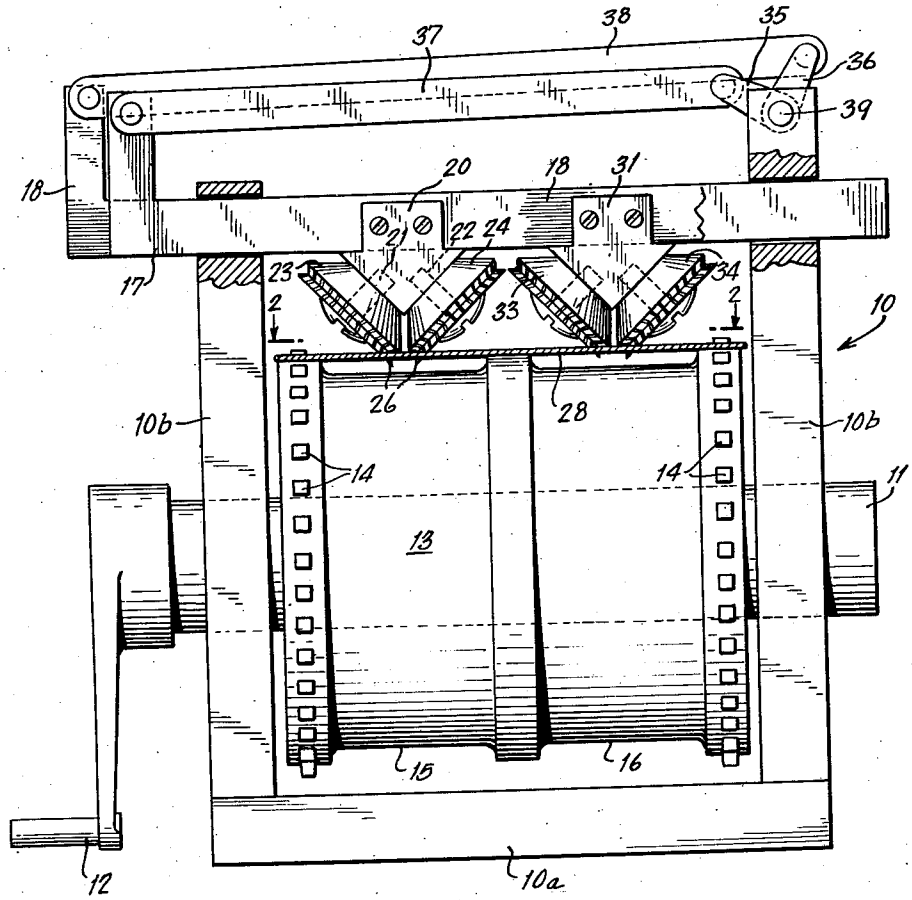
July 16, 1957 G. R. STIBITZ 2,799,171

FUNCTION UNIT

Filed Oct. 8, 1954 2 Sheets-Sheet 1

Fig. 1.



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Filed Oct. 8, 1954 2 Sheets-Sheet 2

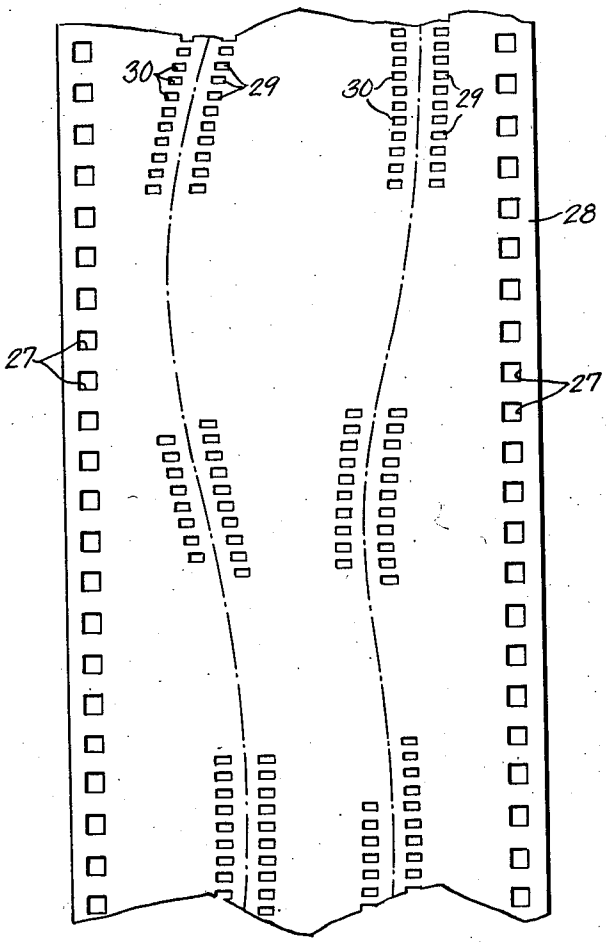


Fig. 2.

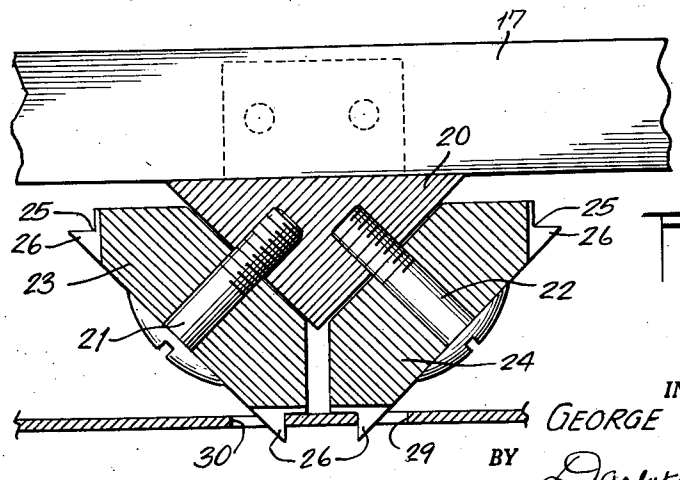


Fig. 3.

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FUNCTION UNIT

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Application October 8, 1954, Serial No. 461,148

9 Claims. (Cl. 74—54)

The present invention relates to function units, that is, devices which serve to transform an input movement into an output movement in accordance with some mathematical law or arbitrary relationship.

More particularly the invention relates to a device by means of which a certain number of revolutions of an input shaft causes an output shaft to rotate through a number of revolutions dependent upon both the input revolutions and a mathematical law or an arbitrary relationship incorporated in a controlling element interposed between the input shaft and output shaft.

The controlling element is not permanently interposed between the shafts mentioned but may be readily changed so that the law of operation of the output shaft with respect to that of the input shaft may be varied at will.

More particularly still the invention relates to a function unit in which the output shaft is driven by means of a crank or a number of cranks mounted thereon and the controlling element is a tape driven by the input shaft and carrying cam tracks which tracks through cooperation of cam rollers therewith cause rotation of the output shaft by virtue of connections between the cranks thereon and connecting rods connected to the roller supports. In order to avoid the practical difficulties arising if a single cam track and single crank arm were used, especially dead center positions and the indeterminate direction of rotation in leaving such positions, two cam tracks and two crank arms controlled by respective cam tracks and angularly displaced on the output shaft, are utilized.

The tape is driven positively from the input shaft by means of sprockets teeth fixed to that shaft and cooperating perforations in the tape arranged in a regular pattern. The cam track comprises perforations in the tape which follow a predetermined quasi-sinusoidal curve, the complete pattern of a single cam track comprising two rows of perforations following a curve such as outlined with an unperforated area between the two rows. Rollers which bear against the inner sides of the perforations of the two rows are rigidly mounted upon members slidable transversely of the tape so that the members move back and forth across the tape as the tape is moved longitudinally beneath them. This results in a rotation of the output shaft since the slidable members are connected to these crank shafts by means of connecting rods.

A device which serves the same function as has been described above is disclosed in my copending application Serial No. 422,790, filed April 13, 1954, this application being a continuation of my earlier application Serial No. 7,982, filed February 12, 1948. The device referred to comprises a tape having cam tracks which comprise scalloped edges. The device of this invention substitutes a punching operation for the difficult machinery operation necessary to provide the edge with a proper curve.

In my Patent No. 2,650,500, issued September 1, 1953, there is described another form of function unit having a tape in which the cam tracks consist of perforations. In this form of device eccentrics are utilized and the eccentric rollers are so formed that their degree of penetration into a control tape determines the rotation of the output shaft. This device is effective but is likewise difficult to manufacture because of the close tolerances required. The present invention is, as stated, similar insofar as the use of cranks and connecting rods is concerned, to that of my application Serial No. 7,982 and is generally similar insofar as the use of a perforated cam track is concerned to the device of my above-mentioned application Serial No. 422,790, but is an improvement upon both of these devices in that both the controlling tape and the other structural elements can be readily manufactured without requiring close manufacturing tolerances and will at the same time yield excellent accuracy of result.

It is an object of the invention to provide a function unit of the type wherein the output shaft is driven by cranks and connecting rods which are in turn driven by means of a control tape advanced by an input shaft, the control tape having cam tracks in the form of perforations therein which perforations form a curve representing a desired mathematical or arbitrary law.

It is another object of the invention to provide such a device wherein the cam tracks comprise pairs of perforations having unperforated areas therebetween, the entire pattern comprised of such pairs of perforations and the area therebetween, following a curve.

It is a further object of the invention to provide such a device wherein a movement of the control tape bearing patterns as defined above is a longitudinal one determined by one set of patterns of perforations and in which toothed rollers bear against the inner ends of a second set of pattern perforations and are caused to move transversely of the tape and to thus, through the medium of connecting rods, cause rotation of the output shaft as the input shaft rotates, the amount of rotation being dependent both upon the amount of rotation of the input shaft as determined by the first pattern set and upon the arbitrary law expressed in the cam tracks or patterns of the second set.

Other objects and features of the invention will be apparent when the following description is considered in connection with the annexed drawings, in which,

Figure 1 is a side elevation of my invention with portions broken away and in section in order to more clearly illustrate the construction;

Figure 2 is a top plan view of a control tape for use with the device of Figure 1, the tape shown being laid out in accordance with a particular mathematical or arbitrary relationship and being illustrative of the solution of a single problem. This figure is taken on the plane of the line 2—2 of Figure 1; and

Figure 3 is an enlarged vertical cross-sectional view of a portion of the control tape showing the cooperation of a set of rollers with the pattern formed by perforating that tape.

Referring now to the drawings, and particularly to Figure 1, there is shown therein a framework 10 consisting of base 10*a* and upstanding sides 10*b*. In the sides 10*b* a shaft 11 is suitably journalled, the shaft 11 being provided with a crank 12 at one end thereof which is utilized for manually rotating the shaft. Fixedly mounted on the shaft 11 is a drum 13 carrying sprocket teeth 14 at its outer edges the drum being reduced in diameter at points 15 and 16 for a reason which will appear hereinafter.

Slidably mounted in the upper portions of the housing sides 10*b* are the slides 17 and 18 which are mounted for reciprocatory movement transversely of the frame 10. Mounted on the slide 17 is a bracket 20 which extends downwardly and has fixed therein two stub shafts 21 and 22 on which rollers 23 and 24 respectively are mounted. The stub shafts 21 and 22 are shown as screws having enlarged heads thus holding the rollers 24 in position

against the faces of the bracket member 20, these faces being at a 45° angle as clearly shown in Figure 1.

Rollers 23 and 24 are shown in detail in Figure 3. These rollers are bevelled and have V-shaped grooves 25 in the peripheries thereof. One surface of this groove is provided with teeth 26 which teeth are properly spaced about the periphery so that they cooperate with perforations in the control tape.

The control tape is fed from a reel (not shown) onto the drum 13 and then to a take-up reel (not shown) which is spring-biased. The tape is driven by means of the sprocket teeth 14 which cooperate with the regularly spaced pattern of perforations 27 at opposite sides of the control tape 28.

A second pattern is formed in the control tape, in duplicate, and consists of the perforations 29 and 30 which perforations are of a particular transverse length and a particular longitudinal width, the longitudinal width being such that the teeth 26 will enter these perforations in the same manner as the teeth of a gear mesh with those of a cooperating rack. The perforations 29 and 30 along each transverse line are spaced apart the same distance as the apices of the teeth 26 of rollers 23 and 24 so that these teeth apices always lie against the facing edges of the perforations. The grooves 15 and 16 described above provide space for the teeth 26 to project through the tape 28.

Mounted on a bracket 31 on the slide 18 is a bracket which is exactly similar to the bracket 20. This bracket carries gears 33 and 34 which mesh with perforations 29 and 30 of the right hand row of the tape 28 in the same manner as the gears 23 and 24 mesh with the left hand rows of perforations.

Mounted in an upper extension of the right hand member 10*b* of frame 10 is an output shaft 39 which carries the two crank arms 35 and 36 thereupon, these two crank arms being angularly displaced by 90°. A link 37 connects crank arm 35 to the slide 17 and similarly a link 38 connects the crank arm 36 to the slide 18. The left hand pattern comprising the perforations 29 and 30 is displaced laterally of the tape with respect to the right hand pattern comprising also perforations 29 and 30 by an amount corresponding to the angular displacements of the crank arms 35 and 36, the two cranks and the two patterns being provided solely so that any dead center position of the output shaft 39 may be avoided.

It will be seen that as the input shaft 11 is rotated and tape 28 moves longitudinally, the rollers 23, 24, 33, 34 are caused to move transversely of the tape by virtue of the meshing of the teeth thereof with the perforations 29 and 30 and due to the bearing of the area between perforations against the teeth of these rollers. As a result the slides 17 and 18 are caused to reciprocate an amount limited by the maximum variation of the curve of patterns 29—30 from the center. This reciprocation causes similar reciprocatory movement of the connecting rods 37 and 38 and rotation of the output shaft 39.

Since the patterns comprising the curves of perforations 29 and 30 are laid out in accordance with the particular mathematical or arbitrary law to be followed it is apparent that the incremental rotation of the output shaft will be in proportion to the incremental rotation of the input shaft as modified by the arbitrary law considered.

It will be noted that with the arrangement hereinabove described, the displacements of the rollers 23, 24, 33, 34 are in the plane of the control tape 27 rather than perpendicular to it as in the eccentric device disclosed in my above-mentioned Patent No. 2,650,500, thus permitting greater amplitudes of displacement and consequently greater tolerances in the manufacture of the device.

In a particular instance the total lateral displacement possible is 0.400", the cranks therefore having a throw of 0.200". It will be assumed that the accumulative errors in the control tape pattern rollers, connecting rod, bearings and cranks equals 0.01". The angular error in

position in the output shaft which will be a maximum when the cranks are at 45° position will amount to approximately 4°. If the rollers are constructed to have a diameter of 0.5" then it will be obvious that the radius of the curvature projected on the tape is 0.34" which of course means that the radius of curvature of the patterns comprising perforations 29 and 30 cannot be less than 0.34". If the track is a generally sinusoidal curve of a wave length of 2" and amplitude of 0.200" then its minimum radius is 0.42" which will permit engagement of the rollers with the tape patterns with a satisfactory amount of clearance. With the figures stated above, there will thus be 90 units of error per cycle or 45 units of error per inch of tape. This error is well within the required degree of accuracy and is comparable to that achieved with the eccentric roller arrangement of my above-mentioned patent, although the tolerances permitted in the manufacture of the device are much larger than those permitted in the manufacture of the device of the patent.

While I have described a preferred embodiment of my invention it will be understood that modifications may be made without departing from the spirit thereof. Thus the rollers 23, 24, 33, 34 instead of being mounted on slides reciprocable laterally of the tape may be mounted on long arms pivotally mounted to permit movement of the rollers transversely of the tape thus reducing the function as compared with the sliding action. Also, the output shaft may clearly be mounted on a vertical axis. Because of these and other obvious modifications I wish to be limited not by the foregoing description but solely by the appended claims.

What is claimed is:

1. In a function unit, in combination, an input shaft, an output shaft, a tape comprising two patterns perforated therein, sprocket teeth on said input shaft, said teeth meshing with perforations of one of said patterns to drive said tape, toothed rollers cooperating with perforations of the other of said patterns, said rollers being mounted for rotary movement with the teeth thereof entering and bearing against the ends of perforations of said other pattern, means for supporting said rollers for movement laterally of said tape, crank arms on said output shaft and connecting means between said supporting means and said crank arms whereby said output shaft is caused to rotate in accordance with the rotation of said input shaft as modified by an arbitrary relationship expressed in said other pattern of said tape.

2. A device as claimed in claim 1, characterized in that one of said patterns of said tape comprises perforations spaced longitudinally along said tape and in longitudinal alignment and further characterized in that the other of said patterns comprises rows of perforations spaced longitudinally along said tape, each row comprising two perforations spaced transversely of said tape, said spacing being the same in all rows, successive rows being displaced transversely of said tape forming a curve representative of the mathematical or arbitrary law which the device is to follow.

3. A device as claimed in claim 2, characterized in that the perforations of said other pattern are substantially rectangular.

4. A device as claimed in claim 3, characterized in that said toothed rollers are provided in pairs, the teeth of said rollers bearing against the facing edges of said rectangular perforations of said other pattern.

5. A device as claimed in claim 4, characterized in that said means for supporting said rollers comprises slides mounted for movement transversely of said tape and further characterized in that said connecting means comprises rods extending from points on said slides to said cranks.

6. A device as claimed in claim 4, characterized in that two sets of said other patterns are perforated in said tape and two pairs of said rollers are provided, each

said pattern set cooperating with a pair of said rollers, and further characterized in that each said pair of rollers is mounted on an individual slide and connected by an individual connecting rod to one of said cranks whereby said output shaft is caused to rotate in accordance with the arbitrary law expressed in said sets of said other pattern, said duplication of patterns, rollers, connecting rods and cranks preventing stoppage of said output shaft at dead center position of one of said cranks.

7. A device as claimed in claim 6, characterized in that the toothed rollers of each pair are rotatably mounted on individual shafts fixed to a corresponding slide, said shafts extending at 90° to each other and at a 45° angle to the plane of the tape, said rollers being provided with a V-shaped groove having an apex angle of 90°, one side of said groove being parallel to and the other side being perpendicular to the plane of said tape, said groove intersecting teeth formed on the roller to form substantially flat surfaces bearing against the top of the tape and triangular shaped teeth bearing against the facing edges of said substantially rectangular perforations of said other pattern sets.

8. A device as claimed in claim 6, characterized in that said two sets of said other pattern form identical grooves extending longitudinally of said tape, said grooves being displaced with respect to each other, said displacement corresponding to the angular displacement of said cranks on said output shaft.

9. In a function unit, in combination, an input shaft, an output shaft, a tape comprising a first set of patterns, each pattern of the set consisting of perforations regularly spaced longitudinally along said tape and in longitudinal alignment, and a second set of patterns each comprising rows of perforations regularly spaced longitudinally along said tape, each row of a pattern comprising two substantially rectangular perforations spaced apart transversely of said tape, the space between said perforations being constant for all rows, the position of the perforations and intervening space varying in different rows foming a curve extending longitudinally of said tape, a drum on said input shaft, teeth on said drum meshing with said perforations of said first set of patterns, grooves on said drum underlying perforations of patterns of said second set, a pair of rollers for each pattern of said second set of patterns, teeth on each said roller meshing with one perforation of each row of a pattern of said second set, said teeth bearing against the sides of said perforations adjacent the other perforations of said row in said pattern, a slide mounting each pair of rollers for movement transversely of said tape, a crank arm on said output shaft for each pattern of said second set, said crank arms being displaced angularly on said output shaft corresponding to displacement of one of said second set of patterns relative to another, and means connecting said slides to said crank arms to thereby rotate said output shaft in accordance with the rotation of said input shaft as modified by the mathematical or arbitrary law expressed by said second set of patterns.

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