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(54) **Metal sheet bending unit, particularly for forming lips**

(57) A metal sheet bending unit (3), particularly for forming lips (65), has a frame (10) for supporting a metal sheet (19), and a blankholder member (24) movable with respect to the frame (10) between a closed and an open position; the unit (3) also has a bending blade (50), which is movable against a lip (65) of the metal sheet (19) to bend the lip (65), in use, while the metal sheet (19) is held in a fixed position by the blankholder member (24); and the blankholder member (24) and the blade (50) are moved back and forth by respective cam and tappet devices (34, 57), the cams (36, 61) of which are fitted in fixed positions to the same powered transmission shaft (4).

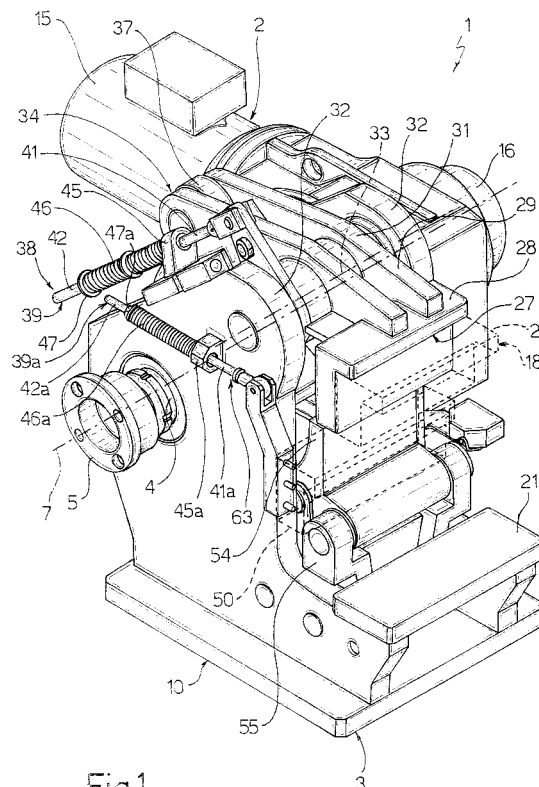


Fig.1

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## Description

**[0001]** The present invention relates to a metal sheet bending unit, particularly for forming projecting end lips on metal sheets forming part of vehicle doors, lids, or vehicle body parts in general.

**[0002]** Vehicle body parts are normally formed by means of a succession of pressing operations which, however, are not always effective when a lip on the end of the sheet is required. Moreover, any lip-forming operations call for a special-purpose press with a specific die, and are therefore relatively expensive and impair the flexibility of the production line.

**[0003]** Such lips can also be formed by bending, using known bending machines in which the sheets are gripped and deformed by means of respective hydraulic actuators powered by a hydraulic system. Known bending machines of this type, however, are unsatisfactory on account of the hydraulic systems, on the one hand, being fairly difficult to control to achieve the required deformation speed and sheet bending angles, and, on the other, involving high maintenance cost which is reflected in overall bending cost. Moreover, the force exerted by the hydraulic actuators may vary, due to changes in the characteristics of the oil circulating in the system and/or oil leakage.

**[0004]** It is an object of the present invention to provide a metal sheet bending unit, particularly for forming lips, designed to provide a straightforward, low-cost solution to the above problems.

**[0005]** According to the present invention, there is provided a metal sheet bending unit, particularly for forming lips, characterized by comprising:

- a structure for supporting a said metal sheet;
- a first pressure member movable with respect to said structure between a closed position retaining a first portion of said metal sheet in a fixed position with respect to said structure, and an open position allowing said metal sheet to be moved freely to and from said structure;
- a second pressure member movable against a second portion of said metal sheet to bend, in use, said second portion while said first portion is retained in a fixed position by said first pressure member;
- first actuating means for moving said first pressure member between said closed and open positions; and
- second actuating means for moving said second pressure member;

said first and second actuating means comprising, respectively, first and second powered cam means synchronized with each other.

**[0006]** A non-limiting embodiment of the invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a view in perspective of a preferred embodiment of a metal sheet bending unit, particularly for forming lips, in accordance with the present invention;

Figures 2 to 4 show schematic side views, with parts removed for clarity, of the Figure 1 unit in three different operating positions;

Figures 5 and 6 show larger-scale views of two cams forming part of the Figure 1-4 unit.

**[0007]** Number 1 in Figure 1 indicates as a whole a bending machine comprising a motor reducer 2, and two bending units 3, only one of which is shown. Units 3 are identical and comprise respective transmission shafts 4, which are coaxial, are connected by a constant-velocity universal joint (shown partly), preferably a lamellar joint, and are powered by motor reducer 2 to rotate together about their axis 7.

**[0008]** For the sake of simplicity, reference is made in the following description to the assembly shown, comprising motor reducer 2 and one of units 3.

**[0009]** Unit 3 comprises a steel supporting frame 10, which is defined by a number of electrowelded plates, is fixed to a base (not shown), e.g. by means of screws, and supports shaft 4 hinged with the interposition of bearings for supporting relatively severe radial loads. Shaft 4 is rotated by motor reducer 2, which is also fixed to the base, and comprises an electric "self-braking" motor 15, preferably with an electromagnetic brake, and a reducer 16 interposed between motor 15 and shaft 4.

**[0010]** With reference to Figures 1 to 4, frame 10 supports a gripping device 18 for retaining a metal sheet 19, for bending, in a fixed position. Device 18 comprises a supporting member or so-called supporting cradle 20, which is fixed releasably, e.g. by screws (not shown), to a horizontal front plate 21 of frame 10, and defines a contoured top surface 22 for supporting a complementary intermediate portion 23 of metal sheet 19.

**[0011]** Device 18 also comprises a blankholder member or so-called die 24 comprising two opposite end portions 25, 26; portion 25 is housed inside a seat 27 defined by an L-shaped supporting member 28, and is fixed releasably, e.g. by screws, to member 28; and portion 26 is shaped externally to clamp portion 23 against surface 22, without permanently deforming metal sheet 19.

**[0012]** Member 28 is integral with the end of a lever 29, which comprises an intermediate portion 31 hinged to two top end portions 32 of frame 10 to oscillate back and forth about an axis 33, parallel to axis 7, under the control of a cam and tappet actuating device 34.

**[0013]** Device 34 comprises a disk 35 fitted in a fixed position to shaft 4 and defined radially by a contoured outer annular surface defining a cam 36, along which rolls a tappet member or cam follower defined by a roller 37 hinged to lever 29, at the opposite end to member 28.

**[0014]** With reference to Figure 1, roller 37 is forced radially against cam 36 by a device 38 comprising a rod

39, which extends perpendicularly to axis 7 and in turn comprises two opposite end portions 41, 42. Portion 41 is hinged to lever 29 at a fixed point eccentric with respect to axis 33; whereas portion 42 extends through an appendix 45 integral with frame 10, and slides inside appendix 45 under the elastic action of a preloaded spiral spring 46, which is fitted to rod 39 and interposed between appendix 45 and a nut 47 screwed to the free end of portion 42.

**[0015]** With reference to Figures 2 to 4, unit 3 also comprises a bending blade 50 in turn comprising two opposite end portions 51, 52. Portion 51 is fixed releasably, e.g. by screws, to the end of a supporting carriage 54, while portion 52 projects towards cradle 20.

**[0016]** Carriage 54 is housed inside frame 10 in an intermediate position between cradle 20 and shaft 4, and is connected to frame 10 by an articulated parallelogram lever mechanism 55 to move back and forth, in a plane perpendicular to axis 7, under the control of a cam and tappet actuating device 57. Device 57 comprises a disk 58, which is fitted in a fixed position to shaft 4, is preferably formed in one piece with disk 35 to form a single body 60, and is defined radially by a contoured outer annular surface defining a cam 61, along which rolls a tappet member or cam follower defined by a roller 62 hinged to carriage 54, at the opposite end to blade 50.

**[0017]** With reference to Figures 2 to 4, roller 62 contacts cam 61 at a point substantially aligned with axis 7 and portion 52, and is forced radially against cam 61 by a device 63, which is interposed between carriage 54 and frame 10, is similar to device 38, and is not described in detail. More specifically, in Figure 1, the component parts of device 63 are indicated using the same reference numbers as for device 38, followed by the letter "a".

**[0018]** An operating cycle of unit 3 will now be described as of the rest position shown in Figure 2, in which rollers 37, 62 rest on respective constant-radius sectors 70a, 70b (Figures 5 and 6) of cams 36, 61; die 24 is in a fully open position allowing sufficient clearance to place metal sheet 19 on surface 22; and carriage 54 is in a fully withdrawn position adjacent to shaft 4.

**[0019]** When shaft 4 is rotated (clockwise in Figures 2 to 6), roller 37 rolls along an increasing-radius sector 71a of cam 36, which rotates lever 29 (clockwise) and so moves die 24 down into a fully closed position in which portion 23 is clamped against surface 22 (Figure 3). At the same time, roller 62 begins rolling along an increasing-radius sector 71b of cam 61, which causes carriage 54 to make a first shift towards cradle 20 along a substantially straight path defined by lever mechanism 55.

**[0020]** On reaching the end of sector 71a, roller 37 rolls along a constant-radius sector 72a of cam 36, which keeps die 24 in the closed position; while roller 62 begins rolling along an increasing-radius sector 72b of cam 61, which causes carriage 54 to make a second shift towards die 24, at a slower speed than that imposed

by sector 71b. During the second shift, portion 52 of blade 50 first comes into contact with a lip 65 projecting from portion 23 of metal sheet 19, and then pushes lip 65 onto an opposing surface 66 defining die 24, while portion 23 is still clamped, so as to bend metal sheet 19 by a predetermined angle along a bend line extending between lip 65 and portion 23 and parallel to axis 7 (Figure 4).

**[0021]** On reaching the end of sector 72b, roller 62 rolls along a constant-radius sector 73b, which keeps carriage 54 in a fully forward position in which lip 65 remains on opposing surface 66 to keep lip 65 bent for a given length of time with portion 23 still clamped by die 24.

**[0022]** Roller 62 then rolls along a decreasing-radius sector 74b back to sector 70b to allow carriage 54 to withdraw completely; while roller 37, on reaching the end of sector 72a, rolls along a decreasing-radius sector 73a back to sector 70a to allow die 24 to withdraw into the open position.

**[0023]** At the end of the above cycle, motor 15 brakes automatically, so that the bent metal sheet 19 can be removed, and another metal sheet for bending can be loaded onto cradle 20.

**[0024]** Devices 34, 57 therefore provide for achieving, for both die 24 and blade 50, constant forces and speeds which remain unchanged between one operating cycle and the next, by comprising synchronized predetermined cam profiles which do not vary over time. Moreover, devices 34, 57 are fairly cheap to maintain, by being powered by an electric motor 15, with no hydraulic actuators.

**[0025]** Unit 3 also comprises a relatively small number of component parts, and is highly reliable, by die 24 and blade 50 being operated fully mechanically, with no complex electronic or other controls, by a single transmission shaft 4, which is rotated directly by a single motor reducer 2 and supports both cams 36, 61. By using a single shaft 4 supporting both cams 36, 61, slack between the component parts of unit 3 is also greatly reduced.

**[0026]** Besides being extremely compact, by virtue of both cams 36, 61 being fitted to shaft 4 and of the relative position of lever 29 and carriage 54, unit 3 is also extremely versatile, by being applicable to different types of metal sheet and different production lines. More specifically, cradle 20, die 24, and blade 50 can be selected from a number of different types, depending on the shape and type of metal sheet for bending, and cams 36, 61 can be selected from a number of different profiles, depending on the thickness and strength of the material for bending.

**[0027]** As regards device 18, portion 23 can be kept in the clamped position to simultaneously work metal sheet 19 on machines (not shown) adjacent to unit 3. Supporting die 24 by means of a rotary lever, i.e. lever 29, enables die 24 to be opened by moving portion 26 away from lip 65, without compromising the newly

formed bend.

**[0028]** Finally, relatively long lips can be formed on machine 1 by gripping and bending two spaced portions of the metal sheet using two in-line units 3. More specifically, joint 5 provides for transmitting torque between shafts 4 of the two units 3, and for perfectly synchronizing rotation of the two pairs of cams fitted to shafts 4.

**[0029]** Clearly, changes may be made to machine 1 and units 3 as described herein without departing from the scope of the present invention.

**[0030]** In particular, cams 36, 61 may differ from those illustrated, e.g. may be defined by contoured grooves as opposed to the outer surfaces of disks 35, 58, and/or may be operated synchronously by other than shaft 4 as described.

**[0031]** Moreover, member 28 and carriage 54 may be connected to frame 10 otherwise than as described, e.g. by means of guide devices.

## Claims

1. A metal sheet bending unit (3), particularly for forming lips (65), **characterized by** comprising:

- a structure (10) for supporting a said metal sheet (19) ;
- a first pressure member (24) movable with respect to said structure (10) between a closed position retaining a first portion (23) of said metal sheet (19) in a fixed position with respect to said structure (10), and an open position allowing said metal sheet (19) to be moved freely to and from said structure (10);
- a second pressure member (50) movable against a second portion (65) of said metal sheet (19) to bend, in use, said second portion (65) while said first portion (23) is retained in a fixed position by said first pressure member (24);
- first actuating means (4, 34, 29) for moving said first pressure member (24) between said closed and open positions; and
- second actuating means (4, 57) for moving said second pressure member (50);

said first (4, 34, 29) and second (4, 57) actuating means comprising, respectively, first (34) and second (57) powered cam means synchronized with each other.

2. A unit as claimed in Claim 1, **characterized by** also comprising a transmission (4) powered by a single motor (15); said first (34) and second (57) cam means both being operated, synchronously with each other, by said transmission (4).

3. A unit as claimed in Claim 2, **characterized in that**

said transmission (4) is defined by a transmission shaft (4); said first (34) and second (57) cam means respectively comprising a first (36) and a second (61) cam, which are carried by said transmission shaft (4) and connected to respective cam follower members (37, 62).

4. A unit as claimed in Claim 3, **characterized in that** said first (36) and said second (61) cam respectively define radially a first (35) and a second (58) disk, which are fitted to said transmission shaft (4) in fixed positions and spaced axially apart along the transmission shaft (4).

5. A unit as claimed in Claim 4, **characterized in that** said first (35) and said second (58) disk form part of a one-piece body (60).

6. A unit as claimed in Claim 4 or 5, **characterized by** comprising a first (28) and a second (54) supporting body, which are fitted to said structure (10) to move in planes perpendicular to said transmission shaft (4) under the control of said first (36) and said second (61) cam respectively; said first (24) and said second (50) pressure member being connected integrally to the ends of said first (28) and said second (54) supporting body respectively.

7. A unit as claimed in Claim 6, **characterized in that** said cam follower members (37, 62) are carried by said first (28) and said second (54) supporting body, and are angularly spaced about said transmission shaft (4).

8. A unit as claimed in Claim 7, **characterized in that** said first supporting body (28) forms part of a lever (29) hinged to said structure (10) about an axis (33) parallel to said transmission shaft (4).

9. A unit as claimed in Claim 7 or 8, **characterized in that** said second supporting body (54) forms part of a carriage (54) connected to said structure (10) by an articulated parallelogram lever mechanism (55).

10. A unit as claimed in any one of Claims 7 to 9, **characterized by** comprising elastic forcing means (38, 63) interposed between said structure (10) and said supporting bodies (28, 54) to force said cam follower members (37, 62) radially against the respective said first (36) and second (61) cam.

11. A unit as claimed in any one of Claims 4 to 10, **characterized in that** said first cam (36) comprises a constant-radius hold portion (72a) for keeping said first pressure member (24) in the closed position; and **in that** said second cam (61) comprises a variable-radius bend portion (72b) for bending said second portion (65) of the metal sheet (19) by

means of said second pressure member (50); said bend portion (72b) beginning to cooperate with the relative cam follower member (62) when said hold portion (72a) is already cooperating with the relative cam follower member (37).

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12. A unit as claimed in Claim 11, **characterized in that** said second cam (61) also comprises a variable-radius approach portion (71b) for moving said second pressure member (50) towards the second portion (65) of said metal sheet (19); said approach portion (71b) imposing a faster speed on the relative cam follower member (62) than said bend portion (72b). 10
13. A unit as claimed in Claim 11 or 12, **characterized in that** said second cam (61) comprises a constant-radius hold portion (73b) downstream from said bend portion (72b) and corresponding to a limit position of said second pressure member (50). 15 20
14. An assembly comprising a unit (3) as claimed in any one of the foregoing Claims, and a motor (15) for powering said unit (3); said motor (15) being a self-braking type. 25
15. A bending machine (1) comprising two identical units (3) as claimed in any one of Claims 2 to 13; a constant-velocity universal joint (5) for transmitting motion from one transmission to the other (4) of the two said units (3); and a single motor (15) powering said transmissions (4). 30

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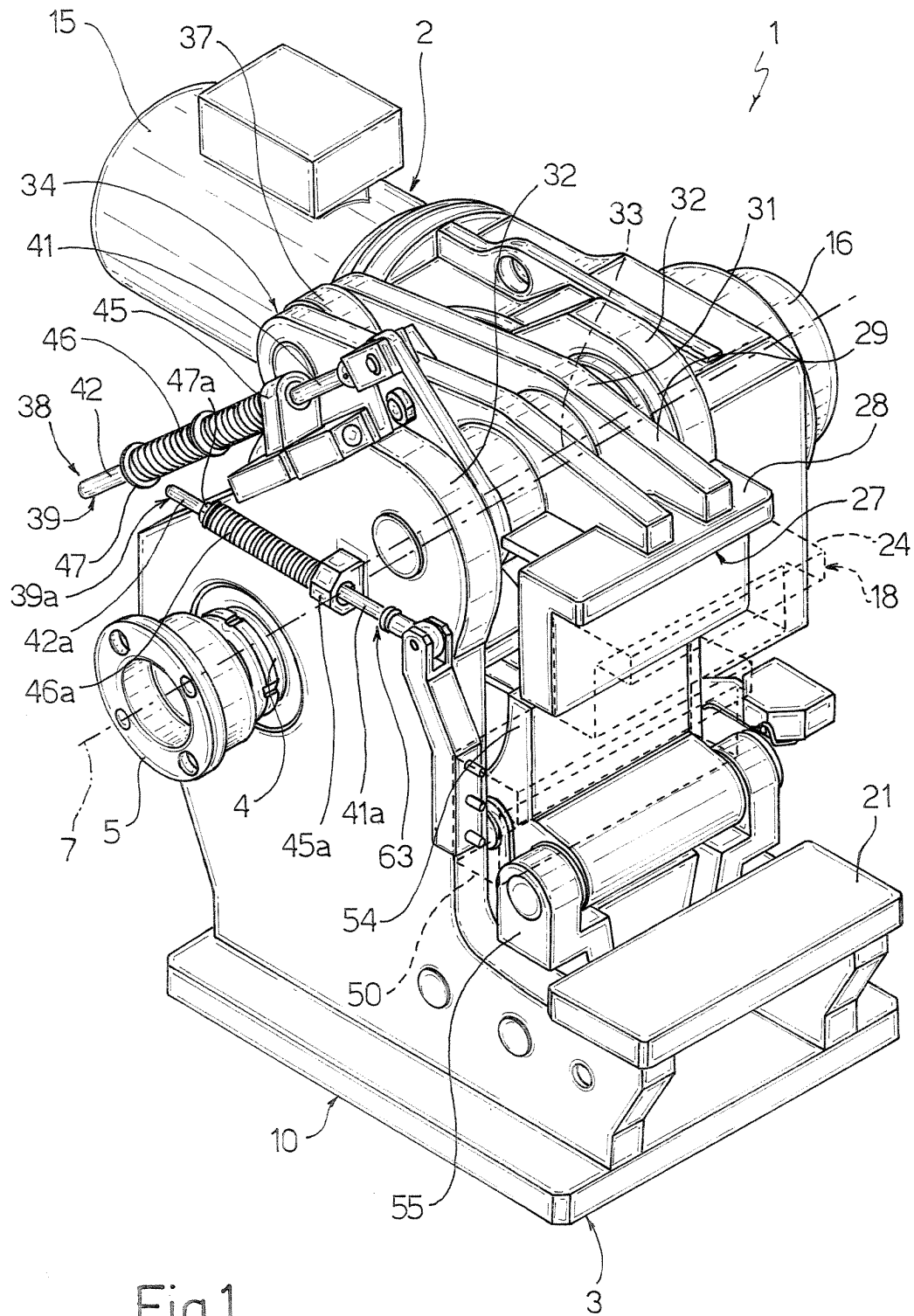
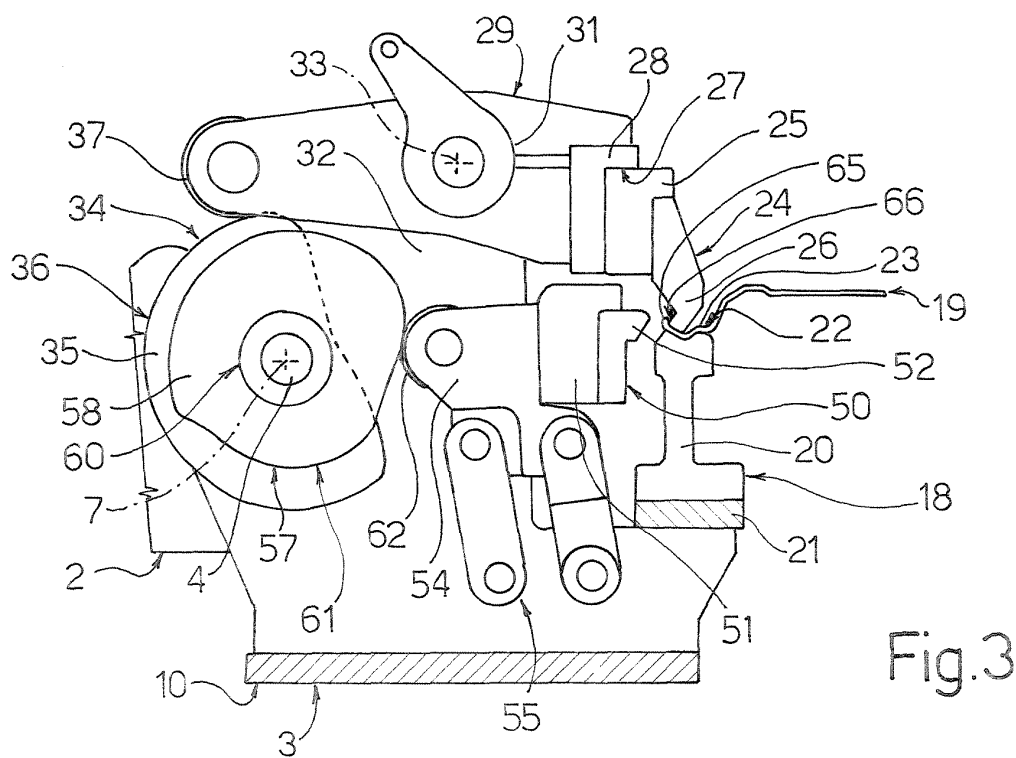
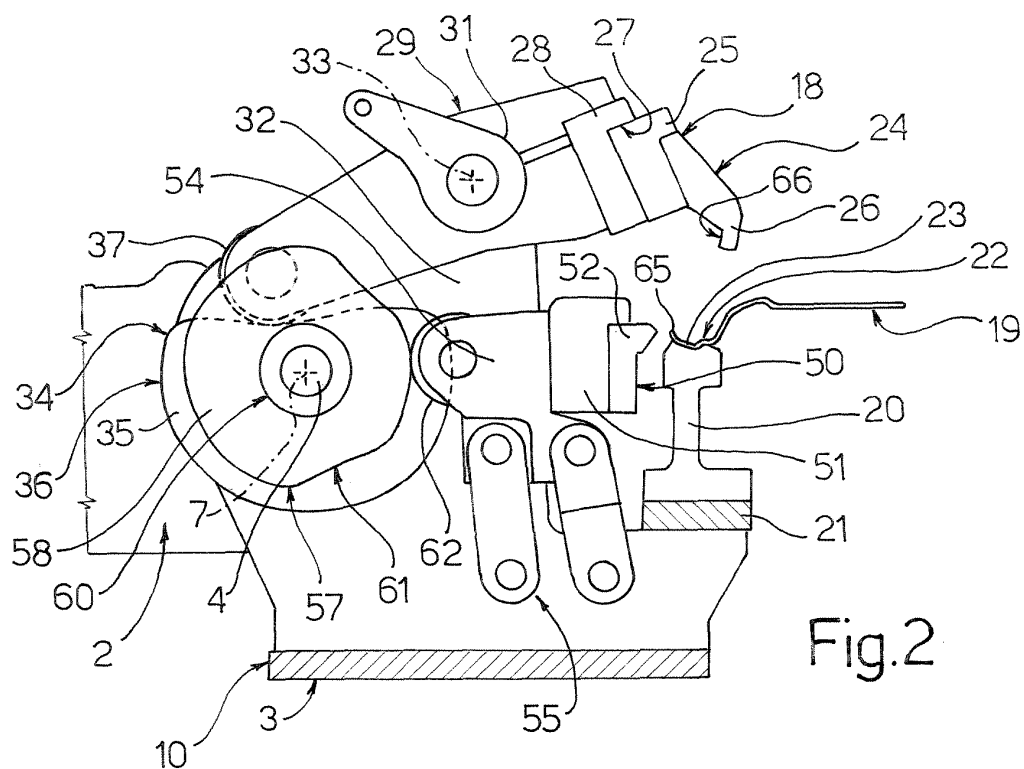


Fig.1



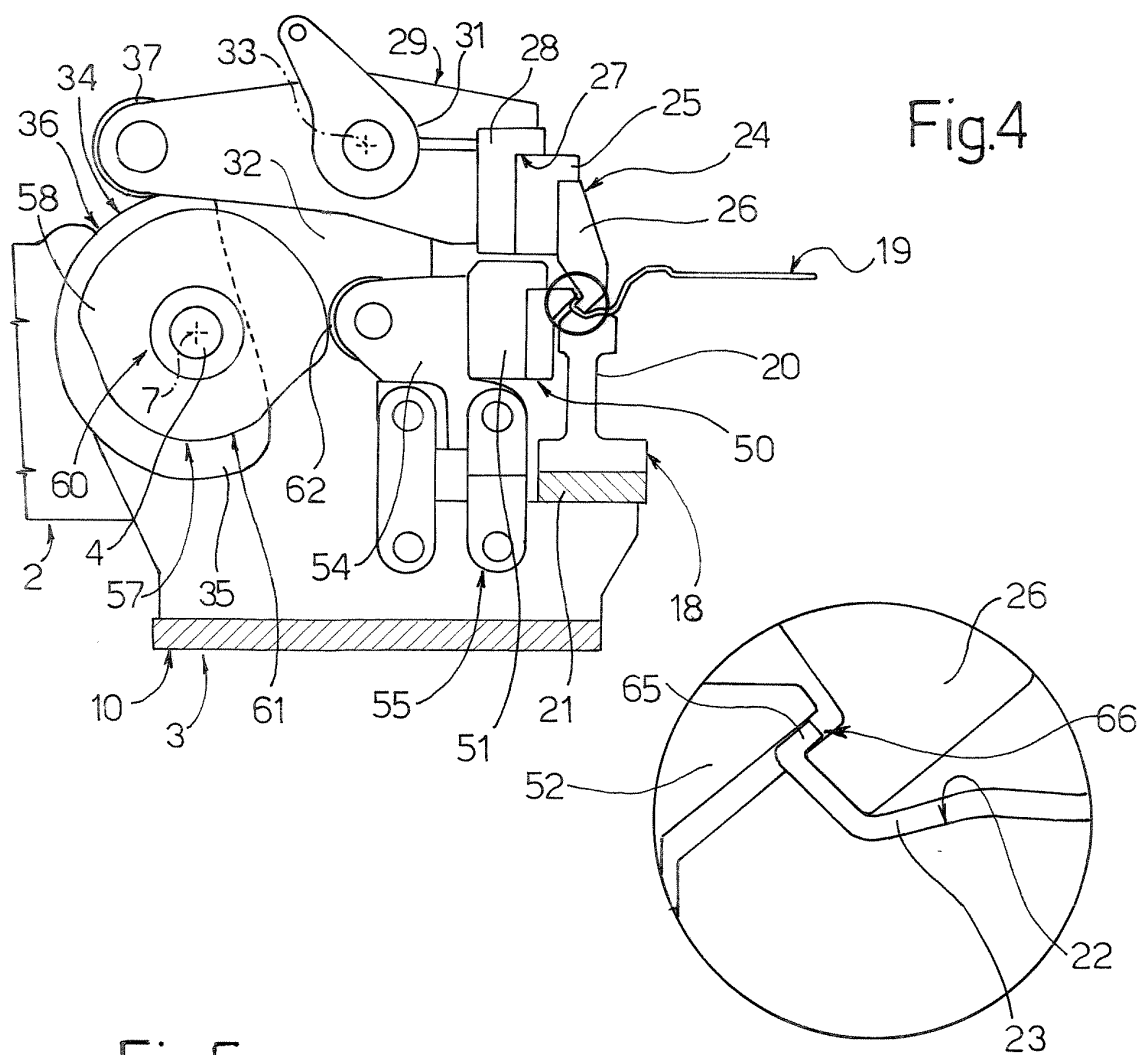


Fig.5

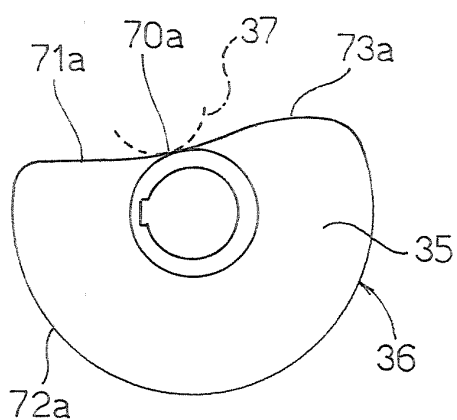


Fig.6

