Dec. 24, 1957 G. OBOLENSKY 2,817,244

SPEED CHANGING DEVICES

Filed Sept. 7, 1954

Fig. 1.

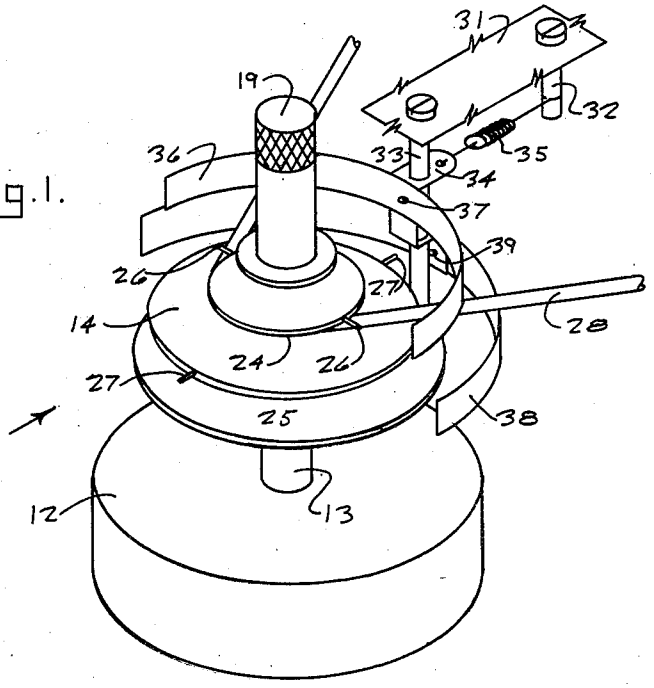


Fig. 2.

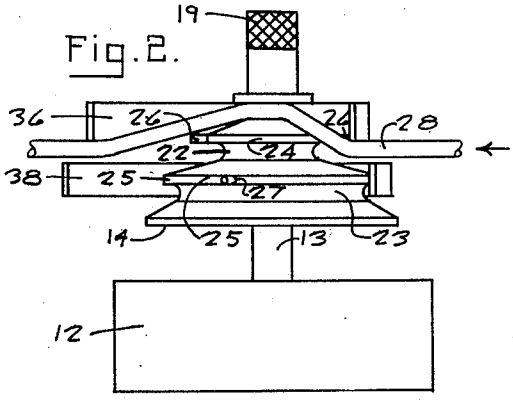


Fig. 3.

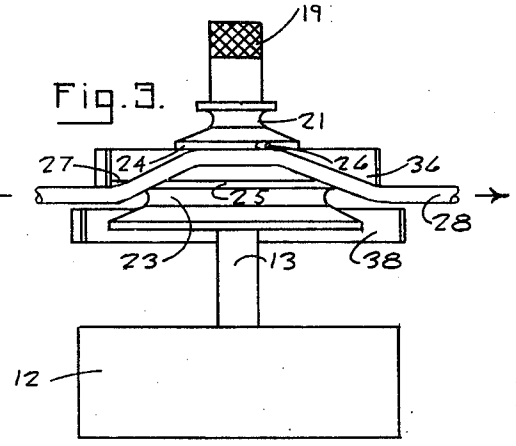
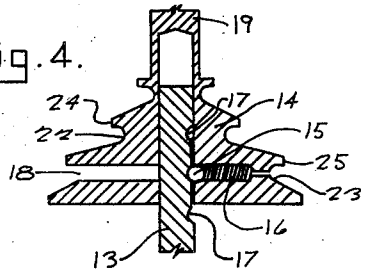


Fig. 4.



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SPEED CHANGING DEVICES

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15 Claims. (Cl. 74—242.3)

This invention relates to speed changing devices, and more particularly to an apparatus having simple means for changing the operative speed of a pulley and belt drive.

In many types of apparatus, particularly in such devices as magnetic recording machines and the like, it is desirable to incorporate a simple, inexpensive and fast operating device for changing the speed of traverse of magnetic tape past a rewind or playback magnetic head, for example. Prior expedients for changing the belt speed of drive wheels or fly wheels have involved expensive multi-speed motors or complex mechanical means for introducing different pulleys or idlers of different diameters into a drive system. In the design of a low cost magnetic recording mechanism, however, it is desirable to reduce the number of parts involved in the drive system as well as to reduce the cost thereof.

The apparatus of the present invention which satisfies these requirements of simplicity and low cost comprises essentially a multi-step pulley and a belt shifting device that is adapted to transfer the drive belt automatically from one step of the pulley to another. Means provided in the flanges between the steps of the pulley cooperate with the belt shifting device to cause the belt to move from one position on the pulley to another.

In one embodiment, the belt shifting device is provided with a yieldable spring-loaded mounting which permits the device to move into an optimum operating position relative to the pulley under the action of the belt as the latter moves.

The features of novelty which I believe to be characteristic of my invention are set forth herein and will best be understood, both as to their fundamental principles and as to their particular embodiments, by reference to the specification and accompanying drawings, in which:

Figure 1 is a diagrammatic perspective view of the multi-step pulley and the belt shifting device together with a fragmentary view of the belt;

Fig. 2 is an elevation of the apparatus shown in the direction of the arrow in Fig. 1, showing the belt in the process of being caused to move from the top step to the middle step of the pulley;

Fig. 3 is a view similar to Fig. 2 wherein the belt is shown being moved from the middle step to the lower step of the pulley; and

Fig. 4 is a fragmentary cross section of the pulley and the shaft upon which it is mounted showing the manner by which the pulley is moved vertically on its mounting shaft and keyed thereto in different positions.

Referring now to the drawing, there is illustrated a belt and pulley drive that may be utilized in various types of apparatus and particularly as it may be utilized in a magnetic recording machine wherein it is desired to cause the magnetic medium to move at different desired speeds. The apparatus is driven by an electric motor **12** having a vertical output drive shaft **13** upon which is mounted a multi-step pulley generally designated **14**.

Pulley **14** is movable vertically relative to shaft **13**,

and it may be set into any one of several positions by means of a detent mechanism comprising ball **15** and spring **16** arranged to cooperate with recesses **17** on shaft **13**, said recesses being joined by a longitudinal channel. Before being mounted on shaft **14**, spring **16** and ball **15** are inserted into transverse slot **18** in pulley **14**, ball **15** is pressed back and pulley **14** is slipped over the top of shaft **13**, after which ball **15** may be seated in any one of the recesses **17** with which it forms a key whereby the rotation of shaft **13** causes the rotation of pulley **14**. Other suitable means that are well known in the art may be utilized for keying pulley **14** to drive shaft **13**, while other detent means for positioning pulley **14** at different points along shaft **13** may be improvised.

Connected to the top of pulley **14** is a knurled knob **19** having a hollow interior which is adapted to accommodate the top of shaft **13** when pulley **14** is moved downward. Knob **19** is provided in order to permit the manual movement of pulley **14** vertically relative to shaft **13**, although other suitable means for moving the pulley may be provided.

Pulley **14** is provided with a plurality of pulley steps of different diameters and arranged in tandem and in graduated order along the pulley axis: specifically, in the embodiment illustrated in the drawing, top step **21**, intermediate step **22**, and lower step **23** (Figs. 2 and 3). Steps **21** and **22** are separated by annular flange **24**, while steps **22** and **23** are separated by annular flange **25**. Mounted in flange **24** are one or more outwardly extending pins **26**, and mounted in flange **25** are one or more outwardly extending pins **27**. It will be noted that recesses **17** are spaced apart the same distance as obtains between the respective pulley steps, so that the selected step becomes aligned in the same plane in which the pulley belt normally operates.

As seen in Fig. 1, an endless belt **28** is positioned within intermediate step **22** of pulley **14**. Although in the illustration belt **28** is shown broken off, it is understood that the portion not shown extends around a fly wheel or another pulley which causes the rotation of other portions of an apparatus, such as the main drive of a magnetic recording machine, or the like.

Belt **28** is made of any suitable elastic material such as rubber, neoprene, or other natural or synthetic elastic material, which has suitable friction characteristics for being driven by a pulley and driving a fly wheel or other pulley.

The cabinet (not shown) in which the motor and pulley are positioned, has a mounting bracket **31**, shown in fragmentary form in Fig. 1, to which are firmly attached a pair of downwardly extending mounting posts **32** and **33**. Pivotally mounted around post **33** is a bracket **34** which may be made of sheet metal or the like and which has a rearward extension to which is attached one end of a spring **35**, the other end of which is attached to post **32**.

Connected to bracket **34** in front of post **33** is an arcuate bow **36** by means of pin **37**. Bracket **34** has a downwardly extending lug positioned rearward of post **33** and has attached to it a second arcuate bow **38** by means of pin **39**. The diameter of bow **38** is somewhat larger than that of bow **36** to provide clearance for the largest flange of the pulley. The upper edge of bow **38** is separated from the lower edge of bow **36** by a distance slightly larger than the width of belt **28** whereby both branches of said belt normally move freely therebetween when said bows are in a neutral position, to operate around pulley **14** and to drive a driven member (not shown) to which it is connected.

Since bracket **34** is pivotable around post **33**, it can be seen that bows **36** and **38** are also pivotable relative to post **33**. Bows **36** and **38** extend partially around pulley **14** a sufficient distance whereby they form double pairs

of fingers over each branch of belt 28, as said belt encircles pulley 14. Bows 36 and 38 together form the belt shifting device under the conditions that will now be described.

It will be assumed that belt 28 operates normally in one plane, while pulley 14 may be shifted upward or downward depending upon which pulley step it is desired that belt 28 operate. Normally, when pulley 14 is lifted to its highermost position, whereby belt 28 is riding in pulley step 23, there is comparatively little difficulty in causing said belt to move into the next pulley step 22 which is accomplished by grasping knob 19 manually, and pushing downward a step in accordance with the stepping action of the ball detent mechanism shown in Fig. 4. This operation may be performed while pulley 14 is rotating; and when the pulley is moved downward, belt 28 will impinge against the top edge of bow 38 which will cause belt to move into the pulley step 22. This would occur in some embodiments where bow 38 was stationary. This procedure is relatively simple in view of the fact that the elastic belt is moving from a position of high friction to one of relatively lower friction and the overall operating diameter of the belt is being reduced, therefore reducing the total friction of the system. The same considerations apply when the belt is caused to move from intermediate pulley step 22 to the upper pulley step 21 by the downward movement of pulley 14.

When, however, it is desired to reverse the direction and to cause belt 28 which is to be considered as running in top pulley step 21 to move into intermediate pulley step 22, this involves an increase in friction and an increase in the overall operating diameter of the belt. In this operation when pulley 14 is moved upward a step, the engagement of belt 28 only by the lower edge of bow 36 may not be sufficient in some cases to press the belt downward into pulley step 22 (see Fig. 2), because of the resistance offered by the outwardly extending flange 24 added to the normal resistance of the belt to an increase in operating diameter and in friction.

It is understood that in order to cause the belt to move from one pulley step to another, it is necessary to impart a requisite angle of deflection to the belt in order to oppose the resistance mentioned hereinabove. Obviously, in the design of a low cost multi-speed pulley belt drive, the requirements of economy and space must be satisfied by positioning the steps of the pulley relatively close together. Since the belt is elastic, vertical movement alone of the pulley may not cause the belt to displace itself from one pulley step to another, and it is necessary, as mentioned above, to impart a sharp angle of deflection particularly when transferring from a pulley step of small diameter to one of larger diameter.

In some cases, applying a point of lateral pressure upon the belt at a distance from the pulley may cause the transfer of the belt to the next pulley step. It is obvious, however, that the closer to the pulley the lateral pressure is applied upon the belt, the greater will be the angle of deflection of the belt, thereby facilitating the transfer thereof to the next pulley step. Additionally, provision may be made in the structure of the flange between pulley steps, whereby the bending of the belt will cause it to be engaged by an irregularity in the flange so that the transfer to the adjacent pulley step will be assisted. This process will not be described as it is performed by at least one embodiment of the present invention.

When pulley 14 is lifted one step on shaft 13, both branches of belt 28 are frictionally engaged by the lower edge of bow 36 and bent downward relative to pulley step 21. See Fig. 2. Motor 12 is started causing shaft 13 and pulley 14 to rotate and move belt 28 in pulley step 21.

Since the upper edges of both branches of belt 28 are in frictional engagement with the lower edge of bow 36, the movement of said belt causes one finger of bow 36 to move away from pulley 14 while it causes the other finger of bow 36 to move toward pulley 14 since said bow is pivotable on post 33. Assuming that the pulley in Fig. 1 rotates clockwise, bow 36 pivots to the left (Fig. 2) and the right finger of bow 36 sharpens the angle of deflection that is imposed upon that portion of the belt that approaches the pulley. The ability of bow 36 to pivot relative to pulley 14 permits the point of lateral pressure upon belt 28 to approach as close as is physically possible to pulley 14 in order to increase the angle of deflection, without interfering with the rotation of the pulley.

As pulley 14 continues to rotate, one of the pins 26 approaches the right finger of bow 36, engages belt 28, and upon continuation of its movement it guides belt 28, in which position belt 28 now moves freely between bows 36 and 38 which have returned to their neutral position (Fig. 1) under the action of spring 35. The operating speed of belt 28 has now been increased. Should motor 12 be arranged to cause shaft 13 and pulley 14 to rotate counter clockwise, the frictional engagement between belt 28 and bow 36 would cause the bow assembly to move towards the right in Fig. 2 and perform the same function of moving the belt into the pulley step that is aligned with the space between bows 36 and 38.

Fig. 3 is similar to Fig. 2 except for the fact that pulley 14 has been raised still another step in order to align pulley step 23 with the space between bows 36 and 38. In this case, the pulley is arranged to rotate counter clockwise whereby one of pins 27 engages belt 28 on the left to cause it to move from pulley step 22 to pulley step 23.

As soon as belt 28 has been aligned in a new pulley step, it runs freely between bows 36 and 38. Having been released from frictional engagement with the belt, bows 36 and 38 now return under the action of spring 35 to a neutral position around pulley 14 until the pulley is again raised or lowered to cause the foregoing sequence of actions to occur again. It is advantageous to arrange bows 36 and 38 to be mouned on a post 33 that is positioned substantially in a line between pulley 14 and the driven pulley, not shown.

If motor 12 is uni-directional, only a single pair of fingers represented either by the left or right hand portion of bows 36 and 38 are necessary for performing the belt transferring action. In this case the single finger 36 or pair of fingers would extend over that branch of belt 28 which always approaches pulley 14. When, however, motor 12 is bi-directional, then it is preferable to utilize the double pair of fingers as illustrated in the drawing, or two oppositely extended fingers 36, whereby the transfer of the belt may be performed regardless of the direction of rotation of pulley 14.

In some cases, depending upon the dimensional characteristics of the pulley that is being used, either or both bows 36 and 38 may be mounted in a stationary position and may adequately perform the belt transferring function. Pins 26 and 27 in each set of pins are axially aligned with each other whereas the axes of said different sets of pins are angularly displaced from each other. Although the angle of displacement between sets of pins 26 and 27 is shown as approximately 90° in the drawing, other displacement angles may be satisfactory, or the axes of pins 26 and 27 may all be aligned in one plane. In the latter case, however, if it is desired to cause belt 28 to move from pulley step 21 directly to pulley step 23, it would appear that both pins 26 and 27 would simultaneously grasp belt 28 to perform the transfer function. In some cases this action would be satisfactory but in other cases where a motor 12 of low power is utilized and it is desired to impose the least amount of strain upon belt 28, it is preferable to have pins 26 and 27 aligned as shown in Fig. 1, whereby belt 28 is first transferred from pulley step 21 to 22 on the first 90° of rotation of pulley 14, and belt 28 is thereafter transferred from pulley step 22 to pulley step 23 by pin 27 during the next 90° of rotation of pulley 14. If pins 26 and 27 were aligned with each

other, this transfer from pulley step 21 to 23 would occur during a 90° rotation of pulley 14.

In actual operation, the transfer of belt 28 from one pulley step to another is practically instantaneous and this function can be performed while pulley 14 is rotating. The speed of operation of the apparatus may be set by manual positioning of pulley 14 either before motor 12 is started, or it may be changed while it is running. In either case the transfer mechanism described herein operates in a matter of a small fraction of a second without any deleterious strain being exerted on any portion of the mechanism described herein. The system of the present invention is such that ordinary production methods and controls involving ordinary materials will produce a foolproof mechanism that will not manifest any signs of wear or deterioration over extremely long periods of usage.

The structure described herein is particularly applicable for producing a low cost belt pulley drive which is actuated by a low power motor, which must occupy a small space and which will meet high fidelity requirements. Therefore, I have provided a flexible mechanism as embodied by the spring actuated assembly of bows 36 and 38 which automatically perform the function of providing within a small space a large angular deflection of belt 28 to cause the belt to move from one pulley step to another. Although a stationary mechanism comparable to bows 36 and 38 or either of them for causing belt 28 to move from one pulley step to another might be provided, it has been found that in order for such an arrangement to be efficient, the pulley steps would have to be spaced apart a considerable distance from each other in order to provide a sufficient skew angle for belt 28 to move from one pulley step to another.

Where the exigencies of space and economy require the pulley steps to be comparatively close to each other, the present arrangement provides movable bows 36 and 38 or either of them which are automatically actuated by frictional engagement with moving belt 28 to cause a portion of said bows to move close to and in some cases make physical contact with the pulley, thereby increasing the angular deflection of belt 28 to facilitate its movement from one pulley step to another.

In some embodiments bow 38 alone may be arranged to be stationary or non-pivotable where its function is to cause belt 28 to move from one pulley step to another pulley step of smaller diameter since the natural tendency of the belt is to seek a condition of lesser resistance and friction and hence a stationary flexing member is often adequate to perform this function. In such an embodiment, only one pivotable bow 36 will be provided for causing belt 28 to move from one pulley step to another of greater diameter where it is necessary to increase the friction of the elastic belt when resistance must be overcome to cause it to shift to the higher speed pulley step. It is also to be understood that pulley 14 may be reversed in position whereby the large diameter pulley step is on top and the small diameter step is on the bottom; and in such an embodiment the position of bows 36 and 38 would be reversed.

Although the pulley steps are illustrated in graduated order as to their respective diameters, it is understood that pulley steps of different diameters may be arranged in tandem along the axis of the pulley in a random or preselected non-graduated order wherever such arrangement is necessary or suitable. It is also apparent that the axis of the pulley and the belt shifting mechanism can be arranged, if desired, to operate in a horizontal direction instead of the vertical operation shown in the drawings.

Although pins 26 and 27, which interrupt the otherwise even perimeter of the pulley flanges, are illustrated as performing the grasping function in conjunction with the skewing of the belt by means of bow 36, it is to be understood that said pins may be replaced by other suitable dimensional irregularities or high friction materials

in the respective perimeters of flanges 24 and 25. Such dimensional irregularities may take the form of axial or angular slots in said flanges or they may take the form of serrations of various kinds that are sufficiently deep to provide frictional engagement between the flange and the belt, to cause the belt to seek a new stable position. In other embodiments the pulley may be made of a high friction material or be provided with a flange of such material for performing the belt transfer function in conjunction with the bows.

It is to be understood that in some embodiments, pulley 14 may be fixed fast on shaft 13 while mounting post 33 may be provided with means for permitting it to be moved axially into any one of several indexed positions in a manner similar to that shown for indexing pulley 14 on shaft 13. Thus, the transferring of belt 28 from one pulley step to another may be accomplished by moving mounting post 33 vertically into the desired position, provided, of course, that the other elements driven by the belt are positioned and arranged to accommodate such action. In sum, the transferring operation is performed in any case by the axial displacement of the pulley and the bow assembly relative to each other, regardless of which one is arranged to be the movable member.

While the drawing herein shows the pulley mounted on the output shaft of a motor, in some embodiments it may be desired to separate the speed changing mechanism from the power source, in which case the pulley would be mounted as an idler upon a stationary shaft with the necessary indexing means provided as desired.

In the specification, I have explained the principles of my invention, and the best mode in which I have contemplated applying those principles, so as to distinguish my invention from other inventions; and I have particularly pointed out and distinctly claimed the part, mode or combination which I claim as my invention or discovery.

While I have shown and described certain preferred embodiments of my invention, it will be understood that modifications and changes may be made without departing from the function and scope thereof, as will be clear to those skilled in the art.

I claim:

1. A speed changing mechanism for a drive belt comprising a rotatable shaft, a pulley mounted upon and movable longitudinally relative to said shaft, indexing means for maintaining said pulley at desired positions on said shaft, a plurality of pulley steps of different diameters on said pulley each adapted to engage said belt, said indexing means being operative to position said pulley at points spaced apart upon said shaft substantially equal to the distance between said pulley steps, a pivotable member mounted near said pulley and having an axis of rotation substantially parallel to said shaft, at least one finger member on said pivotable member past which said belt normally moves freely, spring means on said pivotable member for normally maintaining said finger member spaced apart from said pulley, said finger member being movable toward said pulley by frictional engagement with a portion of the belt moving toward the rotating pulley when said pulley is displaced axially on said shaft, said frictional engagement and said displacement causing said belt to be deflected and to move from one pulley step to another as the pulley rotates.

2. A mechanism according to claim 1 and further comprising a flange between each pulley step and at least one pin mounted in each flange for engaging the deflected belt and moving it to said other step of the rotating pulley.

3. A speed changing mechanism for a drive belt comprising a rotatable shaft, a pulley mounted upon and movable longitudinally relative to said shaft, indexing means for maintaining said pulley at desired positions on said shaft, a plurality of pulley steps of different diameters

on said pulley each adapted to be engaged by said belt, said indexing means being operative to position said pulley at points spaced apart upon said shaft substantially equal to the distance between said pulley steps, a pivotable member mounted near said pulley and having an axis of rotation substantially parallel to said shaft, two pairs of finger members mounted on said pivotable member, one portion of said belt moving between one of said pairs of fingers toward said pulley, and another portion of said belt moving between the other pair of said fingers away from said pulley, spring means on said pivotable member for normally maintaining said pairs of finger members spaced apart from said pulley, one of said pairs of finger members being movable toward said pulley by frictional engagement with said belt as it moves when said pulley is displaced on said shaft, said frictional engagement and said displacement causing said belt to be deflected and to move from one pulley step to another as the pulley rotates.

4. A speed changing mechanism comprising a rotatable pulley, a plurality of pulley steps on said pulley, a belt adapted to run in any of said pulley steps, a pivotable member mounted near said pulley and having an axis of rotation substantially parallel to the axis of rotation of said pulley, said member and said pulley being displaceable axially relative to each other, at least one outwardly extending finger mounted on said member past which said belt normally moves freely, said finger being movable toward said pulley by frictional engagement with said belt as the latter moves toward the rotating pulley when said pulley and said member are displaced axially relative to each other, said frictional engagement and said displacement causing said belt to be deflected and to move from one pulley step to another as the pulley rotates.

5. A speed changing mechanism according to claim 4, and further comprising a flange between each pulley step and at least one outwardly extending pin mounted in each flange for engaging said deflected belt and moving it to said other step of the rotating pulley.

6. A speed changing mechanism according to claim 4, and further comprising a spring element on said pivotable member normally maintaining said finger spaced apart from said pulley.

7. A speed changing mechanism according to claim 4, and further comprising a rotatable shaft upon which said pulley is mounted, detent means between said pulley and said shaft for causing the rotation of said pulley with said shaft, and a plurality of indexing means on said shaft engageable by said detent means for positioning said pulley at points spaced apart on said shaft at distances substantially equal to the respective distances between said pulley steps.

8. A speed changing mechanism comprising a pulley rotatable bidirectionally, a plurality of pulley steps on said pulley, a belt adapted to run in any of said pulley steps, a pivotable member mounted near said pulley and having an axis of rotation substantially parallel to the axis of rotation of said pulley, said member and said pulley being displaceable axially relative to each other, a pair of fingers mounted on said member, each of said fingers extending in substantially an opposite direction from the other, one portion of said belt normally moving freely past one of said fingers toward said pulley and another portion of said belt normally moving freely past the other of said fingers away from said pulley, either of said fingers being movable toward said pulley by frictional engagement with said belt depending upon whatever portion of said belt moves towards said pulley when said pulley and said member are displaced axially relative to each other, said frictional engagement and said displacement causing said belt to be deflected and to move from one pulley step to another as the pulley rotates.

9. A speed changing mechanism according to claim 8, and further comprising a flange between each pulley step and at least one outwardly extending pin mounted in said flange for engaging said deflected belt and moving it to said other step of the rotating pulley.

10. A speed changing mechanism according to claim 8, and further comprising a spring element on said pivotable member normally maintaining said fingers spaced apart from said pulley.

11. A speed changing device according to claim 8, and further comprising a rotatable shaft upon which said pulley is mounted, detent means between said pulley and said shaft for causing the rotation of said pulley with said shaft, and a plurality of indexing means on said shaft engageable by said detent means for positioning said pulley at points spaced apart on said shaft at distances substantially equal to the respective distances between said pulley steps.

12. A speed changing mechanism comprising a pulley rotatable bidirectionally, a plurality of pulley steps on said pulley, a belt adapted to run in any of said pulley steps, a pivotable member mounted near said pulley and having an axis of rotation substantially parallel to the axis of rotation of said pulley, said member and said pulley being displaceable axially relative to each other, two pairs of fingers mounted on said member, each of said pairs of fingers extending in substantially an opposite direction from the other pair, said belt normally moving freely between the fingers of each pair of fingers, either of said pairs of fingers being movable toward said pulley by frictional engagement with said belt depending upon whatever portion of said belt moves toward said pulley when said pulley and said member are displaced axially in either direction relative to each other, said frictional engagement and said displacement causing said belt to be deflected and to move from one pulley step to another as the pulley rotates.

13. A speed changing mechanism according to claim 12, and further comprising a flange between each pulley step and at least one outwardly extending pin mounted in each flange for engaging said deflected belt and moving it to said other step of the rotating pulley.

14. A speed changing mechanism according to claim 12, and further comprising a spring element on said pivotable member normally maintaining said fingers spaced apart from said pulley.

15. A speed changing device according to claim 12, and further comprising a rotatable shaft upon which said pulley is mounted, detent means between said pulley and said shaft for causing the rotation of said pulley with said shaft, and a plurality of indexing means on said shaft engageable by said detent means for positioning said pulley at points spaced apart on said shaft at distances substantially equal to the respective distances between said pulley steps.

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