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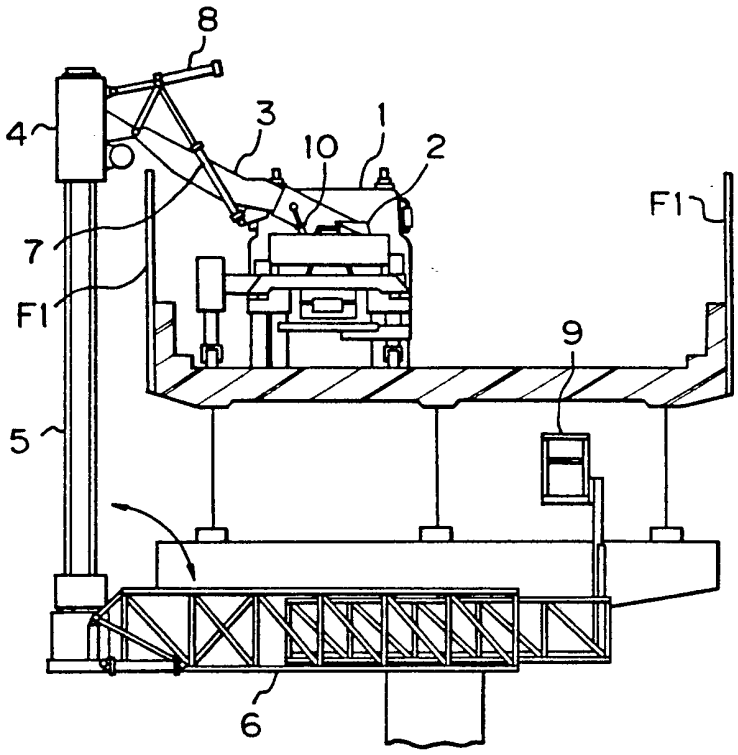
(54) Inspection vehicle for bridges and high level roads

(57) An inspection vehicle is intended to inspect the lower side of a high level road bridge from above the high level road as well as from the ground (Fig. 3) and it comprises an extensible boom (3) vertically swingably pivoted on a pedestal (2) rotatably mounted on the chassis (1) of the vehicle about a vertical axis, a reciprocable column (5) pivotally mounted on the tip of the boom (3) through a saddle (4), and an extensible inspection passageway (6) pivotably connected to one end of the column, the passageway being swingable between a position parallel to the column and a position at right angles thereto while it can be rotated about the longitudinal axis of the column, a plurality of hydraulic cylinder means for the movement of the respective components listed above, and a control device for detecting the amount of movement of each component and controlling the movement thereof on the basis of the detected amount of movement of each component for the required operation of the inspection vehicle. The control device has the function of judging the permission/inhibition of the movements of the respective components under predetermined conditions of the correlationship of the movements of the respective components.

Fig. 1



The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

Fig. 1

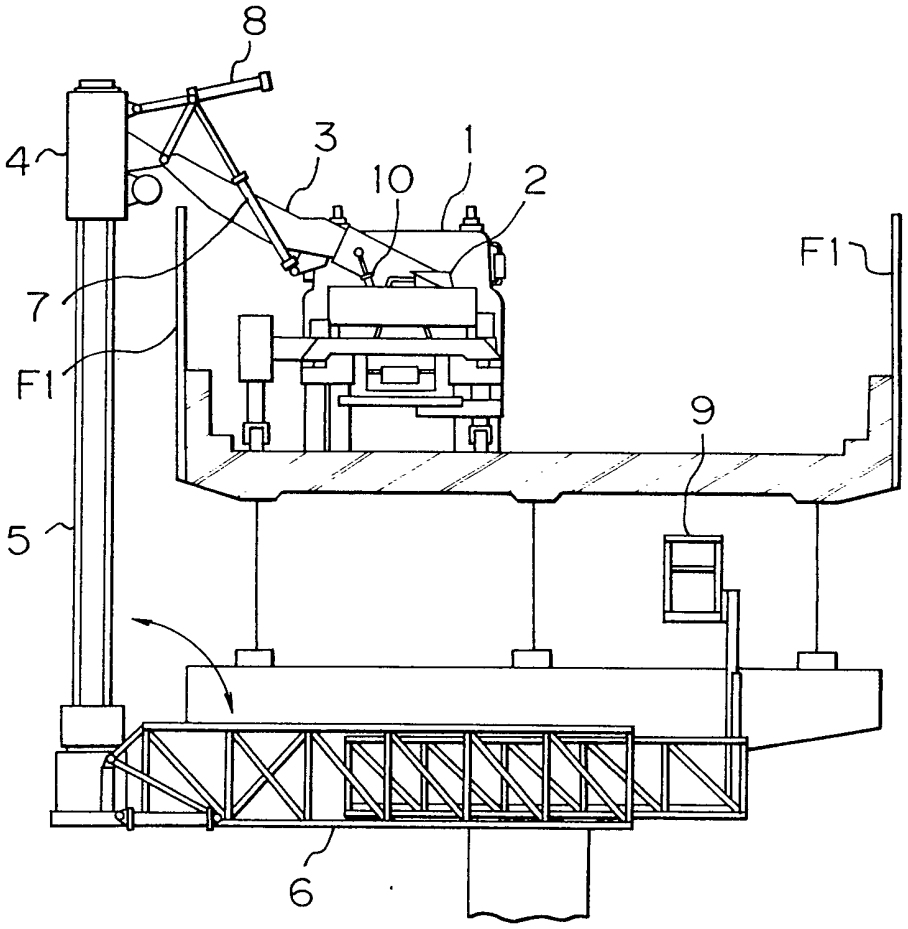


Fig. 2

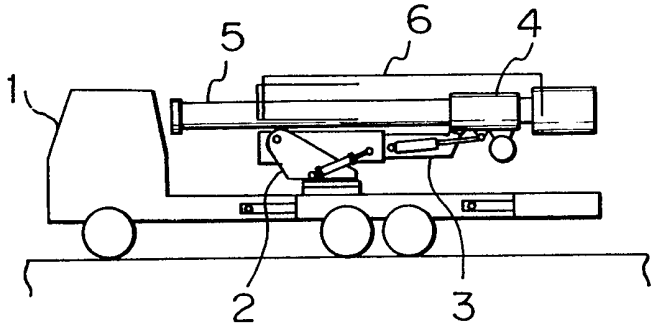
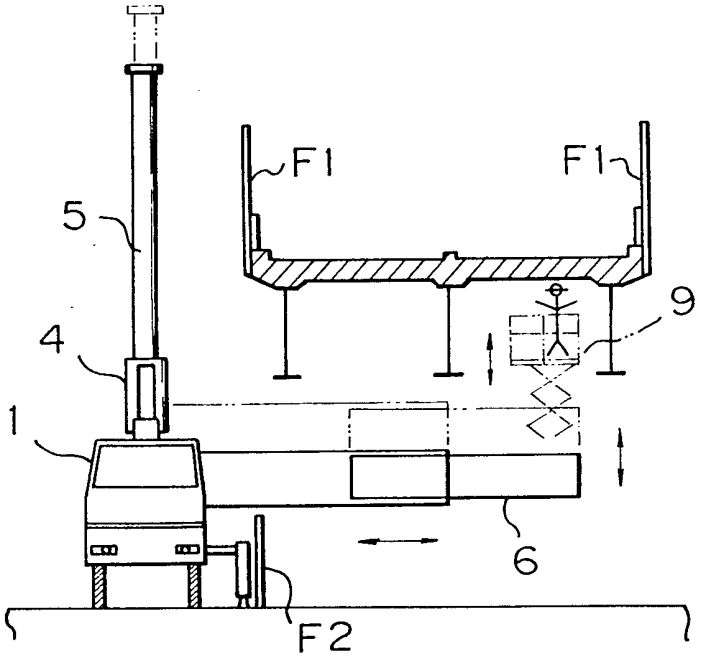
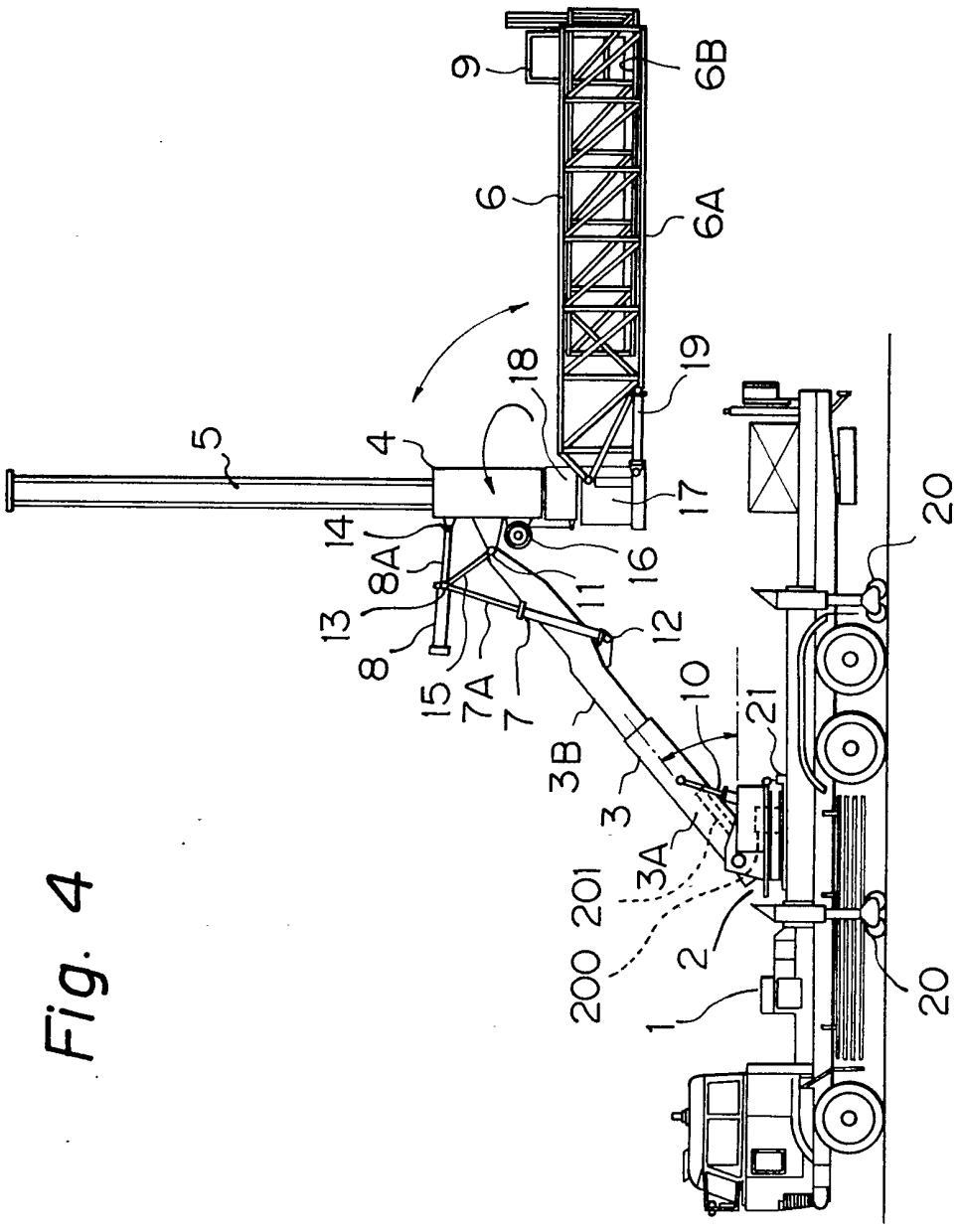


Fig. 3




9
6B
6
6A
18
19
5
4
17
20
14
16
8A
11
13
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15
7A
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3B
3
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201
200
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Fig. 4

Fig. 4A

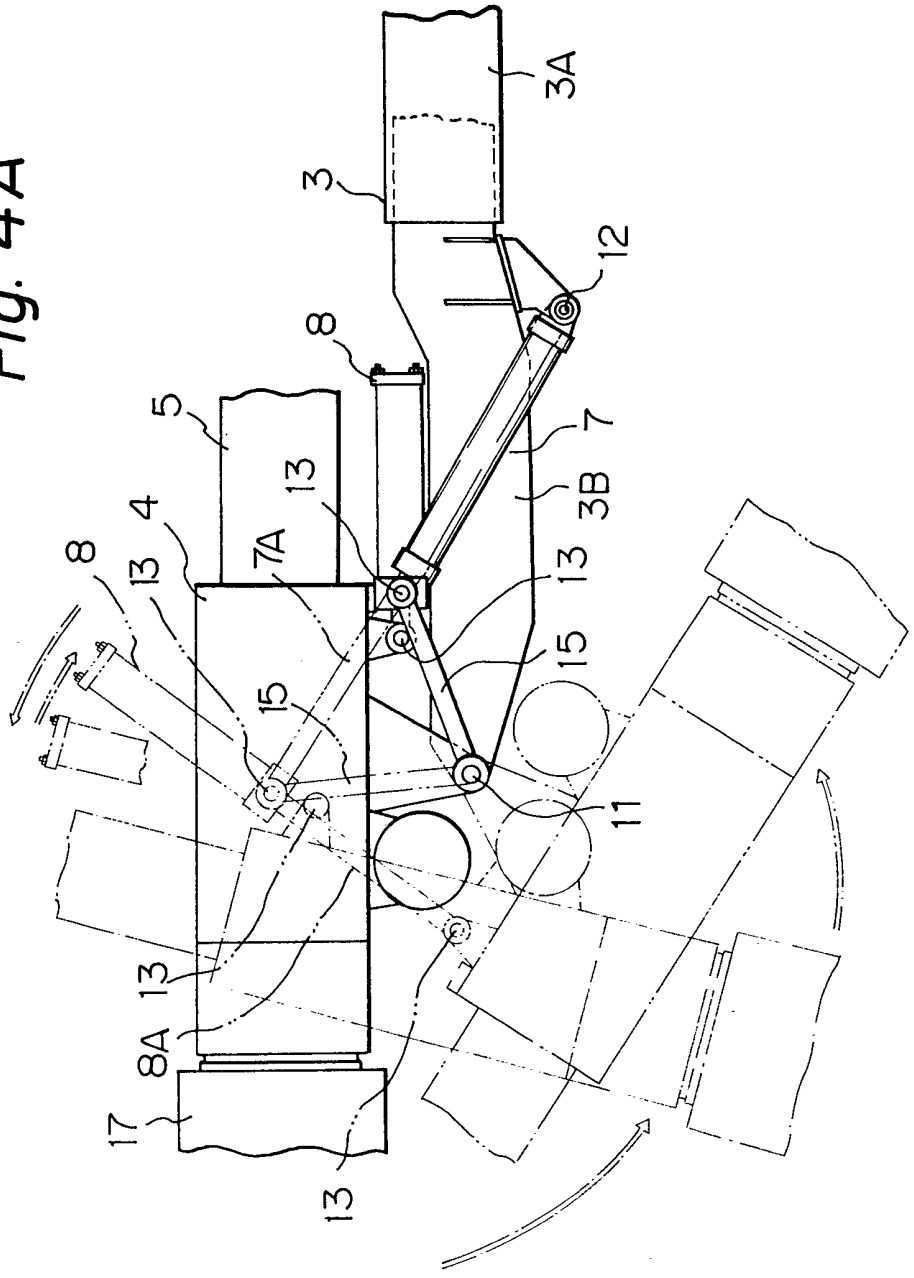


Fig. 4B

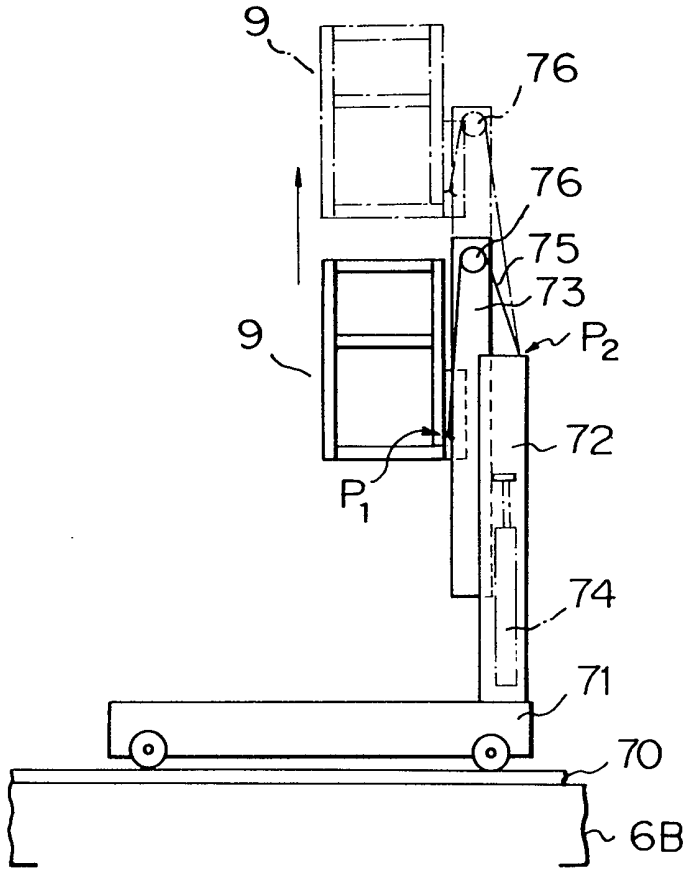


Fig. 5

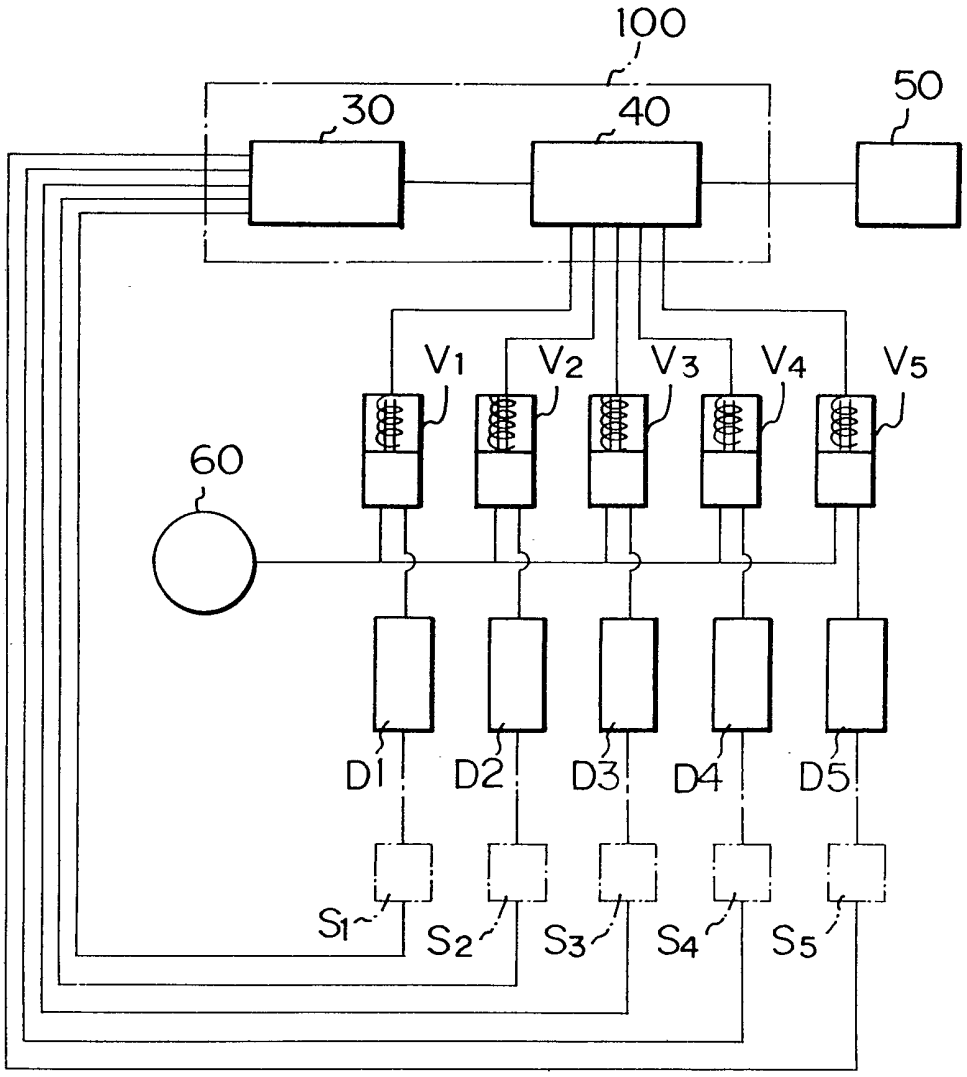


Fig. 6

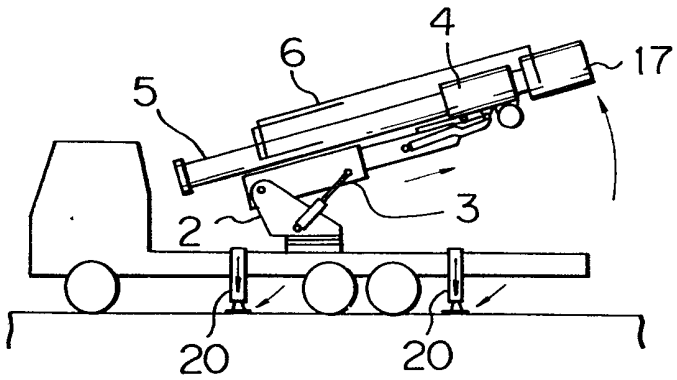


Fig. 7

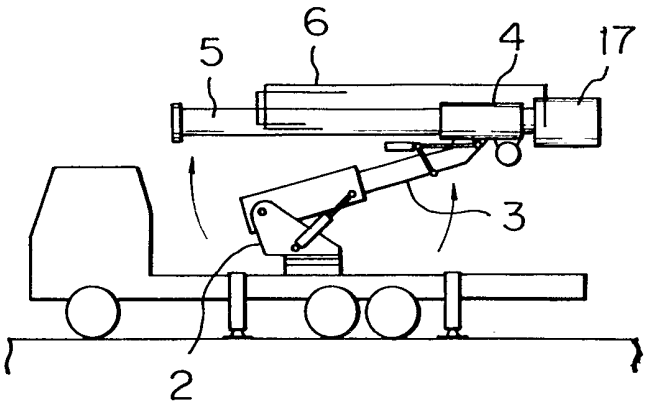


Fig. 8

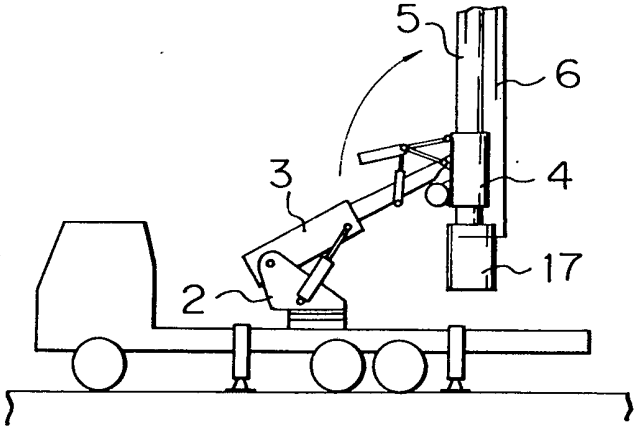


Fig. 9

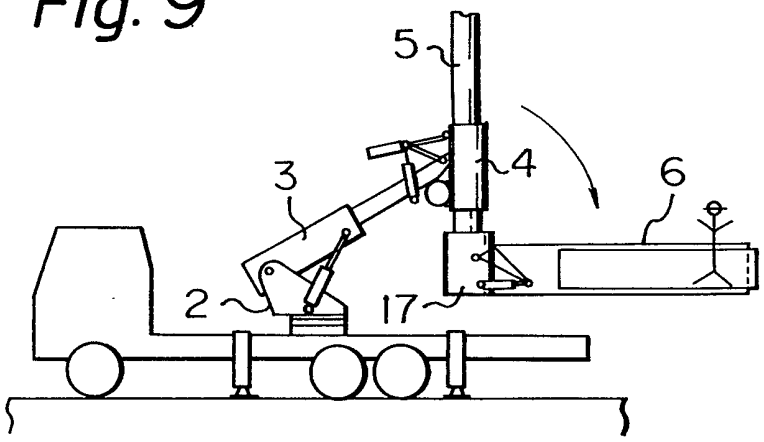


Fig. 10

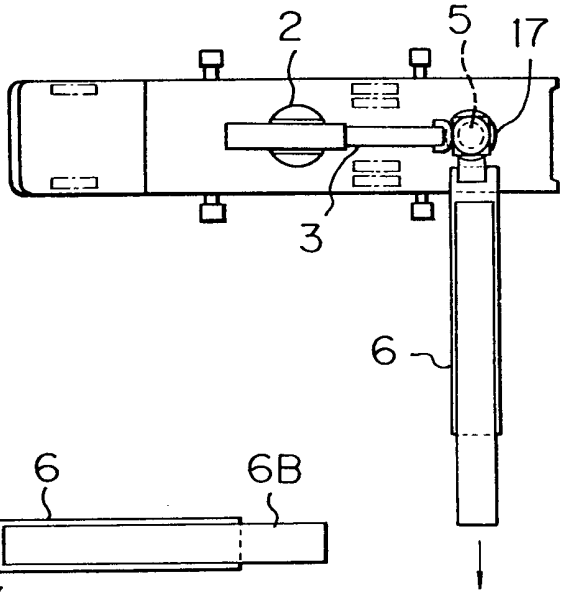


Fig. 11

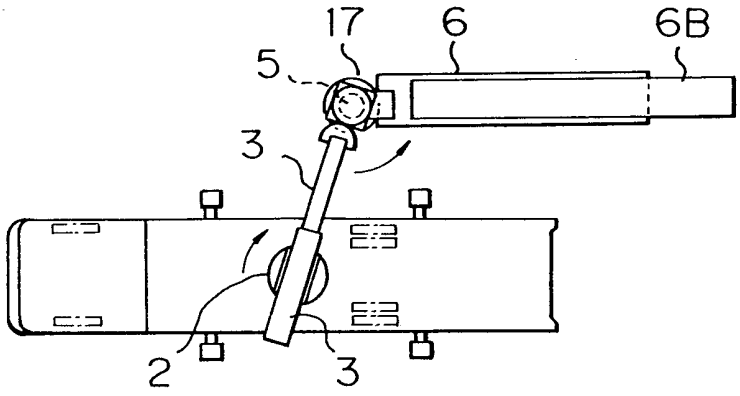


Fig. 12

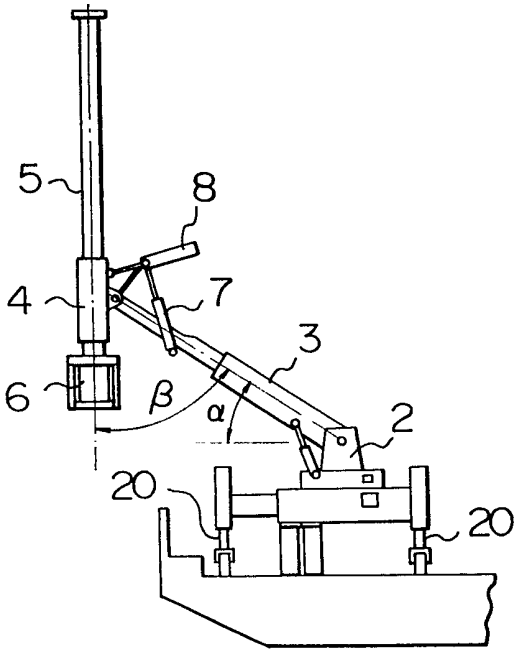
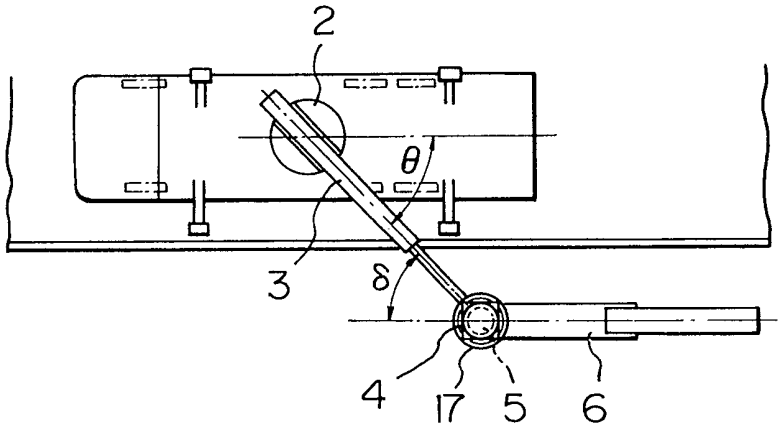


Fig. 13



SPECIFICATION

Inspection vehicle for bridges and high level roads

The present invention relates to an inspection vehicle for bridges and high level roads adapted to carry out inspection for maintainance of the bridge or high level road. High level roads have increased as the development of exclusive roads for automobiles, superhighways or express highways for motor vehicles proceeds.

High level roads have to be provided with sound barriers along the sides thereof where inhabitants residing near such high level roads have to be protected from traffic noise. On the ground beneath the high level road, guard fences are often provided in order to prevent persons and vehicles from entering without notice.

The sound barriers or noise-intercepting walls or fences and the guard fences however, obstruct inspection of the bridge construction for high level roads. For the inspection of the lowerside of the bridge construction from the upper side thereof, for example, it is often impossible to move an inspection stand or pedestal of the inspection vehicle over the sound barrier to a position required for the inspection, if the height of the sound barrier is great. Further, even in a case where such a movement is possible, the operations for effecting such a movement must be increased, thereby rendering the operations very troublesome so that problems arise from the viewpoint of safety while quick operations cannot be achieved.

For the inspection of a bridge construction for a high level road from the ground by moving the inspection pedestal of the inspection vehicle over the guard fence, the vehicular traffic on the ground must often be obstructed.

The above described difficulties are caused by the operating or manipulating mechanism of the inspection pedestal provided in the prior art inspection vehicle.

An object of the present invention is to provide a novel and useful inspection vehicle which avoids the above described difficulties occurring in the prior art inspection vehicles.

Another object is to provide a novel and useful inspection vehicle which makes it possible easily and quickly to carry out the operations for inspection of a bridge or high level road even though tall sound barriers of the bridge or high level road or guard fences on the ground are provided.

An inspection vehicle according to one aspect of the present invention comprises a chassis, a rotatable pedestal rotatably mounted on the chassis so as to be rotatable about the vertical axis of the pedestal, a vertically swingable and preferably extensible boom pivotally mounted on the rotatable pedestal, a vertically swingable saddle pivotally mounted on the tip of the boom, an elongated column longitudinally reciprocably mounted in the saddle, a preferably extensible inspection passageway or corridor swingably mounted on one end of the column, preferably by means of a rotatable supporting member, so as to be swung in the vertical longitudinal centre plane of the passageway, so that the passageway can swing not only in the vertical longitudinal centre plane thereof but also rotatably about the longitudinal axis of the column, and a double hydraulic cylinder mechanism consisting of a pair of extending hydraulic cylinders and a pair of folding hydraulic cylinders each operatively coupling the saddle with the boom so as to enable the saddle to be swung over a wide angle.

With the arrangement of the inspection vehicle described above, when the inspection vehicle is to be moved, the boom, the column and the inspection passageway are folded back upon themselves horizontally together so as to assume parallel positions closely adjacent to each other and located above the chassis closely adjacent thereto so that the transport of the inspection vehicle is facilitated.

For the inspecting operation from the upper side of the bridge or high level road, the boom is vertically swung upwardly and extended over the noise-barrier after the rotatable pedestal is rotated to the required direction and then the saddle is swung so as to direct the column in the vertical direction and then the column is moved downwardly and the inspection passageway is swung so that it is positioned horizontally and in the desired direction for the inspection of the lower side of the bridge or high level road.

Further, for the inspection from the ground, the column is vertically moved so as to locate the inspection passageway horizontally above the guard fence but beneath the bridge construction in the similar manner as in the case of the inspection from the high level road.

Another object of the present invention is also to provide a novel and useful inspection vehicle having a control device capable of controlling the movement of the various components of the inspection vehicle to the required positions with the reduced number of steps of operations, while the components can be moved quickly.

An inspection vehicle according to another aspect of the present invention comprises a chassis, a rotatable pedestal, a swingable and preferably extensible boom, a saddle, a reciprocable column, all of which are preferably of similar construction as previously described, the inspection vehicle further comprising a control device including a detecting station adapted to detect at least the rotational angle of the boom about the vertical axis of the rotatable pedestal and the vertical swinging

angle of the boom, the angle formed between the column and the boom and the rotational angle of the inspection passageway about the longitudinal axis of the column, and the swinging angle of the passageway, and a descriminating station adapted to judge the permission/inhibition of the movements of the various components of the inspection vehicle by comparing the signals received from the detecting station with the reference informations preliminarily set on the basis of the angular corelationship between the rotating or swinging angles of the various components of the inspection vehicle, thereby controlling the movements thereof to achieve the required relative positions of the various components upon permission of such movements.

With the above described inspection vehicle of the present invention, it can be quickly operated for inspection of the required position of the high level bridge from either the high level bridge or the ground below even though high noise barriers are provided at the sides of the high level bridge and the guard fences are provided on the ground beneath the high level bridge, and the control device of the inspection vehicle makes it possible to control the required movements not only of the boom but also of the column and the inspection passageway in coupled relationship to each other by merely giving commands by the operator for swinging and rotating the boom and the column and the passageway to the required positions, thereby simplifying the manual operations, so that the security or safety of the operation of the inspection vehicle is enhanced. Particularly, the steps of operations of the inspection vehicle of the present invention can be greatly reduced even though high noise barriers of the bridge or high level road and guard fences on the ground beneath the bridge or high level road are provided, while the space required for the operation is reduced and obstruction against the traffic of other vehicles on the ground can be greatly reduced.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig.1 is a rear view showing an embodiment of the inspection vehicle having a control device for the inspection of a high level road bridge and constructed in accordance with the present invention in one operational mode;

Fig.2 is a side view of the inspection vehicle of Fig.1 in the transport mode thereof;

Fig.3 is a front view of the vehicle of Fig.1 shown in another mode of operation;

Fig.4 is a side view of the inspection vehicle of Fig.1 showing the detailed construction thereof;

Fig.4A is a fragmentary view to a larger scale, showing the driving mechanism of the saddle of the inspection vehicle of Fig.1;

Fig.4B is a fragmentary view showing the detailed construction of the elevating mechanism of the inspection pedestal of the inspection vehicle of Fig.1;

Fig. 5 is a block diagram showing an embodiment of the control device in the inspection vehicle;

Figs. 6 to 9 inclusive are side views showing various steps of operations of the inspection vehicle of Fig.1;

Figs. 10 and 11 are plan views showing the various steps of operation of the inspection vehicle of Fig.1;

Fig.12 is an end view showing the steps of operations for raising the swingable and extensible boom and locating the reciprocable column in the elevated upright position; and

Fig.13 is a plan view showing one mode of operation of the inspection vehicle of Fig.1.

With reference to Figs. 1 and 4, an inspection vehicle according to the present invention is provided with a rotatable pedestal 2 mounted on a chassis 1 of the vehicle. The rotatable pedestal 2 is rotatable through an angle of 360° about a vertical axis and is driven by a hydraulic motor 200, such as an oil-driven motor through a gear train (not shown). A vertically swingable boom 3 consists of a proximal boom member 3A and a distal boom member 3B. The proximal end of the proximal boom member 3A is pivotally supported on the rotatable pedestal 2 and the distal boom member 3B is telescopically slidably received in the proximal boom member 3A and is extensible from and contractible into the latter by means of a hydraulic cylinder 201, such as an oil driven motor. The swingable and extensible boom 3 is swingable as a whole in the vertical plane by means of a hydraulic cylinder 10.

A saddle 4 is pivotally mounted on the tip of the distal boom member 3B by means of a pivot shaft 11 and is swingable in a vertical plane.

The piston rods 7A of a pair of extending hydraulic cylinders 7 are pivotally supported by one end on the respective sides of the distal boom member 3B by means of a pivot shaft 12 and are pivotally connected at their other end to a pair of folding hydraulic cylinders 8 by means of a pivot shaft 13. The piston rods 8A of the folding hydraulic cylinders 8 are pivotally connected to the saddle 4 by means of a pivot shaft 14, while the pivot shaft 11 and the pivot shaft 13 are swingably connected through connecting links 15, respectively, so that a link mechanism is formed which permits the saddle 4 to be swung in the vertical plane about the pivot shaft 11. In other words, the saddle 4 can be swung over a wide range of angle by virtue of this link mechanism as shown in Fig. 4A.

The saddle 4 is formed as a hollow member and a reciprocable column 5 is slidably received in the saddle 4. The reciprocable column 5 is reciprocally driven in the longitudinal

direction thereof in the saddle by means of a hydraulic motor 16 through a wire rope.

A supporting member 17 is mounted on the lower end of the reciprocable column 5. The supporting member 17 is rotatable about the longitudinal axis of the column 5 by appropriate hydraulic cylinder means.

An extensible inspection passageway or corridor 6 is swingably supported at its proximal end to the supporting member 17 by means of a pivot shaft 18 and is swingably driven in its vertical longitudinal centre plane by means of a hydraulic cylinder 19.

The inspection passageway 6 is also rotatable about the longitudinal axis of the column 5 by rotating the supporting member 17. The inspection passageway 6 is swingable by the hydraulic cylinder 19 between a position parallel to the column 5 closely adjacent thereto and a position extending radially from the column 5 substantially at right angles thereto.

The inspection passageway 6 comprises a passageway 6A with its proximal end pivotally supported on the supporting member 17 and a distal passageway 6B slidably supported in the proximal passageway 6A and extensible from and retractable into the latter by the operation of an appropriate driving means. An inspection platform 9 is mounted on the distal passageway 6B and can be elevated and lowered with respect to the distal passageway 6B by appropriate driving means (not shown). Rails 70 are preferably provided on the distal passageway 6B and a carriage 71 is movable supported thereon on which the inspection platform 9 is vertically movably mounted as shown in Fig.4B.

In the construction shown in Fig.4B, the carriage 71 is provided with a first upright post 72 fixedly secured thereto and a second upright post 73 slidably supported on the first post 72 along the longitudinal direction thereof. The second post 73 is driven by a hydraulic cylinder 74.

The inspection pedestal 9 is slidably mounted on the second post 73 therealong and a pair of wires 75, secured at their ends to both sides of the bottom portion Pl1lof the platform 9 and at their other ends to both sides of the top P2 of the first post 72, is stretched around idler pulleys 76 rotatably supported on the top of the second post 73, respectively, the length of each wire 75 being so set that the inspection platform 9 is just located adjacent to the carriage 71 when the second post 73 is in its descended position. Thus, the inspection platform 9 is effectively elevated quickly by raising the second post 73 by the operation of the hydraulic cylinder 74.

An appropriate number of lowerable outriggers 20 is provided on both sides of the chassis 1 of the inspection vehicle and they are appropriately driven by hydraulic driving means (not shown) so as to engage the ground, and detecting means such as limit switches, encoders and the like are provided so as to permit the swinging angles of the respective booms 3, 5, the saddle 4 and the inspection passageway 6, the elevated or descended position of the reciprocable column 5, the rotational angles of the rotatable pedestal 2 and the supporting member 17, the extended or contracted position of the distal boom member 3B and the distal passageway 6B, and the operating conditions of the outriggers 20, etc. to be detected during the required conditions of operations of the inspection vehicle. The above described required conditions of operations mean that, in the case wherein the extended condition of the boom 3 is to be detected, for example, an appropriate number of increments of extension or extending steps are preliminarily set and the detection is so carried out that, whichever of the steps is detected where the boom 3 is actually extended, the number of steps is selected so as to satisfy the required accuracy of detection of extended amount of the boom 3, such detecting means being well known and not described in detail here.

The control device of the inspection vehicle is shown in Fig.5. In Fig.5, the control device 100 comprises a detecting station 30 and a discriminating station 40. The detecting station 30 has the function of receiving the detected signals issued by the detecting means S1. S_2, ... for detecting the operating conditions of the various components of the inspection vehicle described above and to ascertain the successive operating conditions thereof. To this end, the control device is provided with an appropriate memory circuit and is adapted to issue data signals relating to the conditions of the components to the discriminating station 40 on the basis of the commands therefrom. The discriminating station 40 has the function of judging the permission/inhibition of operations of the respective components. To this end, it is provided with a discriminating circuit for preliminarily setting the operating conditions of the respective components in coupled relationship with each other. When a command is given to the discriminating circuit from a manipulation board 50 by an operator, it functions to judge whether or not the respective components are permitted to operate in accordance with the command given from the manipulation board 50 in relation to the operations of the remaining components. When the components are judged to be allowed to operate, the discriminating station 40 issues switching signals to the respective valve means Vl1l, Vl2l, ... belonging to the components permitted to operate so that hydraulic or oil pressure is supplied from a pump 60 to the respective hydraulic driving means Dl1l, Dl2l, ... belonging thereto, thereby actuating the respective components allowed to operate as required in accordance with the command.

Thus, insofar as the detecting station 30 is detecting by the signals from the detecting means the fact that, for example, the outriggers 20 are not properly set for the required operation of the inspection vehicle, the movement of the swingable and extensible boom 3 towards the lateral direction with respect to the longitudinal axis of the inspection vehicle and the extension of the inspecting passageway 6 laterally of the inspection vehicle are inhibited so as to prevent lateral overturn of the inspection vehicle.

The contents of the operating conditions can be variously set and such settings can be achieved by the combination of the detecting station 30 with the discriminating station 40 wherein microcomputors are incorporated. Such a construction per se is conventionally devised by a person skilled in the art and is not described in detail here.

The operation of the inspection vehicle as described above will be described below.

For the inspecting operation, the outriggers 20 which may be provided with wheels are first set for securing the inspection vehicle as shown in Fig.6. Then, the right-hand end at the side of the supporting member 17 of the assembly of the booms 3 and 5 and the passageway 6 each held folded back upon themselves parallel to each other is raised as shown in Fig.6, or the boom 3 is swung upwardly with the column 5 and the passageway 6 being maintained in the horizontal positions, as shown in Fig.7.

Thereafter, the column 5 and the passageway 6 are swung together to the upright positions as shown in Fig.8.

Thereafter, the inspection passageway 6 is swung to the horizontal position as shown in Fig.9. In this horizontal position of the passageway 6, the reciprocable column 5 is first lowered so that the operator can enter the passageway 6.

For the inspection from the ground below the bridge, as shown in Fig.3, the passageway 6 is rotated in the horizontal plane to the position as shown in Fig. 10, and then the column 5 and the inspection platform 9 are elevated to the required heights, respectively, as shown in Fig.3. The inspection is carried out in this position.

For the inspection from the high level road as shown in Fig.1, the boom 3 is rotated from the position shown in Fig.9 to the position shown in Fig.11, while the passageway 6 is held parallel to the longitudinal axis of the chassis 1, so that the passageway 6 is moved out of the side of the high level road, and then the reciprocable column 5 is lowered until the passageway 6 is positioned at the required level. Thereafter, the passageway 6 is rotated in the horizontal plane beneath the high level road to the required direction, and the height of the inspection platform 9 is adjusted. In this position, the inspection is carried out.

In the case wherein noise barriers and guard fences are provided, the boom 3 and the passageway 6 are elevated to positions sufficient to permit the boom 3 and the passageway 6 to be extended over the noise barrier or the guard fence.

These operations are carried out by giving a command from the manipulating board 50 to the control device 100 so that the respective components can be operated as required only when the discriminating station 40 judges that such operations are allowed, thereby ensuring the safety of operation of the inspection vehicle.

The control operation of the control device of the inspection vehicle will now be described in detail below.

When the angle of the swingable and extensible boom 3 is to be varied from the position shown in Fig.9 to the position shown in Fig.12 the control device operates to control automatically the movement of the saddle 4 so that the reciprocable column 5 is always maintained in its vertical position during the movement of the boom 3 as shown in Fig. 12.

In the similar manner, when the boom 3 is to be elevated with the column 5 and the passageway 6 being maintained in the horizontal positions as shown in Fig.7, the control device operates to control automatically the movement of the saddle 4 in response to the variation in the angle of the boom 3 so as to maintain the column 5 and the passageway 6 in their horizontal positions. Such coupled movements as described above are achieved by the operation of the control device 100. To this end, the control device 100 carries out the computing operation of the angles of column 5 and the passageway 6 on the basis of the feed-back signals from the respective detecting means in order to control the energization of the extending hydraulic cylinders 7 and the folding hydraulic cylinders 8 in coupled relationship to the command for energizing the hydraulic cylinder 10 for driving the boom 3 so that the column 5 and the passageway 6 are moved in the manner as required. Such computing operations per se are well known and, therefore, detailed description thereof is not given here.

Further, when the swingable and extensible boom 3 is to be swung in case the passageway 6 is extended at its entirety over the noise barrier of the high level road on which the inspection vehicle is located as shown in Fig.13, the control device can control the swinging movement of the passageway 6 in coupled relationship to the swinging movement of the swingable and extensible boom 3 in such a manner that the swinging angle δ of the passageway 6 is maintained at all times at the same angle as the swinging angle θ of the boom 3. Such a control operation is also ef-

fected by the control device 100 on the basis of the appropriate computing operation thereof.

Such coupled control operations can be carried out automatically by the command issued from the manipulation board 50 by the operation of the operator or by setting the discriminating station 40 for the coupled automatic movements of the respective components with each other. Such coupled movements of the respective components may be released, if necessity arises.

CLAIMS

1. An inspection vehicle for inspecting bridges and high level roads comprising a chassis, a rotatable pedestal rotatably mounted on the chassis about a vertical axis, a vertically swingable boom with its proximal end pivotally mounted on said rotatable pedestal, a column longitudinally slidably and reciprocably fitted in a saddle pivotally mounted on the distal end of said boom, an inspection passageway with its proximal end pivotally mounted on one end of said column so as to be swung in the vertical longitudinal centre plane of said passageway as well as to be rotated about the longitudinal axis of said column, and a control device, said control device comprising, a detecting station for detecting and ascertaining at least the rotational angle of said pedestal with the boom thereon about the rotational axis of said rotatable pedestal, the vertical swinging angle of said boom, the angle formed between the longitudinal axis of said column and said boom, and the rotational angle of said passageway about said column, and a discriminating station adapted to receive the detected signals from said detecting station and to determine the permission/inhibition of movements of the respective components of the inspection vehicle on the basis of a predetermined correlationship between the movements of the respective components for effecting such movements upon permission.

2. An inspection vehicle according to Claim 1, wherein said chassis has lowerable outriggers and said detecting station detects also the positions of the outriggers.

3. An inspection vehicle according to claim 1 or 2, wherein said control device comprises means for carrying out a computing operation on the basis of the vertical swinging angle of said boom and the swinging angle of said column given by the swinging movement of said saddle so as to permit said column to be maintained in the vertical position in coupled relationship to the movement of said boom.

4. An inspection vehicle according to claim 1, 2 or 3, wherein said control device comprises means for carrying out the computing operation on the basis of the rotational angle of said boom about the rotational axis of said rotatable pedestal and the rotational axis of said passageway about the longitudinal axis of said column so as to maintain said passageway parallel to the longitudinal direction of said chassis in coupled relationship to the rotational movement of said boom about the rotational axis of said rotatable pedestal.

5. An inspection vehicle for inspecting bridges and high level roads comprising a chassis, a rotatable pedestal rotatably mounted on the chassis about a vertical axis, a vertically swingable boom with its proximal end pivotally mounted on said rotatable pedestal, a reciprocable column longitudinally slidably and reciprocably fitted in a saddle pivotally mounted on the distal end of said boom, an inspection passageway with its proximal end pivotally mounted on one end of said column so as to be swung in the vertical longitudinal centre plane of said passageway as well as to be rotated about the longitudinal axis of said column, a pair of extending hydraulic cylinder means arranged along either side of said boom with one end thereof pivotally supported on the distal boom end of said swingable boom, and folding hydraulic cylinder means having one end pivotally connected to said saddle, the other end of said extending hydraulic cylinder means or piston rods thereof being pivotally connected to said folding hydraulic cylinder means, the portion at which said extending hydraulic cylinder means or said piston rods thereof are pivotally connected to said foldLng hydraulic cylinder means bieng relatively swingably connected through connecting links to the portion at which said saddle is pivotally mounted to said swingable boom, said folding hydraulic cylinder means being pivotably connected between the forward ends of the respective piston rods or the extending hydraulic cylinder means.

6. An inspection vehicle according to any preceding claim, wherein said boom comprises a plurality of boom members telescopically and slidably fitted to each other so as to be extended in a plurality of steps.

7. An inspection vehicle according to any preceding claim, wherein said inspection passageway comprises a plurality of passageway sections telescopically and slidably engaged with each other thereby permitting said passageway to be extended by sliding said sections in the outward direction from each other.

8. An inspection vehicle according to any preceding claim, wherein said inspection passageway is provided with a carriage movable in the longitudinal direction of said passageway and an inspection platform mounted on said carriage, said inspection platform being capable of being elevated and lowered with respect to said carriage.

9. An inspection vehicle constructed and adapted to operation substantially as herein described with reference to and as illustrated in the accompanying drawings.

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