F. H. SANDHERR.

GEARING.

APPLICATION FILED NOV. 29, 1911.

1,093,807.

Patented Apr. 21, 1914.

4 SHEETS—SHEET 1.

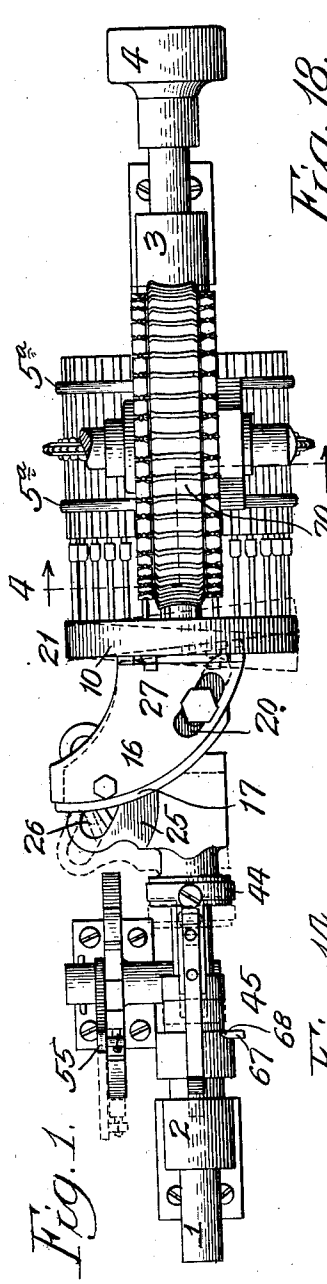


Fig. 1.

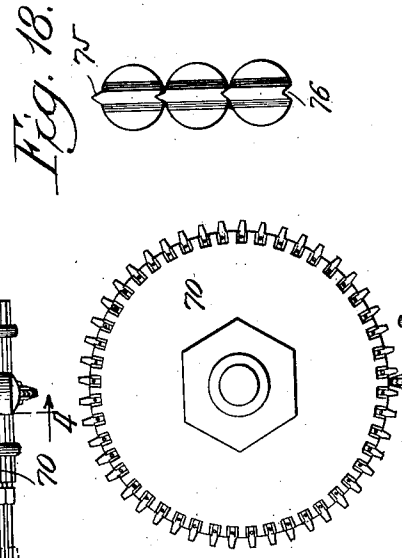


Fig. 1a.

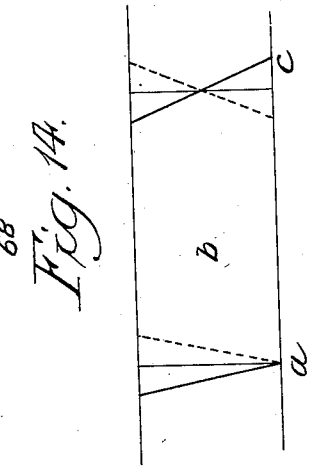


Fig. 14.

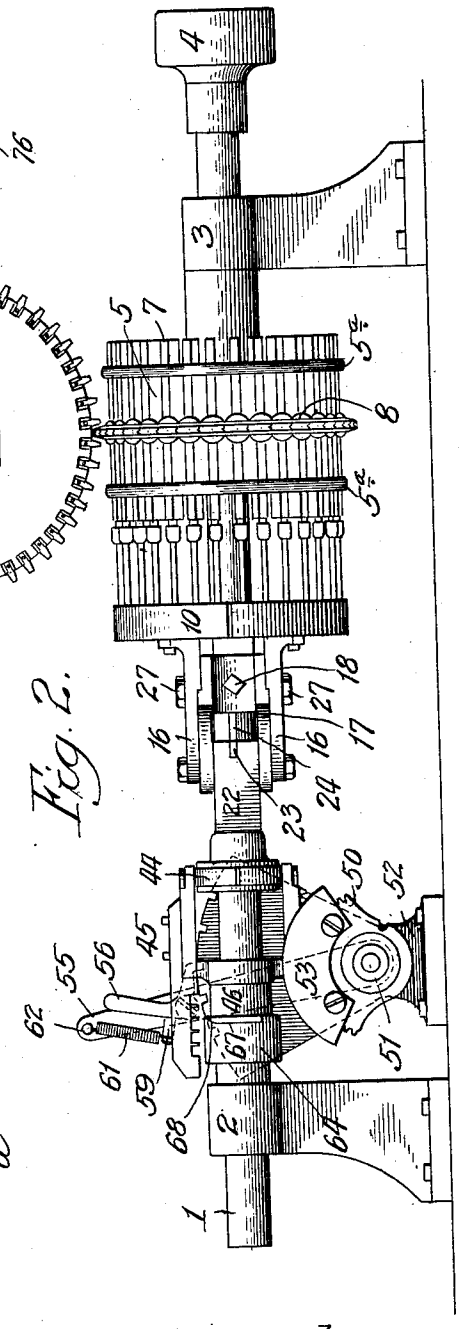


Fig. 2.

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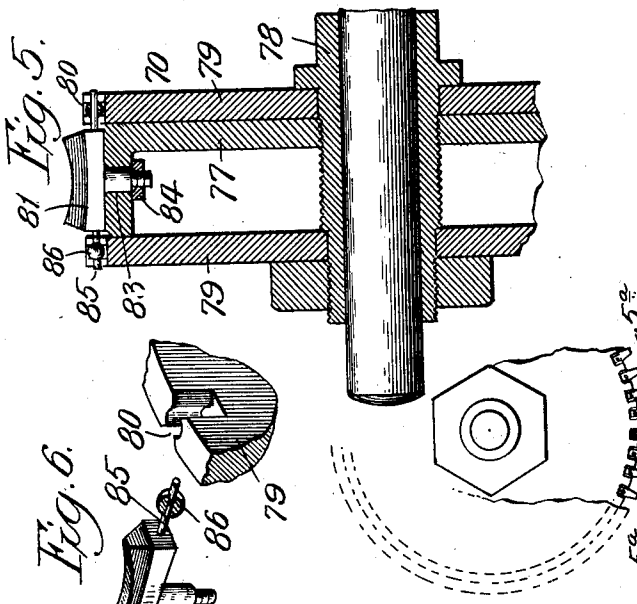


Fig. 5.

Fig. 6.

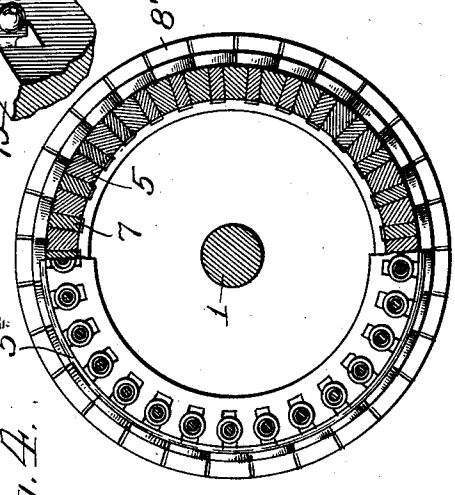


Fig. 4.

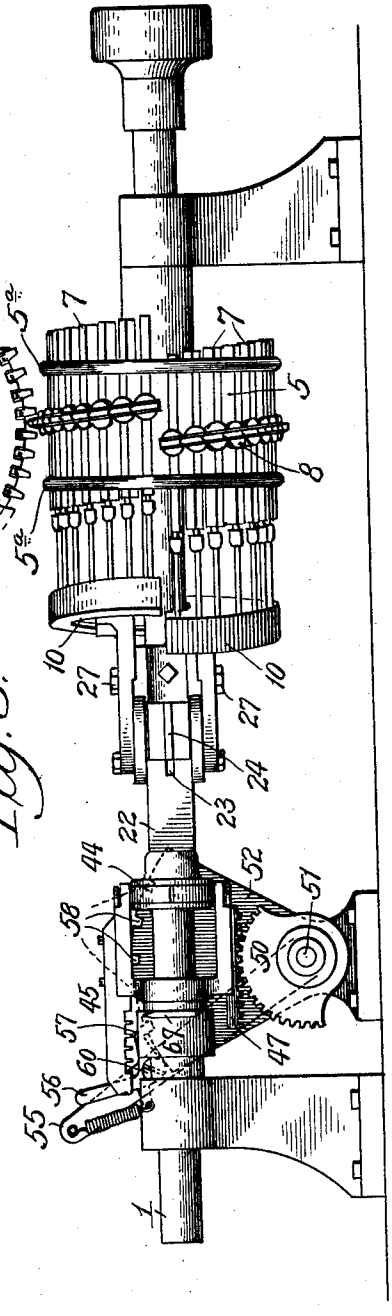


Fig. 3.

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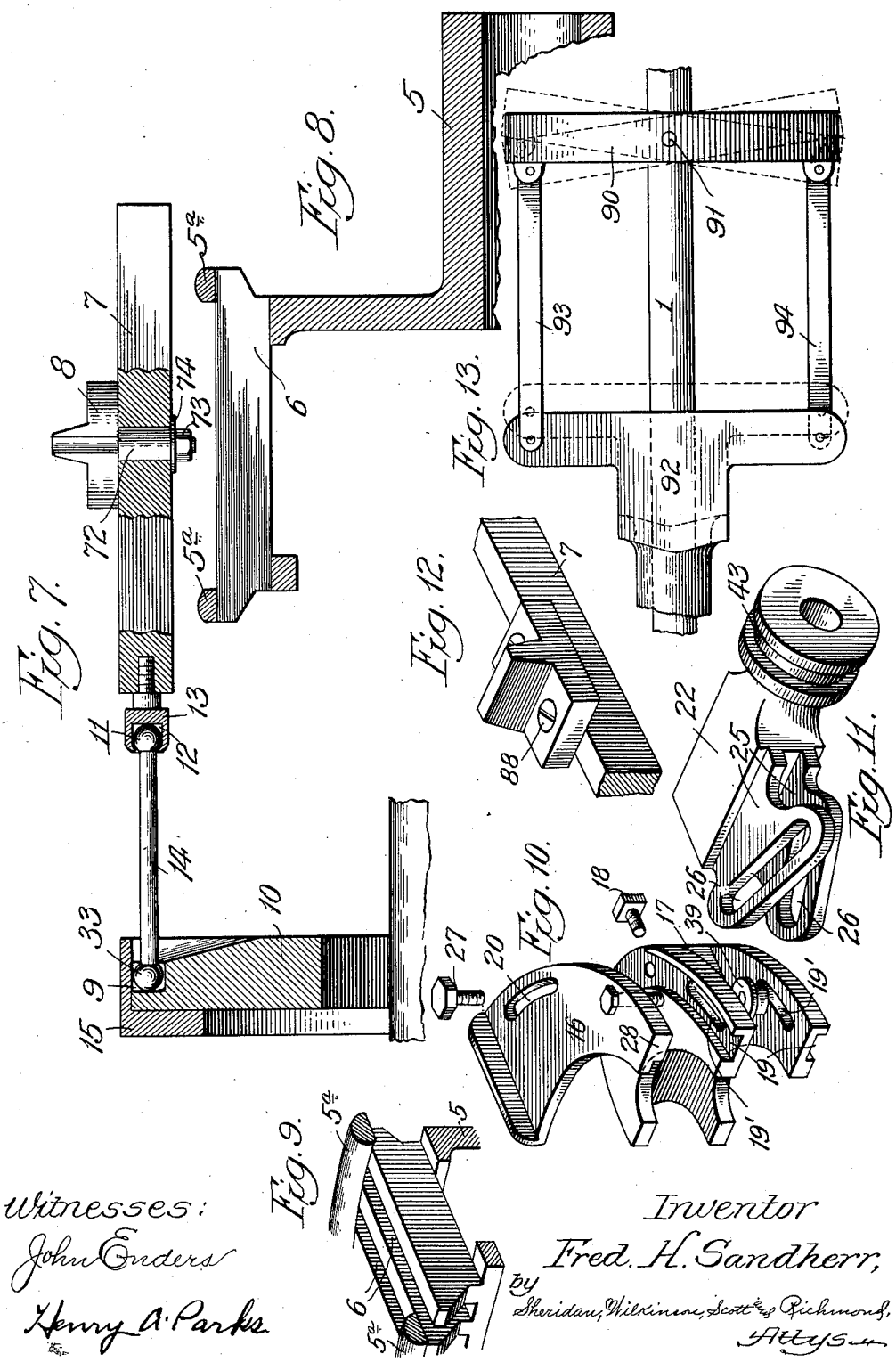
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4 SHEETS—SHEET 3.



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4 SHEETS—SHEET 4.

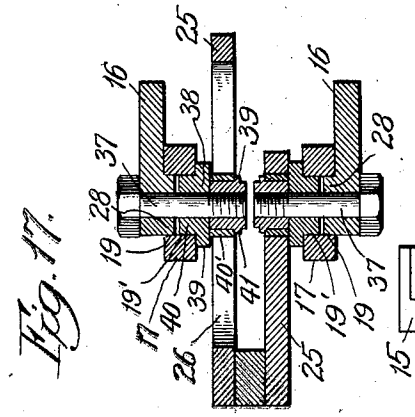


Fig. 17.

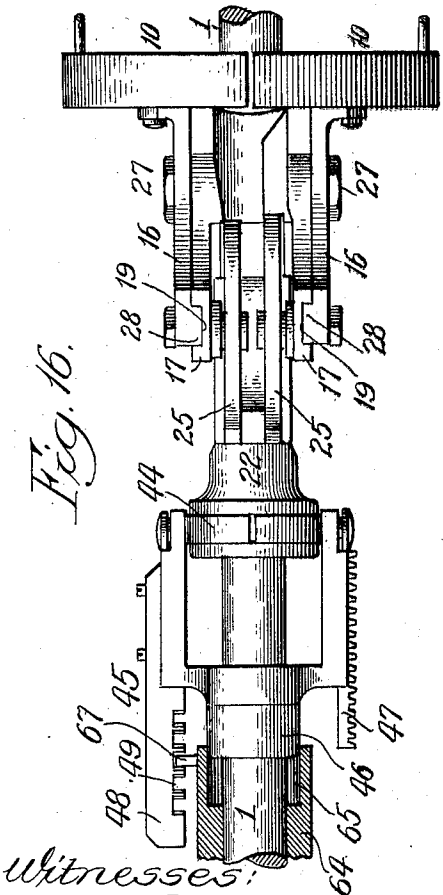


Fig. 16.

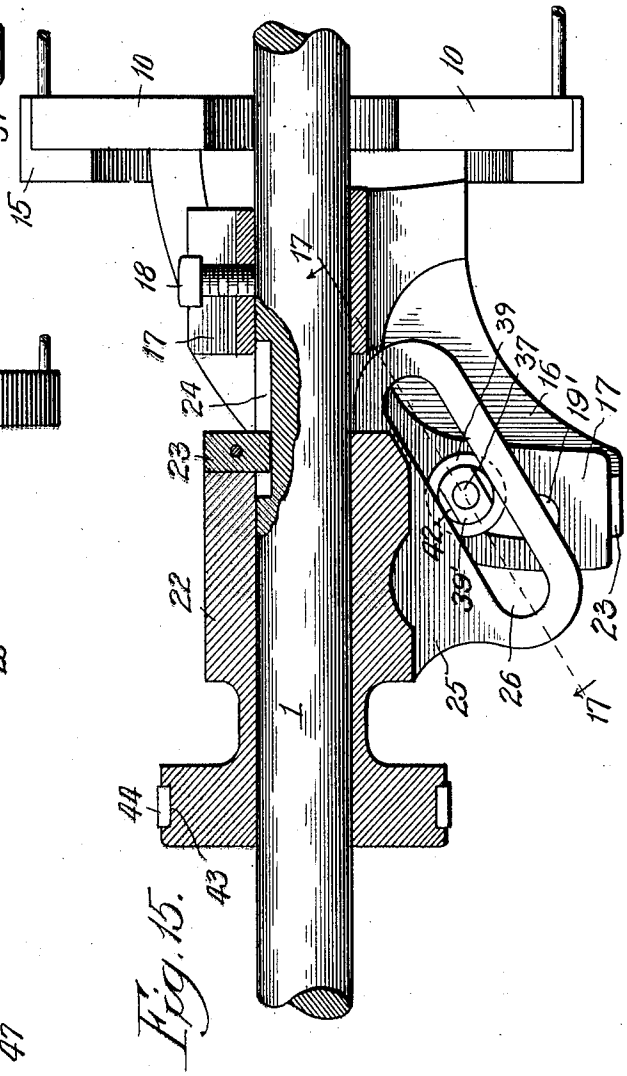


Fig. 15.

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UNITED STATES PATENT OFFICE.

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GEARING.

1,093,807. Specification of Letters Patent. **Patented Apr. 21, 1914.**

Application filed November 29, 1911. Serial No. 663,016.

To all whom it may concern:

Be it known that I, FREDERICK H. SANDHERR, a citizen of the United States, residing at the city of St. Louis, in the State of Missouri, have invented certain new and useful Improvements in Gearing, of which the following is a specification.

The object of my invention is to provide a power transmitting gearing of such form that the direction of rotation and speed of the driven member may be changed while all of the gearing is in mesh, and without the necessity of disconnecting the chain of gearing at any point or replacing a gear of one size by a gear of another size, and whereby the driving member may rotate without transmitting movement to the driven member. Broadly stated, I accomplish this purpose by means of a worm and worm wheel, the thread of the worm being so constructed that it can be adjusted to lie in a continuous circle normal to the axis, and can be adjusted to incline at different degrees in either direction. This object is accomplished by constructing the thread of the worm of a plurality of axially movable parts, and providing in connection therewith means for adjusting said parts to form a thread inclining in either direction at a variable pitch or to form a circular thread having no inclination, that is, lying in a plane normal to the axis of the worm.

The particular objects and nature of the invention will more clearly appear from the following description and claims, taken in connection with the drawings, in which—

Figure 1 is a plan view of a mechanism embodying my invention. Fig. 2 is an elevation of the same, the thread of the worm, as shown in Figs. 1 and 2, being adjusted to its inactive position, in which position movement is not communicated from the worm shaft to the worm wheel. Fig. 3 is a view in elevation corresponding to Fig. 2, and showing the worm thread adjusted to communicate movement to the worm wheel. Fig. 4 is a cross section through the worm structure on the broken line 4 4 of Fig. 1. Fig. 5 is a transverse section of part of the worm wheel. Fig. 6 is a fragmentary perspective view, showing one tooth of the worm wheel and the coöperating parts of the side rings forming part thereof. Fig. 7 is a fragmentary view, showing one of the thread sections of the worm and the connected parts. Fig. 8 is a fragmentary view, showing in axial section part of the hub of the worm wheel. Fig. 9 is a fragmentary perspective view of part of the hub of the worm. Fig. 10 is a perspective view of a bearing member and of a coöperating bearing plate forming part of the structure. Fig. 11 is a perspective view of a cross head. Fig. 12 is a perspective view, showing one method of attaching the thread sections of the worm to the slide bars. Fig. 13 is a view of a modification. Fig. 14 is a diagrammatic view, showing different methods of adjusting the worm thread. Fig. 15 is a fragmentary sectional view on the central plane indicated by the arrows 14 in Fig. 2. Fig. 16 is a fragmentary view from the side opposite that illustrated in Fig. 2. Fig. 17 is a section on the line 17—17 of Fig. 15. Fig. 18 is a detail of the worm thread sections.

The power shaft 1 is mounted in any suitable bearings, such as 2, 3, and may be provided with a pulley 4, or may receive motion directly from an electric or other motor. Fixedly mounted upon the drive shaft 1 is the hub 5 of the worm, this hub having a generally cylindrical form and being provided near its periphery with a series of longitudinal grooves or guides 6 extending parallel to the drive shaft. Seated in the guideways 6 of the worm hub are slide bars 7 which are axially movable therein and are held in place by retaining rings 5^a. Upon each of the slide bars 7 there is mounted a section 8 of the worm thread, these sections abutting against each other and extending circumferentially completely around the worm. Each of the guide bars 7 is connected to one of the head plates 10 by means of a stem 14 provided with ball heads 11 and 33 which engage sockets 12 and 9. The sockets 12 in the construction shown are formed in bearing pieces 13 screw threaded to the ends of the stems 7, and the sockets 9 extend inwardly from the outer periphery of the head plates 10, these sockets taking the form of notches having cylindrical walls. The ends 33 of the stems 14 are retained in the sockets 9 of the head plates 10 by means of keepers 15 which are secured to the head plates. In the construction illustrated there are two head plates 10 of substantially semi-circular form loosely surrounding the shaft 1 and each connected to one-half of the guide bars 7.

It will be understood that all of the guide bars 7 are similarly connected to the head

plates 10 and by the arrangement above described the slide bars are divided into two semi-circular series. It is by movement imposed upon the head plates 10 that the thread sections 8 are adjusted as above described.

Secured to each of the head plates 10, which, as stated above, loosely surround the bearing shaft 1, is a bearing plate 16, and rigidly secured to the shaft 1 between the bearing plates 16 is a bearing member 17, the bearing member 17 being secured in place by a set screw 18. The bearing member 17 is provided upon its outer faces with arcuate guide grooves 19 and arcuate slots 19′, and the bearing plates 16 are provided with arcuate slots 20. In the assembled structure the slots 19′ and 20 and guide grooves 19 lie in the arcs of circles having their centers at the point 21, one of the peripheral points of junction between the head plates 10. It will be apparent that by this arrangement the head plates 10 can move only about the point 21 as a center, the point 21 being a neutral point to which no movement is communicated. In Fig. 1 the structure is illustrated in full lines in the position which the parts occupy when the worm thread is in inactive position, that is, forming a continuous circle lying in a plane at right angles to the shaft 1. In dotted lines, however, the head plates 10 are shown in one of the positions to which they may be adjusted, the dotted line position illustrating the character of movement which the head plates have about the point 21 as a center.

In order to communicate movement to the head plates 10, thereby causing an adjustment of the worm thread, I provide a cross head 22 provided with a key 23 which engages a key slot 24 in the shaft 1. The cross head 22 is by this means non-rotatively mounted upon the shaft 1 but is permitted to reciprocate relatively thereto. The cross head 22 is provided with projecting ears 25 in which are formed oppositely inclined slots 26. Screws 27 pass through the slots 20 in the bearing plates 16 and are threaded into the bearing member 17. The engagement of the screws 27 with the slots 20, together with the engagement of the projections 28 upon the bearing plates 16 with the grooves 19 in the bearing members 17, constrain the head plates 10 to move upon the center 21 as above described. Bolts 37 serve to communicate movement from the ears 25 of the cross head to the bearing plates 16 and the head plates 10 upon which they are mounted. The bolts 37 extend through bolt holes in the plates 16 and surrounding each of the bolts is a thimble 38 provided with a flange 39 and a reduced part 40 which is received in the slot 19′ through the bearing member 17, which receives the bolt 37. The flange 39 upon the thimble 38 serves as a spacer between the member 17 and the member 25 and its flange 39 is wider than the slot 19′ and 26 in the members 17 and 25, thereby securing a bearing upon the faces of the members 17 and 25. Nuts 39′ surrounded by rollers 40′ are threaded upon the inner ends of the bolts 37 and flanges 41 upon the nuts 39 serve to keep the rollers in place. The rollers 40′ serve as an anti-friction bearing between the bolts 37 and the slots 26 of the ears 25 of the cross head. The nuts 39′ have flattened surfaces 42 to facilitate assemblage.

The cross head 22 is provided at its end remote from the worm gear with a groove 43 in which is rotatably seated a strap 44 forming part of a rack frame designated generally by the numeral 45. The shaft 1 is free to rotate within the rack frame 45. In addition to its rotatable bearing 44 upon the cross head 22 the rack frame is provided with a sleeve 46 within which the shaft 1 is also free to rotate. The rack frame 45 is provided at its lower part with a rack 47 and at its upper part with a toothed bar 48, the teeth of said bar being pointed as shown at 49 on the side toward which the shaft 1 rotates. Meshing with the rack 47 is a segmental gear 50 mounted upon a rock shaft 51 which is journaled in a plate 52 fixed to the base of the machine. The gear 50 is provided upon each side with shroud plates 53 which project radially beyond the teeth of the gear and the lower part of the rack frame 45 is received between these shroud plates, whereby the rack frame is restrained against rotation with the shaft 1 and is held in the position shown in Figs. 1, 2 and 3 of the drawings. In Fig. 3 the shroud plates are removed thereby more clearly showing the engagement of the gear 50 with the rack 47.

Secured to the rock shaft 51 is a hand lever 55 provided with a detent 56 having a tooth 57 which is adapted to enter any one of the notches 58 in the upper arcuate edge of the plate 52, thereby restraining the rock shaft and its connected gear 50 against movement. The detent 56 is pivoted at 60 to the hand lever 55 and is provided with a stud 59 which is connected by a spring 61 with a stud 62 projecting from the lever 55. The spring 61 thus serves to hold the tooth 57 of the detent 56 at the limit of downward movement permitted by its engagement with the arcuate edge of the plate 52.

Secured to the shaft 1 is a collar 64 having an annular recess 65 in which the hub 46 of the rack frame 45 is received to permit the necessary degree of movement of the rack frame. Upon the collar 64 I provide a tooth 67 pointed at the end 68 toward which the shaft 1 rotates.

The teeth 49 of the toothed positioning bar 48 are separated by distances slightly less than the pitch or distance between the teeth of the worm wheel 70, and the tooth 67 is so positioned upon the collar 64 that when it lies between any two adjacent teeth of the positioning bar 48 the thread of the worm will be adjusted either to form a complete continuous circle or will have a pitch bearing an integral ratio to the pitch of the worm wheel. When the lever 55 is adjusted to its central position with the tooth 57 of the detent 56 resting in the central notch, the worm thread is adjusted as shown in Fig. 2 to form a continuous circle, thereby permitting the power shaft to move idly and without communicating movement to the worm wheel. In the structure illustrated, movement of the lever one notch from the center imparts to the worm thread an inclination equal in one revolution to the distance between two adjacent teeth of the worm wheel, and adjustment to the second notch from the center gives the worm thread an inclination in one revolution equal to the distance between two alternate teeth of the worm wheel. The direction of rotation imparted to the worm wheel depends of course upon whether the lever 55 is moved to the right or to the left from the position shown in Fig. 2. It will be apparent that a movement of the lever 55 rocks the gear segment 50, thereby communicating a longitudinal movement to the rack frame 45, which movement is communicated from the rack frame 45 to the cross head 22. The longitudinal movement of the cross head, through the engagement of the slots 26 therein with the bolts 37 mounted upon the bearing plates 16 imparts movement to the head plates 10 upon the center 21 as previously described, and the movement of the head plates 10 being in opposite directions about the neutral point 21 breaks the continuity of the thread as shown in Fig. 2 and causes it to assume the helical form shown in Fig. 3. In case the operator moves the lever 55 to a position intermediate between the notches 58 upon the arcuate edge of the plate 52, the worm thread 8 would thereby be adjusted to a pitch not corresponding to the pitch of the worm wheel, and rotation of the shaft 1 would cause the end of the worm thread to strike against the sides of the teeth of the worm wheel. Under such circumstances the tooth 67 prevents the objectionable action referred to and automatically throws the lever 55 to a position where the tooth 57 of its detent 56 enters one of the notches 57 in the plate 52, in which position the pitch of the worm thread will bear an integral ratio to the pitch of the worm wheel. This effect is automatically brought about by the rotation of the shaft 1. If the lever 55 has been left in an intermediate position, as above described, none of the spaces between the teeth 49 of the positioning bar 48 will lie exactly opposite the tooth 67, and the pointed end of the tooth 67 will engage the tapered side of one of the teeth 49, thereby moving the rack frame 45 and cross head to a position in which the detent tooth 57 will fall into one of the notches 58 and in which position the pitch of the worm thread will bear an integral ratio to the pitch of the worm wheel.

A further function served by the tooth 67 is to prevent a change in adjustment of the pitch of the worm thread when the ends of the worm thread are adjacent the worm wheel. It will be noted that the ends of the worm thread, as shown in Fig. 3, lie opposite the point of division between the head plates 10, and the tooth 67 is mounted upon the collar 64 opposite the junction between the free ends of the head plates, that is, the ends opposite the neutral point 21. By this arrangement when the free ends of the worm thread are adjacent the worm wheel the tooth 67 lies between the teeth 49 of the positioning bar 48 thereby locking the device against adjustment. Adjustment at the time the free ends of the worm thread are adjacent the worm wheel might lead to a collision between the ends of the worm thread and the sides of the teeth upon the worm wheel, but this objectionable action is effectually prevented by the means above described.

In Fig. 7 I show one of the slide bars 7 with its connected worm thread section 8. The worm thread section 8 is provided with a stem 72 rotatably mounted in the slide bar 7 and secured against displacement by a nut 73 and washer 74. By this means each of the worm thread sections is permitted to rotate upon its stem 72 and thereby to assume an inclined position corresponding to the inclination to which the worm thread as a whole is adjusted by means of the mechanism above described. The engagement between the worm thread sections and the teeth of the worm wheel will cause the worm thread sections to automatically assume the proper position corresponding to the adjustment of the worm thread as a whole. I also preferably provide each thread section with a projection 75 engaging a depression 76 in the adjacent thread section. By this means the different thread sections are interlocked and caused to preserve proper alinement.

The structure of the worm wheel is shown in detail in Figs. 5 and 6. The central part 77 of the worm wheel is secured rigidly upon the worm wheel shaft 78 and mounted at each side of the central section 77 are freely rotatable rings 79. The rings 79 project outwardly radially beyond the central section 77 and are provided along their

outer edges with notches 80 having a substantially cylindrical contour at their central parts and flaring toward the sides of the rings. Each of the teeth 81 of the worm wheel is provided with a stud 82 which is rotatably received in an aperture 83 in the outer end of the central section 77 of the worm wheel. Nuts 84 serve to hold the teeth 81 upon the worm wheel. At each end the teeth 81 are provided with projecting studs 85, each stud having a slidable enlargement 86. In assembling, the worm wheel teeth 81 are mounted with their spherical bearings 86 lying within the cylindrical part of the notches 80 in the side rings 79. This arrangement permits the worm wheel teeth to assume automatically the proper inclination for different adjustments in the pitch of the worm.

While I prefer the rotatable adjustable mounting of the thread sections of the worm and of the teeth of the worm wheel, I have found in practice that the gearing is operative when the worm wheel is provided with rigid teeth according to the customary practice, and when the thread sections of the worm are secured rigidly to the slide bars 7 by means of screws 88 or otherwise as illustrated in Fig. 12.

In the device as above described, I have shown means for adjusting the worm thread to different pitches, the thread sections being preserved in the form of a single thread. If instead of rotating the head plates 10 upon a center 21 lying tangent to the pitch cylinder of the worm and thereby separating the thread at only one point as shown in Fig. 3, the head plates be rotated upon a central line passing through the axis of the shaft 1, the thread sections will be thrown out of alinement and instead of forming a single line or helix extending around the worm shaft they will form semi-circular parts of two distinct helices of twice the pitch caused by a corresponding adjustment of the form of the device above described.

In Fig. 13 I have illustrated a structure in which the head plates 90 are journaled upon a pin 91 passing centrally through the shaft 1. In this modification the cross head 92 may be connected by links 93 and 94 with the head plates 90, the link 93 being connected to one of said head plates and the link 94 to the other head plate. A longitudinal movement of the cross head 92 in such a structure will cause the head plates 90 to rotate in opposite directions, thereby splitting the worm thread into two parts each extending half way around the axis of the worm.

In Fig. 14 I have shown diagrammatically the adjustment of the worm thread secured by the use of the mechanism illustrated in Figs. 1 to 11, this adjustment being designated by the letter *a*, the shaft of the worm being designated by the letter *b*. At *c* I have shown the adjustment of the worm thread resulting from the use of the structure illustrated in Fig. 13. The arrangement shown in Fig. 13 might be advantageous under some circumstances as where it is desired to secure a less reduction in speed between the worm and worm wheel without unduly elongating the worm.

Various arrangements and variations in the manner of mounting the head plates and of communicating movement thereto will be apparent from the foregoing explanation of the particular embodiment of my invention illustrated in the drawings.

The description and illustration of that particular embodiment are introduced for the purpose of explaining the principle of my invention and showing one preferred form thereof, but it will be apparent that the principle of my invention may be applied in mechanisms of widely divergent form, and that my invention is not restricted to the specific mechanism illustrated and described herein.

I claim:

1. Reversing and change speed gearing comprising a continuously rotating shaft, a worm secured thereto, means operative while said worm is rotating and in mesh with a worm wheel for reversing and varying the inclination of the thread of said worm and for adjusting said thread to the form of a continuous annulus normal to the axis of said shaft, and supplemental means for automatically adjusting said thread to predetermined positions, whereby said worm may communicate movement to said worm wheel in either direction at varying speeds or may rotate idly.

2. Reversing gearing comprising a continuously rotating shaft, a worm secured thereto, means operative while said worm is rotating and in mesh with a worm wheel for reversing the inclination of the thread of said worm and for adjusting said thread to the form of a continuous annulus normal to the axis of said shaft, and supplemental means for automatically adjusting said thread to predetermined positions, whereby said worm may communicate movement in either direction to said worm wheel or may rotate idly.

3. In a device of the class described, a worm, means for adjusting the pitch of the thread of said worm, and supplemental means for automatically adjusting said thread to predetermined positions.

4. In a device of the class described, a worm, the thread of said worm consisting of a plurality of separate sections, means for adjusting said sections whereby the pitch of said thread may be varied, and supplemental means for automatically adjusting said thread to predetermined positions.

5. In a device of the class described, a worm having a thread of adjustable pitch, said thread being composed of sections adjustable axially of the worm, and means for simultaneously adjusting said sections to vary the pitch of the thread formed thereby.

6. In a device of the class described, a series of thread sections, and means to adjust said sections in a continuous circular form or in the form of a discontinuous helix.

7. In a device of the class described, a worm, the thread of said worm consisting of a plurality of separate sections, and means for adjusting said sections axially whereby the pitch of said thread may be varied while having a right hand or a left hand pitch.

8. In a device of the class described, a worm wheel, a worm in mesh therewith, means for adjusting the pitch of the thread of said worm, and means for automatically causing said adjustment to take place in steps bearing an integral ratio to the pitch of said worm wheel.

9. In a device of the class described, a worm wheel, a worm constantly in mesh therewith, means for adjusting the inclination of the thread of said worm, and means to prevent actuation of said adjusting means when the free ends of the worm thread are adjacent to said worm wheel.

10. In a device of the class described, a worm, means for adjusting the pitch of the thread of said worm by moving part of said thread axially in one direction and the other part axially in the opposite direction.

11. In a device of the class described, a shaft, a worm upon said shaft, said worm having a thread composed of a plurality of sections axially movable relatively to said shaft, a plurality of head plates surrounding said shaft and connected to said thread sections, and means for moving said head plates to vary the inclination of the worm thread formed by said sections.

12. In a device of the class described, a shaft, a worm upon said shaft, said worm having a thread composed of a plurality of sections axially movable relatively to said shaft, a plurality of head plates connected to said thread sections and mounted on said shaft, said head plates being movable about an axis tangent to the pitch cylinder of said worm thread, and means for moving said head plates to vary the pitch of said worm thread.

13. In a device of the class described, a shaft, a worm upon said shaft, said worm having a thread composed of a plurality of sections axially movable relatively to said shaft, two head plates mounted on said shaft to rotate therewith, but movable relative to said shaft about an axis tangent to the pitch cylinder of said worm thread, and means for moving said head plates to vary the pitch of said worm thread.

14. In a device of the class described, a shaft, a worm upon said shaft, said worm having a thread composed of a plurality of sections axially movable relatively to said shaft, two semi-circular head plates surrounding said shaft and connected to said thread sections, a cross head reciprocably but not rotatively mounted on said shaft, a bearing member fixedly mounted on said shaft, inter-engaging arcuate guides upon said head plates and bearing member, and inter-engaging cams and guides upon said cross head and head plates whereby reciprocation of said cross head causes said head plates to move about an axis tangent to the pitch cylinder of said worm thread at one of the meeting points between said head plates thereby varying the pitch of said thread.

15. In a device of the class described, a worm wheel, a shaft, a worm upon said shaft, said worm having a thread composed of a plurality of sections axially movable relatively to said shaft, two semi-circular head plates surrounding said shaft and connected to said thread sections, a cross head reciprocably but not rotatively mounted on said shaft, a bearing member fixedly mounted on said shaft, inter-engaging arcuate guides upon said head plates and bearing member, inter-engaging cams and guides upon said cross head and head plates whereby reciprocation of said cross head causes said head plates to move about an axis tangent to the pitch cylinder of said worm thread at one of the meeting points between said head plates thereby varying the pitch of said thread, means for moving said cross head, and a lock for preventing movement of said cross head when the part of said thread diametrically opposite the center of movement of said plates is adjacent said worm wheel.

16. In a device of the class described, a worm wheel, a shaft, a worm upon said shaft, said worm having a thread composed of a plurality of sections axially movable relatively to said shaft, two semi-circular head plates surrounding said shaft and connected to said thread sections, a cross head reciprocably but not rotatively mounted on said shaft, a bearing member fixedly mounted on said shaft, inter-engaging arcuate guides upon said head plates and bearing member, interengaging cams and guides upon said cross head and head plates whereby reciprocation of said cross head causes said head plates to move about an axis tangent to the pitch cylinder of said worm thread at one of the meeting points between said head plates thereby varying the pitch of said thread, means for moving said cross head, means for preventing movement of said cross head when the part of said thread

diametrically opposite the center of movement of said plates is adjacent said worm wheel and for automatically moving said cross head from an intermediate position to a point where the pitch of said worm thread shall bear an integral ratio to the pitch of said worm wheel.

17. In a device of the class described, a shaft, a worm upon said shaft, said worm having a thread composed of a plurality of sections axially movable relatively to said shaft, two semi-circular head plates surrounding said shaft and connected to said thread sections, a cross head reciprocably but not rotatively mounted on said shaft, a bearing member fixedly mounted on said shaft, said head plates and bearing member having inter-engaging arcuate guides, said cross head and head plates having inter-engaging cams and guides whereby reciprocation of said cross head causes said head plates to move about an axis tangent to the pitch cylinder of said worm thread at one of the meeting points between said head plates thereby varying the pitch of said thread, a rock shaft, a hand lever and gear segment secured thereto, and a rack secured to said cross head and engaging said gear segment.

18. In a device of the class described, a worm wheel, a shaft, a worm upon said shaft, said worm having a thread composed of a plurality of sections axially movable relatively to said shaft, two semi-circular head plates surrounding said shaft and connected to said thread sections, a cross head reciprocably but not rotatively mounted on said shaft, a bearing member fixedly mounted on said shaft, said head plates and bearing member having inter-engaging arcuate guides, said cross head and head plates having inter-engaging cams and guides whereby reciprocation of said cross head causes said head plates to move about an axis tangent to the pitch cylinder of said worm thread at one of the meeting points between said head plates, thereby varying the pitch of said thread, a rock shaft, a hand lever and gear segment secured thereto, a rack secured to said cross head and engaging said gear segment, a positioning bar secured to said cross head and having teeth spaced apart a distance equal to the pitch of said worm wheel, and a cam fixed to said shaft and adapted by engaging said teeth to move said cross head from an intermediate position to a position in which the pitch of said worm thread shall bear an integral ratio to the pitch of said worm wheel.

19. In a device of the class described, a worm wheel, a shaft, a worm upon said shaft, said worm having a thread composed of a plurality of sections axially movable relatively to said shaft, two semi-circular head plates surrounding said shaft and connected to said thread sections, a cross head reciprocably but not rotatively mounted on said shaft, a bearing member fixedly secured to said shaft, said head plates and bearing member having inter-engaging arcuate guides, said cross head and head plates having inter-engaging cams and guides whereby reciprocation of said cross head causes said head plates to move about an axis tangent to the pitch cylinder of said worm thread at one of the meeting points between said head plates thereby varying the pitch of said thread, a sleeve reciprocably mounted on said shaft and restrained from rotation therewith, said sleeve engaging said cross head to communicate axial movement thereto without restraining rotation of said cross head, a rack bar and toothed positioning bar secured to said sleeve, a rock shaft, a hand lever and gear segment secured thereto, said gear segment meshing with said rack bar, and a cam fixed to said shaft and adapted by engaging the teeth of said positioning bar to move said sleeve and cross head from an intermediate position to a position in which the pitch of said worm thread shall bear an integral ratio to the pitch of said worm wheel.

20. In a device of the class described, a worm having a thread composed of a plurality of axially adjustable sections, each of said sections being pivotally mounted.

21. In a device of the class described, a worm having a thread composed of a plurality of axially adjustable sections, each of said sections being pivotally mounted, said thread sections having inter-engaging parts.

22. In a device of the class described, a worm having a thread composed of a plurality of axially adjustable sections, each of said sections being pivotally mounted, said thread sections having inter-engaging projections and sockets.

23. In a device of the class described, a worm comprising a hub, a plurality of axially adjustable slide bars mounted thereon, and a thread composed of a plurality of sections pivotally mounted on said slide bars.

24. In a device of the class described, a worm comprising a hub, a plurality of axially adjustable slide bars mounted thereon, and a thread composed of a plurality of sections pivotally mounted on said slide bars, said thread sections having inter-engaging projections and sockets.

In testimony whereof, I have subscribed my name.

FRED. H. SANDHERR.

Witnesses:
WM. F. MARTIN,
JOHN W. GANNETT.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."