No. 803,937. PATENTED NOV. 7, 1905.

D. E. SWEETSER.

VARIABLE SPEED MECHANISM.

APPLICATION FILED JUNE 13, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

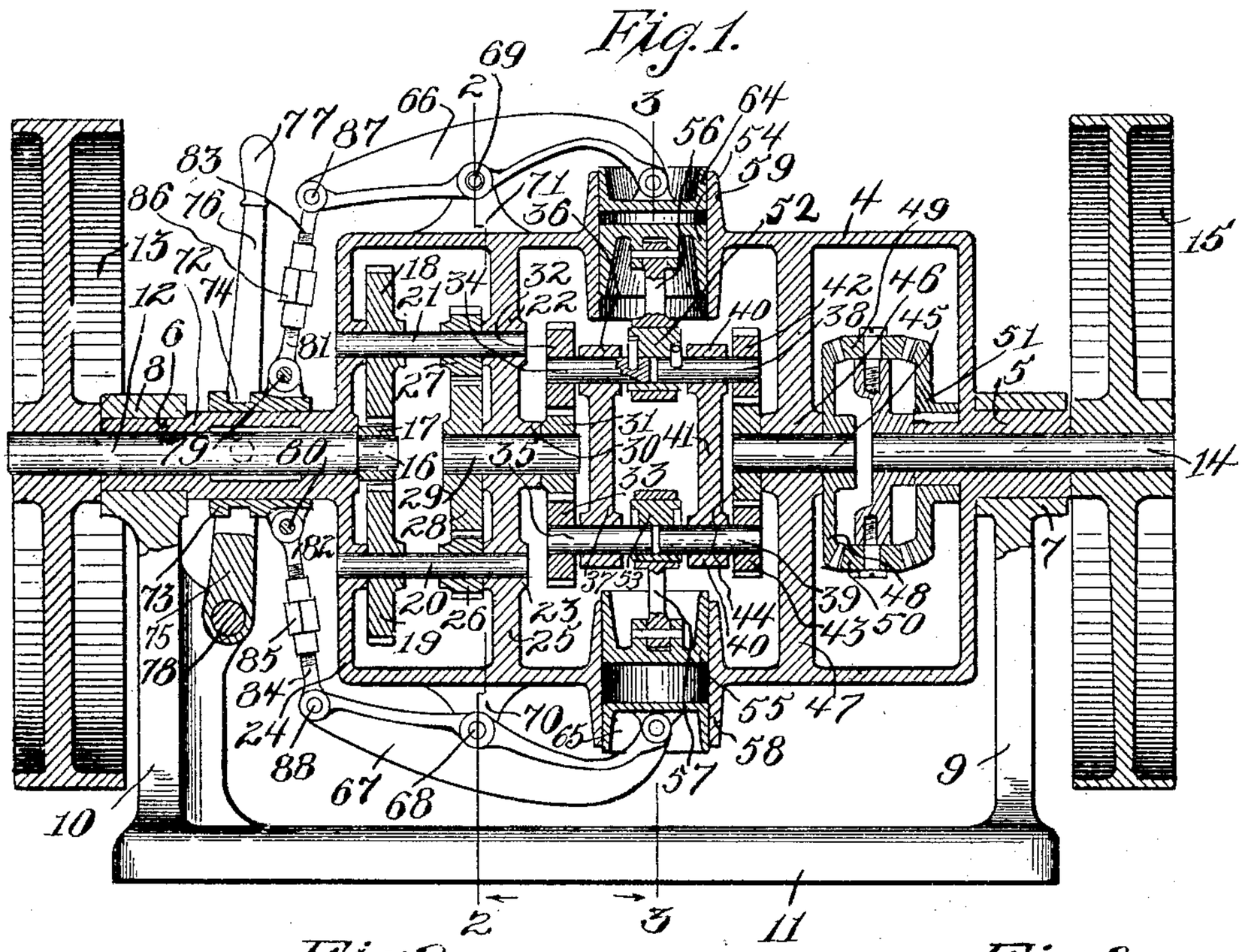


Fig. 2.

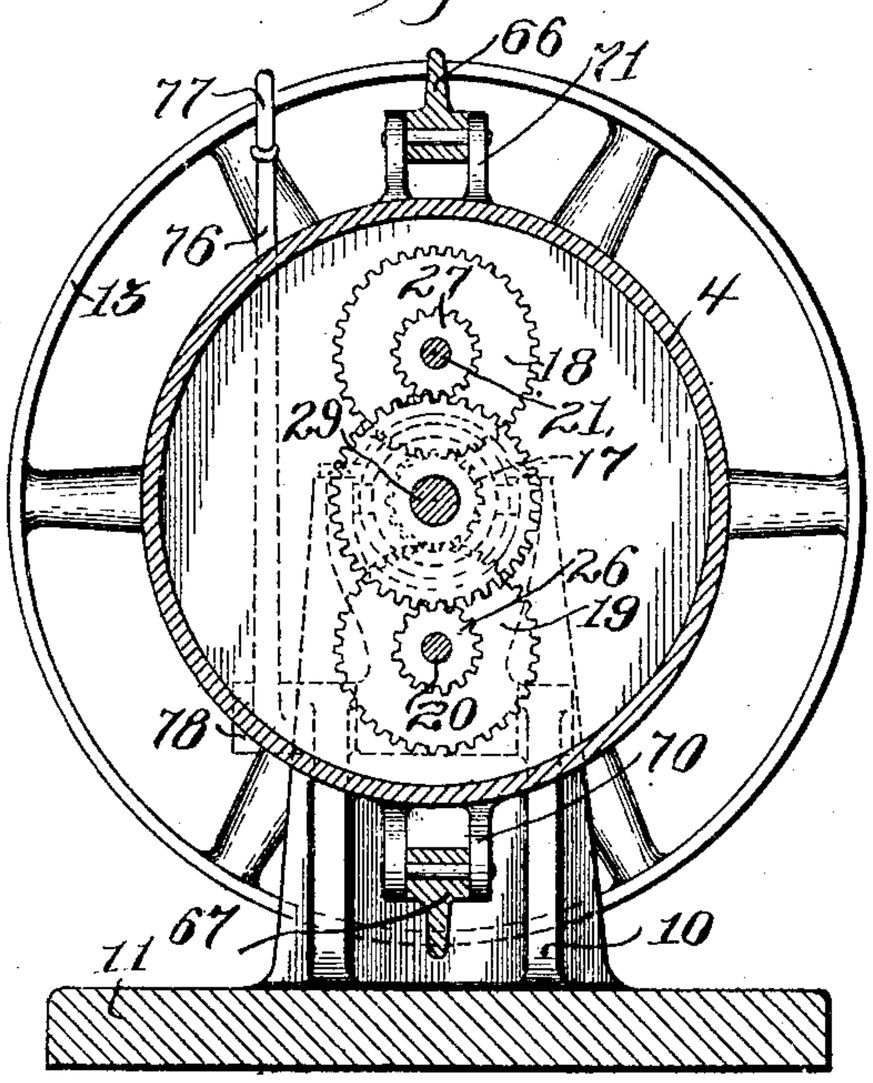
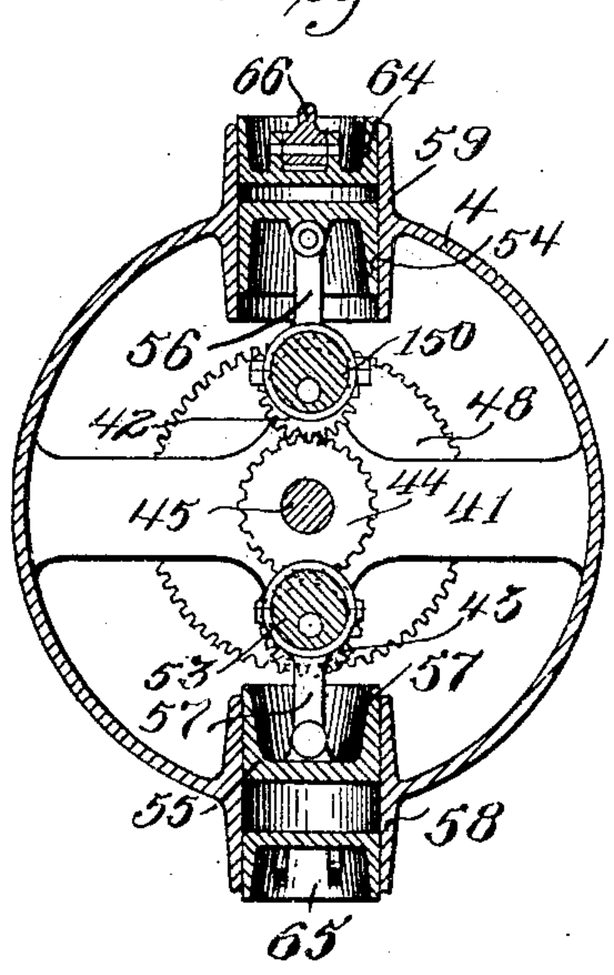


Fig. 3.



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2 SHEETS—SHEET 2.

Fig. 4.

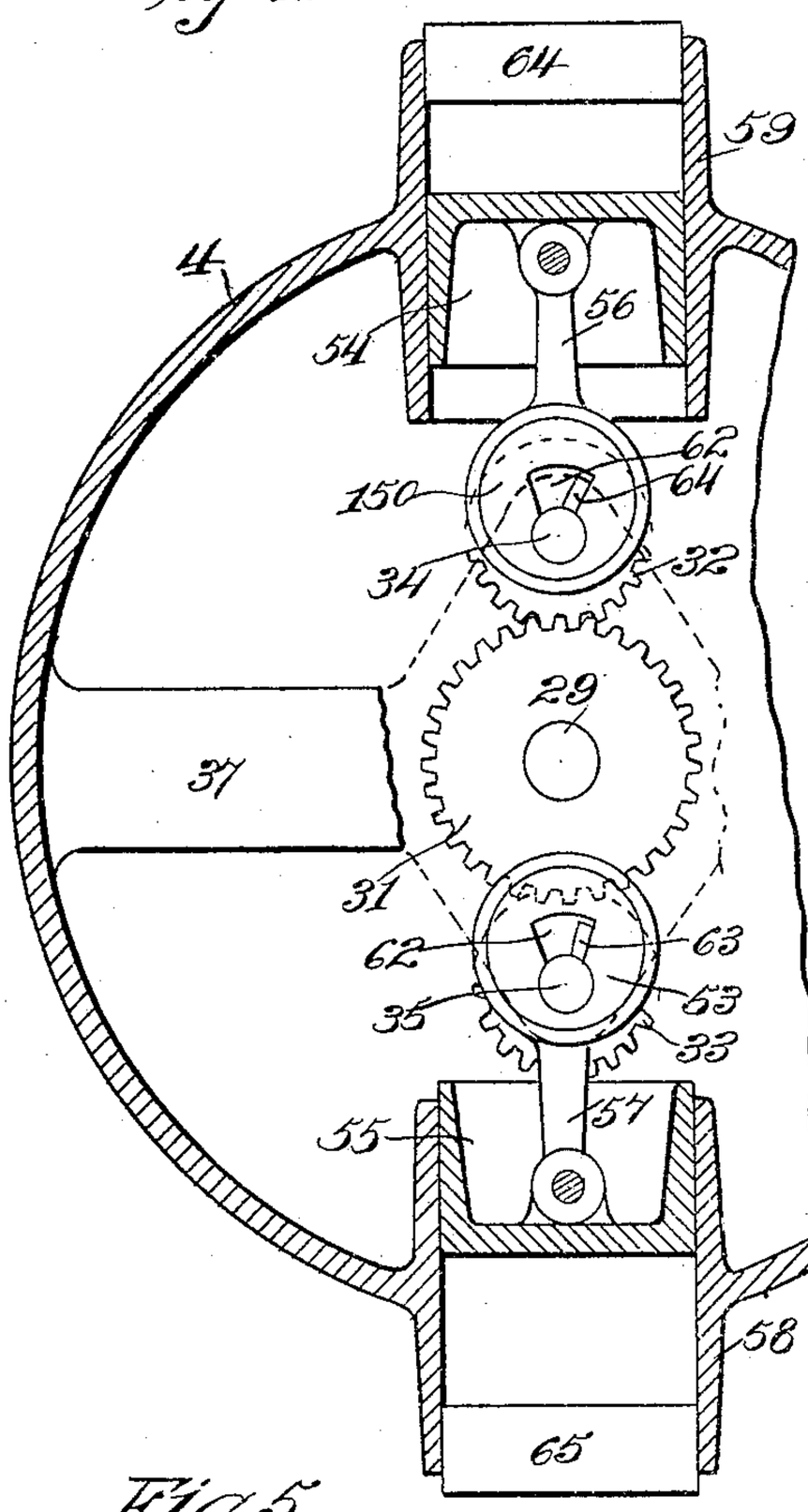


Fig. 7.

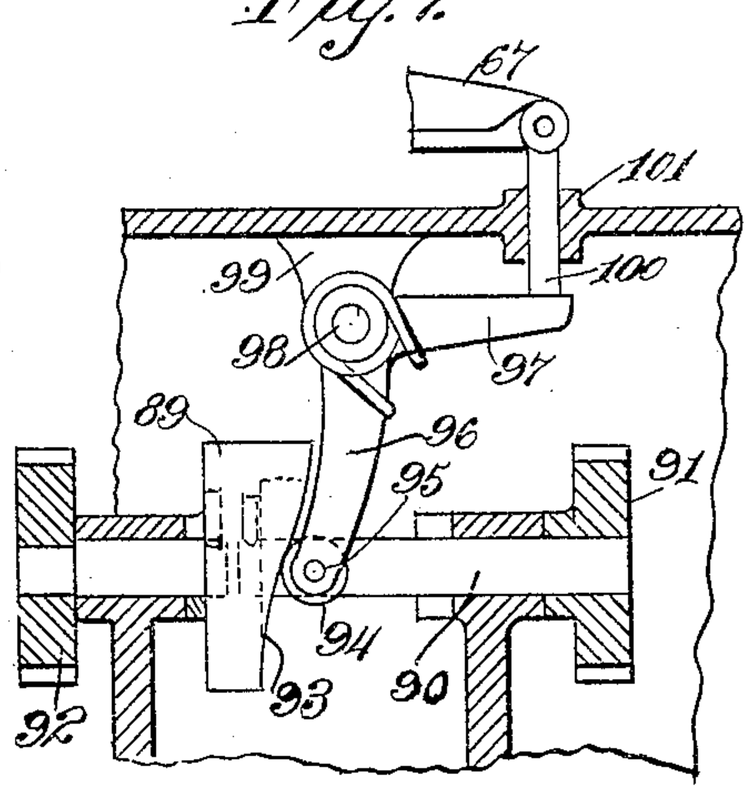


Fig. 8.

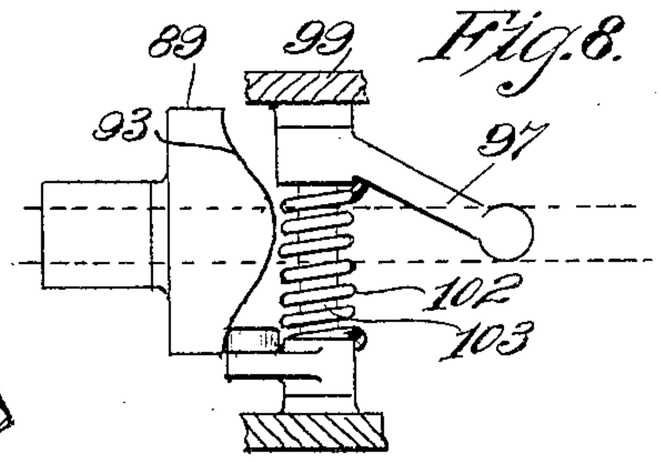


Fig. 5.

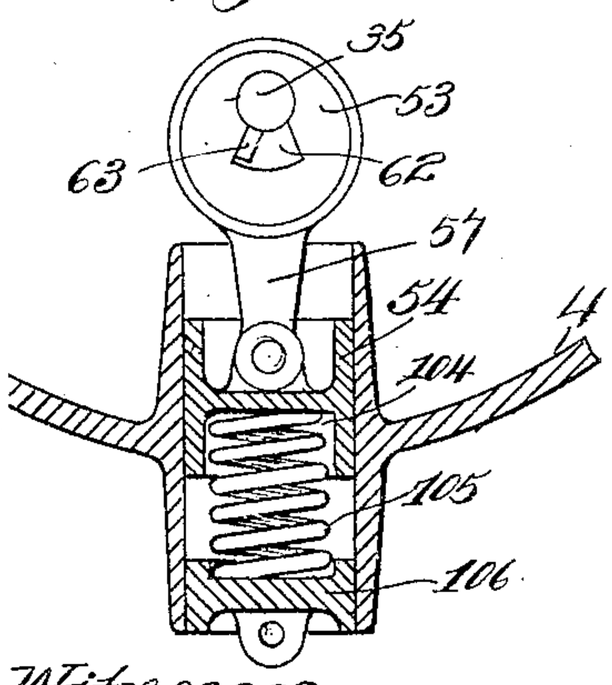
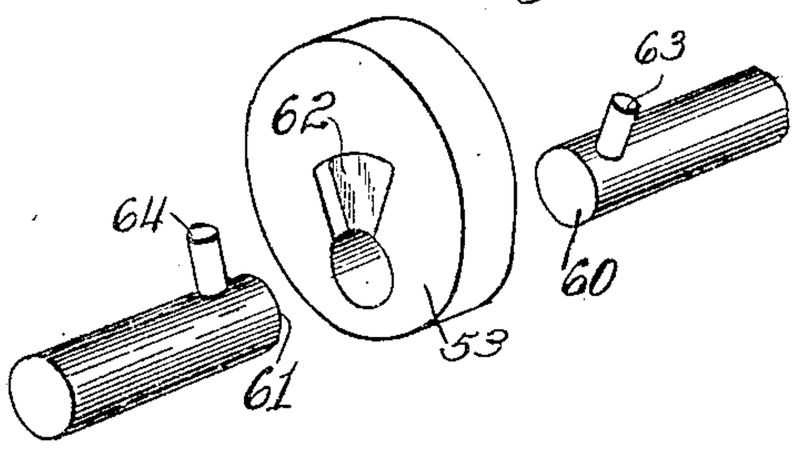


Fig. 6.



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UNITED STATES PATENT OFFICE.

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VARIABLE-SPEED MECHANISM.

No. 803,937. Specification of Letters Patent. Patented Nov. 7, 1905.

Application filed June 13, 1904. Serial No. 212,233.

To all whom it may concern:

Be it known that I, DWIGHT E. SWEETSER, a citizen of the United States, residing in Richmond Hill, in the county of Queens and State of New York, have invented certain new and useful Improvements in Variable-Speed Mechanisms, of which the following is a specification.

This invention has reference to means whereby the power of a driving member may be imparted to a driven member in different relative speeds, preferably through the instrumentality of a train of mechanism, adapted to be controlled by resistance offered by a suitable device mounted for automatic operation. It is comprehended that the resistance devices shall be of any suitable form desirable, and the function thereof may be predetermined to meet varying constructions in which the principle of this invention may be embodied, as well as the resultant operations thereby obtained.

It is an object of the invention to construct a device capable of imparting to a driven member a variety of speeds with relation to the driving member, and to do so either manually or otherwise by devices capable of so offering resistance to the action of an intermediate train of mechanism as to cause said train to impart the motion from the driver to the driven member in any desirable manner.

A further object of the invention is to produce an efficient and durable structure and to render such device positive in its action.

An embodiment of the present invention is illustrated on the accompanying sheet of drawings, whereon—

Figure 1 is a sectional view in elevation of a speed-changing device. Fig. 2 is a transverse section on line 2 2 of Fig. 1. Fig. 3 is a similar section on line 3 3 of Fig. 1. Fig. 4 is an enlarged view of the same. Fig. 5 illustrates a modified form of piston action. Fig. 6 is a detailed view of the eccentric of the piston and the shafts connecting thereto; and Figs. 7 and 8, respectively, are illustrations of modified forms of devices for offering the resistance aforementioned and the actuators therefor.

Similar characters of reference indicate corresponding parts throughout the figures.

In the form illustrated I may have a casing 4, provided with hubs 5 and 6, respectively, which may be mounted in bearings 7 and 8, respectively, carried by standards 9 and 10, which in the present instance may be secured to a base 11.

Each of the hubs 5 and 6, respectively, is bored through, and in the bore of the hub 6 is located a shaft 12, which carries at the outside a drive-wheel 13, adapted to rotate, for instance, at a high rate of speed.

The shaft 14, located in the bore of the hub 5, is also provided with a driven pulley 15, adapted to rotate at the instant of rotation of the drive-wheel 13 and, if desired, at different rates of speeds with relation to said drive-wheel.

That part 16 of the shaft 12 which extends into the casing 4 may connect with a reducer, so as to increase the power of the driving mechanism while reducing speed. As here shown, the shaft 16 is provided with a pinion 17, adapted to mesh with planetary gears 18 and 19, suitably mounted on shafts 21 and 20, respectively, mounted in suitable bearings 22 and 23, respectively, both in a wall 24 of the casing 4 and an internal web 25 within said casing. Also mounted on said shafts 21 and 20, respectively, are pinions 26 and 27, respectively, which are adapted to mesh with a gear 28, carried by an axial shaft 29, located in a bearing 30 in said web 25, and which shaft 29 beyond the web 25 also carries a pinion 31, adapted to mesh with pinions 32 and 33, carried by shafts 34 and 35, respectively, which are each suitably mounted in bearings 36, carried by a cross-bar 37, suitably secured to said casing 4. Mounted in alinement with said shafts 34 and 35, respectively, are also shafts 38 and 39, respectively, suitably located in bearings 40, carried by a cross-bar 41, similar to the cross-bar 37, and on each of said shafts 38 and 39, respectively, is a pinion 42 and 43, respectively, adapted to mesh with a gear 44, mounted on an axial shaft 45, suitably located in a bearing 46, carried by a web 47. In the present instance sa[illegible]haft 45 is also provided on the other side of the web with a bevel-gear 48, which meshes with a set of bevel-pinions 49 and 50, respectively, mounted for rotation transversely to said gear 48, and these pinions also mesh with another bevel-gear 51, mounted on and keyed to hub 5, which in the present instance may be integral with or otherwise secured to the casing or drum 4, and these gears 48 and 51, respectively, and pinions 49 and 50 constitute in the present instance a reducer.

On each set of shafts 34 and 33 and 38 and

39, respectively, may be mounted in the present instance an actuator 150 and 53, respectively, which may be coupled to plungers 54 and 55, respectively, by connections 56 and 57, and these plungers are adapted to reciprocate in alternation in cylinders 59 and 58, which may be suitably formed in said casing 4.

The actuators 150 and 53, respectively, are preferably each located on the adjacent extremities 60 and 61 of each pair of shafts hereinbefore referred to, and may be provided with slots or recesses 62 on opposite sides thereof, in which may play with some lost motion during certain periods of operation pins or studs 63 and 64, carried by each set of shafts 34 and 35 and 38 and 39, and, as will be observed by reference to Fig. 6, the stud 63 will preferably be disposed in a direction opposite to stud 64, so that said stud 64 may rest against a side of the slot on one side of the actuators opposite to the side against which the stud 63 will bear in the opposite slot 62. In this way and when the device is in operation the liability of crowding the actuators on a dead-center is obviated, it being understood that such lost-motion connection between the actuators and shafts will permit such a movement of said actuators upon said shafts as will permit a free shift away from the dead-center line of the actuator-shafts.

Into each of cylinders 58 and 59, respectively, in the present instance may be movably mounted secondary plungers 65 and 64, respectively, to which are suitably connected oscillating levers 67 and 66, each of which may be pivoted at 68 and 69 to bearings 70 and 71, suitably mounted on the exterior of the casing 4.

Mounted for longitudinal movement upon an extension 72 of the journal 6 is a sleeve 73, which, preferably, may be provided with an annular groove 74, adapted to receive a member 75, carried in the present instance by a lever 76, having a handle 77, and which lever may be suitably pivoted in a bearing 78, carried upon one of the standards—for instance, 10. Said sleeve 73 may be provided in the present instance with bearings 79 and 80, respectively, and mounted in such bearings are screw-threaded rods 81 and 82, which may be coupled to other screw-threaded rods 83 and 84 by turnbuckles 86 and 85, respectively, and said rods 83 and 84 may be connected to the pivoted levers 66 and 67 at the points 87 and 88.

Such is the construction of the embodiment herein shown of the invention, but, as is obvious, it will be understood that such construction need not be strictly adhered to, because within the purview of the invention I may resort to various other constructions of equal efficiency and which in practice may be found to be more simple. Then, too, I reserve the privilege to modify the arrangement of the actuating devices in a manner such, for instance, as is disclosed in the modification shown in Figs. 7 and 8. In such modification as is here shown I may provide an actuator 89, suitably mounted on a shaft 90 and which may be employed in lieu of the sets of shafts 34 and 38 and 35 and 39, respectively, and to which shaft may be secured the pinions 91 and 92, corresponding to the pinions 32, 43, 33, and 42, respectively. This actuator 89 may be provided with an irregular face 93, and against this face may bear a roller 94, carried in a bearing 95 of a bell-crank comprising arms 96 and 97 and which is pivoted at 98 to a bearing 99, suitably secured to the wall of the casing 4. In this instance a plunger 100, having a to-and-fro movement in a bearing 101, may be connected to one of the pivoted levers 66 or 67, when the pressure desired for offering a suitable resistance may be governed by the lever 76 aforementioned. Suitably connected to the bell-crank may be a resistance device of any suitable character, such as a spiral spring 102, which may be convoluted on a spindle 103, which in the present form shown connects the arms 96 and 97 of the bell-crank. It will be observed, therefore, that when the actuator 89 is rotated its face 93 will urge the arm 96 outwardly in a direction substantially parallel with the longitudinal axis of the shaft 90, while at the same time the arm 97 will be urged upwardly in a plane parallel with the movement of the plunger 100. The spring 102, being suitably affixed to the spindle 103, will in turn be acted upon and will therefore tend to constantly urge the arm 96 and its roller 94 against the face 93 of the actuator 89.

A modification of the resistance device is found in Fig. 5, wherein is shown that the plungers 54 and 55 may each be provided with a seat 104, wherein may be disposed a spiral spring 105, adapted to occupy the bore of the cylinders and which may be placed under varying tensions by secondary plungers 106, suitably connected to the pivoted levers 66 and 67. Thus it will be seen that there is necessary to the successful operation of this machine four principal elements, viz: A driving member, a driven member, some form of reducing mechanism between them, and some type of resistance device connected with the reducer. In Fig. 1 the planetary gearing to the left of the web 25 is one type of reducer, the mechanism in the chamber to the right of the web 47 is another type of reducer, and if the pinions 42 and 43 are smaller than the gear 44 they constitute still another reducer. It is essential that at least one reducer be employed if the driven wheel is to move more slowly than the driver, as will be understood. The resistance device, here operated by an actuator driven by the rotation of one of the shafts between the two pulleys, comprises a movable member reciprocated or moved to and fro by that actuator, a relatively fixed member opposed to said movable mem-

ber, and setting mechanism for adjusting said fixed member to various positions. When adjusted so that the resistance shall be extreme, the reciprocation of the movable member will be entirely checked, and the resistance device therefore locks the shaft against rotation; but as all the mechanism is carried by a casing which is itself capable of rotation when said shaft is locked the entire casing will be rotated by the driver, and hence the driven pulley will be rotated at the same speed as the driving-pulley.

The normal effect of the action of the reducing-gearing is to cause the rotatable casing to revolve in a direction opposite to that of the driving-shaft whenever there is sufficient load on the driven shaft to overcome the friction of intermediate gearing; but this tendency of the casing to rotate in a reverse direction may be checked or entirely overcome by the application of force to overcome the resistance of the resistance devices, provided that this force is applied to points on the casing outside its axis and provided that the force is exerted in any direction except in planes parallel to the axis. Whenever the resistance of the resistance device is reduced to a certain ratio of resistance of the load, the casing ceases to revolve and the driven shaft will revolve at a speed which will depend on the speed ratio of the reducing-gearing which is between the driving-shaft and the driven shaft. If the resistance of the resistance device be still further reduced, the casing will revolve in a reverse direction. However, as there is reducing-gearing between the driving-shaft and the driven shaft the driven shaft may revolve in the same direction as the driving-shaft, even though the casing is rotating in a reverse direction; but as the speed of the reverse rotation of the casing increases the speed of the driven shaft decreases until it ceases altogether, and if the reverse rotation of the casing is still further accelerated the driven shaft will revolve in the reverse direction. The operator therefore by his control of the resistance device can secure any gradation of speed from zero to the full speed of the driving-shaft, and the speed of the driven shaft will depend on the ratio of the resistance of the resistance device to the resistance of the load.

The employment of the lost-motion mechanism is particularly useful when the resistance device is set between its extremes, because such mechanism then makes of the resistance device an energy-storing device—that is to say, in the construction illustrated the outward movement of the main plunger under the impulse of the driving portion 34 of its shaft compresses air against the secondary plunger, and thereby stores energy, and when the extreme outward movement has ceased the expansion of this air forces the main plunger inward again and communicates its energy to the driven portion 38 of the shaft, whereby the energy is communicated to the driven pulley. Hence it will be seen that this machine is a variable-speed mechanism whose essential elements are adapted to communicate power from the driving-wheel to the driven wheel at the same speed or at a reduced speed, according as the resistance device is set, and yet features are present whereby the energy which is stored by the resistance device is not lost but is communicated to the driven member. Moreover, when the actuator has driven the plunger in its outward movement until it has overcome the resistance of the resistance device energy has been stored which drives the plunger during its inward movement. The so-called "resistance" device is, in fact, a constantly-alternating resisting and driving device. I am aware that there are other variable-speed mechanisms which include a rotatable casing in which a resistance device or brake is carried as part of their elements; but so far as I know there is no variable-speed movement in use and none has ever been designed in which there is a rotatable casing carrying a device which acts with regular and automatic alternations as a resisting and driving device—that is to say, one which resists by storing energy (herein by compression) and then drives by the release and use (herein by expansion) of the energy so stored, and one especially in which these compensating functions of the device take place alternately and automatically, without requiring attention and without detracting from the total energy transmitted except in so far as the friction of parts may become an element of calculation.

The *modus operandi* of the construction disclosed is as follows: When power is applied to the driver 13, the speed of such driver is transmitted at a reduced rate through the various trains of gears and pinions until the pulley 15 is rotating at a much lower rate of speed than the drive-wheel 13. It will be assumed for the present that the lever 76 will be oppositely disposed to the position shown in Fig. 1, when, as is obvious, the ends 87 and 88 of the pivoted levers 66 and 67 will be drawn inward, while their other ends will be thrown outward, and thus carry the secondary plungers 64 and 65 out toward the ends of the cylinders 59 and 58. The plungers 54 and 55 which are connected to the actuators 52 and 53 will now be able, during the operation of the reducing-gearing inside of the casing 4, to have practically unresisted reciprocation in the cylinders 59 and 58, and therefore the operation of the internal gearing may proceed freely and uninterruptedly. During such operation it will be observed that the casing 4 will remain unmoved. When, however, the lever 76 is pushed into the position shown in Fig. 1 and the secondary plungers 64 and 65 are forced into the cylinders 59 and 58, so as to lessen the space between

the said plungers and the plungers 54 and 55, then, as is obvious, the pneumatic resistance becomes such—for instance, when the plungers 64 and 65 are pushed into the extreme—that the further movement of the plungers 54 and 55 is arrested. Consequently the actuators 52 and 53 can no longer pass around in their path of rotation, and the internal gearing is therefore locked against further movement. The transmission is then directed through the shaft 12 to the casing 4, and the gear 51, keyed to said casing at 52, will also be urged around, which will cause the pinions 49 and 50 to rotate slower, and, in consequence, to also rotate the pulley 15. If at any time during the starting of the device it should happen that either of the actuators 52 or 53 should be positioned directly on dead-center, a sufficient amount of play is provided by the lost-motion connection between the actuator-shafts and the actuators, so that either pin or stud 63 or 64 may move in its slot 62 and carry the actuators over the dead-center point. It will be observed also that the speed from the driver may be imparted to the driven member at various ratios with relation to said driver by varying the degree of resistance, which may be accomplished by causing the secondary plungers 64 and 65 to be set farther in or out of the cylinders 59 and 58, whereby the space between said plungers and plungers 54 and 55 will be increased or decreased and whereby the said last-mentioned plungers may have a reciprocation under restraint or no movement whatever.

The construction shown, it will be observed, provides a speed-reduction device controlled by resistance, which may within the purview of this invention be offered in any suitable manner best adapted for varying conditions, and which in the present instance may be offered pneumatically or by a spring action, as shown in the modification, or by any action equivalent to such means.

The invention embodying the provision of means for offering a resistance against the movement of certain elements, whereby to so control them as to vary their functions and produce a speed-reduction device, may be embodied in a mechanism as shown or in any other suitable or desired construction or organization without departing from the spirit of this invention.

Having thus described my invention, I claim—

1. In a variable-speed mechanism, the combination with a driving member and a driven member; of a reducer between them, and a constantly-alternating resisting and driving device applied thereto and having a limited reciprocating movement.

2. In a variable-speed mechanism, the combination with a driving member and a driven member; of a reducer between them, a constantly-alternating resisting and driving device applied thereto, and means for adjusting the degree of resistance while the mechanism is in motion.

3. In a variable-speed mechanism, the combination with a driving member and a driven member; of a rotatable casing connecting said members, a reducer within the casing between said members, and a constantly-alternating resisting and driving device applied thereto and carried by and rotatable with the casing.

4. In a variable-speed mechanism, the combination with a driving member and a driven member; of a rotatable casing connecting said members, a reducer within the casing between said members, a constantly-alternating resisting and driving device applied thereto and carried by the casing, and means also carried by the casing for adjusting the degree of resistance.

5. In a variable-speed mechanism, the combination with a driving member and a driven member; of a rotatable casing connecting said members, and a constantly-alternating resisting and driving device carried by the casing and applied to said members for the purpose set forth.

6. In a variable-speed mechanism, the combination with a driving member and a driven member; of a rotatable casing connecting said members, a constantly-alternating resisting and driving device carried by said casing and applied to said members, and means also carried by the casing for adjusting the degree of resistance.

7. In a variable-speed mechanism, the combination with a rotatable casing, a driving member, a driven member, and driving and driven shafts respectively connected therewith and standing in alinement with each other; of a constantly-alternating resisting and driving device, and an actuator therefor connected with the adjacent ends of said shafts.

8. In a variable-speed mechanism, the combination with a rotatable casing, a driving member, a driven member, and driving and driven shafts respectively connected therewith and standing in alinement with each other; of a constantly-alternating resisting and driving device, an actuator therefor connected with the adjacent ends of said shafts, and means for adjusting the degree of resistance.

9. In a variable-speed mechanism, the combination with a rotatable casing, a driving member, a driven member, and driving and driven shafts respectively connected therewith and standing in alinement with each other; of a resistance device, an actuator therefor connected with the adjacent ends of said shafts, and lost-motion mechanism between the actuator and driving and driven shafts respectively, as and for the purpose set forth.

10. In a variable-speed mechanism, the combination with a rotatable casing, a driving member, a driven member, and driving and

driven shafts respectively connected therewith and standing in alinement with each other; of a resistance device, an actuator therefor connected with the adjacent ends of said shafts, lost-motion mechanism between the actuator and driving and driven shafts respectively, and means for adjusting the degree of resistance, as and for the purpose set forth.

11. In a variable-speed mechanism, the combination with a driving member, a driven member, a rotatable casing, and driving and driven shafts connected respectively with said members and standing in alinement with each other; of a resistance device carried by the casing, an actuator therefor connected with the adjacent ends of said shafts, and lost-motion mechanism between the actuator and driving and driven shafts respectively.

12. In a variable-speed mechanism, the combination with a driving member, a driven member, a rotatable casing, and driving and driven shafts connected respectively with said members and standing in alinement with each other; of a resistance device carried by the casing, an actuator therefor connected with the adjacent ends of said shafts, lost-motion mechanism between the actuator and driving and driven shafts respectively, and means also carried by the casing for adjusting the degree of resistance.

13. In a variable-speed mechanism, the combination with a driving member, a driven member, a rotatable casing between them, driving and driven shafts journaled within the casing in alinement with each other, connections between one shaft and its respective member, and a reducer between the other shaft and its respective member; of a resistance device carried by the casing and connected with the adjacent ends of said shafts, as and for the purpose set forth.

14. In a variable-speed mechanism, the combination with a driving member, a driven member, a rotatable casing between them, driving and driven shafts journaled within the casing in alinement with each other, connections between one shaft and its respective member, and a reducer between the other shaft and its respective member; of a resistance device carried by the casing and connected with the adjacent ends of said shafts, and means also carried by the casing for adjusting the degree of resistance, as and for the purpose set forth.

15. In a variable-speed mechanism, the combination with a driving member, a driven member, a rotatable casing between them, driving and driven shafts journaled within the casing in alinement with each other, and reducers within the casing connecting each shaft with its respective member; of a resistance device carried by the casing and connected with the adjacent ends of said shafts, as and for the purpose set forth.

16. In a variable-speed mechanism, the combination with a driving member, a driven member, a rotatable casing between them, driving and driven shafts journaled within the casing in alinement with each other, and reducers within the casing connecting each shaft with its respective member; of a resistance device carried by the casing and connected with the adjacent ends of said shafts, and means also carried by the casing for adjusting the degree of resistance, as and for the purpose set forth.

17. In a variable-speed mechanism, the combination with a driving member, a driven member, a rotatable casing between them, driving and driven shafts journaled within the casing in alinement with each other, and two trains of planetary gearing differing from each other in speed and respectively connecting said shafts with their respective members; of a resistance device carried by the casing and connected with the adjacent ends of said shafts, as and for the purpose set forth.

18. In a variable-speed mechanism, the combination with a driving member, a driven member, a rotatable casing between them, driving and driven shafts journaled within the casing in alinement with each other, and two trains of planetary gearing differing from each other in speed and respectively connecting said shafts with their respective members; of a resistance device carried by the casing and connected with the adjacent ends of said shafts, and means also carried by the casing for adjusting the degree of resistance, as and for the purpose set forth.

19. In a variable-speed mechanism, the combination with a rotatable casing having hubs, a driving member whose shaft is journaled through one hub, and a driven member whose shaft is journaled through the other; of reducing mechanism and connections between the inner ends of said shafts, a resistance device carried by the casing and applied to said connections, means for adjusting the degree of resistance, and mechanism mounted on one of said hubs for setting said adjusting means.

20. In a variable-speed mechanism, the combination with a rotatable casing having hubs, a driving member whose shaft is journaled through one hub, and a driven member whose shaft is journaled through the other; of reducing mechanism and connections between the inner ends of said shafts, and a resistance device applied to said connections and embracing a radial cylinder through the casing, a main plunger reciprocated therein by said connections, a secondary plunger therein, a resisting medium between the plungers, and means on the casing for adjusting the secondary plunger.

21. In a variable-speed mechanism, the combination with a driving-shaft and a driven shaft; of a reducer between them, a resistance device applied thereto, an actuator for the re-

sistance device, and lost-motion mechanism at the point of connection between said actuator and the shafts.

22. In a variable-speed mechanism, the combination with a driving-shaft and a driven shaft; of a reducer between them, a resistance device applied thereto, an actuator for the resistance device, lost-motion mechanism at the point of connection between said actuator and the shafts, and means for adjusting the degree of resistance.

23. In a variable-speed mechanism, the combination with a driving-shaft and a driven shaft, and a rotatable casing in which such shafts are supported; of a reducer within the casing between the shafts, a resistance device carried by and rotatable with the casing, an actuator for the resistance device, and lost-motion mechanism at the point of connection between said actuator and the shafts.

24. In a variable-speed mechanism, the combination with a driving-shaft and a driven shaft, and a rotatable casing in which such shafts are supported; of a reducer within the casing between the shafts, a resistance device carried by and rotatable with the casing, an actuator for the resistance device, means for adjusting the degree of resistance, and lost-motion mechanism at the point of connection between said actuator and the shafts.

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