K. ALQUIST.

GEARING.

APPLICATION FILED JULY 3, 1915.

1,165,830. Patented Dec. 28, 1915.

Fig.1.

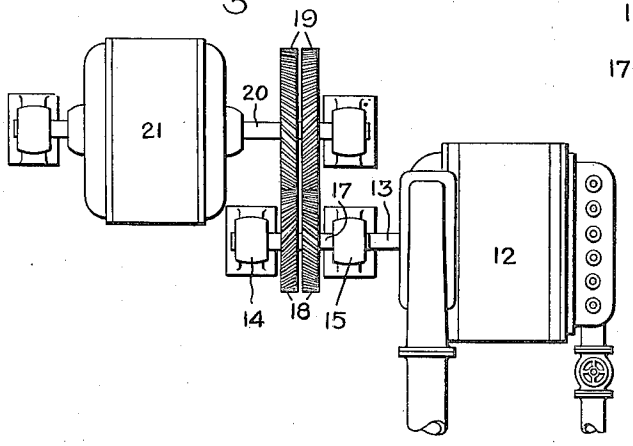


Fig.2.

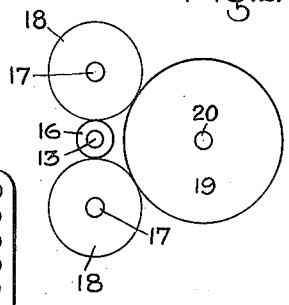


Fig.3.

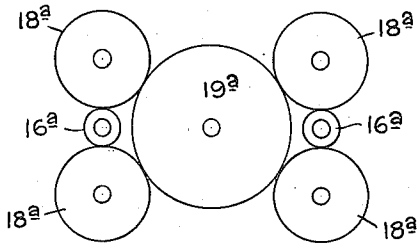


Fig.4.

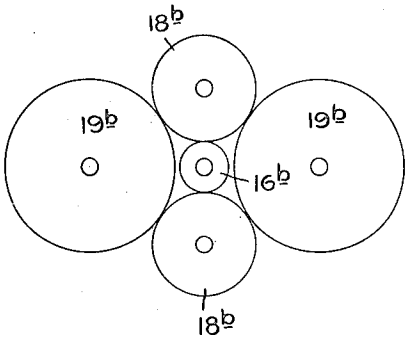


Fig.6.

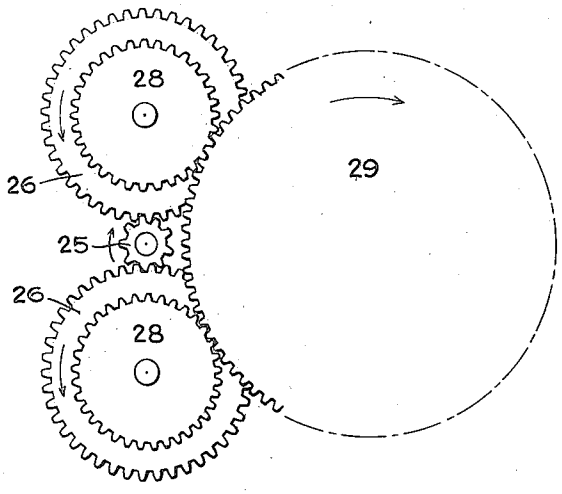
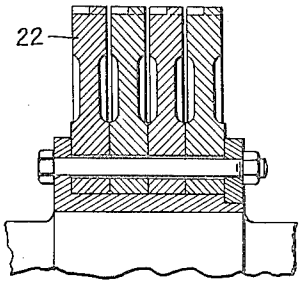


Fig.5.



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by Albert G. Davis
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UNITED STATES PATENT OFFICE.

KARL ALQUIST, OF SCHENECTADY, NEW YORK.

GEARING.

1,165,830. Specification of Letters Patent. Patented Dec. 28, 1915.

Application filed July 3, 1915. Serial No. 37,979.

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 power transmission by means of spur gearing and is a continuation in part of my applications Serial No. 758,825, filed April 4, 1913, and Serial No. 812,812, filed January 17, 1914.

The invention is applicable to gearing for either speed reduction or multiplication, but 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.

The invention relates more particularly to high speed gearing intended to transmit large loads with relatively great speed reduction, and may be embodied in connection with single reduction gearing, or double, or greater reduction gearing. It comprises the introduction between the driving and driven gear-wheels of two elastic or flexible gear-wheels arranged in parallel relation to each other and through which the load is transmitted. In the case of single reduction gearing they are introduced directly between the driving and driven elements, while in the case of double or greater reduction they are introduced at a suitable point in the train of gearing, as will appear more fully hereinafter.

In power transmission by means of spur gearing of any considerable power and speed reduction it is, of course, desirable and advantageous to use single reduction gearing when possible, as it is simpler to construct, but in actual practice there is soon reached a limit beyond which the ordinary single reduction type is unsatisfactory and more expensive to construct, and it becomes necessary to resort to a double reduction. On the one hand there is in most cases a limit to the size of the driven gear-wheel determined by the space available, or by its cost of manufacture, or by a combination of these and other causes. On the other hand, there is a limit to the extent to which the diameter of the pinion or driving gear-wheel may be reduced, which is determined by the power to be transmitted. The power that can be transmitted per unit length of pinion, or width of face, decreases very rapidly as the pinion diameter decreases. The mean radius of curvature of the load carrying tooth surface is a linear function of the pinion diameter, and it is known that the load carrying capacity of a curved surface varies with its radius of curvature. Furthermore, when the pinion diameter is decreased the pitch line velocity is, generally speaking, also decreased, and the power that may be transmitted by the pinion will thus vary at least with the second power of the pinion diameter. Other influences greatly complicate the question and the horse-power that can be transmitted may be said to be for a certain R. P. M. a function of between the second and third powers of the pinion diameter. Thus for a smaller diameter pinion the power which can be transmitted per unit length becomes smaller, which means a greatly increased length of pinion for large powers. Any increase in length of pinion, however, is undesirable, as it means increased width of the driven gear-wheel or gear-wheels, thus adding to their cost of manufacture and weight, and any way the limit to the possible length of the pinion is quickly reached owing to the bending and the deflection or twisting action which takes place in a pinion of small diameter and the difficulty of providing sufficient bearing surface for it.

By my invention wherein two intermediate elastic gears operating in parallel are provided to transmit the power from the driving to the driven shaft, I am enabled to decrease the length of the pinion by one-half for a certain power to be transmitted. This is due to the fact that in view of the elasticity of the intermediate gear-wheels it is insured that at all times the load is equally divided between them. Further, I arrange the pinion shaft directly in line with the shafts which carry the intermediate gear-wheels, and with the pinion thus balanced between the intermediate elastic elements, the pinion bearings receive no part of the driving thrusts as the thrusts will be transmitted to and taken up by the bearings of the intermediate gear-wheels. This is of great advantage in that it is much easier to provide substantial bearings for these inter-

mediates than for the pinion. The pinion also is not subject to bending strains, and any torsional deflections or imperfections in the gear teeth will be taken care of by the elastic elements.

From the above it will be seen that I am enabled by my invention to transmit a larger load per unit length of pinion at a given speed reduction with a single reduction gearing; and that when a double reduction gearing is found to be desirable the invention also enables the use of a shorter length of pinion, which means a smaller gearing throughout and one which will be more compact and cheaper to manufacture.

Referring to the accompanying drawings, Figure 1 is a plan view of a single reduction gearing embodying my invention and is here shown, by way of example, as connecting a steam turbine to an electric generator; Fig. 2 is a diagrammatic elevation of the gearing shown in Fig. 1; Fig. 3 is a similar elevation showing an arrangement wherein two pinions are each connected through parallel elastic elements to a single large gear-wheel; Fig. 4 is a similar view showing a single pinion connected through two elastic elements to two large gear-wheels; Fig. 5 is a sectional elevation illustrating a preferred form of elastic gear-wheel; and Fig. 6 is an elevation showing my invention as applied to double reduction gearing.

Referring to the drawing, Figs. 1 and 2, 12 indicates a steam turbine having its shaft 13 journaled in bearing blocks 14 and 15 and fixed thereon between the blocks is a solid pinion 16. The bearing blocks also have journaled therein two counter shafts 17, one above and one below the shaft 13, each of which carries a flexible or elastic gear-wheel 18, and both of these elastic gear-wheels mesh with the large driven gear-wheel 19 fixed on the shaft 20 of the electric generator 21. It will be apparent that the elastic gear-wheels 18 in this arrangement are idlers, since they neither increase nor reduce the ratio existing between pinion 16 and gear 19. In the present instance the pinion 16 and wheels 18 are shown located at one side of the wheel 19, but it will be understood that they may be located either above or below it as found desirable. The pinion shaft 13 is directly in line with shafts 17, thus balancing the pinion 16 between the flexible wheels 18. It is desirable to have perfect alinement of these shafts, as the degree to which the pinion is balanced depends upon this.

In gearing of this type the double helical or herring-bone type of gearing possesses well recognized advantages as to smoothness of running and other qualities, and I have accordingly illustrated my invention in connection with such gearing. In this case I prefer to use for my elastic element the form of elastic gear-wheel invented by me and illustrated in Fig. 5. It comprises a plurality of elastic or flexible laminations or plates 22 rigidly mounted on the shaft or support and having a small clearance space between each two plates near the periphery. The face of the gear-wheel is provided with helically cut teeth which are free to yield laterally by a slight amount under the pressure of the teeth of the coöperating gear-wheels. This yielding of the teeth is due to the fact that the metal plates are elastic and also to the fact that each plate at its periphery is separated from the other by a small space.

In Fig. 3 I have shown my invention in connection with a double sided drive, which gives a maximum power transmission for a minimum weight. I then prefer to use on each side of the driven wheel 19^a two flexible or elastic gear-wheels 18^a, each pair driven by a pinion 16^a. Where it is desired to drive two large wheels 19^b from a single pinion 16^b, I employ the arrangement shown in Fig. 4 in which two intermediate flexible or elastic wheels 18^b transmit the power from the latter to the former.

In Fig. 6 I have shown my invention in connection with double reduction gearing. In this arrangement 25 indicates the driving pinion driving the two intermediate elastic gear-wheels 26 fixed on the same shaft with which are intermediate or low speed pinions 28 which mesh with the driven wheel 29. The elastic wheels 26 are preferably of the type referred to above and in this arrangement, although their functions are the same, they are not idlers as in the case of single reduction gearing but they form a part of the speed reduction train.

My invention as applied to double reduction gearing is not specifically claimed herein as it forms the subject matter of another application, Serial No. 36,961, filed June 29, 1915.

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 transmission gearing, the combination of a driving gear-wheel, a driven gear-wheel, and two intermediate elastic gear-wheels, both of which are peripherally in mesh with and directly transmit power from the driving to the driven gear-wheel.

2. In a transmission gearing, the combination of a helical driving gear-wheel, a helical driven gear-wheel, both located in the same plane, and two intermediate elastic

gear-wheels, both of which mesh with and directly transmit power from the driving to the driven gear-wheel.

3. In a transmission gearing, the combination of a helical driving gear-wheel, a helical driven gear-wheel, both located in the same plane, and one or more gear-wheels having elastic teeth that mesh with and directly transmit power from the driving to the driven gear-wheel.

4. In a transmission gearing, the combination of a pinion, two elastic gear-wheels which directly transmit power and are arranged to mesh therewith at substantially diametrically opposite points, and a driven gear-wheel which meshes with both of said elastic gear-wheels.

5. In a transmission gearing, the combination of a pair of helical driving gear-wheels having teeth with right and left hand pitch, a helical driven gear-wheel, and four intermediate gear-wheels having elastic teeth which directly transmit power and mesh with said driving and driven gear-wheels.

6. In a transmission gearing, the combination of a rigid pinion, two elastic gear-wheels which receive power from the pinion and are in mesh therewith at substantially diametrically opposite points, and a rigid driven gear-wheel which meshes with and is driven by both of said elastic gear-wheels.

7. In a transmission gearing, the combination of a driving gear-wheel, a driven gear-wheel, and two intermediate gear-wheels which are arranged between the driving and driven gear-wheels and transmit power from the one to the other, said intermediate gear-wheels having elastic teeth.

8. In a transmission gearing, the combination of a driving gear-wheel, a driven gear-wheel, and two intermediate elastic gear-wheels, both of which transmit power from the driving to the driven gear-wheel, said elastic gear-wheels comprising a plurality of plates securely bound together at their central portions and with their outer portions unbound and slightly spaced apart so as to be free to yield at right angles to the planes of the plates.

9. In a transmission gearing, the combination of a helical driving gear-wheel, a helical driven gear-wheel, both located in the same plane, and two elastic gear-wheels that transmit power from the driving to the driven gear-wheel, each of said elastic gear-wheels comprising a plurality of plates rigidly supported at their central portions and slightly spaced apart at their outer portions so as to be capable of slight lateral yielding.

In witness whereof I have hereunto set my hand this 2nd day of July, 1915.

KARL ALQUIST.