No. 787,080. PATENTED APR. 11, 1905.

W. C. CONANT.

VARIABLE SPEED GEARING.

APPLICATION FILED MAY 9, 1904.

8 SHEETS—SHEET 1.

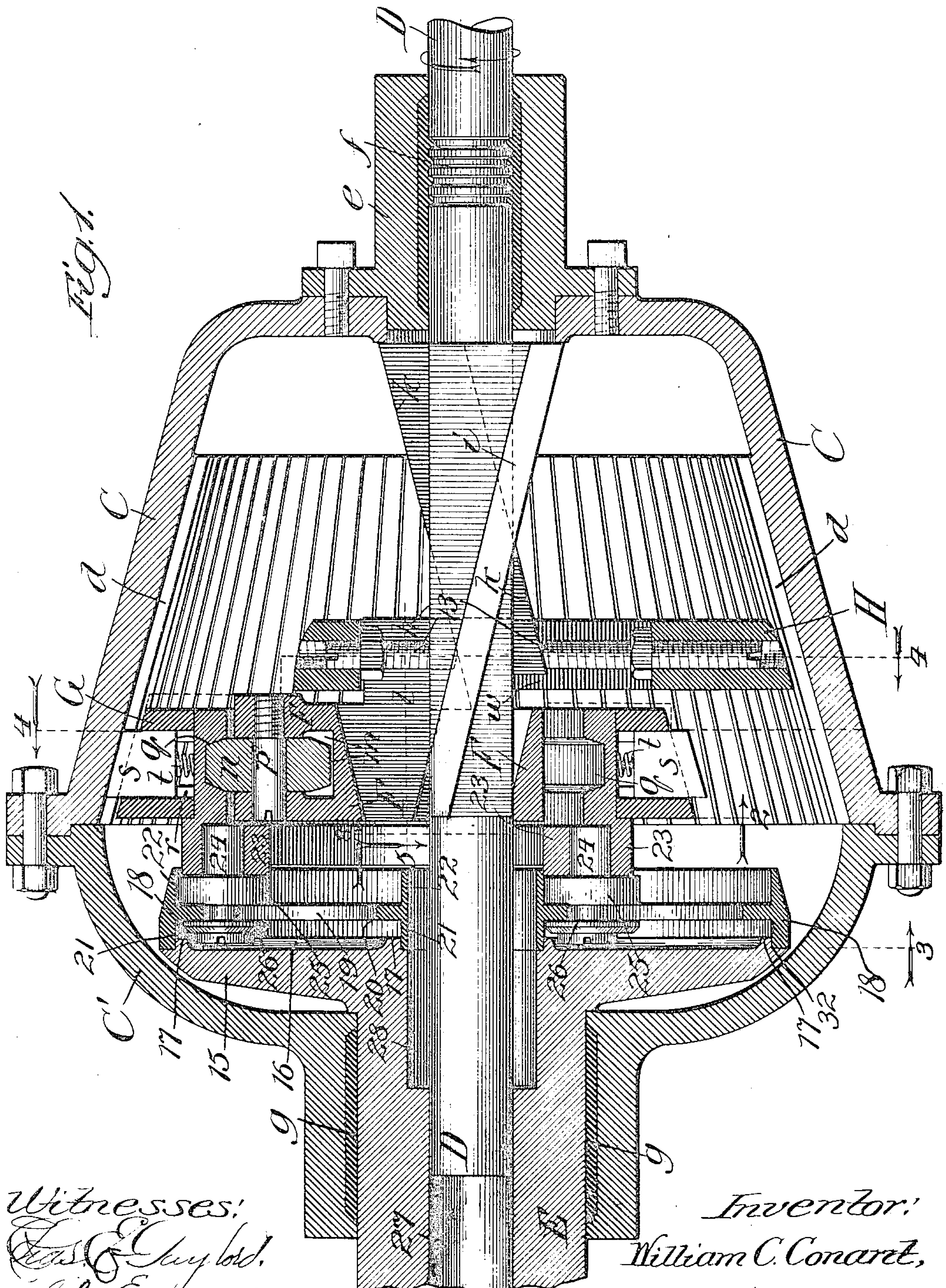

Fig. 1

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Fig. 2.

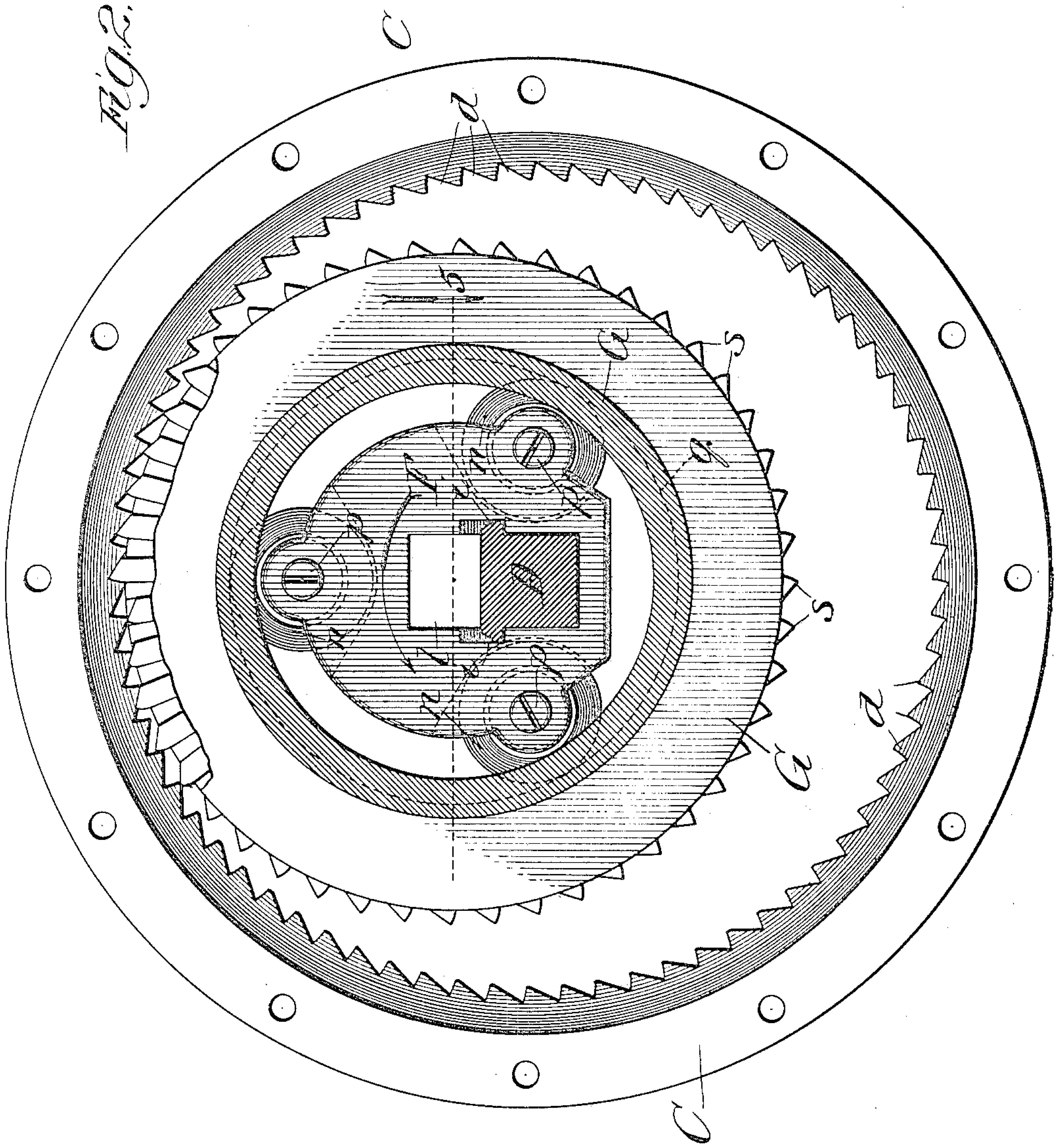

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Fig. 3.

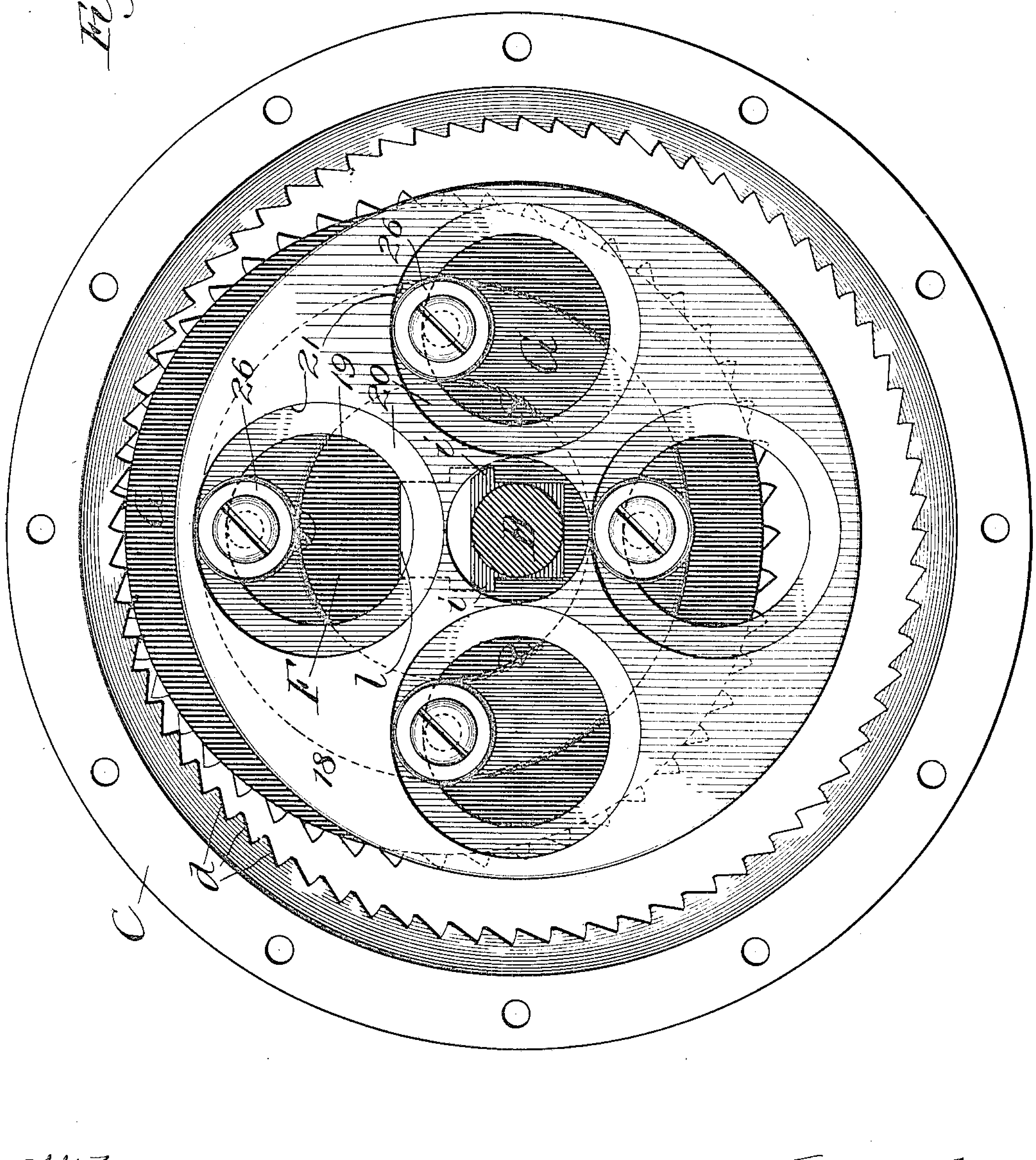

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Fig. 4.

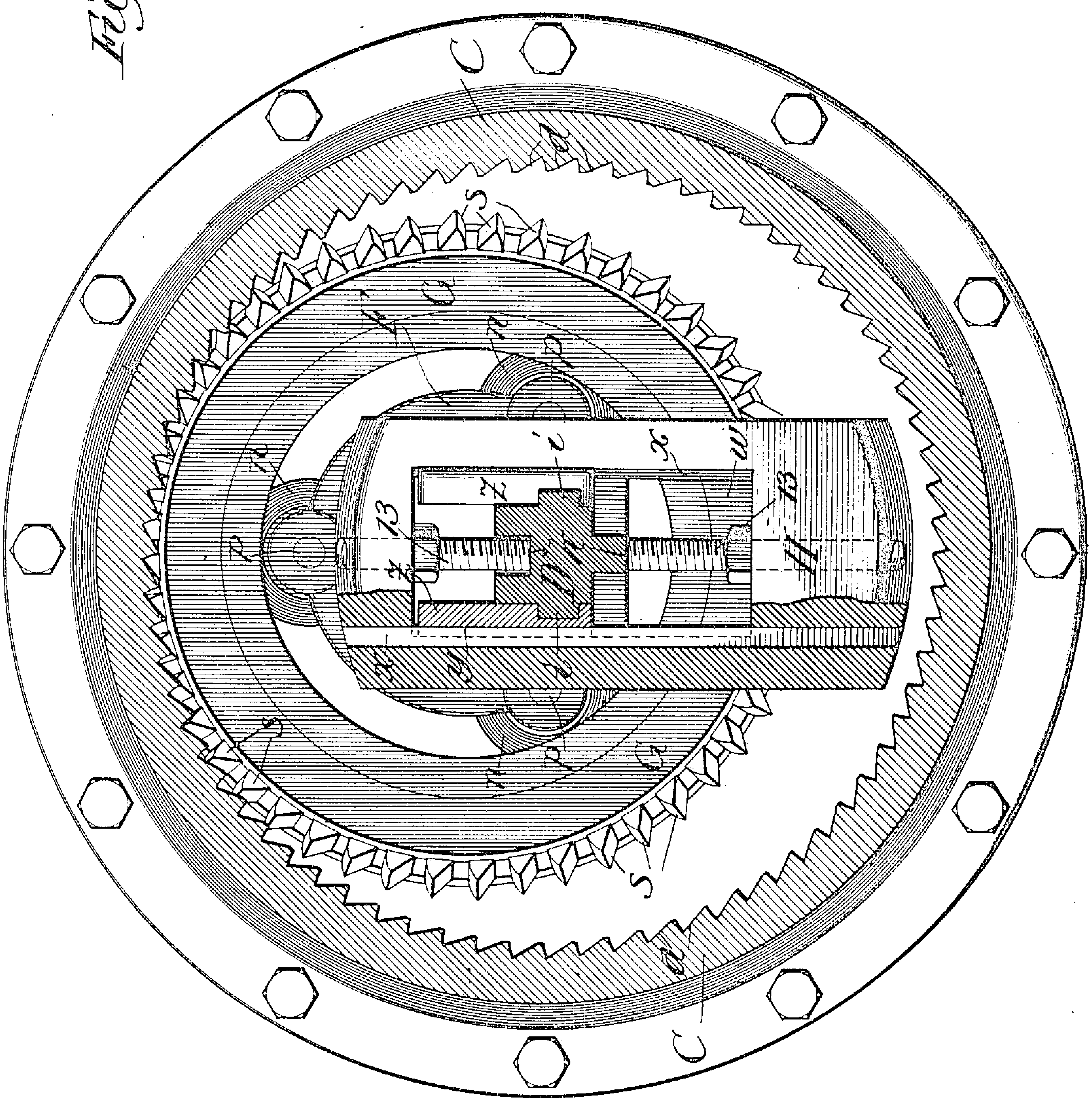

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Fig. 5.

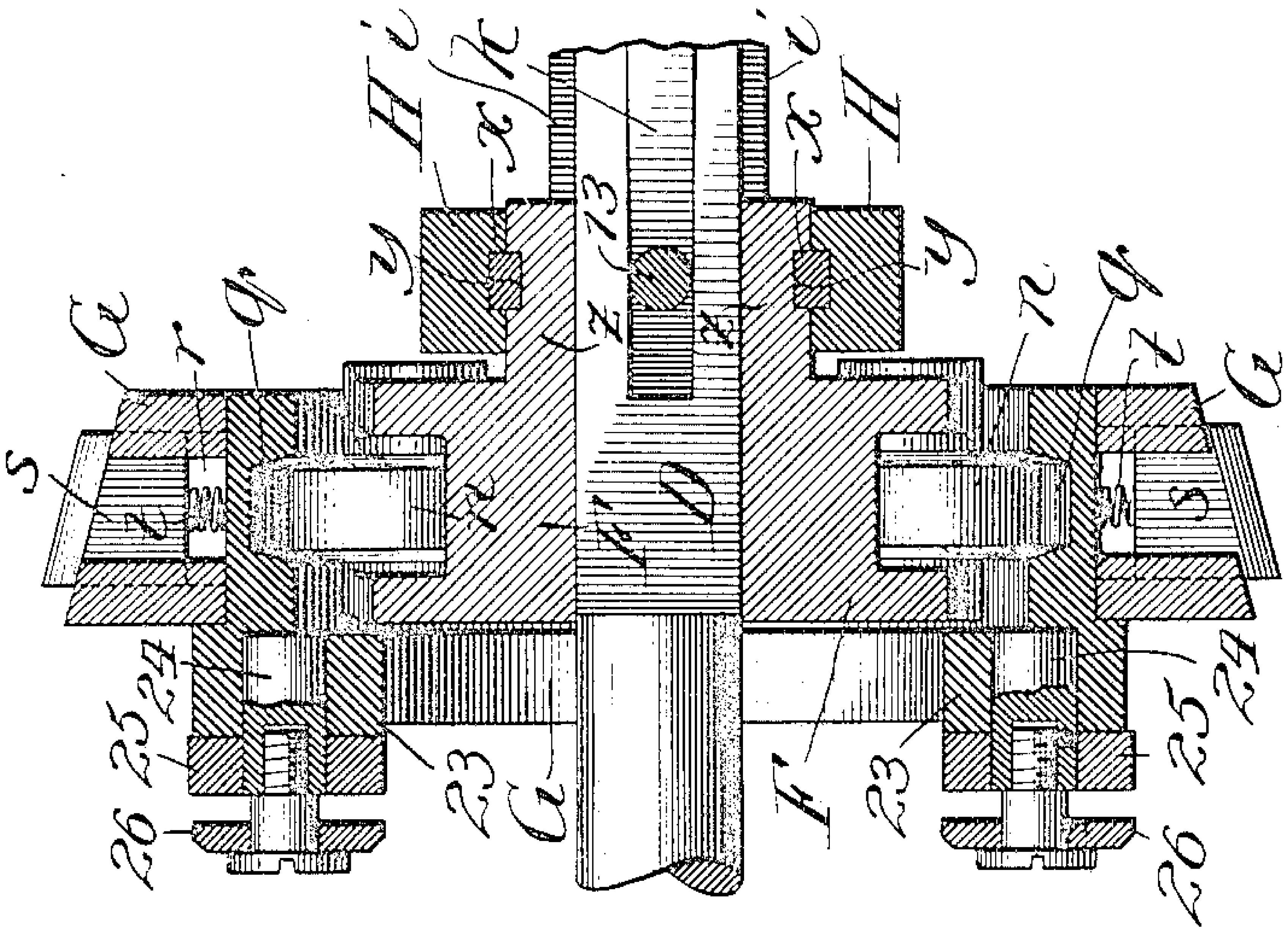


Fig. 6.

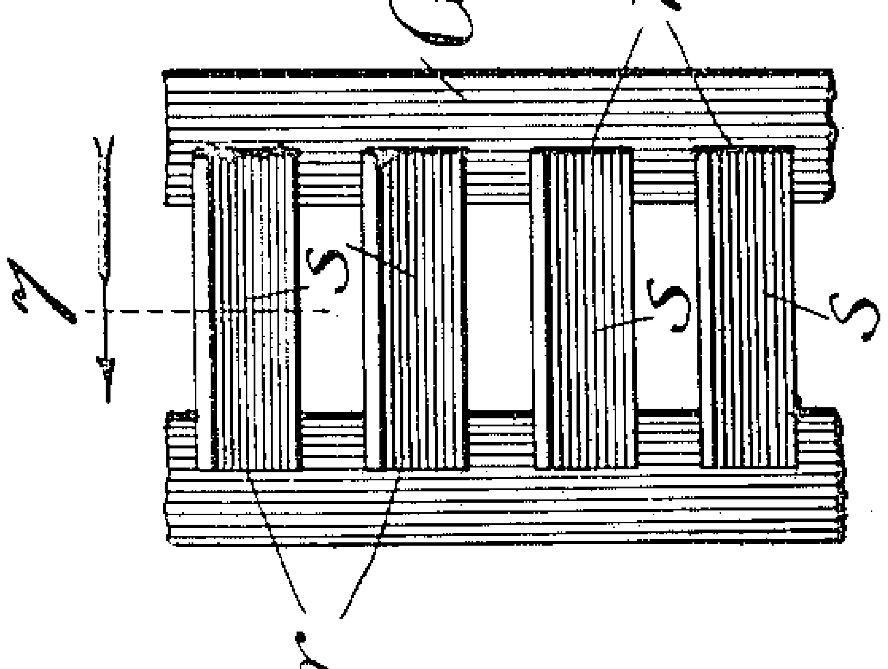


Fig. 7.

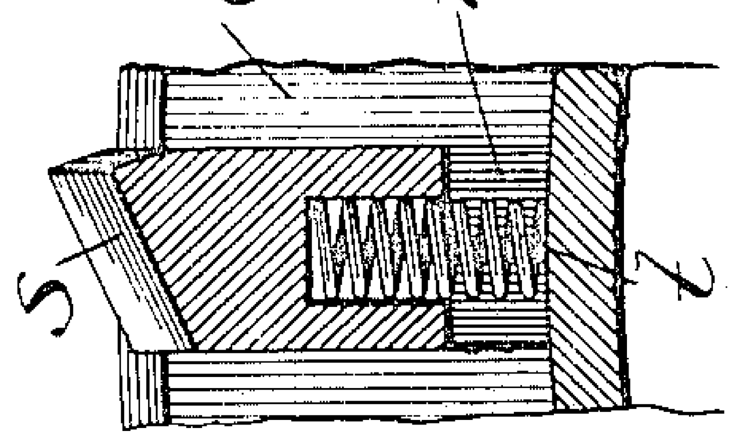
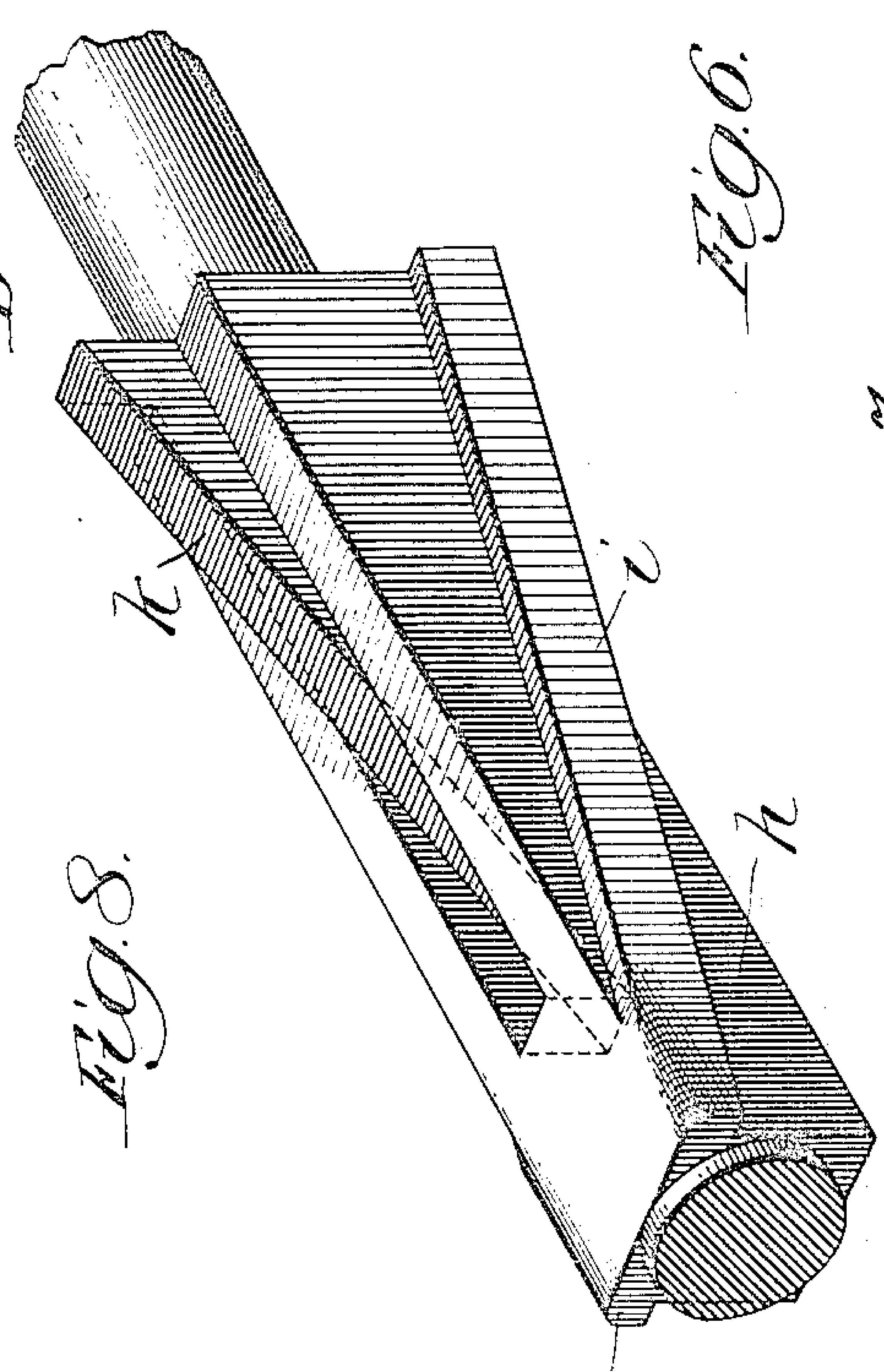


Fig. 8.



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8 SHEETS—SHEET 6.

FIG. 9.

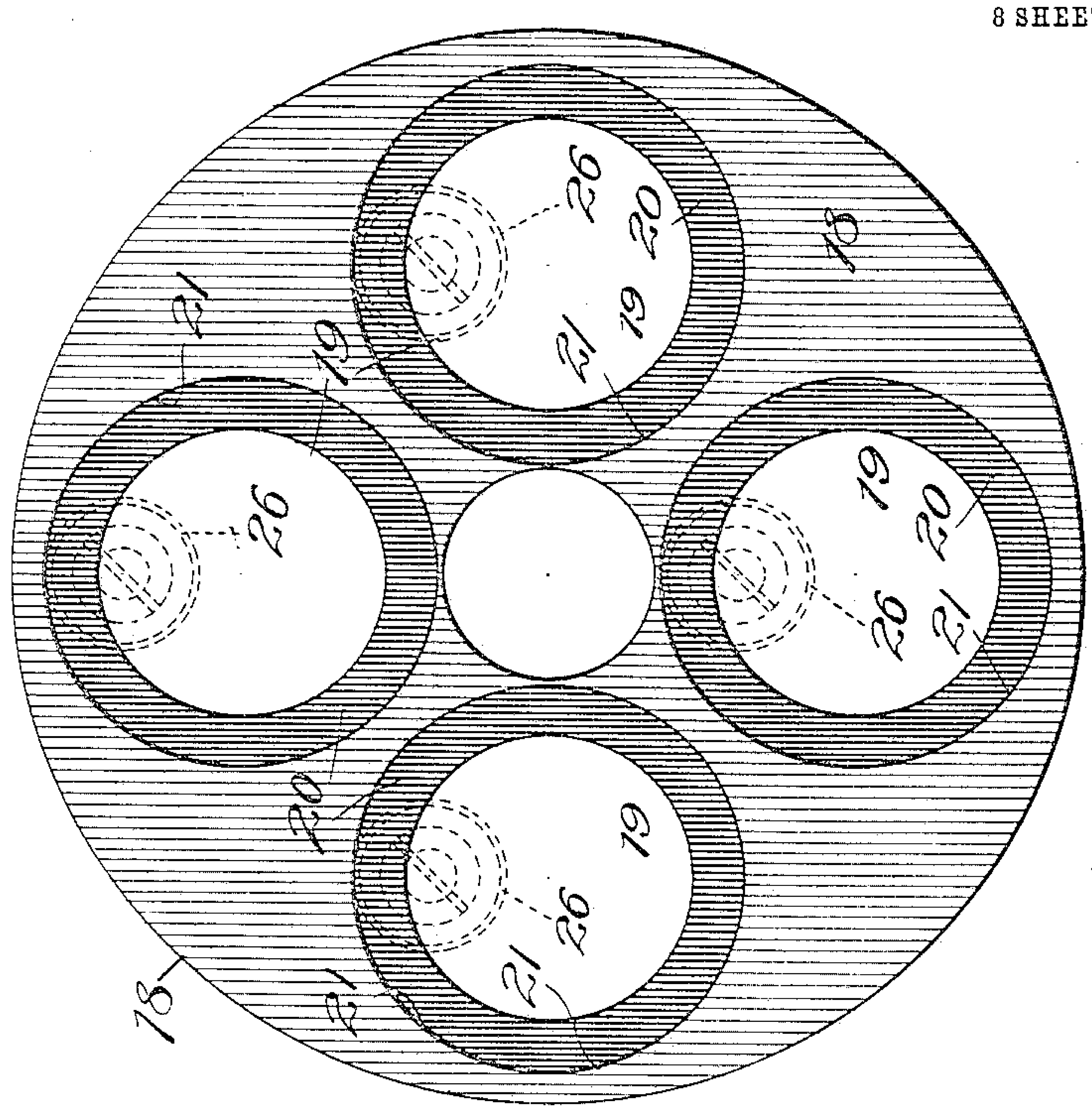
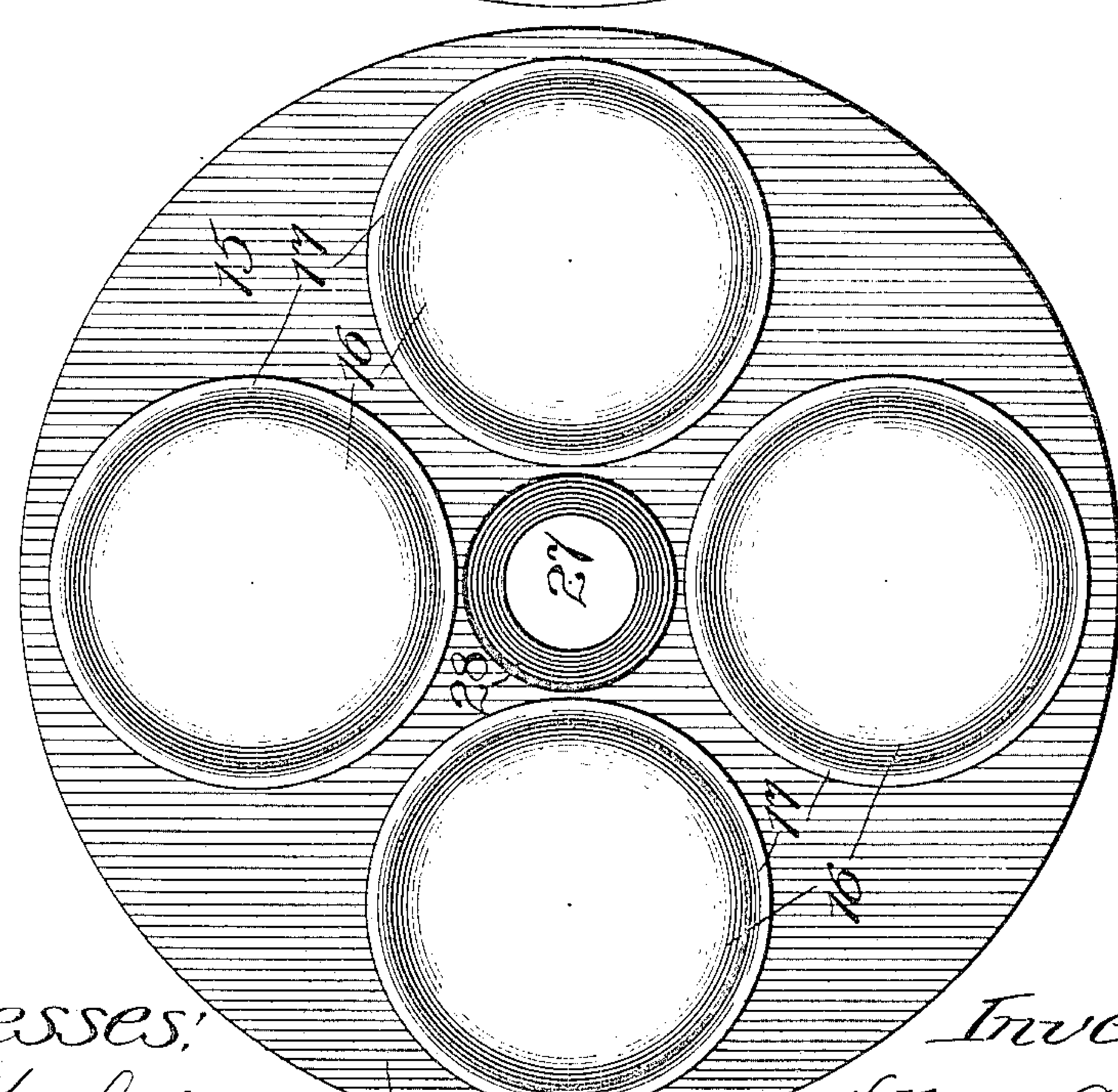


FIG. 10.



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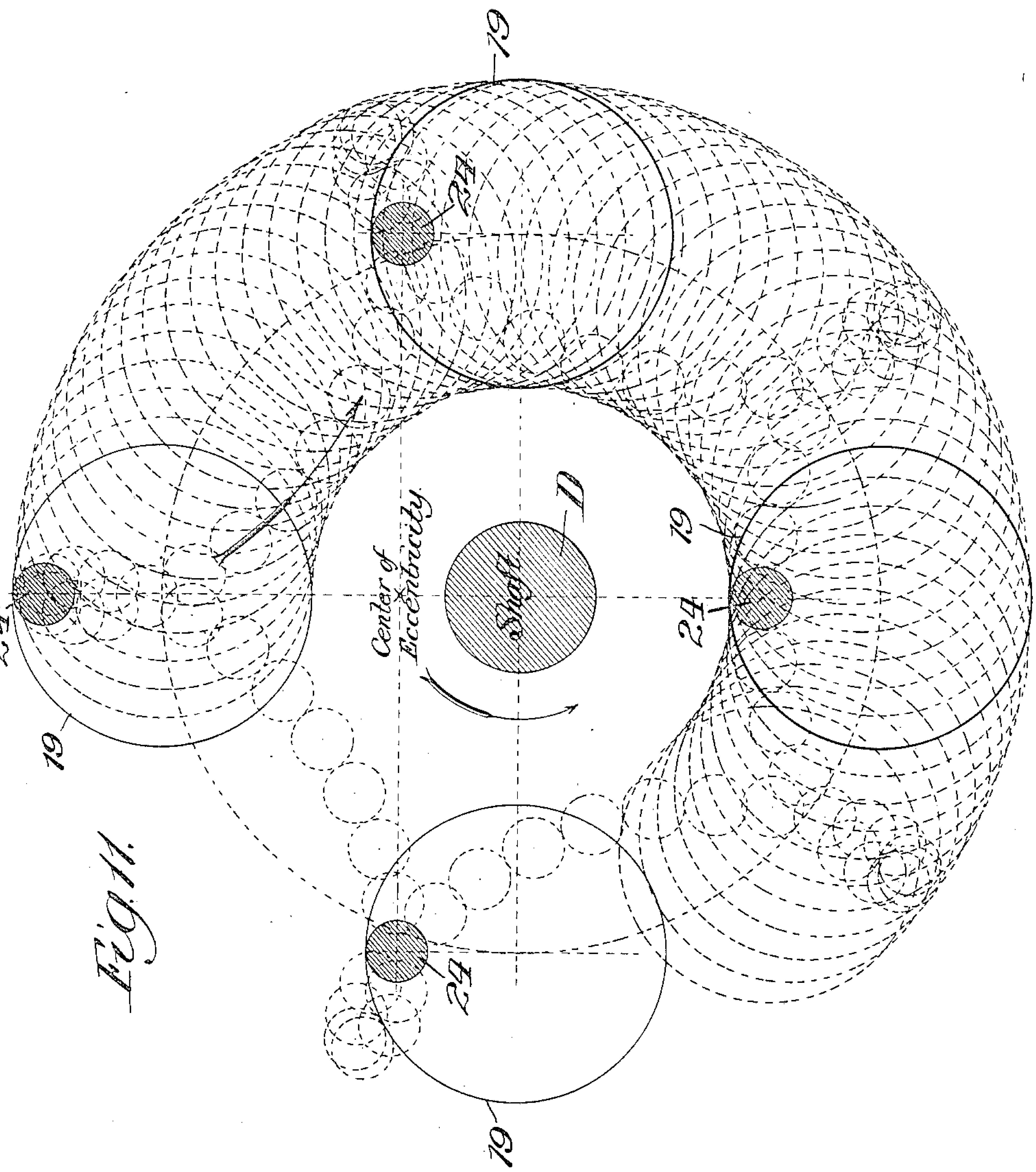

Fig. 11.

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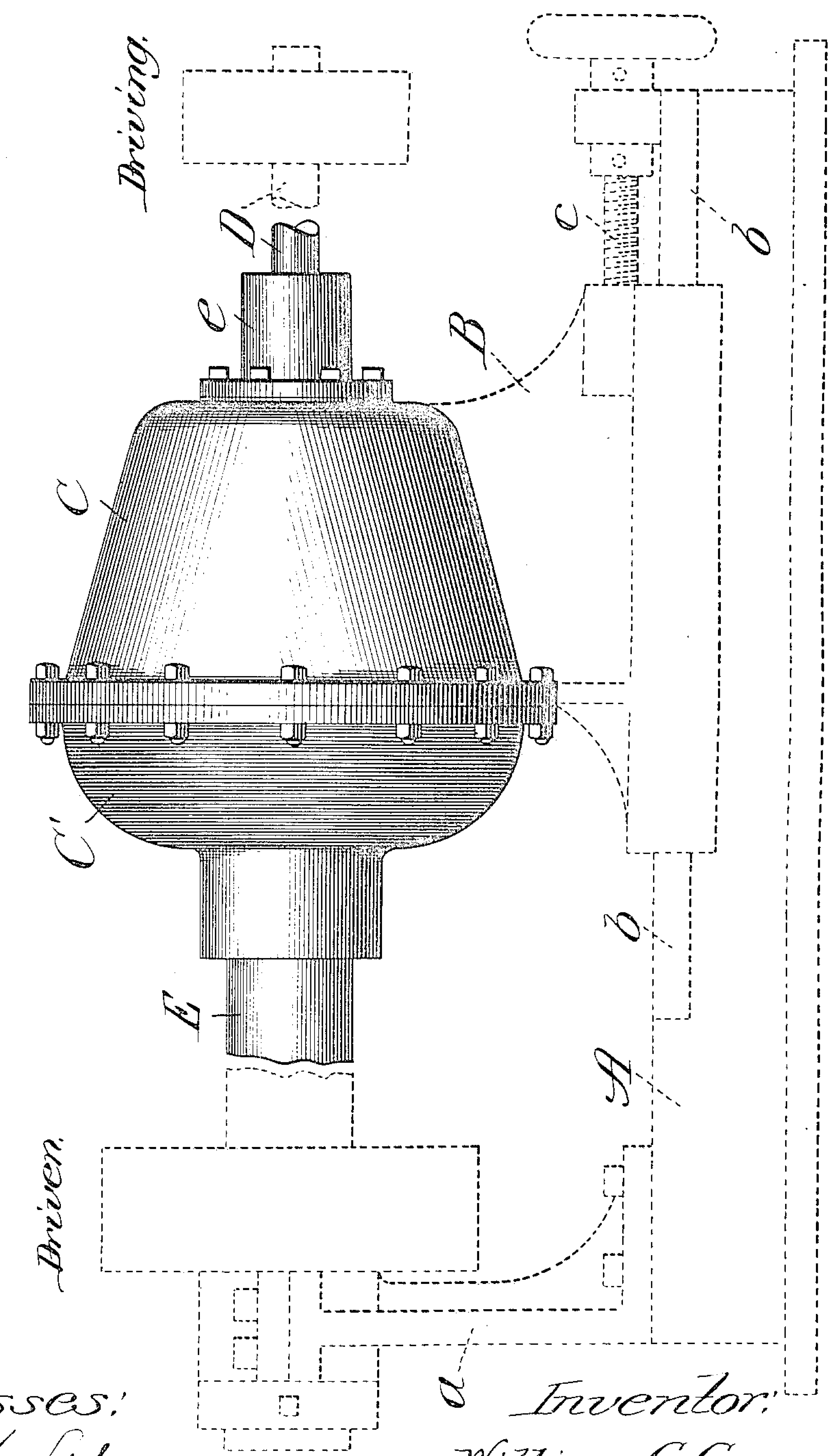
8 SHEETS—SHEET 8.

Fig. 12.



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UNITED STATES PATENT OFFICE.

WILLIAM C. CONANT, OF ATLANTA, GEORGIA.

VARIABLE-SPEED GEARING.

SPECIFICATION forming part of Letters Patent No. 787,080, dated April 11, 1905.

Application filed May 9, 1904. Serial No. 207,083.

To all whom it may concern:

Be it known that I, WILLIAM C. CONANT, a citizen of the United States, residing at Atlanta, in the county of Fulton and State of Georgia, have invented a new and useful Improvement in Variable-Speed Gearing, of which the following is a specification.

This invention relates to improvement in the construction of transmission-gear mechanism adapted to be interposed between more especially driving and driven shafts and adjustable to vary the power and speed transmitted through it to the driven shaft.

My object is to provide such a transmission-gear mechanism of generally improved construction, capable of ready adjustment to change the speed of the driven shaft throughout a comparatively wide range with relation to the driving-shaft and of effecting such changes in a smooth and gradual manner without jar.

It is further my object to embody my improvement in a compact, strong, and durable device or construction.

My invention is particularly well adapted for use upon automobiles, as well as in other connections, where the prime mover, such as a gas-engine or electric motor, runs at a constant high speed of greatest efficiency and drives the running-gear or the like at a reduced speed. In carrying out my invention I prefer to provide a drive-shaft or its equivalent having a radially-adjustable crank or eccentric cam surrounded by and forming a driving-bearing for an independently-revoluble power-transmitting or driving wheel. Surrounding the said driving-wheel is a ring or shell having an inner conoidal driving-wheel-engaging surface concentric with the said drive-shaft. The shell and driving-wheel form engaging members which are maintained in constant surface-gripping contact and so mounted with relation to each other that one may be moved independently of the other along the plane of the center of rotation of the said drive-shaft without relaxing the surface engagement between them, whereby in the rotation of the drive-shaft and its crank the said driving-wheel is rotated in the direction contrary to that of the shaft. The driven shaft is in alinement with the drive-shaft and is rotated by and in the same direction as the said driving-wheel.

The variations in speed are produced at will by adjusting the shell and driving-wheel with relation to each other along the line of the center of rotation of the shafts, the gripping engagement between the wheel and shell being always maintained to prevent slip between them. Improved means are provided for maintaining the desired gripping contact between the said engaging members, comprising in the present embodiment of my invention an annular series of longitudinally-extending relatively flaring teeth on the inner frusto-conic surface of the shell and an annular series of radially-yielding teeth upon the driving-wheel. An improved driving connection is provided between the said driving-wheel and the driven shaft, and means also of improved construction are provided for automatically balancing the adjustable crank and driving-wheel in any adjusted position along the drive-shaft.

In the construction shown in the accompanying drawings the drive-shaft and shell are moved longitudinally with relation to the said driving-wheel and driven shaft to produce the the changes of adjustment for speed variations.

Referring to the drawings, Figure 1 is a broken vertical longitudinal section through the variable-speed gearing; Fig. 2, a section on line 2 in Fig. 1 with parts broken away; Fig. 3, a section taken on line 3 in Fig. 1 with the cap or casing at that part removed; Fig. 4, a broken sectional view, the section being taken on an irregular line 4 4 in Fig. 1 and viewed in the direction of the arrows; Fig. 5, a plan section taken on line 5 in Fig. 1; Fig. 6, an enlarged broken plan view of the periphery of the driving-wheel; Fig. 7, a still further enlarged broken section taken on line 7 in Fig. 6; Fig. 8, an enlarged broke perspective sectional view of the drive-shaft, the section being taken at line 8 in Fig. 1; Fig. 9, a face view of a disk secured to a head forming the inner end of the driven shaft; Fig. 10, a face view of the head or inner end of the driven shaft; Fig. 11, a diagrammatic view illustrating the operation of the driving-ring in driving the disk shown in Fig. 9 with the head shown in Fig. 10 and the driven shaft; and Fig. 12, a view in elevation, on a reduced scale, of the variable-speed gearing device.

A means of supporting and adjusting the variable-speed device is indicated for purposes of illustration by dotted lines in Fig. 12.

A is a base carrying a pillow-block *a* and having guide-flanges *b*, on which a block B slides longitudinally, being moved by a screw *c*.

C is a shell or casing which is shown in Fig. 12 to be integral with the block B. The said shell has a frusto-conic inner surface formed with teeth *d*. On the end of the shell is a journal-bearing *e*, through which extends the drive-shaft D, and the teeth *d* extend longitudinally of the shell. Thus the apexes of the teeth *d* are not parallel with each other, but converge toward the apex of the cone of the conoidal surface. The connection at *f* between the drive-shaft and shell is such that the shaft rotates freely in the bearing, but moves longitudinally with the shell. Fastened to the large end of the shell C is a cap or shell member C', forming a bearing at *g* for a driven shaft E. As shown in Fig. 12, the driven shaft E rotates in the pillow-block *a*, but is held therein against longitudinal movement. Within the body portion C of the shell the shaft D is squared. This squared portion *h* is provided on opposite sides with feathers *i i*, extending in an inclined direction, as shown in Figs. 1 and 8. The angle of the feathers *i* with reference to the center of rotation of the drive-shaft is the same as that of the toothed conoidal surface of the shell. On the other faces of the squared portions *h* of the shaft are guide-surfaces *k*, parallel with each other and of the same pitch with reference to the center of rotation as the feathers *i*, but in a plane at right angles thereto. Surrounding the shaft D is a radially-adjustable block F, which when not concentric with the shaft operates as a crank or eccentric cam. It is provided with an opening *l* through it, formed with guide-grooves fitting the feathers *i* of the drive-shaft. The connection between the shaft and crank F is such that the shaft turns the crank, but may be moved longitudinally through it, and in such movement guides the crank at its most eccentric side parallel with the adjacent surface of the conoidal shell. The crank F is formed in its periphery with recesses *m*, in which are journaled rollers *n* on bearing-pins *p*.

G is a driving-wheel provided in its inner circumferential face with an annular recess *q*, into which the rollers *n* extend to form an antifriction-bearing around which the wheel rotates. The wheel G is formed in its peripheral bell-shaped or conical face with an annular series of sockets *r*, containing radially-movable plunger-teeth *s*, held normally in extended position by springs *t* and having outer edges parallel with said face. The wheel G rotates freely upon the rollers *n*, eccentrically with relation to the drive-shaft, and thus gyrates with its most eccentric point or part at all times close to the toothed surface of the shell, whereby one or more of its teeth will extend in engaging contact with one or more of the teeth of the shell. When the shell and drive-shaft are shifted longitudinally by means of the screw *c*, the shaft in sliding through the crank F moves the latter by means of the feathers *i* radially toward or away from the center of rotation of the shaft in a manner to maintain the most eccentric point of the driving-wheel G at the same distance at all times from the conoidal surface of the shell.

H is a radially-adjustable counterweight for the crank F and eccentric wheel G. It comprises a block having a rectangular opening *w* through it. At opposite sides of the opening *w* are inward-projecting splines *x*, which engage grooves *y* in two projecting flanges *z* on the adjacent face of the crank F. Passing through opposite ends of the counterweight H are adjusting-screws 13, which at their inner ends engage the parallel surfaces *k* on the shaft D. The ends of the screws are in sliding contact with the surfaces *k*, and in the movement of the shaft and shell in the longitudinal direction the counterweight is slid radially inward or outward in the direction contrary to the radial movement of the crank and eccentric wheel. Thus as the said crank and wheel are shifted toward the center of rotation of the shaft the counterweight is also shifted toward the center of rotation, and vice versa. It will be seen, therefore, that whatever the adjustment of the eccentric with reference to the drive-shaft it will be counterbalanced at all times by the counterweight H.

15 is a disk-shaped head integral with the driven shaft E. It is provided in its inner face with four shallow circular recesses or clearance-spaces 16, surrounded by annular ribs or tongues 17, as shown in Figs. 1 and 10. Fitting against the head 15 is a disk 18, provided with four circular openings 19 through it registering with the recesses 16 in the lead 15. The disk 18 fits flat against the face of the disk or head 15, and around the openings 19 are central narrow ribs 20, flanked by annular recesses around the openings 19. The circumferential walls of the recesses nearest the head 17 form annular bearing-surfaces 21, and the circumferential walls of the other recesses form annular bearing-surfaces 22. On the wheel G are four bearing-sockets 23, in which are fastened four short shafts 24, extending through the openings 19 in the disk 18. Journaled on the shafts 24 are rollers 25, in contact with the annular surfaces 22, and rollers 26, in contact with the annular surfaces 21. Each pair of rollers 25 26 loosely embraces the respective rib 20, and the disk 18 is held tightly by the head 15. Thus there

is no material relative longitudinal play between the head 15, wheel G, and intermediate parts.

In the turning of the drive-shaft D the crank F turning upon the center of rotation of the drive-shaft swings the driving wheel or member G around the same center, while the wheel is maintained in engagement with the conoidal surface of the other member or shell C. The wheel is thus given angular movement around the crank F at a comparatively slow speed in the direction opposite the direction of rotation of the drive-shaft. The rollers 25 26 engaging the surfaces 22 21 turn the disk 18, and consequently the head 15 and shaft E, in the same direction as the driving-wheel G, the curve or path of movement of the rollers 25 26 in the openings 19 while driving the said disk and head being a hypocycloid, as indicated for purposes of illustration in the diagram Fig. 11. The driving engagement between the driving-wheel and driven shaft is such that in the revolutions of the said wheel at least one pair of rollers 25 26 will at all times be in driving contact with surfaces 22 21, and the driving is performed smoothly and with a minimum amount of friction.

According to the construction of my invention, as illustrated in Fig. 1, the drive-shaft and shell may be shifted to the left from the position shown until the drive-wheel G is adjusted to a position concentric with the drive-shaft, the figures showing the wheel in the position of greatest eccentricity. The teeth *s* may be sufficiently numerous to cause at least one thereof to be engaged by a tooth *d* in driving relation without slip or with but a very slight slip while in any position of adjustment. Those teeth *s*, which cannot enter to the full extent the serrations *d* are more or less retracted against their springs by the pressure in the radial direction of the serrated surface of the shell.

In the movement of the shell C and cap C′ the latter slides readily along the driven shaft, and the said shaft has a bore 27, in which the cylindrical part of the shaft D beyond the squared portion *h* may slide and rotate. In the end portion of the driven shaft the bore is enlarged, as indicated at 28, to surround the path of rotation of the splines or feathers *i* on the squared portion of the shaft, which in adjustments for speed variations may slide into said enlargement.

The drawings show the member or wheel G in the position of greatest eccentricity with relation to the drive-shaft and member or shell C, in which position the diameter of the wheel G is approximately four-fifths that of the surface of the shell which it engages. Movement of the block or crank counter clockwise causes the wheel G to be moved bodily counter clockwise at the speed of the crank and owing to its engagement with the shell to be given angular movement clockwise at a speed, in this adjustment, approximating one-fourth that of the crank and drive-shaft. Thus in the construction shown the members when adjusted as illustrated will cause the driven shaft to rotate once clockwise with approximately every four rotations counter clockwise of the drive-shaft. As the drive-shaft and shell are shifted toward the left in Fig. 1 the eccentricity of the wheel G and diameter of the shell-surface engaged thereby diminish proportionately, with proportionate decrease in relative angular movement and consequent increase of torque of the wheel G and driven shaft. This shifting movement may progress until the wheel G is concentric with the drive-shaft and shell, at which time turning of the drive-shaft will turn the block F in the wheel G without imparting any motion to the latter or consequently to the shaft E. By shifting the drive-shaft and shell from the last-named position and in the direction contrary to that stated the shaft E may be started at very slow speed and the speed then increased as desired.

The gist of my invention lies in providing a variable-speed gearing formed with a pair of engaging members, one or both of which rotates, one said member of relatively small diameter engaging the other said member of relatively larger diameter, and means for changing the relative engaging diameters of the members while maintaining positive driving engagement between them. Mere frictional engagement between the members would not effect the positive driving engagement desired. The drawings show but one embodiment of my improvements where a comparatively short range of power and speed variation is provided for. Of course the shell or its equivalent may be of any desired length and its conoidal surface of any desired pitch with reference to the drive-shaft's center of rotation, other parts of the mechanism being constructed to correspond. Thus the range of adjustment for speed variations may be greatly increased.

While I have alluded to the shaft D as the "drive-shaft," the power may be applied to the shaft E to drive the shaft D through the variable-speed gearing.

It will be obvious that a change in construction employing a driving wheel or drum with an elongated conoidal engaging face and a surrounding stationary short-faced toothed ring in lieu of the shell would together constitute a mere reversal and equivalent of the construction shown. This would also be the case if the surrounding ring or shell were provided with yielding teeth instead of or as well as the drive-wheel. If desired, the shell and shaft D may be held against longitudinal movement, and adjustments for speed variations brought about by shifting the driven wheel and attendant parts, and various other changes may be made in details of construction without departing from the spirit of my invention as defined by the claims.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination with driving and driven bodies, of variable-speed gearing interposed between them, having toothed engaging members one of which meshes with and rolls upon the other and is operatively connected with both of said bodies, the members being adjustable one with relation to the other to gradually change the relative diameters of their meshing surfaces.

2. The combination with driving and driven bodies, of variable-speed gearing interposed between them having toothed engaging members one of which moves as a planet-wheel meshing with and rolling against the other, the members being adjustable one with relation to the other to gradually change the relative diameters of their toothed engaging surfaces.

3. In a variable-speed gearing, the combination of an internally-toothed ring forming one of a pair of engaging members, a rotary toothed wheel having an eccentrically-moving axis within the said ring and forming the other engaging member, the toothed engaging face of one member being conoidal and longer than the toothed engaging part of the other member, and means for moving one of said members longitudinally with relation to the other while maintaining them in mesh.

4. In a variable-speed gearing, the combination of a ring forming one of a pair of engaging members and having an internal toothed frusto-conical engaging face, a toothed rotary wheel having an eccentrically-moving axis within said ring and forming the other engaging member, and means for moving one of said members longitudinally with relation to the other while maintaining them in mesh.

5 In a variable-speed gearing, the combination of an internally-toothed ring forming one of a pair of engaging members, a peripherally-toothed rotary wheel eccentrically mounted within said ring and forming the other engaging member, the engaging face of one of said members being conoidal and longer than the engaging part of the other member, and means for moving one of said members longitudinally with relation to the other, while maintaining them in driving engagement.

6. In a variable-speed gearing, the combination of an internally-toothed ring forming one of a pair of engaging members, a peripherally-toothed rotary wheel eccentrically mounted within said ring and forming the other engaging member the teeth of one member being radially yielding and the engaging face of one member being conoidal and longer than the engaging part of the other member, and means for moving one of said members longitudinally with relation to the other while maintaining them in driving engagement.

7. In a variable-speed gearing, the combination of a ring having an internal conoidal surface provided with longitudinally-extending teeth and forming one of a pair of engaging members, a rotary wheel having peripheral radially-yielding teeth and eccentrically mounted within said ring and forming the other engaging member, and means for moving one of said members longitudinally with relation to the other while maintaining them in driving engagement.

8. In a variable-speed gearing, the combination of an internally-toothed ring forming one of a pair of engaging members, a peripherally-toothed rotary wheel eccentrically mounted within said ring and forming the other engaging member, the teeth of one member being radially yielding, the teeth of the other member being of ratchet form and the engaging face of one member being conoidal, and means for moving one of said members longitudinally with relation to the other while maintaining them in driving engagement.

9. In a variable-speed gearing, the combination of a rotary shaft, engaging members comprising an internally-toothed ring and a toothed wheel eccentrically and rotatably mounted on said shaft within and meshing with the ring, one of said members having a conoidal engaging surface longer than the engaging part of the other member, means for moving one of said members longitudinally with relation to the other while maintaining their engagement, and a second shaft operatively connected with said wheel.

10. In a variable-speed gearing, the combination of a rotary shaft, engaging members comprising a ring and an independently-rotating wheel eccentrically mounted on said shaft within the ring, one of said members having a conoidal engaging surface longer than the engaging part of the other member, means for moving one of said engaging members longitudinally with relation to the other while maintaining their engagement, means for preventing angular slip of the driving-wheel against the ring, and a second shaft operatively connected with said wheel.

11. In a variable-speed gearing, the combination of a rotary shaft, a radially-adjustable peripherally-toothed eccentric wheel loosely journaled about said shaft, a non-rotatable internally-toothed ring about said wheel, said wheel and ring forming engaging members relatively adjustable longitudinally, one member being longer than the other and having a conoidal engaging surface and the teeth of one member being radially yielding, a second rotary shaft and a connection between said eccentric wheel and said second shaft.

12. In combination with driving and driven shafts, a variable-speed gearing having an ec-

centric toothed wheel operatively connected with one of said shafts and mounted on the other of said shafts to rotate independently thereon and forming one of a pair of meshing members, an internally-toothed ring about said wheel forming the other member, the toothed engaging face of one member being conoidal and longer than the engaging part of the other member, and means for shifting one of said members longitudinally of the other while maintaining them in mesh.

13. In combination with driving and driven shafts, a variable-speed gearing having a radially-adjustable eccentric wheel operatively connected with one of said shafts and mounted on the other said shaft to rotate independently thereon and forming one of a pair of engaging members, a ring about said wheel forming the other of said members, the engaging face of one member being conoidal and longer than the engaging part of the other member, an adjustable counterbalance for said eccentric wheel, means for shifting one of said members longitudinally of the other while maintaining the engagement between them, and means for shifting the counterbalance, substantially as and for the purpose set forth.

14. In a variable-speed gearing, the combination of a rotary shaft, a shell having an internal conoidal surface, about and concentric with said shaft, provided with longitudinally-extending teeth and forming one of a pair of engaging members, an inclined guide on the said shaft at the same pitch as the conoidal surface of the shell, a cam slidably mounted on said guide, an eccentric drive-wheel, forming the other engaging member, journaled on said cam and provided with peripheral radially-yielding teeth engaging said longitudinally-extending teeth, a second shaft, a driving connection between said drive-wheel and second shaft, and means for moving one of said members longitudinally with relation to the other and at the same time sliding the cam upon said guide, substantially as and for the purpose set forth.

15. In a variable-speed gearing, the combination of a rotary shaft, a shell having an internal conoidal surface about and concentric with said shaft, provided with longitudinally-extending teeth and forming one of a pair of engaging members, inclined guides on the said shaft at the same pitch as the conoidal surface of the shell but at right angles to each other, a cam slidably mounted on one of said guides, an eccentric drive-wheel forming the other engaging member, journaled on said cam and provided with peripheral radially-yielding teeth engaging said longitudinally-extending teeth, an adjustable counterbalance for the cam and eccentric slidably mounted on the other of said guides, a second shaft, a driving connection between said drive-wheel and second shaft, and means for moving one of said members longitudinally with relation to the other and at the same time sliding the said cam and counterbalance upon said guides, substantially as and for the purpose set forth.

16. The combination with driving and driven bodies, of variable-speed gearing interposed between them having engaging members one of which moves as a planet-wheel rolling against the other, the members being adjustable one with relation to the other to gradually change the relative diameters of their engaging surfaces, and a driving connection between one of the said bodies and the said rolling member, comprising a disk on the one having a plurality of circular bearing-openings, and rollers on the other of smaller diameter than said openings and engaging the same.

17. The combination with driving and driven bodies, of variable-speed gearing interposed between them having engaging members one of which moves as a planet-wheel rolling against the other, the members being adjustable one with relation to the other to gradually change the relative diameters of their engaging surfaces, and a driving connection between one of the said bodies and the said rolling member, comprising a disk on the said body having a plurality of circular bearing-openings, and rollers on the said rolling member of smaller diameter than said openings and engaging the same.

18. In a power-transmitting gear, the combination of a gear member free to rotate upon its own axis and also to gyrate, said gear member having a toothed contact-surface, a nonrevoluble member provided with a toothed contact-surface of substantially conical shape engaged by said contact-surface of said gear member, means for shifting the general position of said non-revoluble member relatively to said gear member, and mechanism connected with said gear member for transmitting power to or from the same.

19. In a power-transmitting gear, the combination of a driving member and a driven member connected in operative engagement with each other by means of toothed, meshing, changeable-diameter contact-surfaces, one of said members having a gyratory movement and also a rotary movement, the other of said members being acted upon in response to said gyratory movement, and means for shifting one of said members bodily in relation to the other.

20. In a power-transmitting gear, the combination of a gear member free to rotate upon its own axis and also to gyrate, said gear member having a toothed contact-surface, a nonrevoluble member provided with a toothed contact-surface of substantially conical shape engaged by said contact-surface of said gear member, means for bodily shifting one of said members with relation to the other while maintaining them in mesh, and mechanism connected with said gear member for transmitting power to or from the same.

21. In a power-transmitting gear, the combination of a toothed gear member, means for actuating said gear member so as to cause the same to gyrate, toothed mechanism meshing with said gear member in its gyrations for the purpose of causing said gear member to rotate upon its own axis at a speed independent of said gyrations, rotary mechanism connected with said gear member and having a positive motion in accordance with the rotation thereof, and mechanism controllable at will for shifting the position of said gear member relatively to said mechanism engaged thereby, for the purpose of varying the relative speed therebetween.

22. In a power-transmitting gear, the combination of a gear member free to rotate upon its own axis and also to gyrate, said gear member having a toothed contact-surface, a second member having a toothed contact-surface meshing with that of said gear member and adapted to coact therewith for changing the speed thereof according to the positions of said gear member and said second member relatively to each other, means for transmitting power to or from said gear member, and mechanism for controlling the positions of said gear member and said second member relatively to each other.

23. In a power-transmitting gear, the combination of a gear member free to rotate upon its own axis and also to gyrate, said gear member having a toothed contact-surface, a second member having a toothed contact-surface meshing with said contact-surface of said gear member and adapted to coact therewith for changing the speed thereof according to the positions of said gear member and said second member relatively to each other, means for transmitting power to or from said gear member, and mechanism controllable at will for shifting said gear member bodily in relation to said second member.

24. In a power-transmitting gear, the combination of a gear member free to rotate upon its own axis and also to gyrate, said gear member having a toothed contact-surface, a second member having a toothed contact-surface meshing with said contact-surface of said gear member and adapted to coact therewith for changing the speed thereof according to the positions of said gear member and said second member relatively to each other, means for transmitting power to or from said gear member, and shifting mechanism connected with both said gear member and with said second member and controllable at will for shifting the same relatively to each other.

25. In a power-transmitting gear, the combination of a gear member free to rotate upon its own axis and also to gyrate, said gear member having a toothed contact-surface, a second member having a toothed contact-surface meshing with said contact-surface of said gear member, thereby causing said gear member to rotate as aforesaid upon its own axis, a shaft connected with said gear member for transmitting power to or from the same, and another shaft connected with said last-mentioned shaft and having a rotary movement corresponding to the gyratory movement of said gear member.

WILLIAM C. CONANT.

In presence of—
HARRY W. ANDERSON,
HARRY LESLIE WALHER.