April 30, 1968 D. S. CHISHOLM 3,380,309

MECHANICAL LINKAGE

Filed March 21, 1966 2 Sheets-Sheet 1

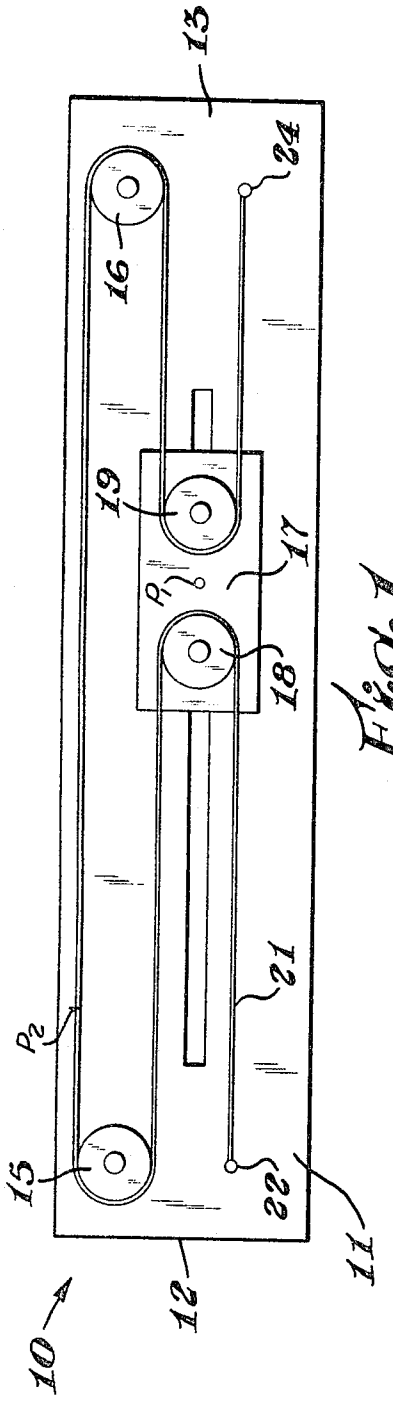


Fig. 1

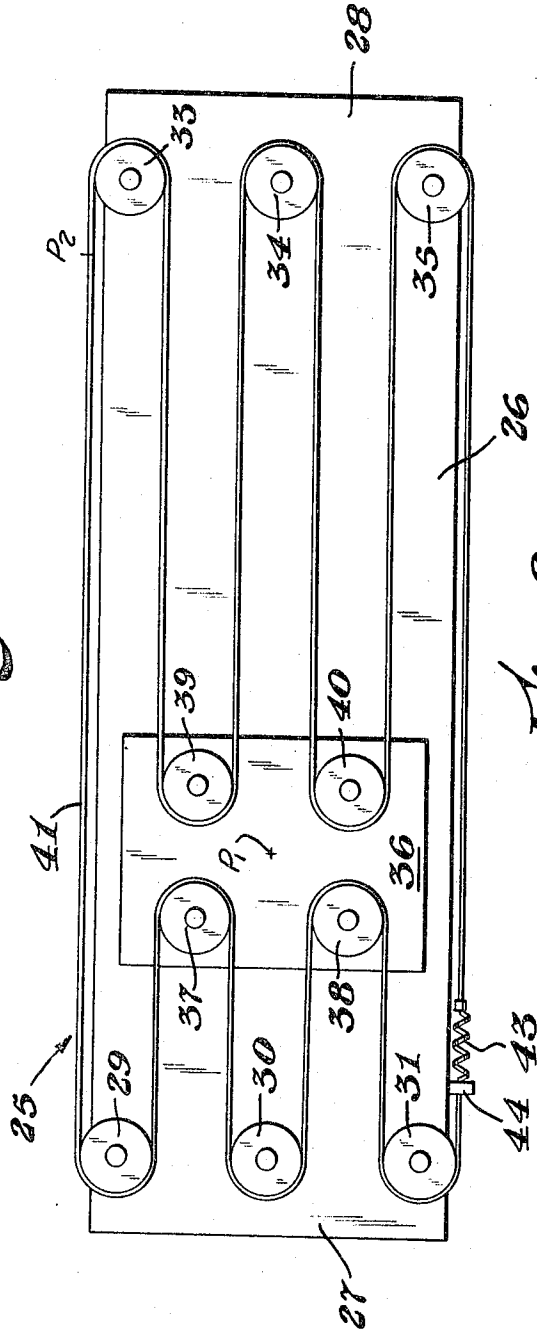


Fig. 2

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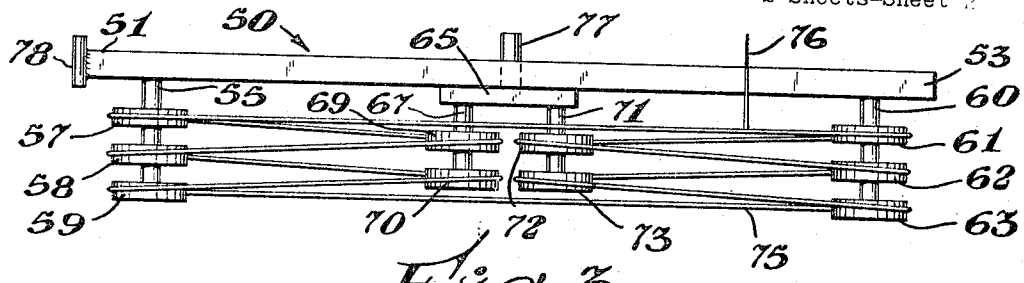


Fig. 3

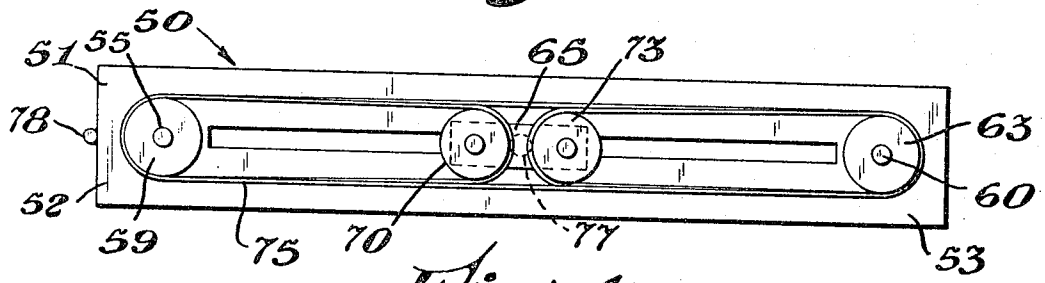


Fig. 4

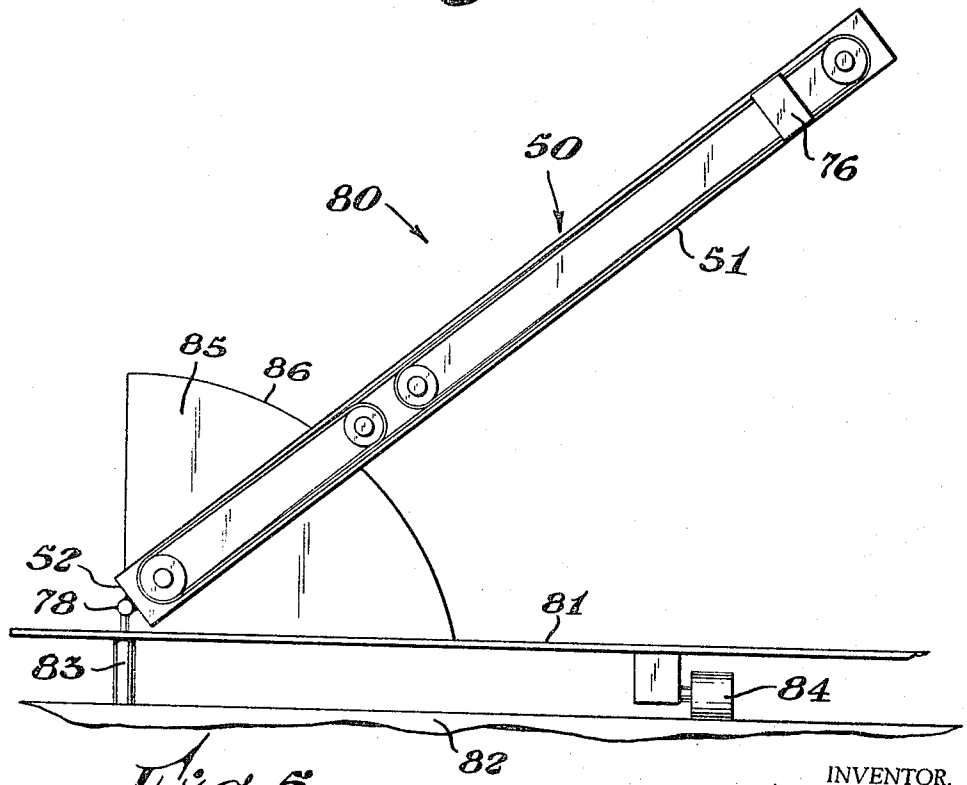


Fig. 5

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3,380,309

MECHANICAL LINKAGE

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7 Claims. (Cl. 74—1)

This invention relates to an improved mechanical linkage. It more particularly relates to an improved mechanical linkage capable of positioning a point on a predetermined curved line or surface.

Frequently in the construction of buildings having curved surfaces it is desirable to provide a guide or a tool which is readily positionable on or adjacent to the building structure in such a manner that the required design is adhered to. In cases of circular or spherical structures this is readily accomplished, for example, by pivoting an arm on the center of the desired structure. However, oftentimes it is desirable to generate structures wherein there is no ready access to the center. For example, in a spherical or spheroidal dome often a suitable geometric center is not available or in the case of a dome having an elliptical cross sectional configuration the centers of generation may be remote and inaccessible such as being positioned well within the earth. Oftentimes it is desired to support a construction unit such as a bricklaying machine or the like at the end of a boom or arm and position the terminal portion of the boom in such a manner that it serves as a guide and determines the final form of the structure. Such a technique is particularly advantageous when buildings are constructed from strips or portions of synthetic resinous foam which are adhered together to form the desired configuration.

It is an object of this invention to provide an improved mechanical linkage adapted to position an arm on a desired curved surface.

A further object of this invention is to provide a mechanical linkage for the multiplication or division of motion.

A further object of this invention is to provide an apparatus for the positioning of an operating mechanism in a guided pattern capable of generating a dome-like surface.

These benefits and other advantages in accordance with the present invention are achieved in an apparatus for the multiplication of linear motion comprising a frame, the frame having a first end and a second end, a first wheel disposed adjacent the first end, a second wheel disposed adjacent the second end, a movable support, first and second movable wheels affixed to the movable support, the movable support being slideably positionable along the frame, a motion transmitting means extending from a point adjacent the first end of the frame about the first movable wheel, from the first movable wheel to the first wheel, about the first wheel, from the first wheel to the second wheel and about the second wheel, from the second wheel to the second movable wheel, about the second movable wheel and to a location generally adjacent to the second end of the frame.

Further features and advantages of the present invention will become more apparent from the following specification when taken in connection with the drawing wherein:

FIGURE 1 is a schematic representation of the operation of apparatus in accordance with the invention;

FIGURE 2 is a schematic representation of an alternate embodiment of the invention;

FIGURES 3 and 4 depict a compact arrangement of apparatus employing a principle of the apparatus of FIGURE 2; and

FIGURE 5 is a schematic representation of an operating apparatus such as is depicted in FIGURES 3 and 4 particularly adapted for tracing curved surfaces.

In FIGURE 1 there is schematically depicted an apparatus which is generally designated by the reference numeral **10**. The apparatus **10** comprises a frame or support **11** having a first end **12** and a second end **13**. A first wheel **15** is pivotally affixed to the first end **12** of the frame **11**. A second wheel **16** is pivotally affixed to the second end **13** of the frame **11**. A movable wheel support **17** is slideably disposed on the frame **11** and adapted to move between the first and second ends **12** and **13**, respectively. The support **17** carries a first movable wheel **18** and a second movable wheel **19**. By the term wheel is meant a pulley gear, sprocket gear drum or the like. A motion transmitting means **21** such as a sprocket chain, cable or belt is affixed to the first end **12** of the frame **11** at location **22**. Motion transmitting means **21** extends from location **22**, about the wheel **18**, from the wheel **18** to the wheel **15**, about the wheel **15** and toward the second end **13**, about the wheel **16** and toward the wheel **19**, about the wheel **19** to location **24** generally adjacent the second end **13** of the frame **11**. A point P_1 is disposed upon the movable wheel support **17**. A second point P_2 is disposed on the motion transmitting means **21** which extends between the wheels **15** or **16**. Motion of the support **17** causes the point P_1 to be moved a given distance whereupon the point P_2 will be moved twice the distance the support **17** is moved. Thus, by moving the point P_1, the point P_2 is caused to move a distance twice that which the point P_1 was moved. Similarly, if motion is applied to the point P_2 and it is moved a given distance, the point P_1 will be moved one-half of that distance. Thus, the apparatus **10** provides motion multiplication or division by a factor of 2.

In FIGURE 2 there is illustrated an alternate embodiment of the invention generally designated by reference numeral **25**. The apparatus **25** comprises a frame **26** having first end **27** and second end **28**. First, second and third wheels **29**, **30** and **31** are disposed adjacent the first end **27** and pivotally mounted thereon and adapted to rotate about generally parallel axes. Third, fourth and fifth wheels **33**, **34** and **35**, respectively, are pivotally mounted on the second end **28** of the frame **26** and are adapted to pivotally rotate about generally parallel axes. A movable support **36** is disposed slideably adjacent the frame **26** and then disposed intermediate the first and second ends **27** and **28**. The support **36** carries a plurality of wheels, the 7th, 8th, 9th and 10th wheels **37**, **38**, **39** and **40**, respectively. A motion transmitting means **41** such as a belt, cable or sprocket chain extends between the first and fourth wheels, about the fourth wheel to the ninth wheel, about the ninth wheel to the fifth wheel, about the fifth wheel to the tenth wheel, about the tenth wheel to the sixth wheel, about the sixth wheel to the third wheel, about the third wheel to the eighth wheel, about the eighth wheel to the second wheel, about the second wheel to the seventh wheel, about the seventh wheel to the first wheel and to the fourth wheel. Advantageously, a tensioning means **43** such as a spring is disposed within the motion transmitting means of **41** and adapted to maintain tension thereon. A portion of the motion transmitting means **41** is secured to the frame at a location **44**. A point P_1 is disposed on the wheel carrier **47** and the point P_2 is disposed on the motion transmitting means **41** which extends between the first and fourth wheels. Movement of the point P_1 toward the second end of the frame for a distance d causes the point P_2 to move a distance $4d$ toward the first end **27** of the frame **26**, thus providing a constant factor of 4. Thus, in essence the apparatus **25** provides a pantographic arm with a constant ratio of 4.

In FIGURES 3 and 4 there is schematically depicted

a practical arrangement of the motion transmitting configuration of the FIGURE 2 and is generally designated by the reference numeral **50**. The apparatus **50** comprises a frame **51** having a first end **52**, a second end **53**. A shaft **55** is disposed adjacent to the first end **52** and supports first, second and third pulley wheels **57**, **58** and **59**, respectively. A shaft **60** is disposed adjacent to the second end **53** and supports fourth, fifth and sixth wheels **61**, **62** and **63**, respectively. A movable wheel support **65** is disposed between the first and second ends **52** and **53** for frame **51**. The pulley support **65** supports a first shaft **67** which carries seventh and eighth wheels **69** and **70**, respectively. A second shaft **71** carries the ninth and tenth wheels **72** and **73**, respectively. A motion transmitting means such as a belt, cable or sprocket chain **75** passes about the wheels in the manner as demonstrated in FIGURE 2 and operating means **76** is affixed to the motion transmitting means **75** extending between the first and fourth wheels and an actuating means **77** is affixed to the support **65**. A pivot **78** is affixed to the first end **52** and frame **51**.

In FIGURE 5 there is a schematic representation of an apparatus **80** having a motion multiplication means **50** as illustrated in FIGURES 3 and 4 pivotally affixed by its first end **52** and pivot **78** to a rotatable support **81**. The support **81** is pivotally affixed to a base **82** by means of a pivot **83** having an axis of rotation which is in a plane normal to the axis of rotation of the pivot **78**. Beneficially, a support or guide wheel **84** is affixed to the support **81** and adapted to engage the base **82**. A template **85** is affixed to the base **81** generally adjacent to the pivot **78**. The base **85** has an edge **86** which defines a desired curve and is adapted to engage the actuating means **77** of the apparatus **50** and cause the operating means **76** to be positioned along the frame **51** in proportion to the displacement of the actuating means **77** caused by the edge or model surface **86**. Thus, the apparatus **80** by rotation of the apparatus **50** about the pivot **78** and rotation of the base about the pivot **83** permits the operating means **76** to be positioned on a curved surface of generation four times the size of the surface of generation of the edge **86**.

Beneficially either of the embodiments of the apparatus in accordance with the present invention are advantageously employed for such applications as the construction of buildings having generally circular cross sections, for the rotation of radiating devices such as those emitting high energy ionizing radiation about a center remote from the apparatus. Also beneficially, such radiation devices as radar antennas are rotated without the necessity of providing large circular tracks or bearings.

As is apparent from the foregoing specification, the apparatus of the present invention is susceptible of being embodied with various alterations and modifications which may differ particularly from those that have been described in the preceding specification and description. For this reason, it is to be fully understood that all of the

foregoing is intended to be merely illustrative and is not to be construed or interpreted as being restrictive or otherwise limiting of the present invention, excepting as it is set forth and defined in the hereto appended claims.

What is claimed is:

1. An apparatus for the multiplication of linear motion comprising a frame, the frame having a first end, a second end, a first wheel disposed adjacent the first end, a second wheel disposed adjacent the second end, a movable support, first and second movable wheels affixed to the movable support, the movable support being slideably positionable along the frame, a motion transmitting means extending from a point adjacent the first end of the frame about the first movable wheel, from the first movable wheel to the first wheel, about the first wheel, from the first wheel to the second wheel, about the second wheel, from the second wheel to the second movable wheel and to a location generally adjacent the second end of the frame.

2. The apparatus of claim **1** wherein the motion transmitting means is resiliently secured to the frame.

3. The apparatus of claim **1** wherein a plurality of wheels are fixed rotatably to the first end and a like number of wheels are affixed to the second end; a number of movable wheels mounted on a slideable support and disposed intermediate the wheels on the first and second ends wherein the linear motion transmitting means primarily interconnects slideable wheels adjacent the first end and slideable wheels adjacent the second end with the wheels of the first end and the second end, respectively, by passing about at least a portion of the periphery thereof and the linear motion transmitting means extending between not more than two wheels of the first end and of the second end.

4. The apparatus of claim **3** including a support; a pivot pivotally securing the first end of the frame to the support; and means to slideably position the movable support in a predetermined pattern.

5. The apparatus of claim **4** wherein the support is pivotally supported to rotate about an axis generally normal to the axis of the pivot securing the first end of the frame to the support.

6. The apparatus of claim **5** wherein the movable support has affixed thereto a follower, a template positioned adjacent the frame, the template having an edge which engages the follower and thereby positions the movable support in a predetermined manner.

7. The apparatus of claim **1** wherein a separating means is affixed to the linear motion transmitting means at a location wherein the linear motion transmitting means extends between a wheel of the first end and a wheel of the second end.

No references cited.

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