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(54) **A pantograph linkage**

(57) A pantograph linkage 11 is actuated by two linear actuators 30, 32 pivotally connected together at the linkage 11. The displacement of the actuators 30, 32 is monitored by rectilinear potentiometers to provide feedback signals to a microprocessor which also receives input signals related to a required movement of a slave end 26 of the linkage 11. In response to these signals, the microprocessor provides signals to control the displacement of the linear actuators 30, 32 to effect the required movement of the slave end 26. The movement of the slave end 26 might be straightline in a substantially horizontal or vertical direction.

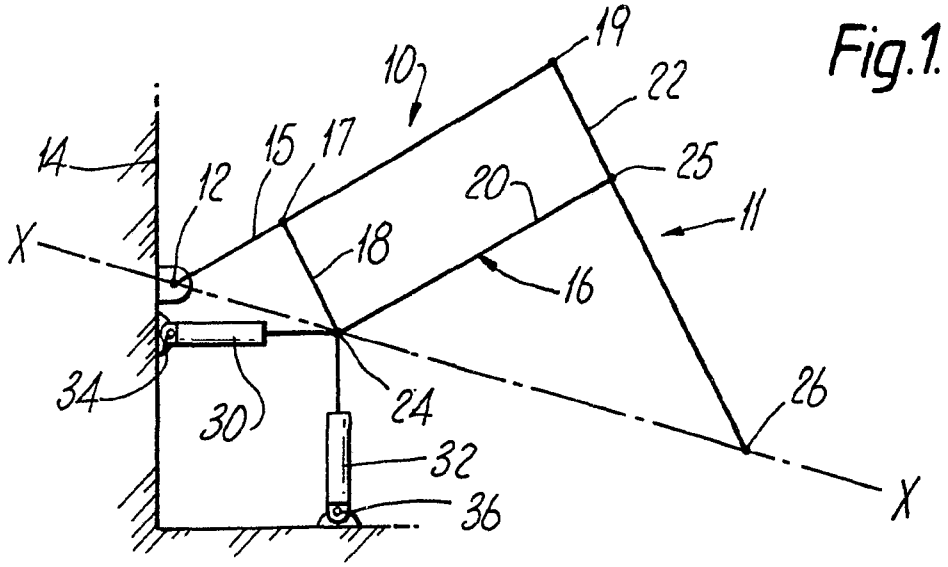

Fig.1.

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Fig.1.

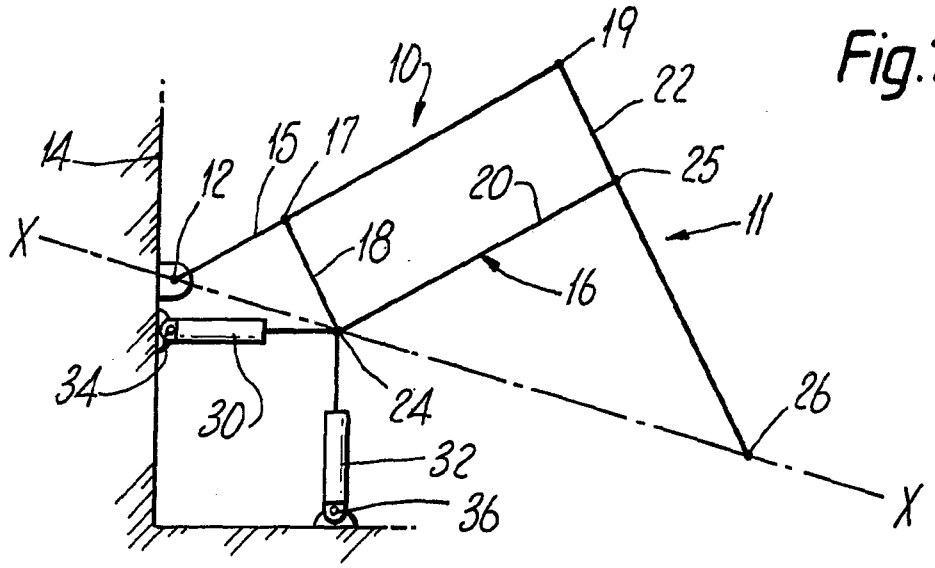

19
10
22
14
15
17
12
20
25
X
18
11
16
34
30
24
26
32
36
X

Fig.2.

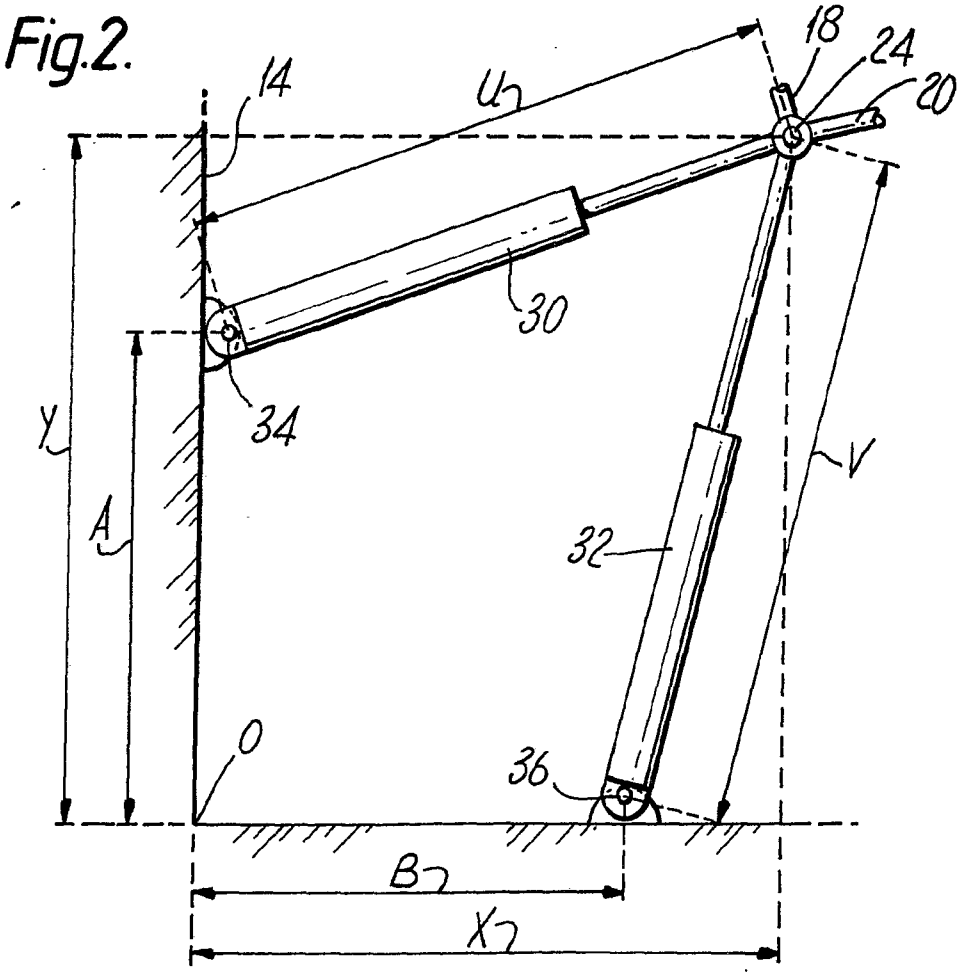
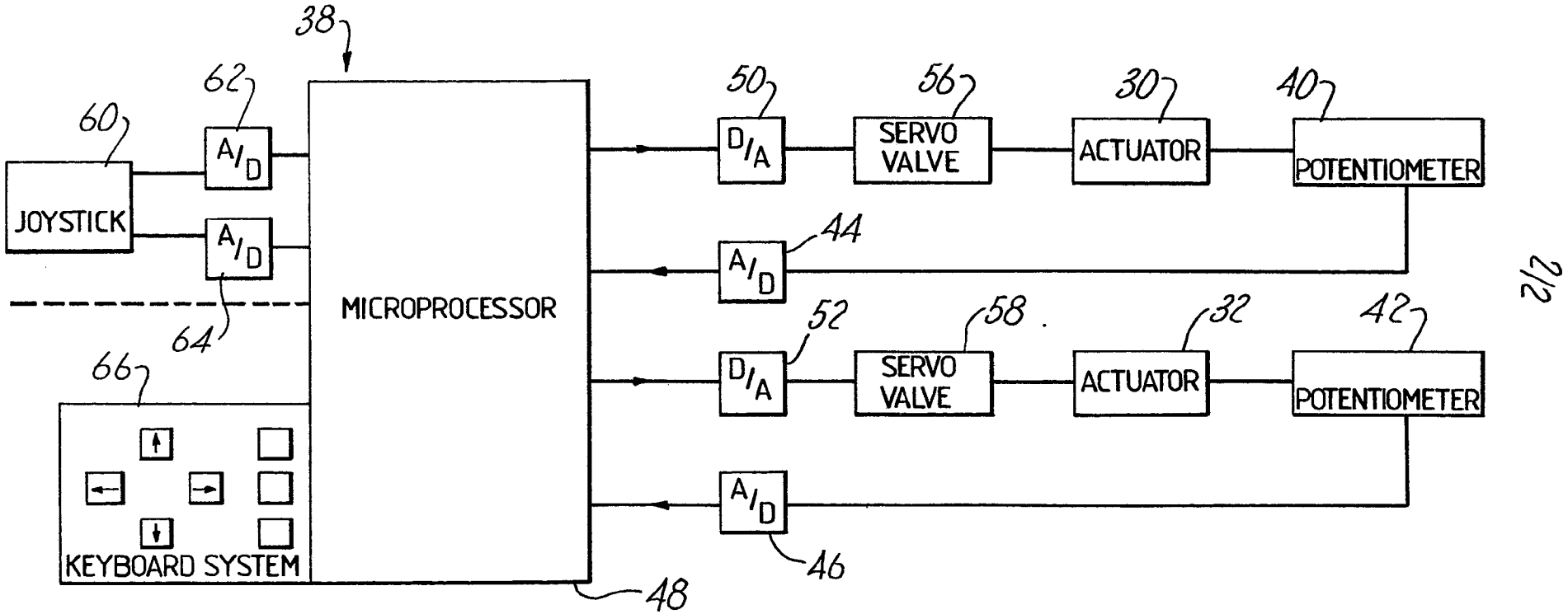

18
24
20
14
U
30
34
Y
A
V
32
0
36
B
X

Fig.3.



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SPECIFICATION

A pantograph linkage

This invention relates to a pantograph linkage, and more particularly but not exclusively, to a pantograph linkage incorporated in a mechanical handling device.

According to the present invention, there is provided a pantograph linkage having a captive end pivotally connected to a support structure, a slave end, and means for displacing the linkage at a master pivotal connection of the linkage lying in a straight line between the slave end and the captive end, the displacing means comprising two linear actuators pivotally connected to the structure and pivotally connected together at the master pivotal connection, and there being provided, feedback means for monitoring the displacement of each said actuator and for providing feedback signals related to said displacement, means responsive to the feedback signals from the feedback means for controlling the displacement of the actuators, and means for providing input signals to the control means related to a required movement of the slave end.

In the preferred form of the invention, the required movement of the slave end constitutes straightline motion thereof in a substantially horizontal or vertical direction.

Conveniently, the feedback means comprises rectilinear potentiometer means for monitoring the linear displacement of each said actuator, the control means comprises microprocessing means, and the linear actuators comprise hydraulic actuator means.

The invention has one application in a mechanical handling arm which may be pivotally connected to a rigid said support structure or to a mobile said support structure.

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

Figure 1 shows a side diagrammatic representation of a mechanical arm;

Figure 2 shows to an enlarged scale part of the mechanical handling arm of Figure 1, and

Figure 3 shows in block schematic form a control system for the mechanical handling arm of Figure 1.

Referring now to Figure 1, a mechanical handling arm 10 is shown comprising a pantograph linkage 11 pivotally connected at 12 to a support structure 14. The pantograph linkage 11 comprises an extended link 15 extending from the pivotal connection 12 and forming part of a parallelogram linkage 16 which has additional links 18, 20 and 22. The link 15 is pivotally connected to the links 18 and 22 at 17 and 19 respectively, the link 20 being pivotally connected to the links 18 and 22 at 24 and 25 respectively. The link 22 extends to a slave end 26 which lies on a straight line through 12 and 24 and shown as the chain broken line X—X.

Thus, in the known manner of pantograph linkages, displacement of the pivotal connection 24 which constitutes the master pivotal connection is faithfully reproduced but to an enlarged scale by the sleeve end 26, and this displacement is arranged by two angularly displaced hydraulic linear actuators 30, 32 respectively which are pivotally connected together at the pivotal connection 24 and pivotally connected to the support structure 14 at 34 and 36 respectively.

The hydraulic actuators 30, 32 are shown to an enlarged scale in Figure 2 to which reference is made. In Figure 2, the distance between the pivotal connections 24 and 34 is represented by the dimension U, and the distance between the pivotal connections 24 and 36 is represented by the dimension V. The Cartesian co-ordinates (X, Y) of the pivotal connection 24 are found from the intersection of circles having radii U and V respectively and struck from the pivotal connections 34 and 36 where the pivotal connections 34, 36 have known approximate Cartesian co-ordinates (O, A) (B, O) respectively. Thus the Cartesian Co-ordinates (X ,Y) of the pivotal connection 24 can be deduced when U and V are known, and suitable control of the actuators 30, 32 can be used to move the pivotal connection 24 in a required direction, a system for controlling the actuators 30, 32 being shown in Figure 3.

In Figure 3 a control system 38 comprises a rectilinear potentiometer 40 provided to monitor the displacement of the actuator 30 and thus the dimension U, and a rectilinear potentiometer 42 for monitoring the actuator 32 and thus the dimension V. The potentiometers 40, 42 provide signals representative of U or V respectively through a respective analogue to digital converter 44, 46 to a microprocessor 48 in which the position of the pivotal connection 24 (not shown in Figure 3) is computed. For controlling the displacement of the actuator 30 or 32, a signal is supplied from the microprocessor 48 through a digital to analogue converter 50 ro 52 to a servo valve 56 or 58 connected to the respective actuator 30, 32. Master input signals 'D' and 'E' respectively to the microprocessor 48 are provided from a multi-function joystick device 60 through respective analogue to digital converters 62, 64 or from a keyboard system 66, the 'D' signal representing displacement of the pivotal connection 24 in a direction where the co-ordinate Y remains constant and the 'E' signal representing displacement of the pivotal connection where the co-ordinate X remains constant.

The operation of the control system 38 for producing straightline motion of the pivotal connection 24 is as follows:—

Periodically the microprocessor 48, processes the 'D' and 'E' signals received from the joystick device 60 or the keyboard system 66, and the signals from the potentiometers 40, 42, to determine whether any changes in the values of the co-ordinates X or Y of the pivotal connection 24 are required. When a change is necessary, the

microprocessor 48 estimates the values of the velocities DU, DV of the actuators 30, 32 respectively to keep either X or Y constant, and provides signals through the digital to analogue converters 50, 52 to the servo valves 56, 58 to effect the required displacement of the actuators 30, 32. After a short delay (e.g. 0.02 seconds) the aforesaid processing of the signals received at the microprocessor 48 is repeated and new estimates are made of the required values of DU, DV. Thus the control system 38 operates on a step by step basis, and the pivotal connection 24 moves in a straight line having constant X or Y co-ordinates until either one of the 'D' and 'E' signals received from the joystick device 60 of the keyboard system 66 is changed.

Additional feedback signals relating to the displacement of the actuators 30, 32 may be provided by rotary potentiometers (not shown) fitted at the pivotal connections 34, 36, for monitoring the angular displacement of each actuator 30, 32.

In practical application of the mechanical handling arm 10, a load carrying member such as a pivotally attached hook (not shown) may be fitted at the slave end 26, and the support structure 14 might be provided by a fixture such as a wall (not shown), or by a mobile structure (not shown).

If desired, the microprocessor 48 may be programmed to arrange that the pivotal connection 24 follows some alternative selected straightline path, or a predetermined non-linear path.

In a similar manner to that aforedescribed, three-dimensional straightline movement or control of the pantograph linkage may be arranged.

CLAIMS

1. A pantograph linkage having a captive end pivotally connected to a support structure, a slave end, and means for displacing the linkage at a master pivotal connection of the linkage lying in a straight line between the slave end and the captive end, the displacing means comprising two linear actuators pivotally connected to the structure and pivotally connected together at the master pivotal connection, wherein there are provided, feedback means for monitoring the displacement of each said actuator and for providing feedback signals related to said displacement, means responsive to the feedback signals from the feedback means for controlling the displacement of the actuators, and means for providing input signals to the control means related to a required movement of the slave end.

2. A pantograph linkage as claimed in Claim 1, wherein the required movement of the slave end constitutes straightline motion thereof in a substantially horizontal or vertical direction.

3. A pantograph linkage as claimed in Claim 1 or Claim 2, wherein the feedback means comprises rectilinear potentiometer means for monitoring the linear displacement of each said actuator.

4. A pantograph linkage as claimed in any one of the preceding Claims, wherein the linear actuators comprise hydraulic actuator means.

5. A pantograph linkage as claimed in Claim 4, wherein the control means comprises, microprocessing means, and servo valve means controlled by the microprocessing means and in respective hydraulic circuits each having a said hydraulic actuator means therein.

6. A pantograph linkage as claimed in any one of the preceding Claims, wherein the input means comprises a multi-function joystick means.

7. A pantograph linkage as claimed in any one of Claims 1 to 5, wherein the input means comprises a keyboard system.

8. A mechanical handling arm incorporating a pantograph linkage as claimed in any one of the preceding Claims.

9. A mechanical handling arm substantially as hereinbefore described with reference to Figures 1 to 3 of the accompanying drawings.

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