J. B. FOOTE.

SPEED REDUCING MECHANISM

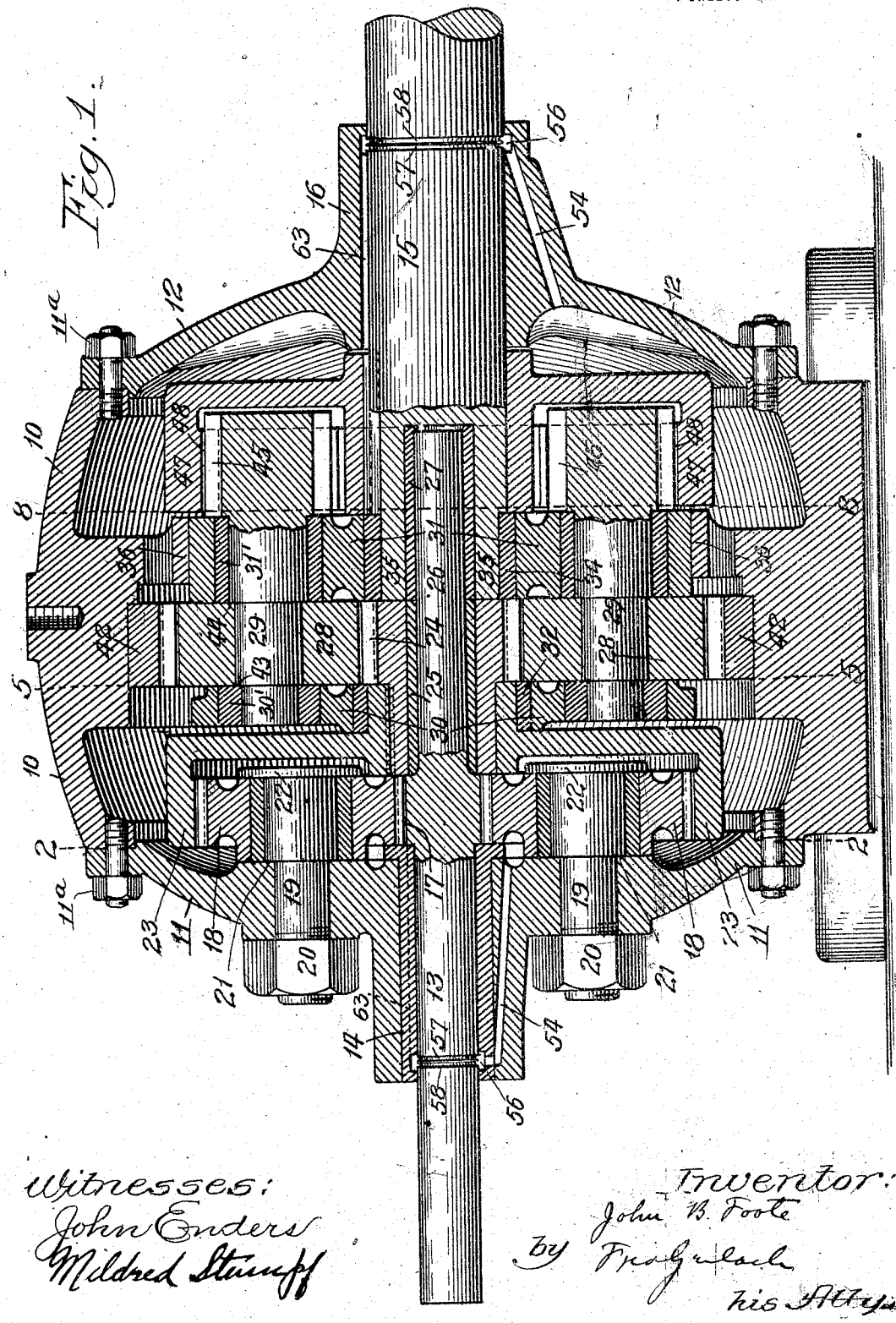
APPLICATION FILED SEPT. 23, 1914.

1,190,278.

Patented July 11, 1916.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
John Enders
Mildred Stumpf

Inventor:
John B. Foote
by Fred J. Lach
his Attys

J. B. FOOTE.

SPEED REDUCING MECHANISM.

APPLICATION FILED SEPT. 23, 1914.

1,190,278

Patented July 11, 1916.

4 SHEETS—SHEET 2.

Fig. 2.

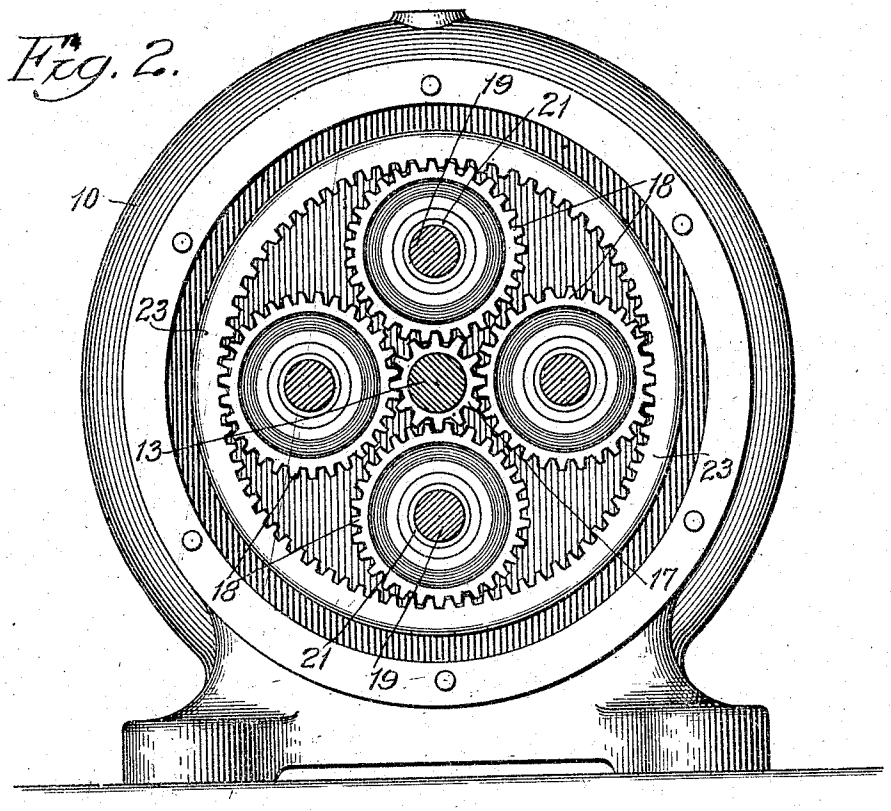


Fig. 3.

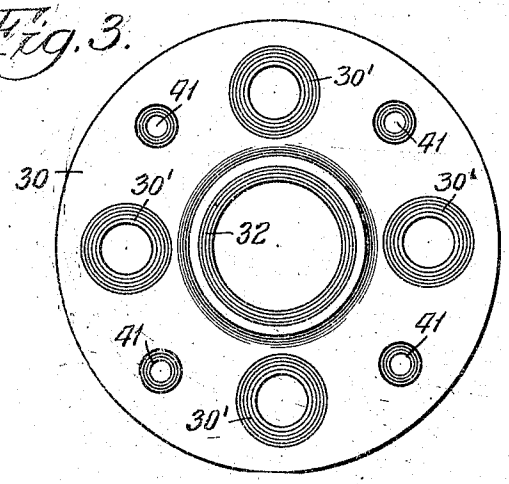
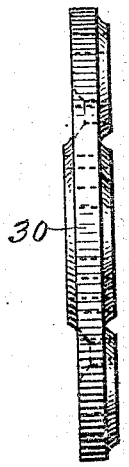


Fig. 4.



Witnesses:
John Enders
Mildred Stumpf.

Inventor:
John B. Foote
by Fred Galach
his Atty.

J. B. FOOTE.

SPEED REDUCING MECHANISM.

APPLICATION FILED SEPT. 23, 1914.

1,190,278.

Patented July 11, 1916.

4 SHEETS—SHEET 3.

Fig. 5.

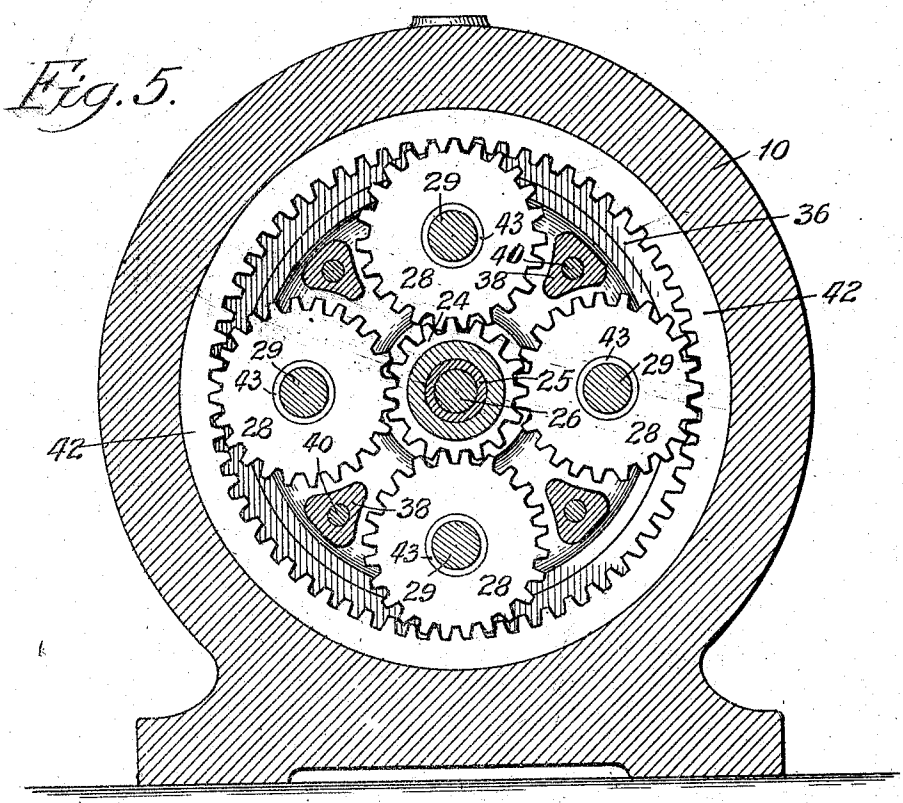


Fig. 6.

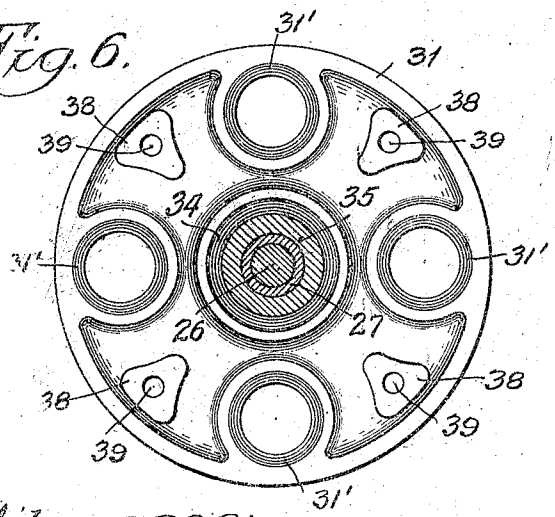
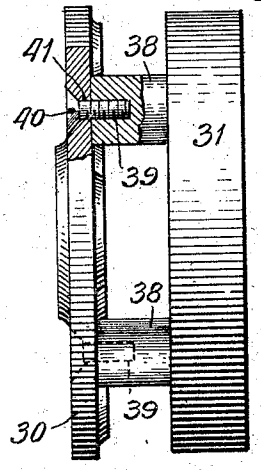


Fig. 7.



Witnesses:
John Enders
Mildred Stumpf

Inventor:
John B. Foote
by Frost & Black
his Attys.

J. B. FOOTE.

SPEED REDUCING MECHANISM.

APPLICATION FILED SEPT. 23, 1914.

1,190,278.

Patented July 11, 1916.

4 SHEETS—SHEET 4.

Fig. 8.

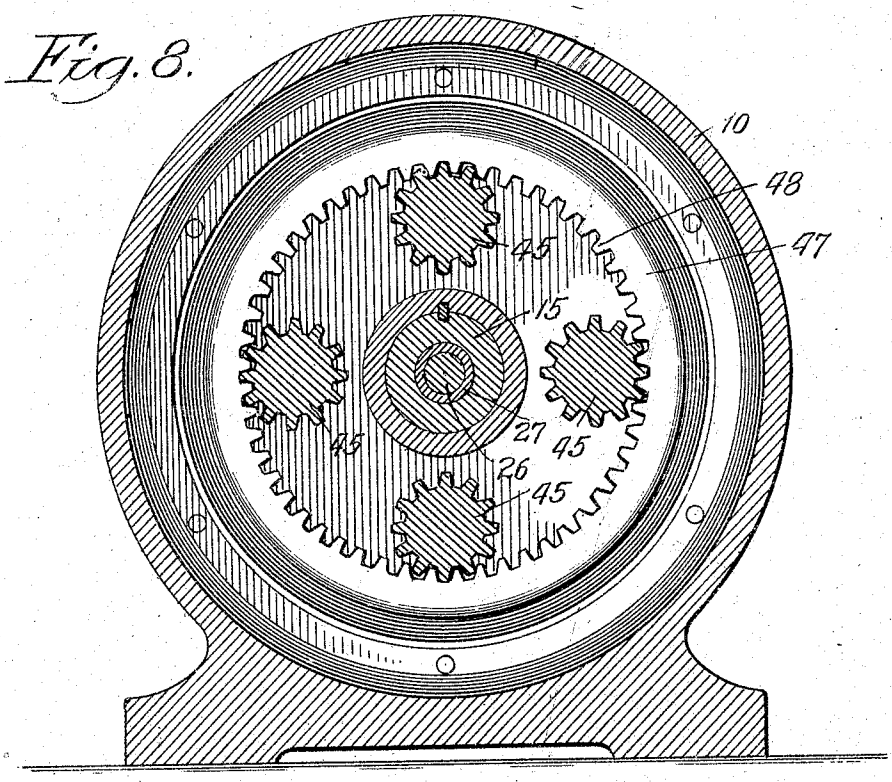
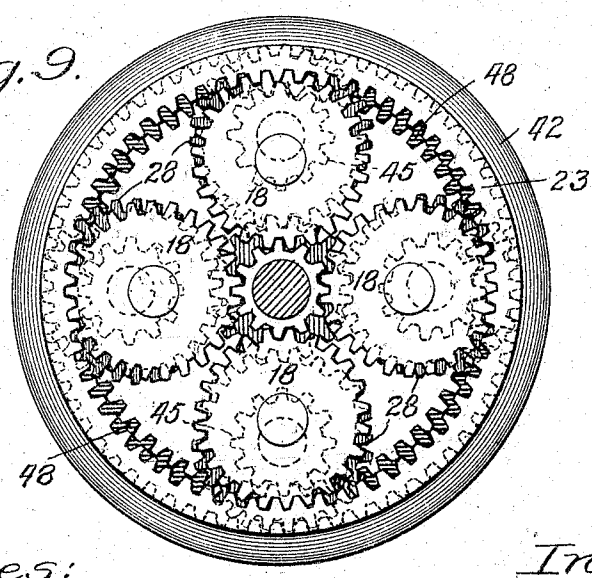


Fig. 9.



Witnesses:
John Enders
Mildred Stumpff

Inventor.
John B. Foote
by Fred Gralach
his Attys.

UNITED STATES PATENT OFFICE.

JOHN B. FOOTE, OF CHICAGO, ILLINOIS.

SPEED-REDUCING MECHANISM.

1,190,278. Specification of Letters Patent. **Patented July 11, 1916.**

Application filed September 23, 1914. Serial No. 863,057.

To all whom it may concern:

Be it known that I, JOHN B. FOOTE, a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Speed-Reducing Mechanism, of which the following is a full, clear, and exact description.

The invention relates to speed reducing mechanism and designs to provide a mechanism which is simple in construction and is adapted to be compactly embodied in a case.

The invention further designs to provide a speed reducing mechanism in which a high speed pinion on the drive shaft meshes with a series of pinions on a rotary cage revolving concentrically with the drive shaft and the driven shaft, said pinions meshing with an internal annular rack secured to the outer casing, the shafts for said pinions carrying another series of pinions respectively, which engage with a pinion on the slow speed or driven shaft.

A further object of the invention is to improve the speed reducing mechanism set forth in Letters Patent No. 1,059,450, so that greater reduction in speed may be attained without materially increasing the number of gears employed.

The invention further designs to provide a speed reducing mechanism having a gear on the drive shaft meshing with a series of idlers fixed to the cover of the device, said idlers meshing with a wheel having internal teeth, said wheel having a pinion fixed in its hub, said pinion contacting with a series of pinions secured in a rotary cage revolving concentrically with the drive shaft, said pinions in the cage meshing with an annular rack secured to the outer case and a series of pinions on the shafts carrying the pinions in the cage meshing with a wheel having internal teeth fixed on the slow speed shaft.

The invention further designs to provide a new and improved means for oiling the shafts of this device.

The invention consists in the several novel features hereinafter set forth and more particularly defined by claims at the conclusion hereof.

In the drawings: Figure 1 is a longitudinal section of a speed reducing mechanism embodying the invention. Fig. 2 is a section taken on the line 2—2 of Fig. 1. Fig. 3 is a face view of one of the rotatable rings in which the planetary pinion-shafts are sustained. Fig. 4 is a side elevation of said ring. Fig. 5 is a section taken on line 5—5 of Fig. 1. Fig. 6 is a detail view of the other ring in which the planetary pinion shafts are sustained. Fig. 7 is a side elevation of said ring. Fig. 8 is a section taken on line 8—8 of Fig. 1. Fig. 9 is a diagrammatic view of the gearing in the case.

The mechanism is inclosed within a suitable case which, in practice, contains lubricant in which the gearing operates. This case comprises a hollow body 10, a removable side 11 at one end and a removable side 12 at the other, said sides being secured to the body 10 by suitable stud bolts 11^a. A high speed drive-shaft 13 is journaled in a suitable bearing 14 in the case-side 11, may be driven from any suitable source of power at a high speed, and will communicate power by means of intermediate reducing gear mechanism to a driven shaft 15 which is journaled in case-side 12 at 16. Drive shaft 13 and driven shaft 15 are coaxially disposed or alined and extend outwardly from the sides of the case respectively, so that the former may be connected to a suitable source of power, such as an electric motor, and the shaft 15 will serve to drive the mechanism to be driven at a reduced speed.

A pinion 17 is formed on the drive shaft 13 adjacent the inner side of the case-side 11. This pinion meshes with a series of idlers 18 each of which is suitably journaled on a stud 19 which is secured in the case 11 by a nut 20. Each stud is provided with a shoulder 21 facing the inner face of the side 11 and a head 22 at its inner end, so that the pinion mounted thereon will be free to rotate. Idlers 18 communicate power from the pinion 17 to a wheel 23 having internal teeth and which is concentrically mounted with respect to the shafts 13 and 15. The pitch diameter of this wheel is much greater than that of the pinion 17, so that the speed of the wheel 23 will be correspondingly reduced. The reduction in speed between pinion 17 and gear wheel 23 constitutes what will be termed for convenience the "first reduction". Gear wheel 23 is keyed to the hub of a pinion 24 which is provided with a bushing 25 and is journaled on the reduced portion 26 of the drive shaft 13. Resultantly, the movement of the gear wheel 23 will be communicated from said wheel to the pinion 24, the latter being much less in diameter, to cause said pinion 24 to drive the remainder of the gearing at a correspondingly less speed. The

inner end of the reduced portion 26 of shaft 13 is journaled in a bushing 27 in the recessed end of the driven shaft 15, so that the drive shaft will be coaxially disposed or alined with the driven shaft by being supported in said shaft adjacent to the journal 16 for the latter. Pinion 24 meshes with a series of gears 28, each of which is keyed to an arbor 29 which is journaled in a rotary cage comprising rings 30 and 31.

The reduction in speed between the pinion 24 and the gears 28 constitutes the "second reduction." This reduction may be varied by replacing pinion 24 and gear 28 with gears of different ratios. Therefore, the invention provides a speed reducing gear which permits the ratio of reduction to be conveniently varied or adapted for different reductions. By removing the case-side 11 from the body 10 of the case and withdrawing the shaft 13 and the idlers 18 which are journaled on studs 19 from the case, the gear wheel 23 pinion 24 and gear wheels 28 may be readily accessible to permit the substitution of gear wheels necessary to effect the change in the ratio of the second reduction in speed

Ring 30 is provided with a bushing 32 and is journaled on the hub of the wheel 23. Ring 31 is provided with a bushing 34 and is journaled on the reduced end 35 of the driven shaft 15, and its periphery is free to rotate within the annular flange 36 formed in casing 10 Ring 31 is provided with a series of integral spacing and connecting lugs 38 having holes 39 therein for receiving screws 40 which pass through apertures 41 in the ring 30 and secure the rings together. By disposing ring 30 to rotate upon the hub of the wheel 23, and ring 31 to rotate on the reduced end of the driven shaft 15, the rotary cage is provided with a bearing on the central shafts and its axis of rotation is coincident with that of the shafts 13 and 15 and this, with the journal bearing for the ring 31 in the flange 36, will relieve the shaft 29 of stresses which are likely to cause it to wear away the bearings in the rings 30 and 31 for said shaft.

Gears 28 disposed in the rotary cage en gage a circular rack 42 which is fixed to the casing 10. Thus, the gears 28 mesh between the pinion 24 and the rack 42 and this disposition also relieves the arbors 29 of stresses which are likely to cause undue wear on their bearings in the rings 30 and 31

Each gear 28 is keyed to its arbor 29 which passes through bearings 30 and 31 of the rings 30, 31 and is provided with shoulders 43 and 44 adjacent said rings respectively and each has a pinion 45 formed thereon adjacent the case side 12. These pinions 45 mesh with a gear wheel 47 having internal teeth 48, which is secured to the driven shaft 15.

The reduction resulting from the ratio between the pinions 45 and the wheel 47, constitutes the "third reduction" of speed, and this reduction may likewise be varied by replacing pinions 45 and wheel 47, with gears of different ratios.

As previously stated, the speed reducing mechanism runs in oil or other lubricant contained within the outer casing, and means are provided whereby some of this lubricant will be drawn from the interior of the casing to lubricate either of the shafts. This means comprises an inclined channel 54 leading from the bearing for the shaft down into the interior of the casing. The bearing for the shaft is provided with an annular groove 56 having its lower portion communicating with the channel 54. The shaft adjacent this annular groove is provided with double grooves 57 and 58, and a groove 63 conducts oil from the interior of the case to groove 56. It has been found by practice, that while the shafts are rotating there is a tendency to pull oil or lubricant toward the outer end of the case through grooves 63 and into the annular recess 56 from said recess the lubricant flows through, through channel 54 back into the case, thus producing a constant flow of oil through the bearing to oil the shaft without the aid of an oil ring.

The case is usually provided with a filling-plug to permit lubricant to be introduced into the gear case, so that the mechanism will run in the lubricant, and with a plug to permit the lubricant to run from the case when desired, such plugs being of usual construction as well understood in the art and therefore it has not been deemed necessary to illustrate them.

In operation, shaft 13 will be driven at a high speed, usually from an electric motor. Pinion 17 will be driven by said shaft and rotate idlers 18 which impart rotation in the opposite direction to the gear wheel 23 at a reduced speed, corresponding to the ratio between pinion 17 and said gear wheel 23, and the latter will correspondingly rotate pinion 24 to drive gears 28 and shafts 29 whereon they are mounted and to which they are secured, and the gears 28 will mesh with the teeth on the circular rack 42. The relative speed of the shaft 29 and the pinion 24 will be reduced correspondingly to the ratio of the pinion 24 to the circular rack 42, thus resulting in a further reduction of speed. The number of turns that the shaft 29, which carries the gears 45, will make during each revolution of the rotary cage, will be the ratio between the pinions 28 and the rack 42 and a further reduction in speed will result between the gears 45 and the driven shaft 15, corresponding to the ratio of the gears 45 to the wheel 47, which is secured to the driven shaft 15. Resultantly, the improved speed reducing mechanism as described and

illustrated involves three reductions in speed, namely, the "first reduction" that between pinions 17 and wheel 23, the "second reduction" that between the pinion 24 and pinions 45; the "third reduction" that between the pinions 45 and the wheel 47.

By this construction, a reduction of speed as great as over a thousand to one may be accomplished, for if pinions 45 have 12 teeth and make three revolutions on its own shaft, and if the internally toothed wheel 47 had 37 teeth, the ratio between these two would be 37 to 1, and it is possible to provide a ratio of 6 to 1 in the first reduction, and $4\frac{3}{4}$ to 1 in the second, by the use of suitable toothed gears, meshing with each other, so that the total ratio of the case will be equal to the products of the ratios of the three reductions which will equal $1054\frac{1}{2}$ to 1.

The invention thus exemplifies a speed reducing mechanism, in which there are three reductions between the drive shaft and the driven shaft, and in which the second reduction is accomplished by the use of a series of planetary gears meshing with a gear concentrically disposed with respect to the eye on the driven shaft, the shafts of each gear carrying another series of gears which mesh with a gear or an internal toothed wheel secured to the driven shaft.

The invention also exemplifies a gear reducing mechanism in which planetary pinions are utilized to drive an internally toothed gear rotating about the axis of the planetary movement, and in connection with idler pinions which effect the first reduction. In the construction set forth, the gears are compactly disposed so that a great reduction of speed may be effected with a small mechanism, which can be produced at a low cost.

The invention is not to be understood as restricted to the details set forth, since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is:

1. The combination of a non-rotatable case having sides, a drive shaft mounted in one side of the case, a driven shaft mounted in the other side of the case, said shafts being coaxial, idler pinions at one side of the case mounted to rotate about fixed axes, a pinion on the drive shaft engaging said idler pinions, an internally toothed gear wheel meshing with said idler pinions, a pinion secured to said internally toothed wheel, planetary gearing comprising arbors, and a plurality of pinions on each of the arbors, a stationary rack engaging one pinion on each of the arbors, and a gear meshing with the other pinions on the arbors and connected to said driven shaft.

2. The combination of a non-rotatable case having sides, a drive shaft mounted in one side of the case, a driven shaft mounted in the other side of the case, said shafts being coaxial, idler pinions at one side of the case mounted to rotate about fixed axes, a pinion on the drive shaft engaging idler pinions, an internally toothed gear wheel meshing with said idler pinions, a pinion secured to said internally toothed wheel, planetary gearing comprising arbors, and a plurality of pinions on each of the arbors, a stationary rack engaging one pinion on each of the arbors, and an internally toothed wheel meshing with the other pinions on said arbors and connected to said driven shaft.

3. The combination of a non-rotatable case having sides, a drive shaft mounted in one side of the case, a driven shaft mounted in the other side of the case, said shafts being coaxial, studs fixed on one side of the case, idler pinions mounted to rotate on said studs, a pinion on the drive shaft engaging the idler pinions, an internally toothed gear wheel meshing with said pinions at the side of the case, a pinion secured to rotate with said internally toothed wheel, planetary gearing comprising arbors and a plurality of pinions on each of the arbors, a stationary rack engaging one pinion on each of the arbors, and a gear meshing with the other pinions on the arbors and connected to said driven shaft.

4. The combination of a non-rotatable case having removable sides, a drive shaft mounted in one side of the case, a driven shaft mounted in the other side of the case, said shafts being coaxial, idler pinions mounted on one side of the case, a pinion on the drive shaft engaging the idler pinions, an internally toothed gear wheel meshing with said idler pinions, a pinion secured to rotate with said internally toothed wheel, planetary gearing comprising arbors and a plurality of pinions on each of the arbors, a stationary rack engaging one pinion on each of the arbors, and a gear driven by the other pinions on the arbors and connected to said driven shaft, said internally toothed gear and planetary gearing being removable from the case when one case-side is removed.

5. The combination of a non-rotatable case having removable sides, a drive shaft mounted in one side of the case, a driven shaft mounted in the other side of the case, said shafts being coaxial, idler pinions mounted on one side of the case, a pinion on the drive shaft engaging the idler pinions, an internally toothed gear wheel meshing with said idler pinions, a pinion secured to rotate with said internally toothed wheel, planetary gearing comprising arbors and a plurality of pinions on each of the arbors,

a stationary rack engaging one pinion on each of the arbors, and an internally toothed gear meshing with the other pinions on the arbors and secured to the driven shaft, the planetary gearing being removable through one side of the case and the internally toothed gear on the driven shaft being removable through the other side.

6. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, a gear-wheel on the driven shaft, planetary gearing comprising arbors and a plurality of pinions fixed on each arbor, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, and a rotatable ring in which the arbors are journaled, disposed between the pinions on the arbors.

7. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, an internally toothed gear on the driven shaft, planetary gearing comprising arbors and a plurality of pinions on each arbor, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, and a rotatable ring in which the arbors are journaled, disposed between the pinions on the arbors.

8. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, idlers engaging with said pinion, an internally toothed wheel meshing with said idlers, a pinion fixed to the internally toothed gear, a gear-wheel on the driven shaft, planetary gearing comprising arbors and a plurality of pinions on each arbor a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft and a rotatable ring in which the arbors are journaled, disposed between the pinions on said arbors, the pinion on the internally toothed gear meshing with the pinions which mesh with the stationary rack.

9. The combination of a non-rotatable case having removable sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, a gear-wheel on the driven shaft planetary gearing comprising arbors and a plurality of pinions on each arbor, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, and a rotatable ring in which the arbors are journaled, disposed between said pinions on said arbors, said ring and planetary gearing being removable through one side of the case.

10. The combination of a non-rotatable case having removable sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, a gear-wheel on the driven shaft, planetary gearing comprising arbors and a plurality of pinions on each arbor, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, and a rotatable ring in which the arbors are journaled, disposed between said pinions on said arbors, said ring and planetary gearing being removable through one side of the case, the gear on the driven shaft being removable through the other side.

11. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, a gear-wheel on the driven shaft, planetary gearing comprising arbors and a plurality of pinions fixed on each arbor, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, a ring in which the arbors are journaled, a bearing in the case for the outer periphery of the ring, and a bearing for the hub of the ring.

12. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, a gear-wheel on the driven shaft, planetary gearing comprising arbors each having a plurality of pinions thereon, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, a ring in which the arbors are journaled, a bearing in the case for the outer periphery of the ring, and a bearing on one of said shafts for the hub of the ring.

13. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pin-

ion on the drive shaft, a gear-wheel on the driven shaft, planetary gearing comprising arbors each having a plurality of pinions thereon, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, a ring in which the arbors are journaled, a bearing in the case for the outer periphery of the ring, and a bearing on the driven shaft for the hub of the ring.

14. The combination of a non-rotatable case having removable sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, a gear-wheel on the driven shaft, planetary gearing comprising arbors and a plurality of pinions on each arbor, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, a ring in which the arbors are journaled, a bearing in the case for the outer periphery of the ring, and a bearing for the hub of the ring, said ring and planetary gearing being removable through one side of the case.

15. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, an internally toothed gear wheel on the driven shaft, planetary gearing comprising arbors and a pair of pinions fixed on each arbor, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the internally toothed wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, a ring in which the arbors are journaled, a bearing in the case for the outer periphery of the ring, and a bearing for the hub of the ring.

16. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, idlers mounted on the case, an internally toothed gear meshing with the idlers, a pinion fixed to rotate with said internally toothed gear, an internally toothed gear on the driven shaft, planetary gearing comprising arbors and a plurality of pinions fixed on each of the arbors, a stationary rack meshing with one pinion on each of the arbors, the pinion fixed to the internally toothed gear-wheel meshing with the pinions which mesh with the stationary rack, the other pinions on the arbors meshing with the wheel on the driven shaft, a ring in which the arbors are journaled, a bearing in the case for the outer periphery of the ring, and a bearing for the hub of the ring.

17. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, a gear wheel on the driven shaft, a planetary gearing comprising arbors and a plurality of pinions fixed on each arbor, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, and rotatable supporting means for the arbors comprising a plurality of rings, a hub bearing for each of the rings and a bearing on the case for the periphery of one of the rings.

18. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, a gear wheel on the driven shaft, planetary gearing comprising arbors and a plurality of pinions fixed on each arbor, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, and rotatable supporting means for the arbors comprising a plurality of rings, one of said rings being disposed between the pinions on the arbors.

19. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, a gear wheel on the driven shaft, planetary gearing comprising arbors and a plurality of pinions fixed on each arbor, a stationary rack meshing with one pinion on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, said planetary gearing being driven by the pinion on the drive shaft, and rotatable supporting means for the arbors comprising a plurality of rings, one of said rings being disposed between the pinions on the arbors, the other ring being disposed at one end of the arbors.

20. The combination of a non-rotatable case having sides, a drive shaft and a driven shaft journaled in the sides of the case respectively, said shafts being coaxial, a pinion on the drive shaft, a gear wheel on the driven shaft, planetary gearing comprising arbors and a plurality of pinions fixed on each arbor, said planetary gearing being driven by the pinion on the drive shaft, a stationary rack meshing with one pinion

on each of the arbors, the other pinions on the arbors meshing with the wheel on the driven shaft, rotatable supporting means for the arbors comprising a plurality of rings, a hub bearing for each of the rings on the drive and driven shafts respectively, and a bearing on the case for the periphery of one of the rings.

21. The combination of a non-rotatable case having fixed sides, a drive shaft and a driven shaft journaled in the fixed sides of the case respectively, a pinion in the case and fixed on the drive shaft, a gear on the driven shaft, studs carried by one side of the case and sustained against movement thereby, idlers on said sides respectively, an internally toothed rotatable gear meshing with said idlers, and planetary gearing in the case, and driven by said internally toothed rotatable gear to drive the gear on the driven shaft.

22. The combination of a non-rotatable case having fixed sides, a drive shaft and a driven shaft journaled in the fixed sides of the case respectively, a pinion in the case and fixed on the drive shaft, an internally toothed gear on the driven shaft, studs carried by one side of the case, idlers on said studs respectively, an internally toothed rotatable gear meshing with said idlers, and planetary gearing in the case and driven by and driving said internally toothed gears respectively.

23. The combination of a non-rotatable case having fixed sides, a drive shaft and a driven shaft journaled in the fixed sides of the case respectively, a pinion in the case and fixed on the drive shaft, an internally toothed gear on the driven shaft, studs carried by one side of the case, idlers on said studs respectively, an internally toothed rotatable gear meshing with said idlers, and planetary gearing in the case and driven by and driving said internally toothed gears respectively, comprising arbors and a pair of pinions fixed on each arbor.

24. The combination of a non-rotatable case having fixed sides, a drive shaft and a driven shaft journaled in the fixed sides of the case respectively, a pinion in the case and fixed on the drive shaft, an internally toothed gear on the driven shaft, studs carried by one side of the case, idlers on said studs respectively, an internally toothed rotatable gear meshing with said idlers, and planetary gearing in the case and driven by and driving said internally toothed gears respectively, comprising arbors and a pair of pinions fixed on each arbor, a stationary rack meshing with one of the pinions on each arbor, the other pinions meshing with the gear on the driven shaft, and a pinion on the internally toothed gear meshing with the pinions which mesh with the stationary rack.

JOHN B. FOOTE.

Witnesses:
KATHARINE GERLACH,
MILDRED STUMPF.