K. ALQUIST.

GEARING.

APPLICATION FILED JAN. 9, 1918.

1,351,318. Patented Aug. 31, 1920.

Fig.1.

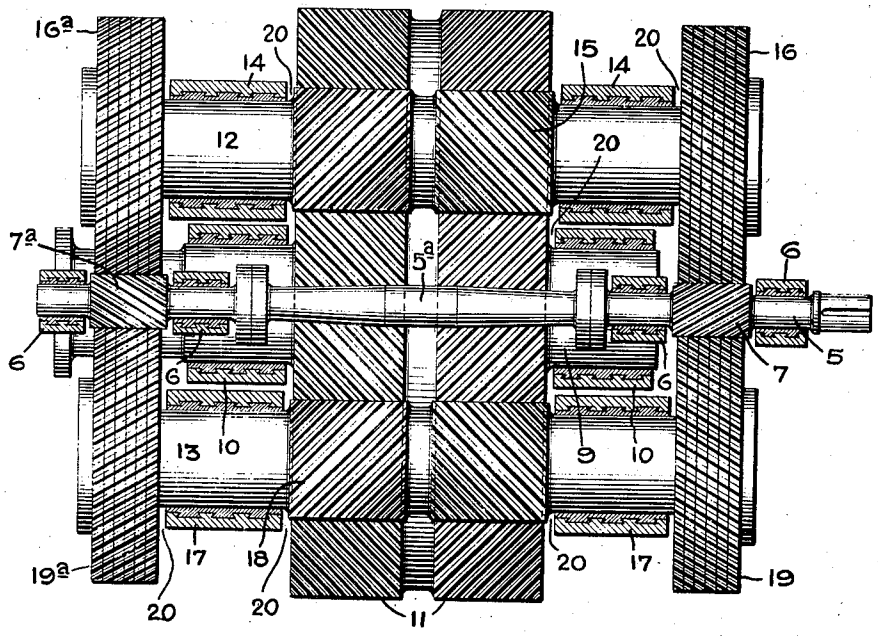


Fig.2.

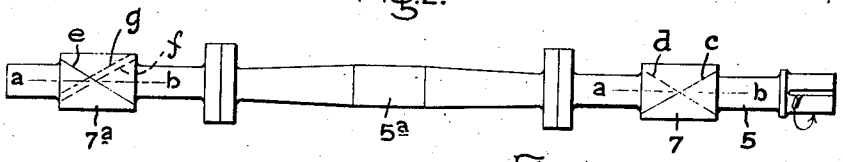


Fig.3.

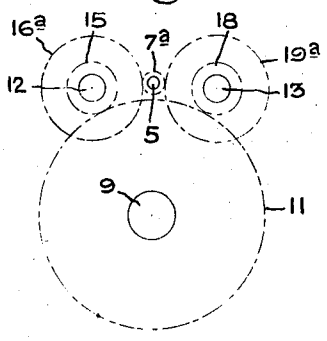


Fig.4.

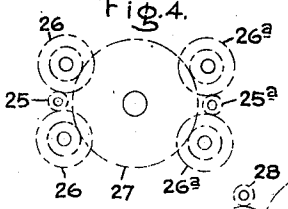
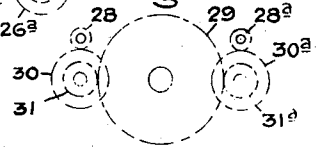


Fig.5.



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His Attorney.

UNITED STATES PATENT OFFICE.

KARL ALQUIST, OF SCHENECTADY, NEW YORK.

GEARING.

1,351,318. Specification of Letters Patent. Patented Aug. 31, 1920.

Application filed January 9, 1918. Serial No. 210,955.

To all whom it may concern:

Be it known that I, KARL ALQUIST, a subject of the King of Sweden, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Gearing, of which the following is a specification.

The present invention relates to gearing, and while it is applicable to gearing for either speed reduction or multiplication, the more general field is for speed reduction, and as a matter of convenience the invention is described in connection with reduction gearing, but it will be understood that it is not necessarily limited thereto.

One object of my invention is to provide an improved structure in a double reduction gearing of the double or parallel drive type which will automatically take care of any slight inaccuracies in the bearing alinements and in the tooth structure and maintain an equal division of the load between the sets of intermediate gear wheels. By a double or parallel drive type of gearing I mean a gearing in which the load is transmitted from the driving shaft to the driven shaft through a plurality of sets of intermediate gear wheels which operate in parallel to transmit the load, each set comprising a high speed gear wheel and a low speed pinion mounted in fixed angular relation to each other on the same shaft. The high speed gear wheel and the low speed pinion may be both fixed directly to the shaft, or one of them may be connected thereto through a suitable coupling which will permit of more or less axial adjustment.

Another object of my invention is to provide an improved structure or arrangement in double helical gearing wherein the two parts or halves of the high speed pinion are so connected together that they can adjust themselves relatively to each other to take care of inequalities in the bearing alinements and in the tooth structures.

A further object of my invention is to provide an improved gearing arrangement which is compact, symmetrical, well balanced and economical to build, and as to these features of my invention they may be embodied in a gearing of the double drive type referred to above, or in a gearing of the single drive type, as will appear more fully hereinafter.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying specification and the claims appended thereto.

In the drawing, Figure 1 may be considered as being either a plan view or a side elevation of a gearing embodying my invention; Fig. 2 is a diagrammatic view of a high speed pinion which illustrates the operation of the invention; Fig. 3 is a diagrammatic end view of the gearing, the driving pinion being shown vertically above the driven gear wheel, and Figs. 4 and 5 are diagrammatic end views illustrating different arrangements of gearing.

Referring to the drawings, Figs. 1, 2 and 3, 5 indicates a high speed shaft carried in bearings 6 and having mounted on it a high speed pinion of the double helical or herringbone type, the two parts or halves of which are indicated at 7 and 7^a. The part 7 has single helical teeth which run in one direction and the part 7^a has single helical teeth which run in the opposite direction; *i. e.*, one part has right-hand helical teeth and the other left-hand helical teeth. The two parts 7 and 7^a of the high speed pinion are so arranged or connected to each other that either is capable of sidewise adjustment or movement relative to the other, and to this end I preferably make the shaft 5 of considerable length and locate the pinion parts some distance apart thereon so that there is a length of shaft between them. The sidewise adjustment may then take place either by a shifting of the angular position of the shaft as a whole, or by a slight flexing of it; or the adjustment may be accomplished by a combination of both. In any event, the actual sidewise movement is very slight and the exact means by which it occurs is not material to the invention. In the present instance I have shown the shaft 5 as comprising a separate intermediate shaft length 5^a, but the shaft may, of course, be made all in one piece. There are preferably four bearings 6, two adjacent each pinion part, and to permit of the sidewise movement referred to, the bearings may be made slightly over size so as to provide a clearance between the shaft and the bearing surfaces, or the bearings themselves may be made adjustable sidewise. 9 indicates a driven shaft carried in bearings 10 and having

mounted thereon the low speed gear wheel 11. Power is transmitted from the high speed pinion parts 7 and 7ª to the low speed gear wheel through two sets of intermediate gear wheels which transmit the load in parallel, each such set comprising a shaft carrying a high speed gear wheel which meshes with the high speed pinion, and a low speed pinion which meshes with the low speed gear wheel. 12 indicates the shaft of one of the intermediate sets and 13 the shaft of the other. Shaft 12 is mounted in bearings 14 and carries a low speed pinion 15 and a high speed wheel which comprises two parts or halves 16 and 16ª, and shaft 13 is mounted in bearings 17 and carries a low speed pinion 18 and high speed gear wheel which comprises two parts 19 and 19ª. The pinion parts 7 and 7ª and the gear wheels 16, 16ª and 19, 19ª form the high speed end of the gearing. The wheels 16, 16ª and 19, 19ª have helical teeth so cut as to mesh with pinion parts 7 and 7ª and such pinions parts are balanced between them so that there is but little pressure on the bearings 6. The gear wheels 16, 16ª and 19 19ª are preferably of the elastic type invented by me, wherein each is made up of a plurality of disks, plates or laminae fixed at their central portions on a common support or shaft and slightly spaced apart at their peripheries to permit of axial yielding under tooth pressure. The pinions 15 and 18 and the gear wheel 11 form the low speed end of the gearing and they are preferably of the double helical or herringbone type as shown. Between all the gear wheels and pinions and the bearings for the shafts, which carry them, are clearances as indicated at 20 to permit of axial shifting or adjustment of the shafts in their bearings.

The pinion part 7 and gear wheel parts 16 and 19 are arranged on one side of the low speed end of the gearing, and the pinion part 7ª and gear wheel parts 16ª and 19ª are arranged on the other side thereof. By this arrangement the gear wheel parts 16 and 16ª are located on shaft 12 on opposite sides of the pinions 15 and the gear wheel parts 19 and 19ª are located on shaft 13 on opposite sides of pinions 18 as shown.

By the above described arrangement I provide a gearing which makes possible a perfect division of load between the two intermediate sets of gear wheels 15, 16, 16ª and 18, 19, 19ª. This will be understood best by reference to Fig. 2. In this figure the pinion parts 7 and 7ª are to be considered as being shown in side elevation, the lines *a*, *b*, indicating a plane through the pitch lines; *i. e.*, the lines of engagement between the teeth of pinion parts 7 and 7ª and the teeth of gear wheels 16, 16ª and 19, 19ª. The gear wheel parts 16 and 19 engage the pinion part 7 on opposite sides of the shaft 5, and the full line *c* indicates a tooth on the near side of pinion part 7 with which a tooth of gear wheel part 19 engages and the dotted line *d* indicates a tooth on the far side of pinion part 7 with which a tooth of gear wheel part 16 engages. The other teeth are omitted for the sake of clearance, but it will be understood that they may be represented by lines parallel to the lines *c* and *d*. In a similar manner the full line *e* indicates a tooth on the near side of pinion part 7ª and the dotted line *f* a tooth on the far side, such teeth meshing with teeth of gear wheel parts 19ª and 16ª respectively.

Now, as is well understood in connection with double helical gearing, the high speed pinion shaft 5 will automatically adjust itself by axial movements to maintain the teeth of pinion parts 7 and 7ª as far as possible in correct engagement with the teeth of gear wheel parts 16, 16ª, 19 and 19ª, and it is always possible by such axial adjustment to bring the pinion parts into engagement with at least three of the gear wheel parts. The pinion can then be brought into engagement with the fourth gear wheel part by a slight sidewise movement of a pinion part coupled with a slight axial and turning movement. It will be understood that by a "sidewise movement" I mean a movement of the pinion parts out of axial alinement by a slight amount. This will be better understood by considering the following instance. Assume that in Fig. 2 the teeth *c*, *d* and *e* are in contact along the pitch lines *a*, *b*, with the teeth of gear wheel parts 19, 16 and 19ª respectively, but that the teeth *f* as represented by the dotted line are not in contact with the teeth of gear wheel part 16ª, there being a slight clearance space between them. This is indicated in Fig. 2 where *g* represents a tooth of gear wheel part 16ª. Now if the pinion part 7ª be moved sidewise in a direction toward the top of the sheet according to Fig. 2 by an amount equal to one-half the clearance space between *f* and *g* then the teeth of pinion part 7ª will be out of engagement with the teeth of both gear wheel parts 16ª and 19ª by an equal amount, since the movement brings the pinion part toward gear wheel part 16ª and away from gear wheel part 19ª. It will be then brought into engagement with both of them by an axial movement coupled with a turning movement brought about by the driving torque on the pinion part 7.

It will be understood that inequalities in the division of the load between the two sets of intermediate gear wheels may be due to slight inaccuracies in the gear teeth or in the bearing alinements. Inaccuracies in the bearing alinements may be due to their not having been exactly alined originally, or

may be occasioned, for example, by wear or by a twisting of the gearing casing. This latter is particularly likely to occur when the gearing is located on a ship due to the strains to which the ship is subjected in operation.

From a consideration of the foregoing it will be seen that any small deviation from the true position of the gear wheel which may take place while the gearing is running and which may result in unequal meshing between pinion parts 7 and 7ª and the gear wheel parts 16, 19 and 16ª, 19ª respectively, and unequal division of the load, can be taken care of by slight sidewise movement of one of the pinion parts 7 or 7ª coupled with an axial and turning movement of the pinion shaft 5. It will be appreciated, of course, that these movements are very slight, and that during operation of the gearing such movements are continually taking place. Correct meshing of the gear wheels and equal division of the load between the two intermediate sets of the gear wheels is accordingly always assured.

It will be understood that the high speed pinion and intermediate gear wheels may be arranged at any suitable or desired point around the periphery of the driven gear wheel. In Fig. 3 the pinion and intermediate gear wheels are shown as being arranged above the driven gear wheel 11.

In Fig. 4 is shown an arrangement wherein the high speed driving pinion 25 and the two sets of intermediate gear wheels 26 are arranged at one side of a driven gear wheel 27. This arrangement is of advantage where it is desired to utilize two pinions to drive a single driven gear wheel, as with such an arrangement the driving pinion and intermediate gear wheels may be duplicated on the opposite side of the driven gear wheel 27, as indicated at 25ª and 26ª.

Referring now particularly to the symmetrical arrangement of the gearing, it will be seen that the dividing of the high speed end of the gear into two parts, one placed on each side of the low speed end gives a compact, symmetrical and balanced gearing structure. Furthermore, with such an arrangement the gear wheel parts 16, 16ª, 19 and 19ª may with advantage be overhung on the ends of the shafts 12 and 13 so that only two bearings are required for each of these shafts, thus saving a number of bearings and reducing the cost of manufacture. The arrangement also insures a balanced distribution of the weight of the intermediate gear wheels relatively to the transverse central plane of the low speed gear wheel. This is of particular advantage in a gearing intended to be reversed, as a marine gearing, since there will be no tendency upon reversal for the low speed pinions to change their parallelism with the low speed wheel and a good alinement is thus maintained. The arrangement furthermore insures a symmetrical loading of the low speed pinions 15 and 18 since power is transmitted to them from each end of the shaft.

As to this symmetrical arrangement of gearing, it will be clear that it may be utilized with advantage in connection with a single drive type of gearing in which the load is transmitted from the driving shaft to the driven shaft by a single set of intermediate gear wheels, as well as with the double drive arrangement shown, and in Fig. 5 I have illustrated diagrammatically such an arrangement. In this figure, 28 is a high speed pinion driving a gear wheel 29 through the intermediate set of gearing comprising high speed wheel 30 and low speed pinion 31. The pinion 28 and high speed gear wheel 30 are divided into two parts placed on opposite sides of the low speed end of the gearing comprising low speed pinion 31 and gear wheel 29 in the same manner as shown in Fig. 1. In other words, the arrangement is substantially the same as is shown in Fig. 1, with the exception that one of the intermediate sets of gear wheels through which power is transmitted from the pinion to the driven gear wheel has been omitted. If desired, in the arrangement shown in Fig. 5, the drive may be duplicated on the opposite side of the gear wheel 29 as indicated at 28ª, 30ª and 31ª. Such an arrangement may be utilized, for example, where it is desired to drive a single shaft from two prime movers, for example, a high pressure and a low pressure turbine.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In a gearing, the combination of a high speed pinion comprising two parts, a low speed gear wheel, gearing means through which power is transmitted between said pinion parts and the low speed gear wheel, and means connecting said pinion parts together so arranged that such parts can adjust themselves relatively to each other by moving sidewise out of axial alinement.

2. In a gearing, the combination of a pinion member having right hand helical teeth thereon, a pinion member having left hand helical teeth thereon, a low speed gear wheel, intermediate gearing means through which power is transmitted between the pinion members and the low speed gear

wheel, and means connecting said pinion members together so arranged that the pinion members can adjust themselves relatively to each other by moving sidewise out of axial alinement.

3. In a gearing, the combination of a pinion member having right hand helical teeth thereon, a pinion member having left hand helical teeth thereon, a low speed gear wheel, intermediate gearing means through which power is transmitted between the pinion members and the low speed gear wheel, and a length of shaft connecting said pinion members together so arranged that the pinion members can adjust themselves relatively to each other by moving sidewise out of axial alinement.

4. In a gearing, the combination of a high speed pinion comprising two parts, a low speed gear wheel, and two gearing means through which power is transmitted between the pinion parts and the low speed wheel, said pinion parts being arranged to move sidewise out of axial alinement.

5. In a gearing, the combination of a pinion member having right-hand helical teeth thereon, a pinion member having left-hand helical teeth thereon, a low speed gear wheel, and intermediate gear wheels through which power is transmitted in parallel between the pinion members and low speed gear wheel, said pinion members being arranged to move sidewise out of axial alinement.

6. In a gearing, the combination of a pinion member having right-hand helical teeth thereon, a pinion member having left-hand helical teeth thereon, a low speed gear wheel, intermediate gear wheels through which power is transmitted in parallel between the pinion members and low speed gear wheel, and means connecting said pinion members together so arranged that the pinion members can adjust themselves relatively to each other by moving sidewise out of axial alinement.

7. In a gearing, the combination of a shaft, a pinion member comprising two parts, means connecting said parts together so arranged that said parts can adjust themselves relatively to each other by moving sidewise out of axial alinement, a gear wheel, and intermediate gearing members which transmit power between said pinion parts and said gear wheel.

8. In a gearing, the combination of a high speed shaft having two gearing members thereon, one of which has right hand helical teeth and the other left hand helical teeth, means connecting said parts together so arranged that said parts can adjust themselves relatively to each other by moving sidewise out of axial alinement, a low speed gear wheel, and two sets of intermediate gear wheels which transmit the load between said gearing members and the low speed gear wheel, each of said intermediate sets comprising a low speed pinion which meshes with the low speed gear wheel, and a high speed gear wheel which meshes with one of the gearing members, said gearing members being balanced between said high speed gear wheels.

9. In a double reduction gearing, the combination of a low speed gear wheel, a low speed pinion meshing therewith, a shaft for said pinion having projecting ends, a high speed gear wheel of the double helical type having its two parts mounted on the ends of said shaft, and a shaft carrying spaced pinion members which mesh with the parts of said high speed wheel, the length of shaft between said pinion members being flexible whereby said members can move sidewise out of axial alinement.

10. In a double reduction gearing, the combination of a low speed gear wheel, a low speed pinion meshing therewith, a shaft for said pinion having overhung ends, a high speed gear wheel of the double helical type having its two parts mounted on the ends of said shaft, and a shaft carrying spaced pinion members which mesh with the parts of said high speed wheel, the length of shaft between said pinion members being flexible whereby said members can move sidewise out of axial alinement.

11. In a gearing, the combination of a low speed gear wheel, two low speed pinions meshing therewith, shafts for said pinions having overhung ends, high speed gear wheels mounted on the overhung ends of said shafts, and a shaft carrying pinion members which mesh with said high speed gear wheels, said pinion members being balanced between said gear wheels and having right and left-hand helical teeth respectively.

12. In a gearing, the combination of a low speed gear wheel, two low speed pinions meshing therewith, shafts upon the central portions of which said pinions are mounted, a high speed gear wheel of the double helical type mounted on each of said shafts, said high speed gear wheels being divided into two parts, one located on each side of the low speed pinions, and a high speed pinion of the double helical type, the two parts of which mesh with the parts of said high speed wheels, said two pinion parts being arranged so that one may move sidewise out of axial alinement with the other.

13. In a gearing, the combination of a low speed gear wheel, two low speed pinions meshing therewith, shafts upon the central portions of which said pinions are mounted, a high speed gear wheel of the double helical type mounted on each of said shafts, said high speed gear wheels being divided into two parts, one located on each side of the

low speed pinions, a high speed pinion of the double helical type, the two parts of which mesh with the parts of said high speed wheels, and a length of shaft connecting together said two pinion parts, the arrangement being such that said shaft may flex to permit said pinion parts to move out of axial alinement.

14. In combination, a low speed gear wheel, and means for driving it comprising low speed pinions which mesh with said gear wheel on opposite sides thereof, shafts for said pinions which project beyond the ends of the pinions, gear wheels on the ends of said shafts, a driving pinion for the gear wheels on each of said shafts, which driving pinion comprises two parts one meshing with a gear wheel at each end of a shaft, and means connecting said driving pinion parts together so that they can adjust themselves relatively to each other by moving sidewise out of axial alinement.

15. In combination, a low speed gear wheel, and means for driving it comprising low speed pinions which mesh with said gear wheel, shafts for said pinions which project beyond the ends of the pinions, single helical high speed gear wheels mounted on the ends of said shafts, single helical high speed pinion members meshing with said high speed gear wheels, and means connecting said pinion members together so arranged that they can adjust themselves relatively to each other by moving sidewise out of axial alinement.

16. In combination, a low speed double helical gear wheel, and means for driving it comprising double helical low speed pinions which mesh with said gear wheel on opposite sides thereof, shafts for said pinions which project beyond the ends of the pinions, single helical gear wheel members on the ends of said shafts, single helical pinion members meshing with the gear wheel members on each of said shafts, and means connecting said single helical pinion members together so they can adjust themselves relatively to each other by moving sidewise out of axial alinement.

In witness whereof I have hereunto set my hand this seventh day of January, 1918.

KARL ALQUIST.