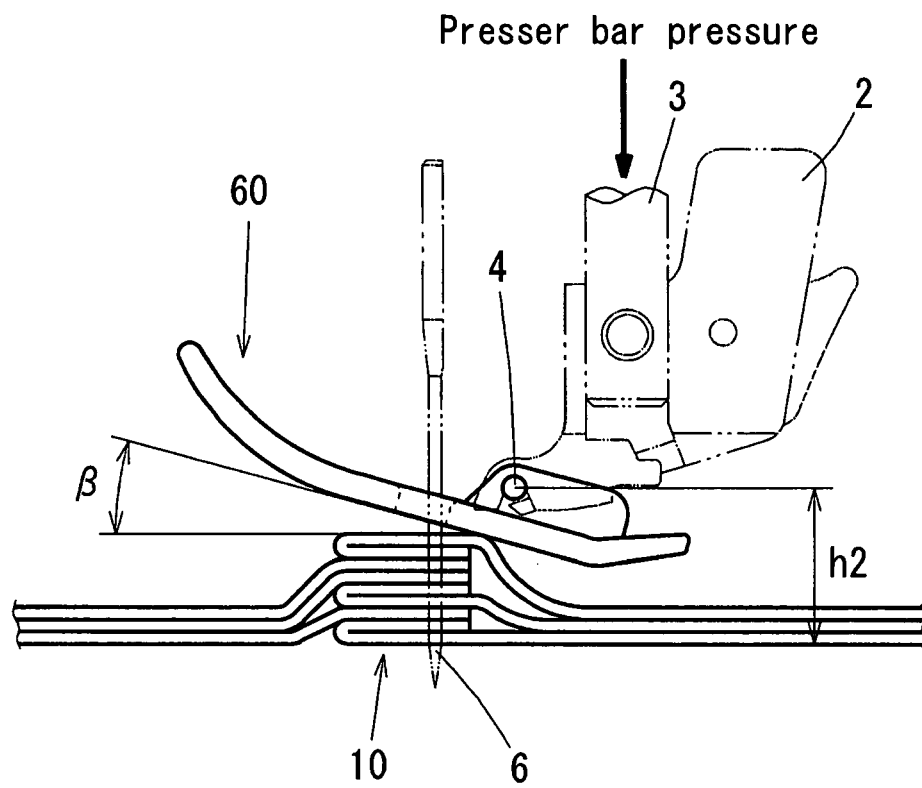
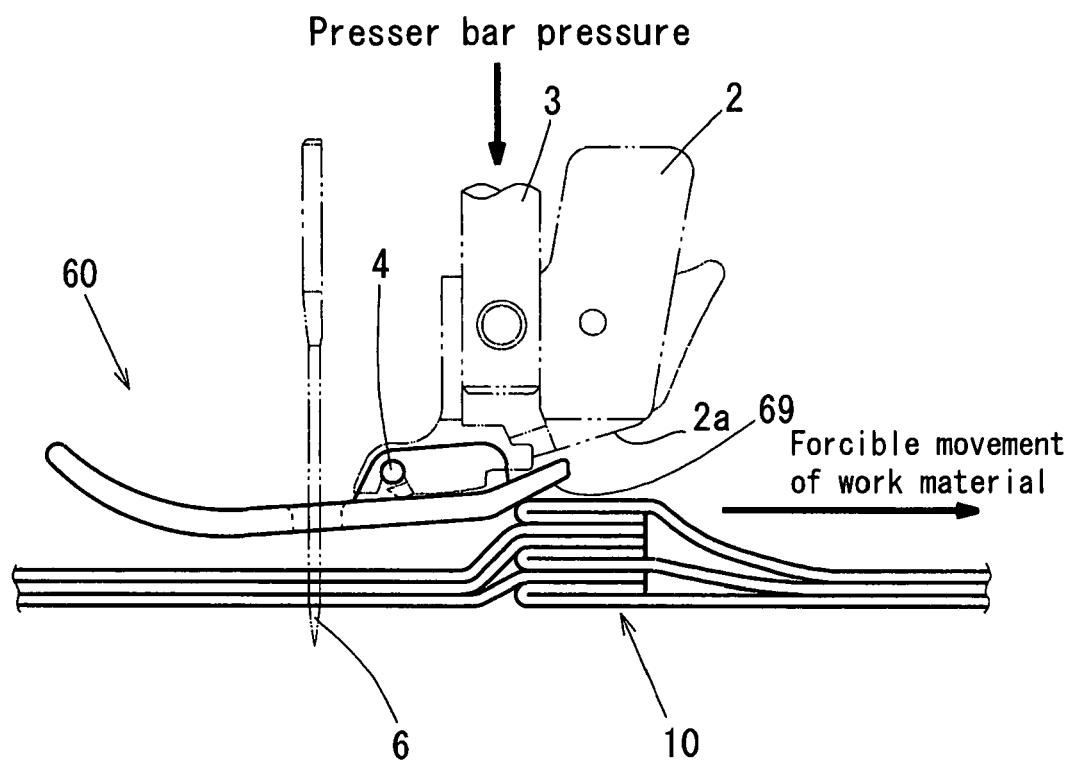


FIG. 35 Prior Art



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- JP 8141251 A [0006]
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