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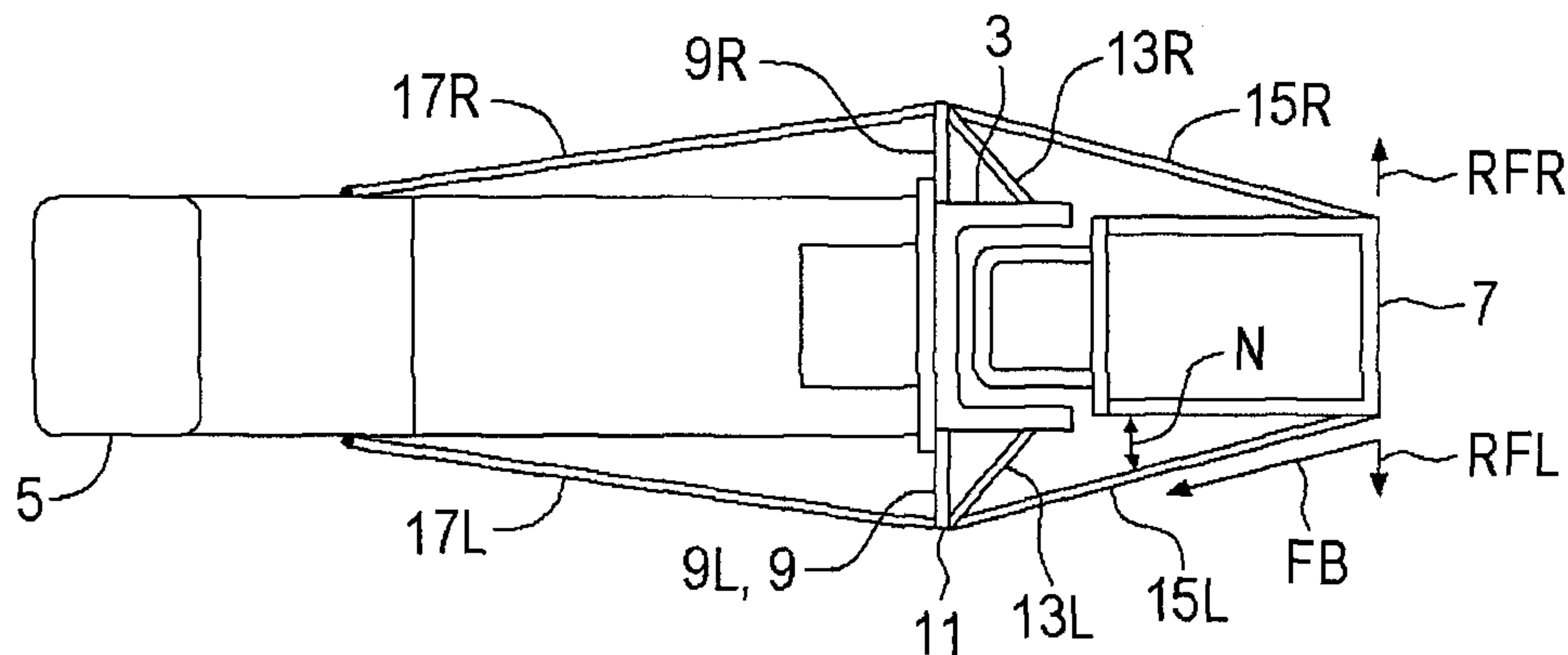
(71) **Demandeur/Applicant:**
SPARTA ENGINEERING INC., CA

(72) **Inventeur/Inventor:**
HANSEN, SHAWN PETER, CA

(74) **Agent:** MACPHERSON LESLIE & TYERMAN LLP

(54) **Titre : STABILISATION DU COUPLE D'UN MAT D'APPAREIL DE LEVAGE**

(54) **Title: TORQUE STABILIZATION FOR A RIG MAST**



(57) **Abrégé/Abstract:**

A rig mast torque stabilization system has a racking board extending rearward from a middle portion of a vertical mast. Right and left braces are movable from a transport position to an operating position extending laterally outward from the mast. Right and left mast tethers are each connected to the corresponding brace, and to the mast above the brace. Right and left board tethers are each connected to the corresponding brace, and to the racking board. Right and left vehicle tethers are each connected to the corresponding brace, and to a forward location on the vehicle supporting the mast. The mast tethers, board tethers, and vehicle tethers are configured to be in tension when the racking board is in the board operating position, the mast is in the mast operating position, and the braces are in the brace operating position.



ABSTRACT

5 A rig mast torque stabilization system has a racking board extending rearward from a middle portion of a vertical mast. Right and left braces are movable from a transport position to an operating position extending laterally outward from the mast. Right and left mast tethers are each connected to the corresponding brace, and to the mast above the brace. Right and left board tethers are each connected to the corresponding brace, and to
10 the racking board. Right and left vehicle tethers are each connected to the corresponding brace, and to a forward location on the vehicle supporting the mast. The mast tethers, board tethers, and vehicle tethers are configured to be in tension when the racking board is in the board operating position, the mast is in the mast operating position, and the braces are in the brace operating position.

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TORQUE STABILIZATION FOR A RIG MAST

This disclosure relates to the field of well drilling and servicing rigs and in particular a system for resisting torque forces on the mast of such rigs.

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BACKGROUND

A typical rig for drilling and servicing wells, such as oil and gas wells, comprises a mast mounted on a transport vehicle for movement from one work site to another. The mast typically has a winch mechanism at the top thereof for drawing tubing out of a well. The mast is laid down horizontally on the vehicle for transport, and moved to a vertical position at the work site, typically by tipping the front end of the mast up so the mast extends upward from the rear end of the vehicle.

Typically as well the mast is extended vertically when at the well site, since a taller mast allows for multiple lengths of tubing to be handled which reduces the time required for the various drilling or servicing operations which require the tubing to be pulled out of the well or placed in the well. A common configuration is for the mast to comprise two or more frame members that telescope up and down to extend and retract the mast. The lengths of tubing are commonly supported vertically by a racking board which extends rearward from the mast at a middle vertical location on the mast.

Examples of such rigs are disclosed in United States Patent Numbers 7,246,983 to Zahn and 4,290,495 to Elliston.

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A significant surface area is presented to wind loading when the racking board is filled with tubing extending rearward from the mast. A wind pushing laterally on the tubing puts a considerable torque force on the mast and causes same to twist. The upper ends of

the tubing may move laterally in response to the wind forces causing them to lean against the racking board and add further torque forces on the mast. These torque forces must be resisted to avoid damage to the mast. Typically external guy wires are attached from the mast and/or racking board to anchors spread across the ground, however these interfere
5 with activities taking place around the work site. It is also known to provide internally guyed rigs, typically with outriggers at the rear end of the transport vehicle which extend laterally to stabilize the vehicle and mast, and with the guy wires anchored to the outriggers and to the vehicle itself as well with no actual anchors on the ground.

10 **SUMMARY OF THE INVENTION**

The present disclosure provides a system for resisting torque forces on the racking board of a rig mast that overcomes problems in the prior art.

15 The present disclosure provides a rig mast torque stabilization system comprising a mast pivotally mounted on a vehicle for transport, the mast movable from a substantially horizontal mast transport position to a substantially vertical mast operating position extending upward from a rear end of the vehicle. A racking board extends, when in a board operating position, rearward from a vertical location in a middle portion of the
20 mast when the mast is in the mast operating position. Right and left elongated braces are movably attached to corresponding right and left sides of the middle portion of the mast, and are movable from a brace transport position where outer ends of the braces are in proximity to the mast, to a brace operating position where the braces extend laterally outward from corresponding right and left sides of the mast to the outer ends of the
25 braces. Right and left mast tethers are each connected at a lower end thereof to the corresponding right and left brace, and each is connected at an upper end thereof to the mast at a location above the corresponding right and left brace. The mast tethers are configured to be in tension when the racking board is in the board operating position, the

mast is in the mast operating position, and the braces are in the brace operating position. Right and left board tethers are each connected at an outer end thereof to an outer end of the corresponding right and left brace, and each is connected at an inner end thereof to the racking board. The board tethers are configured to be in tension when the racking
5 board is in the board operating position, the mast is in the mast operating position, and the braces are in the brace operating position. Right and left vehicle tethers are each connected at an upper end thereof to the corresponding right and left brace, and connected at a lower end thereof to a forward location on the vehicle. The vehicle tethers are configured to be in tension when the racking board is in the board operating position,
10 the mast is in the mast operating position, and the braces are in the brace operating position.

The tethers, braces, etc. will be sized and connected at locations suitable for a particular rig configuration. The tension on the board tethers exerts lateral right and left forces on
15 the racking board that resists torque forces caused by wind, leaning tubing, or the like. Positioning the braces just below the racking board provides a large proportion of the tension force in the board tethers providing lateral force on the racking board with little downward force exerted on the racking board. The system can be configured for a variety of rig configurations to suitably stabilize the racking board against torque forces
20 from wind, leaning tubing and like factors

DESCRIPTION OF THE DRAWINGS

While the invention is claimed in the concluding portions hereof, preferred embodiments
25 are provided in the accompanying detailed description which may be best understood in conjunction with the accompanying diagrams where like parts in each of the several diagrams are labeled with like numbers, and where:

Fig. 1 is a schematic top view of an embodiment of the rig mast stabilization system of the present disclosure in the operating position;

Fig. 2 is a schematic side view of the embodiment of Fig. 1 in the operating position;

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Fig. 3 is a schematic top view of the embodiment of Fig. 1 in the transport position;

Fig. 4 is a schematic side view of the embodiment of Fig. 1 in the operating position;

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Fig. 5 is a schematic side view of the embodiment of Fig. 1 in an intermediate position with the mast vertical but not yet extended;

Fig. 6 is a schematic side view of the embodiment of Fig. 1 in the operating position with the mast fully extended and all tethers in tension;

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Fig. 7 is a schematic side view of an internally guyed rig of the prior art;

Fig. 8 is a rear view of the prior art internally guyed rig of Fig. 7;

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Fig. 9 is a schematic perspective view of the outer end of the brace of the embodiment of Fig. 1;

Fig. 10 is a schematic end view of the outer end of the brace illustrated in Fig. 9;

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Fig. 11 is a schematic front view of the braces of the embodiment of Fig. 1 showing the braces pivoting from the brace transport position to the brace operating position;

Fig. 12 is a schematic front view of an alternate arrangement of braces of showing the braces telescoping from the brace transport position to the brace operating position.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

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Figs. 1 - 6 schematically illustrate an embodiment of a rig mast stabilization system 1 of the present disclosure. The system 1 comprises a mast 3 pivotally mounted on a vehicle 5 for transport. The mast 3 is movable from a substantially horizontal mast transport position shown in Figs. 3 and 4 to a substantially vertical mast operating position shown in Fig. 2 extending upward from a rear end of the vehicle 5. In the illustrated system 1 the mast pivots about a horizontal mast pivot axis MPA to move between horizontal to vertical. Typically such masts operate slightly off exact vertical by about three to four degrees.

15 A racking board 7 extends, when in a board operating position, rearward from a vertical location in a middle portion of the mast 3 when the mast 3 is in the mast operating position shown in Fig. 2.

Right and left elongated braces 9R, 9L are movably attached to corresponding right and left sides of the middle portion of the mast 3. The braces 9 are movable from a brace transport position 9A where outer ends 11 of the braces 9 are in proximity to the mast 3 as shown in Fig. 3, to a brace operating position 9B where the braces 9 extend laterally outward from corresponding right and left sides of the mast 3 to the outer ends 11 of the braces 9.

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Right and left mast tethers 13R, 13L are each connected at a lower end thereof to the corresponding right and left brace 9R, 9L, and each mast tether 13 is connected at an upper end thereof to the mast 3 at a location above the corresponding right and left brace

9. The mast tethers 13 are configured to be in tension when, as shown in Fig. 2, the racking board 7 is in the board operating position, the mast 3 is in the mast operating position, and the braces 9 are in the brace operating position. The mast tethers 13 will typically be connected to the braces 9 at or near the outer ends 11 thereof.

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Right and left board tethers 15R, 15L are each connected at an outer end thereof to the outer end 11 of the corresponding right and left brace 9R, 9L, and each board tether 15 is connected at an inner end thereof to the racking board 7, and for best advantage to the outer corners of the racking board 7. Like the mast tethers 13, the board tethers 15 are configured to be in tension when, as shown in Fig. 2, the racking board 7 is in the board operating position, the mast 3 is in the mast operating position, and the braces 9 are in the brace operating position.

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Finally, right and left vehicle tethers 17R, 17L are each connected at an upper end thereof to the corresponding right and left brace 9R, 9L, typically at or near the outer ends 11 thereof, and each vehicle tether 17 is connected at a lower end thereof to a forward location 19 on the vehicle 5. Like the mast tethers 13 and the board tethers 15, the vehicle tethers 17 are configured to be in tension when, as shown in Fig. 2, the racking board 7 is in the board operating position, the mast 3 is in the mast operating position, and the braces 9 are in the brace operating position.

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Further cables and lines extend between the mast 3, the vehicle 5, and the racking board 7 as is known in the art and are not further illustrated to allow clear illustration of the present rig mast stabilization system 1.

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With all the tethers 13, 15, 17 in tension, it can be seen that lateral right and left stabilizing forces RFR and RFL are exerted on the racking board 7. These forces stabilize the mast 3 by resisting lateral forces from wind, tubing leaning on the racking

board, and the like which tend to twist the mast 3. The forces RFR, RFL are equal to the right and left components of the tension forces BF exerted on the board tethers 15. It can be seen that as the length of the braces 9 increases, the angle N increases as well and the lateral component of the tension force F, which provides the racking board forces RFR, RFL, increases as well. Typically in the present system 1 the length of the braces 9 is selected to provide sufficient lateral right and left forces RFR and RFL on the racking board 7 while still being practical to use.

In the prior art, rigs are stabilized by external guy wires where guy wires connect ground anchors to the racking board however these ground anchors interfere with the work area on the ground around the rig and so are undesirable. Internally guyed systems are also known, for example as schematically illustrated in the system 101 in Figs. 7 and 8, where guy wires 117 connect the racking board 107 with outriggers 121 which extend outward from the transporting vehicle 105. It can be seen that, because of the limited length of the outriggers 121, the angle N' between the guy wires 117 and the mast 103, which provides the lateral force component RF' on the racking board 107, is quite small compared to the angle N in the system 1 of the present disclosure.

Thus in the internally guyed systems of the prior art the lateral component RF' of the tension force F' is a small proportion of the total, and so a significantly greater tension force F' must be exerted to achieve a satisfactory stabilizing lateral force RF on the racking board 107. It can be seen as well that the downward component of force DF' pulling down on the outer end of the racking board 107 is very significant, requiring further guy wires extending up to the upper part of the mast 103 and from the mast 103 to the vehicle 105.

In contrast it can be seen in Fig. 2 that the downward component DF of the tension force BF in the board tether 15 is a small proportion of the total.

As is common with service and drilling rigs of the type contemplated the mast 3 is extendable. As schematically illustrated in Figs. 3 – 6, the mast 3 is retracted when in the mast transport position seen in Figs. 3 and 4, and when moving from the mast transport position to the mast operating position the mast 3 is moved from the horizontal transport position of Fig. 4 to a vertical retracted position shown in Fig. 5 with a lower mast section 3A extending upward from the rear end of the vehicle 5, and then an upper mast section 3B is moved upward with respect to the lower mast section 3A to extend the mast 3 vertically to the mast operating position shown in Fig. 6. The braces 9 are attached to an upper portion of the lower mast section 3A and the racking board 7 is attached to a lower portion of the upper mast section 3B, such that the racking board 7 moves upward with the upper mast section 3B to a vertical position in proximity to the braces 9 when the mast 3 moves to the mast operating position.

15 The tethers 13, 15, 17 can be installed and tensioned after the mast 3, racking board 7, and braces 9 are in their operating positions, and this may be most convenient where the mast is of a fixed length and not extendable. Where as is common the industry, the mast is extendable, installing the tethers and tensioning them can be more problematic.

20 The illustrated system 1 with the extendable mast 3 conveniently facilitates installation and tensioning of the tethers by using right and left main tethers 23R, 23L to provide the corresponding right and left board tethers 15R, 15L and right and left vehicle tethers 17R, 17L. Each main tether 23 comprises a board section 23A between the upper end thereof connected to the racking board 7 and a stop member 25 attached to the main tether 23 at a distance from the racking board 7 that corresponds to a length of the board tether 15, and
25 a vehicle section 23B between the stop member 25 and the lower end thereof attached to the forward location on the vehicle which corresponds to the length of the vehicle tether 17.

The vehicle section 23B of each main tether 23 passes through a hole 27 in a stop plate 29 attached to the outer end 11 of the corresponding brace 9 and then over a pulley 31 attached to the corresponding brace 9, and then downward and forward to the forward location 19 on the vehicle.

As is common in the art, the racking board 7 is pivotally attached to the upper mast section 3B about a horizontal board pivot axis BPA and the racking board 7 pivots upward to a board transport position lying against the upper mast section 3B as seen in Figs. 3 and 4, and then pivots downward to the board operating position extending rearward from the mast as shown in Figs. 5 and 6 when the mast 3 is moved from the horizontal transport position of Fig. 4 to the vertical position of Fig. 5.

In operation, when moving the system 1 from a transport position to an operating position the braces 9 are moved from the transport position 9A shown in phantom lines in Fig. 3 lying against the lower mast section 3A out to the board operating position . When the mast 3 and racking board 7 are in their transport positions as shown in Figs. 3 and 4, and when the mast 3 is moved to the vertical position and the racking board 7 moves to the board operating position as shown in Fig. 5, the vehicle section 23B of each main tether 23 is loose, as shown with the lower end thereof lying coiled on the ground in Fig. 4 and coiled lying on the vehicle 5 in Fig. 5.

The lower end of the main tether 23 is pulled downward as the upper mast section 3B, and the racking board 7 and board section 23A of the main tether 23 attached thereto, moves upward, and when the mast 3 is in the mast operating position of Fig. 6 the lower end of the main tether 23 is connected to a tensioning device 33 at the forward location on the vehicle 19. The tensioning device 33, such as a winch, turnbuckle, or the like is operative to exert tension on the main tether 23 such that the stop members 25 on the right and left main tethers 23R, 23L bear against the stop plates 29 on the corresponding

right and left braces and exert a forward force on the stop plates 29. The stop members 25 is located on the main tethers 23 at locations such that when the stop member 25 contacts the stop plate 29, the board section 23A of the main tether 23 is in tension. The mast tethers 13 have a length selected such that the downward force exerted by the
 5 tension in the vehicle section 23B of the main tether 23 exerts tension in the mast tethers 13.

The combination of forces FM, FB, and FV exerted by the mast tether 13, board tether 17, 23A, and vehicle tether 17, 23B on the outer end 11 of the brace 9 result in a force FB
 10 on the brace 9 is generally inward toward the mast 3.

Typically the stop member 25 is releasably clamped to the main tether 23 with a clamp device 35 so that its location on the main tether can be adjusted to conveniently set up the system initially, and to adjust the position to compensate for stretch or like variations
 15 during continued use.

For most applications it is contemplated that the outer ends 11 of the braces 9 will be just slightly below the board pivot axis BPA when the racking board 7 is in the board operating position, the mast 3 is in the mast operating position, and the braces 9 are in the
 20 brace operating position. This results in a small downward force component DF as shown in Fig. 2, which prevents the racking board 7 from moving upward, and yet keeps a large proportion of the force FB acting perpendicular to the racking board 7 to maximize the lateral stabilizing forces RFR, RFL.

25 In the illustrated system 1 the right and left braces 9R, 9L are pivotally attached to corresponding right and left sides of the mast 3, and pivot from the brace transport position 9A folded substantially into alignment with the mast 3, to the brace operating

position 9B extending substantially perpendicularly outward from the mast 3, as schematically illustrated in Fig. 11.

5 It is also contemplated that the braces could be movably attached in other ways, for example Fig. 12 schematically illustrates the braces 9' telescopically attached to corresponding right and left sides of the mast 3', where the braces 9' telescope outward from the brace transport position 9B' to the brace operating position 9A'.

10 The tethers will typically be wire cable, but could also be chain or the like if same suited a particular application. The exact configuration of the system, such as dimensions, attachment locations of the tethers, braces, etc. will depend on the particular rig in question, and further stabilization equipment such as outriggers or the like will typically be required to support the mast vertically, however the tethers and braces described herein can be configured for a variety of rig configurations to suitably stabilize the
15 racking board against torque forces from wind, leaning tubing and like factors.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous changes and modifications will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation
20 shown and described, and accordingly, all such suitable changes or modifications in structure or operation which may be resorted to are intended to fall within the scope of the claimed invention.

CLAIMS

What is claimed is:

1. A rig mast torque stabilization system comprising:

a mast pivotally mounted on a vehicle for transport, the mast movable from a substantially horizontal mast transport position to a substantially vertical mast operating position extending upward from a rear end of the vehicle;

a racking board extending, when in a board operating position, rearward from a vertical location in a middle portion of the mast when the mast is in the mast operating position;

right and left elongated braces movably attached to corresponding right and left sides of the middle portion of the mast, the braces movable from a brace transport position where outer ends of the braces are in proximity to the mast, to a brace operating position where the braces extend laterally outward from corresponding right and left sides of the mast to the outer ends of the braces;

right and left mast tethers, each mast tether connected at a lower end thereof to the corresponding right and left brace, and each mast tether connected at an upper end thereof to the mast at a location above the corresponding right and left brace, the mast tethers configured to be in tension when the racking board is in the board operating position, the mast is in the mast operating position, and the braces are in the brace operating position;

right and left board tethers, each board tether connected at an outer end thereof to an outer end of the corresponding right and left brace, and each board tether connected at an inner end thereof to the racking board, the board tethers

configured to be in tension when the racking board is in the board operating position, the mast is in the mast operating position, and the braces are in the brace operating position;

right and left vehicle tethers, each vehicle tether connected at an upper end thereof to the corresponding right and left brace, and each vehicle tether connected at a lower end thereof to a forward location on the vehicle, the vehicle tethers configured to be in tension when the racking board is in the board operating position, the mast is in the mast operating position, and the braces are in the brace operating position.

2. The system of claim 1 wherein the mast is extendable, and wherein the mast is retracted when in the mast transport position, and wherein when moving from the mast transport position to the mast operating position the mast is moved from the horizontal transport position to a vertical retracted position with a lower mast section extending upward from the rear end of the vehicle, and then an upper mast section is moved upward with respect to the lower mast section to extend the mast vertically to the mast operating position.
3. The system of claim 2 wherein the braces are attached to an upper portion of the lower mast section and the racking board is attached to a lower portion of the upper mast section, such that the racking board moves upward with the upper mast section to a vertical position in proximity to the braces when the mast moves to the mast operating position.
4. The system of claim 3 wherein the right and left board tethers and right and left vehicle tethers are provided by corresponding right and left main tethers, each main tether comprising a board section between an upper end thereof connected to the racking board and a stop member attached to the main tether at a distance from the racking board that corresponds to a length of the board tether, and a

vehicle section between the stop member and a lower end thereof attached to the forward location on the vehicle.

5. The system of claim 4 wherein the vehicle section of each main tether passes through a hole in a stop plate attached to the outer end of the corresponding brace and then over a pulley attached to the corresponding brace, and then downward and forward to the forward location on the vehicle, where in operation the lower end of the main tether is pulled downward as the upper mast section moves upward, and when the mast is in the mast operating position the lower end of the main tether is connected to a tensioning device operative to exert tension on the main tether such that the stop members on the right and left main tethers bear against the stop plates on the corresponding right and left braces and exert a forward force on the stop plates.
6. The system of any one of claims 4 and 5 wherein the stop member is releasably clamped to the main tether.
7. The system of any one of claims 5 and 6 wherein the racking board is pivotally attached to the upper mast section about a substantially horizontal board pivot axis and wherein the racking board pivots upward to a board transport position lying against the upper mast section, and downward to the board operating position extending rearward from the mast.
8. The system of claim 7 wherein the outer ends of the braces are below the board pivot axis when the racking board is in the board operating position, the mast is in the mast operating position, and the braces are in the brace operating position.
9. The system of any one of claims 1 – 8 wherein the right and left braces are pivotally attached to corresponding right and left sides of the mast, and pivot from the transport position folded substantially into alignment with the mast, to the operating position extending substantially perpendicularly outward from the mast.

10. The system of any one of claims 1 – 8 wherein the right and left braces are telescopically attached to corresponding right and left sides of the mast, and telescope outward from the brace transport position to the brace operating position.

FIG. 1

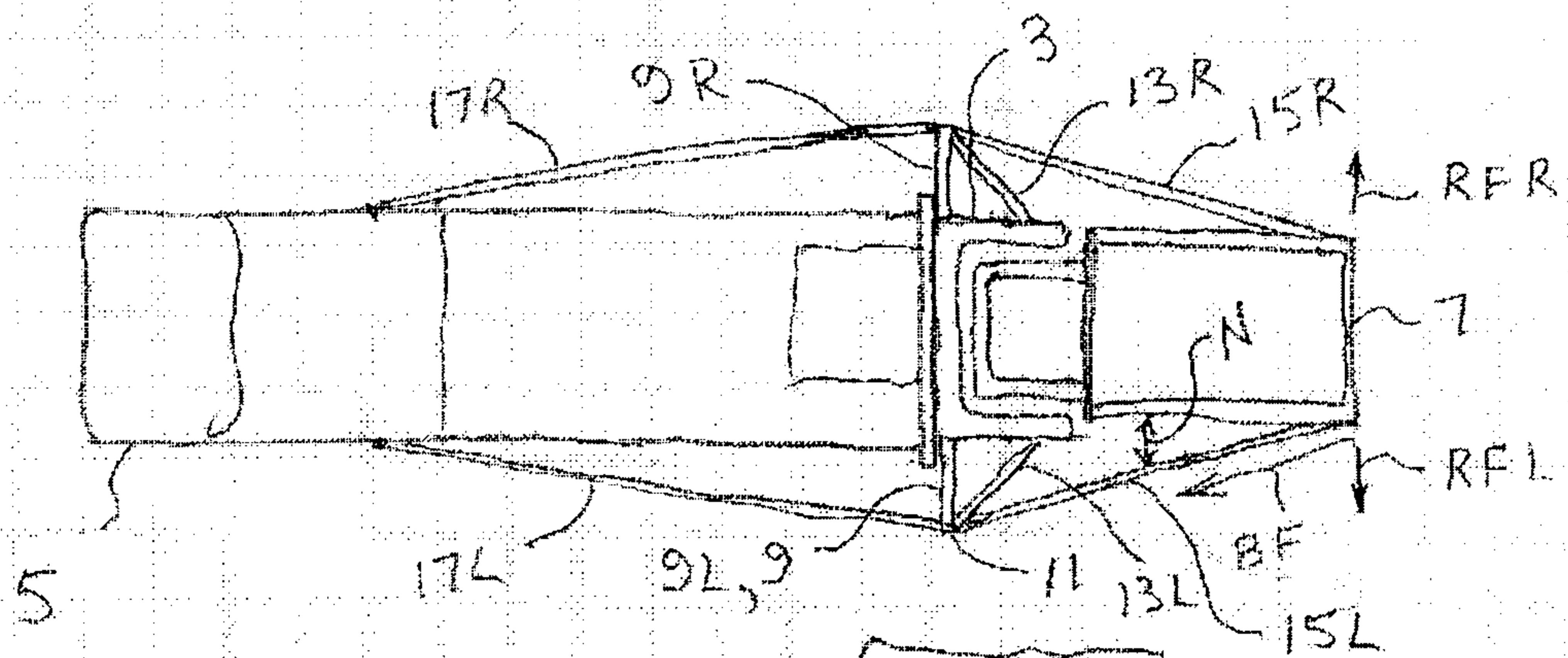


FIG. 2

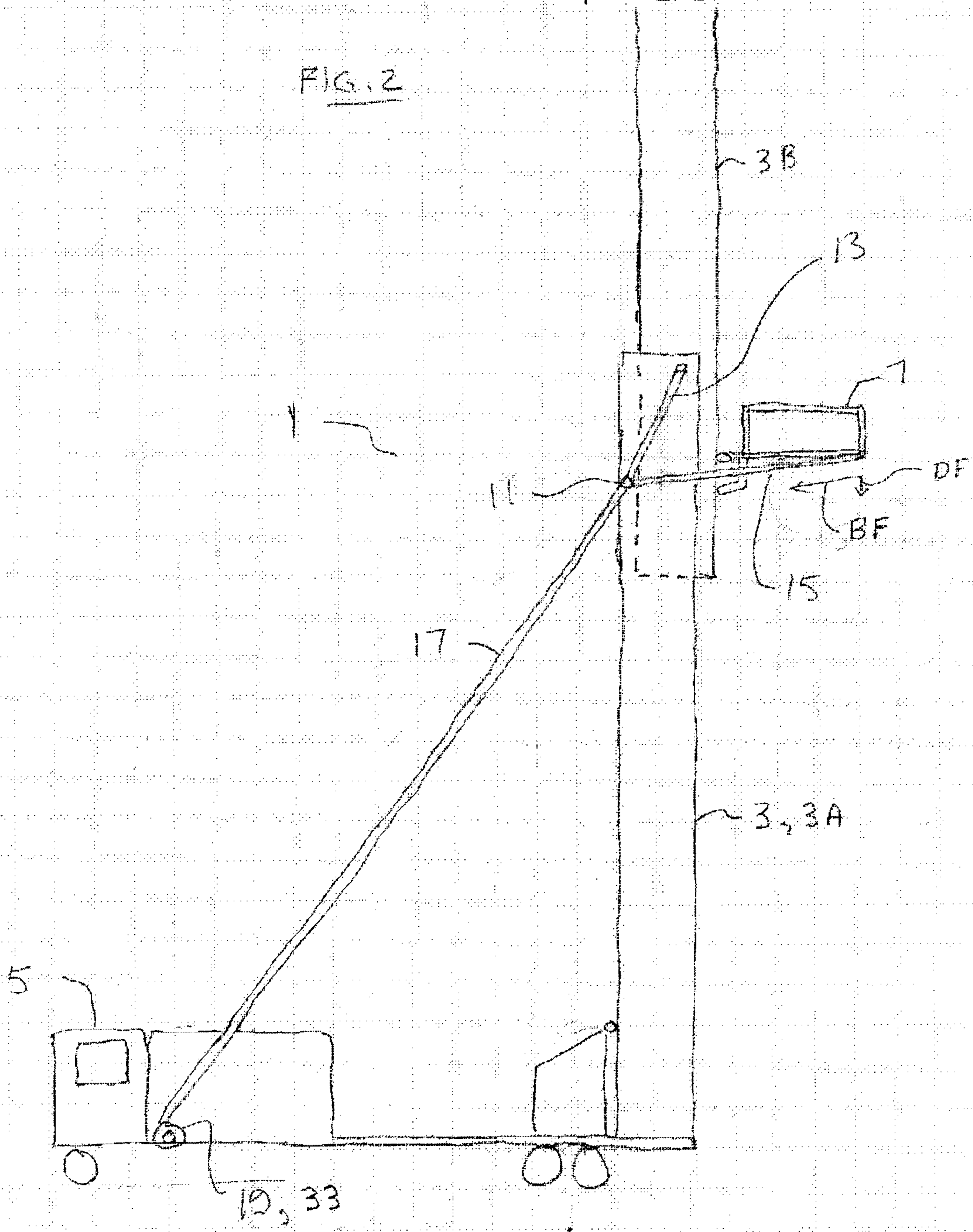


FIG. 3

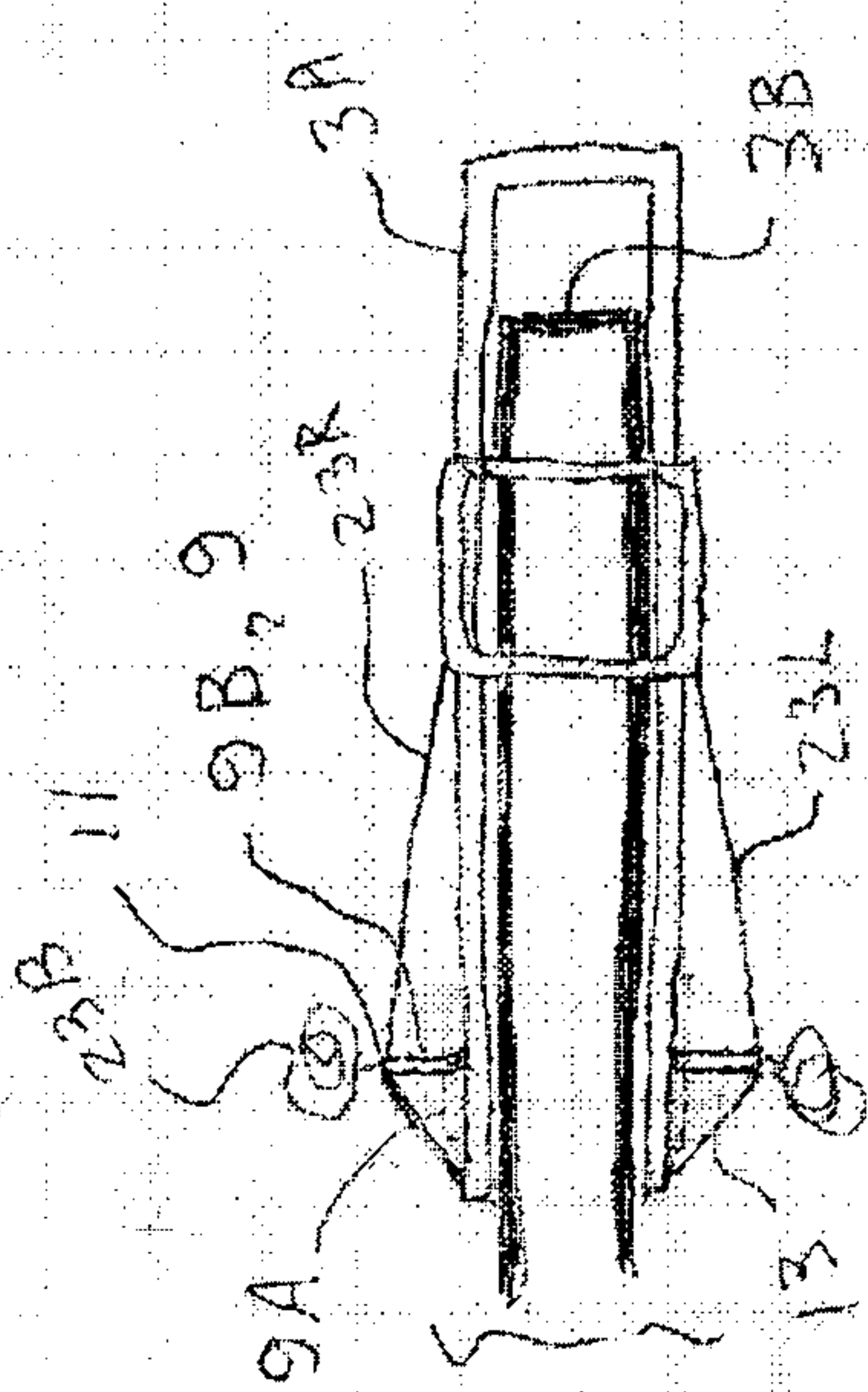


FIG. 4

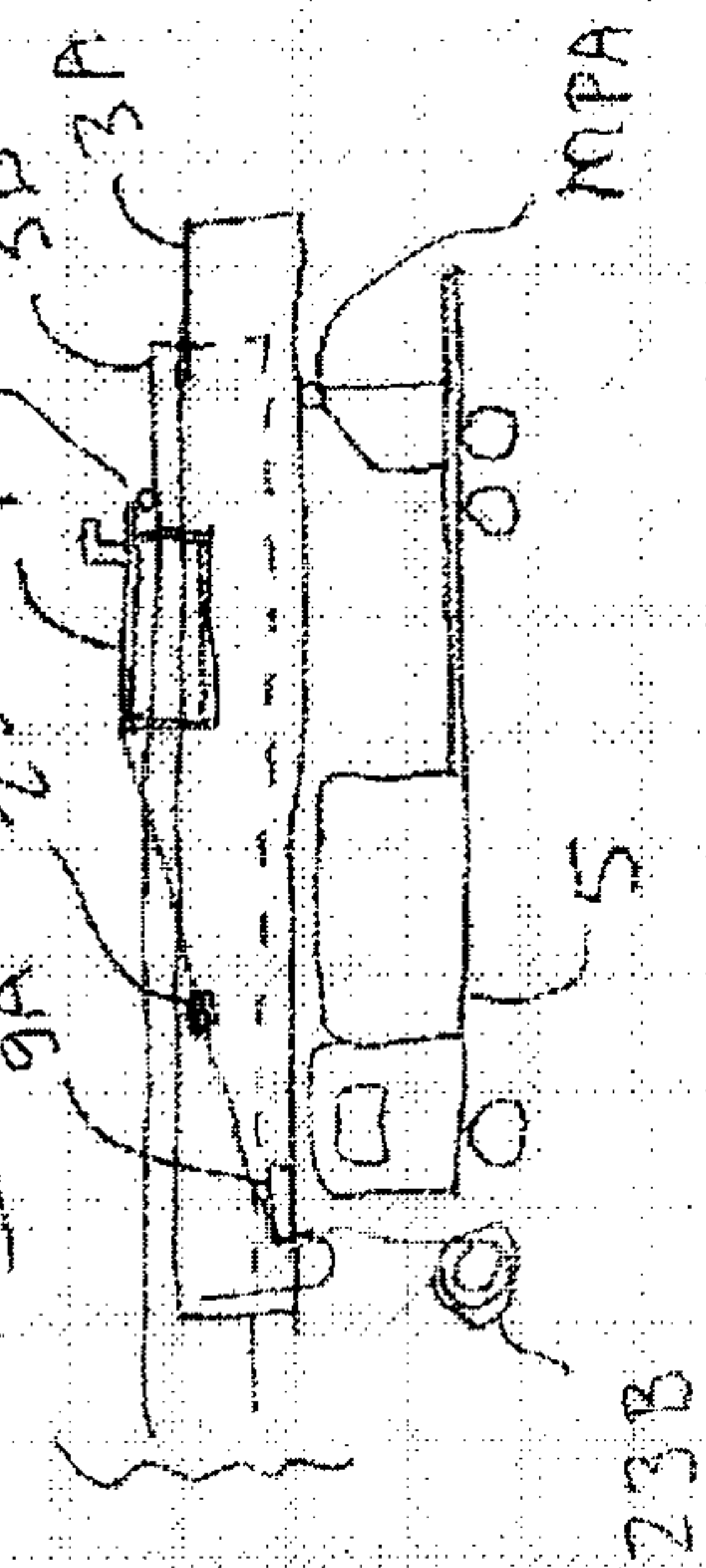


FIG. 5

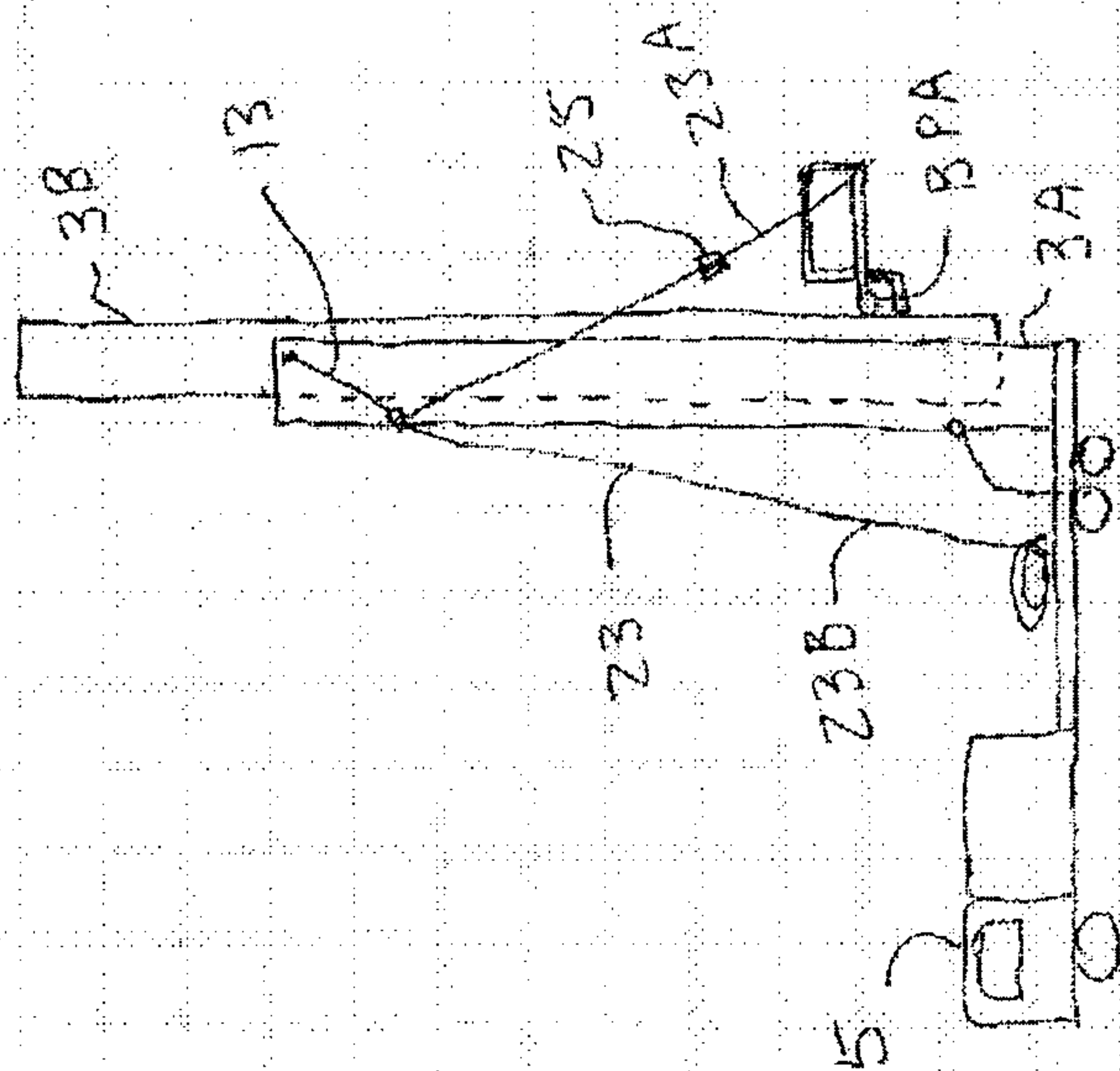


FIG. 6

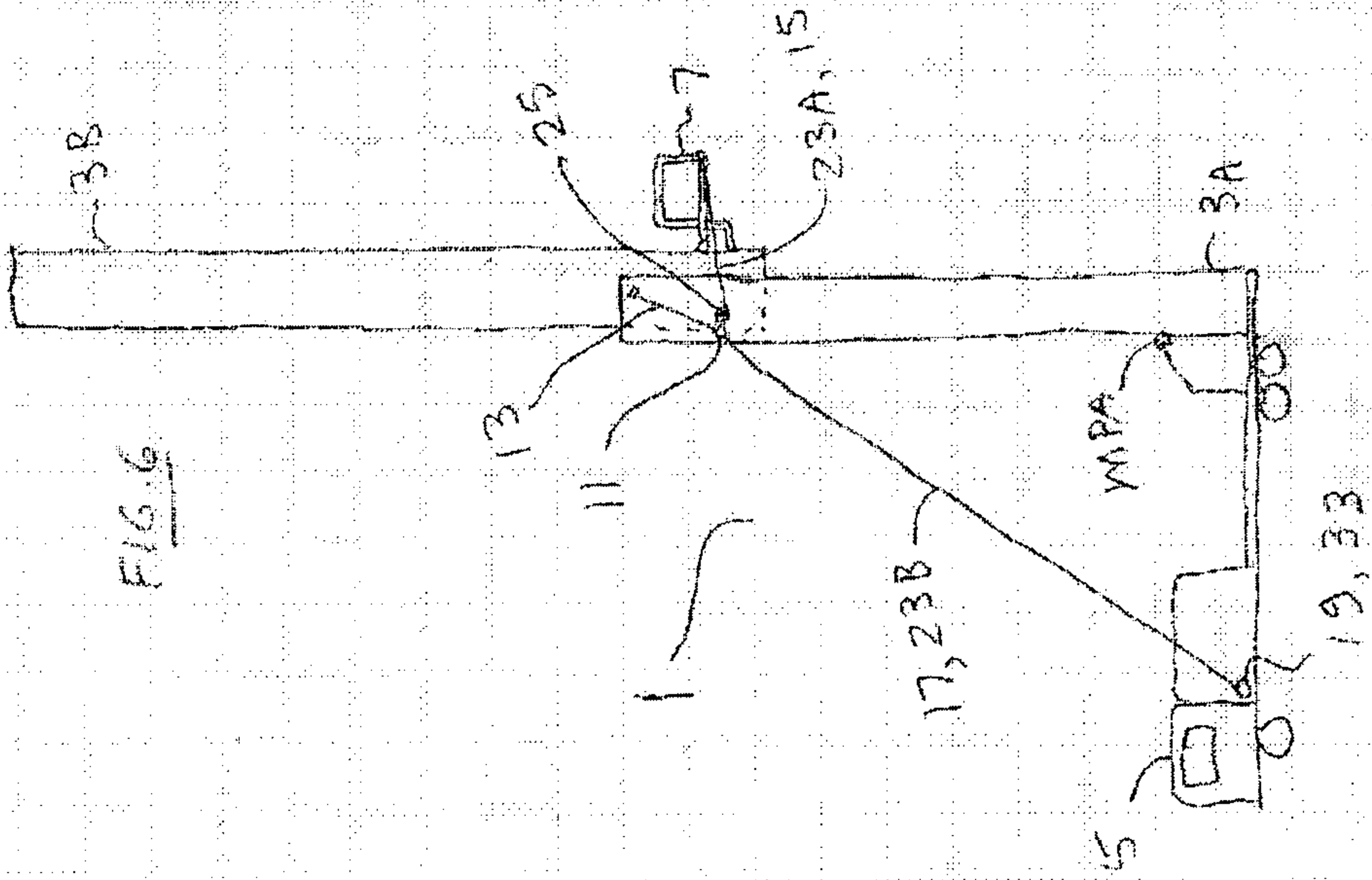


FIG. 7

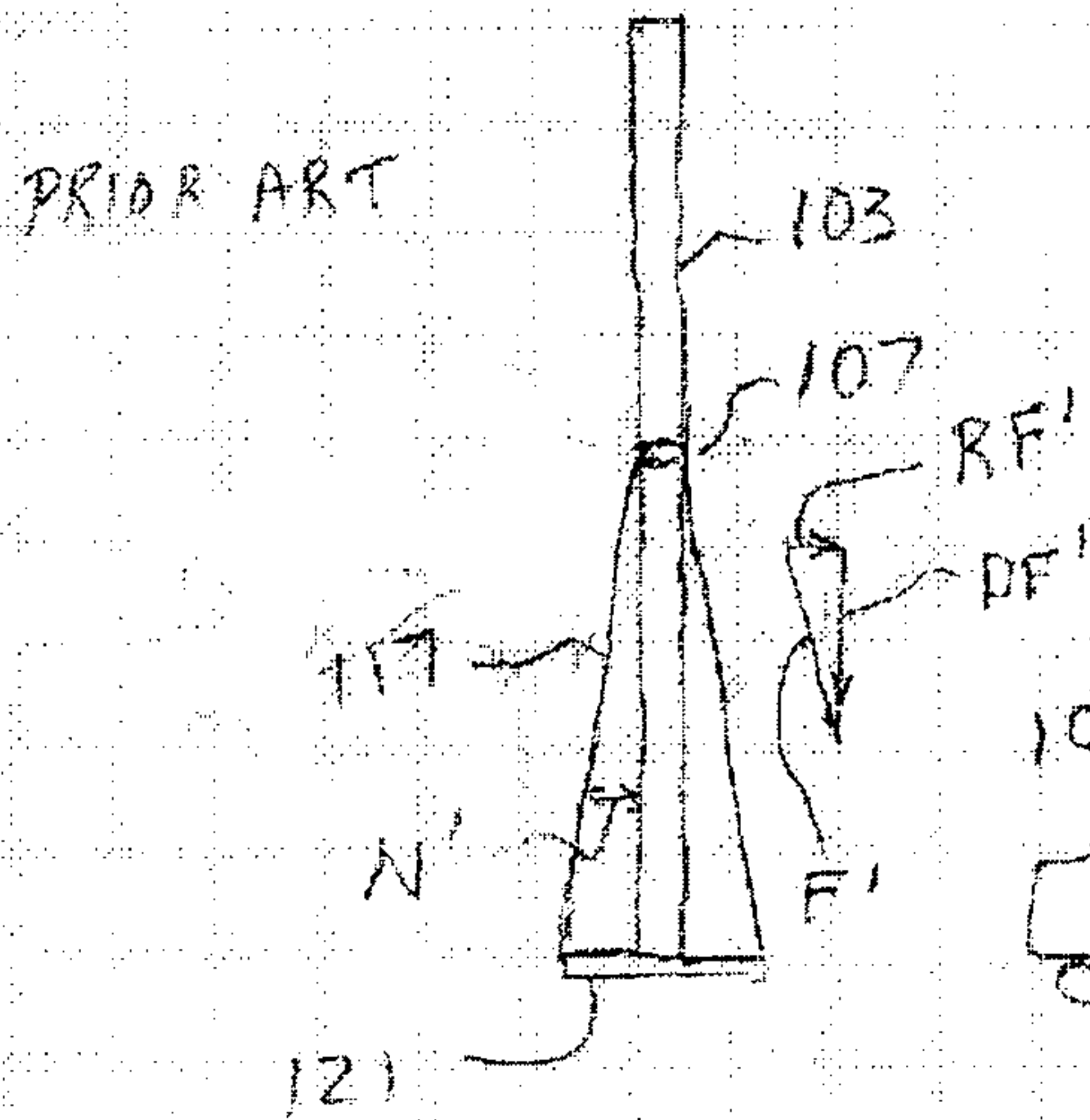


FIG. 8

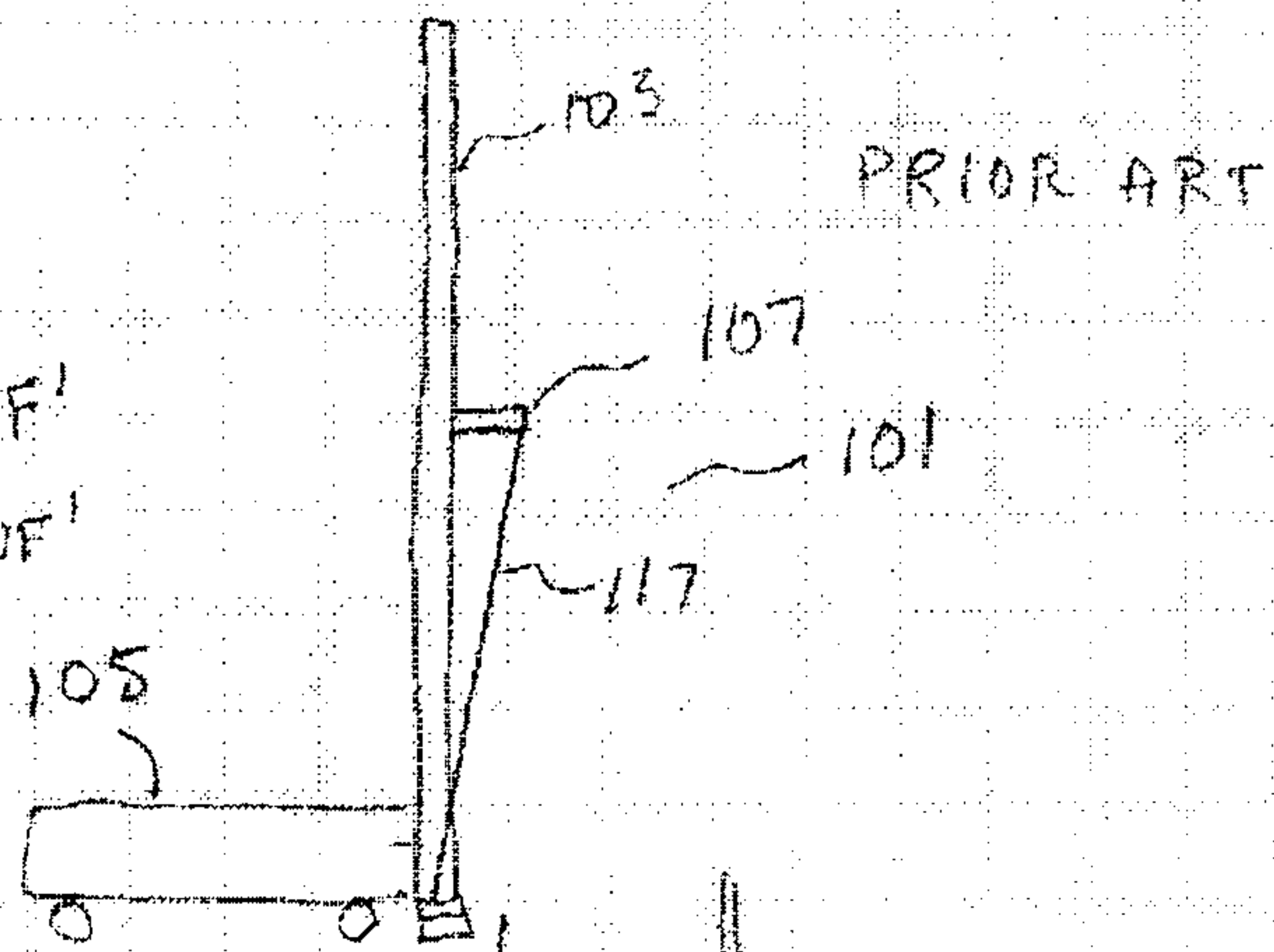


FIG. 9

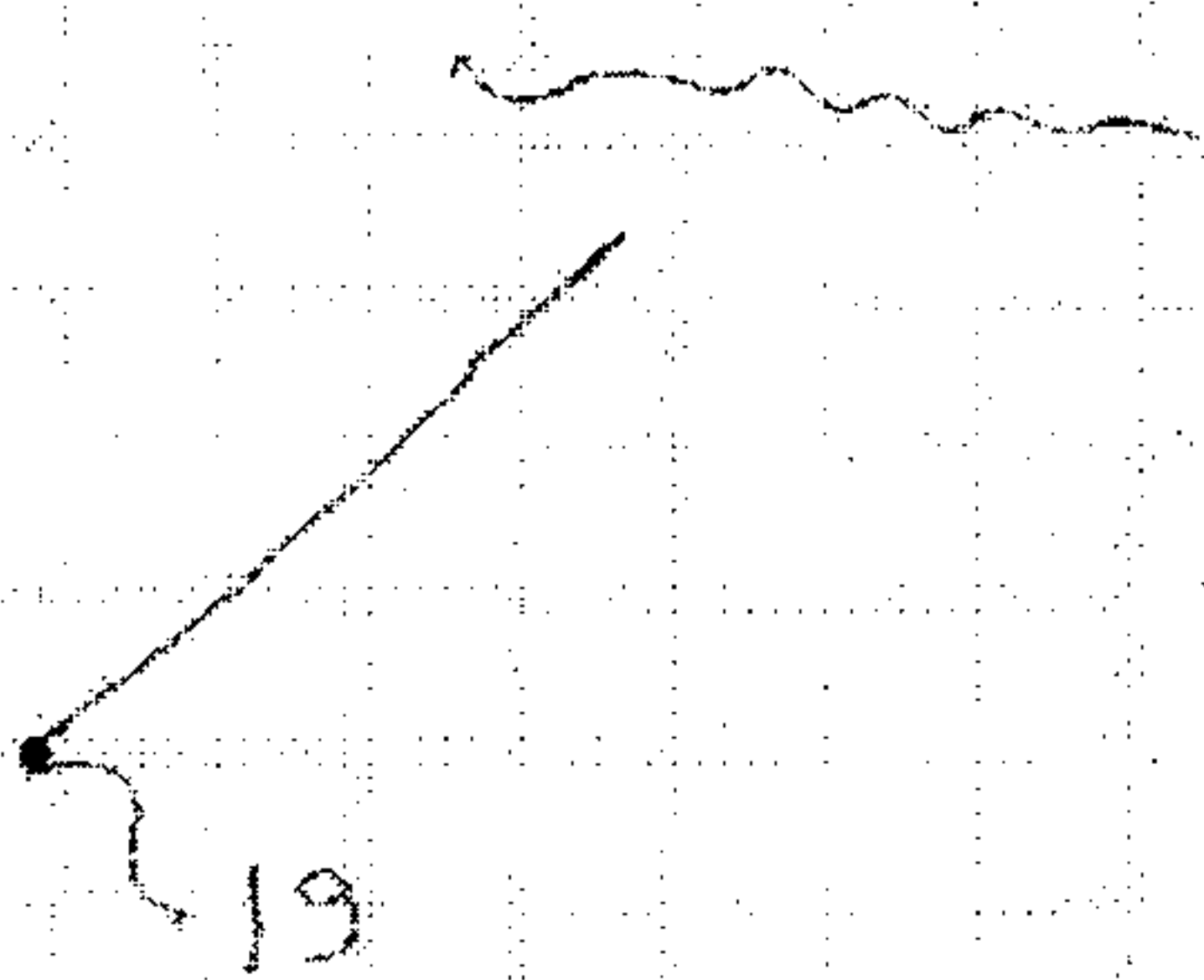
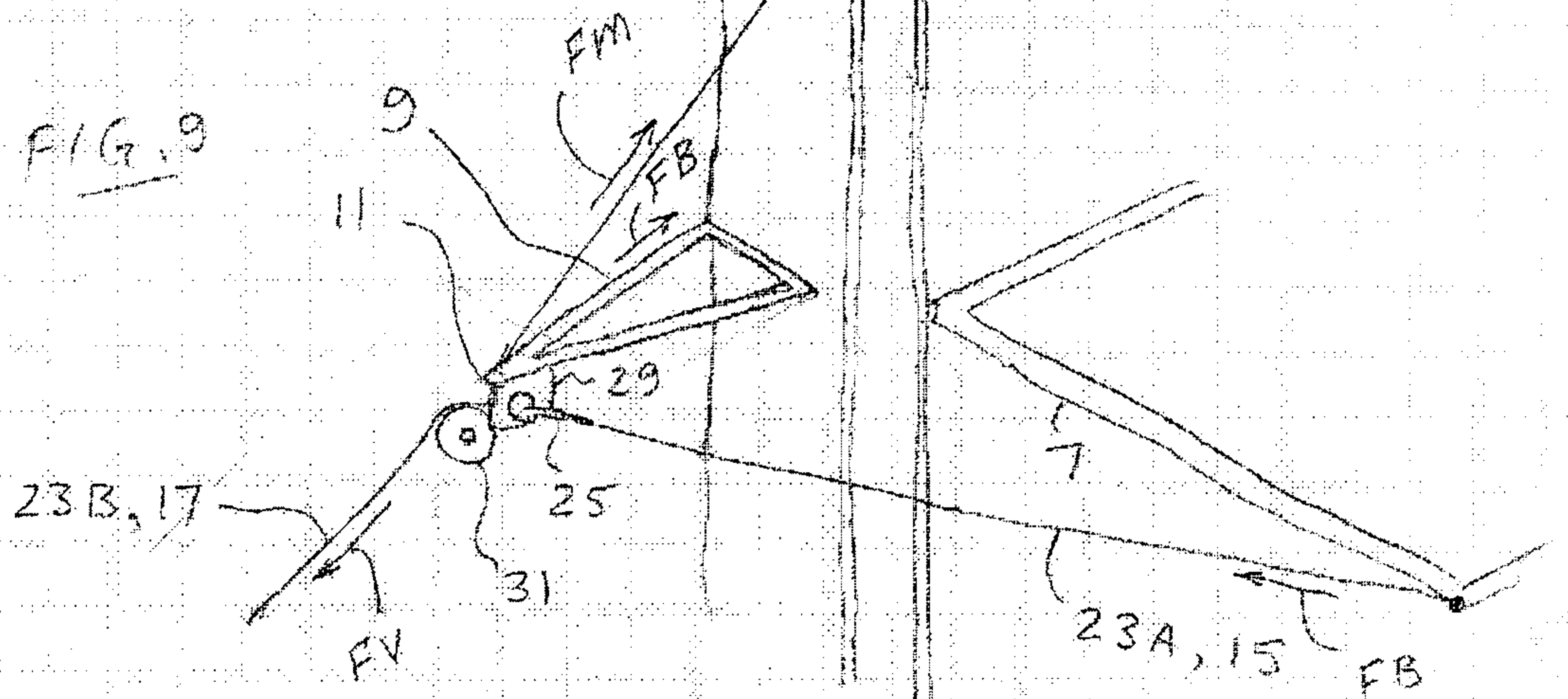


FIG. 10

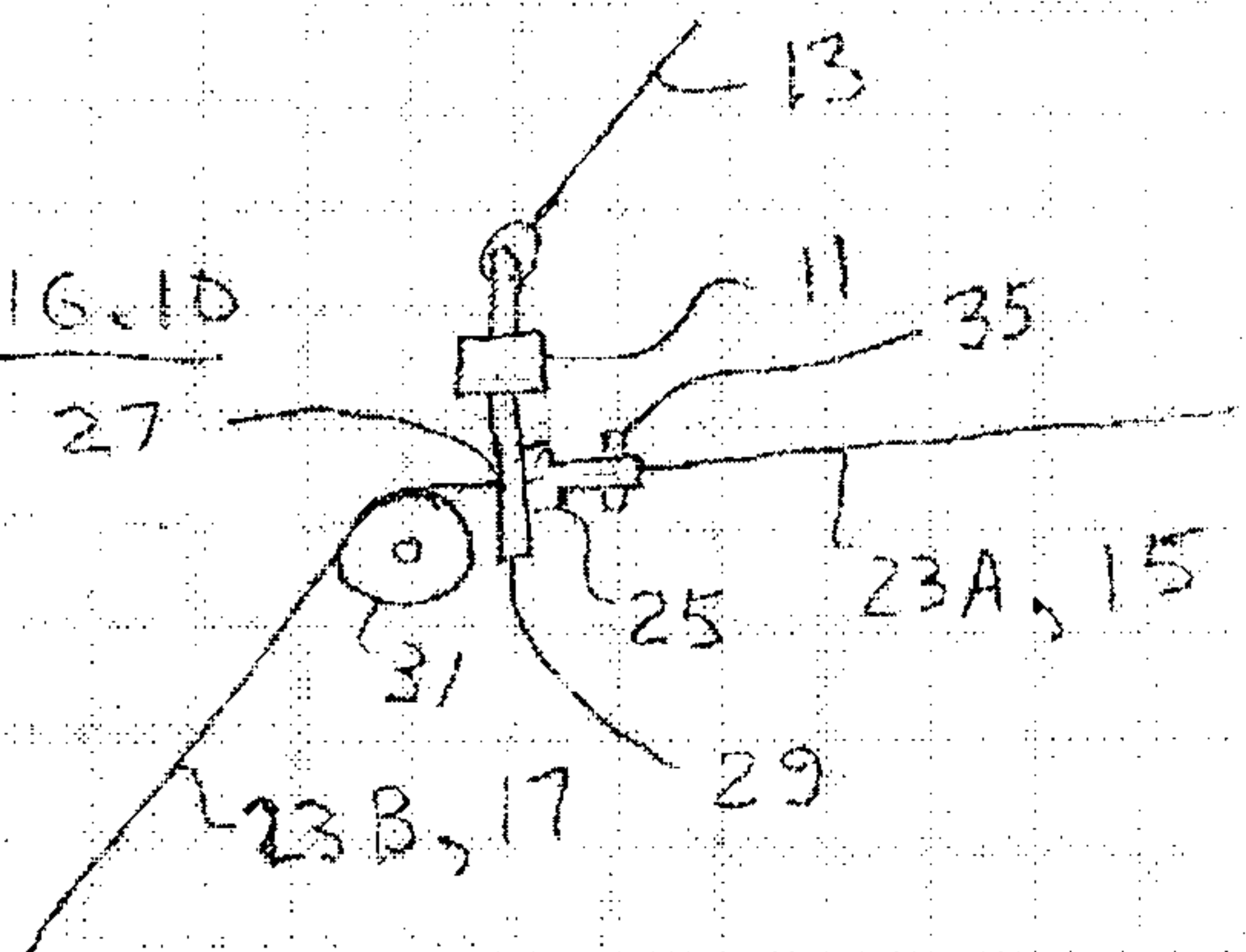
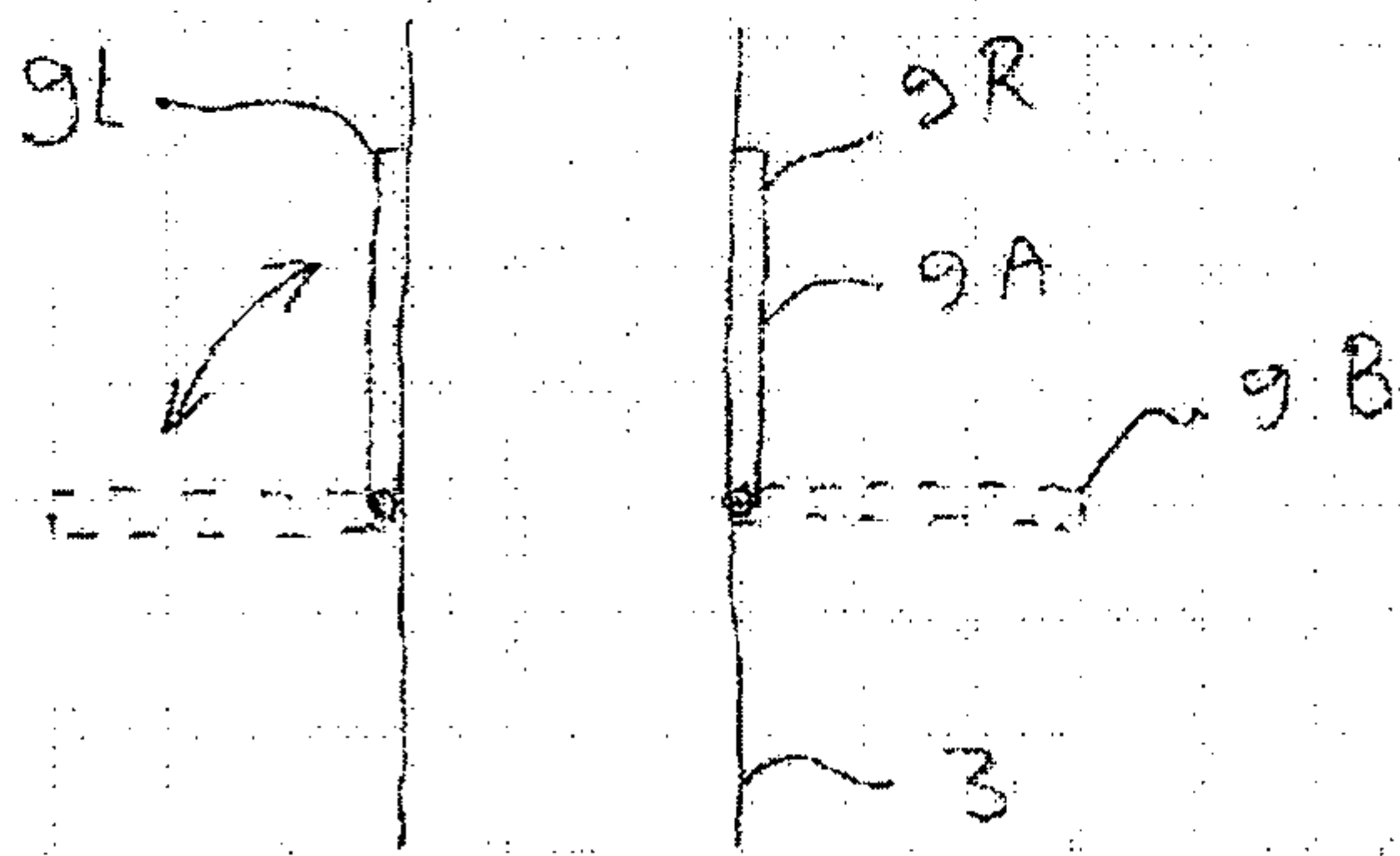
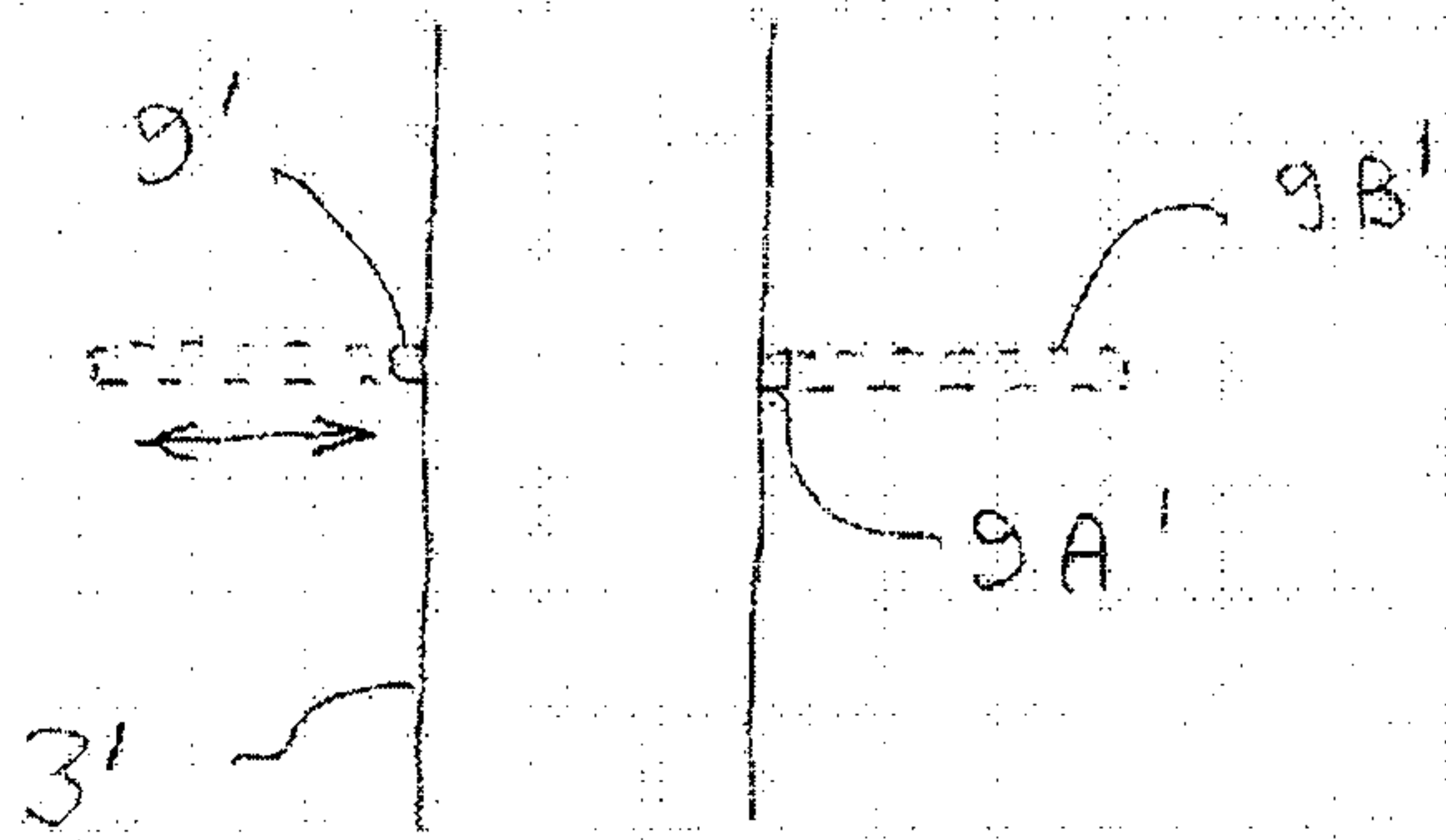


FIG. 11FIG. 12

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