



(86) Date de dépôt PCT/PCT Filing Date: 2000/05/12

(87) Date publication PCT/PCT Publication Date: 2000/11/23

(85) Entrée phase nationale/National Entry: 2001/11/09

(86) N° demande PCT/PCT Application No.: CA 2000/000562

(87) N° publication PCT/PCT Publication No.: 2000/069354

(30) Priorité/Priority: 1999/05/13 (2,272,040) CA

(51) Cl.Int.⁷/Int.Cl.⁷ A61B 19/00, B66F 11/04, F16M 11/12,
F21S 8/04

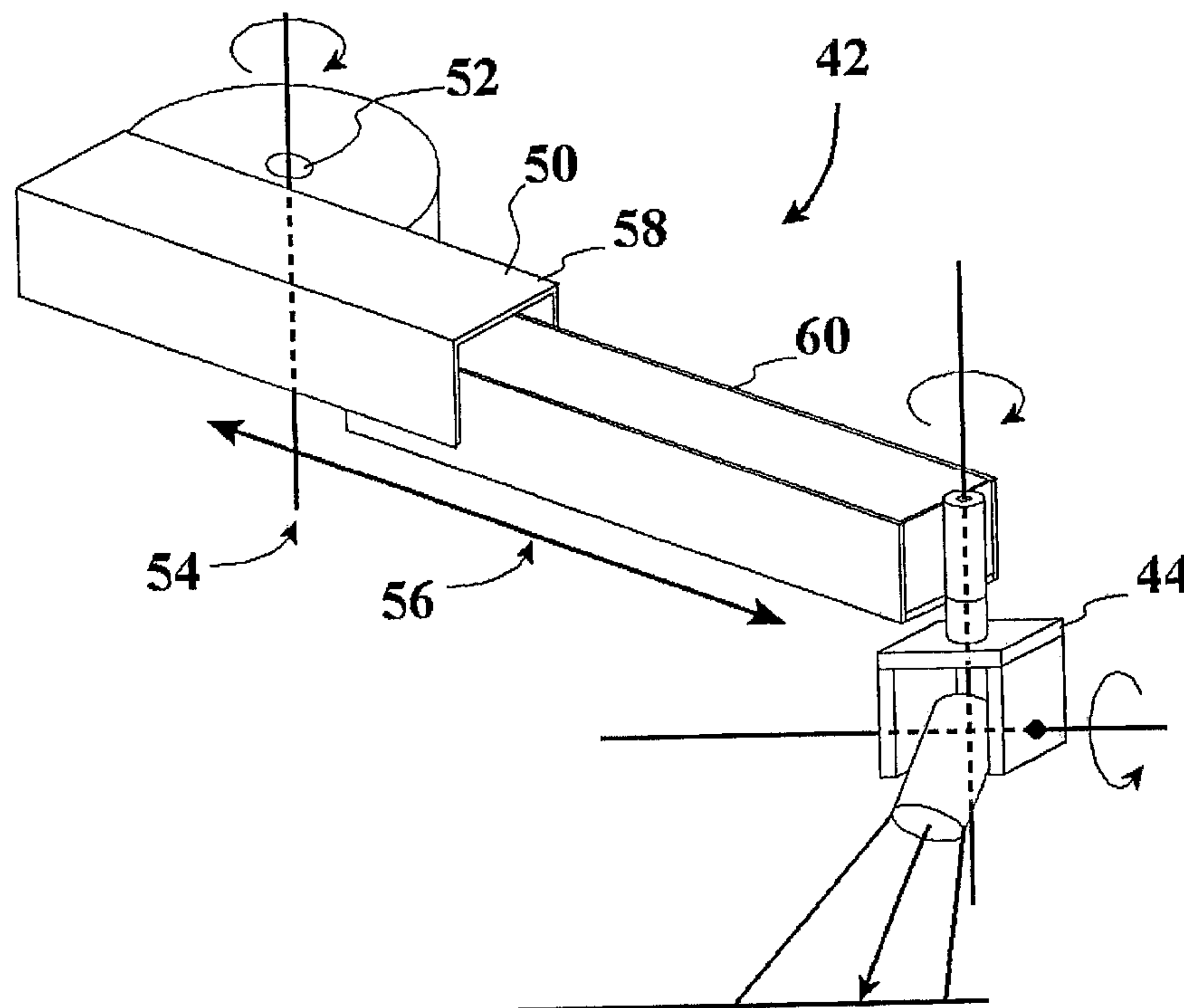
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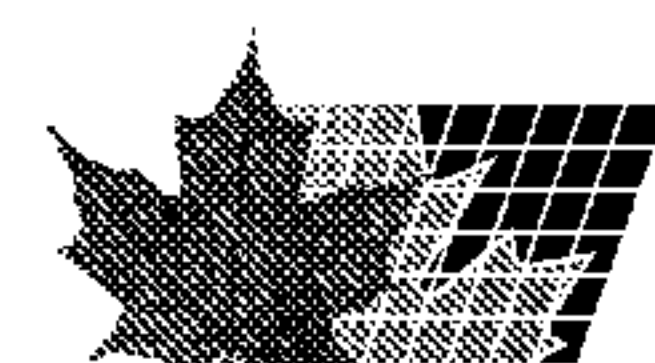
(54) Titre : SUPPORT DE CAMERA REGLABLE ET SYSTEME Y RELATIF

(54) Title: CONTROLLABLE CAMERA SUPPORT AND SYSTEM



(57) Abrégé/Abstract:

A controllable camera support comprising a pivoting arm (50) adapted to be rotatably connected to a pivot point (52) defining a first rotational axis (54). The pivoting arm (50) also defines a radial axis (56). The camera support also includes a camera holder (44) mounted on the pivoting arm (50). The camera holder (44) is displaceable along the radial axis (56). The camera further includes motors (62, 68) coupled to the pivoting arm (50) and to the camera holder (44). The motors (62, 68) are adapted to impart rotational and radial motions to the camera holder (44). The camera support also comprises a control device (100) for controlling the motors (62, 68). The invention also covers a system further including a focal adjustable, rotational, tilting camera mounted on the camera holder (44).



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
23 November 2000 (23.11.2000)

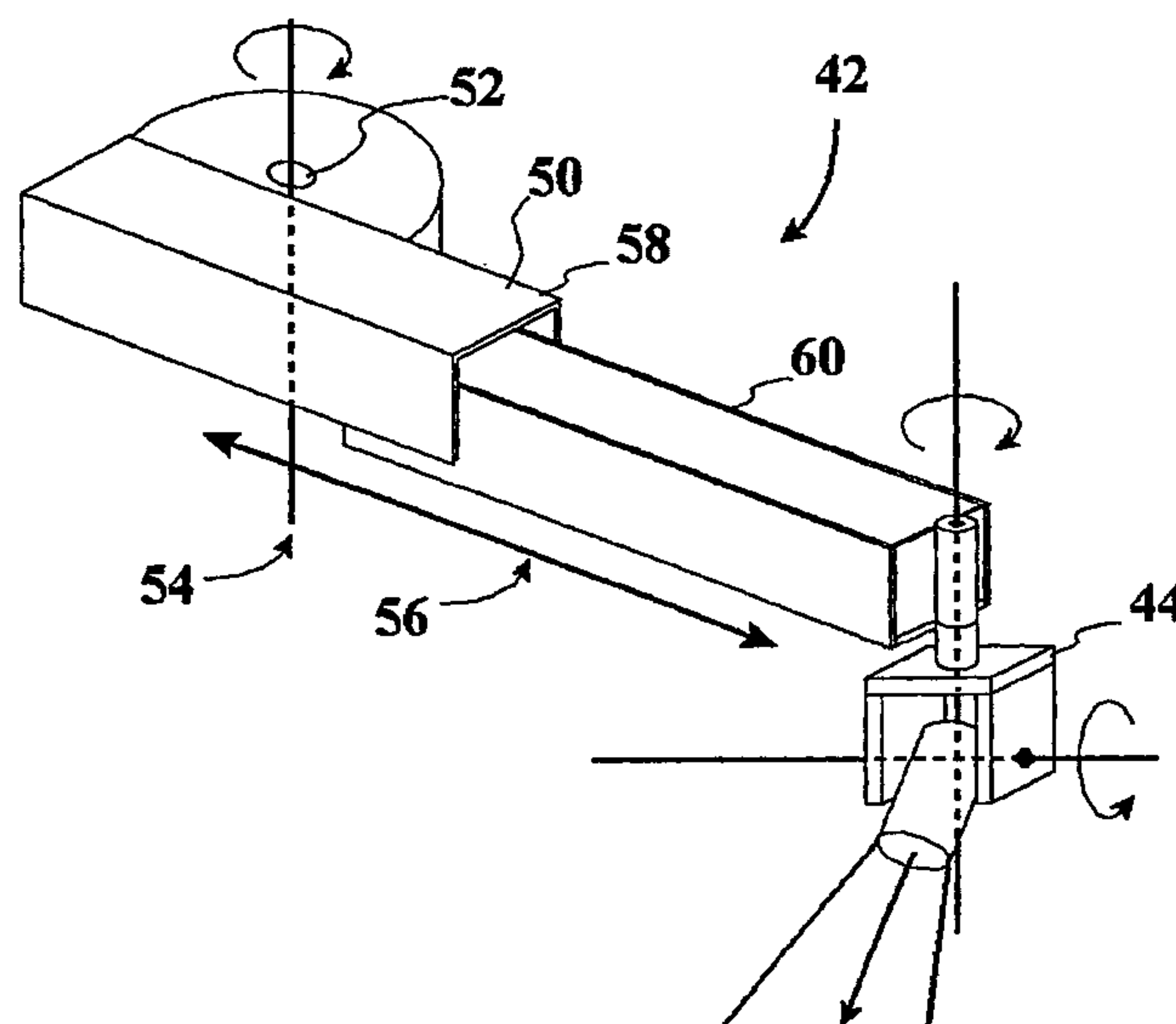
PCT

(10) International Publication Number
WO 00/69354 A1

- (51) International Patent Classification⁷: **A61B 19/00**, B66F 11/04, F16M 11/12, F21M 1/00
- (21) International Application Number: PCT/CA00/00562
- (22) International Filing Date: 12 May 2000 (12.05.2000)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
2,272,040 13 May 1999 (13.05.1999) CA
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- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: CONTROLLABLE CAMERA SUPPORT AND SYSTEM



(57) Abstract: A controllable camera support comprising a pivoting arm (50) adapted to be rotatably connected to a pivot point (52) defining a first rotational axis (54). The pivoting arm (50) also defines a radial axis (56). The camera support also includes a camera holder (44) mounted on the pivoting arm (50). The camera holder (44) is displaceable along the radial axis (56). The camera further includes motors (62, 68) coupled to the pivoting arm (50) and to the camera holder (44). The motors (62, 68) are adapted to impart rotational and radial motions to the camera holder (44). The camera support also comprises a control device (100) for controlling the motors (62, 68). The invention also covers a system further including a focal adjustable, rotational, tilting camera mounted on the camera holder (44).

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Another system has been developed at the University of Tokyo in collaboration with National Hospital of Fukuyama (Mitsuishi et al., 1995). This system is a very complex robotic system for observing and controlling a surgical robot from a distance. The system comprises a slave type manipulator and a slave surgical microscope which is moved correspondingly with the tip of a device used by a user. This system has been successful in performing an anastomose of a blood vessel having a diameter of less than 1 mm in a rat (Mitsuishi).

These aforementioned technologies are quite evolved but are not directly applicable for use in an operating room. In particular, these solutions are too complicated and expensive to be used in an operating room.

EP-A-823 396 (LINDSAY et al.) discloses a counter-balanced load carrier having a multi-stage telescopic arm. One stage is mounted for rotation about a horizontal axis in a carrier mounted for rotation on a vertical axis. An adjacent end stage of the arm carries a counterweight and the end stage at the other end of the arm carries a support for a TV camera.

EP-A-0 415 891 (BUCEFARI et al.) discloses an apparatus for manoeuvring a TV camera remotely. The apparatus is formed by an articulated structure having a slide vertically traversing on a column with an end of a lifting arm that is rotatable in a vertical plane. The lifting arm supports at the other end a camera supporting arm that is rotatable in a horizontal plane and has a mechanism imparting rotatory movements about two perpendicular axes to the TV camera mounted thereon.

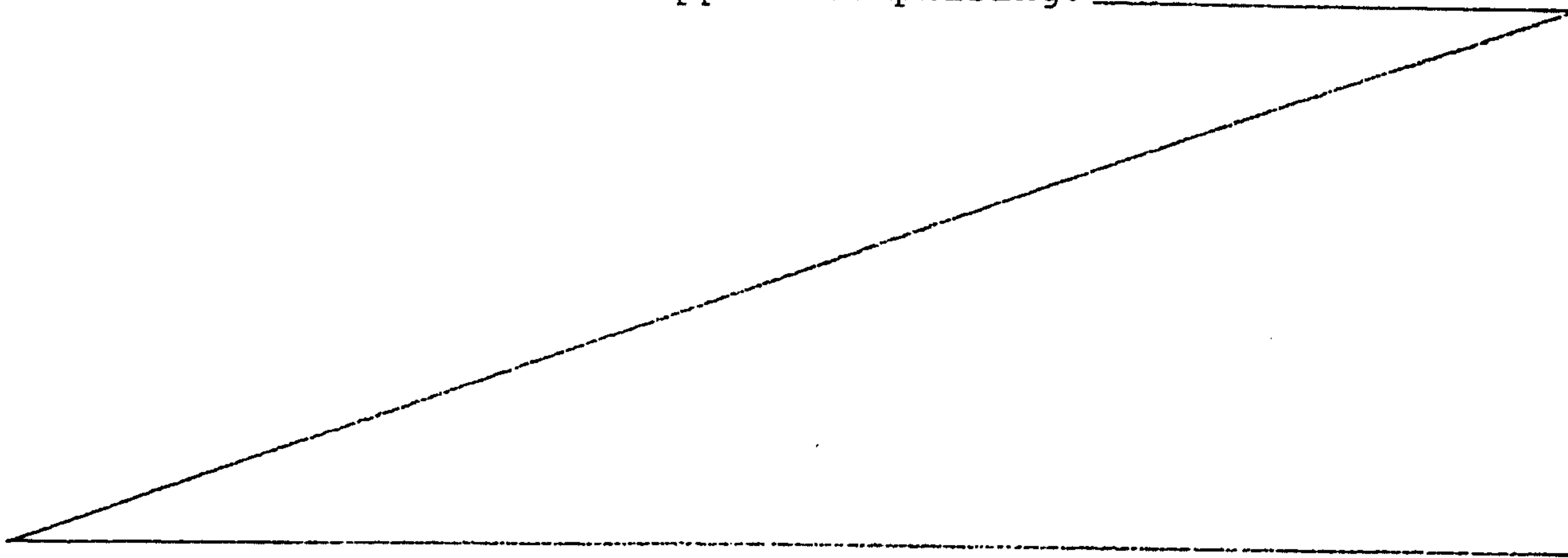
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- US patent no. 5,762,458 (WANG et al.) discloses a system for performing cardiac procedures. The system has a pair of surgical instruments that are coupled to a pair of robotic arms. The robotic arms are coupled to a pair of master handles by a controller. The handles can be moved by the surgeon to produce a corresponding movement of the arms. The system may also have an robotically controlled endoscope which allows the surgeon to remotely view the surgical site.
- 10 These above-mentioned patents do not provide a solution to the problem of a target becoming obstructed when the target is focused by a camera.

SUMMARY OF THE INVENTION

15

- An object of the present invention is to provide a controllable camera support and a system which are relatively simple and less expensive than those known in the art.
- 20 Another object of the present invention is to provide a algorithm and method that will allow a distant observer to control the camera support and the camera.

- Another object of the present invention is to provide a
25 controllable camera support comprising: _____
- 

to include any type of prismatic movement. The term prismatic movement is widely used in robotics and is equivalent to the radial movement defined above.

5

Motor devices, which will be later exemplified, are coupled to the pivoting arm 50 and to the camera holder 44. These motor devices are adapted to impart rotational and radial motions to the camera holder 44.

10

The controllable camera support 42 also includes a control system for controlling the motor devices.

Referring to FIG. 9, the pivoting arm 50 comprises a first portion 58 and a second portion 60. The first portion 58 is connected to the pivot point 52 and the second portion 60 is adapted to effect a relative movement with respect to the first portion along the radial axis 56. As illustrated, a simple rail system 59 may be used wherein one portion 60 slides under another 58.

20

As mentioned above, the above structure is for illustration purposes only and the invention should cover any prismatic movement of a controllable camera support.

25

The pivoting arm 50 may also contain an additional portion adapted to effect a relative movement with respect to the first and second portions 58, 60, thereby forming a telescoping arm.

25

the pivoting arm while still pointing the camera to the same spot or target.

WHAT IS CLAIMED IS:

1. A camera system comprising:

- 5 a pivoting arm (50) adapted to be rotatably connected to a pivot point (52) defining a first rotational axis (54), said pivoting arm (50) defining a radial axis (56);
- a camera holder (44) mounted on said pivoting arm (50), said camera holder (44) being displaceable along said
- 10 radial axis (56);
- a focal adjustable, rotational, tilting camera (46) mounted on said camera holder (44), said camera (46) defining a second rotational axis parallel to said first rotational axis about which said camera (46) may rotate by
- 15 means of a camera rotation motor, said camera (46) defining a third rotational axis perpendicular to said first rotational axis about which said camera (46) may tilt by means of a camera tilting motor, said camera (46) including a focal adjustment mechanism, said camera (46) focusing on
- 20 a target (32);
- motor means (62, 68) coupled to said pivoting arm (50) and to said camera holder (44), said motor means (62, 68) adapted to impart rotational and radial motions to said camera holder (44); and
- 25 control means for controlling said motor means (62, 68), said camera rotation motor, said camera tilting motor, and said focal adjustment mechanism;
- characterized in that when the target (32) focused by the camera (46) becomes obstructed by an obstruction, said
- 30 control means is adapted to move said camera (46) to another position all the while focusing on said target (32), whereby as said camera (46) moves, said target (32) is always focused by said camera (46) so that said camera (46) can be moved to

another position where the obstruction does not obstruct said camera (46).

2. The camera system according to claim 1,
5 characterized in that said pivoting arm (50) comprises at least first and second portions (58, 60), said first portion (58) being connected to said pivot point (52), and said second portion (60) being adapted to effect a relative movement with respect to said first portion (58) along said
10 radial axis (56).

3. The camera system according to claim 2,
characterized in that said pivoting arm (50) comprises at least one additional portion adapted to effect a relative
15 movement with respect to said first and second portions (58, 60), thereby forming a telescoping arm.

4. The camera system according to claim 2,
characterized in that said first portion (58) has first and
20 second extremities, said second portion (60) has first and second ends, said first portion (58) being connected to said pivot point (52) near said first extremity, said camera holder (44) being mounted on said second portion (60) near said second end thereof, thereby defining a
25 maximum distance between said pivot point (52) and said camera holder (44).

5. The camera system according to claim 4,
characterized in that said pivoting arm (50) is rotatably
30 connected to said pivot point (52) by means of a conical bearing (78).

6. The camera system according to claim 5,
characterized in that said motor means (62, 68) comprises:
a radial motor (62) and an endless screw mechanism
(64) for sliding said first portion (58) with respect to
5 said second portion (60) of the pivoting arm (50); and
a rotational motor (68) for rotating said pivoting arm
(50).

7. The camera system according to claim 6,
10 characterized in that the rotational motor (68) comprises a
slip clutch mechanism for disengaging said rotational motor
(68) from said pivoting arm (50).

8. The camera system according to claim 7,
15 characterized in that the radial motor (62) and endless
screw mechanism (64) are coupled to said slip clutch
mechanism for disengaging said radial motor (62) from said
endless screw mechanism (64).

20 9. The camera system according to claim 6,
characterized in that it further comprises limit switches
(76) connected to said radial (62) and rotational (68)
motors, said limit switches (76) adapted to shut down power
to said motors (62, 68) before reaching a mechanical limit.

25

10. The camera system according to claim 6,
characterized in that the motors (62, 68) are brush type DC
servo-motors coupled to pulse width modulation (PWM) type
amplifiers.

30

11. The camera system according to claim 1,
characterized in that said control means comprises:
sensors coupled to said pivoting arm (50) for

measuring or calculating said rotational and radial motions thereof;

a computer means for receiving measured or calculated rotational and radial motions from said sensors;

5 a user interface (102) coupled to said computer means for generating positioning and/or calculated speed and/or trajectory commands; and

an open and/or closed loop control system (106) for receiving said positioning and/or calculated speed and/or
10 trajectory commands from said user interface and sending motor commands to said motor means.

12. The camera system according to claim 11,
characterized in that said closed loop control system is a
15 PID control system.

13. The camera system according to claim 1, wherein said control means comprises:

position sensors coupled to said pivoting arm (50) for
20 measuring rotational and radial positions thereof;

a computer system for receiving measured rotational and radial positions from said sensors;

a user interface (102) coupled to said computer means for generating a position command signal;

25 an feed forward controller (122) for generating a first output signal in response to the position command signal;

a differential controller for generating a second output signal in response to the position command signal
30 and speed feedback signal;

a proportional controller for generating a third output in response to the position command signal and position feedback signal;

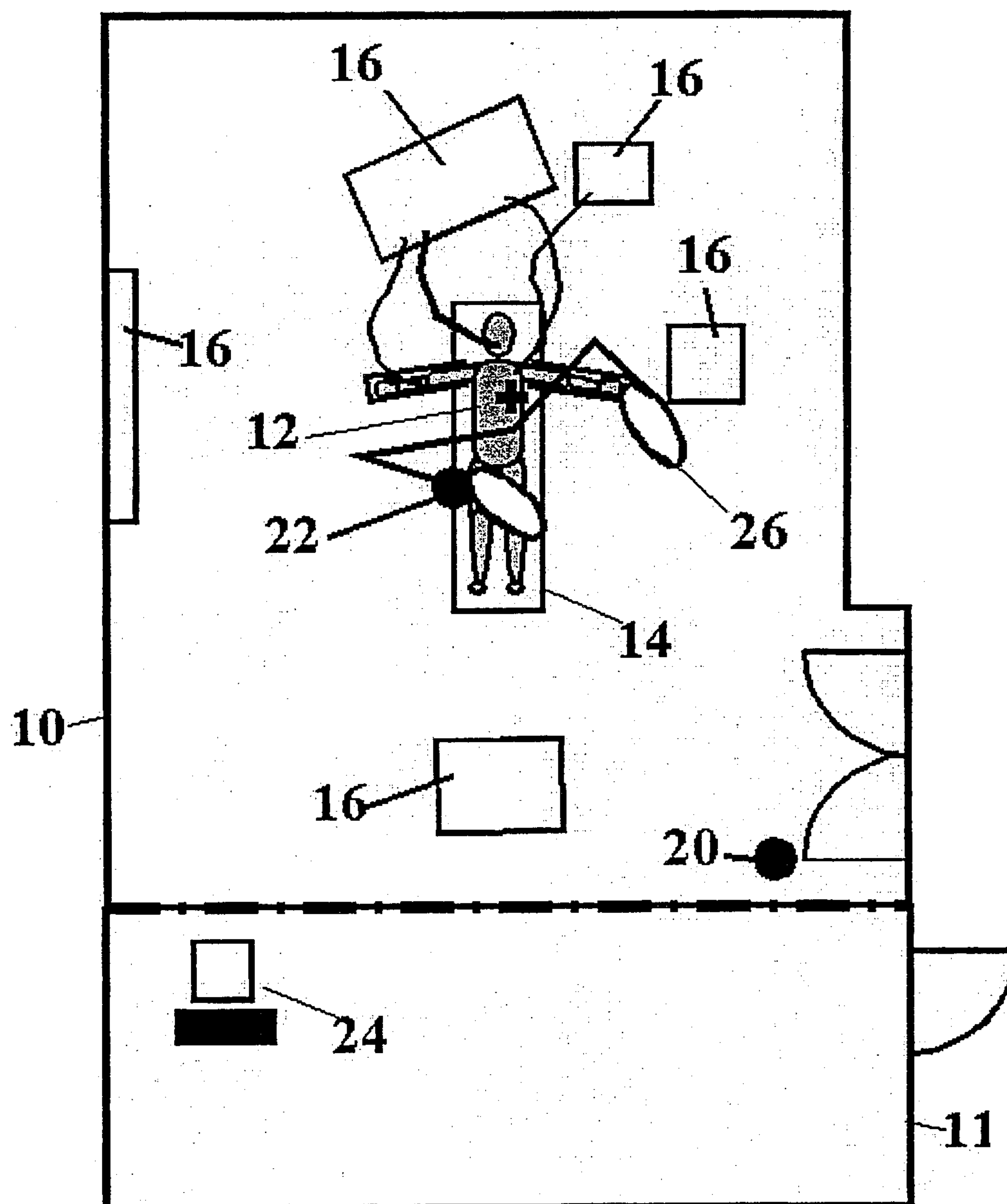
a treatment controller for generating said speed feedback signal in response to said output signals from the feed forward, differential, and proportional controllers;

an integral controller for generating said position
5 feedback signal in response to the position feedback signal, for controlling said motor means.

14. The camera system according to claim 1,
characterized in that the pivoting arm (50) is adapted to be
10 coupled with a surgical lamp system, said surgical lamp system having a receiving point rotatably connectable to said pivot point (52).

15. The camera system according to claim 1,
15 characterized in that the pivoting arm (50) is adapted to be mounted to a ceiling of a room to be inspected.

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**FIG 1**

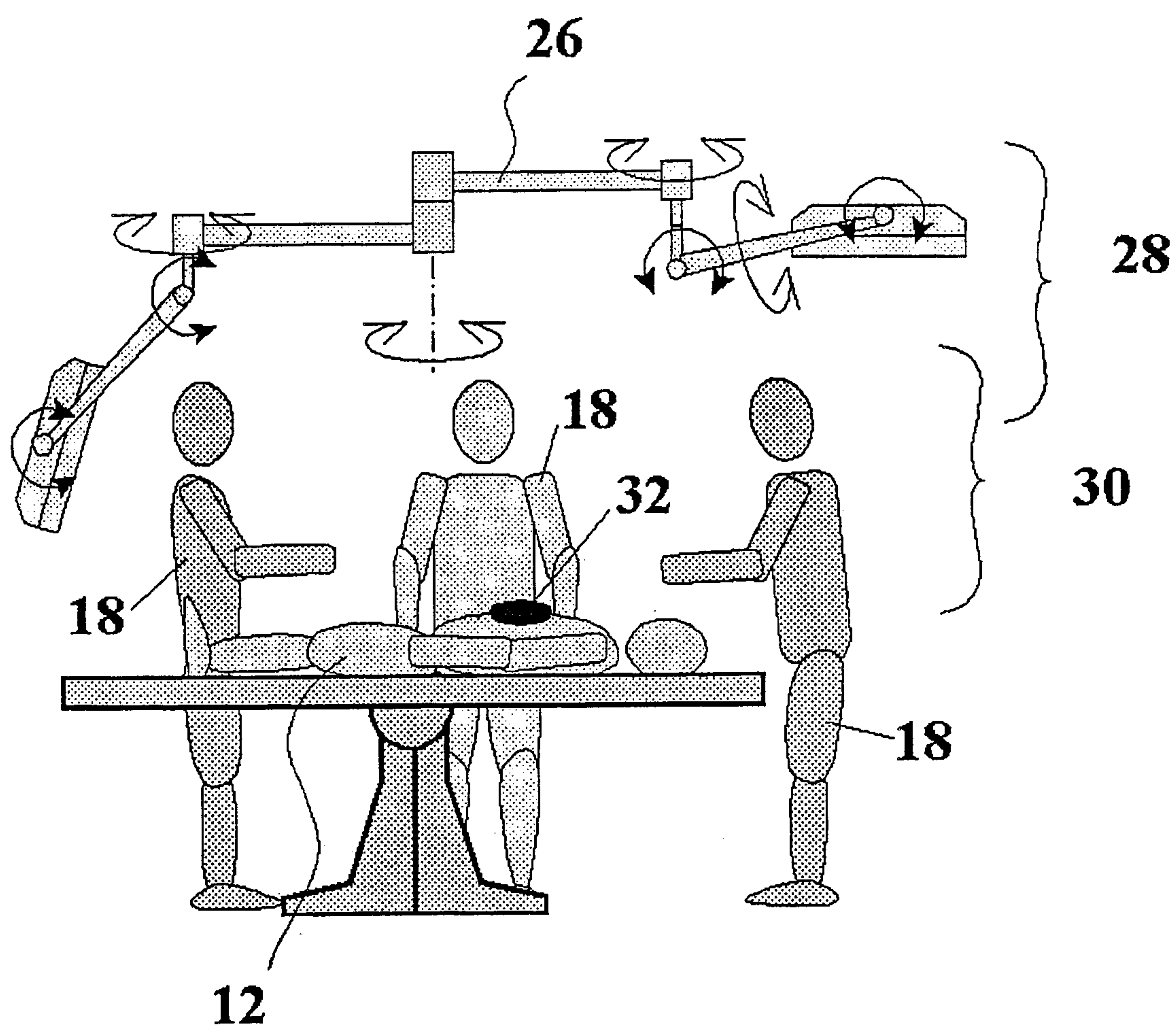


FIG. 2

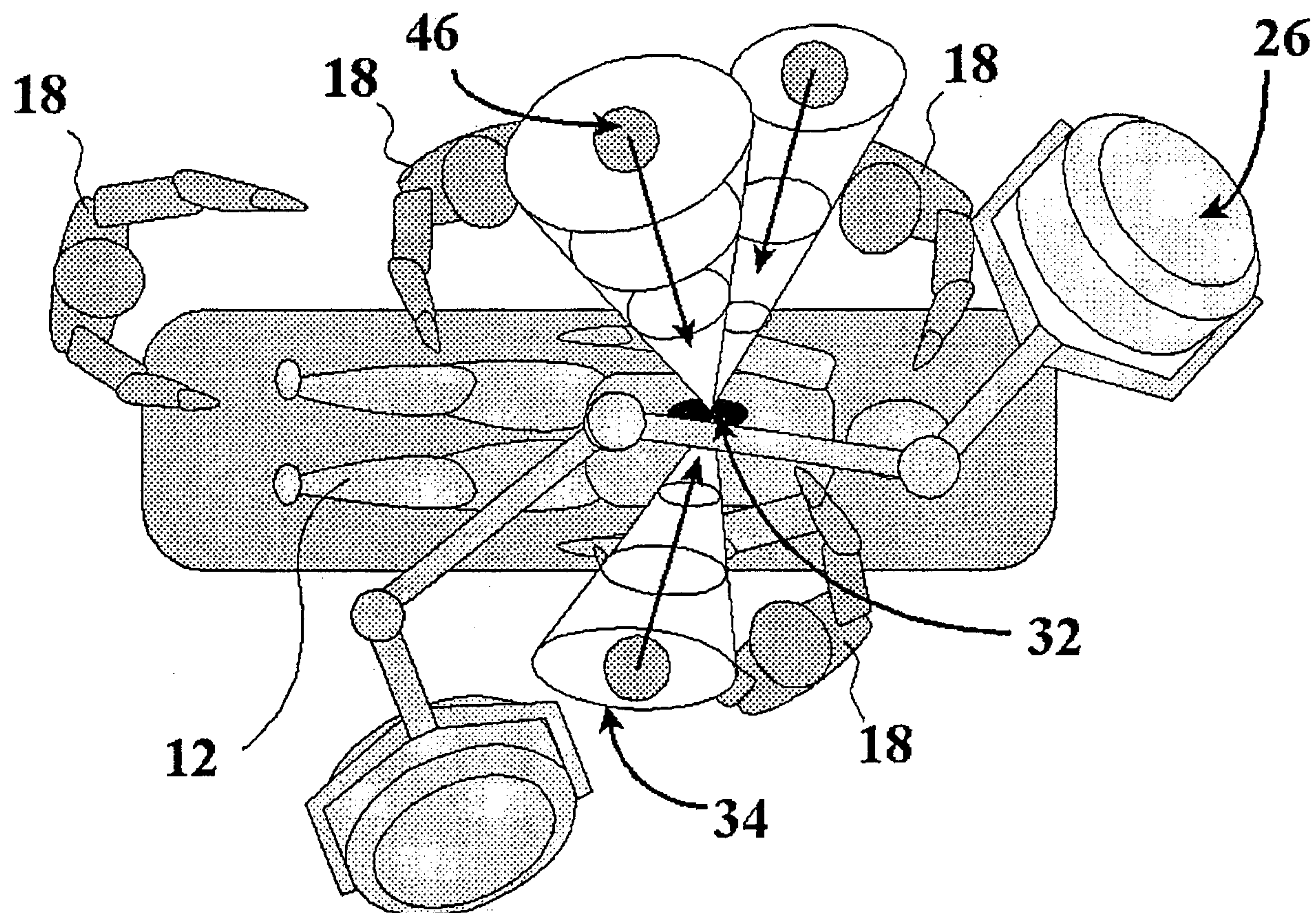
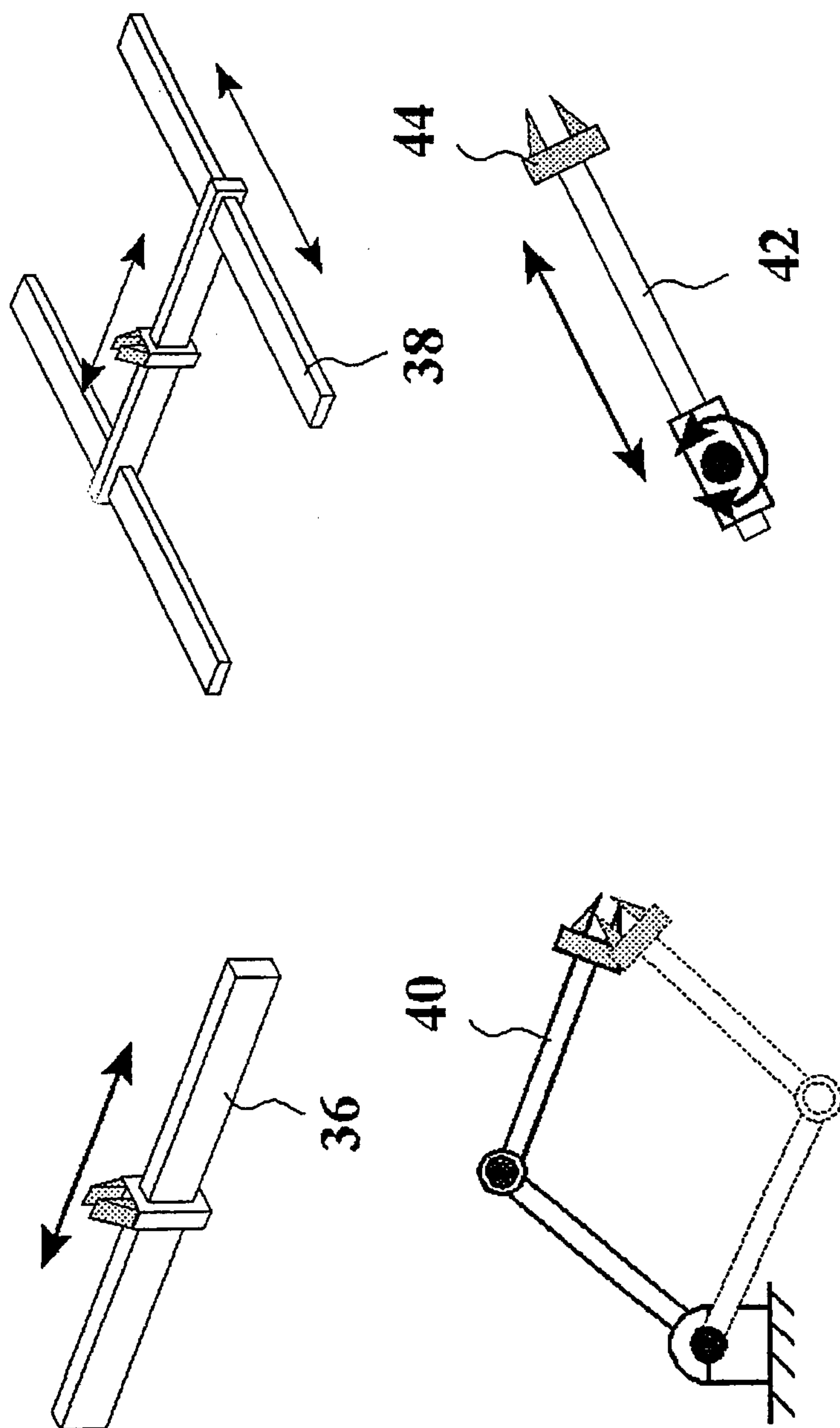


FIG. 3

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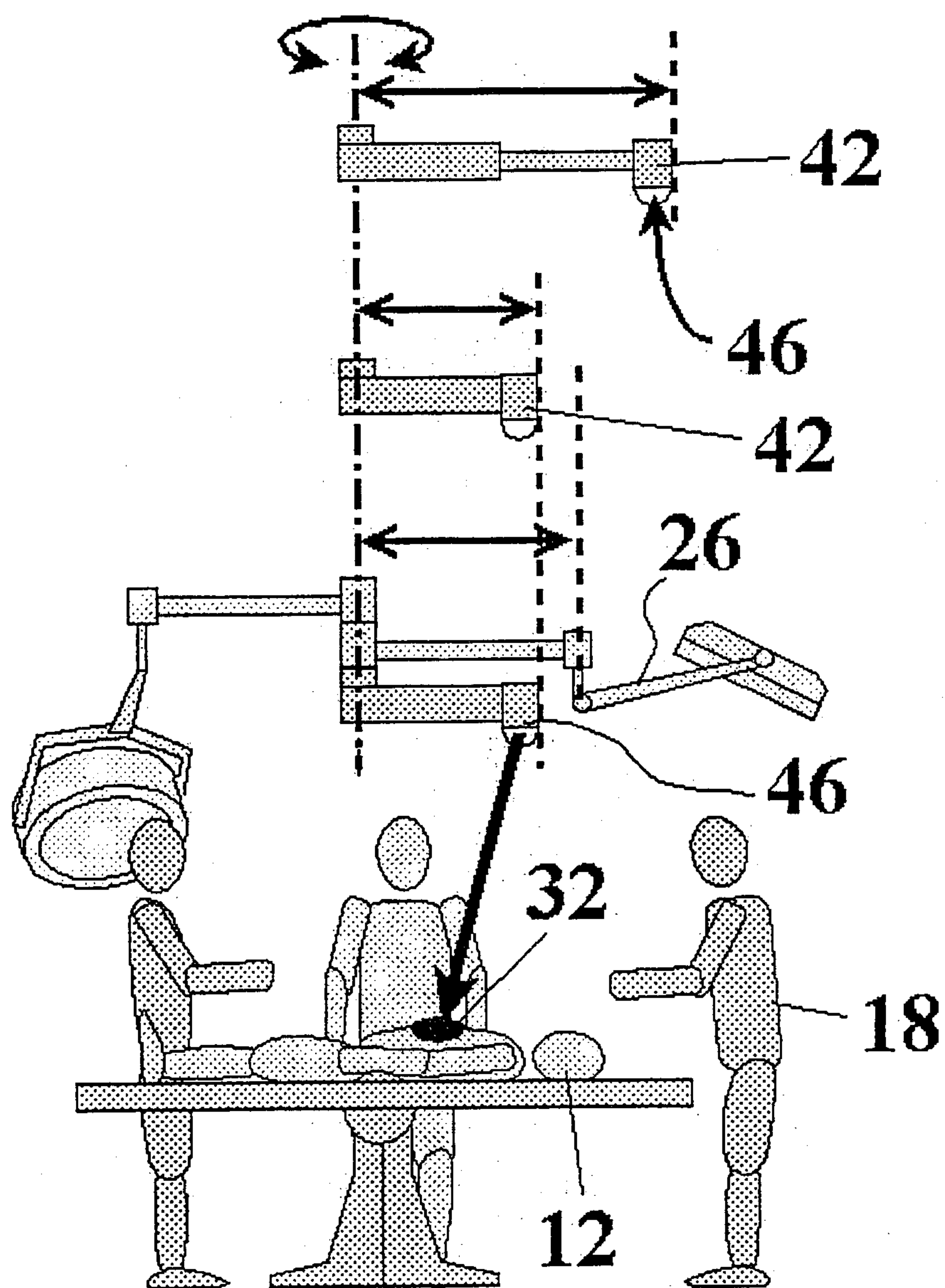
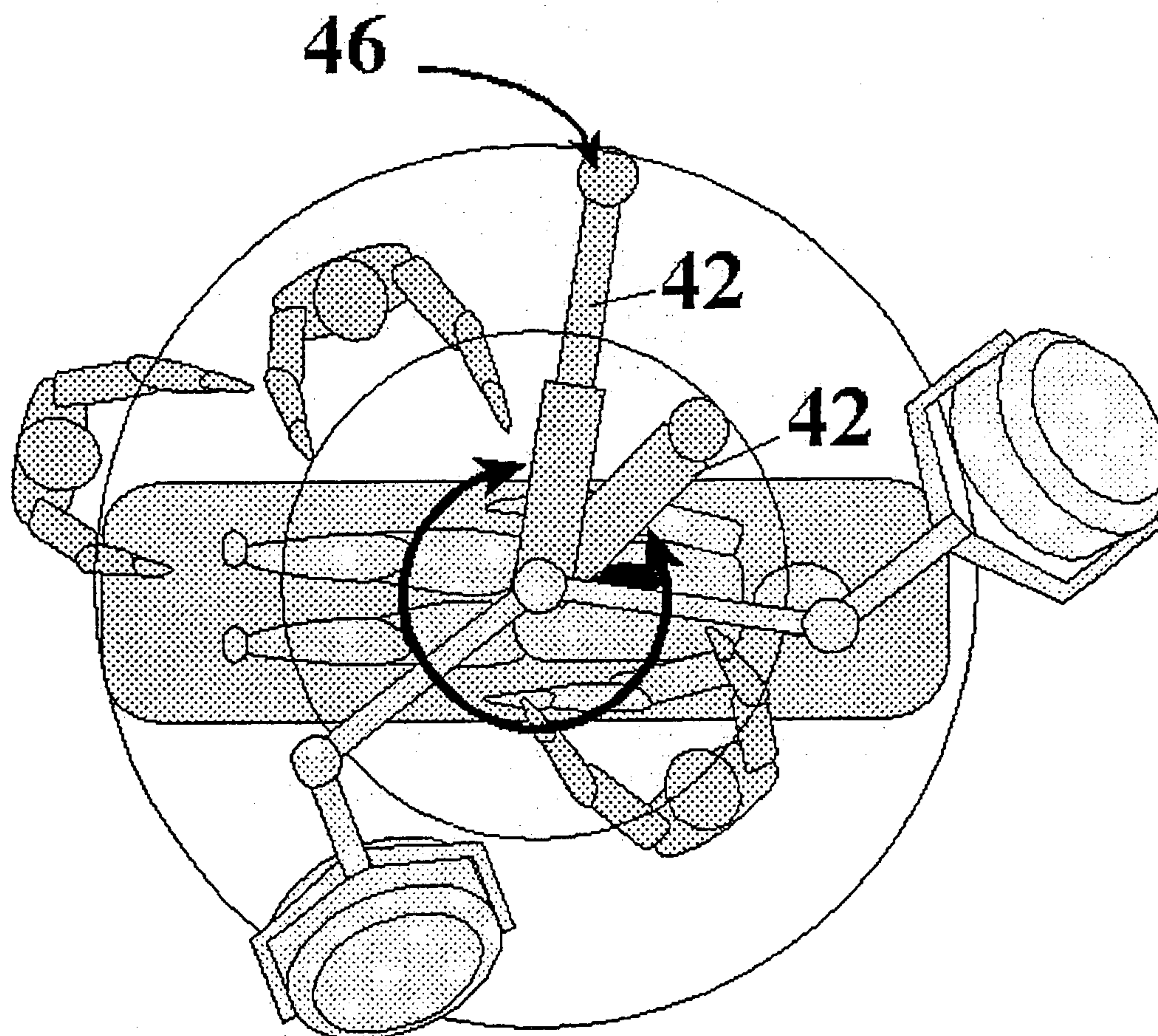


FIG. 5

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**FIG. 6**

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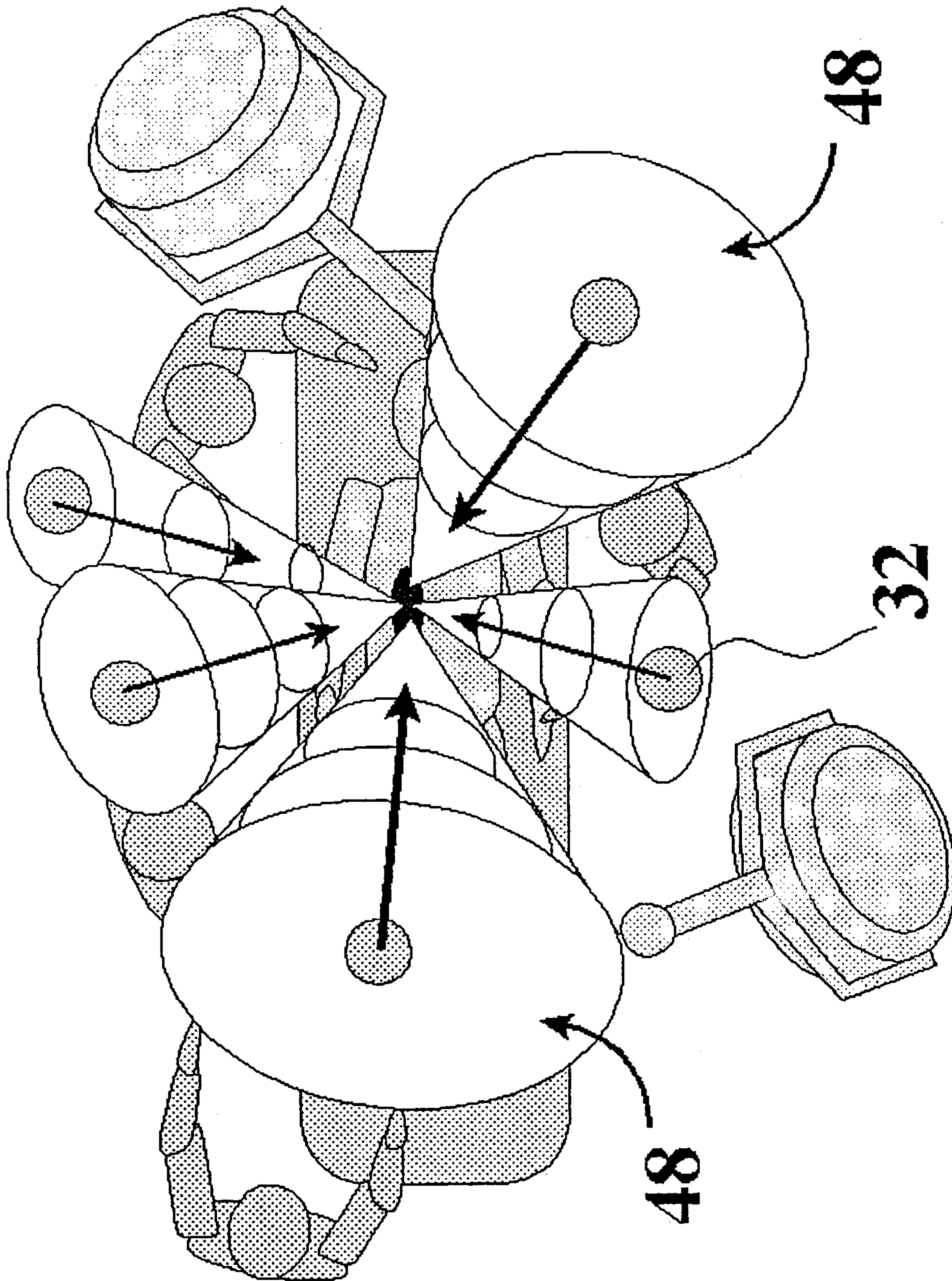
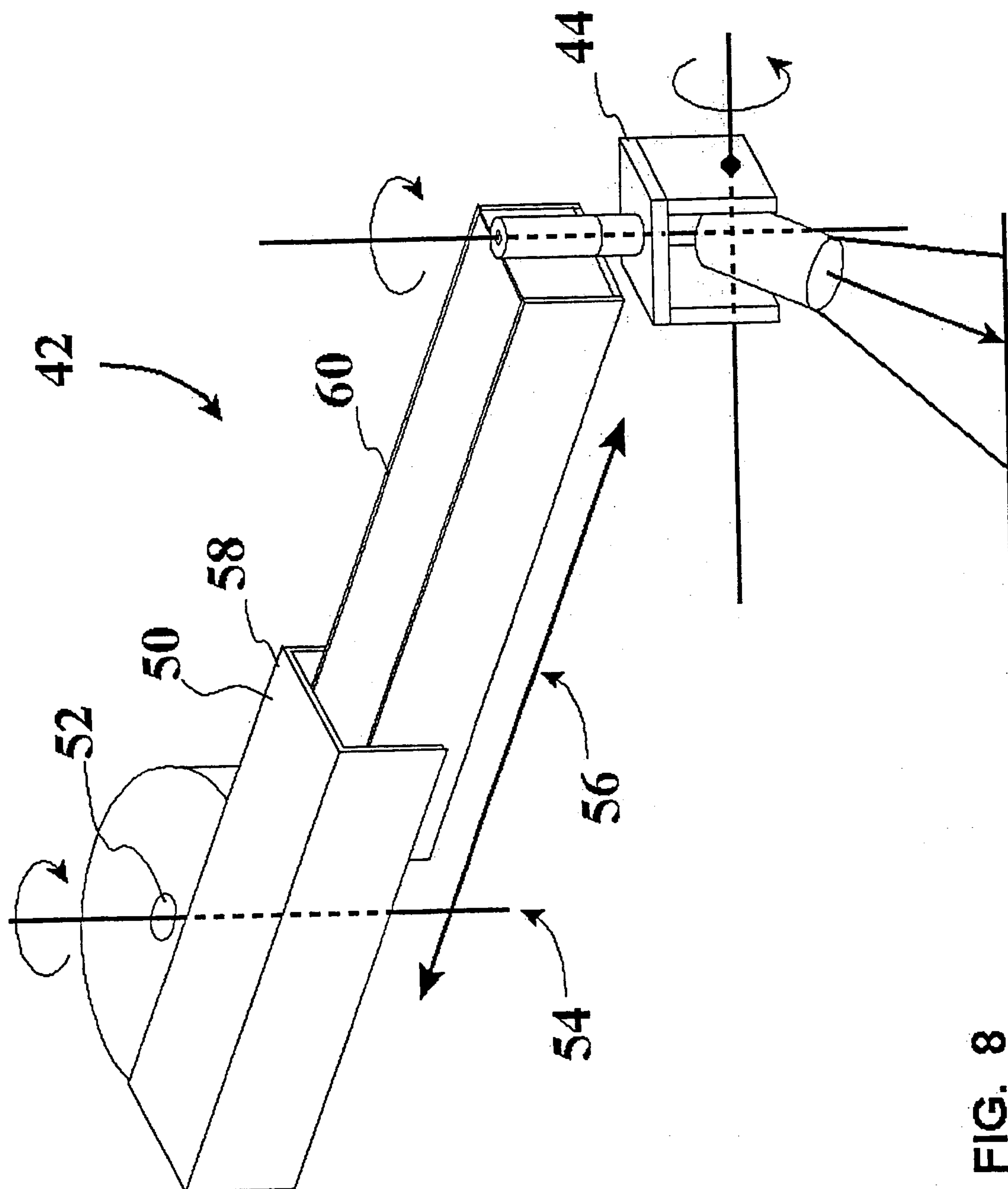


FIG. 7



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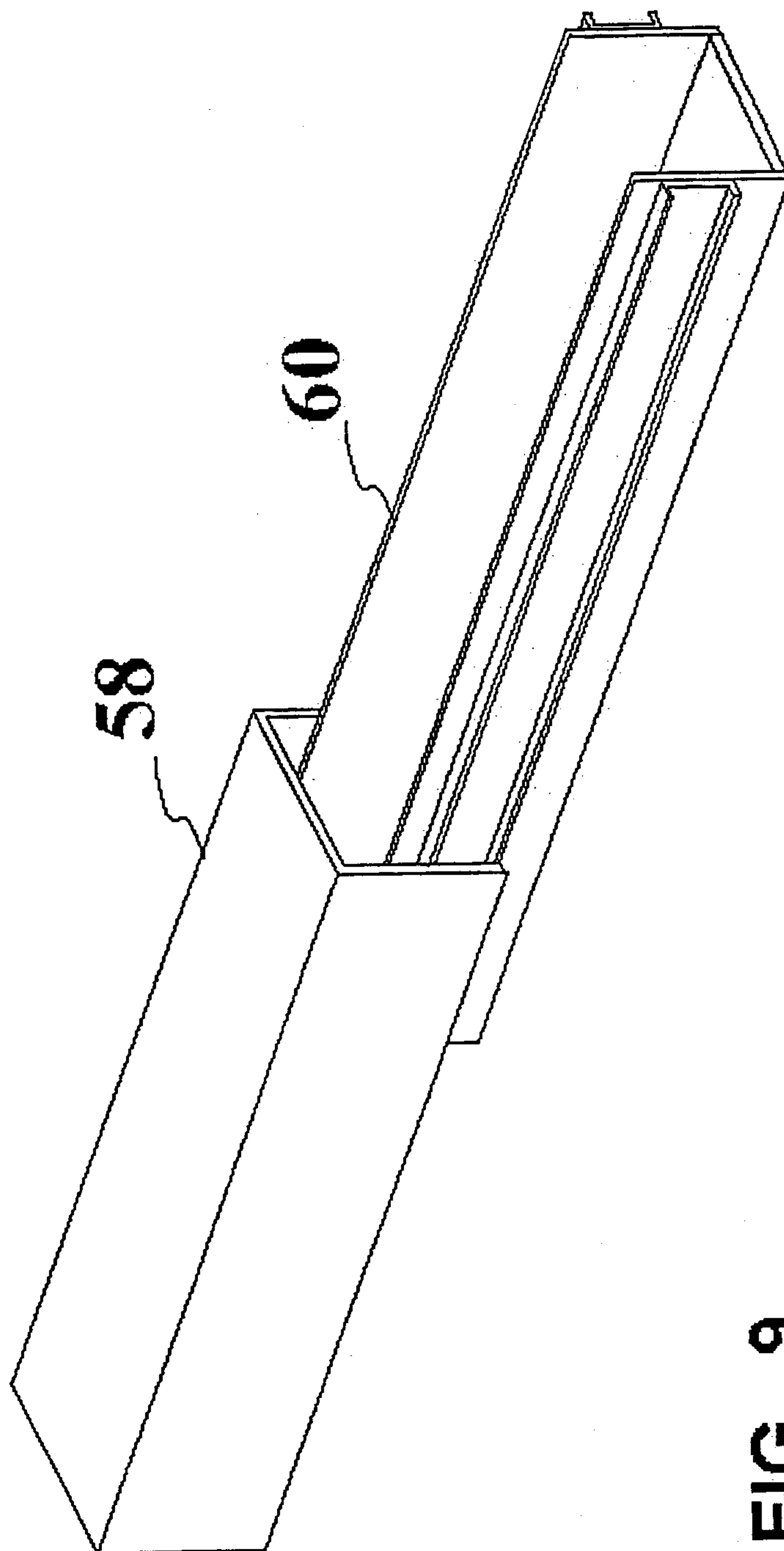


FIG. 9

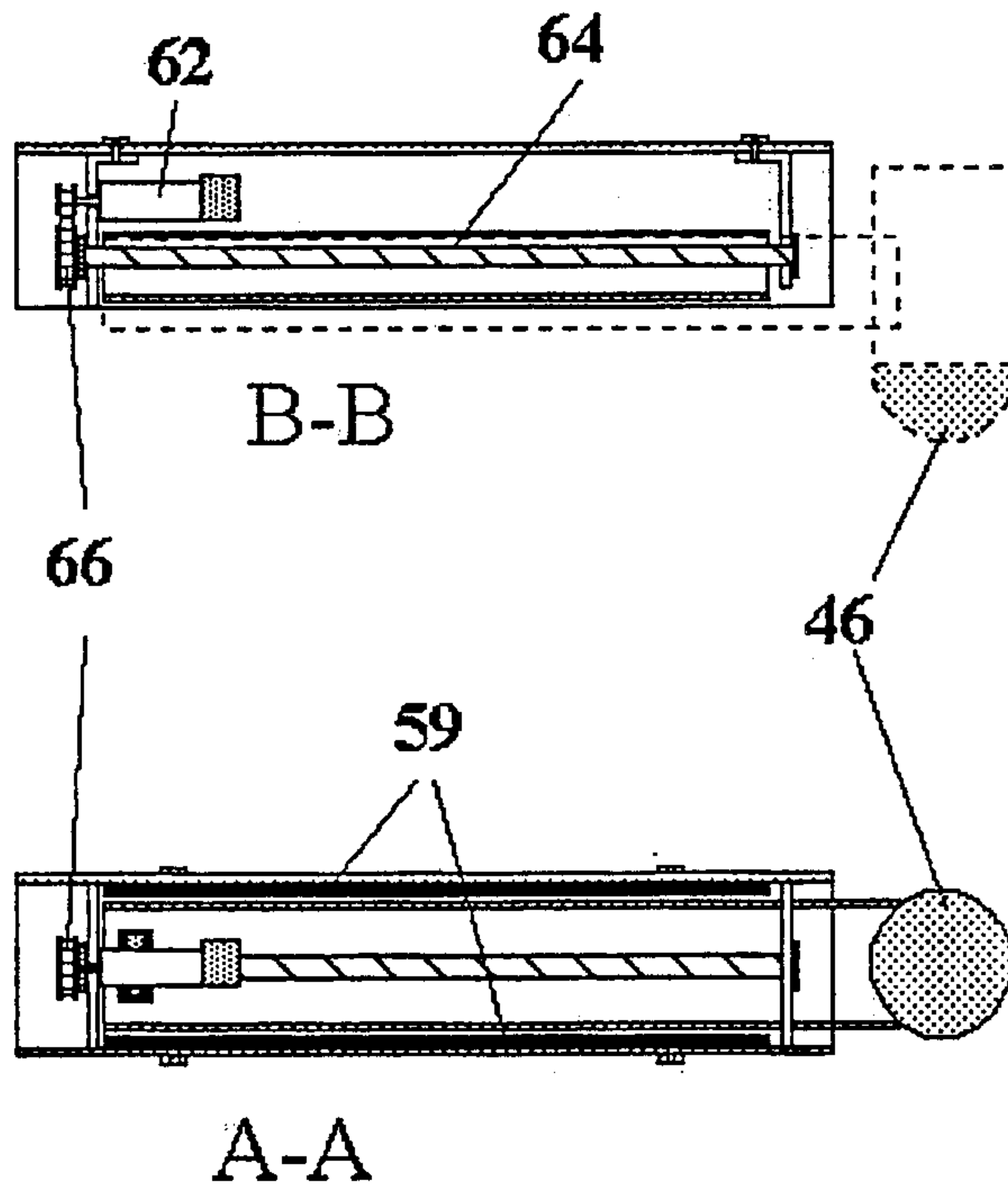
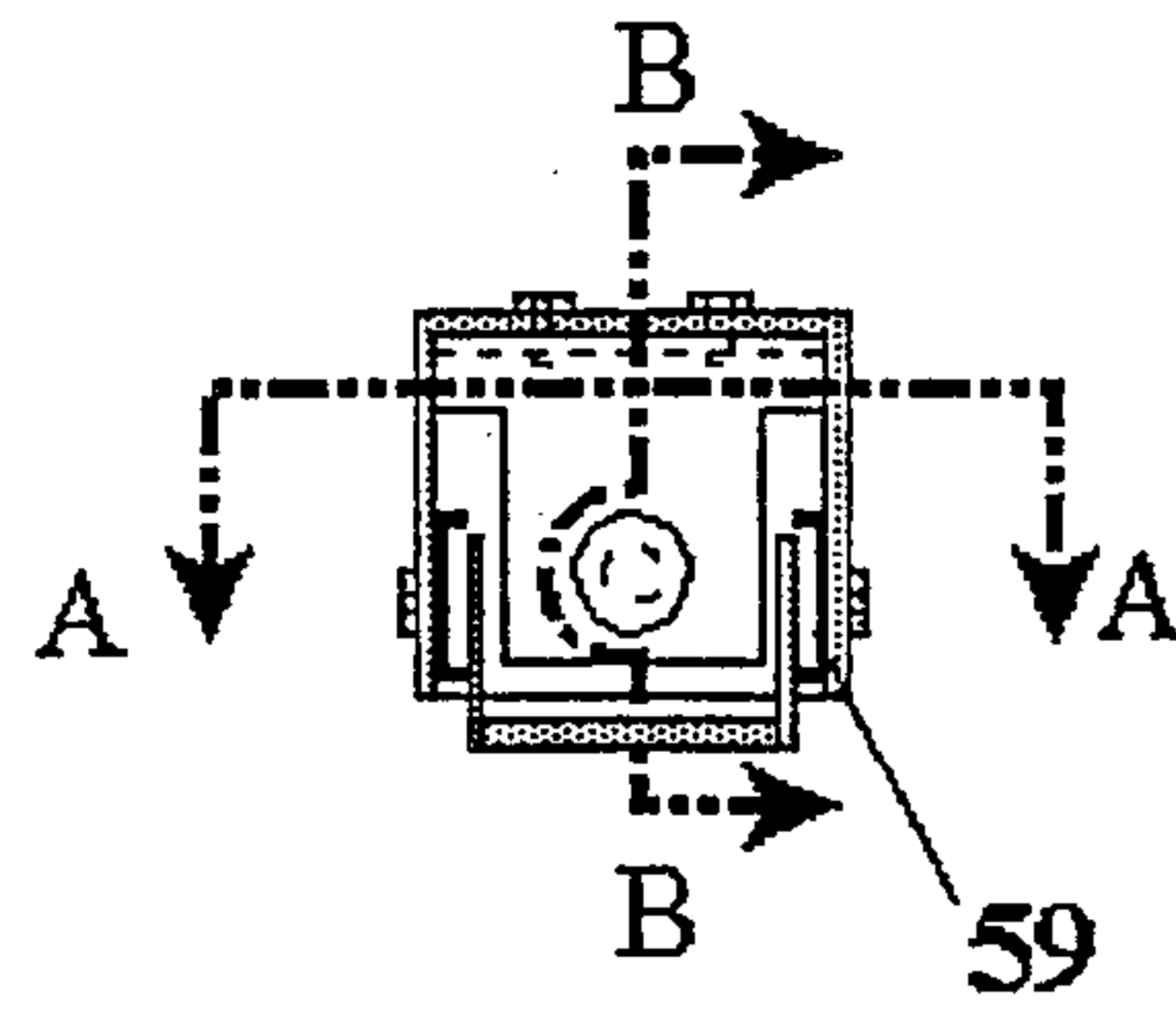
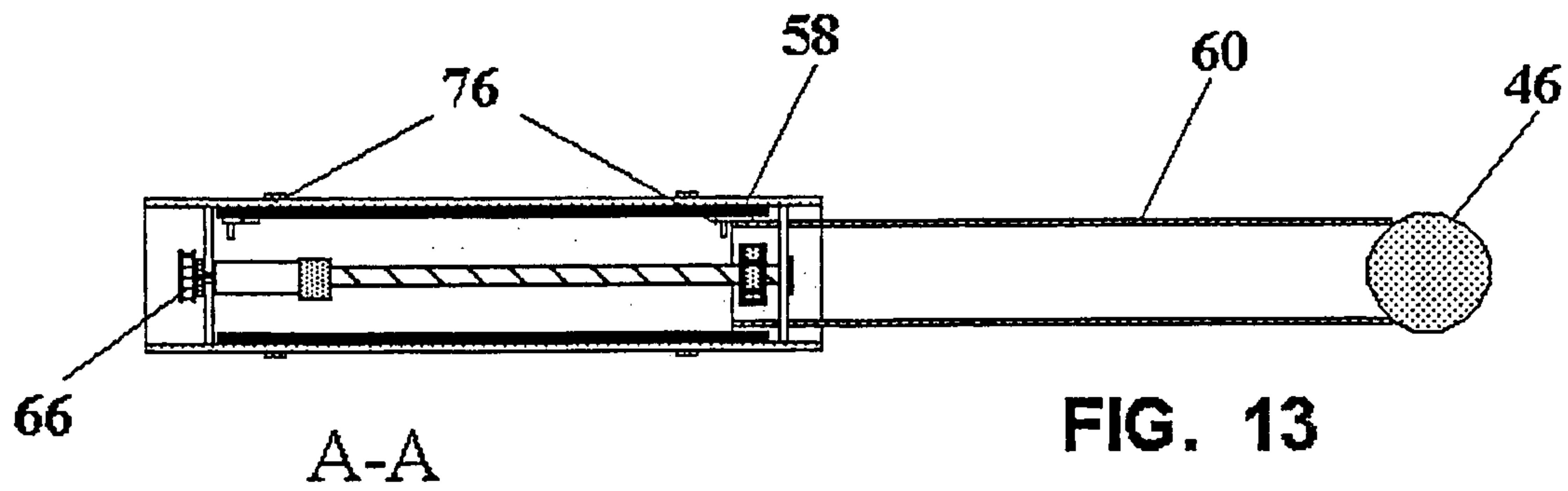
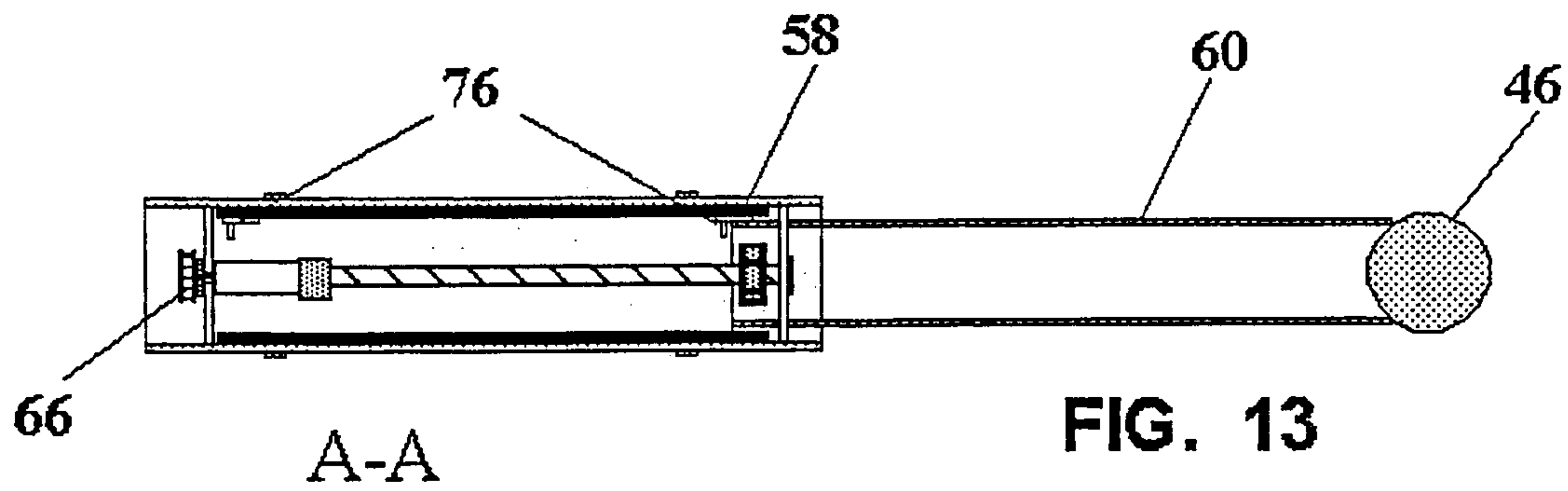
FIG. 11**FIG. 10****FIG. 12****FIG. 13**

FIG. 14

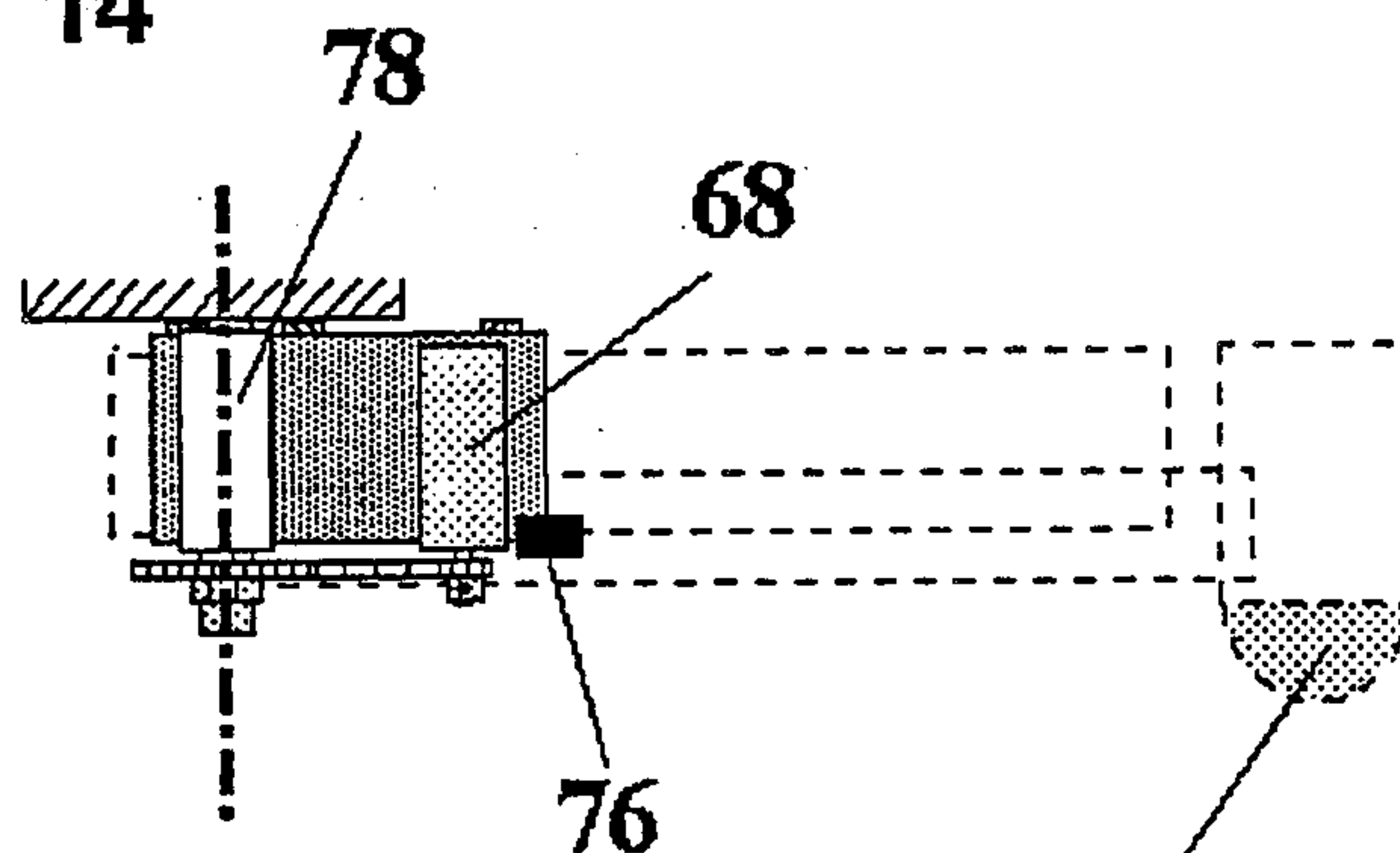
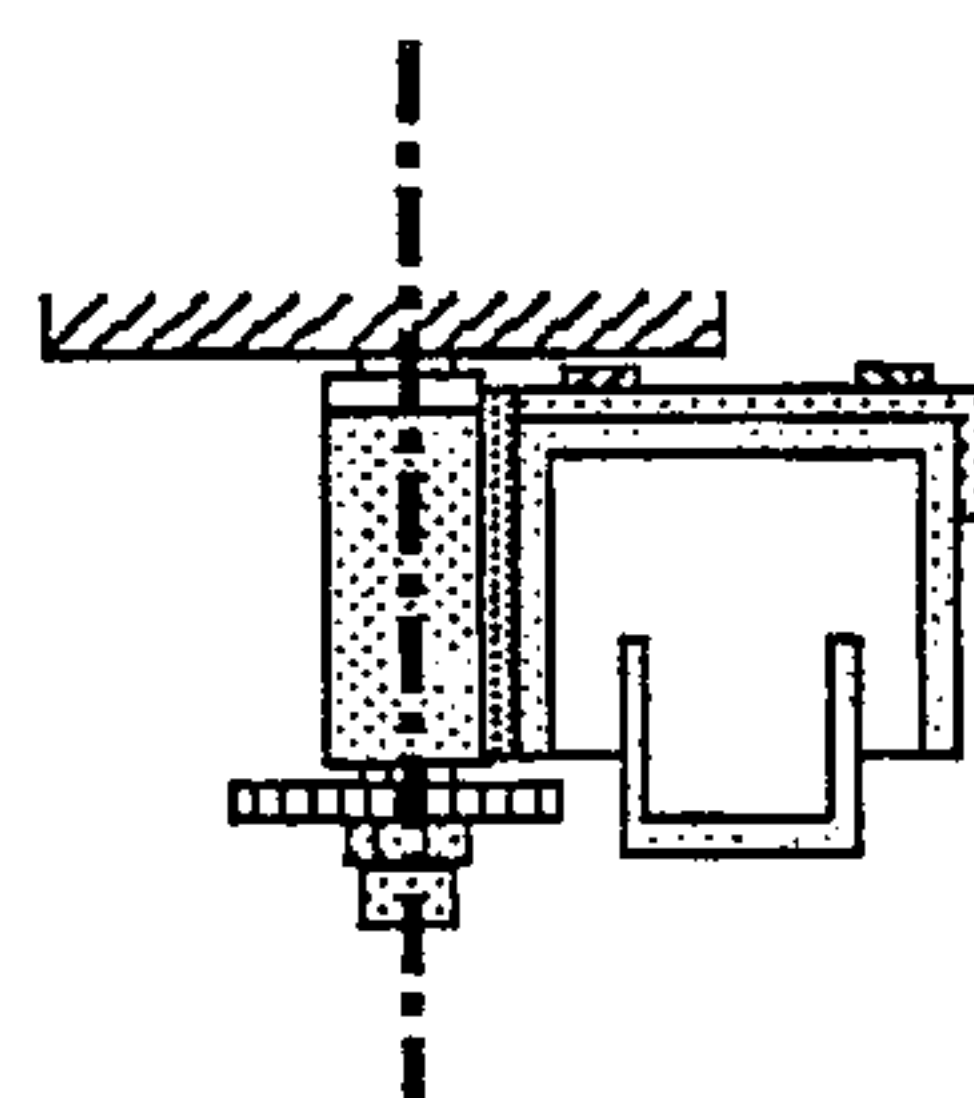


FIG. 16



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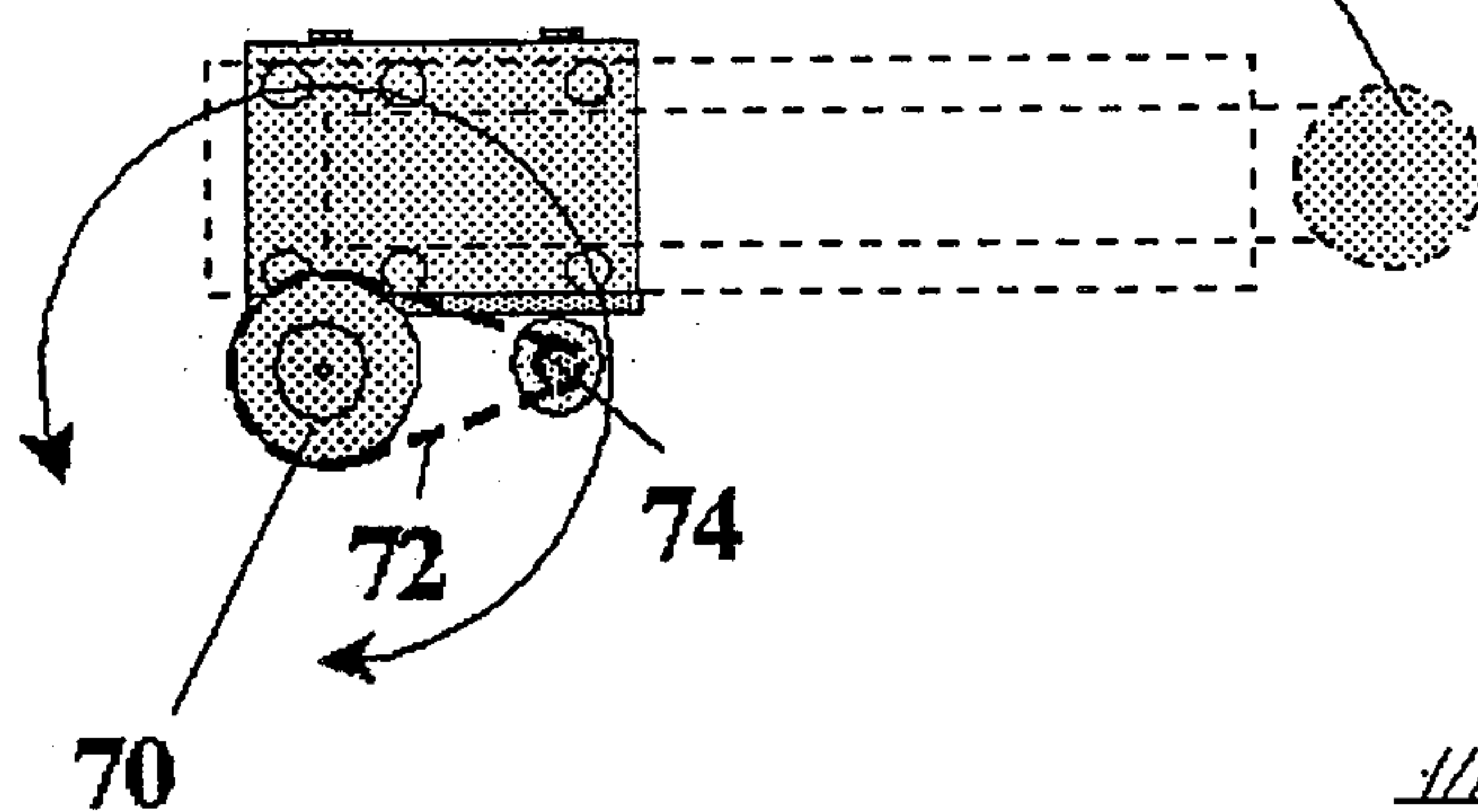
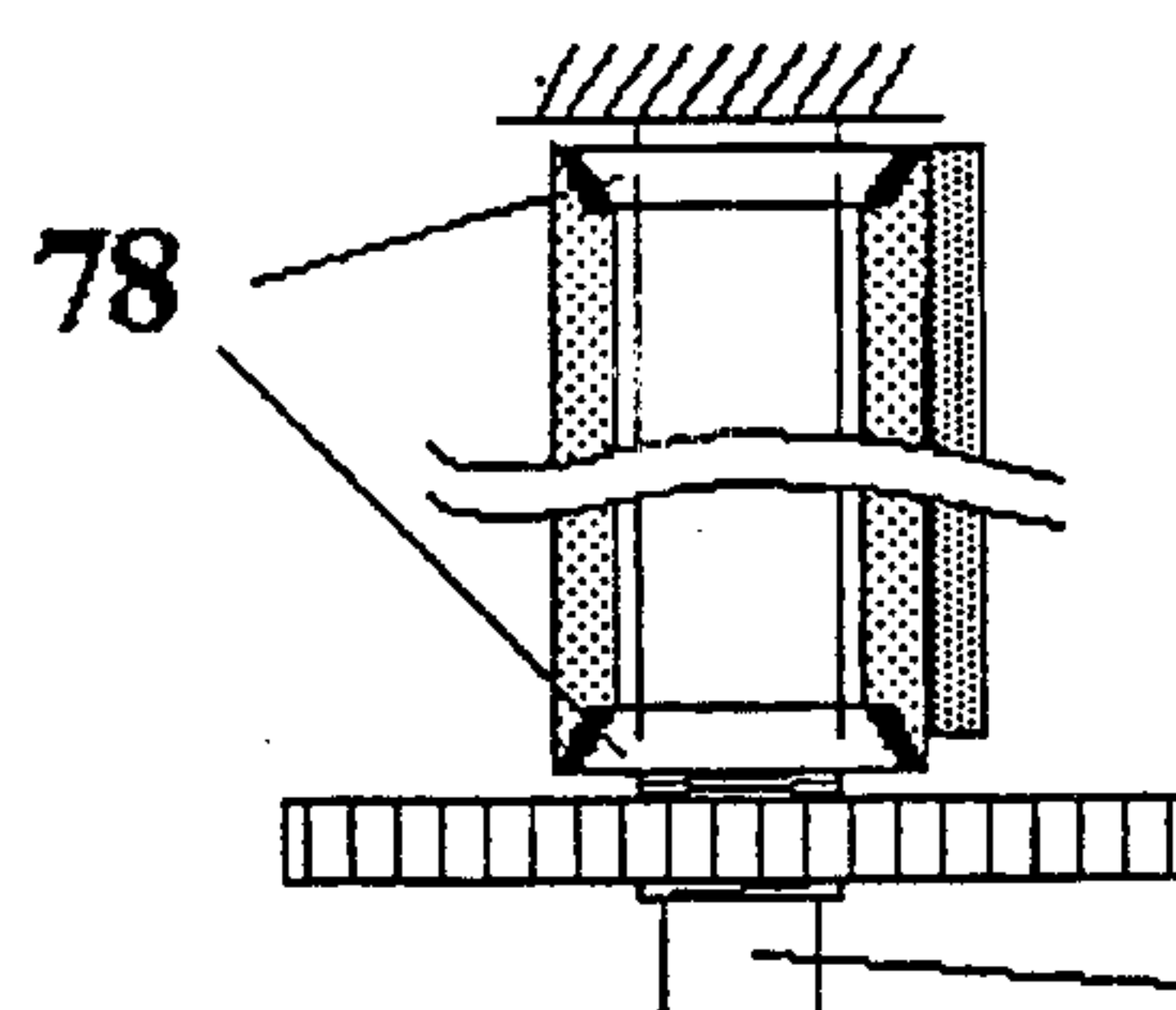


FIG. 17

FIG. 15



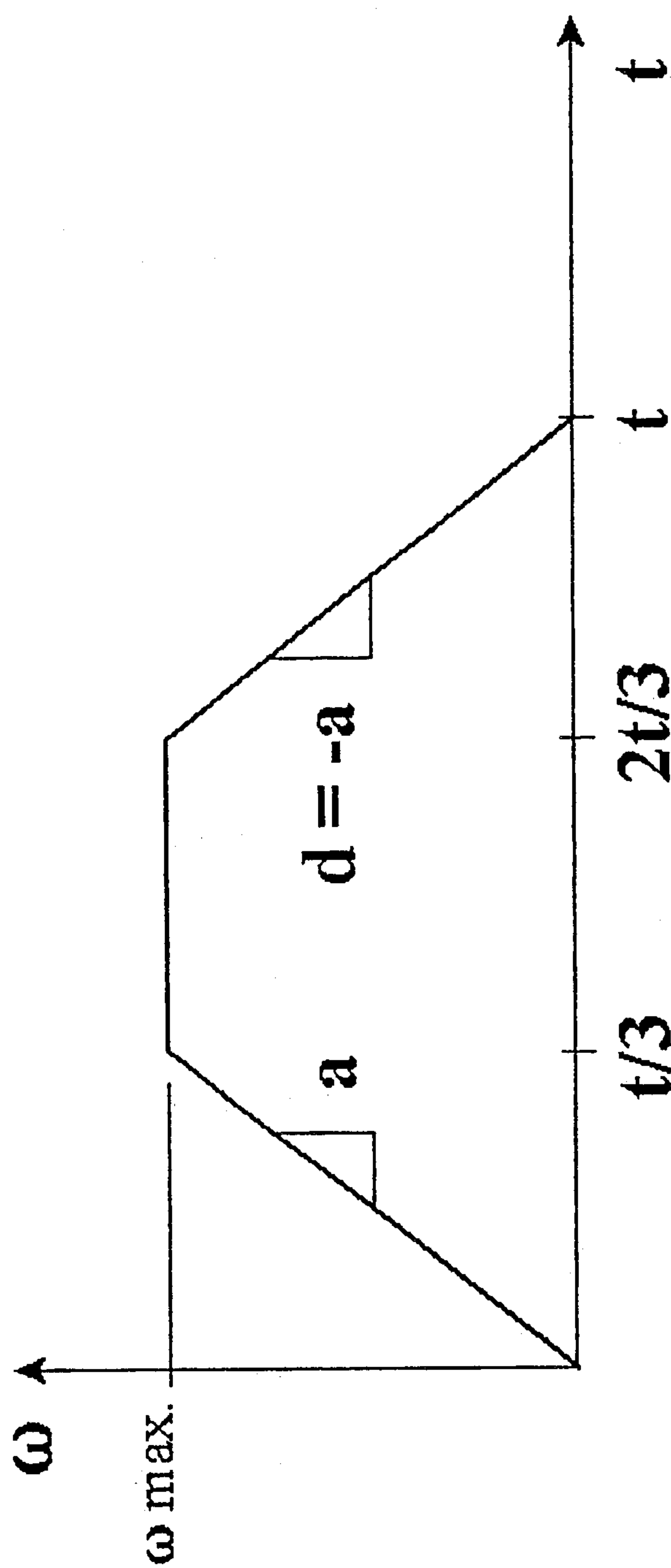


FIG. 18

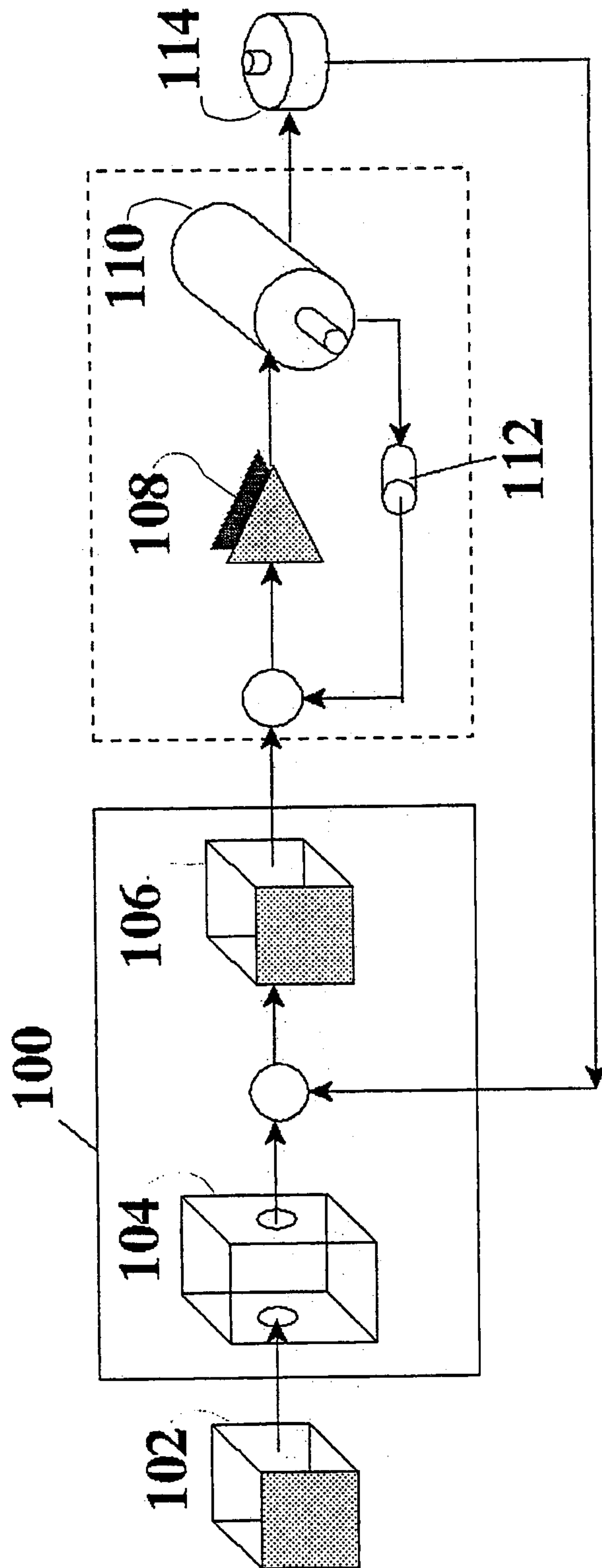


FIG. 19

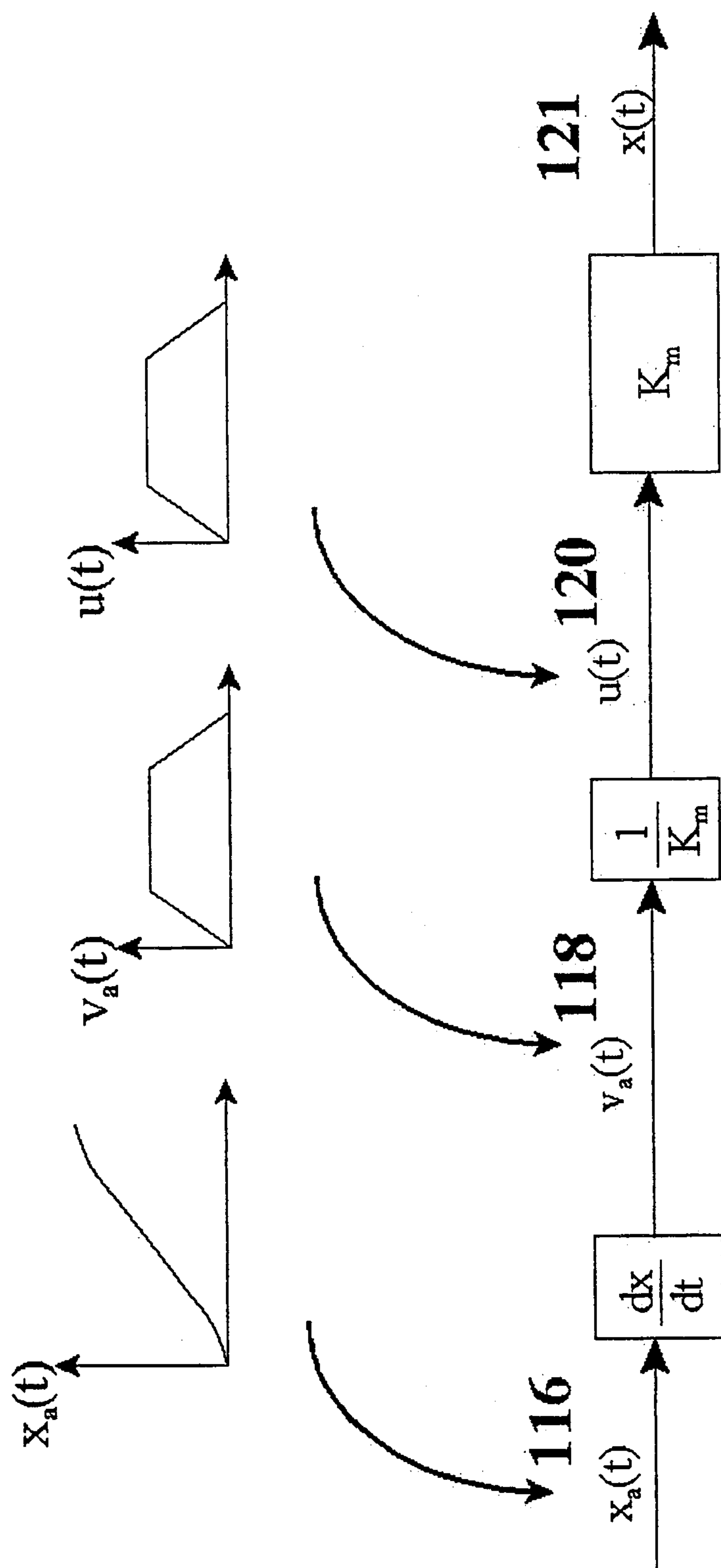


FIG. 20

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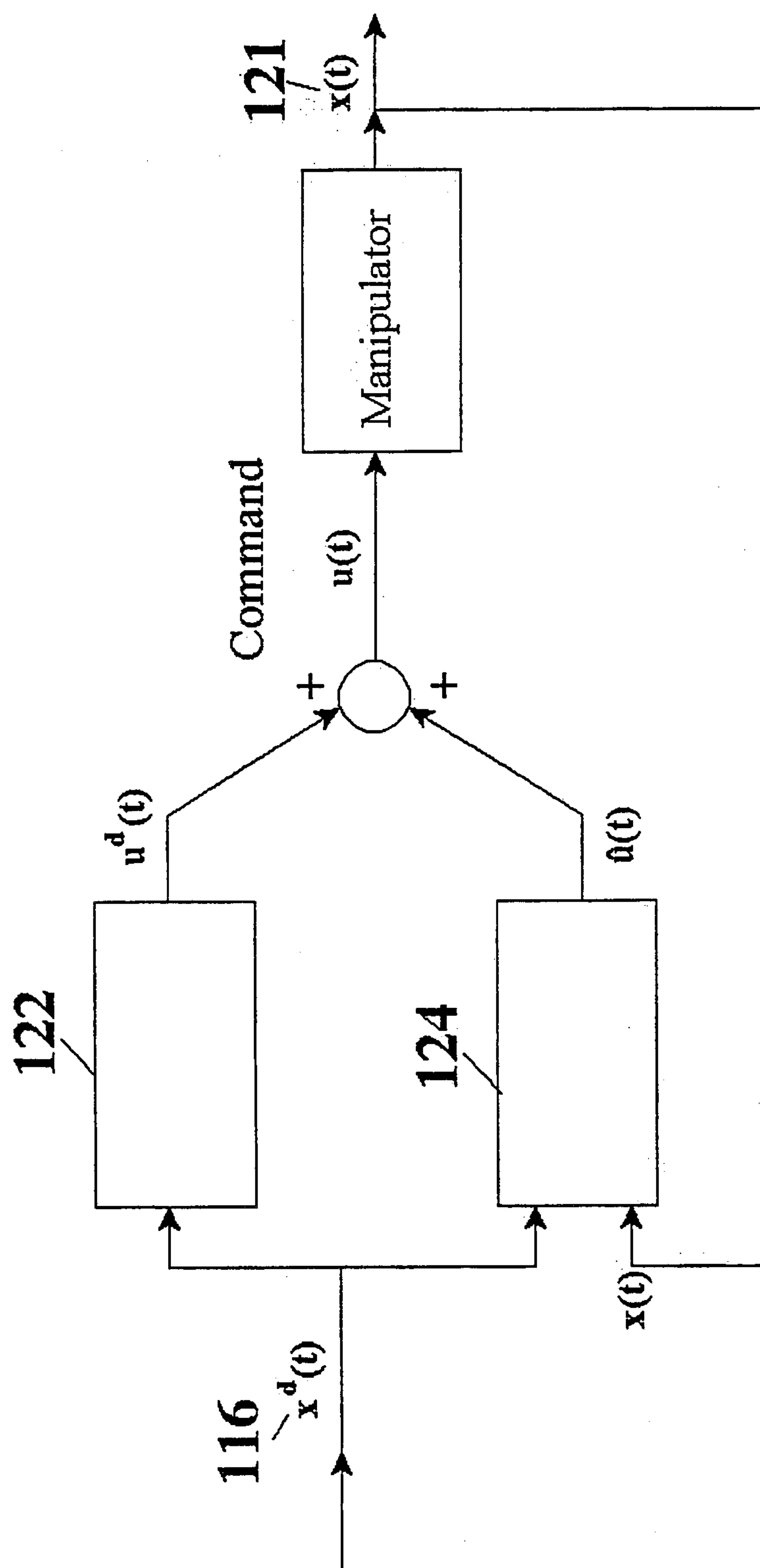


FIG. 21

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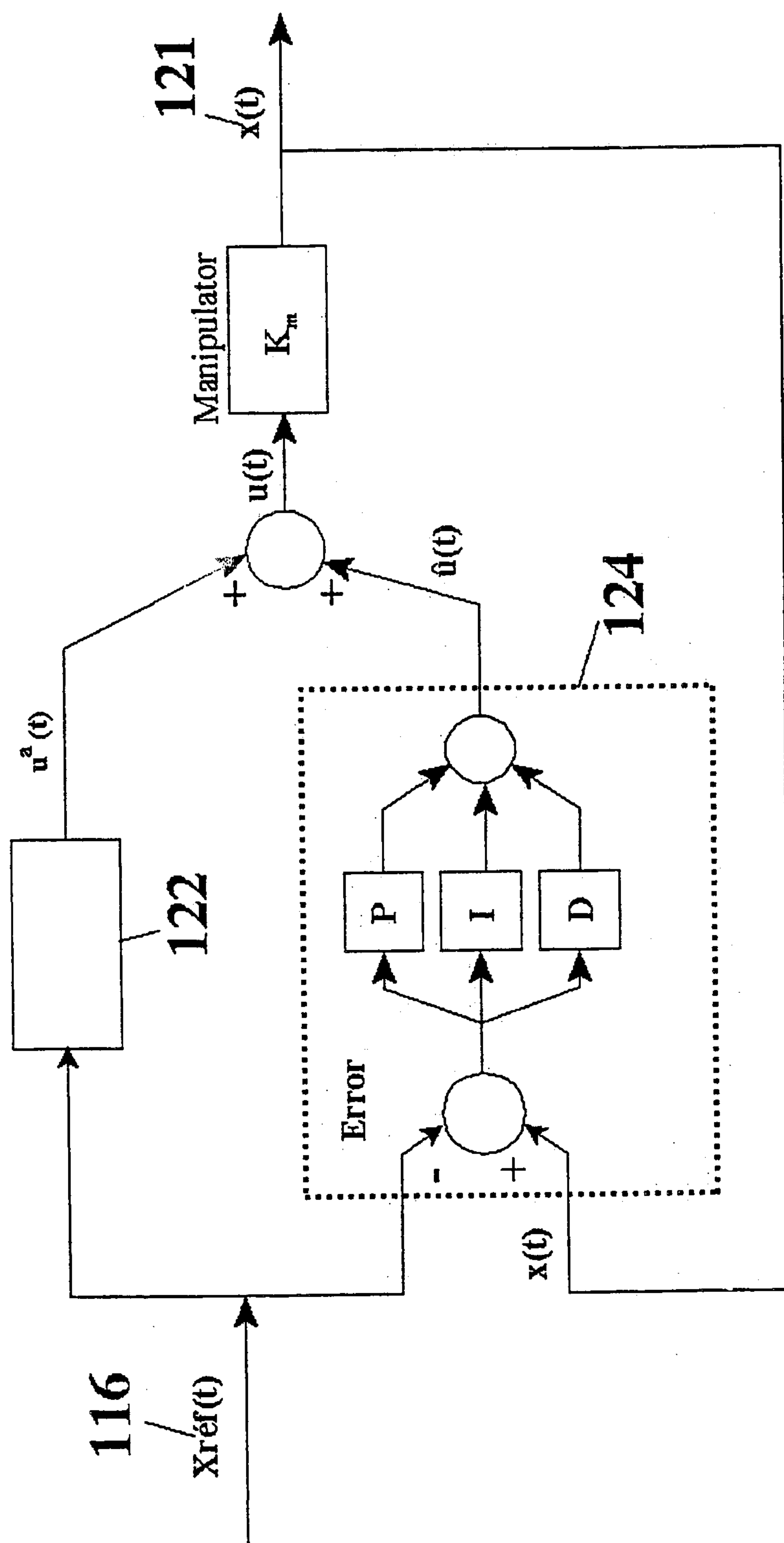


FIG. 22

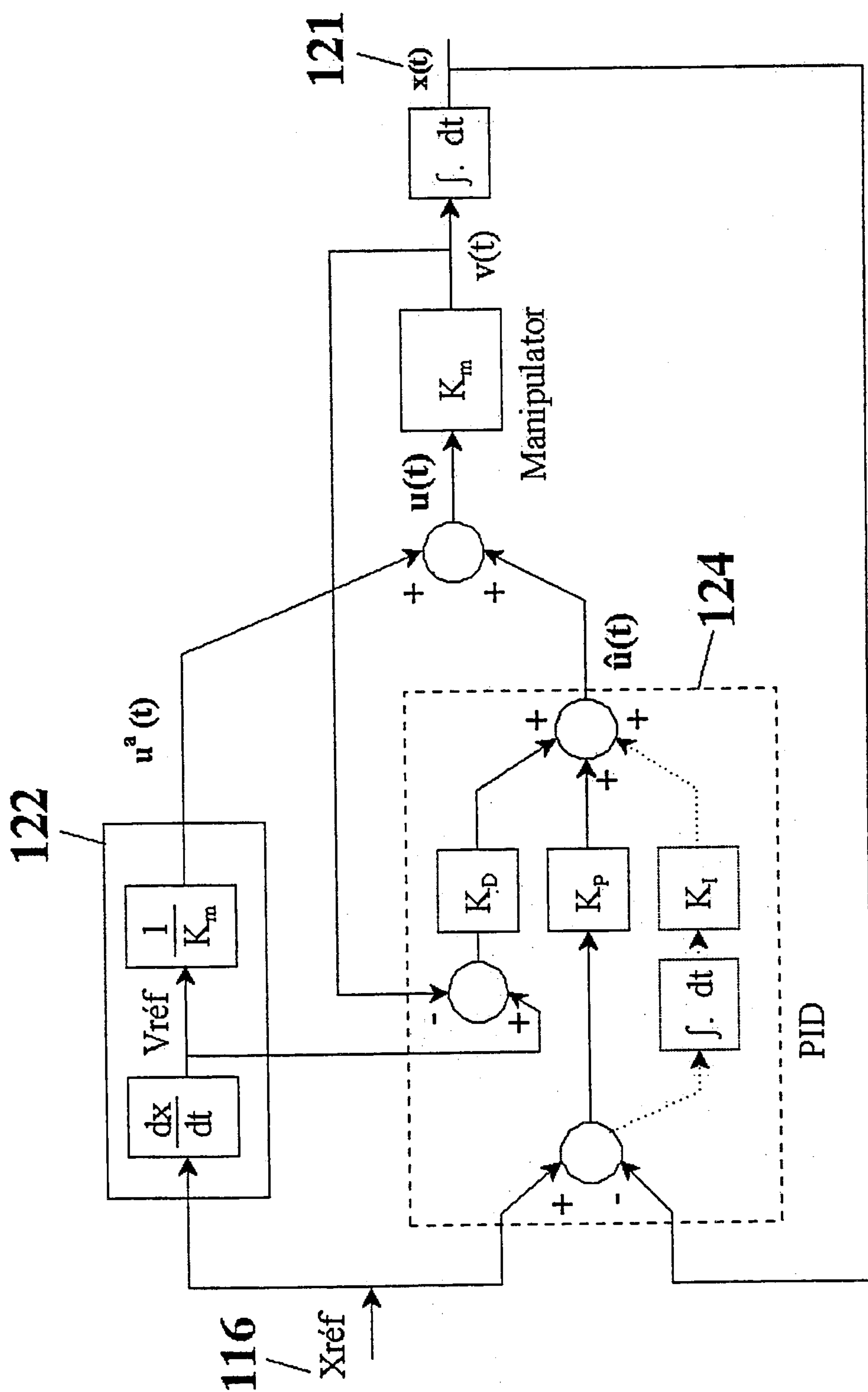
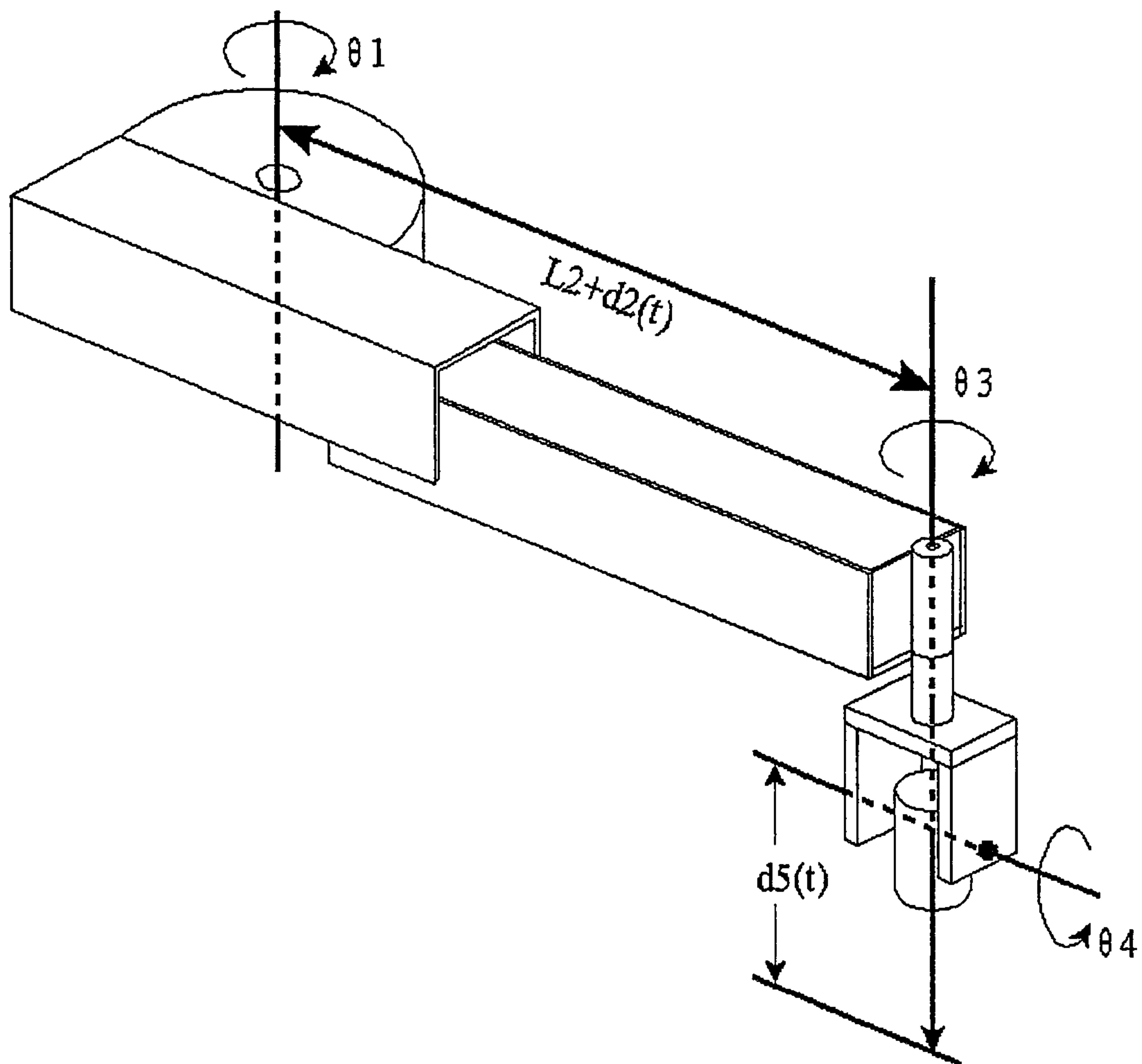


FIG. 23

FIG. 24A

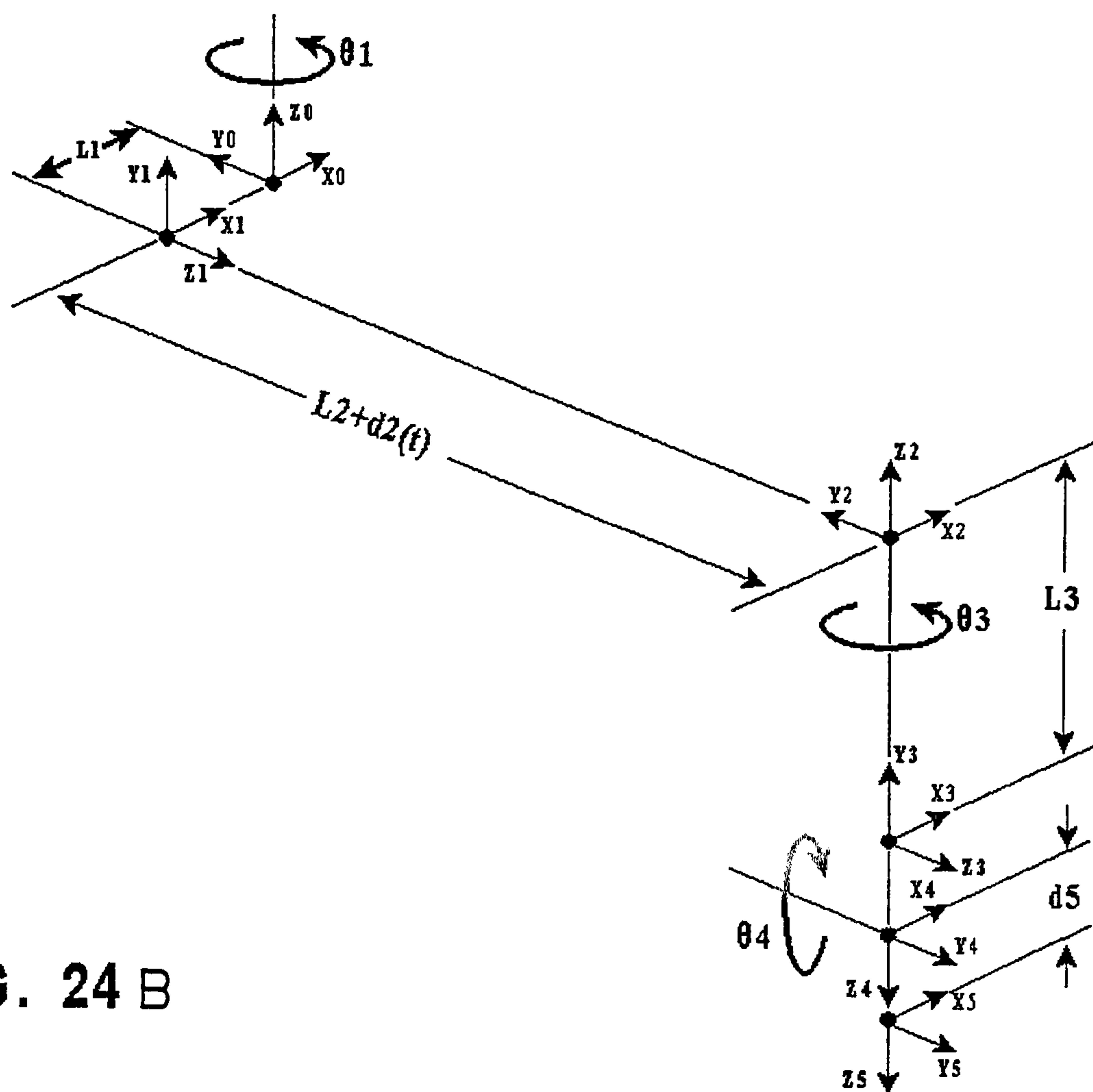
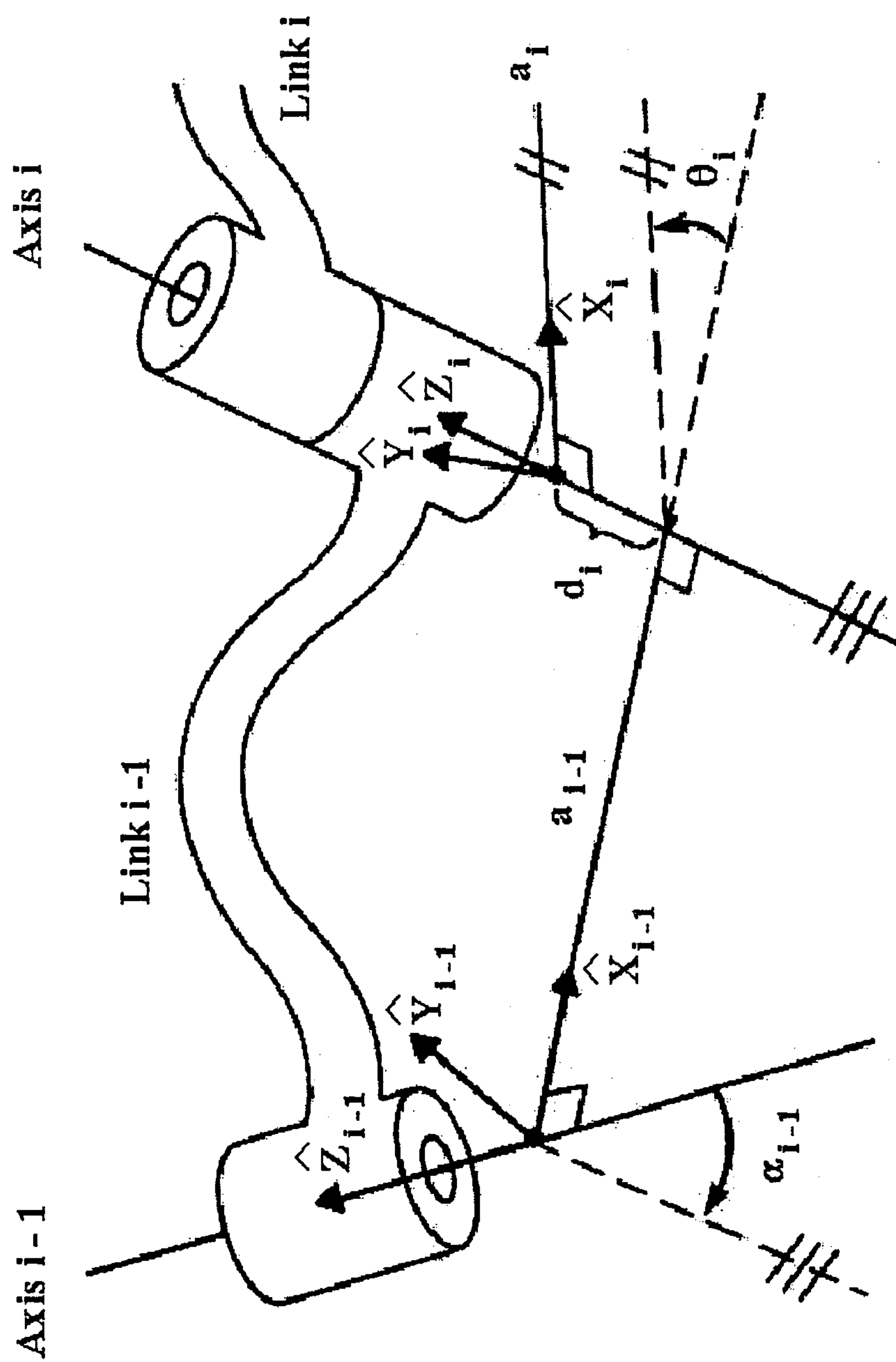
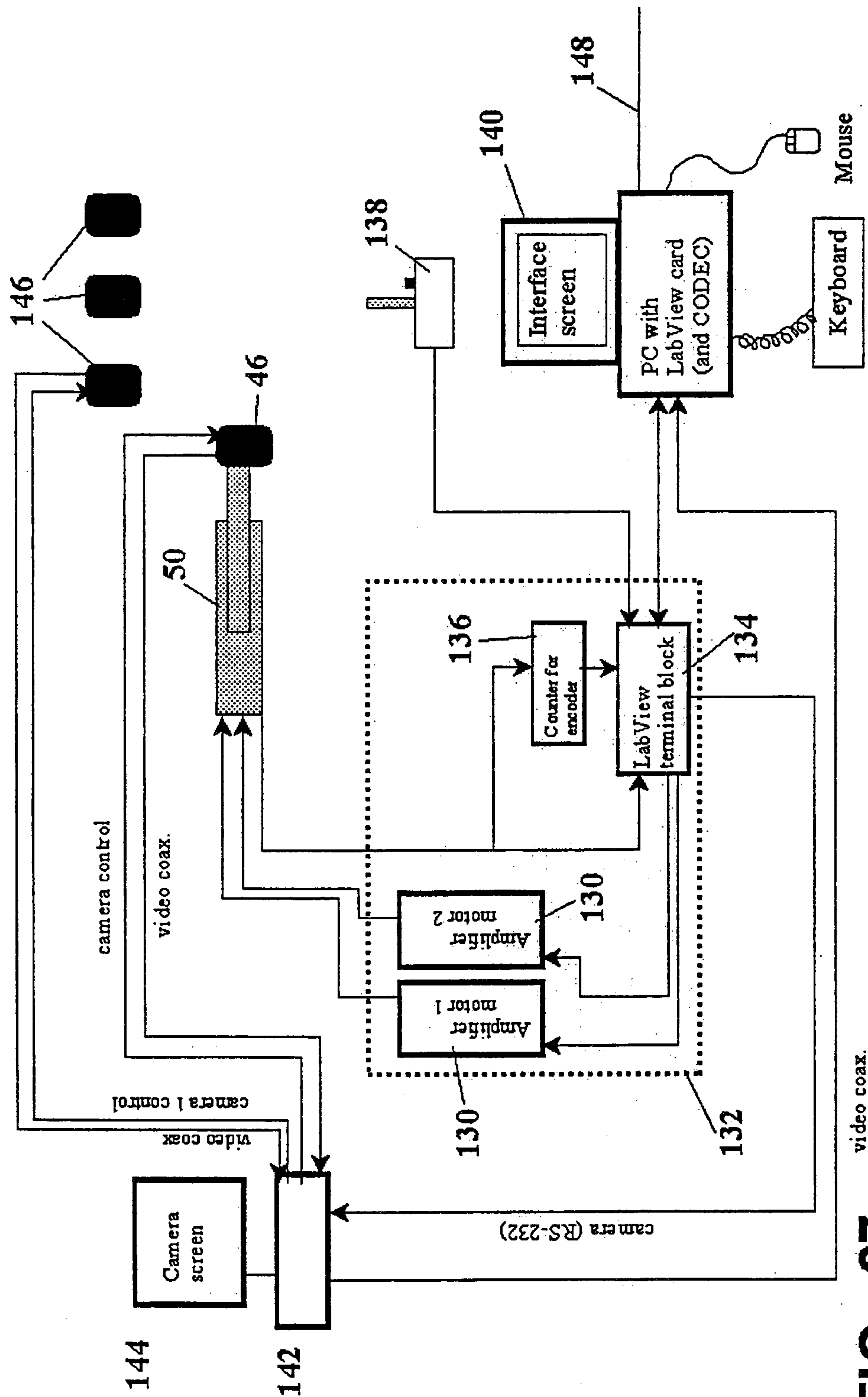


FIG. 24 B

**FIG. 25**

i	d_i	a_i	α_i	θ_i
1	0	-L1	$\pi/2$	$\theta 1$
2	$L2+d2(t)$	0	$-\pi/2$	0
3	-L3	0	$\pi/2$	$\theta 3$
4	0	0	$\pi/2$	$\theta 4$
5	$d5(t)$	0	0	0

FIG. 26

**FIG. 27**

150

Cursor Mode

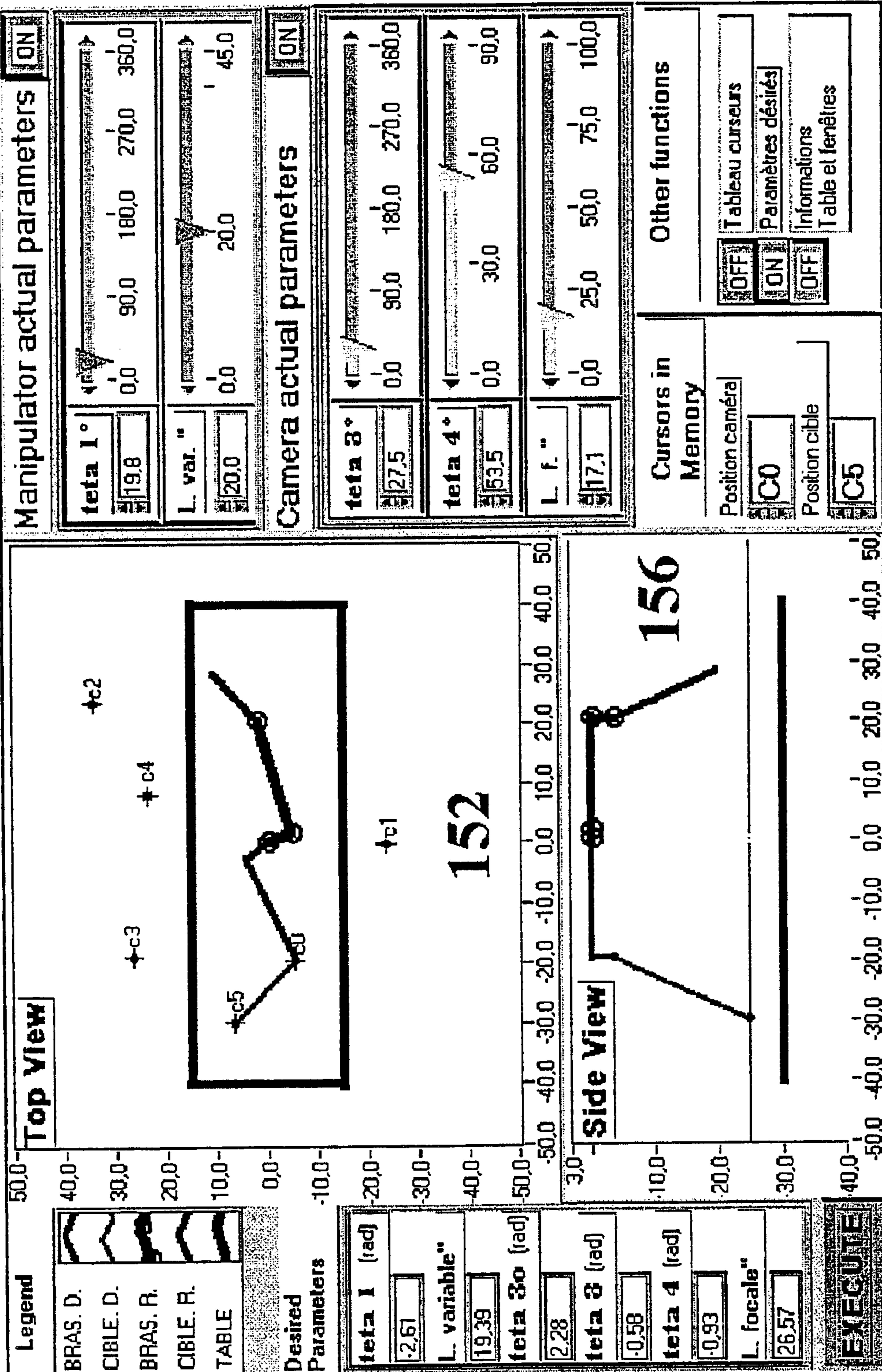


FIG. 28

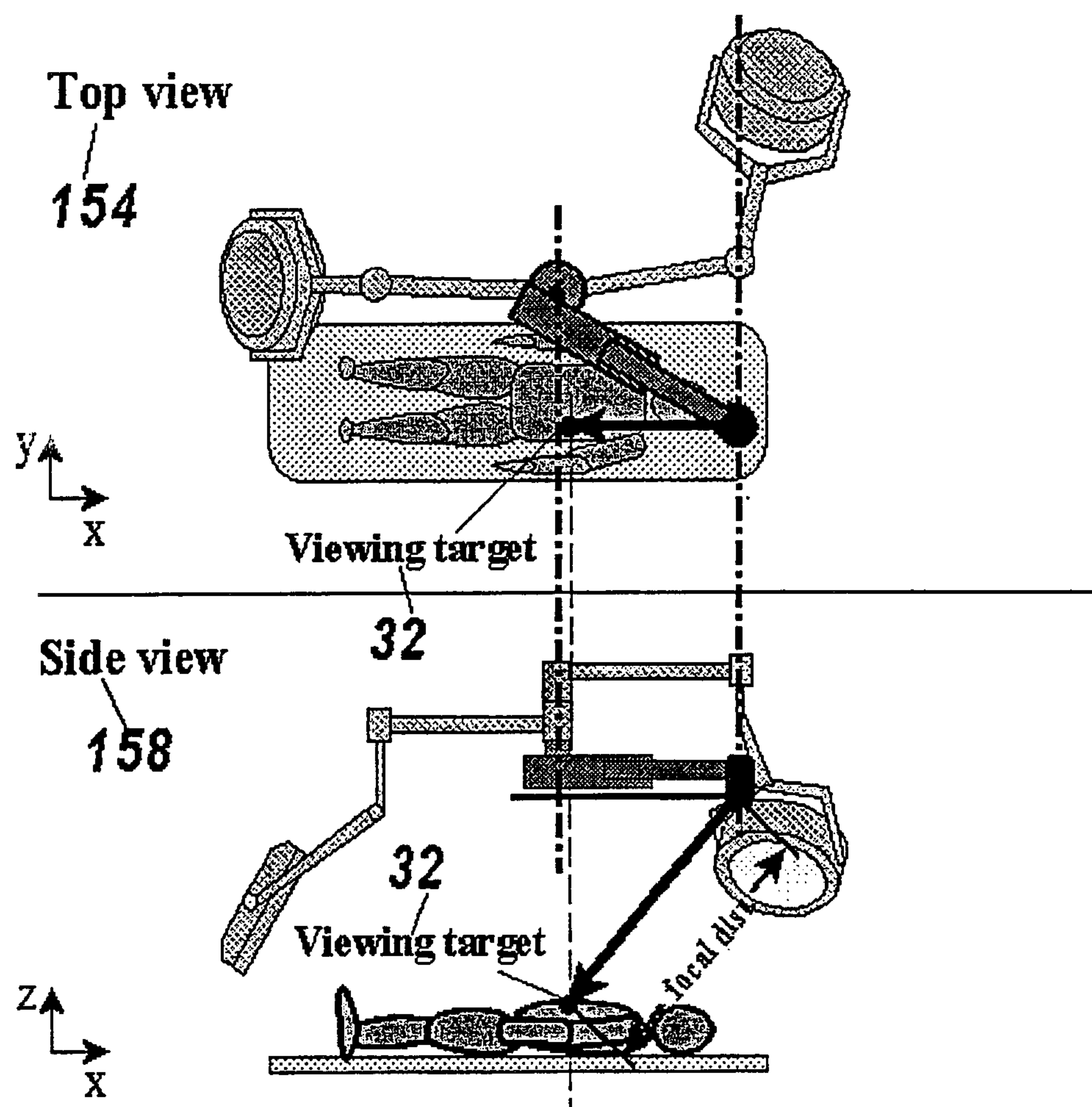


FIG. 29

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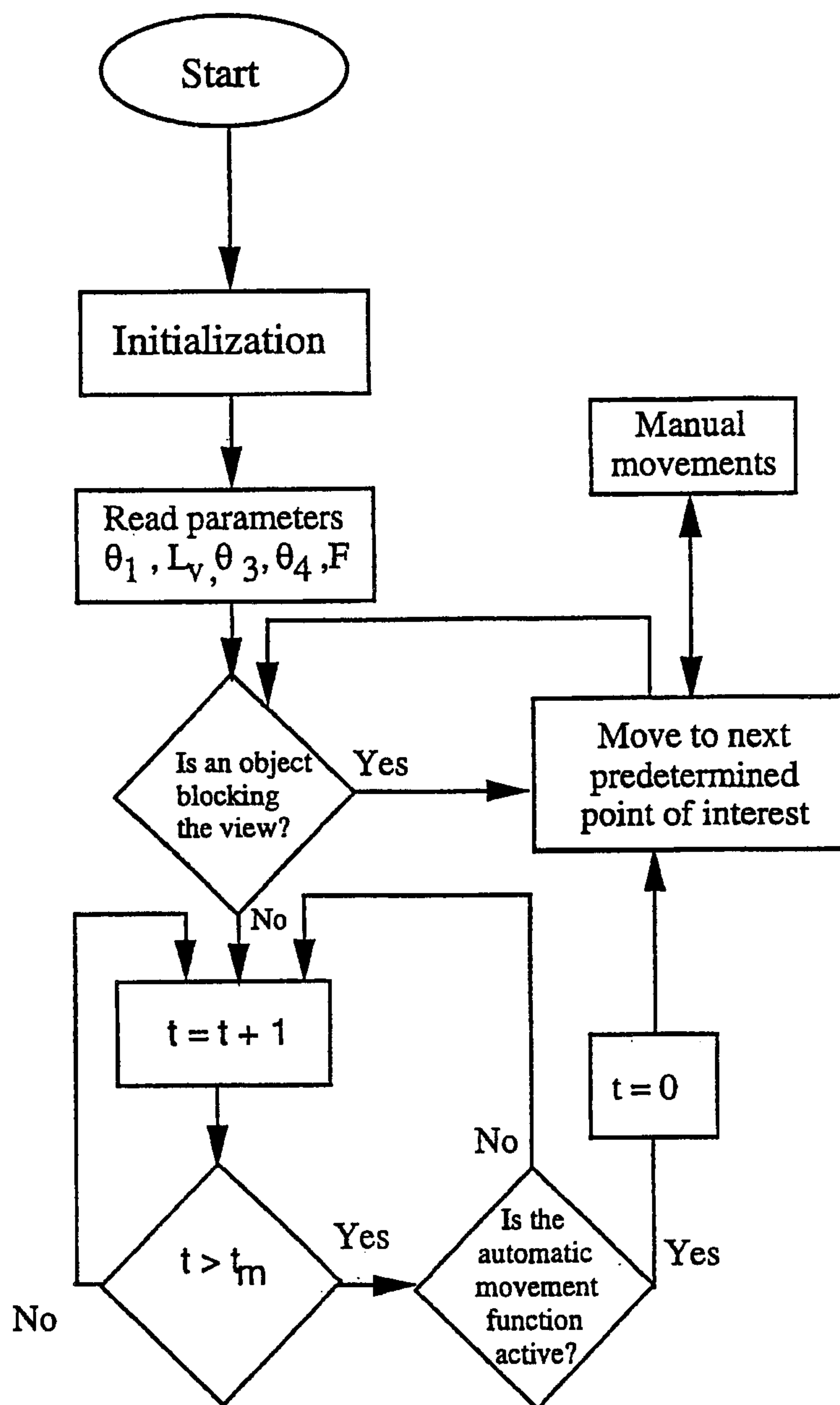


FIG 30

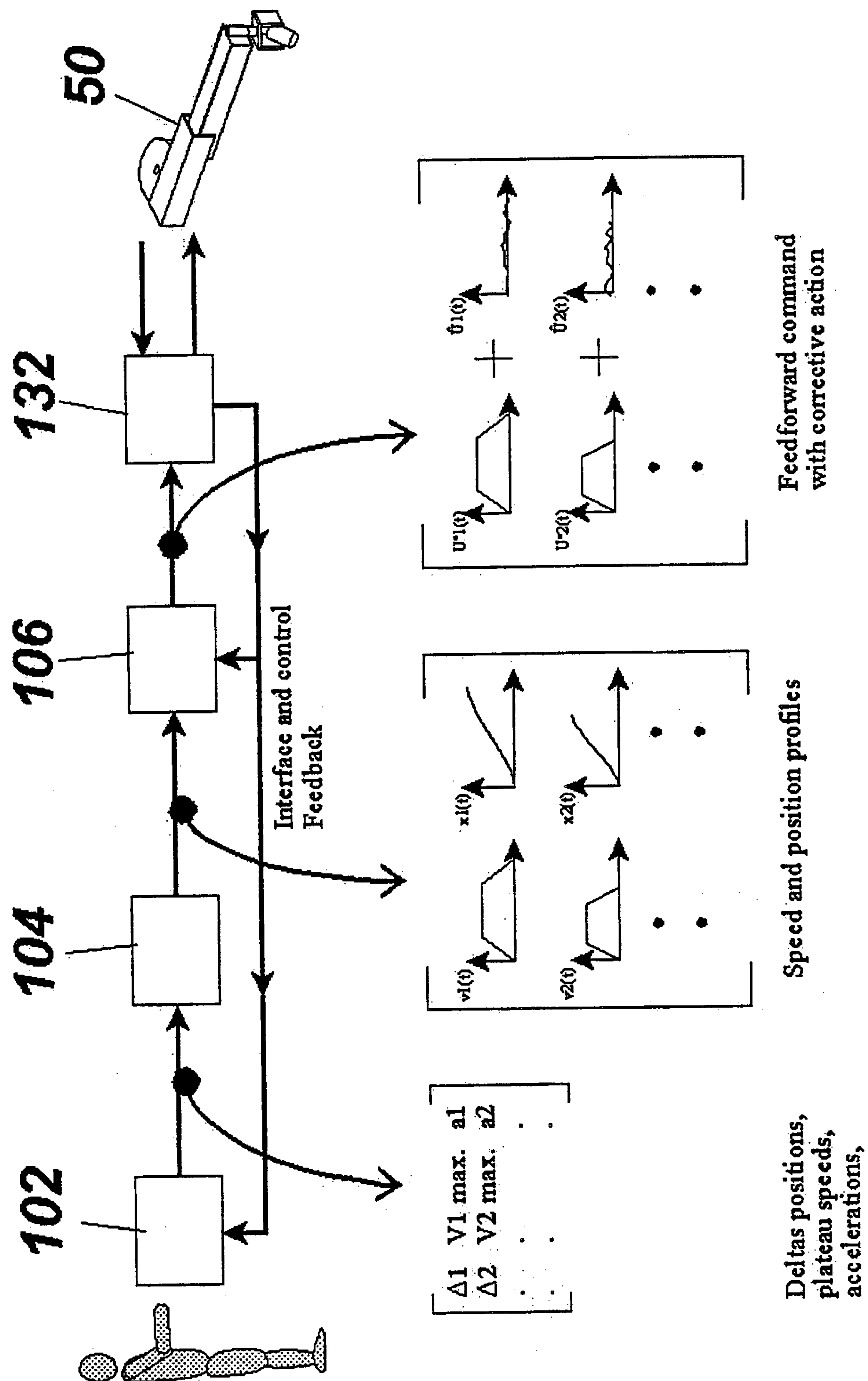


FIG. 31

