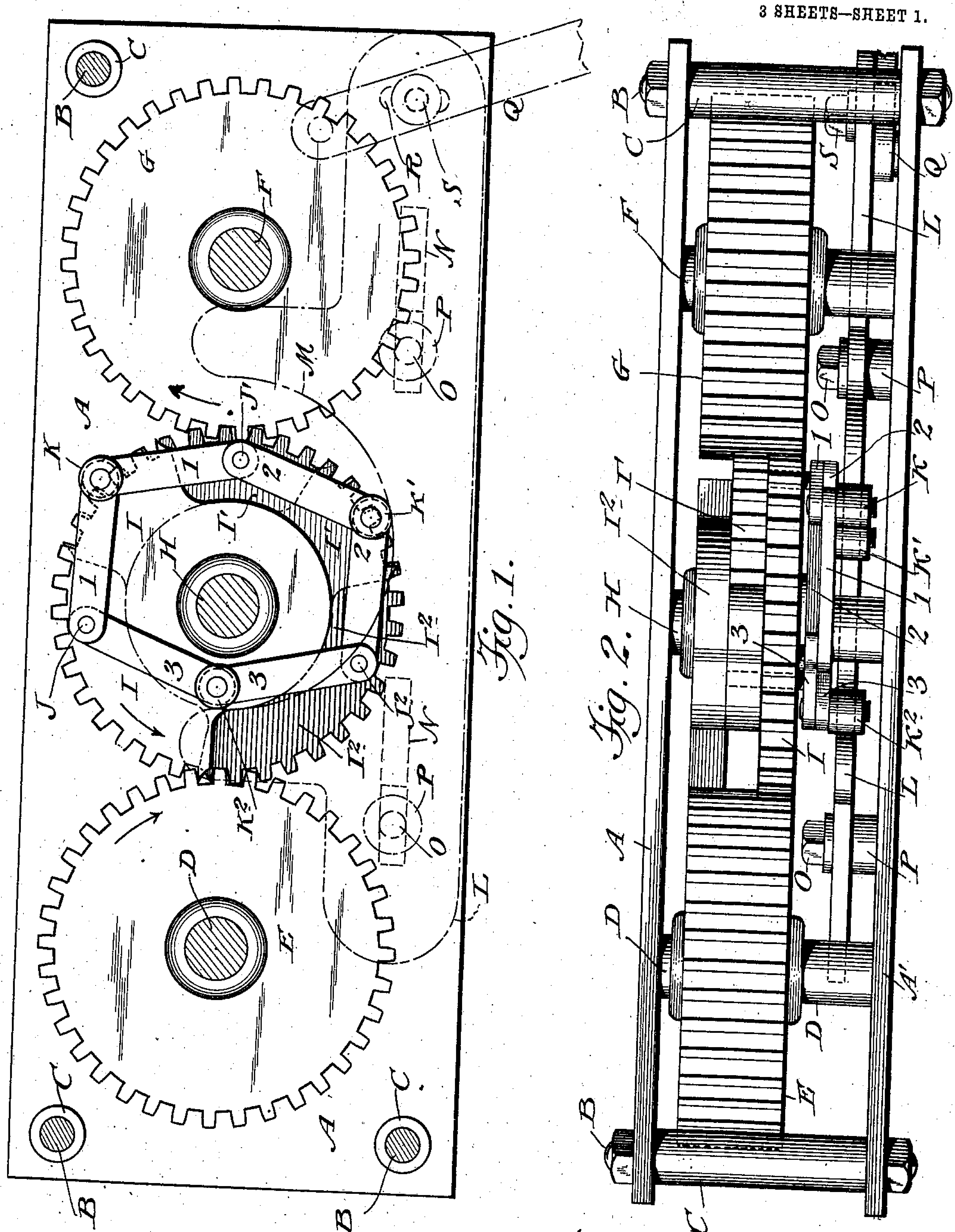
No. 827,119. PATENTED JULY 31, 1906.

A. W. PUPKE.

VARIABLE SPEED MECHANISM.

APPLICATION FILED OCT. 3, 1905.

3 SHEETS—SHEET 1.



Witnesses
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THE NORRIS PETERS CO., WASHINGTON, D. C.

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Fig. 3.

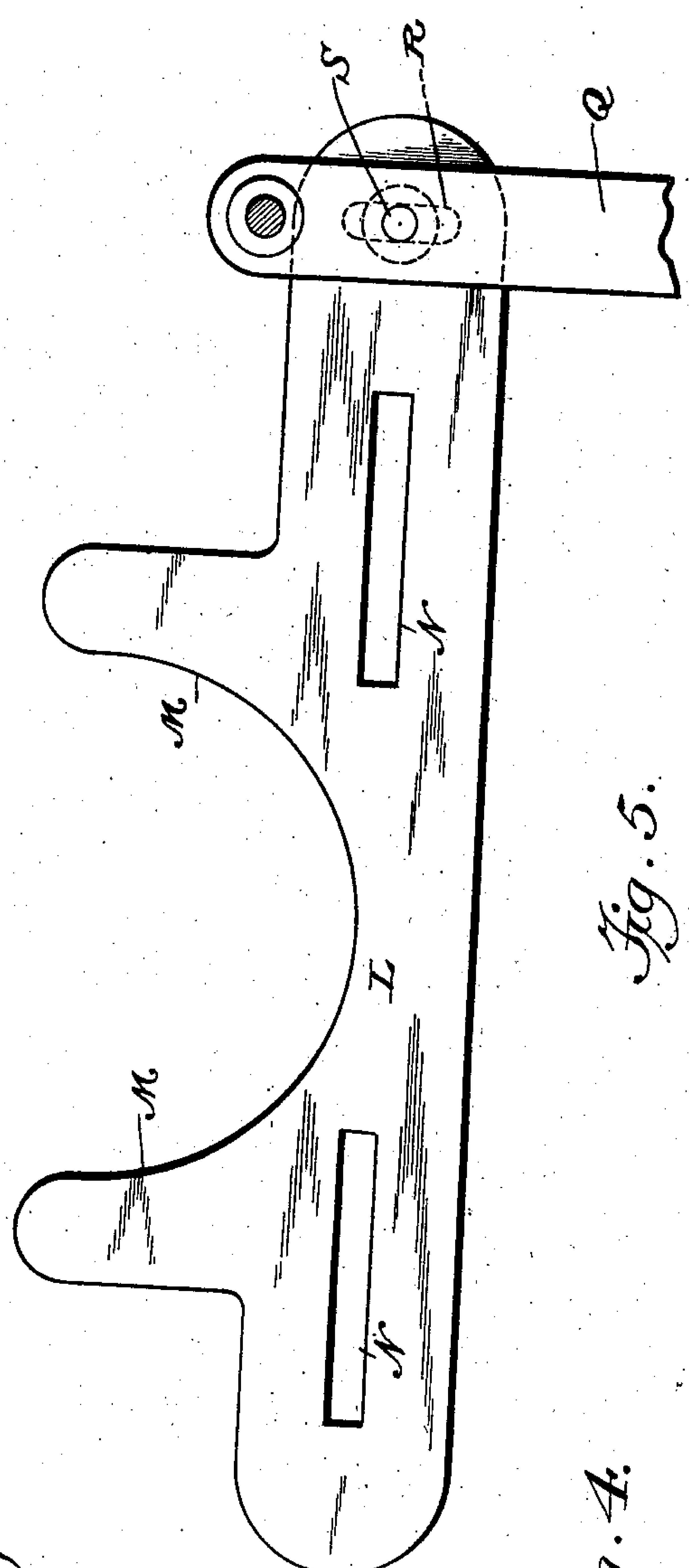


Fig. 6.

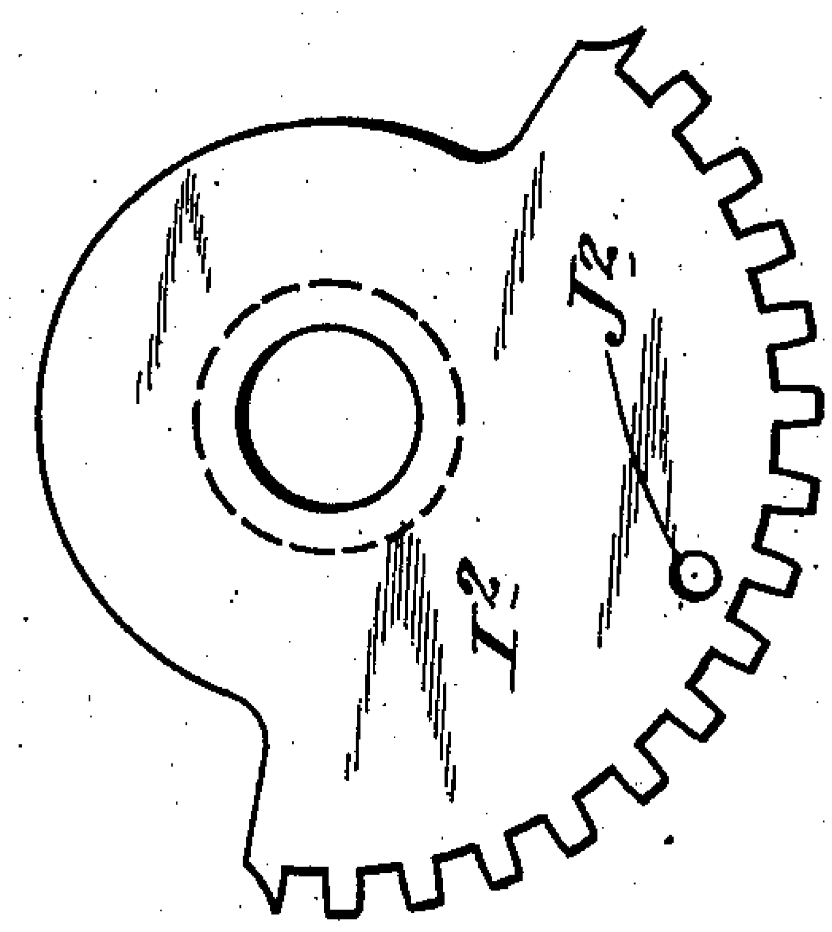


Fig. 5.

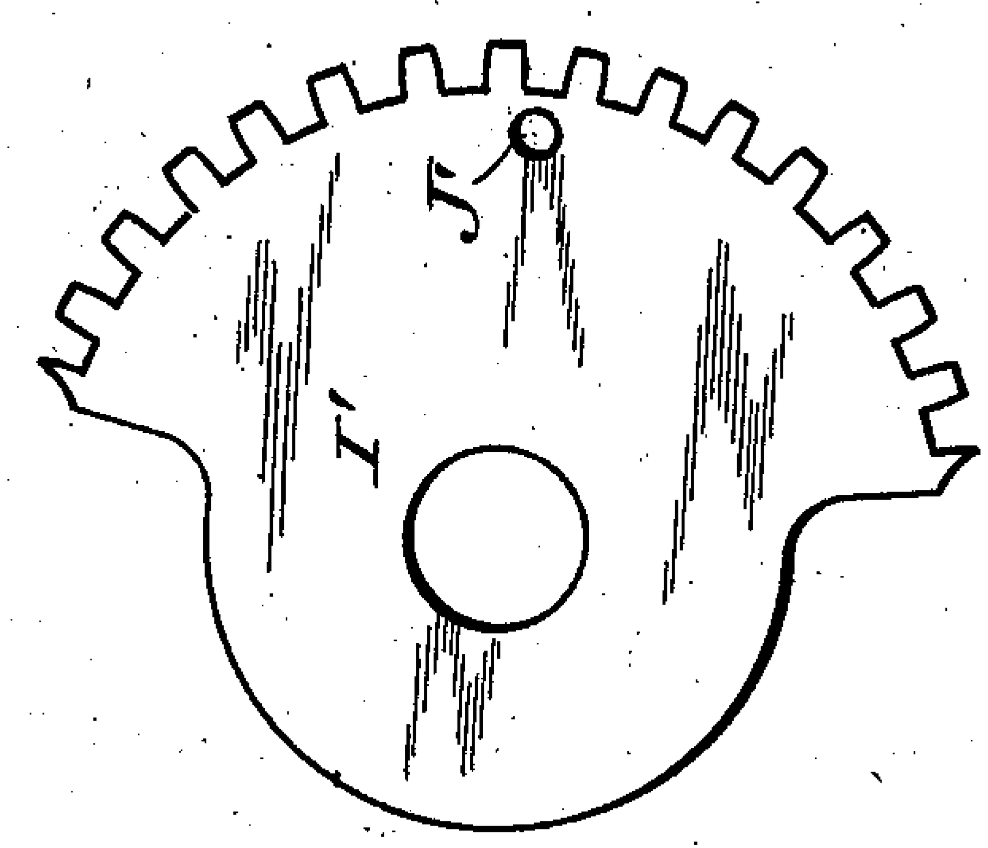
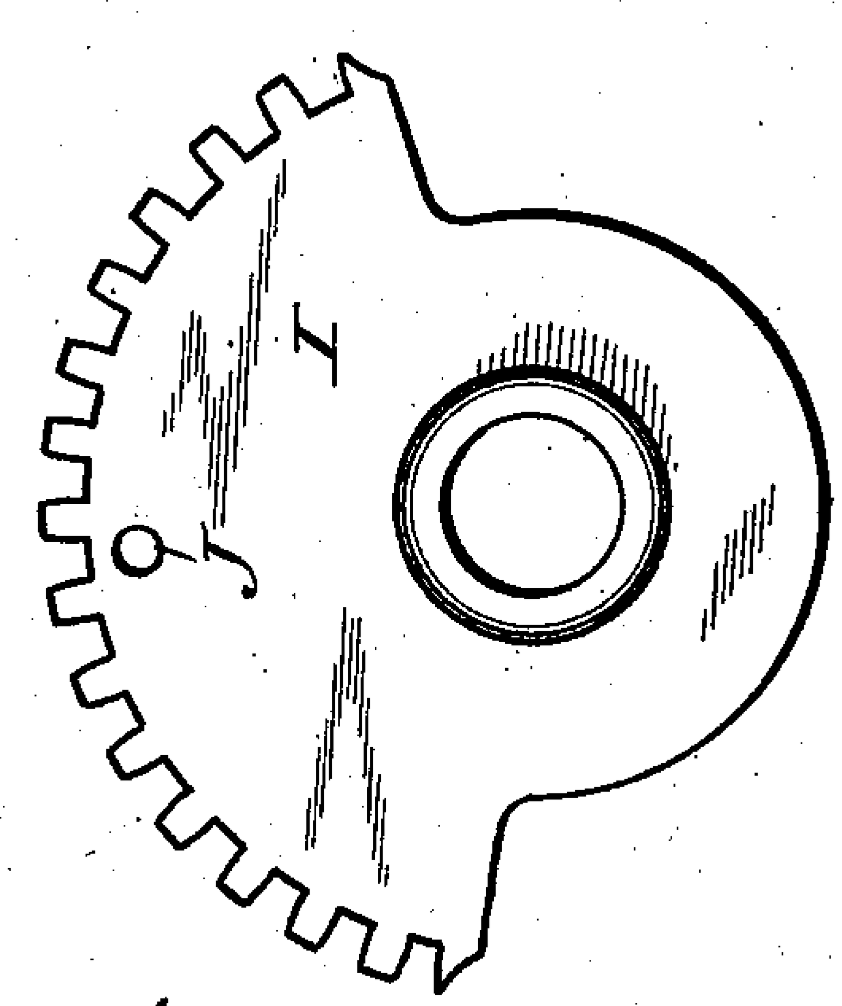


Fig. 4.



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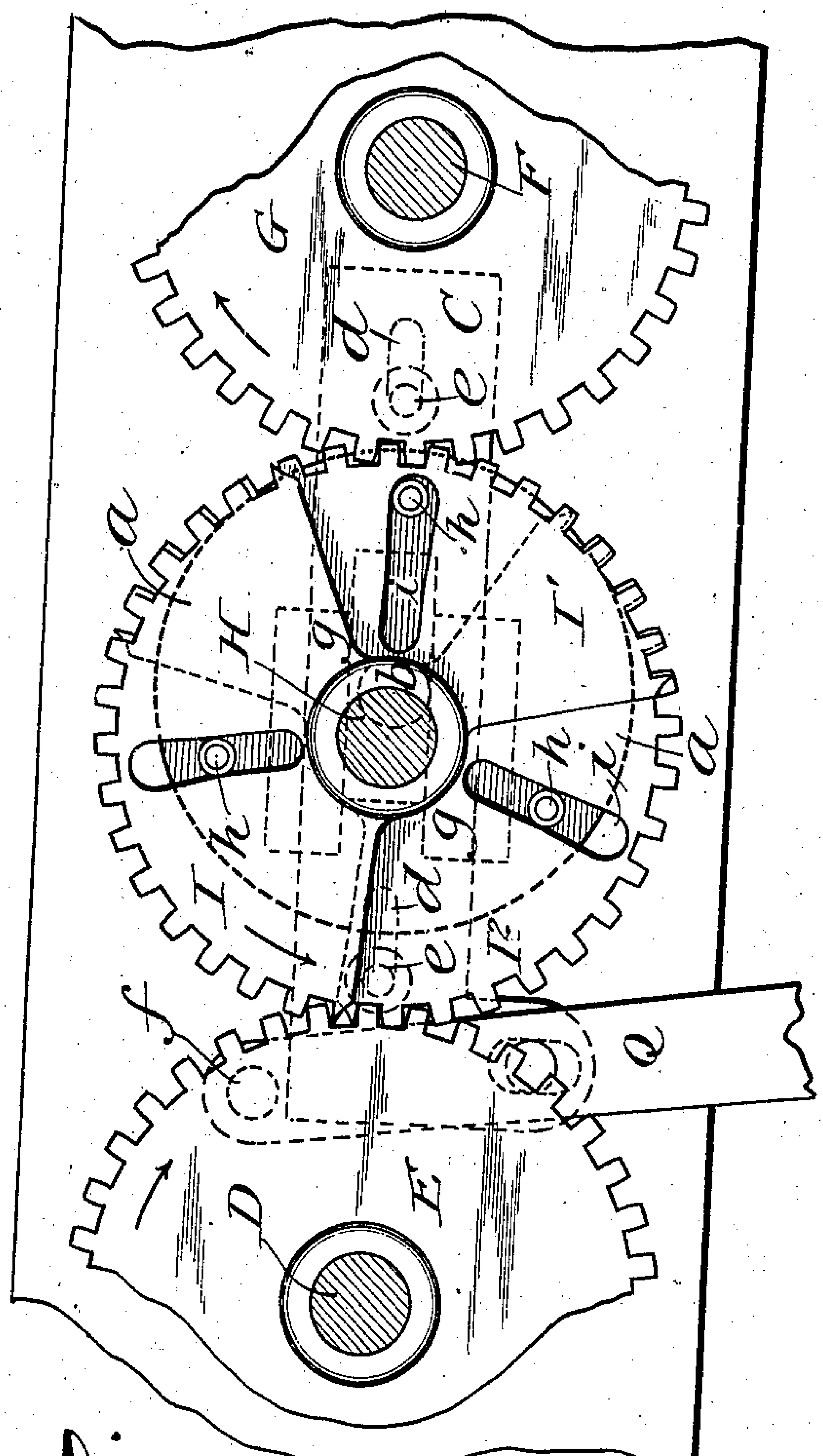

Fig. 7.

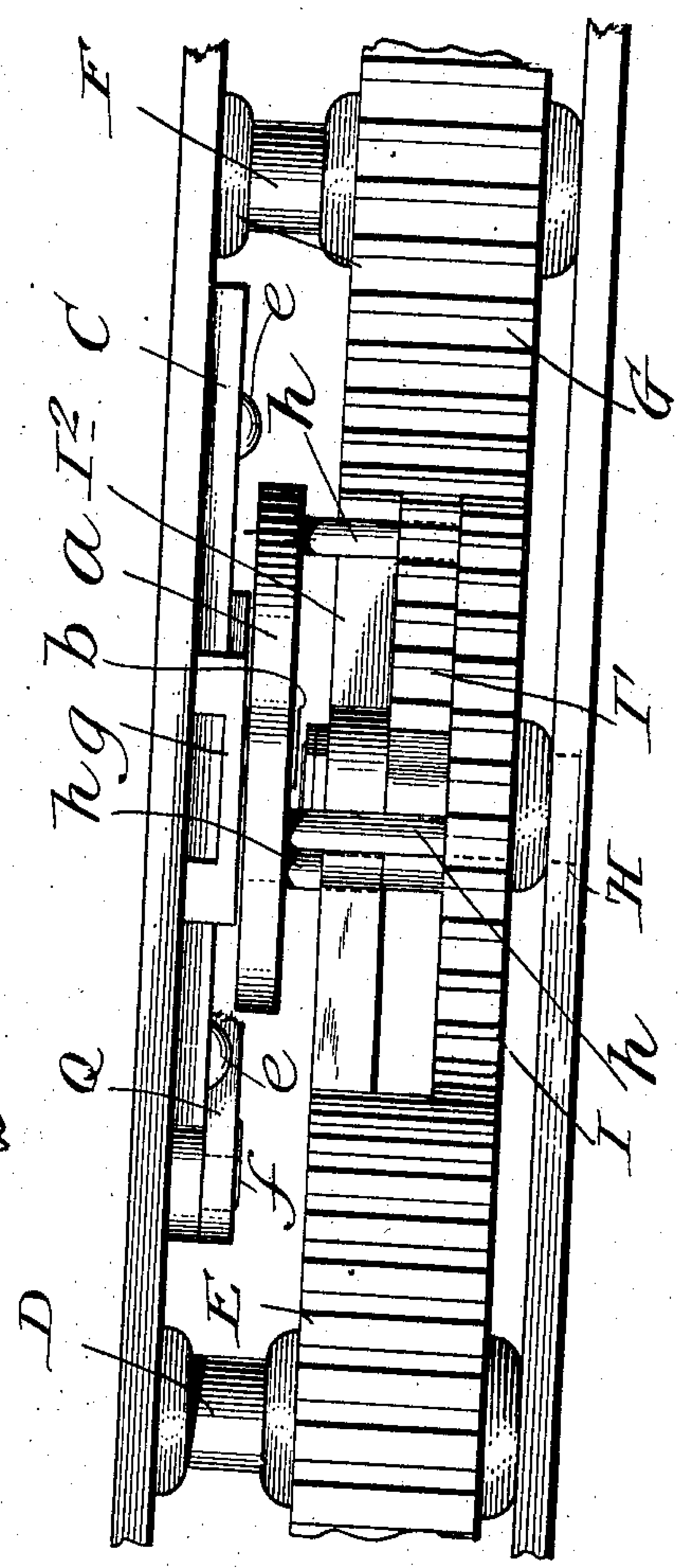

Fig. 8.

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UNITED STATES PATENT OFFICE.

ARNOLD W. PUPKE, OF NEW YORK, N. Y.

VARIABLE-SPEED MECHANISM.

No. 827,119. Specification of Letters Patent. Patented July 31, 1906.

Application filed October 3, 1905. Serial No. 281,121.

To all whom it may concern:

Be it known that I, ARNOLD W. PUPKE, a citizen of the United States, and a resident of the borough of Manhattan, city, county, and State of New York, have invented a new and useful Improvement in Variable-Speed Mechanism, well adapted to general use, but especially to automobiles, autoboats, and the like, of which the following is a specification, reference being had to the accompanying drawings, in which—

Figure 1 illustrates an elevation of the mechanism, the side frame toward the observer being removed and the controller and coacting parts illustrated in broken lines. Fig. 2 illustrates a plan view of that which is shown in Fig. 1. Fig. 3 illustrates an elevation of the controller separated from all other parts. Figs. 4, 5, and 6 illustrate the intermediate speed-differentiating broken gears in the positions which they respectively occupy in Figs. 1 and 2. Fig. 7 illustrates an elevation, with side plates removed, substantially as in Fig. 1, of a modified construction. Fig. 8 illustrates a plan view substantially as Fig. 2, of the modified construction shown in elevation in Fig. 7.

Before describing the invention in detail I will state generally its construction and method of operation. The mechanism embodies a driving-shaft, which may be the motor-shaft or one geared to it, which I will call the "power-shaft." It is also supplied with a driven shaft, or that which carries, directly or indirectly, the driving-wheels of an automobile, the propeller in an autoboat, or the corresponding part in other mechanism. Upon each of these shafts is a gear, preferably, but not necessarily, a spur-gear. They may, however, be gears of any preferred construction. Between these two gears is arranged a counter-shaft which acts merely as a support for the broken gears, through which I effect the differential speeding of the machine, and upon it are mounted three or more sectional or broken gears which operate as hereinafter explained. They may all run loose upon the counter-shaft or any one of them may be fixed upon it, the others running loose, for it is immaterial whether that shaft be stationary or adapted to rotation. The mechanism likewise embodies a system of levers or their equivalents as shown in the modified form herein illustrated and described and a controller which coacts with them. If the levers are employed, they are arranged in pairs, the number of which will depend upon the number of intermediate broken gears used. In the example illustrated, where I show three intermediate broken gears, three pairs of these levers are required. Each pair of levers is provided with an antifriction-roller at their meeting ends, and at one end of one member of each pair a pin or equivalent device connects with one of the intermediate broken gears, each pair, however, connecting with a separate broken gear. The antifriction-rollers of each pair are adapted to engage with an instrumentality which I call the "controller." This controller is a structure adjustable relative to the axis of the counter-shaft which carries the broken gears and is provided with a curved surface adapted to engage with the antifriction-rollers upon each pair of levers above referred to. As stated, this controller is adapted to be adjusted concentrically as well as eccentrically relative to the axis of the counter-shaft. The broken gears are so arranged that the intermissions in the cogs thereof are out of coincidence with each other and the intermissions in each wheel extend preferably over slightly more than one-half the circumference thereof. I say "preferably," because certain of the advantages resulting from my invention may be realized if the broken-away or intermitted part of each gear is not so extensive as above stated. I prefer, however, that the teeth in each gear shall be intermitted somewhat more than throughout half the circumference—as, for example, in the illustrations here presented the periphery of each of the interposed speed-differentiating gears is adapted to thirty-six teeth, one-half of which would be eighteen, whereas they each embody sixteen only.

The mechanism in operation effects the following results—*i. e.*, although the motor-gear may revolve with uniform speed, yet through the peculiar construction and arrangement of the interposed broken gears and their coactive operation the speed transmitted to the driven or load-carrying gear may be reduced or increased as compared with that of the motor-gear, depending upon the adjustment of the controller.

I wish here to state that the fundamental system or principle involved in this present invention differs from that set forth in an application for Letters Patent filed by me on the 3d day of August, 1905, Serial No.

272,459; in that the present invention embodies features which under certain circumstances will effect an improvement over that set forth in my said pending case, because in this present construction the periodical, although momentary, coincidences in speed between the motor-gear and the driven gear is done away with and uniform, smooth, and shockless motion secured. This feature of my former construction was of no considerable consequence, except that it has a tendency the same as the violent explosions of the charge in explosive-engines and the reversal of the piston in reciprocating engines to more or less rack the mechanism, which detractive feature, small though it be, I overcome in this present construction. Also in this present invention I reduce the number of parts and likewise attain a greater degree of differentiation in speed than in the former construction.

I will first describe the invention as it is illustrated in Figs. 1 to 6; but I wish here to state that the two constructions which I have shown and described in this specification are given as desirable examples, but not by any means the only forms in which my invention may be embodied, because it will be obvious to those who are familiar with such matters that the results attained may be realized in mechanisms of a considerable variety of forms or details of construction. I therefore do not limit myself to the forms specifically shown and described. A A′ represent any suitable frame or support for the apparatus, which in the illustrations are held in proper relation to each other by cross-bolts B and spacing-sleeves C. These parts will of course in the actual mechanism be constructed as preferred or be parts of the vehicle, vessel, or the like, as the case may be. D is the motor-shaft; E, the motor-gear keyed thereon. F is the driven shaft, upon which the driving-wheels, propeller, or equivalent part, as the case may be, are mounted. G is the driven gear thereon. H is a counter-shaft upon which are loosely supported three broken gears I I′ I^2. As heretofore stated, there may be more than three of these broken or speed-differentiating gears, if desired, and they may all of them turn loosely upon the counter-shaft H or one of them may be fixed thereon. These intermediate gears are illustrated in Figs. 4, 5, and 6 in the same relative position they occupy in Figs. 1 and 2, and it will be observed that, as heretofore stated, the cogs thereon extend over not quite one-half their circumferences, respectively, although the cogs may be more extended, if desired. Each of these gears is provided, preferably at or near the center of the cogged or toothed section, with a laterally-extending stud or supporting-trunnion J J′ J^2. The trunnion J projects laterally from its broken gear I only a sufficient distance to properly engage with the pair of levers (about to be described) which coact with that broken gear. The trunnion J′ on the broken gear I′, on the contrary, has added length equal to the width or thickness of the gear I, because it has to pass across the broken-away portion of that gear in order that it may engage with its pair of levers. Similarly the trunnion J^2 of the broken gear I^2 is longer than that of the broken gear I′ by a length equal to the width of that gear, so that it may pass across the broken-away parts of both gears I and I′ and engage with its pair of levers. 1 1 are the pair of levers which pertain to the broken gear I. They are connected to it by the trunnion J, as heretofore stated, and K is the antifriction-roller at the angle or joint between this pair of levers. 2 2 are the second pair of levers—in other words, those which pertain to the broken gear I′—and they are connected with it by the trunnion J′, to which same trunnion one of the levers 1 is likewise connected, and K′ is the antifriction-roller for this pair of levers. 3 3 are the pair of levers which pertain to the broken gear I^2, and they are connected therewith by the trunnion J^2, to which likewise one of the levers 2 is connected, and K^2 is the antifriction-roller for this pair of levers. The lever 3 to complete the system of pairs of toggle-levers is likewise connected with the trunnion J of the broken gear I. It will thus be seen that each pair of levers forms a connecting-link between two of the broken gears. L is the controller. Its shape is best shown in Fig. 3. It has a guiding-surface M of a general semicircular contour and slots N N, through which pass supporting-studs O O, with spacing-blocks P P or other confining means. Q is the controller-lever, which is preferably pivoted between its ends and connected with the controller by slot-and-bolt connection R S and is of course provided with the usual locking rack and pawl. Any equivalent device may be employed. The controller, as indicated in Fig. 1, is adapted to longitudinal movement relative to the gearing above described, during which movement the stay-pins or bolts O O slide through the slots N in the controller, and this adjustment of the controller may be such that the center of the substantially semicircular opening N therein shall be in the same vertical line as the axis of the counter-shaft H or to the right of it, as shown in Fig. 1, when reduction of speed is desired, or to the left of it when increase of the speed is desired, and the mechanism is so arranged that the antifriction-rollers K K′ K^2 above described of the system of levers will during the rotation of those levers engage with and be controlled by the substantially semicircular surface of the controller. The operation, therefore, is as follows: It will be assumed that the motor-gear E revolves at constant speed. One of the broken gears will at all times be in full mesh with the motor-gear E and one of them will at all times be in full mesh with the driven gear G and part of the time another of the broken gears will be in mesh with one or the other of these main gears—*i. e.*, the motor-gear or the driven gear. Referring to the drawings, particularly Fig. 1, it will be seen that the broken gear I^2 is in mesh with the motor-gear E, although just about to leave it, and the gear I' is in mesh with the driven gear G and the gear I is just commencing to enter into mesh with the gear E, and the controller in this Fig. 1 is shifted to the right of the central line, the intent being to reduce speed. It will be noted that when the parts are in the position shown in this figure the power is applied to the broken gear I^2 and the load is carried by the gear I', and I is not in mesh with the driven gear G. Thus the thrust is conveyed through the trunnion J^2 of the broken gear I^2 to the pair of levers 2 2, the result of which is obviously to force the roller K' outwardly or radially from the shaft H, because since both of the gears I^2 and I' are loose upon the counter-shaft H and capable of independent movement a flexure of the levers connecting them is inevitable and the transmission of the power from one broken gear to the other—in other words, the speed of the driven part of the mechanism—may be determined by limiting the flexure in the levers. This, therefore, is the function of the controller, because the antifriction-roller K' in its radial movement carried by the levers encounters the substantially semicircular surface of the controller, which surface, it will be seen, lies near to the shaft H on one side, but is quite distantly removed therefrom on the other side. Consequently as the antifriction-roller K' moves over this surface the circumferential movement is transformed into combined circumferential and radial movement, whereby the circumferential speed of the broken gear I', and consequently the speed transmitted by it to the driven gear G, is necessarily reduced. As the mechanism revolves in due course the antifriction-roller K^2, as shown in Fig. 1, comes in turn into engagement with the curved surface of the controller and simultaneously therewith the broken gear I passes into engagement with the driven gear E, as likewise shown in Fig. 1, and immediately thereafter the broken gear I^2 passes out of engagement therewith and into engagement with the driven gear G. At this point results a repetition of the process, except that the broken gear I^2 now becomes the retarded gear, because of the movement of the antifriction-roller K^2 over the gradually-expanding surface of the controller, as heretofore stated. The movement of the broken gear I' toward the broken gear I^2 is illustrated in Fig. 1, where at the lower right-hand quarter the teeth of I' are shown as slightly lagging behind the adjacent teeth of the gear I^2. This is taking place during the period of slow movement of the broken gear I', so that by the time the first tooth of the broken gear I^2 engages with the teeth of the driven gear G the teeth of I^2 and I' will be coincident. In this way successively the broken gears engage with the motor-gear E, and travel at the same speed as it and through the instrumentality of its pair of levers and antifriction-roller coacting with the eccentrically-arranged bearing-surface of the controller the immediately-preceding broken gear is reduced in speed, and consequently transmits reduced speed to the driven gear G. Since it is somewhat difficult to follow the movements of these parts and the resulting mechanical effect, attention is called to the fact that in securing the reduction in speed the broken gears, through which the power transmission is effected, when the speed is reduced, slide toward one another, whereas when the controller is shifted to the other side of the axis of the counter-shaft the two power-transmitting gears will start together and slide away from each other. In other words, as the antifriction-roller K' (this is taken as an example only, the other two successively operate the same way) travels over the gradually-expanding surface of the controller the positions of the broken gears I^2 and I' relative to each other change—that is to say, the gear I^2 will be driven at the same speed as the motor-gear, but the gear I', since the controller is in position to the right, so that its working surface expands relative to the counter-shaft H—in other words, shows an enlarging radius—will be slowed down and will approach or slide toward the broken gear I^2. If, on the other hand, the controller were shifted so that its center lies to the left of the axis of the counter-shaft H, then the relative movements of the broken gears would obviously be reversed. Also, if the controller be located exactly midway, so that its central line is in the same vertical plane as the axis of the counter-shaft H, then all parts will move in unison and the speed of the driven gear will be the same as that of the motor-gear.

It will be noted that when two of the broken gears are in mesh with either the motor-gear or the driven gear from that moment until the connection is broken again the antifriction-roller pertaining to the levers connecting those broken gears will revolve concentrically about the shaft H. This effects a desirable result, because it aids in presenting the antifriction-rollers as they successively complete their revolution properly to the entering end of the controller—that is to say, the engagement of the several broken gears with the motor-gear and the driven gear is such that the antifriction-rollers through the agency of the pivoted levers are compelled after completing their circuit to properly present themselves at the entering end of the controller irrespective of the position of the latter. In order that this may be more clearly understood, the course of one of the antifriction-rollers, as shown upon Fig. 1 of the drawings, will be traced as follows: Starting at the entering end of the controller, it traverses along the semicircular surface thereof, as already described, until it approaches the rear or leaving end. At this point the gear I^2 comes into engagement with the driven gear G, both the gears I′ and I^2 being then in engagement with that gear. From this point the two will move concentrically about the shaft H, and the antifriction-roller K′ will therefore also revolve concentrically about the shaft H until the point is reached where the broken gear I′ leaves the driven gear G. It will be found that at this point the roller K′ touches the hypothetical prolongation of the curved surface of the controller, and since the fact is that irrespective of the position of the broken gears if constructed as shown in the drawings all of the antifriction-rollers will always touch or be interiorly tangent to a circle which engages any two of them, the radius of which circle will always be found to be the same, at this point having one roller in engagement with the controller and the other in contact with the hypothetical prolongation of the curved surface thereof, the third roller will also be on that circle, and therefore be in proper registration with the entering end of the controller. It should here be suggested that owing to the irregular course described by certain of the parts in their revolution there will be a trifling divergence from the movements above suggested; but they are so exceedingly trifling as to be entirely unimportant in mechanism of this class and too small to be indicated upon the drawings, since the thickness of a draftsman's line would more than compensate therefor. In order, however, that the operation of the mechanism may be described with accuracy, the statement is made that when the controller is placed in a position about midway between its concentric and extreme eccentric positions then the antifriction-roller about to enter the controller will theoretically overreach to a minute degree the curve thereof if the latter be an exact circle. For this reason the entering end of the controller may beneficially be slightly enlarged. This divergence is so small that, as stated above, it cannot be indicated in Patent Office drawings and it will be more than compensated for by lost motion and the inevitable spring of the parts. It will be further noted that whereas it is impossible with but two intermediate or broken gears to effect the transmission without momentary acceleration of speed it is possible so to do when three or more are used, because when but two broken gears are used it is impossible to remove so much as half of the teeth of each. Consequently each broken gear must be some time in each revolution in momentary mesh with both the motor-gear and the driven gear. Hence the forward or backward thrust, as the case may be; but when three or more broken gears are employed more than half the teeth may be removed from each broken gear, and thus simultaneous intermeshing of any of the broken gears with the motor-gear and the driven gear is impossible. In this way uniform, smooth, and unvarying yet differential speed, either increased or decreased, may be transmitted to the driven gear, or, if desired, when all things are brought to a position of neutrality or, so to speak, centralized the same speed may be transmitted and in all these instances without shock, jar, or racking effect upon the mechanism.

Referring now to Figs. 7 and 8, they illustrate a construction in which the same result is attained by modified mechanism—that is to say, the motor-gear and driven gear and intermediate gears are lettered the same as before. Instead, however, of employing the pairs of levers with antifriction-rollers and a controller having a curved working surface in this construction I show a circular disk *a*, which is pivoted at *b* to a sliding controller-plate *c*, which is slotted at *d* to allow requisite longitudinal movement and is supported upon stay bolts or studs *e*. The controller-lever Q is or may be the same as before, and it is pivoted, as at *f*, to any suitable part of the controller-plate *c*. The plate is suitably supported upon and slides in ways made in a bed or in blocks *g g*. The guide-blocks *g* are employed for greater solidity and durability in the construction. The controller-blade may be guided and supported upon the studs *e* only, if preferred, or in any other suitable manner. In this construction the counter-shaft H should preferably be a stud-shaft—in other words, like a trunnion, so as not to interfere with the to-and-fro movement of the controller and coacting parts—and likewise should be provided with a lock-bolt or its equivalent for the proper retention of the broken gears in position. *h h h* are three studs rigidly set in the face of the disk *a*, which engage in slots *i i i*, which are made radially in the several broken gears, the outer parts of which slots are somewhat enlarged to allow simultaneous and coincident movement of two adjacent broken gears during the period they both engage either of the main gears. It will be seen that when the controller-plate carrying with it the revolving disk *a* is moved to the right or left of the axis of the counter-shaft or stud H, thereby the control exercised upon the broken gears by the studs *h* or rollers on them, which work in the slots *i* in said gears, will effect the same relative movements of the broken gears as do the pairs of pivoted levers and antifriction-rollers in conjunction with the curved surface of the controller in the construction shown in Figs. 1 to 6—that is to say, when the controller is in the central position—in other words, so that the center of the disk *a* is coincident with the axis or center of the stud H, then the transmitted speed will be the same as that of the motor-gear. When, on the contrary, it is moved to the right of the axis of the stud H, the transmitted speed will be reduced, so likewise when moved to the left of said axis the speed will be increased.

It will be obvious to those who are familiar with this art that while my invention is capable of extensive use in conjunction with various mechanisms it is peculiarly adapted to automobiles, autoboats, and the like, and that it has a number of advantages which, so far as I am aware, have never been attained before—that is to say, the transmission is effected in a smooth shockless manner and by positively-acting mechanism devoid of frictional transmission of any kind, that the differentiation may be accomplished while the machinery is in motion without throwing out one gear and throwing in another, which proceeding is attendant with danger of stripping, disagreeable shocks, and tendency to rupture the mechanism; also that my apparatus is substantially noiseless and that there are no violent forward thrusts which are perceptible in change of speed in most or at least many other mechanisms, excepting in frictional transmission devices, which are inadequate for other than light work, and as applied to electric motors and other prime movers my invention is peculiarly useful because it enables a change of speed, hence variation of power, without change in the current and without breaking contacts.

I present the two forms described and illustrated as examples merely of constructions in which my invention may be embodied, and I do not limit myself to the special details of construction there presented, because they may be departed from and still the essence of the invention be present.

I claim—

1. In mechanism of the class stated the combination of a motor-shaft and a driven shaft, a gear upon the motor-shaft, another gear upon the driven shaft, speed-differentiating gears interposed between them adapted to independent movement relative to each other, none of which are in mesh with both the motor-gear and the driven gears at the same time, mechanism brought into action by the resistance of the load to the power, whereby the differentiating gears are caused to shift position relative to each other and means to regulate and control such shift of position.

2. In mechanism of the class stated the combination of a motor-shaft and a driven shaft, a gear upon the motor-shaft, another gear upon the driven shaft, speed-differentiating gears interposed between them which are adapted to movement independent of each other, none of which are in mesh with both the motor-gear and driven gear at the same time and mechanism brought into action by the resistance of the load to the power, whereby the speed of the driven gear may be differentiated from that of the motor-gear or made coincident therewith, as desired.

3. In mechanism of the class stated the combination of a motor-shaft and a driven shaft, a gear upon the motor-shaft, another gear upon the driven shaft, a shaft interposed between them, independently-movable speed-differentiating gears supported upon the interposed shaft, none of which are in mesh with the motor-gear and the driven gear at the same time, devices connecting each of said differentiating gears with the others, whereby the movement of each will be transmitted to the other and a controller to regulate the degree of movement.

4. In mechanism of the class stated the combination of a motor-shaft and a driven shaft, a gear upon the motor-shaft, another gear upon the driven shaft, a shaft interposed between them, independently-movable speed-differentiating gears supported upon the interposed shaft, none of which are in mesh with the motor-gear and the driven gear at the same time, devices connecting each of said differentiating gears with the others, whereby the movement of each will be transmitted to the others, and an adjustable controller adapted to secure uniform as well as variable speed between the motor-gear and driven gear.

5. In mechanism of the class stated the combination of a motor-shaft and a driven shaft, a gear upon the motor-shaft, another gear upon the driven shaft, independently-movable speed-differentiating gears interposed between them, none of which are in mesh with both the motor-gear and the driven gear at the same time, but each of which successively meshes with the motor-gear and the driven gear, means connecting the differentiating gears each with the others, whereby the movement of each is transmitted to the others and means to regulate and control the degree of such movement.

6. In mechanism of the class stated the combination of a motor-shaft and a driven shaft, a gear upon the motor-shaft, another gear upon the driven shaft, a shaft interposed between them, independently-movable speed-differentiating gears supported upon said interposed shaft, the teeth whereof are broken away throughout more than half their circumferences, devices connecting

the differentiating gears each with the others and means engaging with said last-named devices whereby the independent movement of the differentiating gears is controlled and regulated.

7. In mechanism of the class stated the combination with a suitably-supported motor-gear and suitably-supported driven gear, of speed-differentiating gears interposed between them, the cogs of which are broken away or intermitted throughout more than half their circumferences respectively, and which gears never engage simultaneously with both the motor-gear and driven gear, and means connecting the differentiating gears, whereby the motion of each is transmitted to the others.

8. In mechanism of the class stated in combination with a suitably-supported motor-gear and suitably-supported driven gear, of speed-differentiating gears interposed between them, the cogs of which are broken away or intermitted throughout more than half their circumferences respectively, and which gears never engage simultaneously with both the motor-gear and driven gear, and means connecting the differentiating gears, whereby the motion of each is transmitted to the others and an adjustable device whereby the transmitted speed may be made coincident with or differentiated from that of the motor-gear.

9. In mechanism of the class stated the combination of a motor-shaft and a driven shaft, a gear upon the motor-shaft, another gear upon the driven shaft, speed-differentiating gears interposed between them, all rotating about a common and fixed center, none of which are in mesh with both the motor-gear and the driven gear at the same time, devices which connect all of said differentiating gears together, whereby the speed transmitted by them is varied, and which in operation revolve about a different and movable center.

10. In mechanism of the class stated the combination of a motor-shaft and a driven shaft, a gear upon the motor-shaft, another gear upon the driven shaft, speed-differentiating gears interposed between them, all rotating about a common and fixed center, none of which are in mesh with both the motor-gear and the driven gear at the same time, devices which connect all of said differentiating gears together, whereby the speed transmitted by them may be varied and means whereby said connecting devices may be made to revolve about a center coincident with or different from that about which the differentiating gears revolve.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ARNOLD W. PUPKE.

Witnesses:
F. M. DONSBACH,
WALTER H. CRITTENDEN.