No. 801,517. PATENTED OCT. 10, 1905.

J. S. FAIRFAX.

SPEED REDUCTION AND DRIVING GEAR.

APPLICATION FILED MAY 11, 1904.

6 SHEETS—SHEET 1.

Fig. 1.

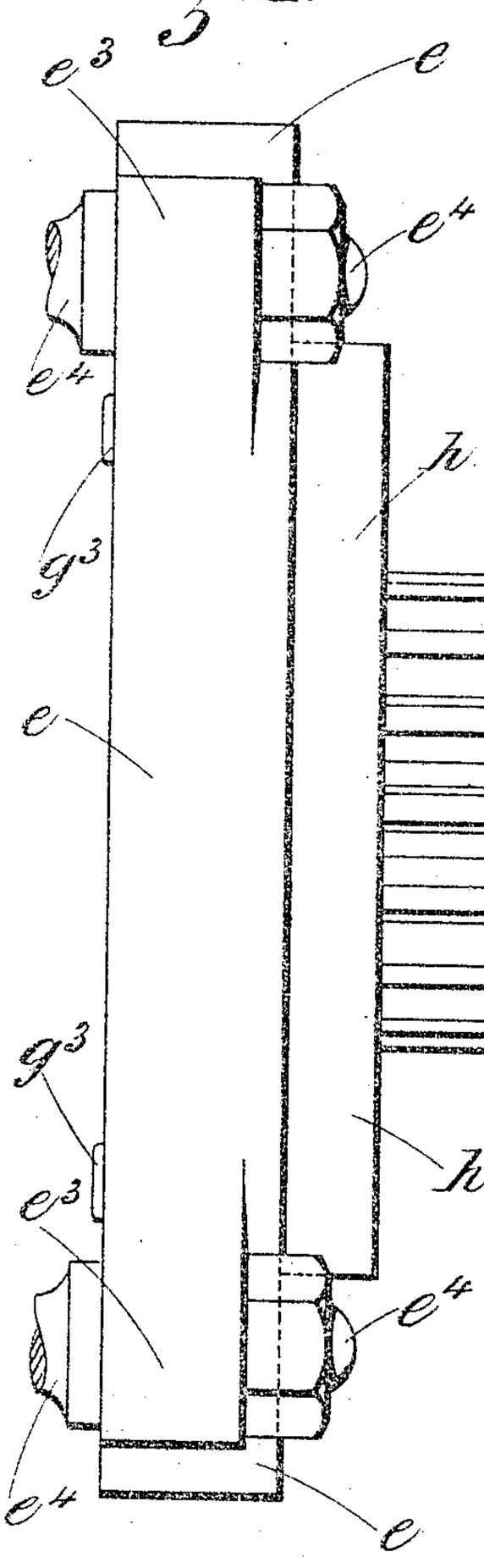
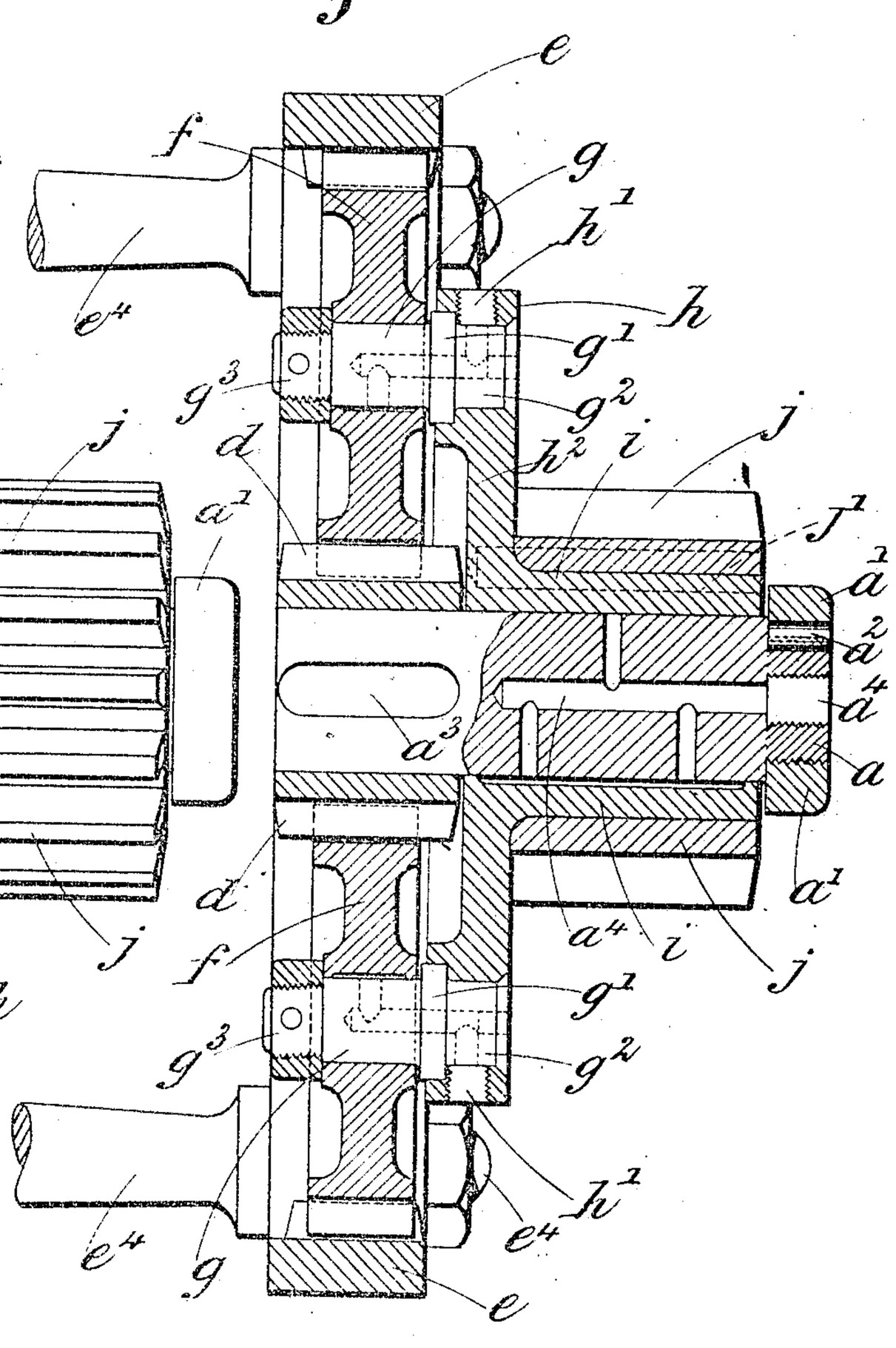


Fig. 3



WITNESSES.

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Henry J. Brockwell.

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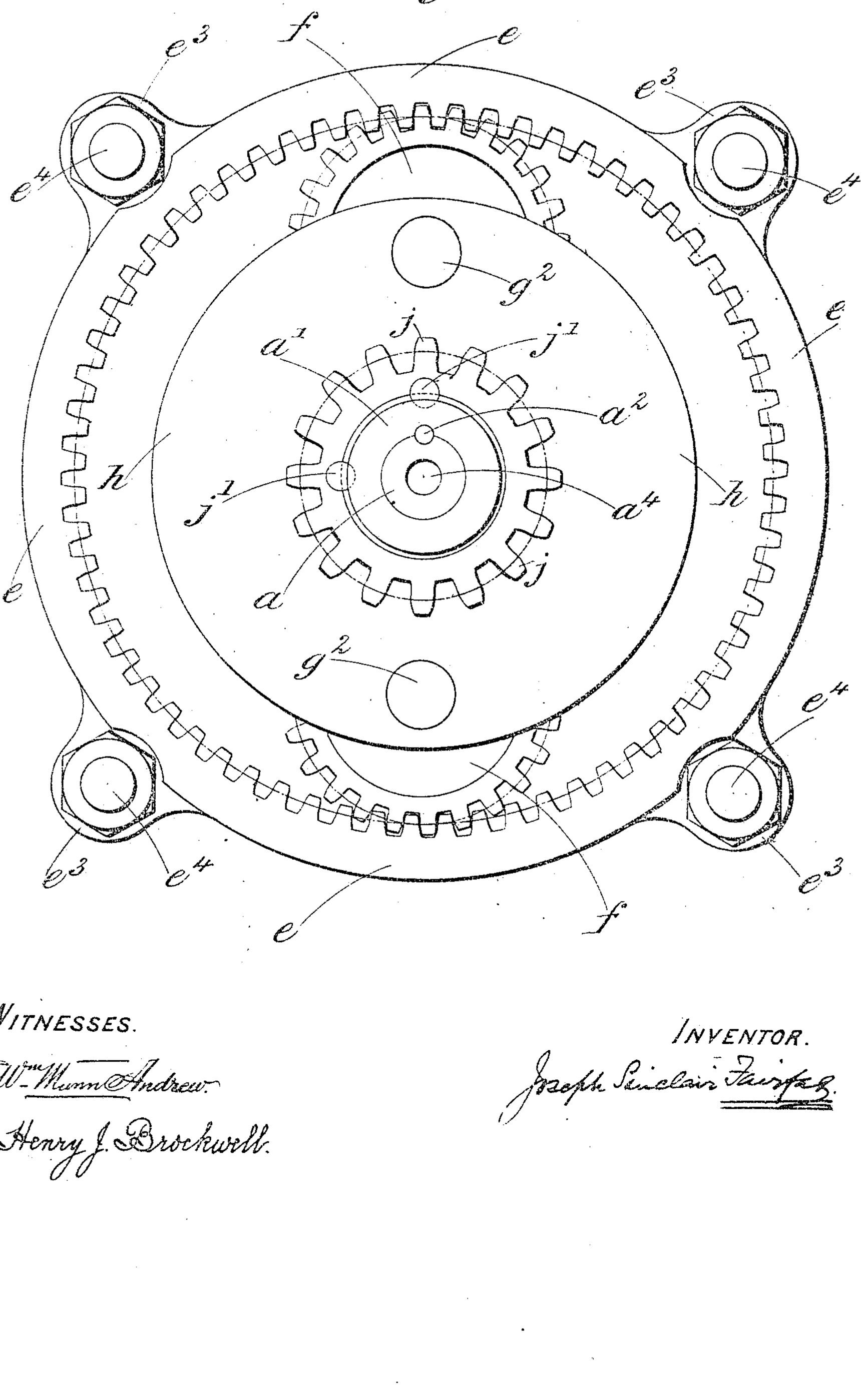
6 SHEETS—SHEET 2.

Fig. 2.



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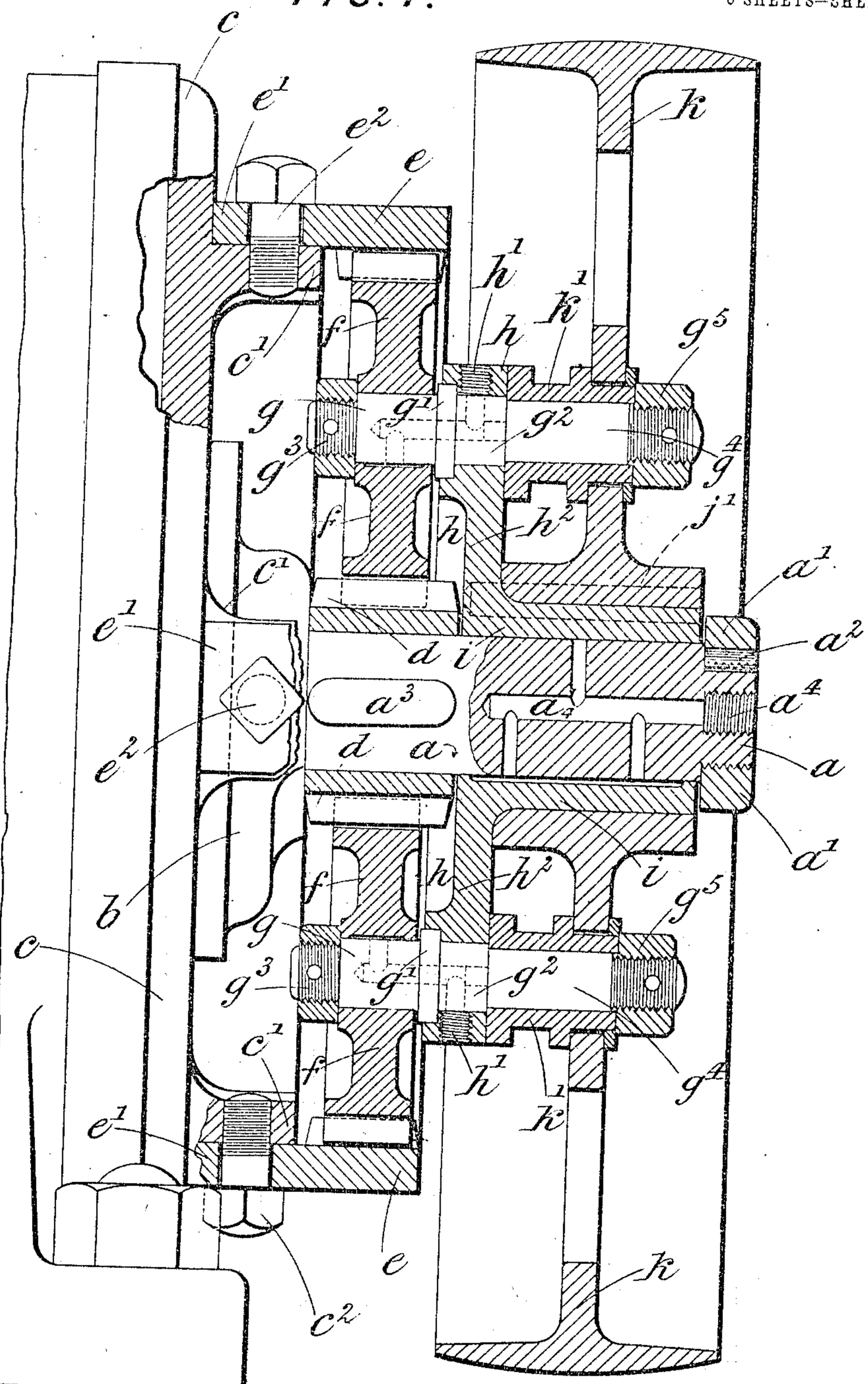
6 SHEETS—SHEET 3.

FIG. 4.



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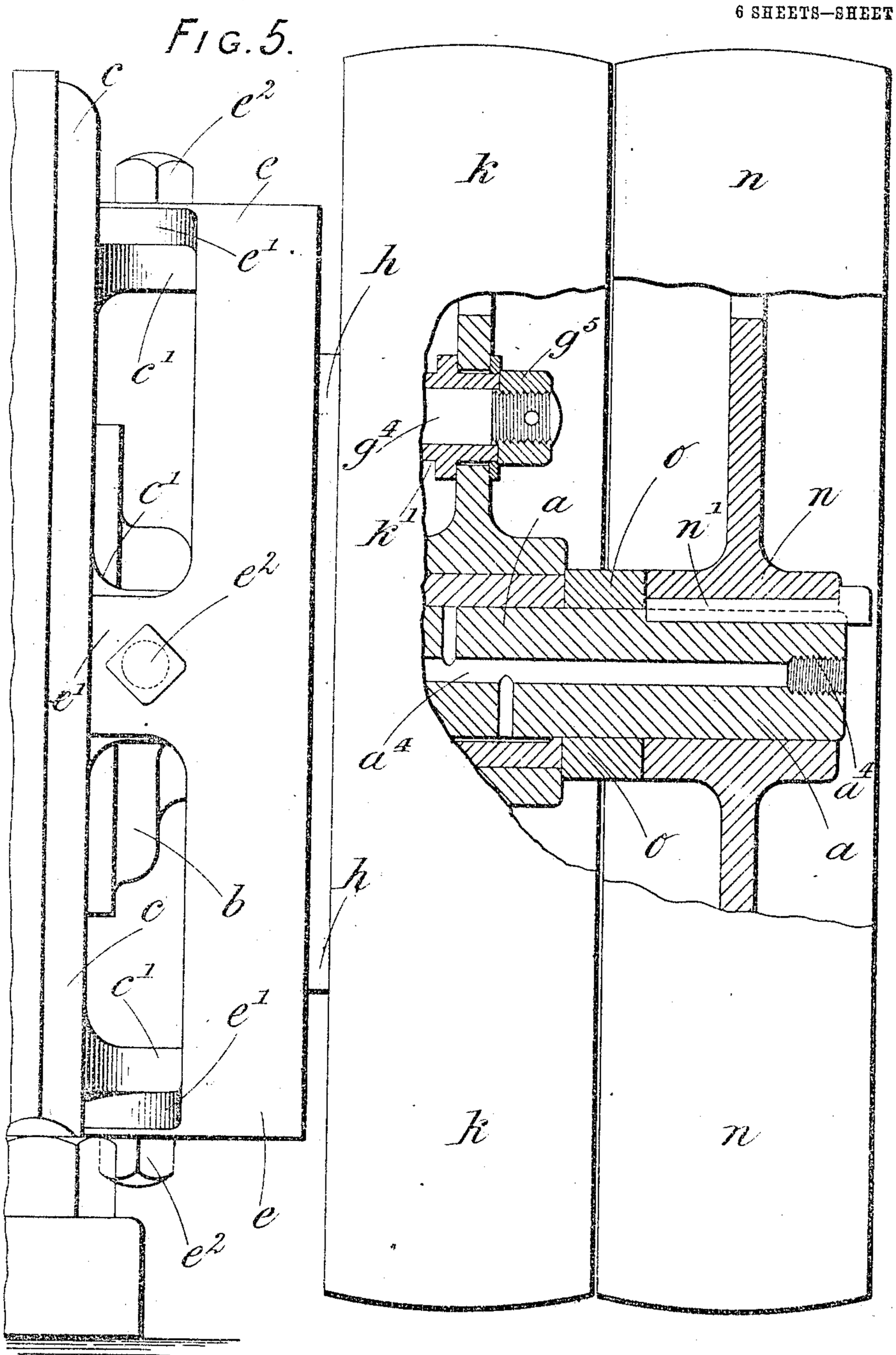
6 SHEETS—SHEET 4.

FIG. 5.



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6 SHEETS—SHEET 5.

FIG. 6.

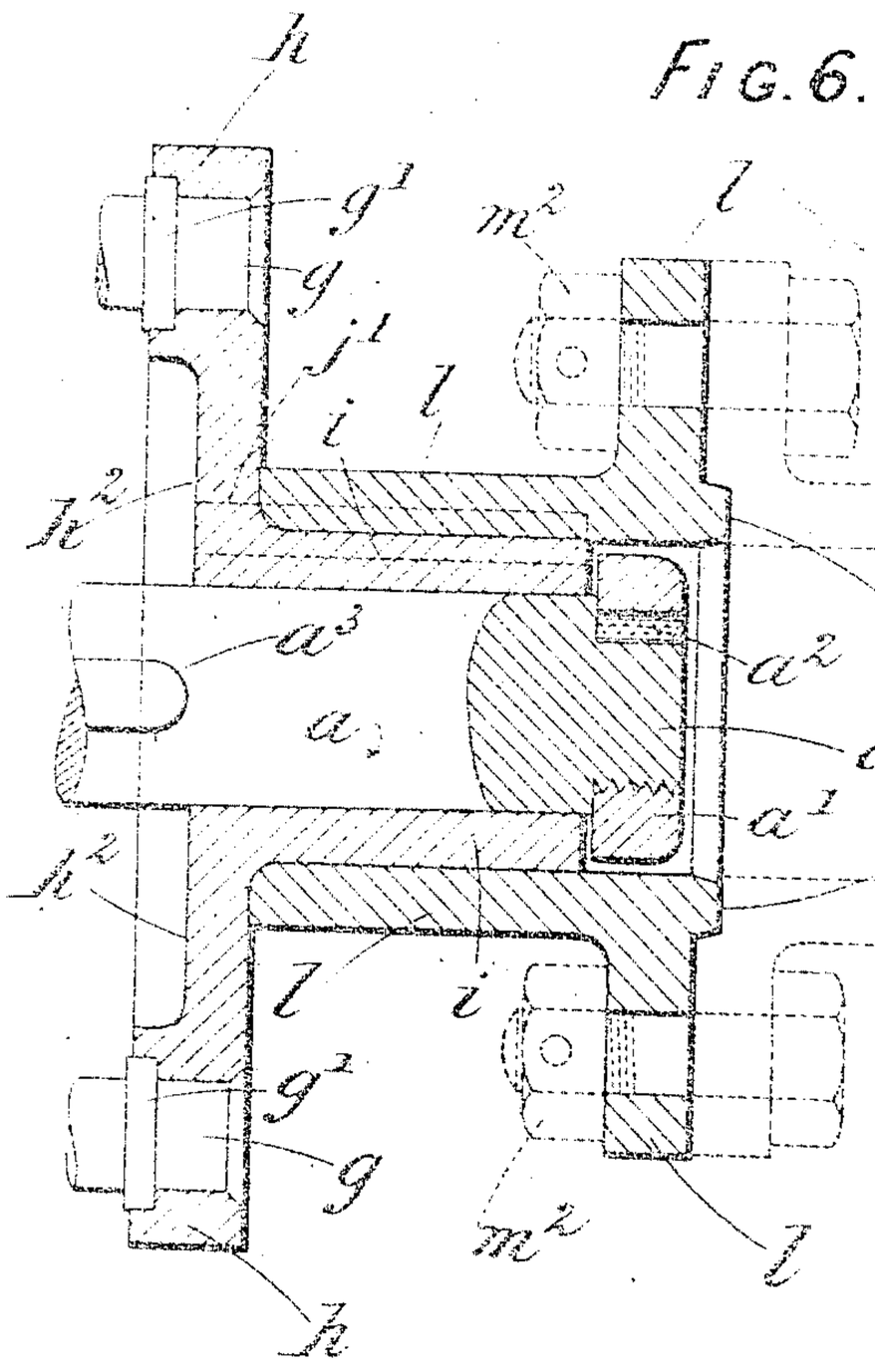
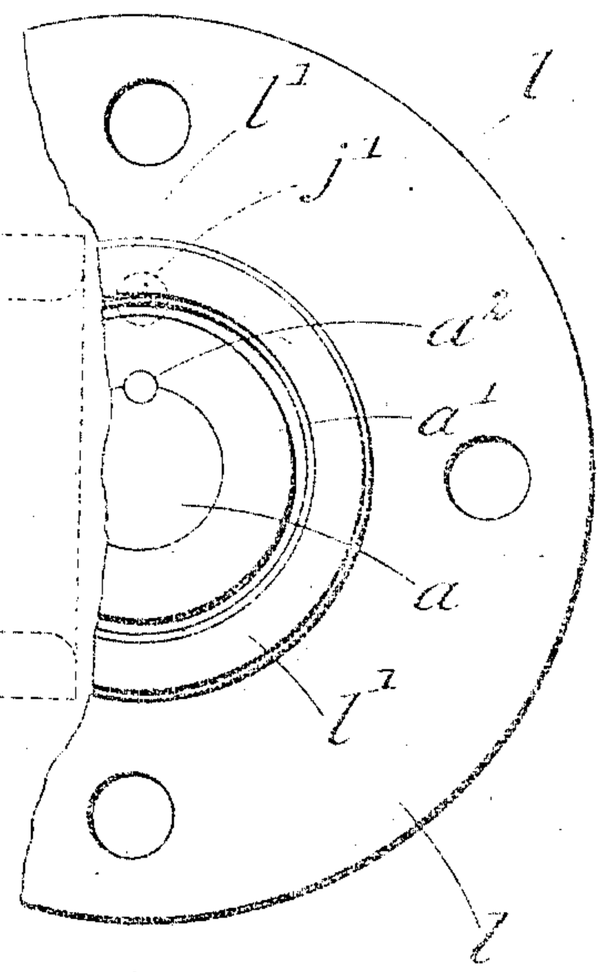


FIG. 7.



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6 SHEETS-SHEET 6.

FIG. 8.

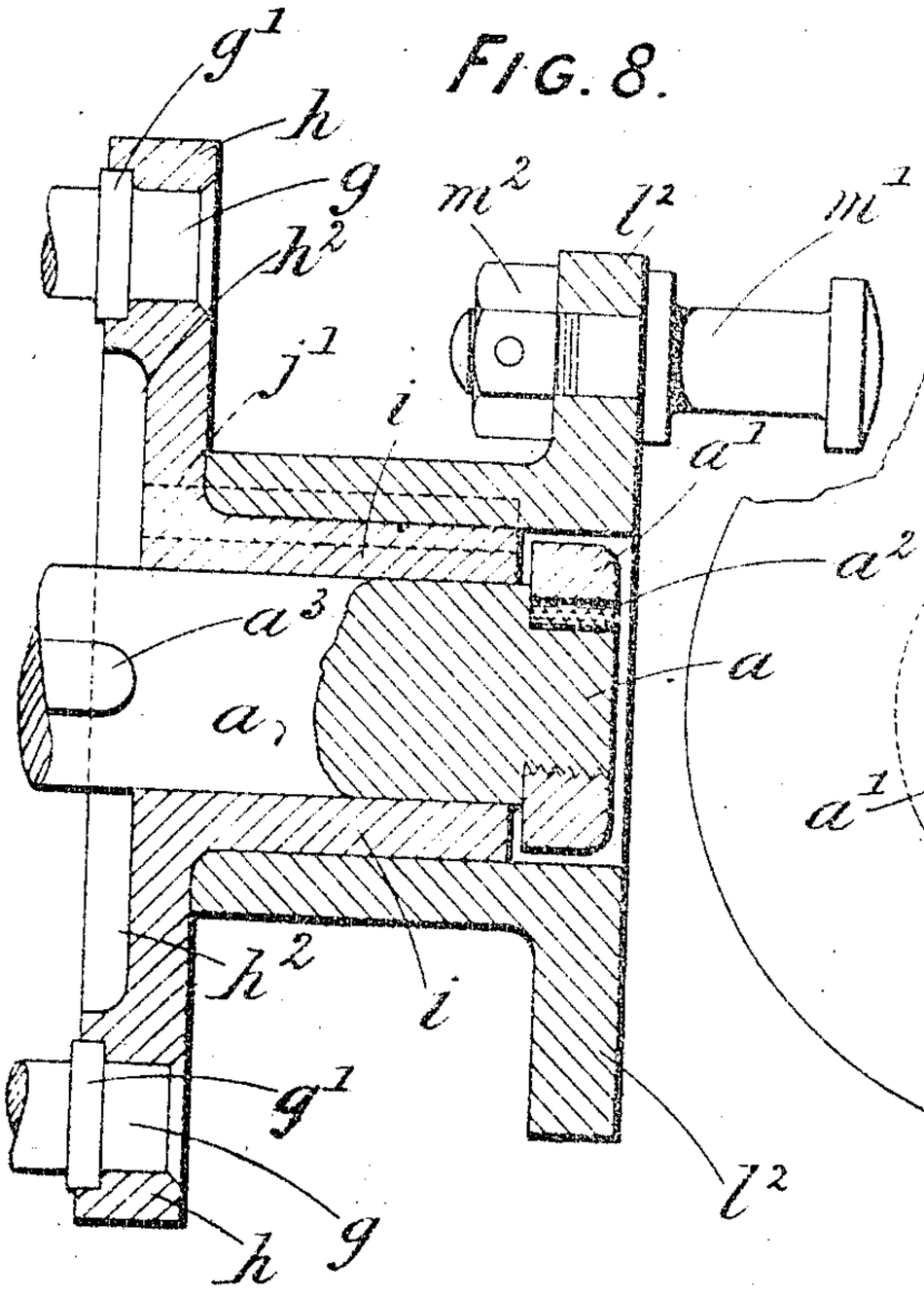
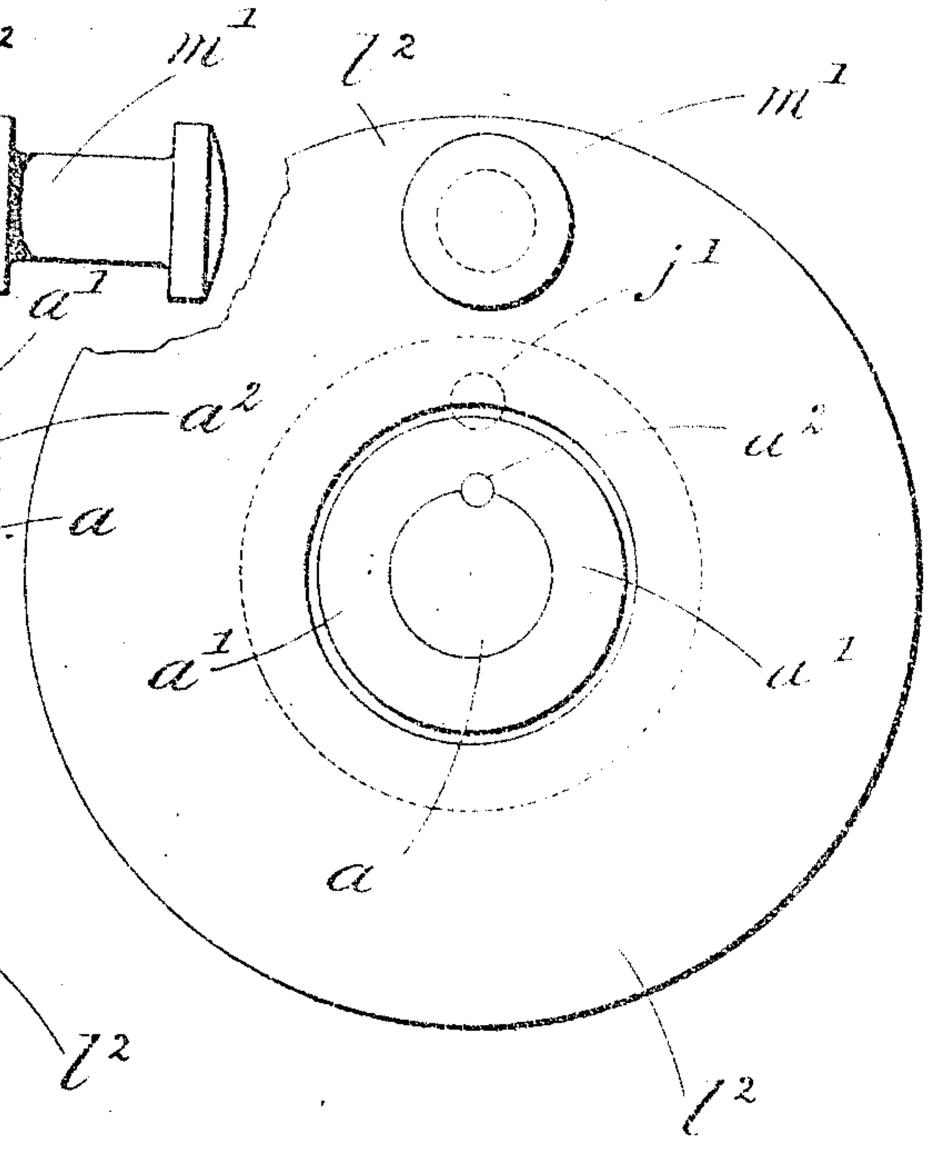


FIG. 9.



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UNITED STATES PATENT OFFICE

JOSEPH SINCLAIR FAIRFAX, OF LONDON, ENGLAND.

SPEED-REDUCTION AND DRIVING GEAR.

No. 801,517. Specification of Letters Patent. Patented Oct. 10, 1905.

Application filed May 11, 1904. Serial No. 207,434.

To all whom it may concern:

Be it known that I, JOSEPH SINCLAIR FAIRFAX, a subject of the King of the British Dominions, residing at Chiswick, London, England, (whose post-office address is 37 and 39 Essex street, Strand, London, England,) have invented certain new and useful Improvements in Speed-Reduction and Driving Gear, of which the following is a specification.

My invention relates to an improved speed-reduction and driving gear adapted to transmit power directly from the driving-shaft of an electric motor, turbine, engine, or other like shaft at a reduced number of revolutions to that of the said driving-shaft. The ratio of reduction is prearranged and is positive, having a range within the practical limits of from about three to one to about seven or eight to one. As the said driving-gear is adapted to drive in the same manner from the same position and in the same direction as hitherto, its use practically converts a high-speed motor into a moderate or slow speed motor.

In the further description of my invention reference is made to the accompanying drawings, in which—

Figure 1 is a longitudinal elevation of reduction-gear having a pinion at the outer end from which the reduced speed is transmitted to an outside spur-wheel, as described. Fig. 2 is an end elevation of Fig. 1. Fig. 3 is a vertical section of Figs. 1 and 2, showing the combination of parts as arranged to drive spur-gearing at the predetermined reduced speed directly from the motor or engine shaft by the aforesaid pinion. Fig. 4 is an elevation, partly in section, of the improved reduction-gear having a pulley for driving at the reduced speed by belt instead of the said pinion. Fig. 5 is a similar elevation to Fig. 4, but showing two pulleys, the right-hand pulley being shown by the part in section as secured to the driving-shaft, and therefore rotatable at its full speed, side by side with the other pulley, which is rotatable at the reduced speed. Fig. 6 is a longitudinal section of a half-coupling, its sleeve being fitted upon and keyed to the hub of the planet-wheel disk and adapted to transmit reduced speed in the axial direction to any other machine or apparatus by a similar half-coupling, as indicated by dotted lines. Fig. 7 is a partial end elevation of Fig. 6. Fig. 8 is also a longitudinal section through a similar sleeve and disk fitting to that shown in Figs. 6 and 7, but provided with a crank-pin to transmit reciprocating motion at reduced speed to a pump or the like; and Fig. 9 is an end elevation of Fig. 8.

In the drawings the motor or engine shaft or other driving-shaft whose revolutions it is required to reduce is indicated by *a*, which projects outwardly from a bearing *b*, carried by a standard, frame, or cover *c*, such as that of an electric motor, as indicated in Fig. 4. The shaft *a* carries an inner driving-pinion or sun-wheel *d*, formed integral with the shaft or secured thereto by the key a^3. Surrounding and in line with the sun-wheel *d* is a stationary wheel *e*, having internal teeth whose pitch-line is exactly concentric with that of *d*. A system of two, three, or four planet-wheels *f* are adapted to be driven by and revolve around the sun-wheel *d* and travel against the internal teeth of the stationary wheel *e*, the planet-wheels *f* being rotatable upon pins *g*, secured in or integral with a disk *h* or its equivalent—an arm or arms or a pulley or wheel. The said disk or its equivalent is provided with a hub *i*, bored to receive and be seated upon the outer end of the driving-shaft *a* and free to revolve thereon independently of the motion of the shaft. As the sun-pinion *d* drives the planet system of wheels *f* they revolve upon the pins *g*, carrying the disk *h* and its hub *i* forward with them in the well-known manner of sun and planet gear devices. The speed of the disk *h* and its hub *i* is reduced from that of the driving-shaft in accordance with the ratio employed of *d* to *e*. Consequently a power-transmitting member integral with or secured to the disk *h* or the hub *i* is available for driving an outside mechanism at the said reduced speed directly from the high-speed or motor driving-shaft.

Suitable power-transmitting members are the pinion *j*, pulley *k*, the half-coupling *l*, and crank-disk *m* with crank-pin *n'*. An eccentric may also be formed on or fitted to the hub *i*, but is not shown, as the crank-pin is considered an equivalent for producing reciprocating motion, while the other members transmit circular motion. These power-transmitting members are shown with an eye bored out to fit upon the hub *i* and keyed in position by a circular or other shaped key or keys *j'*, (indicated by dotted lines in Fig. 3;) but the pulley *k* or any other transmitting member provided with a flange or web may be driven by an extension g^4 of the pin *g*, as indicated in Fig. 4. In this case the washer

and nut g^3 secures the pulley upon and against the thimble h'.

The planet-disk h is recessed at h^2 to cover the end of the sun-wheel d, and by thus saving space and working in close proximity to the bearing b and motor-cover e, Fig. 4, the reduction-gear overhangs the bearing to a minimum extent. The hub i extends outwardly from the planet-disk sufficiently to make a steady bearing upon the shaft a and also affords sufficient width for the form of power-transmitting member adopted. For example, if the hub i is formed integrally as a toothed pinion j or separately-formed pinion or wheel is secured to the hub, as in Figs. 1, 2, and 3, the teeth should be sufficiently long and strong enough by means of their pitch to transmit the required number of horse-power safely to a similarly-formed outside-supported spur-wheel, with a margin for clearance of the wheel from contact on the outer face of the planet-disk h. If it is formed as a pulley k to transmit power by a belt, the inside face of the flange may be in line with the outer face of the planet-disk or extend over it or even over the fixed wheel e, so that neither transmitting member overhangs the bearing greatly nor conflicts with the self-contained characteristic of a motor having no outer bearing. This is also the case, but to a slightly less extent, when the half-coupling l is formed on or fitted to the hub i for transmitting power axially and similarly with the crank-disk m and crank-pin m' for transmitting a reciprocating motion transversely to the shaft.

In order to resist the strain of driving and adapt the improved reduction-gear to suit various forms of transmitting members, the planet-disk h and its hub i are preferably made integral and the central driving-shaft a is extended well into or through the hub and provision made for retaining-collar a' or other means of keeping all the parts in their relative positions. The shaft a and hub i are relatively made an easy or working fit, the former working freely at its full number of revolutions within the latter, which in its turn revolves at its reduced number of revolutions upon the former. An oil-channel a^4 is drilled into the shaft, and a suitable lubricator (not shown) is secured into the end of the shaft or to the retaining-collar a' to supply the lubricant. In some cases the lubricator itself may be enlarged to form a retaining washer or collar at the end of the shaft, if required, and holes are drilled from the outside of the shaft into the central oil-channel a^4, communicating with a groove or grooves cut in the bore of the hub i for distributing the lubricant, as indicated in Fig. 3.

In some cases the main shaft is extended sufficiently beyond the hub i to receive a pulley n, secured to the shaft by a key n' beside the pulley k. These pulleys being of the same diameter, as shown in Fig. 5, provide a variable speed from the full speed of the shaft given by pulley n to the predetermined reduced speed given by the pulley k, the variation being obtained by shifting a belt from one to the other. This arrangement with a single belt would be suitable for giving a slow cutting speed and a quick return speed to a planing-machine, while with two belts and by varying the relative diameters of the pulleys in driving onto other pulleys further modifications in the relative speeds are obtainable. Similarly with respect to toothed pinions, which if of the same diameter may drive a wheel or pinion slidable on an outside shaft parallel with a; but in this case there should be a sufficient space between the two driving-pinions for the driven wheel to stand clear between. Such an arrangement would be suitable for cranes and some other machinery, and the variable speed thus produced is an improvement on the invention described in the specification to British Letters Patent to me, dated May 31, 1902, No. 12,321.

The spindles or pins g for the planet-wheels f are shown in Fig. 3 with a collar g' let into the rim of the planet-disk h, the end g^2 of each pin being received therein and riveted. This arrangement also saves axial space upon the shaft a. The other end is provided with a screw and nut g^3 to retain each planet-wheel f in place, and oil-channels are indicated by dotted lines fed from a lubricator to be screwed into the orifice h' in the planet-disk h.

The stationary wheel e is secured to the bearing, standard, cover, or other part of the prime mover or apparatus carrying the driving-shaft a in any convenient manner, so as to virtually form a part of the apparatus and be self-contained therewith. For example, Figs. 4 and 5 show lugs e' extending from the stationary wheel e, each having a screw e^2 passed through it into the tapped hole of a corresponding bracket e', cast on or screwed to the cover o of an electric motor. By turning or milling the outside of the brackets e' concentric with the journal or shaft a and similarly boring the lugs e' to fit the stationary wheel the latter can be easily and cheaply secured in concentric position with the sun-wheel d. Another way is to face up the lugs e^3 and drill holes therein parallel and concentric with the shaft. Studs e^4 (their outward ends with nuts only being shown, Figs. 1, 2, and 3) are screwed at their outer end to the motor-cover, as before stated, or the stationary wheel e may be provided with arms and a central bored boss or hub fitted upon a concentric circular part of the bearing b and secured in that position or be cast integral with the cover of the motor and the teeth accurately formed or cut in place therein, as desired.

The half-coupling l in Figs. 6 and 7 is fitted upon the hub i and keyed thereto by the key j'' when it is required to transmit rotary mo-

tion at the reduced speed in an axial direction. It is shown with a projection l' upon the face of the disk; but it may be flat or recessed, the other half-coupling (indicated by dotted lines m) being correspondingly formed and bolted thereto in the well-known manner. A sleeve and disk l^2, similar to the half-coupling l, may also be fitted upon and keyed to the hub or boss i, as shown in Figs. 8 and 9, but is provided with a crank-pin m', secured to the disk l^2 by the nut m^2. This is used for transmitting reciprocating motion.

While the hub i may be integrally formed as a power-transmitting number, it is preferably turned to a standard dimension for each size of the reduction-gear to receive either the pinion j, the pulley k, the half-coupling l or crank-disk l^2 with crank-pin m', as may be required. Any other power-transmitting member—such as an eccentric, rope driving bevel, chain, or worm wheel—may be similarly fitted on and secured to the hub i or disk k instead for the object of my invention. It is to be observed, therefore, that although motion may be transmitted transversely or axially by means of the above-named well-known members for such purposes, yet in all cases it is the reduced speed and not the high speed that is thus dealt with; also, the reduced speed is available in and transmitted from substantially the same position upon the motor-shaft and in the same general manner as that from which only the high speed has hitherto been obtained. Moreover, so long as the fixed wheel does not exceed the outer diameter of an electric motor, for example, it occupies practically no greater space than before, and within the proportion a ratio of reduction can be readily obtained of seven to one. Furthermore, I have found that my improved reduction-gear can be fitted on the projecting shaft on which the ordinary pulley or pinion is keyed of almost all electric motors previously made and sold in this country, and it is comparatively easy to lengthen the exceptions sufficiently for the purpose. Consequently by my invention a high-speed electric or engine motor can be used to drive directly from its main or central shaft as though it were a moderate or slow motor, this bringing it close to its work and often avoiding the use of a special bedplate and special outside reduction-gear.

It is also to be understood that an epicyclic train or sun-and-planet gear being well known and applied to so many arrangements of gearing I make no claim thereto alone. I am aware, too, that a train of such gearing has been combined within a gear-box and coupled to a driving-shaft or bolted to an electric motor, and this is also beyond the scope of my invention; but the points of novelty relied on are set forth in the claims.

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

1. A speed-reduction and driving gear combining a cover, having a bearing, with a shaft revoluble in and projecting from said bearing; a sun-wheel secured to the shaft in close proximity to the bearing; a wheel having internal teeth secured to said cover so as to surround and be concentric with said sun-wheel; a planet system of wheels rotatable on pins and revoluble between the said sun and stationary wheels; a disk carrying the said pins and having a hub rotatable upon the outer end of the shaft, and a power-transmitting member formed on or secured to the said hub, substantially as and for the purpose hereinbefore described and shown in the drawings.

2. A speed-reduction and driving gear combining a cover having a bearing, with a shaft revoluble in and projecting from said bearing; a sun-wheel secured to the shaft in close proximity to the bearing, a wheel having internal teeth secured to said cover so as to surround and be concentric with said sun-wheel; a planet system of wheels rotatable on pins and revoluble between the said sun and stationary wheels; a disk carrying the said pins and having a hub rotatable upon the outer end of the shaft adapted to receive one of various forms of power-transmitting members, substantially as and for the purpose hereinbefore described and shown in the drawings.

3. The combination of an electric motor having an armature-shaft projecting from a bearing with a stationary internal-toothed wheel surrounding and concentric with the shaft next to the bearing, a sun-wheel secured on the shaft next to the bearing in line with the stationary wheel, and a planet system of wheels carried by a disk operated by said sun-wheel against the teeth of the stationary wheel revoluble on the outer end of the shaft and a power-transmitting member carried and driven thereby at a reduced speed relative to that of the shaft, substantially as and for the purpose specified and shown in the drawings.

4. The combination of a high-speed motor having a driving-shaft overhanging its bearing on one side of the motor, with a toothed wheel secured to the said motor a sun-and-planet speed-reduction gear working upon and operated by the said shaft against said toothed wheel, and two power-transmitting members arranged concentrically beside each other, one driven directly by and at the full speed of the shaft, and the other by and at the speed of the reduction-gear, substantially as and for the purpose specified and shown in the drawings.

5. The combination of a motor having a driving-shaft projecting from and overhanging its bearing with a speed-reduction gear mounted upon and driven by said shaft, substantially as and for the purpose specified and shown in the drawings.

6. The combination of a stationary bearing, with a shaft projecting from and revoluble in

said bearing, and a sun-and-planet speed-reducing gear mounted and revoluble on said shaft, having its stationary member secured to said bearing substantially as and for the purpose specified and shown in the drawings.

7. The combination of a stationary bearing, with a driving-shaft projecting from and revoluble in said bearing, a sun-and-planet gear having a power-transmitting member mounted and revoluble on said projecting shaft, and means for securing its stationary member in a fixed concentric position with the said sun and planet members, substantially as and for the purpose specified and shown in the drawings.

8. A speed-reduction and driving gear having in combination a frame *c*, having a bearing *b*, and a driving-shaft journaled in and projecting from said bearing; a sun-wheel *d* secured to the shaft close to the bearing; an internal-toothed wheel *e*, means for securing it to the said frame concentrically and in line with said sun-wheel; a disk *h'*, having a recess h^2 overhanging a part of the sun-wheel, and a hub *i*, revoluble on the shaft and adapted to carry a pinion, pulley, or analogous power-transmitting member; pins *g*, a system of planet-wheels *f* rotatable on said pins; and means for retaining said hub on the shaft substantially as and for the purpose herein specified and shown in the drawings.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

JOSEPH SINCLAIR FAIRFAX.

Witnesses:
HENRY J. BROCKWELL,
HILDA R. FORSTER.