United States Patent [19]

Tranchero

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[54] **THREE-STAGE SELF-PROPELLED CRANE**

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[52] **U.S. Cl.** **212/8,** 212/55

[51] **Int. Cl.** **B66c 23/14**

[58] **Field of Search** ..... 212/58 R, 55, 35 R, 46 A, 212/8

[56] **References Cited**

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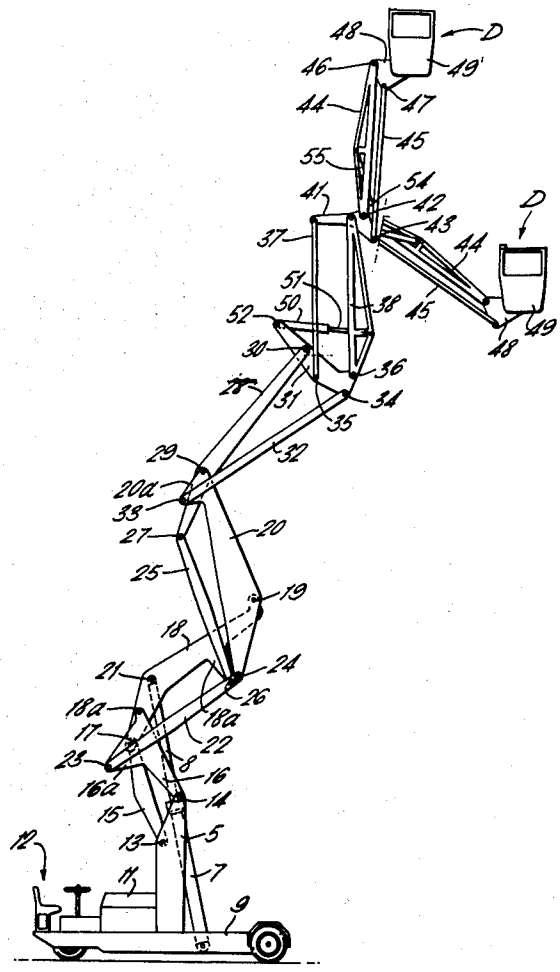
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Assistant Examiner—Norman L. Stack, Jr.

[57] **ABSTRACT**

The present invention relates to a crane that is provided with a principal or first hydraulic lifting stage, co-operating with a first lever system and with two secondary hydraulic stages for controlling the movement of two further lever systems that are mutually pivoted with respect to each other and with respect to the first stage through an intermediate lever mechanism which does not have its own hydraulic plunger and which is actuated in movement by the movement of the first lifting stage.

5 Claims, 5 Drawing Figures



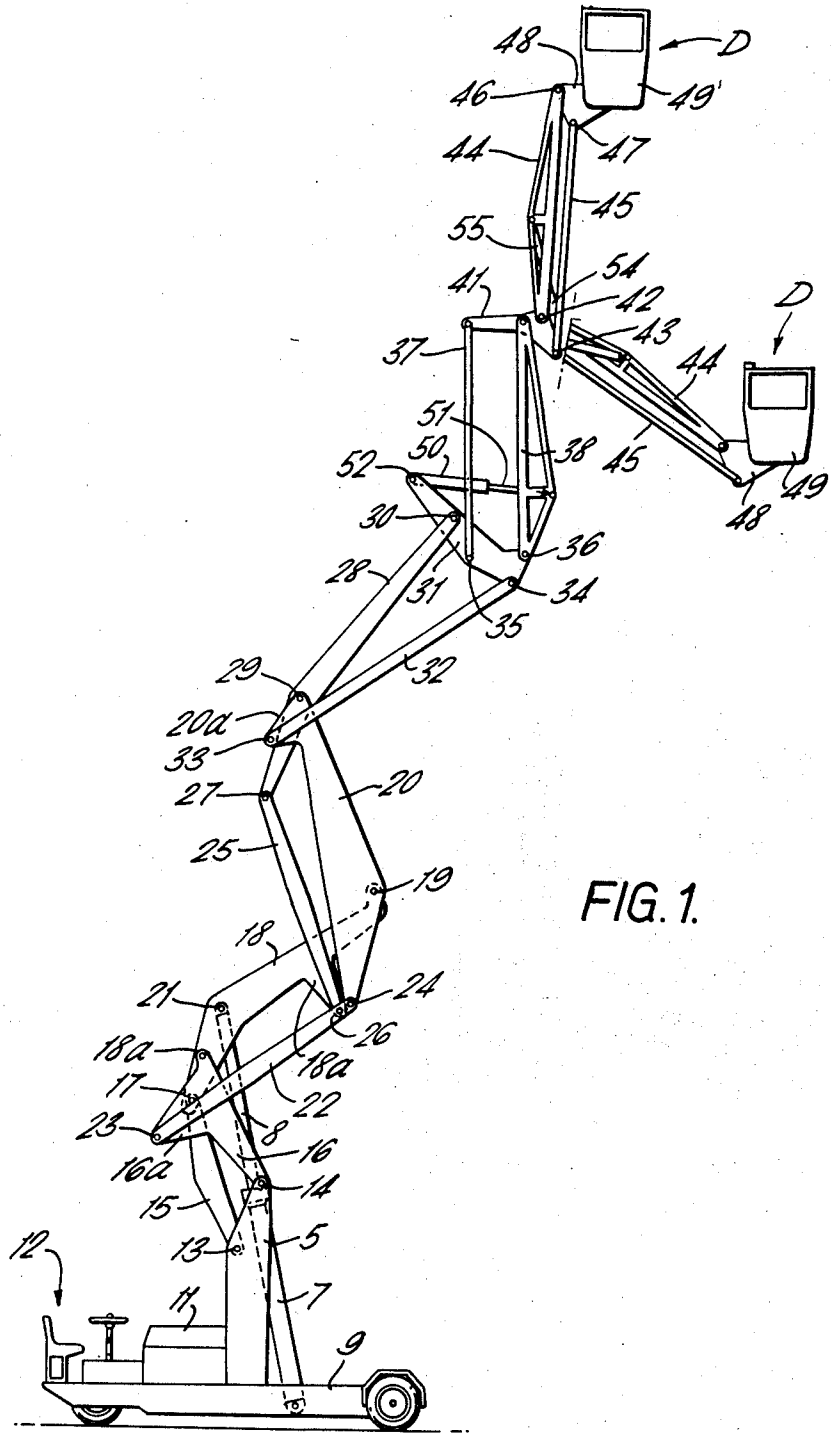

48
D
46
49'
44
47
45
55
54
41
42
D
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38
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20a
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18a
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16a
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7
9

FIG. 1.

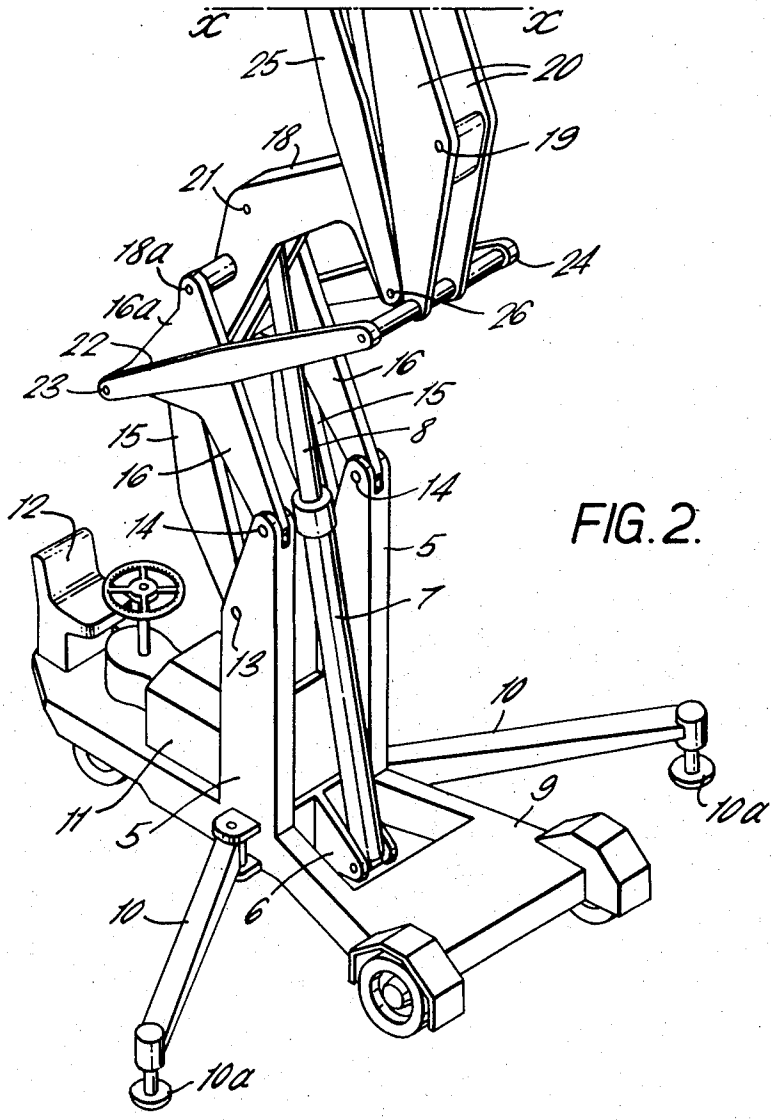

x
x
25
20
18
19
21
18a
24
16a
26
22
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8
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10
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5
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10a
10
6
10a

FIG. 2.

FIG. 2a.

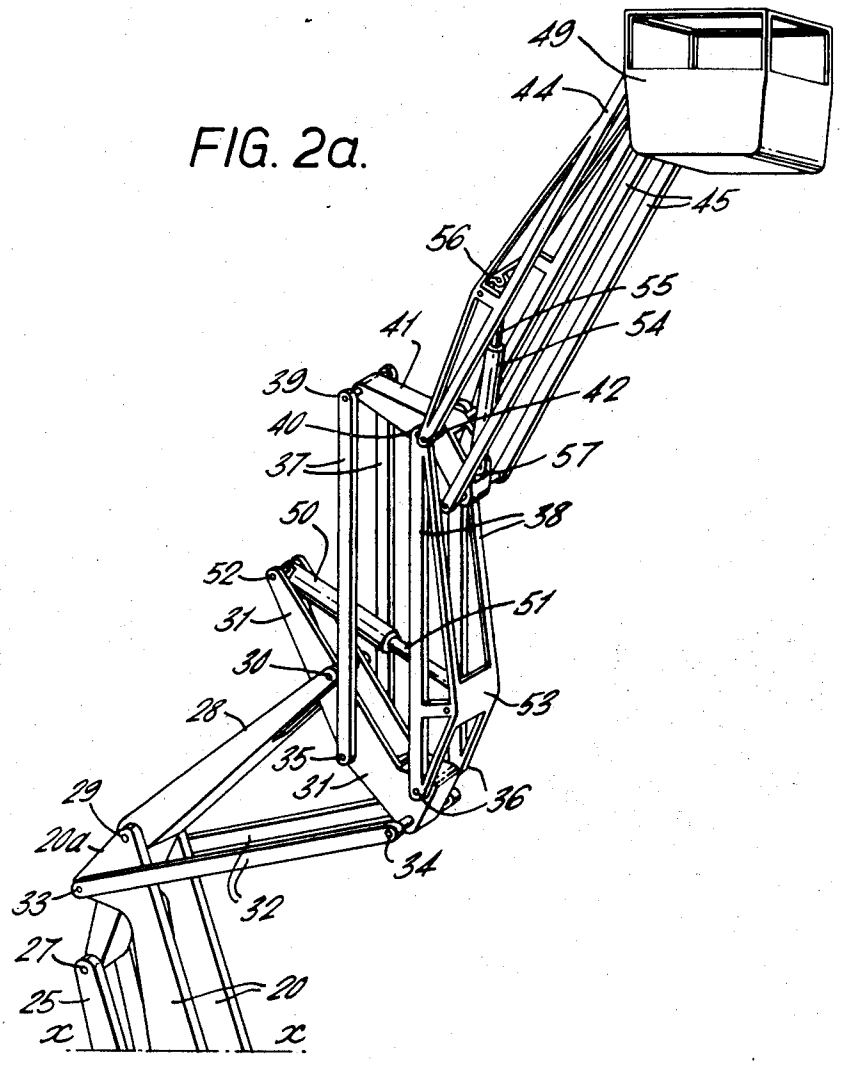
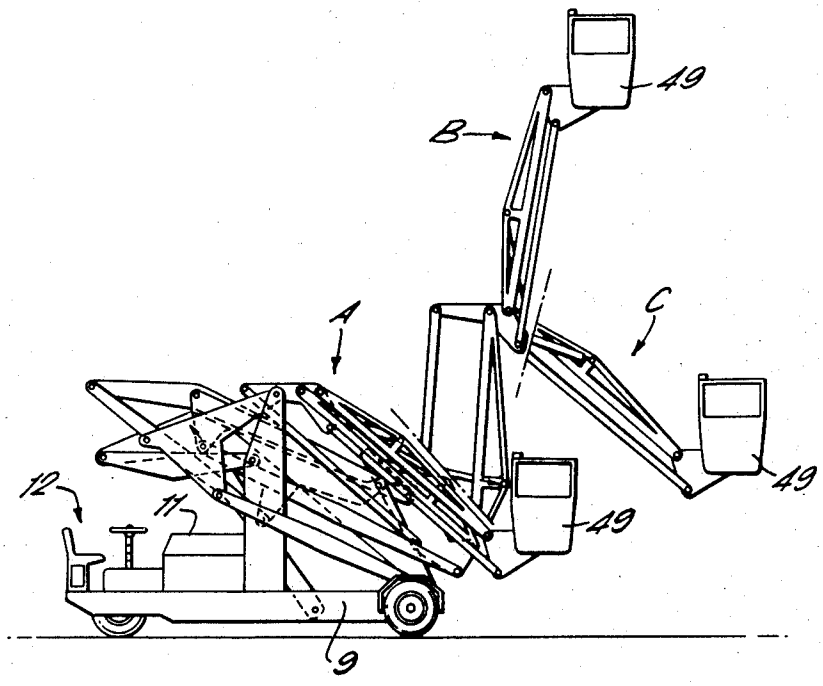

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36
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20a
34
33
32
27
25
20
x
x

FIG. 3.



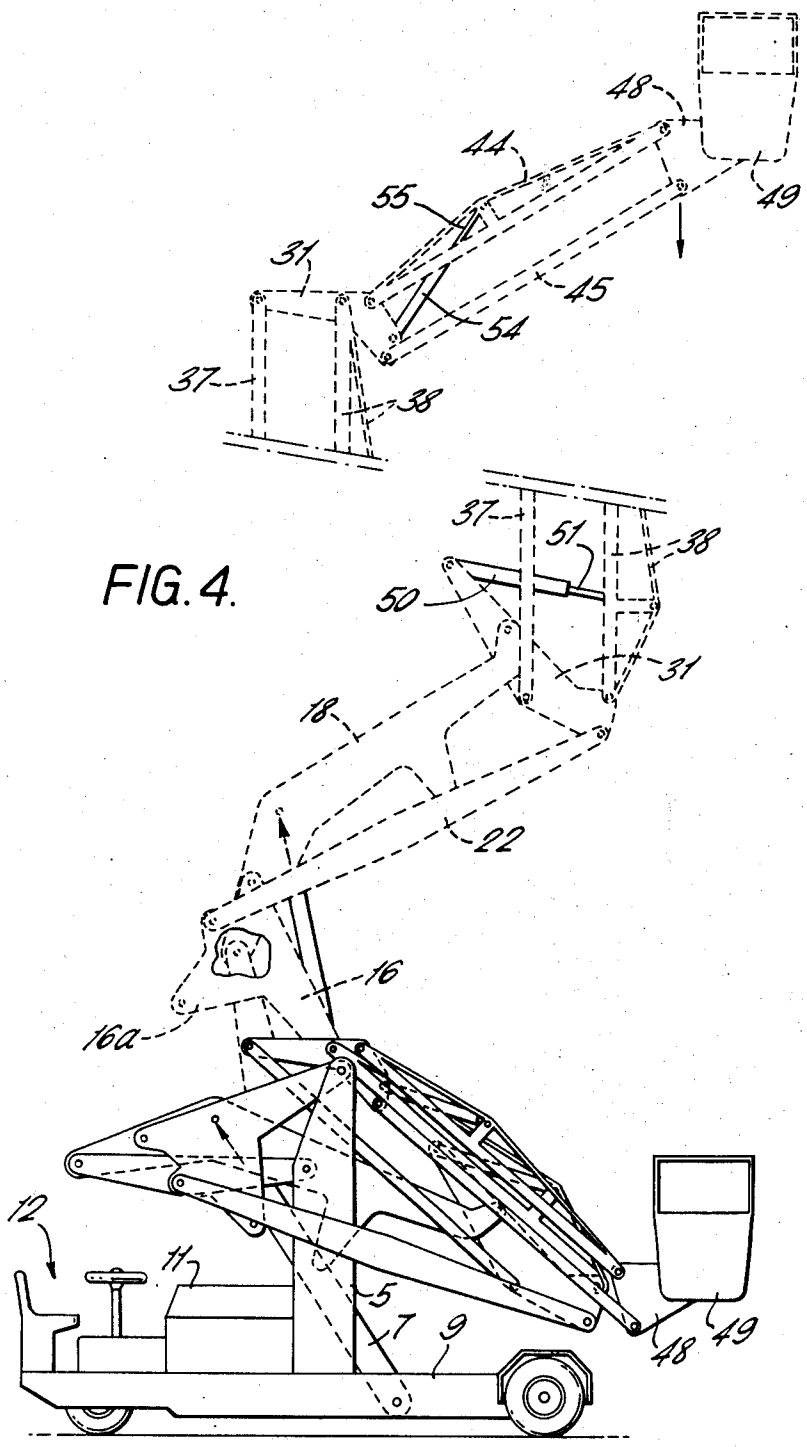


FIG. 4.

THREE-STAGE SELF-PROPELLED CRANE

One feature of the crane according to the improvement of the present invention derives from the rocker lever structure of the second or mechanical intermediate stage whose relative movement and positions are determined by the movement and the positions imparted to the first stage which, in turn, is formed by a device of articulated levers that are piloted by a hydraulic group comprising a cylinder and piston which is fed by a suitable pump.

Another feature of the improved crane resides in the fact that, at any intermediate height, the nacelle is locked between the lower height deriving from the "at rest" position of the crane and the highest extension of the same. The bottom plane of the nacelle remains perfectly horizontal.

A further feature of the crane according to the present invention resides in the fact that the terminal nacelle is not of the known pendular type, whose stability is controlled by electromechanical devices which are sensitive to the inclinations of the plane of its bottom relative to the horizontal plane. Instead, the nacelle is rigidly supported by a terminal support having a substantially triangular outline whose vertices are the seats of three articulations with their axes parallel to one another and which do not change their relative position for any position that the nacelle may assume in space with respect to any position imposed to the lifting device.

Other features of the crane according to the invention will be evident from the following specification and with reference to the drawings that are annexed only as a demonstrative and non-limiting example, wherein:

FIG. **1** is a schematic side elevational view of the complete crane comprising this invention;

FIGS. **2** and **2a** are partial perspective views illustrating the complete crane cut along line x—x, due to space necessities;

FIG. **3** shows, in a side view, the crane when partially lowered and completely lowered; and

FIG. **4** illustrates in a side view the same crane according to a structural variant wherein the intermediate mechanical stage is eliminated.

With reference to the drawings and particularly to FIGS. **1** to **3**, the crane base comprises a sturdy fork-shaped support with parallel branches **5** that are integral with a bracket **6** (FIG. **2**) on which the closed end of the hydraulic cylinder **7**, having a piston **8**, is articulated. This base group may be mounted on a carriage **9** that is provided with stabilizer arms **10**, motor group **11** and drive means **12** or the base group be mounted on a thrust bearing carried by a motor vehicle or a part of a railway carriage or any other means intended for specific services as aeronautical, electrical, antifire, etc.,

The ends of a pair of levers **15** are articulated on pivot pins **13** proximate the upper end of the fork-shaped support **5** while the ends of another pair of levers **16** are articulated on pivot pins **14** at the same end of the support **5**. The other end of the levers **15** is articulated on pivot pins **17** to an end of an angled lever **18**. The lever **16** is articulated on pivot pin **18***a* on the same lever **18** and therefore, in co-operation with the lever **15**, conditions the movement of the lever **18**. The opposite end of the lever **18** is articulated on pivot pin **19** in a position almost median with respect to a pair of levers **20**. The free end of the piston **8** is articulated on a pivot pin **21** in a median position with respect to the angled lever **18**. A pair of tie rods **22** is articulated on pivot pins **23** of a beak **16***a* of the levers **16** and respectively, at **24** on one end of the rocker arm formed by levers **20**. A pair of tie rods **25** is respectively articulated on pivot pins **26** and **27** of a beak **18***a* of the angled lever **18** and on the end of a lever **28** that is, in turn, articulated on pivot pin **29** on the end of the lever **20** and on pivot pin **30** on a cradle **31**. A pair of tie rods **32** is articulated at one end thereof on pivot pins **33** on a beak **20***a* of the lever **20** and at the opposite end on pivot **34** of the base of a cradle **31**, respectively. To the base of the cradle **31**, pivot pins **35** and **36** are articulated the ends of parallel levers **37**, **38** the opposite ends of which are articulated on pivot pins **39**, **40** on the back of an overturned cradle **41** whose base is articulated on pivot pins **42** and **43** to the ends of parallel levers **44** and **45**. The opposite ends of the levers **44** and **45** are articulated on pivot pins **46** and **47** on two vertices of a triangular support **48** at whose third vertex is firmly engaged a nacelle **49**.

A hydraulic cylinder **50** having a piston **51** is articulated at one free end on pivot pin **52**, the end of the cradle **31** and at its opposite end **53** at an intermediate point of the levers **38**. Another hydraulic cylinder **54** having a piston **55**, is articulated at its free ends on pivot pins **56** and **57** on an intermediate point between the levers **44** and the base of the overturned cradle **41**, respectively.

The "at rest" position, with the crane being completely lowered, is shown in FIG. **3** and indicated by A. Starting from said position and by the actuation of the hydraulic cylinder **7** and piston **8**, the crane operates as follows:

By the feeding of the cylinder **7** with a fluid under pressure, preferably oil, the piston **8** lifts the arm **18** which, due to the presence of the articulation **17** with respect to the arm **15** and the articulation **18***a* with respect to the arm **16**, moves in such a way as to cause the arms **15** and **16** to move along an arc in a clockwise direction. At the same time as these movements, the tie rods **22** cause the rocker arm **20** to oscillate around the articulation axis of the pivot pin **19** in a clockwise direction, while the tie rods **25** displace the angled lever **28** an arcuate movement in a counterclockwise direction. The lever **28**, co-operating with the tie rods **32**, actuates the cradle **31** in an arcuate movement and with respect to which the parallel levers **37** and **38** are articulated. By the actuation of the hydraulic cylinder **50** and the piston **51**, the parallel levers **37** and **38** are driven in the position shown on FIGS. **1** and **2**, **2***a*. The arcuate movement in a counterclockwise direction imparted to the parallel levers **37** and **38**, positions automatically the overturned cradle **41**. The hydraulic cylinder **54** and piston **55** moves the parallel levers **44** and **45** and the nacelle **49** to the position indicated by D or the position indicated by D1, or any of the intermediate positions comprised within the arc that the parallel levers **44** and **45** may describe by rotating around the articulation axes of the pivot pins **42** and **43**.

The position D which may be imparted to the nacelle **49** drives it so as to reach the maximum lifting height which may be obtained with the crane, while the position D1 and the intermediate positions between the D

and D1 positions, drive the nacelle in an overhanging condition with respect to the lifting kinematic column, without the slightest lessening of the stability of the machine the center of gravity of which, for any position of the nacelle **49**, does not undergo any appreciable displacement, in relation with the prescribed load range.

The principal features of the apparatus, according to the improvement so far described may be summarized as follows:

The movement of the kinematic assembly, under the thrust of the principal hydraulic group, comprising the cylinder **7** and the piston **8**, is gradual and without brusque jerks. To the arcuate and counterclockwise directed movement of the lever **18**, is opposed the arcuate and clockwise directed movement of the lever **28** with a harmonic development of the assembly, in the lifting as well as in the lowering of the apparatus and a counterbalanced position of the moving masses whose movement is realized in such a way as to discharge the gravitational components only on the hubs of the various articulations, as said members do not present, as known and when opportunely dimensioned, any technical difficulties for their best and more suitable realization.

Another feature of this invention derives, as already mentioned in the introduction, from the fact that for any relative position imparted to the kinematic assembly of levers mutually articulated of the machine, in relation to the height where it is desired to stop the nacelle **49**, the latter presents the bottom plane perfectly horizontal and this condition is in no way affected during the movement of the machine, both in the lifting and in the lowering phase of the same. An analogous condition occurs for the cradle **31**, the position of which remains unvaried for any movement phase of the kinematic system and/or any lifting height imposed to the crane or lifting machine according to the invention.

With reference to the structural variant represented in FIG. **4**, while keeping unchanged the particular features so far described of the machine, the cradle **31** instead of being articulated on the angled lever **28** and on the tie rod **32**, is directly articulated on the ends of the lever **18** and the tie rods **22**, without changes also in the two upper stages actuable by the hydraulic cylinders **50** and **54**.

Substantially, according to this variant, the machine operates without the intermediate, mechanical stage comprising the levers **20** and **28** and the relative tie rods and therefore is suitable to lift the nacelle **49** to a limited height as compared with the maximum height which may be reached by the crane represented in FIGS. **1** to **3**; further, the lifting machine according to the variant, shown in FIG. **4** is particularly suitable for the lifting of loads greater than those which may be lifted with the preceding machine.

Obviously, the nacelle **49** may be replaced by members intended to effect various works and services, as a bucket, a load lifting platform, a poly-shaped load gripper, while keeping unchanged the particular features of the kinematic system.

In the case where the machine is mounted on a self propelled carriage, as represented in the drawings, said carriage, in addition to being provided with stabilizer arms **10** also has height adjustable feet **10***a*. Further, if requested, hooks for the connection of tie rods intended to stabilize the lifted machine against wind may be provided at some suitable points of the framework.

In order to avoid any accidental lowering of the crane for any grade of lifting of the same, the use of suitable safety means may be provided. In the lowering phase particularly there may be provided a braking hydraulic device with a controllable delivery which is the subject of another patent in the name of the same applicant.

Obviously in the machine according to the invention further improvements and variants may be effected without departing from its scope, defined by the following claims.

What I claim is:

1. A self propelled crane with three hydraulic lifting stages which may be mounted on motor vehicles, characterized in that the first lifting stage comprises a hydraulic cylinder (**7**) having a piston (**8**) for actuating in a lifting movement, a pantograph system of levers comprising an arm (**18**) pivotally connected proximate the mid-point thereof to said piston (**8**) of tie rods (**15**) pivotally coupled to the end of said arm (**18**), a first order a fork-shaped support (**5**) pivotally coupled to the opposite end of said tie rods (**15**), the base of said support (**5**) being pivotally connected to the bottom of the hydraulic cylinder (**7**); a second order of tie rods (**16**) pivotally coupled, respectively, to the ends of said fork-shaped support (**5**), to said central arm (**18**) and to a pair of tie rods (**22**) for providing the lifting thrust to a group of two levers (**20, 25**) and to a pair of tie rods (**32**); a cradle member (**31**) pivotally coupled to said tie rods (**32**); two pairs of levers (**37, 38**) pivotally coupled to said cradle member (**31**) and which, together with said cradle member (**31**) and an analogous second member (**41**) mounted in opposition to said cradle member (**31**), form a first parallelogram, a second parallelogram being defined by doubled levers (**44, 45**) terminally articulated to a bracket (**48**) having a triangular outline and a nacelle (**49**) carried by said bracket (**48**); said second parallelogram (**44, 45**) being controllable as to its position with respect to the member (**41**) which supports it, by the action of a hydraulic cylinder and piston (**54, 55**).

2. The crane, as claimed in claim **1**, characterized in that the thrust generated by the hydraulic cylinder (**7**) and piston (**8**) is directly transmitted to a rocker lever (**18**) and from said lever (**18**), to a second rocker lever (**20**) and then to a third rocker lever (**28**) up to said two parallelograms (**37, 38**) and (**44, 45**) thus providing a kynematic system with an extension substantially vertical wherein said cradle-outlined members (**31**) and (**41**) as well as said terminal support bracket (**48**) do not change their trim with respect to the horizontal plane for any position of relative height which may be imparted to the crane between the completely lowered and the completely lifted positions, allowing the terminal nacelle (**49**) to maintain in any case the perfect horizontality of its bottom.

3. The crane, as claimed in claim **1**, characterized in that the last stage formed by said second parallelogram (**44, 45**) is adapted to rotate around the pivot axes (**42, 43**) through an arc slightly lesser than 180°, allowing the terminal nacelle (**49**) to assume a plurality of overhanging positions with respect to the lever framework and a plurality of height positions limited by said arc-shaped movement path.

4. The crane as claimed in claim **1**, characterized in that said nacelle (**49**) is integrally coupled to said support bracket (**48**) which is, in turn, pivotally connected to said second parallelogram (**44, 45**).

5. The crane as claimed in claim **1**, characterized in that said first parallelogram formed by said two opposite cradle members (**31, 41**) and said doubled levers (**37, 38**), is pivotally coupled to said first rocker lever (**18**).

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