March 12, 1940. F. A. REECE 2,193,344

DRIVE

Filed Jan. 5, 1939 2 Sheets-Sheet 1

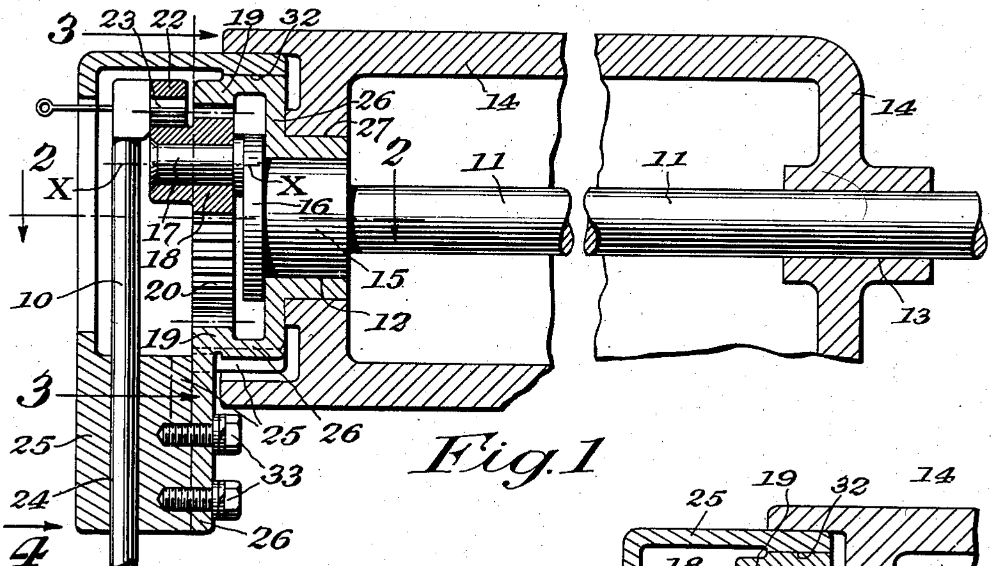

Fig.1

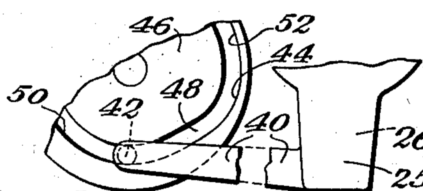

Fig.4

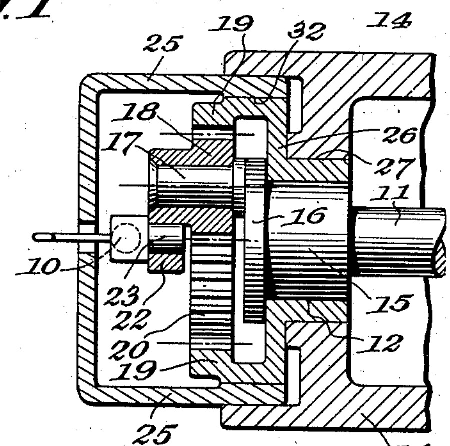

Fig. 2

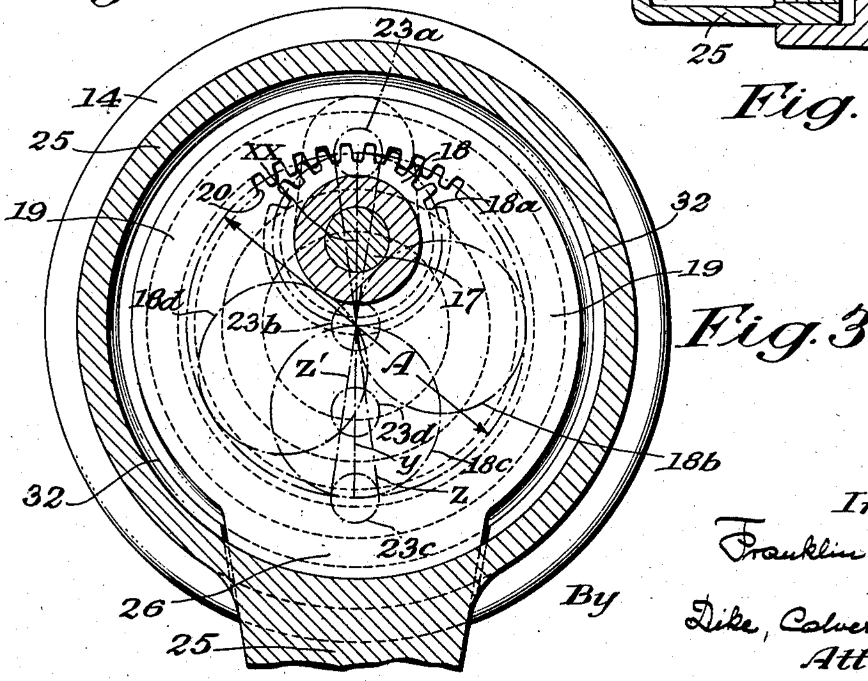

Fig.3

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2 Sheets-Sheet 2

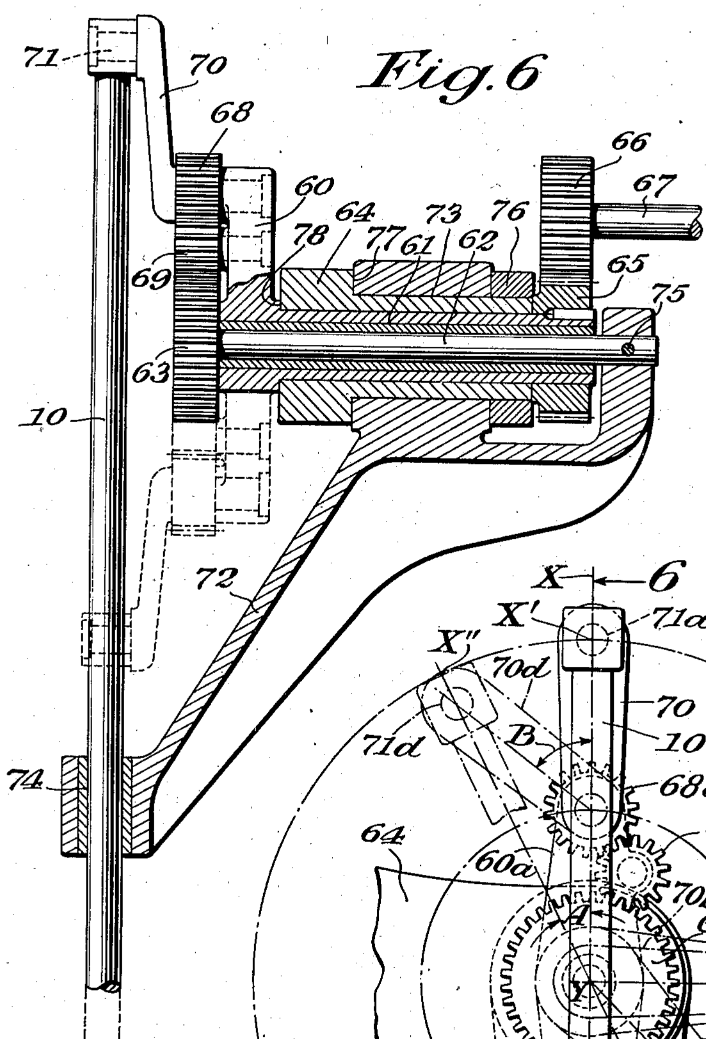

Fig. 6

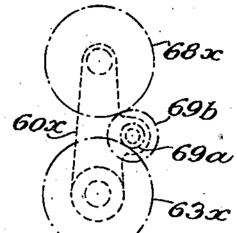

Fig. 6a

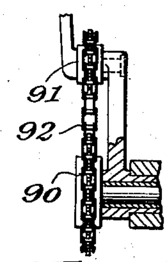

Fig. 7

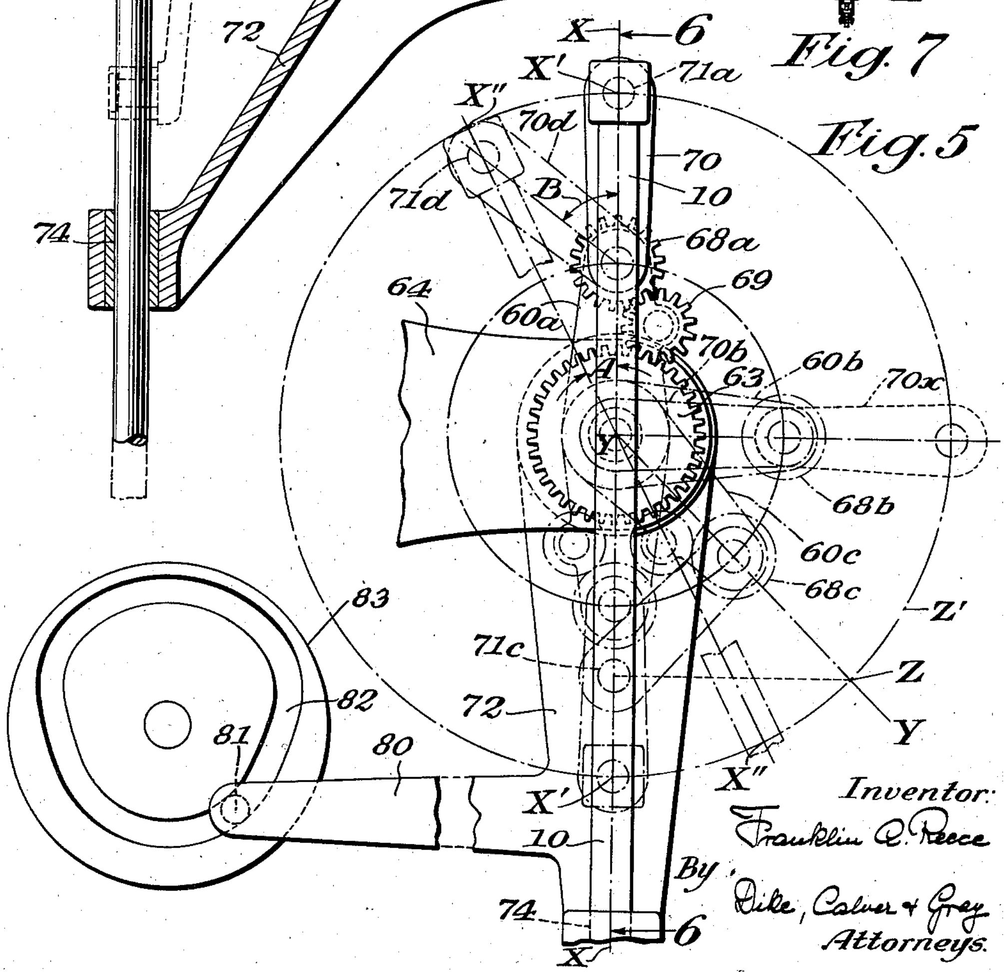

Fig. 5

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Patented Mar. 12, 1940 **2,193,344**

UNITED STATES PATENT OFFICE

2,193,344

DRIVE

Franklin A. Reece, Brookline, Mass.

Application January 5, 1939, Serial No. 249,428

17 Claims. (Cl. 74—52)

This application is a continuation in part of my prior application Serial No. 196,379, filed March 17, 1938.

The present invention relates to a novel drive for a reciprocatory and oscillatory element.

It is the primary aim and object of the present invention to provide a mechanism for reciprocating an oscillatory element so that the same may have a true harmonic motion in any direction in its plane of oscillation and always reciprocate through the same distance.

It is also among the objects of the present invention to so devise the mechanism that rotary motion is transformed into reciprocatory motion so that the rotary parts exert no side thrusts on the reciprocatory and oscillatory element, which allows of short bearings for the element, eliminates bending stresses in the element and makes possible a compact and small overall design.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention claimed herein beyond the requirements of the prior art.

In the drawings:

Fig. 1 is a fragmentary, longitudinal section through a drive which embodies the present invention.

Fig. 2 is a fragmentary section taken substantially on the line 2—2 of Fig. 1, certain elements of the drive being shown in a different position of operation than in Fig. 1, however.

Fig. 3 is an enlarged, fragmentary section taken substantially on the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary elevation of a part of the construction shown in Fig. 1 as viewed in the direction of arrow 4 in Fig. 1.

Fig. 5 is a fragmentary front elevation of a modified drive.

Fig. 6 is a section taken on the line 6—6 of Fig. 5.

Fig. 6*a* is a diagrammatic view of a modified gearing usable in the drive shown in Figs. 5 and 6.

Fig. 7 is a fragmentary section of another modified drive.

The present invention is shown in the drawings, by way of example, as being embodied in a sewing machine for driving a needle bar **10**. It is to be distinctly understood, however, that the novel drive is thereby not meant to be limited to operating a needle bar in a sewing machine, as said drive may be used with equal advantage in any other type of mechanism which requires a drive between a rotary element and a reciprocatory and oscillatory element.

In Fig. 1, the reference numeral **11** designates a suitably driven shaft which is journalled in any convenient manner at **12** and **13** in the conventional head **14** of any sewing machine. More particularly, the forward end **15** of the shaft **11** is provided with a disc **16**, having a projecting crank pin **17** which rotatably supports a spur gear **18**. The spur gear **18** is in permanent mesh with the internal teeth **20** of a ring gear **19** which is mounted in, or integral with, a member **26** that is rotatably supported at **27** in the head **14** of the machine and provides the bearing **12** for the shaft **11**. The spur gear **18** is also provided with an extending arm **22**, receiving a stud or crank pin **23** which is connected with the needle bar **10**. The needle bar **10** is guided at **24** for reciprocation radially of the axis of the ring gear **19** in a cover **25** which is positioned on a cylindrical portion **32** of the member **26** and secured to the latter by screws **33** for combined oscillation with said member **26**. Hence, the cover **25** with its needle bar guide **24** is oscillated together with the ring gear **19**.

The ratio between the teeth of the spur gear **18** and the internal gear **19** is one to two, and the stud **23** is spaced from the axis x—x of the crank pin **17** (Figs. 1 and 3) a distance which is exactly ¼ the pitch diameter A (Fig. 3) of the internal gear **19**.

Consequently, on rolling the spur gear **18** on the internal teeth **20** of the ring gear **19** through 180 degrees of the latter and starting either at the position **18***a* or **18***c* in Fig. 3, the stud **23** will move through a linear distance which is equal to the pitch diameter A of the ring gear **19**. Moreover, the stud **23** is bound to move in the linear path y (Fig. 3) which is diametrical with respect to the ring gear **19**, as will be readily understood.

Fig. 3 illustrates several momentary positions of the spur gear **18** while the same rolls on the internal or ring gear **19** through 360 degrees of the latter. In the home or starting position **18***a* of the spur gear **18**, the stud **23** is in its uppermost position, assuming thereby that the needle bar **10** is to reciprocate vertically. Hence, the gear position **18***a* in Fig. 3 corresponds to the position of the gear **18** as shown in Fig. 1. On rolling the spur gear 18 on the internal gear 19 from the position 18*a* into the position 18*b*, the stud 23 will travel on the diameter *y* of the internal gear 19 from the position 23*a* to the position 23*b* and the needle bar 10 will have completed one half of its downward or work stroke. On continued rolling of the spur gear 18 on the internal gear 19 from the position 18*b* into the position 18*c*, the stud 23 will continue to move on the same straight line *y* to the position 23*c* in which the needle bar 10 assumes its lowermost position. On continued rolling of the spur gear 18 on the internal gear 19 from the position 18*c* into the position 18*d* in Fig. 3, the stud 23 will move reversely on the same straight line *y* into the position 23*d*, and the needle bar 10 will ascend through the vertical distance between the stud positions 23*c* and 23*d*. On continued rolling of the spur gear 18 on the internal gear 19 from the position 18*d* into the starting position 18*a*, the stud 23 will move, on the same straight line *y*, from the position 23*d* to the starting position 23*a* in which the needle bar 10 is returned to its home or uppermost position.

It will now be understood that rotation of the drive shaft 11, and consequently of the crank pin 17, causes rolling of the spur gear 18 on the internal gear 19 and reciprocation of the needle bar 10. More particularly, one revolution of the shaft 11 results in one complete reciprocation of the needle bar as will be readily observed in Fig. 3.

The needle bar 10 is reciprocated with a true harmonic motion on uniform rotation of the crank shaft 11. This is due to the fact that the projection of the meshing engagement between gear 19 and gear 18, in any position of the latter, upon the linear path of movement of the stud 23 coincides with the corresponding position of said stud. This appears clearly from the gear positions 18*a*, 18*b*, 18*c* and 18*d* and their corresponding stud positions 23*a*, 23*b*, 23*c* and 23*d* in Fig. 3.

In order to oscillate the needle bar, it is merely necessary to oscillate the ring gear 19 together with the cover 25 with its needle bar guide 24. If the ring gear 19 and the cover 25 are turned counter-clockwise (Fig. 3), gear 18 will also be rotated counter-clockwise, with the result that the stud 23 will be moved inwardly from the pitch diameter of the ring gear. In other words, the stud 23 will not be at its extreme outward position. To place the stud 23 in the extreme outward position, the disc 16 with the crank pin 17 must be rotated counter-clockwise (Fig. 3). Therefore, the diametric straight line on which the stud 23 will travel is then no longer the vertical line *y* but is inclined relative thereto as, for instance, the diametric line *z* (Fig. 3). If the ring gear 19 and the cover 25 are turned slightly clockwise (Fig. 3) and then crank 17 rotated, it will be understood that the stud 23 travels on a diametric straight line which may be the line *z'* (Fig. 3), depending on the angle through which the ring gear 19 and the cover 25 have been rotated clockwise. Hence, for an oscillating needle bar construction, it is only necessary to oscillate the ring gear 19 and the cover 25 with its needle bar guide 24.

Oscillation of the ring gear 19 and cover 25 may be accomplished by any suitable means. In the present instance, the member 26 or the cover 25 may have a lateral extension 40 (Fig. 4), carrying a follower 42 which cooperates with a continuous groove 44 in a cam disc 46. The cam groove 44 has two diametrically opposite groove portions 48 (one being shown in Fig. 5) which join two concentric groove portions 50 and 52 of different radii. The cam disc 46 may be rotated in any suitable manner at a one to two speed ratio with respect to the needle-bar reciprocating shaft 11 (Fig. 1) so that the needle bar 10 is laterally shifted for each reciprocation. It is to be distinctly understood, however, that the present invention is not limited to a needle bar which is laterally shifted for each reciprocation as it would not involve invention to substitute for the cam 46 in Fig. 4 other suitable means to cause a lateral shifting of the needle bar after a number of reciprocations of the same.

A modified drive, illustrated in Figs. 5 and 6, departs from the previously described drive primarily by substituting for the internal gear a spur gear and by drivingly connecting the crank-operated gear with said spur gear by means of an idler gear which is bodily rotating with said crank-operated gear. To this end, a crank 60 is provided with a sleeve 61 in which is journaled coaxially of said sleeve a shaft 62 that carries at one end the spur gear 63. The sleeve 61 is itself journaled in a bearing 64 which is mounted in, or integral with, the overhanging head (not shown) of a sewing machine. Keyed or otherwise secured to the free end of the sleeve 61 is a gear 65 which meshes with another gear 66 on a suitably driven shaft 67. Rotatably mounted on the crank 60 is another spur gear 68 which is drivingly connected with gear 63 by means of an idler gear 69, also rotatably mounted on the crank 60. Gear 68 is provided with an extending arm 70, having a pivot or stud 71 which is connected with the needle bar 10 in the illustrated manner. A member 72 is journaled coaxially of the sleeve 61, preferably on a machined cylindrical surface 73 of the bearing 64, and provides a bearing or guide 74 for the needle bar. The guide member 72 is connected by a pin 75 or other suitable means with the free end of shaft 62, wherefore the spur gear 63 and said guide member 72 are together oscillatable about the axis of shaft 62. Axial movement of the guide member 72 on its bearing surface 73 is prevented by a collar 76 thereon which retains said guide member in engagement with a machined shoulder 77 of the bearing 64. Axial movement of the sleeve 61 in bearing 64 is prevented by a shoulder 78 of said sleeve and the previously described gear 65 which are in engagement with the opposite ends, respectively, of said bearing 64. Axial movement of shaft 62 in the sleeve 61 is prevented due to its pin connection 75 with the axially immovable guide member 72. The guide member 72 has a laterally extending arm 80 (Fig. 5) carrying a follower 81 that cooperates with a continuous cam groove 82 in a cam disc 83 which may be operated in the same manner as the previously described cam disc 46 in Fig. 4 in order to cause combined oscillation of the guide member 72 and spur gear 63.

As shown in Fig. 5, the guide or bearing 74 guides the needle bar for reciprocation radially of the gear 63, and inasmuch as the guide member 72 is journaled coaxially of the gear 63 the needle bar is guided for reciprocation radially of gear 63 in any angular position of said guide member 72. The speed ratio between the gears 68 and 63 is two to one, and the pivot 71 on arm 70 is spaced from the axis of gear 68 a distance which is equal to that between the latter axis and the axis of gear 63.

Due to the specified speed ratio and spacing of the pivot 71 from the axis of gear 68, said pivot 71 is on rotation of the crank 60 reciprocated in a linear path which is diametrical with respect to gear 63. Moreover, the reciprocation of the pivot 71 is harmonic when the crank 60 is rotated at uniform speed. This appears evident from a comparison between the illustrated crank positions 60*a* and 60*b* in Fig. 5 and an analysis of the component motions of gear 68 during its movement from position 68*a* to position 68*b*. In the assumed home position 68*a* of the gear 68 (Fig. 5), the arm 70 is radially disposed with respect to gear 63 and the pivot 71 is in the one dead center position 71*a*. If the pin 71 is to reciprocate harmonically in the linear path X—X (Fig. 5), the same must, for instance, be in coaxial alignment with gear 63 after a quarter revolution of the crank 60 from its home position 60*a* into the dot-and-dash line position 60*b*. Assuming now that crank 60 were turned a quarter revolution from the home position 60*a* into the dot-and-dash line position 60*b* without causing any rotation of gear 68 about its own axis, the arm 70 then would in the crank position 60*b* assume the dotted line position 70*x*, i. e., 180 degrees displaced from the proper dot-and-dash line position 70*b* of arm 70. However, inasmuch as the speed ratio between the gears 68 and 63 is two to one and the idler gear 69 causes rotation of gear 68 about its own axis in a direction opposite to that of crank 60, gear 68 is rotated counter-clockwise (Fig. 5) through 180 degrees while the crank 60 is rotated clockwise through 90 degrees from the home position 60*a* into the dot-and-dash line position 60*b*, with the result that arm 70 is in the proper position 70*b* when the crank is in the dot-and-dash line position 60*b*. Due to the above-explained spacing of the pivot 71 from the axis of gear 68, the former is furthermore located on the linear path X—X (Fig. 5), i. e., in coaxial alignment with gear 63, when the crank is in the dot-and-dash line position 60*b*. In any other angular position of the crank 60, th pivot 71 is at a point in the linear path X—X which indicates harmonic motion of said pivot 71 if the crank is rotated at uniform speed. This is evidenced by the dot-and-dash line position 71*c* (Fig. 5) of the pivot 71 when the crank assumes the dot-and-dash line position 60*c*. In this position, the radial line Y—Y of said crank, which passes through the axis of gear 68, intersects at Z the dot-and-dash line circle Z′ the diameter of which is equal to the stroke X′—X′ of the pivot 71 and, hence, of the needle bar 10, and the pivot position 71*c* coincides with the projection of said intersection point Z upon the linear path X—X. Thus, the position of the pivot 71 on the linear path X—X coincides in every crank position with the projection upon said path X—X of the point of intersection between the circle Z′ and the radial line Y—Y of said crank, with the result that the pivot 71 and the needle bar 10 reciprocate with a true harmonic motion on uniform rotation of the crank 60.

On combined oscillation of the guide member 72 and gear 63 by the cam disc 83, or other suitable means, gear 68 is so rotated about its own axis that the pivot 71 moves with the needle bar 10 so that the longitudinal axis of the latter always intersects the axis of gear 63. To amplify this, let it be assumed that the guide member 72 and the gear 63 are rotated counter-clockwise A degrees (Fig. 5) relative to the crank 60 in the position 60*a* so that the needle bar will be swung into a position in which its longitudinal axis coincides with the diametrical dot-and-dash line X″—X″. During this counter-clockwise rotation or rocking motion of the guide member 72 and gear 63 through A degrees, gear 68 will be rotated counter-clockwise through B degrees (Fig. 5) which equals 2A degrees due to the speed ratio of two to one between the gears 68 and 63, with the result that the arm 70 on gear 68 will be rotated into the dot-and-dash line position 70*d* (Fig. 5) in which the pivot 71 assumes the dot-and-dash line position 71*d*, i. e., a position on the new path of reciprocation X″—X″ of the needle bar 10. On uniform rotation of the crank 60 in either direction, the needle bar 10 will reciprocate with a true harmonic motion in the new path X″—X″, as will be readily understood. Thus, in the absence of the specific cam disc 83 in Fig. 5, the needle bar 10 may be swung into any desired angular disposition for harmonic reciprocation in that disposition. It is also evident that the stroke of the needle bar is always the same irrespective of its direction of reciprocation.

While in the preceding description of the modified drive shown in Figs. 5 and 6 the gear 63 is twice the size of gear 68 and one idler gear 69 is interposed between the gears 63 and 68, it is not imperative that this modified drive be so constructed in order to operate the needle bar 10 in the specified manner. For instance, the gears 68 and 63 may be of equal size or other combination as long as the ratio of two to one is maintained, as indicated diagrammatically at 68*x* and 63*x* in Fig. 6*a*, in which case two coaxial gears 69*a* and 69*b*, which are together rotatable about their common axis and are rotatably mounted on the crank 60*x*, mesh with the gears 63*x* and 68*x*, respectively.

Fig. 7 discloses another modification of the drive which departs from that shown in Figs. 5 and 6 by substituting sprockets 90 and 91 for the gears 63 and 68, respectively, and a chain 92 for the idler gear 69. The sprocket 91 has one-half the number of teeth of the sprocket 90 and the chain 92 drivingly connects both sprockets. In all other respects, the drive may be of exactly the same construction as the drive shown in Figs. 5 and 6. It is evident that the modified drive shown in Fig. 7 performs in exactly the same manner as the drive shown in Figs. 5 and 6.

The wide adaptability of the present drive is thus obvious, and it is for this reason that the present invention is not intended to be limited for use in sewing machines, this specified use being merely an example of the adaptability of the present invention.

I claim:

1. A drive comprising, in combination, a bar; a guide rotatable about an axis at right angles to the axis of the bar and guiding the latter for axial reciprocation; and a device operable to reciprocate the bar in any position of the guide and including a direct connection with said bar so that the entire driving force transmitted through said connection is always directed parallel to the bar axis, and means differently operating said device on rotation of the guide to move said connection angularly with the bar.

2. The combination in a drive as set forth in claim 1, wherein said connection with the bar is such that the entire driving force transmitted through said connection is always directed substantially coaxially of the bar.

3. In a drive of the type described, the combination of a bar; a member rotatable about its own axis; a guide rotating with the member and

guiding the bar for axial reciprocation in a plane at right angles to the axis of said member and radially of the latter in any position of the guide; an element rotatable about its own axis which is parallel to that of the member and being bodily rotatable about the axis of said member and so drivingly connected with the latter at a two to one speed ratio as to be rotated about its own axis in one direction on being bodily rotated in the opposite direction relative to said member or on rotation of the latter in said one direction; and a pivot connection between the element and bar, said connection coaxially aligning with said member during rotation of said element about its own axis.

4. In a drive of the type described, the combination of a bar; a first gear rotatable about its own axis; a guide rotating with the gear and guiding the bar for axial reciprocation in a plane at right angles to the gear axis and radially of the latter in any position of the guide; a second gear rotatable about its own axis which is parallel to that of the first gear and being bodily rotatable about the axis of said first gear and so drivingly connected with the latter at a two to one speed ratio as to be rotated about its own axis in one direction on being bodily rotated relative to said first gear in the opposite direction or on rotation of the latter in said one direction; and a pivot connection between said second gear and the bar, said connection coaxially aligning with said first gear during rotation of said second gear about its own axis.

5. The combination in a drive as set forth in claim 4, in which the guide is provided with a laterally extending arm for oscillating said guide and said first gear.

6. The combination in a drive as set forth in claim 4, in which said first gear is an internal gear and said second gear has external teeth and is in permanent mesh with the teeth of said internal gear.

7. The combination in a drive as set forth in claim 4, in which said gears have external teeth and are drivingly connected by intermediate gears which are bodily rotated with said second gear.

8. The combination in a drive as set forth in claim 4, in which said gears have external teeth and are drivingly connected by an idler gear which is bodily rotated together with said second gear, and the latter has one-half the pitch diameter of said first gear.

9. The combination in a drive as set forth in claim 4, in which said first gear is a ring gear with internal teeth and said second gear has external teeth and is in permanent mesh with the teeth of said internal gear, and said guide has a circular extension journalled on the outer periphery of said ring gear.

10. The combination in a drive as set forth in claim 4, in which said first gear is a ring gear with internal teeth and said second gear has external teeth and is in permanent mesh with the teeth of said internal gear, and said guide is provided by a casing covering said bar and gears and having a circular extension journalled on the outer periphery of said ring gear.

11. In a drive of the type described, the combination of a bar; a first sprocket rotatable about its own axis; a guide rotating with the sprocket and guiding the bar for axial reciprocation in a plane at right angles to the sprocket axis and radially of the latter in any position of the guide; a second sprocket having one half the number of teeth of said first sprocket and being rotatable about its own axis which is parallel to that of said first sprocket and bodily rotatable about the axis of said first sprocket; a chain connecting both sprockets; and a pivot connection between said second sprocket and the bar, said connection coaxially aligning with said first sprocket during rotation of said second sprocket about its own axis.

12. In a drive of the type described, the combination of a bar; an externally journalled sleeve having a crank at one end; means for driving said sleeve; a shaft journalled in said sleeve coaxially thereof; a first spur gear mounted on one end of said shaft adjacent said crank; a second spur gear rotatably carried by said crank and having its axis parallel to that of said first gear and being so drivingly connected with the latter at a two to one speed ratio as to be rotated about its own axis in one direction on rotation of said crank in the opposite direction or on rotation of said first gear in said one direction; a guide journalled coaxially of said sleeve and guiding the bar for axial reciprocation in a plane at right angles to the axis of said first gear and radially of the latter in any position of the guide, said guide being connected with the other end of said shaft for combined rotation with said first gear; and a pivot connection between said second gear and the bar, said connection coaxially aligning with said first gear during rotation of said second gear about its own axis.

13. The combination in a drive as set forth in claim 12, further comprising a bearing in which said sleeve is journalled, said bearing having an external cylindrical surface on which said guide is journalled.

14. The combination in a drive as set forth in claim 12, in which said sleeve-driving means includes two meshing gears one of which is mounted on the other end of said sleeve.

15. In a drive of the type described, the combination of a bar; an externally journalled sleeve having a crank at one end; means for driving said sleeve; a shaft journalled in said sleeve coaxially thereof; a first sprocket mounted on one end of said shaft adjacent said crank; a second sprocket rotatably carried by said crank and having its axis parallel to that of said first sprocket; a chain connecting said sprockets; a guide journalled coaxially of said sleeve and guiding the bar for axial reciprocation in a plane at right angles to the axis of said first sprocket and radially of the latter in any position of the guide, said guide being connected with the other end of said shaft for combined rotation with said first sprocket; and a pivot connection between said second sprocket and the bar, said connection coaxially aligning with said first sprocket during rotation of said second sprocket about its own axis, and said second sprocket having one-half the number of teeth of said first sprocket.

16. In a drive of the type described, the combination of a bar; means for guiding said bar for axial reciprocation; a non-rotating first spur gear having its axis extending at right angles to and intersecting the bar axis; a second spur gear rotatable about its own axis which is parallel to that of said first gear and being bodily rotatable about the axis of said first gear and so drivingly connected with the latter at a two to one speed ratio as to be rotated about its own axis in one direction on being bodily rotated in the opposite direction; and a pivot connec-

tion between said second gear and the bar, said connection coaxially aligning with said first gear during rotation of said second gear about its own axis.

17. In a drive of the type described, the combination of a bar; means for guiding said bar for axial reciprocation; a non-rotating first sprocket having its axis extending at right angles to and intersecting the bar axis; a second sprocket rotatable about its own axis which is parallel to that of said first sprocket and being bodily rotatable about the axis of said first sprocket and having one-half the number of teeth of the latter; a chain connecting both sprockets; and a pivot connection between said second sprocket and the bar, said connection coaxially aligning with said first sprocket during rotation of said second sprocket about its own axis.

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