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CYCLICALLY VARIABLE SPEED DRIVING MECHANISM

Filed March 4, 1938

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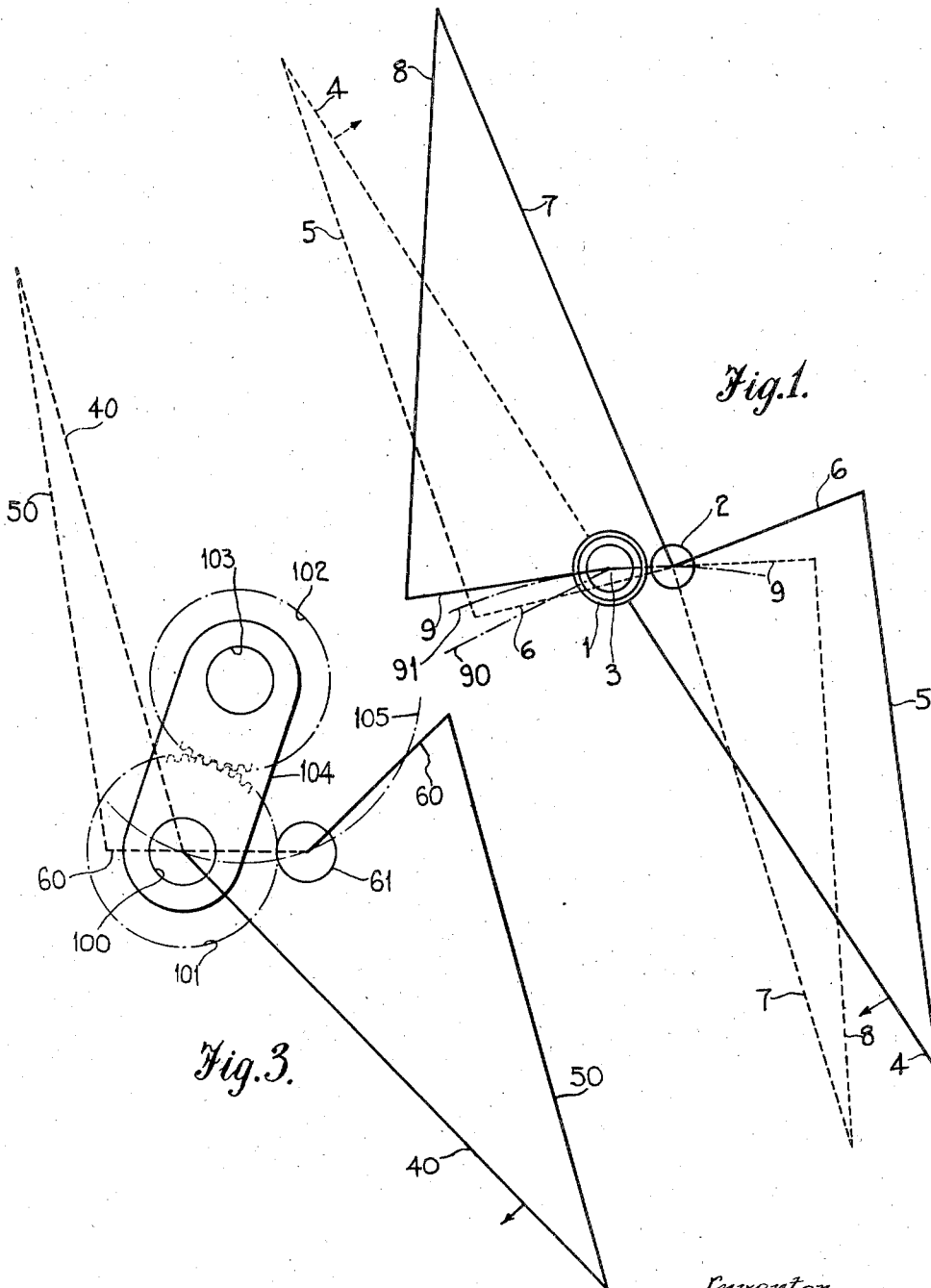


Fig. 3.

Fig. 1.

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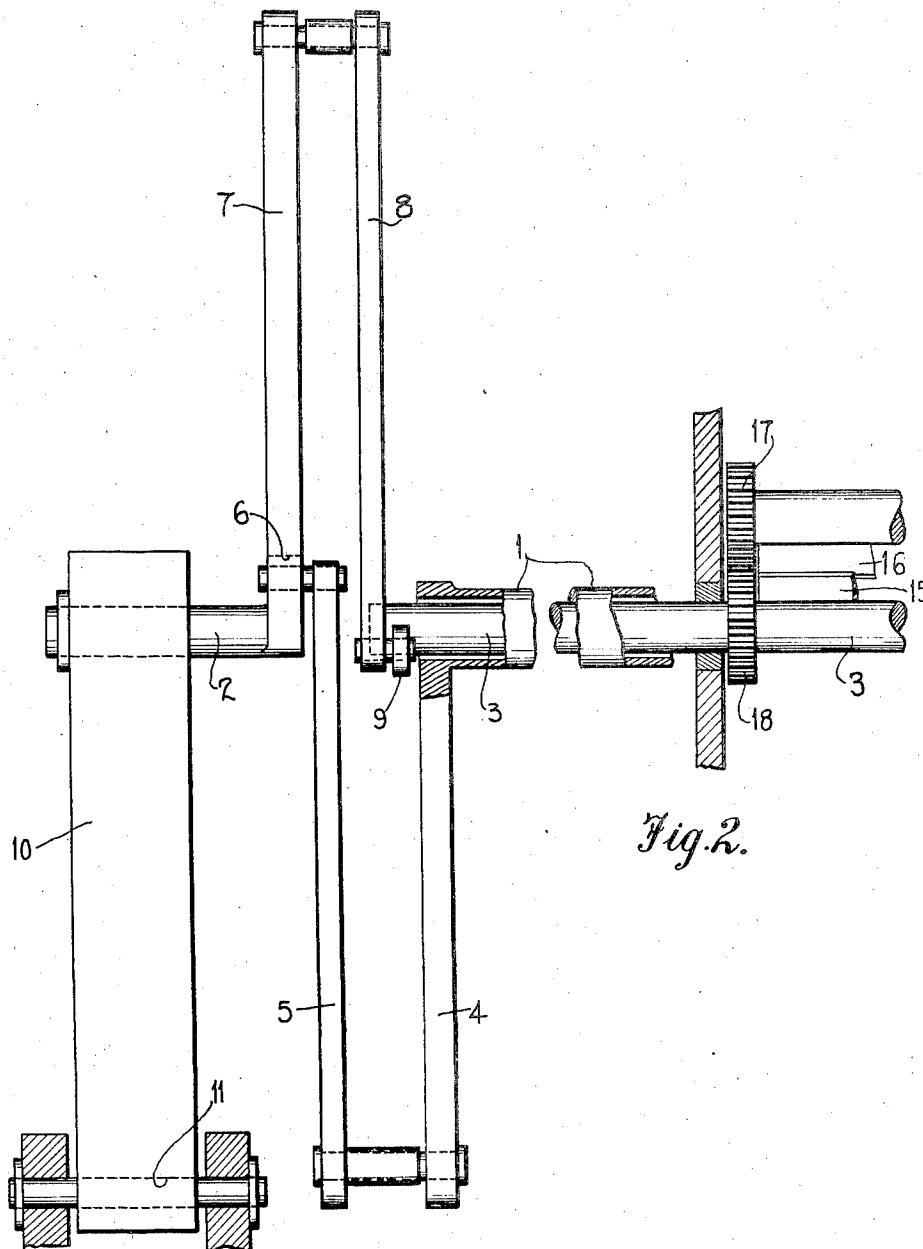
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CYCLICALLY VARIABLE SPEED DRIVING MECHANISM

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5 Sheets-Sheet 2



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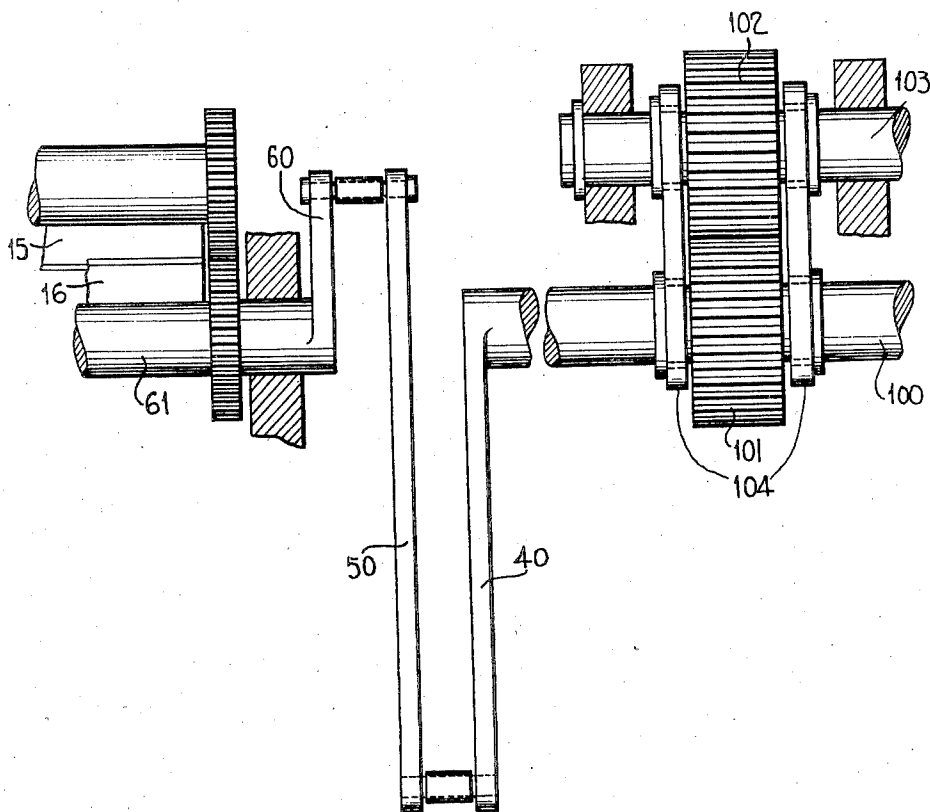
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CYCLICALLY VARIABLE SPEED DRIVING MECHANISM

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5 Sheets-Sheet 3

Fig. 4.



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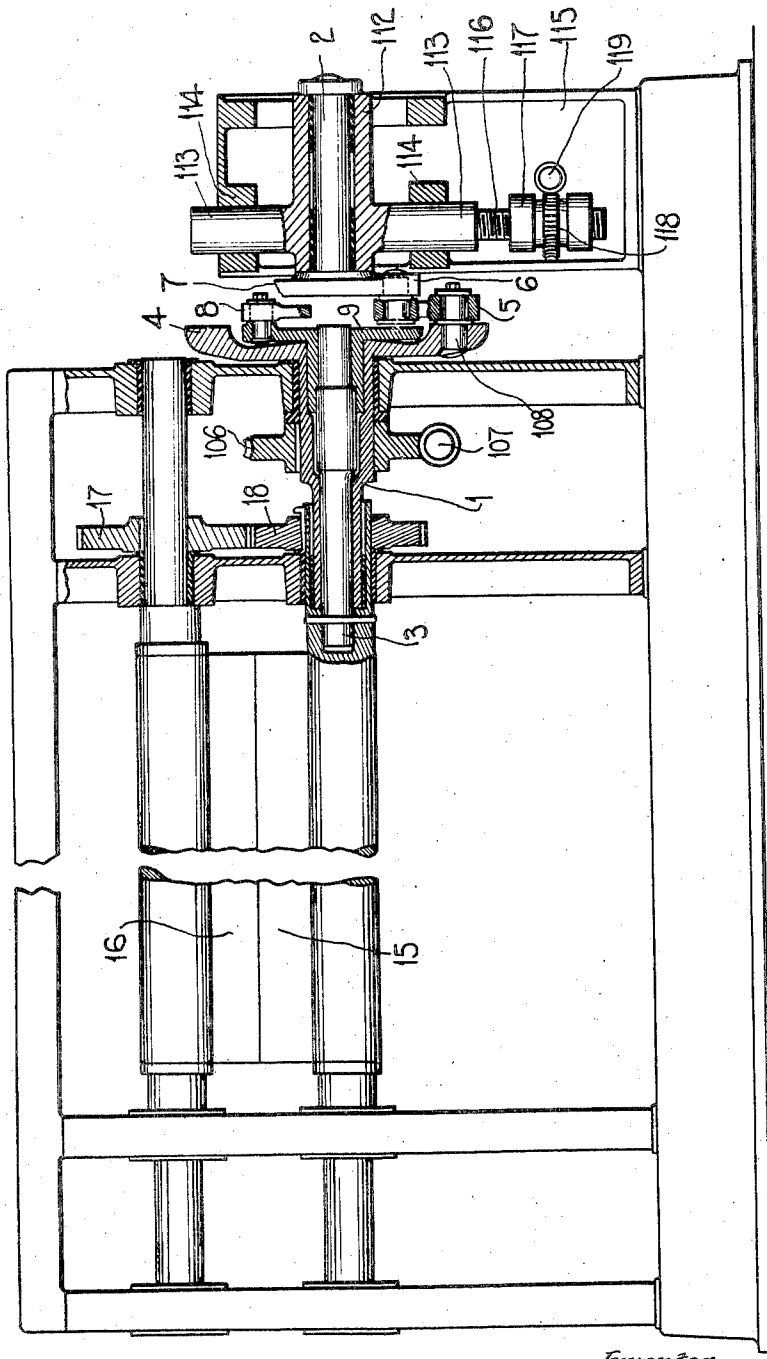
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CYCLICALLY VARIABLE SPEED DRIVING MECHANISM

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Fig. 5.



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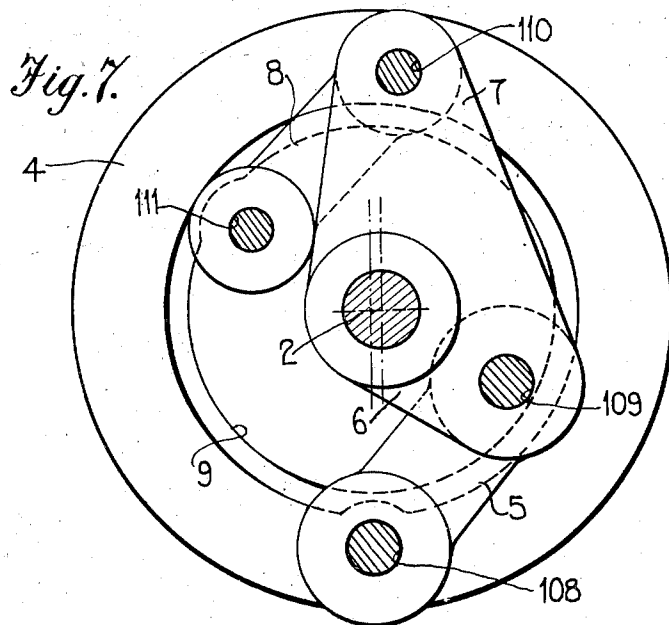
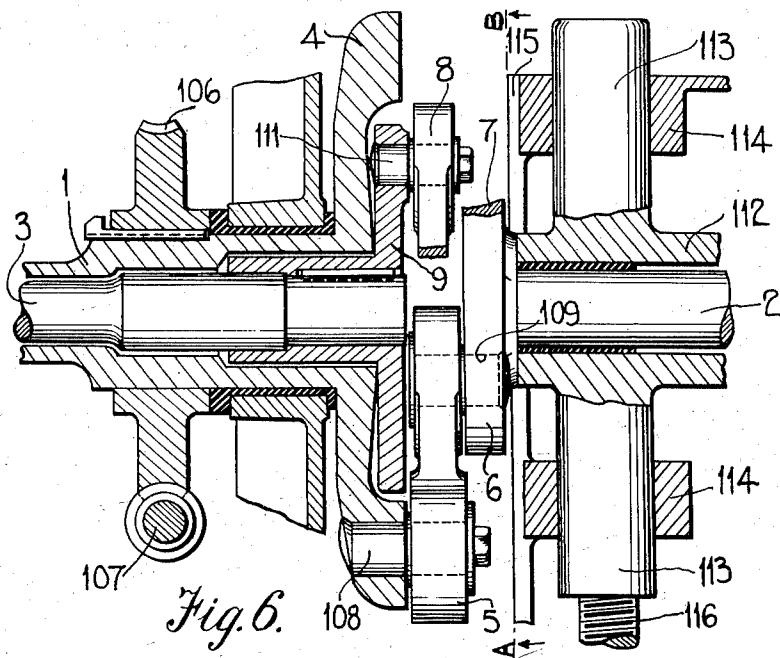
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CYCLICALLY VARIABLE SPEED DRIVING MECHANISM

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5 Sheets-Sheet 5



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CYCLICALLY VARIABLE SPEED DRIVING
MECHANISM

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In Great Britain March 12, 1937

5 Claims. (Cl. 164—68)

This invention is for improvements in or relating to cyclically variable speed driving mechanism, and refers to that type of cyclically variable speed driving mechanism in which both the driving and driven members are rotatable, that is to say, mechanism in which the driving and driven elements move through a full 360° about their respective axes during each cycle.

The invention is applicable for driving the cutter in a cut-off mechanism of the continuously driven type in which the cutter or cutters is or are arranged to have at the time of cutting a component of movement in the direction of travel of the material being cut, said cutter or each cutter also being arranged to have varying peripheral speeds whilst making one complete revolution. The expression "a cut-off mechanism of the type described" when used herein shall mean a cut-off mechanism as defined above.

Such cut-off mechanisms are used in the manufacture of corrugated paper board and fibre board, and are used for cutting continuous webs of such board into lengths whilst said webs are moving.

It is desirable in such mechanisms to provide some means whereby the cutter can be arranged to be adjustable so as to sever the moving web into different lengths according to requirements. Thus for instance at one period it may be desirable to cut off lengths of board to a certain length and when a sufficient number of such lengths have been severed it may be desired to cause the cutters to cut off lengths which are longer or shorter as the case may be than the first set of sheets.

In all cases, however, it is necessary to arrange that the cutter at the time of cutting moves with the web and at the web speed or substantially the web speed. It will be understood that where throughout the specification it is stated that the cutter has a movement at the time of cutting equal to the web speed, or at the time of cutting has a component of movement equal to that of the web, that these movements are not necessarily restricted to the exact web speed at the time of the cut. It is, however, important that the speeds of cutter and web at the time of cutting should approximate at least very closely to one another, otherwise the web may be damaged.

Machines of the type described for effecting these purposes are already known, and certain such machines are described in prior British Patent specifications Nos. 437,029 and 412,127 and United States patent specification No. 2,059,412.

Certain of the machines referred to in the prior specifications mentioned in the foregoing paragraph are machines having single co-operating cutters for operating upon a single moving web, whilst one deals with a machine having two pairs of co-operating cutters, each pair of cutters operating on a single slit web. It will be understood that the invention is applicable to any of the types of machines, whether the cutters operate on a single web or multiple webs or slit webs. It is to be understood, however, from the standpoint of the invention in such broader aspects as may be permissible in the light of the prior art, that the variable speed driving mechanism may be used for other purposes in which it is desired to obtain continuous rotation of both the driving and driven shafts.

According to one form of the present invention there is provided in or for a cut-off mechanism of the type described, a cyclically variable speed driving mechanism for the cutter or each cutter, said mechanism comprising a four-bar kinematic chain in which the driving and driven members are rotatable.

Further, according to the present invention there is provided in a cut-off mechanism of the type described, a cyclically variable speed driving mechanism for the cutter or each cutter, wherein said mechanism comprises two kinematic four bar chains arranged in series, and wherein the driving lever of the second chain is arranged to rotate in fixed angular relationship with and about the same axis as the driven lever of the first chain and wherein the driven lever of the second chain and the driving lever of the first chain are mounted to rotate about a common axis and capable of relative angular movement. The variable speed driving mechanism may comprise in combination three rotatable shafts, the first and third of said shafts being co-axial and the axis of the second shaft being parallel to the axes of the first and third shafts. The second shaft is located and terminates beyond the ends of the first and third shafts and means is provided coupling the three shafts, said means comprising a lever fixed relatively to the first shaft and coupled by a link to a lever fixed relatively to the second shaft and another lever fixed relatively to the third shaft, said lever being connected by a link to a second lever fixed relatively to the second shaft. The first and third shafts are concentric and one of said shafts may comprise a sleeve encircling the other. The lengths of the levers and the link of said four bar chain or of each chain and the distance be-

tween the axes about which the levers rotate are so proportioned that the sum of the lengths of the levers is greater than the sum of the length of the link connecting said levers plus the distance between the said axes, and the sum of the lengths of the connecting link and one lever is greater than the sum of the length of the other lever plus the distance between the said axes.

The driving lever of the four bar chain or of each chain may be longer than the driven lever of that chain. The distance between the axes about which the levers rotate may be adjustable for the purpose of varying the value of maximum and minimum speeds attained. The axis of rotation of one lever of a chain may be adjustable so as to be capable of being moved relatively to the axis of the other lever of said chain and to be adjusted to lie on either side of a given plane containing the axis of said other lever, for the purpose of altering the angular position of the driven element when maximum and minimum speeds are attained.

The adjustable axis above-mentioned may be movable across the axis about which the other lever rotates, so that the two axes can be made to coincide in order to enable the driving and driven levers to rotate at the same angular speeds. The adjustable axis may be moved through an angular path, the apex of said angle being coincident with the axis of the other lever of the chain for the purpose of enabling maximum and minimum speeds to be obtained at one angular position of the driven lever.

The curved path aforesaid approximates closely to the angular path above-mentioned for the purpose of enabling a close approximation of full range of maximum and minimum speeds to be obtained at one angular position of the driven lever. The lever whose axis moves through a curved path may be moved through an arcuate path and may be the driving lever and said driving lever is driven from a drive having its axis of rotation coincident with the axis about which the axis of the lever moves in its arcuate path.

Again, according to the present invention there is provided a cyclically variable speed driving mechanism in which the driving and driven members are continuously rotatable, said mechanism comprising a kinematic four bar chain wherein the length of the driving lever is greater than that of the driven lever.

The invention also provides a variable speed driving mechanism as defined in the two immediately preceding paragraphs, said mechanism comprising two such kinematic four bar chains arranged in series and comprising in combination three rotatable shafts, wherein the first and third of said shafts are co-axial and the axis of the second shaft is parallel to the axes of the first and third shafts, the second shaft being located and terminating beyond the ends of the first and third shafts, and means coupling the three shafts, said means comprising a lever fixed relatively to the first shaft and coupled by a link to a lever fixed relatively to the second shaft, and another lever fixed relatively to the third shaft, said lever being connected by a link to a second lever fixed relatively to the second shaft. The first and third of said shafts may be concentric, and one of said shafts comprises a sleeve encircling the other.

Alternatively, the adjustable axis may be moved through a curved path which approximates closely to the above-mentioned angular path, for the

purpose of enabling a close approximation of full range of maximum and minimum speeds to be obtained at one angular position of the driven lever.

Mechanism made in accordance with the present invention will now be described by way of example with reference to the accompanying drawings, in which—

Figure 1 shows diagrammatically a cyclically variable speed mechanism comprising two kinematic four bar chains in series.

Figure 2 is a side elevation of the construction shown diagrammatically in Figure 1 looking from the left-hand side of Figure 1.

Figure 3 is an alternative construction of cyclically variable speed mechanism showing in diagrammatic form a single four bar kinematic chain made in accordance with the invention.

Figure 4 is a side elevation of the construction shown diagrammatically in Figure 3.

Figure 5 shows a side elevation partly in section of a practical embodiment of a board cutting machine with two four bar kinematic chains in series for driving the cutters.

Figure 6 is an enlarged section of part of Figure 5 showing the cyclically variable speed mechanism in greater detail. Parts are broken away and the section arranged to show how the links co-operate.

Figure 7 is a section of Figure 6 on line A—B, but shows the various links in their proper positions.

Like reference numerals refer to like parts throughout the several figures of the drawings.

In the first example shown in Figures 1 and 2, the mechanism comprises in combination three rotatable shafts 1, 2 and 3, the first and third of such shafts, namely, shafts 1 and 3, being concentric, the first shaft 1 being arranged as a hollow sleeve around the third shaft 3. The first shaft 1 is driven in any desired manner from a source of power which rotates said shaft at a constant speed. The third shaft 3 is in this case the final driven element of the mechanism, and it is desired that this driven element shall rotate continuously, but that in making one complete revolution it shall have varying angular velocity. In Figure 1 the levers and links are shown in full lines at the angular position at which the driven lever has approximately maximum speed, and the dotted lines show the positions of the levers and links when the driven element has approximately minimum speed. A lever arm 4 is rigidly secured to the shaft 1. At the end of this lever arm 4 there is provided a link 5, which link is pivotally connected to another lever 6 which is secured rigidly to the second shaft 2. This second shaft 2 has its axis parallel with the first shaft 1, and as can be seen from Figure 2 there is a space measured in the direction of the axes between the ends of the first and second shafts, in order to enable the link 5 to be pivoted to the two levers 4 and 6. On the second shaft 2 there is provided a second lever 7 which forms with the other lever 6 a bell crank lever. A further link member 8 pivotally connected to this second lever 7 on the second shaft 2 and to a lever 9 on the third shaft 3 completes the main structural elements of the drive. It will be seen that this arrangement comprises two kinematic four bar chains in series, the first chain being constituted by the lever 4 on the shaft 1, the link 5 connecting that lever 4 to the lever 6 on the second shaft 2, whereas the fourth bar or link of the chain is consti-

tuted by the distance between the axes of the first and second shafts respectively. In this first chain the first shaft 1 is the driving member, whereas, the second shaft 2 is the driven member. In the second chain the lever 7 on the second shaft 2 is the driving lever, and thus the lever 9 mounted on the shaft 3 is the driven lever and the third bar of the second chain is the link 8, whilst the fourth bar or link in this second chain is also the distance between the axes of the first and second levers respectively, since the first and third shafts are co-axial.

The proportions of the parts and the lengths of the levers and the links and the distance between the axes about which the levers rotate are in the construction illustrated within the following limits: In each four bar chain (a) the sum of the lengths of the levers is greater than the sum of the length of the link connecting the two levers and the distance in said chain between the axes of the shafts, and (b) the sum of the lengths of the connecting link and one lever is greater than the sum of the length of the other lever and the distance between the axes of the shafts.

It will be appreciated that where the term "lever" is used it is to be understood that the term "lever" is merely illustrative of the effective distance between the axis about which the lever rotates and the axis at which a link member is pivoted to it. The lever itself may be constituted by any member and may be in the form of a disc or wheel. In such a case the link may be pivoted at any point between the axis and the periphery of the wheel, and in such a case the lever would be the distance between the centre of the disc or wheel or the axis about which this disc rotates and the centre of the pivotal axis of the connecting link.

It will be appreciated that the hollow sleeve 1 may be the driven element of these two four bar chains, in which case the lever 9 on the shaft 3 is the driving element of the chains. When, therefore, one of the two concentric shafts 1 or 3 is rotated (as the driving element), at a constant speed, it causes the two levers 6 and 7 on the second member to rotate at a speed which continuously varies throughout one revolution, and one of these levers 6 or 7, as the case may be, on the second shaft, acts as the driving lever in the second of the chains and has a varying speed during one revolution, and causes the final lever on one of the concentric shafts 1 or 3 to rotate at a speed which varies cyclically to a greater extent than the second shaft.

The amount of these variations is determined by the lengths and angular positions of the links, and more particularly by the relationship of the distance between the axis of the concentric shafts 1 and 3 on the one hand and the axis of the second shaft 2 on the other hand. The axis of the second shaft 2 is made adjustable relatively to the axis of the other two shafts, and this is effected by mounting the second shaft on a pivoted support 10. The pivot 11 about which this support can swing is parallel to the axis of the two concentric shafts 1 and 3 and the distance of the pivotal axis of this support 10 from the axes of the concentric shafts is equal to the distance of the axis about which the support 10 turns to the axis of the second shaft 2. The effect of this is to enable the axis of the second shaft to move through an arcuate path from one side to the other of a given plane containing the axes of the concentric shafts 1 and 3. This arrangement not only enables the distance between

the first and second shafts to be varied, but also enables the second shaft to be brought to one side or the other of, or in alignment with the co-axial shafts 1 and 3. By varying the distance between the axes of the concentric and second shafts it is possible to vary the value of maximum and minimum speeds attained by the driven element 9. The nearer the axes of the concentric and second shafts are brought, the less will be the variation in the angular velocity of the driven element in each of the four bar chains, and the more will the speed of the driven element in each chain approach constant speed. When all three shafts are in alignment all the shafts 1, 2 and 3 will rotate at constant angular speed, or if the first driving element 4 is driven at a variable speed all three shafts will rotate in the same angular relationship. When the axis of the second shaft lies on one side of a plane containing the axes of the concentric shafts (e. g., on the right hand side of the concentric shafts as shown in Figure 1) it will be found that maximum and minimum speeds will occur at certain angular positions of the driven element 9, and when the axis of the second shaft is arranged to lie on the opposite side of the said plane containing the axes of the concentric shafts (i. e., on the left hand side of the axis of shaft 1 when looking at Figure 1), then the maximum and minimum speeds attained will occur in different angular positions of the driven element. In the case of the construction shown in Figure 1, it is found that if the parts are suitably proportioned in the manner indicated above, that when the levers are in the position shown in full lines in Figure 1, the lever 9 is moving at approximately maximum speed and when the levers are in the position shown in dotted lines, then the lever 9 is moving at approximately minimum speed.

Since the shaft 2 is rotatably supported by the pivoted support 10, such support may be adjusted while the machine is running to position shaft 2 in any of the positions above described, and such adjustments may also be made while the machine is at rest.

In the specific construction shown in Figure 1 it will be seen that in each four bar chain the length of the driving lever 4 or 7 as the case may be is longer than the driven lever in that chain (6 or 9 as the case may be) and the link connecting the driving and driven levers in each chain, (that is the link 5 or 8 as the case may be), is shorter than the driving lever in its chain, and the distance between the axes of the shafts 1 and 2 is less than the length of the driven lever 6 or 9. By arranging that the driving lever of a chain is longer than its driven lever all other factors being constant, a greater variation in speed is obtainable than would be obtainable if the driving and driven levers were, for example, equal. By taking advantage of this fact, it is possible to increase the cyclic speed variation by increasing within reasonable limits the length of the driving lever of a chain relatively to the driven lever, and by putting two such chains in series the cyclic speed difference is obviously still further increased. This fact can be used to advantage when designing the cyclically variable speed driving mechanism for use in board cutting machines which are to be capable of cutting from a web, boards of comparatively widely differing lengths.

When the second shaft is arranged to lie on the left hand side of the axis of shafts 1 and 3 and at the same distance from said axis, mini-

imum speed will occur substantially at the angular position of the lever 9 where maximum speed occurred previously, and maximum speed will occur at the angular position of the driven lever 9 where minimum speed occurred previously.

It is found that the points of maximum and minimum velocity occur at about 180° from one another, and thus when the axis of the shaft 2 moves from one side to a position on the other side of the axis of the shaft 1, the point of minimum velocity will be substantially in the same angular position of the driven element in which maximum velocity occurred previously and vice versa.

It is also found that the point of minimum velocity occurs when the driven lever of a given four bar chain approximately overlies a line joining the axes of the driving and driven levers respectively, that is, when the driven lever lies approximately across the axis of the driving lever.

Thus, by this construction it is possible to vary not only the amount or value of maximum and minimum speeds attained, but also to alter the angular positions of the driving element at which maximum and minimum speeds are attained.

In applying such a driving mechanism to a cut-off mechanism of the type described for cutting a moving web it will be appreciated that if the cutter is mounted so as to be fixed in definite relationship with the driven lever 9, then that cut-off mechanism can be arranged to cut when the cutter has approximately its maximum peripheral speed, and it can be arranged to cut when it has approximately its minimum peripheral speed. Further, it is also possible to vary the value of these maximum and minimum speeds by altering the distance between the driving and driven shafts, and in addition, by providing a variable-reduction gear for driving the driving lever 4 of this cyclically variable speed driving gear, it is possible to obtain a very large range of variation in the lengths which the cutting element can sever from a web which moves at a predetermined speed.

The cutter usually comprises two co-operating cutting elements geared together. In Figures 2 and 5, one of the cutters 15 is shown mounted on the shaft 3, and the other cutter 16 is mounted to co-operate with the cutter 15, the two cutters 15 and 16 being geared together by the toothed wheels 17 and 18. The remaining references on Figures 1, 2 and 5 are dealt with later when comparing the arrangement shown in Figures 1 and 2 with that shown in Figures 3 and 4.

It will be appreciated that by means of the present invention a very simple and easy adjustment can be made for altering the length of cut by simply changing the position of the second shaft, and at the same time altering the speed at which the driving lever 4 is to be rotated. It will be understood, when changing the speed of the driving element 4 one would merely have to increase or reduce the angular velocity at which this element is rotating, that angular velocity of course being preferably constant throughout a complete rotation.

In an alternative example shown in Figures 3 and 4, instead of having two four bar chains in series as mentioned above, a single four bar chain is provided with levers and links having proportions as mentioned above for each of the chains in the first example. In Figure 3, the full lines indicate the positions of the levers when the driven lever is moving at approximately maximum speed, and the dotted lines indicate the

positions of the levers when the driven lever has approximately minimum velocity.

In this second alternative the driving lever 40 is fixed to a shaft 100 which is provided with a toothed wheel 101 which meshes with a second toothed wheel 102, this second toothed wheel 102 being mounted on a fixed axis 103 and rotated for example at constant angular speed through a reduction gear. The driven lever 60 is fixed to a shaft 61 which is at the same distance from the axis 103 of the second toothed wheel 102 as is the axis of the driving lever 40. The axis of the driving lever 40 can be moved through an arcuate path, and thus the distance between the axes of the shafts 100 and 61 can be varied, or these two axes can be brought into alignment to cause the driving and driven levers 40 and 60 to move at the same angular velocity. Also, the axis of the driving lever 40 can be moved to lie on either side of a given plane containing the axis of the driven lever 60. Thus in this example also a fixed position of the main drive is provided, although the axis 100 about which the driving lever of the four bar chain rotates is movable. By correctly proportioning the distance between the fixed axis of the second or driving toothed wheel 102 and the axis about which the driving lever 40 rotates, that is, the radial distance of the axis of the driving lever 40 from the point about which it moves through an arcuate path, it is possible (as will be explained below), to arrange that the maximum speed of the driven lever 60 when the axis about which the driving lever rotates is at its greatest distance from the driven shaft 61 (on, say, the right hand side thereof), and the minimum speed of the driven lever 60 when the axis about which the driving lever 40 rotates is at its greatest displacement from the driven shaft (on, say, the left hand side thereof) will occur at substantially the same angular position of the driven lever 60. When such a construction is used on a cutting machine as described above, this angular position can be arranged to coincide fairly approximately with the cutting position of the cutter. The cutter 16 fixed to the shaft 61 in Figure 4 is arranged similarly to the cutter shown in Figure 1.

In this construction, comprising a single kinematic four bar chain, the driving lever 40 is longer than the driven lever 60, the link 50 connecting the two levers 40 and 60 is shorter than the driving lever 40, and the distance between the axes about which the levers 40 and 60 rotate is itself less than the length of the driven lever 60.

In the case of the particular second construction shown in Figure 3, in which there is only a single four bar chain, minimum velocity occurs when the driven lever 60 is approximately in the position shown in dotted lines, and maximum velocity occurs when the driven lever 60 is (as shown in full lines), at an angle of approximately 136° to the position in which it lies when it has minimum velocity.

In the construction shown in Figure 3, the driving shaft 100 is shown on the left hand side of a vertical plane which contains the axis of the shaft 61. If, now, it is desired that when the axis of the shaft 100 is on the right hand side of the vertical plane containing the axis of the shaft 61 that minimum velocity will occur when the lever 60 is in the position shown in full lines in Figure 3, it will be necessary to arrange that the axis of the shaft 100 will intersect the full line 60 shown in Figure 3, since minimum velocity al-

ways occurs approximately when the driven lever intersects the axis of the driving lever.

Thus, in order to obtain the ideal, the shaft 100 when it lies on the left-hand side of the shaft 61 should move along the dotted line shown in Figure 3 joining axes of 100 and 61 so that in all cases maximum velocity will occur when the driven shaft 60 is in the angular position shown in full line in Figure 3 and when the shaft 100 is on the right-hand side of the axis of the shaft 61 looking at Figure 3, if the axis of the shaft 100 moves along the full line 60 in Figure 3, then whenever the lever 60 is in that position (shown in full lines) the lever 60 would, in that position, have minimum velocity.

Thus with such an arrangement one can ensure that maximum and minimum velocity will occur approximately at the position of the lever 60 in full lines in Figure 3 when the shaft 100 is on the left and right hand side respectively of the shaft 61, subject of course to the shaft 100 lying on the dotted or full line 60 as the case may be. In practice, however, since it is desired to make the shaft 100 the driving shaft it would be inconvenient to have the shaft moving along the line joining the shafts 100 and 61 and along the full line in which the lever 60 is shown in Figure 3. Since the shaft 100 is driven through the toothed wheels 101 and 102 the latter being on the fixed shaft 103, it is found that by suitably proportioning the size of the wheels 101 and 102 it is possible to arrange that the centre of the shaft 100 is at such a distance from the shaft 103 that the shaft 100 will move through an arcuate path shown by the broken line 105 in Figure 3 which arcuate path should be arranged to coincide as nearly as possible with the angular path mentioned previously.

A link member 104 is provided to keep the shafts 100 and 103 at the proper distance from one another so that the toothed wheels 101 and 102 remain in mesh. During adjustment of the cutting speed, the link member 104 which acts as a pivoted support for shaft 100, moves angularly about shaft 103 as an axis and thus alters the spacing between the axes of shaft 61 and shaft 100, which latter is rotatably carried by member 104. As in the case of support 10 previously referred to, the member 104 may be adjusted to different angular positions either while the machine is running, or at rest. Under either condition, the gear 101 during adjustment will move arcuately in planetary manner with respect to its driving gear 102 while maintaining proper meshing relationship therewith, and support 104 will move angularly about shaft 103 as an axis while relative angular movement takes place between support 104 and shaft 100, which latter moves bodily with support 104.

In the embodiment of Figures 1 and 2 shaft 1 constitutes a rotary driving member and shaft 2 a rotary driven member of the first four bar chain, embodying the pivoted link 5. Shaft 2 constitutes a rotary driving member and shaft 3 a rotary driven member of the second four bar chain including the link 8, the two four bar chains thus operating in series.

In the embodiment of Figures 3 and 4, shaft 100 constitutes a rotary driving member and shaft 61 a rotary driven member of the single four bar chain used, which includes the link 50. In both embodiments last above referred to, the shafts and the levers or arms respectively affixed thereto constitute crank arms between which the respective links above referred to are pivotally

connected at points spaced from the respective axes of rotation.

It will be appreciated that when the axis of the shaft 100 moves through the arcuate path shown in chain lines in Figure 3 that it is not possible to ensure that maximum and minimum velocities will always occur for exactly the same angular position of the driving element 60 when the axis of shaft 100 is on one side or the other as the case may be of the axis of the driven shaft 61. Nevertheless, it is possible to obtain a fair approximation of the position of the driven lever 60 when maximum and minimum velocities occur, since the position of the driven lever 60 at which maximum and minimum speeds occur will lie within a close range of positions of that lever.

In the case of the construction shown in Figure 1 employing two four bar chains in series, the reason for mounting the second shaft on the pivoted member is merely to provide an easy means for moving the second shaft and not for the reason just mentioned in relation to Figure 3.

In Figure 1 the shaft 2 is mounted on an angularly movable member, merely to provide a means whereby an easy adjustment may be made in regard to the setting of the shaft 2, and thus any well known means may be provided for aligning the angularly movable support 10 in the desired position.

In the construction shown in Figure 1, therefore, it is desirable that the arc through which the axis of the shaft 2 swings shall be as near as possible to a straight line passing through the axes of the shafts 1 and 2, because by swinging the shaft through an arcuate path it will be appreciated that one will not necessarily obtain maximum and minimum velocities at the position of the lever 9 shown in full lines in Figure 1 when the axis of shaft 2 is on the right and left hand side respectively of the shaft 1.

It is found, however, in practice that the lever 9 reaches its maximum velocity when it is in the position marked by the chain line 90 in Figure 1, and thus if the arcuate curve 91 through which the axis of the shaft 2 is moved by the pivoted support 10 is fairly flat as shown in Figure 1, then for practical purposes it can be stated that for certain angular positions of the driven member 9 at which maximum velocity occurs, when the shaft 2 is on the right hand side, the minimum velocity will occur at substantially one of those positions when the axis of the shaft 2 is on the left hand side of the axis of shaft 1.

In the example first discussed above, and as shown in Figures 1 and 2, the proportions of the links and levers were such that the angular positions at which the driven lever reached maximum and minimum positions were at about 180° to one another, and in that case, therefore, the movement of the adjustable axis through an arcuate path was simply for the purpose of providing an easy adjustment to that axis.

It will be appreciated, however, that when other proportions for the links and levers are provided that the angular positions of the driven element at which maximum and minimum speeds occur are not always necessarily at 180° to one another. In such cases the adjustable member will be moved through an arcuate path for the same reason as the construction shown in Figures 3 and 4 is arranged to move the adjustable shaft through an arcuate path. In such a case, therefore, the member 10 shown in Figures 1 and 2 would be made of a sufficient length to enable the desired arcuate path to be obtained.

In Figures 5, 6 and 7 is shown a somewhat modified embodiment of the machine in which two kinematic four bar chains are provided in series for driving the cutters and the same reference letters are used as in Figures 1 and 2 which show diagrammatically a similar machine.

The shaft 1 is in the form of a sleeve and is rotated by a worm wheel 106 keyed to it and driven by a worm 107. The driving lever 4 is in the form of a crank disc connected by a pin 108 to the link 5. The link 5 is connected to lever 6 by a pin 109 and in this case levers 6 and 7 are formed in one piece or web, see Figure 7. The shaft 2 is fixed to a boss in the web constituting levers 6 and 7. The link 8 is connected to lever 7 and lever 9 by pins 110 and 111 respectively, and it will be seen from Figure 7 that the lever 9 is also formed as a crank disc. The shaft 3 is keyed to the middle of disc 8 and is co-axial with the sleeve forming the shaft 1.

In order to enable the shaft 2 to be moved relatively to shafts 1 and 3 it is carried in a bearing 112 which has spigots 113 attached to it and supported in bearings 114 in the frame 115 of the machine. A screw 116 is attached to one spigot and a rotatable nut 117 causes the screw to rise or fall as desired and move the shaft 2 bodily, parallel to itself. The nut 117 is rotated by a worm wheel 118 fixed to it and rotated by a worm 119.

It will be observed in this case that the movable shaft 2 is moved in a straight line instead of in an arc as in the constructions shown in Figures 1-4.

In this last described embodiment of the invention, adjustment of the cutting speed also may be made either while the machine is running or at rest, since the movable shaft 2 is journaled in the support constituted by members 112, 113, which support like the supports 10 and 104 previously referred to, remains stationary during normal operation and is the part of the machine which is shifted from one position to another when adjustment is to be made.

In the embodiment of Figures 5 to 7, the hollow shaft 1 constitutes a rotary driving member having the crank arm 4, and shaft 2 having the crank arm 6 constitutes a rotary driven member, of the first four bar chain including pivoted link 5. Shaft 2 having the crank arm 7 constitutes a rotary driving member, and shaft 3 having the crank arm 9 a rotary driven member, of the second four bar chain including the pivoted link 8. Thus the two four bar chains operate in series.

The cutter 15 is fixed on shaft 3 and a gear 18 on the same shaft drives the cutter 16 through gear 17 as in the case of the arrangement described with reference to Figures 1 and 2.

What I claim as my invention and desire to secure by Letters Patent is:

1. A cutting machine of the continuously driven type including a cutter constructed to have at the time of cutting a component of motion in the direction of travel of the material being cut, and an actuating mechanism for said cutter including rotary driving and driven members, a link pivotally connected to each of said driving and driven members at points spaced from their respective axes of rotation, a normally stationary

support rotatably carrying one of said rotary members, said support however being adjustably mounted for movement in a path transverse to the axes of rotation of said rotary members to vary the distance between such axes of rotation and thereby regulate the cutting speed of the cutter, mechanism for positioning said support in various positions in said path, the above mentioned parts of the machine being constructed and arranged to afford adjustment of said support while the machine is running.

2. A cutting machine of the continuously driven type including a cutter constructed to have at the time of cutting a component of motion in the direction of travel of the materials being cut, and an actuating mechanism for said cutter including a plurality of pairs of rotary driving and driven crank members connected in series, each of said pairs of driving and driven crank members having a link pivotally connected therebetween at points spaced from their respective axes of rotation, the output crank member of one of said pairs and the input crank member of another of said pairs being carried by a common support, and means for adjusting the position of said support with respect to the axes of rotation of the input crank element of the first pair and the output crank element of the other pair, to thereby regulate the cutting speed of said cutter.

3. A cutting machine as set forth in claim 1, wherein said rotary driven member is mounted to rotate about a fixed axis, and said support is mounted to afford pivotal movement thereof about an axis spaced from said fixed axis, said support rotatably carrying said rotary driving member at a point spaced from said spaced axis.

4. A cutting machine as set forth in claim 1, wherein said rotary driving member comprises a hollow member, and a rotatable driving member for the cutter mechanism enclosed by said hollow member.

5. A cutting machine of the continuously driven type including a cutter constructed to have at the time of cutting a component of motion in the direction of travel of the material being cut, and an actuating mechanism for said cutter including rotary driving and driven members, a link pivotally connected to each of said driving and driven members at points spaced from their respective axes of rotation, a normally stationary support rotatably carrying one of said rotary members, said support however being adjustably mounted for movement in a path transverse to the axes of rotation of said rotary members to vary the distance between such axes of rotation and thereby regulate the cutting speed of the cutter, said rotary driving member carrying a gear, a driving gear meshing therewith and mounted to rotate on a fixed axis, said support being pivotally mounted on the axis of said last mentioned gear, said support rotatably carrying said rotary driving member at a point spaced from said last mentioned axis, said support being angularly adjustable about said fixed axis to vary the distance between the axes of rotation of said rotary driving and driven members, the above mentioned parts of the machine being constructed and arranged to afford adjustment of the support while the machine is running.

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