Dec. 16, 1952 A. A. HAUSER 2,621,855

BAR LINKAGE COMPUTER

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Fig. 1.

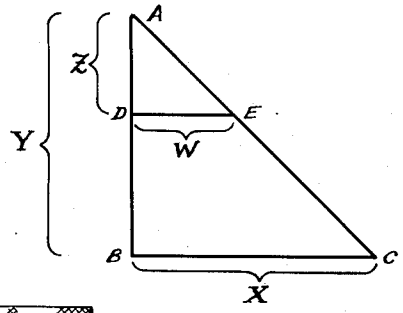


Fig. 3.

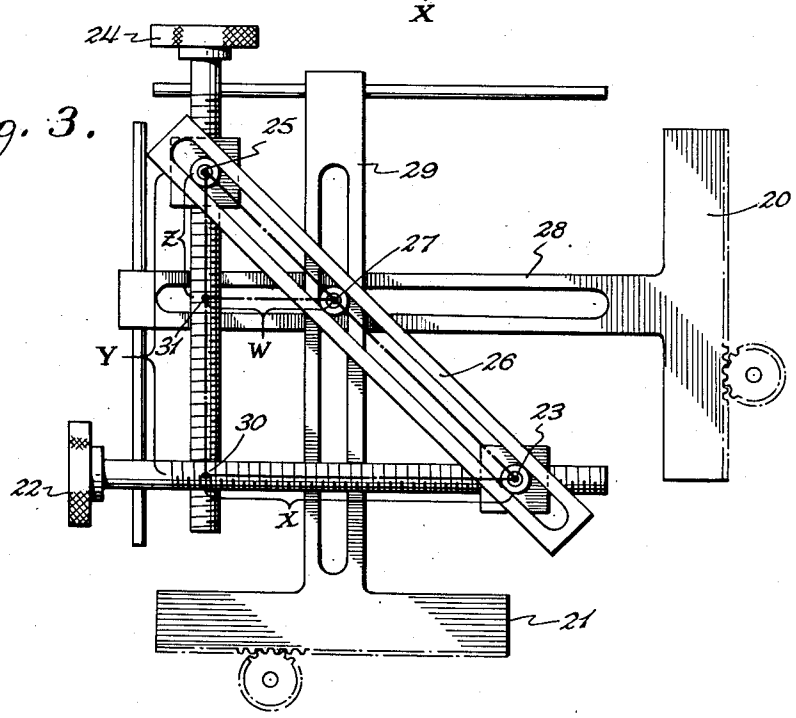
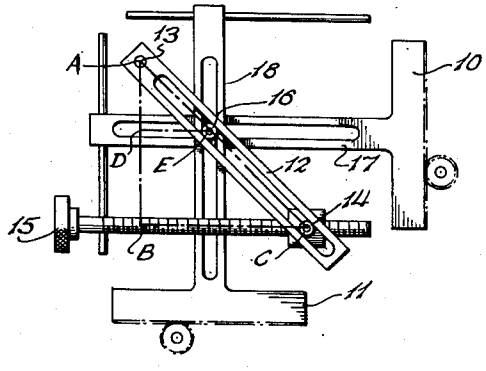


Fig. 2.



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BAR LINKAGE COMPUTER

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6 Claims. (Cl. 235—61)

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This invention relates in general to computing mechanisms and in particular to straight-bar linkage computing mechanisms.

In the past, straight-bar linkage computers have been developed which apply the similar triangle principle in order to provide a means for multiplying two inputs mechanically. In addition, it has been possible, by reversing the input and output connections, to provide, mechanically, the quotient of two inputs. However, such devices were unable to provide the product of two inputs divided by a third input.

It is, therefore, the principal object of this invention to provide a computing mechanism which supplies the product of two variable inputs divided by a third variable input.

A further object of the present invention is to provide a computing mechanism adapted to receive two input signals to provide an output which is either the product or quotient of the input signals.

These objects and other features of the present invention will become more readily apparent from a consideration of the following specification taken in connection with the figures wherein:

Fig. 1 is a diagram illustrating the principle of the present invention;

Fig. 2 is a schematic diagram of a straight-bar linkage multiplier useful in explaining the present invention; and

Fig. 3 is a schematic diagram of one embodiment of the present invention.

Referring now to Figure 1, which illustrates two similar triangles DAE and BAC, the relation

$$\frac{ED}{BC}=\frac{AD}{AB}$$

may easily be derived. This relation may be more conveniently written in single letter notation

$$\frac{W}{X}=\frac{Z}{Y}$$

where $W=ED$, $X=BC$, $Y=AB$ and $U=AD$. It follows from this last equation that

$$W=\frac{XZ}{Y}$$

To utilize this relation, it is possible to reconstruct the two triangles physically, setting into the physical analogue the sides X, Y and Z and reading off the side W. In such a physical reconstruction, constraints are placed on the members in such a way that, regardless of the value

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of the inputs X, Y and Z, the two triangles always remain similar. In a practical embodiment, these triangles are generally made to be right angle triangles. However, the operation of devices is in no way limited to such triangles.

Figure 2 illustrates a straight-bar linkage computer which provides either the product of two inputs or the quotient of two inputs. This mechanical multiplier utilizes an input rack 10 which is free to move vertically, and is constrained to move at right angles to output rack 11 which is free to move horizontally. Input cross link 12 is pivoted about fixed point 13. The opposite end of input cross link 12 is moved by slide pin 14, which has its horizontal position varied by lead screw 15. Slide pin 16, which is free to move across input cross link 12, is also positioned at the intersection of input slide 17 of input rack 10 and output slide 18 of output rack 11. From this configuration, it is readily seen that the position of input rack 10 and the position of slide pin 14, which is controlled by lead screw 15, in turn controls the position of output rack 11. It should be noted in this configuration that the vertical distance between fixed pin 13 about which the input cross link 12 pivots, and the axis of the input lead screw 15, remains constant.

It follows from the configuration that

$$\frac{ED}{BC}=\frac{AD}{AB}$$

where BC is the distance from slide pin 14 to the vertical projection of fixed pin 13 on the axis of input lead screw 15; AB is the distance between fixed pin 13 and the axis of input lead screw 15; ED is the horizontal distance between slide pin 16 and the intersection of AB with the longitudinal axis of input slide 17; and AD is the vertical distance from the fixed pin 13 to the longitudinal axis of the input slide 17.

Using a more convenient notation, $X=BC$, $Y=AB$, $W=ED$, and $Z=AD$, the following relation is obtained.

$$\frac{X}{Y}=\frac{W}{Z}$$

from which it follows

$$W=\frac{XZ}{Y}$$

Since Y has a fixed length, it is readily seen that W, the output, is the product of the two inputs X and Z.

If it is desired to perform division on such a

straight-bar linkage computer, the function of input rack 10 and output rack 11 may be reversed. In which case, Z becomes the output and W is the input. From the previous relations, it follows that

$$Z=\frac{YW}{X}$$

or in other words, Z, the output, equals the quotient of two inputs W and X times the constant Y.

In many computations, it is necessary to provide the product of two variables divided by a third variable. This, of course, could be achieved by utilizing two of the previously described straight-bar linkage computers: the first to obtain the product of two of the inputs and the second to obtain the quotation of this product divided by the third output. However, in accordance with the teachings of the present invention, it is possible to construct a single straight-bar linkage computer which will provide this desired result. Figure 3 illustrates diagrammatically such a computer. In this device, input rack 20, which is free to move vertically, is oriented at right angles to output rack 21, which is constrained to move horizontally. Horizontal lead screw 22 carries slide pin 23 and vertical lead screw 24 carries slide pin 25. These two slide pins 23 and 25 in turn slidably and pivotally engage cross link 26. Slide pin 27, which also slidably and pivotally engages link 26, is constrained to the intersection of input slide 28 of input rack 20 and output slide 29 of output rack 21. If X is the distance from the intersection 30 of lead screws 22 and 24 to slide pin 23; Y is the distance from the intersection 30 of lead screws 22 and 24 to slide pin 25; W is the distance from the slide pin 27 to the intersection 31 of lead screw 24 and the horizontal axis of input slide 28, and Z is the vertical distance from the slide pin 25 to the intersection 31 of lead screw 24 and the horizontal axis of input slide 28, then it follows that

$$\frac{Z}{W}=\frac{Y}{X}$$

from which the relationship

$$W=\frac{XZ}{Y}$$

is obtained.

It is readily seen from this relationship that by holding either X or Z constant, the quotient of the remaining parameter divided by Y is obtained. In addition, by holding Y constant, the product of X and Z will be obtained. In addition it is possible to obtain by this single computer constructed in accordance with the present invention, the product of two parameters or input signals divided by a third parameter or input signal.

Since many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

In the claims:

1. A computing mechanism comprising a cross link, a first input means for imparting motion in a first direction to one end of said cross link, a second input means for imparting motion in a second direction at an angle to said first direction and to the other end of said cross link, means for pivotally and slidably connecting said first and second input means to said cross link, a third input means movable in a direction parallel to said second direction, coupling means guided by and movable lengthwise along said cross link and connected with said third input means so as to move in accordance with movements of said third input means in said second direction, and an output member supported for movement in a direction paralleling said first direction and connected with said coupling means so that said output member is moved in accordance with movements of said coupling means in said first direction.

2. A computing mechanism of the character recited in claim 1 in which the first and second input means are arranged to be moved respectively in directions mutually perpendicular to each other.

3. A computing mechanism comprising a cross link having a longitudinally extending slot thereon, a pair of pins pivotally and slidably mounted within said slot, means for linearly moving one of said pins in a first direction, means for linearly moving the second pin in a second direction angularly disposed relative to said first direction, an input link having a lengthwise extending slot therein, means for supporting said input link to move parallel to said first direction, an output link having a longitudinal slot therein, means for supporting said output link to move parallel to said second direction, and means comprising a coupling pin disposed in slidable engagement with all of said slots.

4. A computing mechanism of the character recited in claim 3 in which the first and second input means operate linearly in directions substantially normal to each other.

5. A computing mechanism of the character recited in claim 3 in which the means for imparting linear movement to the first and second pins respectively include threaded shafts arranged at right angles to each other.

6. A computing mechanism of the character recited in claim 3 in which the input link and the output link are each slidably supported and provided with a rack, and pinions respectively engaging the racks of said links.

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