(No Model.) 5 Sheets—Sheet 1.

W. MAIN.

CAR PROPELLING APPARATUS.

No. 407,094. Patented July 16, 1889.

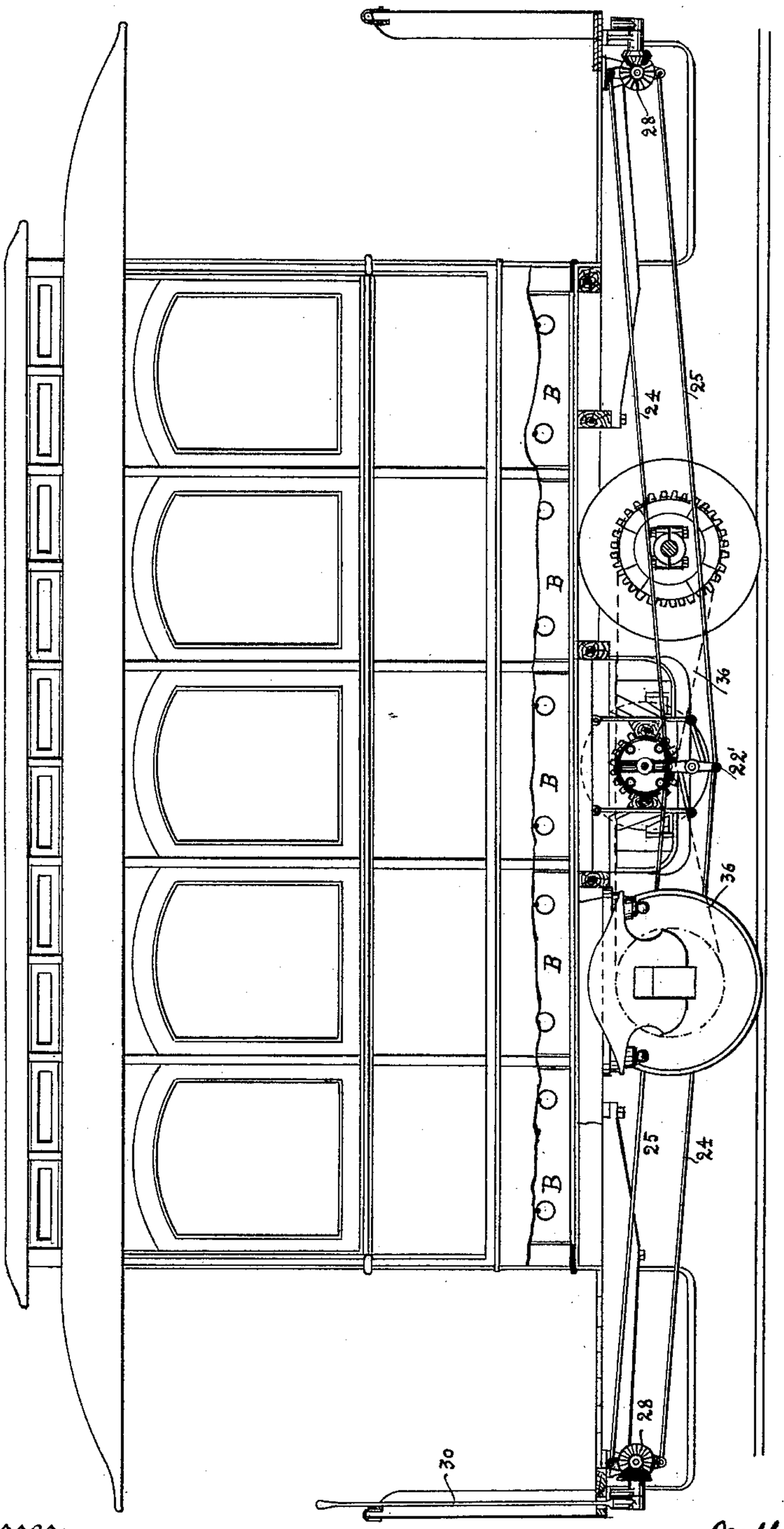

Fig. 1.

Witnesses
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(No Model.)

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CAR PROPELLING APPARATUS.

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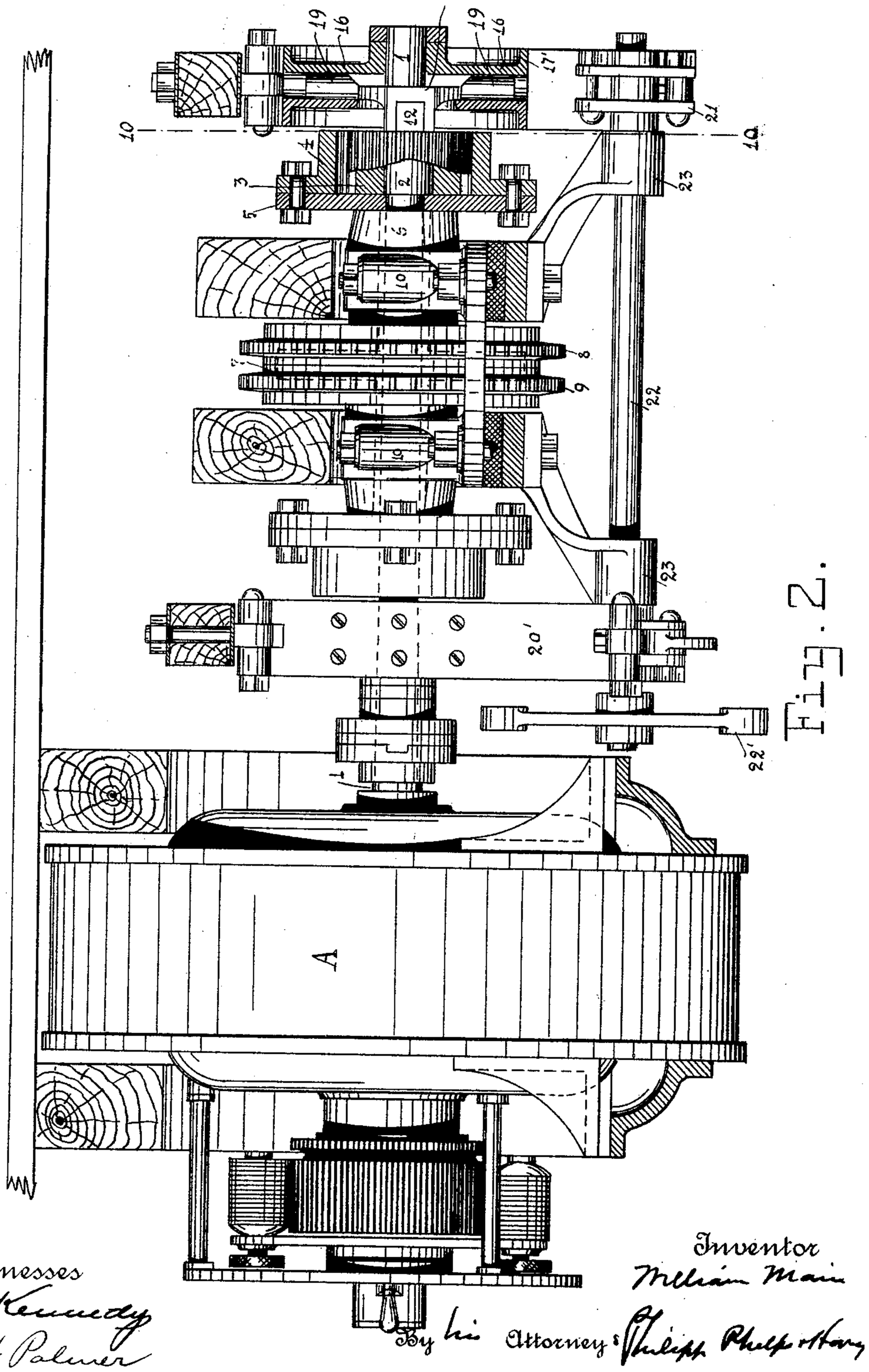

Fig. 2.

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(No Model.)

5 Sheets—Sheet 3.

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CAR PROPELLING APPARATUS.

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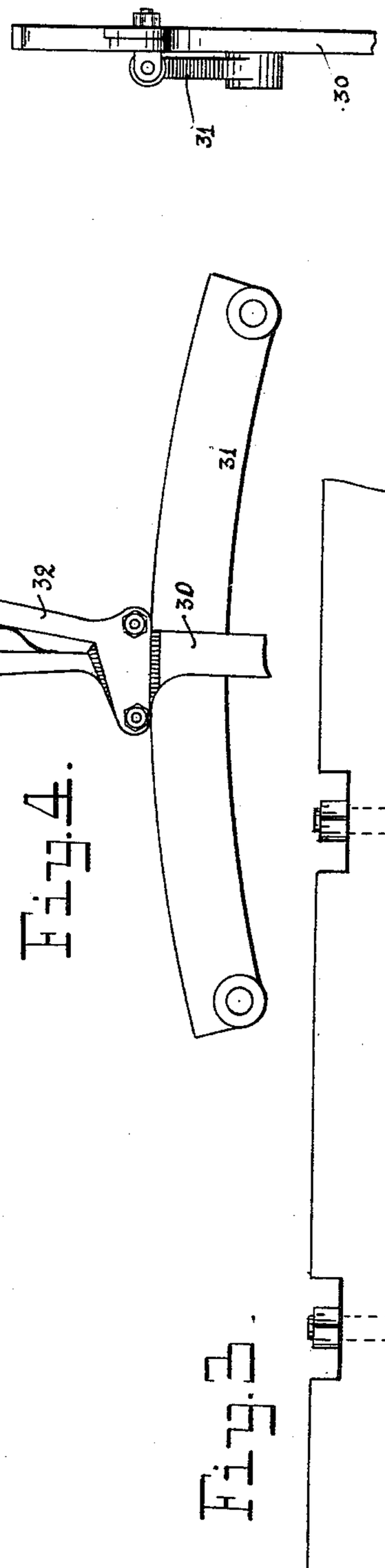

Fig. 4.

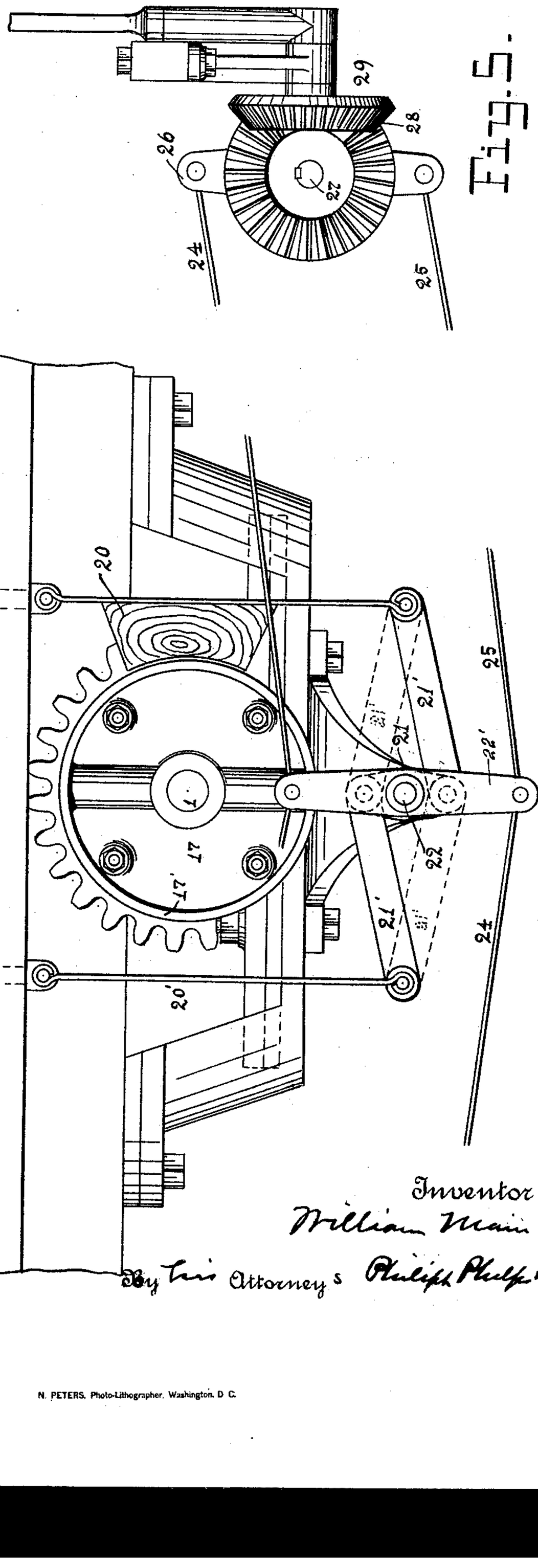

Fig. 5.

Fig. 3.

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(No Model.) 5 Sheets—Sheet 4.

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CAR PROPELLING APPARATUS.

No. 407,094. Patented July 16, 1889.

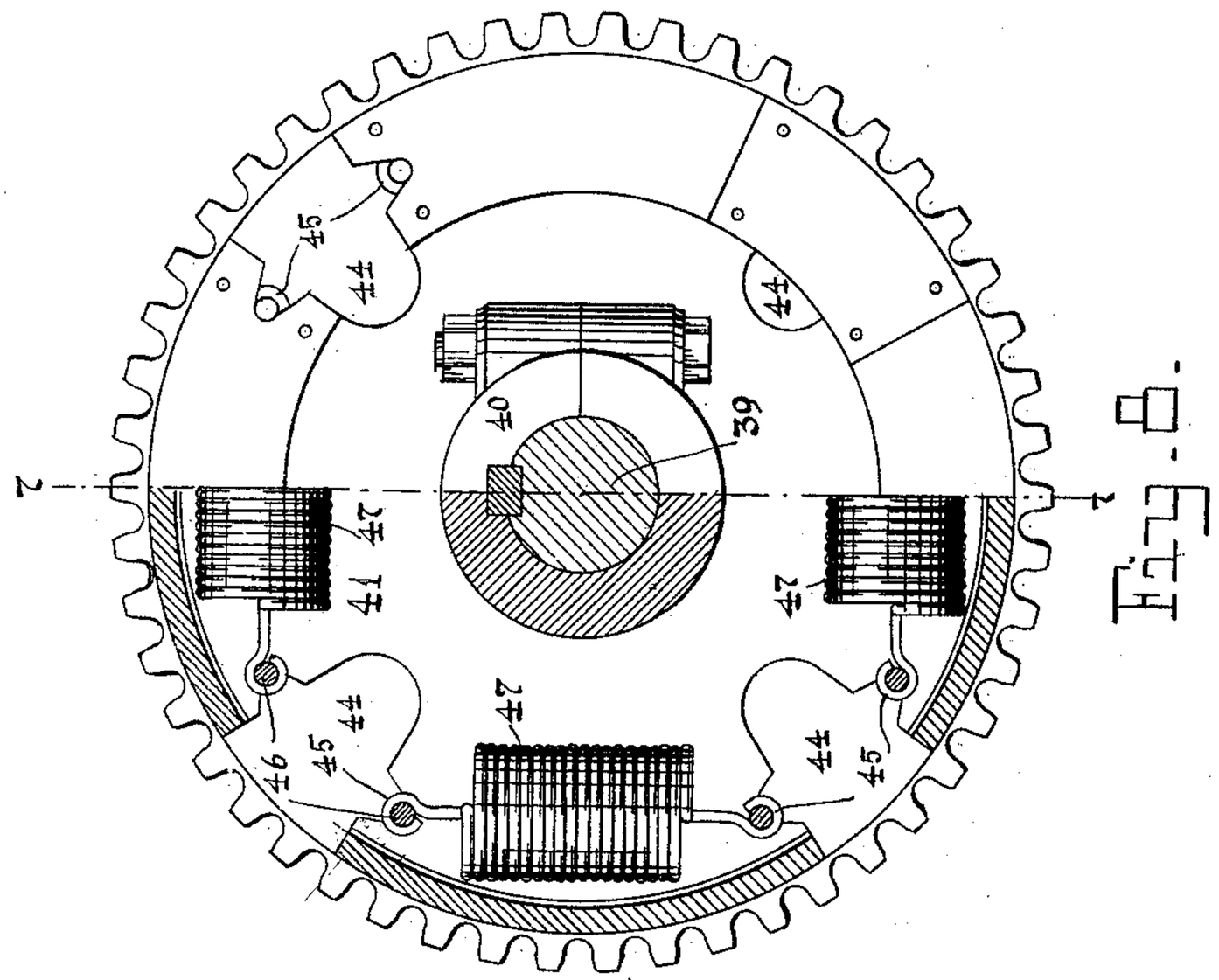

Fig. 6.

Fig. 7.

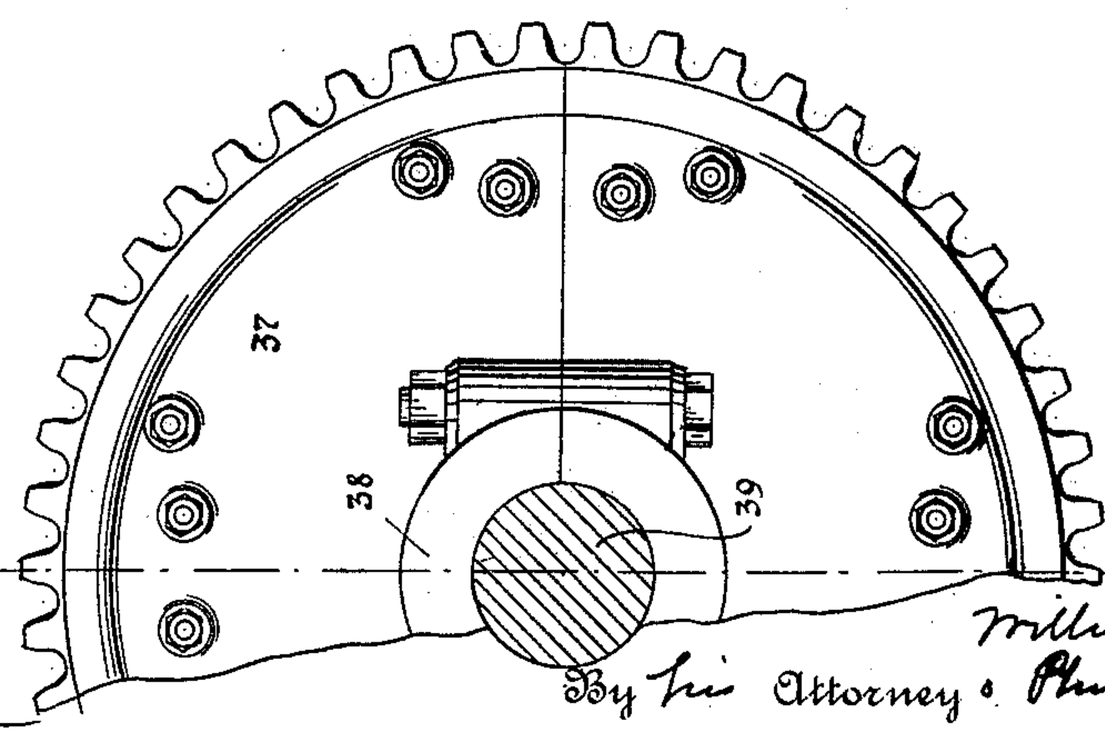

Fig. 5.

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(No Model.)

5 Sheets—Sheet 5.

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CAR PROPELLING APPARATUS.

No. 407,094. Patented July 16, 1889.

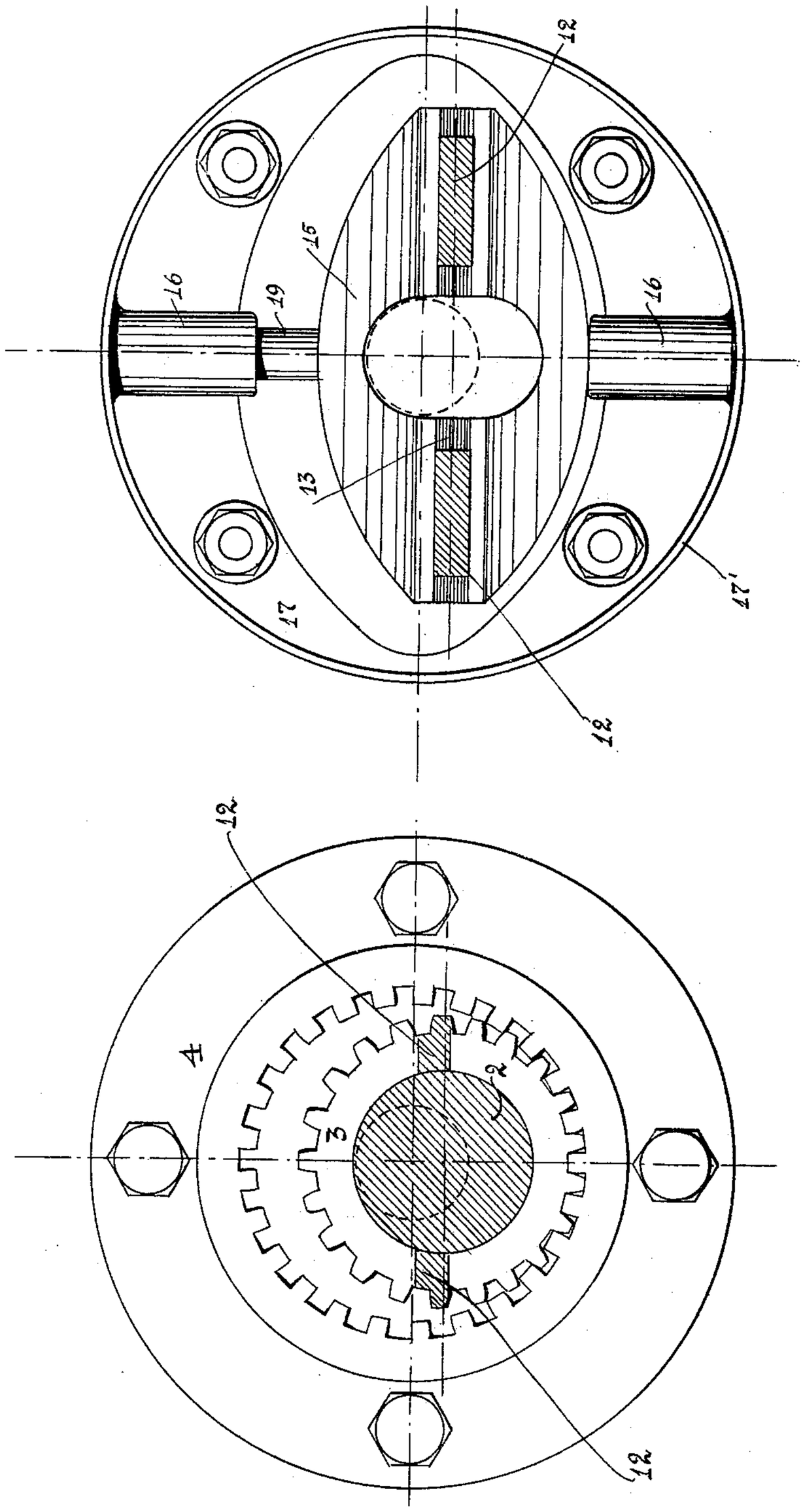

Fig. 10.

Fig. 11.

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UNITED STATES PATENT OFFICE.

WILLIAM MAIN, OF BROOKLYN, NEW YORK.

CAR-PROPELLING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 407,094, dated July 16, 1889.

Application filed August 21, 1888. Serial No. 283,355. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM MAIN, a citizen of the United States, residing at Brooklyn, county of Kings, and State of New York, have invented certain new and useful Improvements in Car-Propelling Apparatus, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

My invention has for its object the practical application of motors to the running of street-cars and other vehicles and the overcoming of the difficulties which have heretofore been encountered in that art. I show and describe an electric motor driven by storage-batteries; but I do not limit myself to that or any other type of motor, claiming my inventions herein set forth in combination with any sort of motor with which they can be used. Among the numerous difficulties attendant upon the use of motors for this purpose has been this: that the starting of the car or other vehicle requires a much greater amount of power than its propulsion after the starting has been effected, necessitating, where electric motors and batteries are employed, the carriage of a very great amount of battery material which otherwise would not be required, besides an unnecessary size of motor, and, where third rails or suspended wires are used to complete the circuit, necessitating an extraordinary amount of current-power as well as of motor-power. This difficulty results obviously from the fact that the entire inertia of the vehicle has to be overcome at the moment of starting, and is of special importance in connection with the use of motors for street-cars and for purposes of locomotion generally, the load in these cases being necessarily the same at the moment of starting as afterward, while in the case of applications of power to the driving of machinery it is generally practicable to reduce the load at the moment of starting and to apply portions of the driven machinery or of the work to be accomplished gradually and successively.

A further most serious difficulty encountered in this art has been that of providing a mechanism for reducing the high rate of speed ordinarily requisite for obtaining from a motor—particularly an electric motor—its maximum efficiency to such a rate of speed as is required for the driving of the axle or propelling-shaft of the vehicle. The mechanism heretofore devised for effecting this reduction has been so considerable in size and weight as to cause a very large percentage of loss of power in friction, as well as to encumber the vehicle by a large mass of inert material. For the successful application of electric motors to street-cars a simple, compact, and light form of reducing mechanism is a practical necessity which has not yet been supplied. Such a mechanism to be effective and practicable should be capable not only of effecting the required reduction of speed, but also of gradual application to the source of power, so that the connection of the motor with the driving-axle in starting the car may be effected by degrees and without the jar and strain upon the connecting parts incident to the sudden application of the driving-power.

A further difficulty encountered arises from the fact that in car-propulsion it is convenient to place the motor upon the body of the car and to provide springs between the car-body and the truck. As the driving-connection between the motor and the driving-axle of the truck must in that case bridge a constantly-varying distance, it is necessary to provide some sort of a yielding power-transmitting mechanism, and the construction of such a mechanism which shall be at once simple and effective has been found to be a practical difficulty.

A further difficulty has arisen from the fact that in the propulsion of vehicles in which the motive power is carried upon the vehicle itself, the vehicles being of comparatively small weight, the friction is, in unfavorable conditions of the track and grade, insufficient to propel the vehicles where the propulsion is effected by means of a single driving-axle. If both axles of the vehicles can be brought into simultaneous operation, this friction is very greatly increased; but such use of the two axles has been heretofore found impracticable without the use of two separate motors, one for each axle, because of the liability of one of the axles in passing over irregularities of track to gain upon the other, thus causing a binding or locking between the two when

driven by rigid connections from the same shaft.

I propose by means of the devices and mechanisms hereinafter described to effectually overcome these difficulties in the following manner: Instead of arresting the rotation of the motor when stopping the car, I propose to interrupt the driving-connection between the motor-shaft and the driving-axle, permitting the rotation of the motor to continue at full speed. The stops of the vehicle being generally for a brief period only, this will result in but slight loss of power, while it will subject neither the motor nor (where electric batteries are used) the battery to the effects of sudden variations in the quantity of the driving-current, and it will permit the entire force of the motor to be used in the starting of the vehicle without danger to any of the parts of the apparatus. Moreover, the motor and connected parts, by virtue of their revolution at a high rate of speed, will maintain stored up a very considerable amount of force which can be utilized in the starting of the car, and will, in connection with the devices which I propose to use for effecting the gradual application of power to the driving-shafts, enable the starting to be effected without the application of any considerably greater amount of power than is normally required for the propulsion of the vehicle when in full motion.

In order to permit the ready making and unmaking of the connection between the rapidly-revolving motor and the driving-axles, an unusually effective and readily-controlled mechanism is required, which I have devised specially for this purpose, and which has the advantage, as a reducing mechanism, of extreme simplicity, compactness, and small weight, and the capability of permitting as gradual application of the power in starting as may be desirable. There are two requisites of special importance in such a mechanism—to wit, that of a gradual application while the motion is being initiated and that of positive and absolute power-transmitting capacity after the transmission of power is thoroughly under way—and these requisites I obtain by employing a friction device for initiating the transmission of power, devices of this character, as is well known, being capable of gradual application, and a gear-connection for effecting the transmission when established; and I secure the requisite absolute and delicate capacity of control by providing such an association of parts that when the train of gears which I employ is out of transmitting-connection one member of the train is revolving at a high rate of speed, but without effective engagement with the other members thereof, the driving-connection between the gears being established by the gradual application of a friction-brake to the revolving gear. It is apparent that such an application of brakes can be made in any desired degree, and consequently with any desired amount of acceleration to the driven parts, and that this application of power can always be under absolute and convenient control. The mechanism which I propose to use for this purpose consists of a novel application of what is known as the "Watt sun-and-planet gear," which in its application to the transmission of power, broadly, I have described and claimed in an application for Letters Patent filed August 27, 1887, Serial No. 248,011.

The provision which I propose to make for the requisite elasticity of connection between the driving-shaft and the motor in order to overcome the variation of distance due to the springs under the car-body, and also to permit two shafts to be driven from the same motor, consists in a novel application of springs. I prefer to effect the requisite springy connection so that the springs shall have a torsional action relative to the driving and driven shafts, under which conditions the simplest mechanism and the most effective spring action can be obtained.

The several devices above referred to have especial value as applied to locomotion, broadly, for the reason that in the propulsion of vehicles the average rate of speed of the driven shafts or axles is considerably less than that of the shafts of machinery in general, and consequently a sufficiently compact and light reducing mechanism is difficult to obtain, while at the same time the space occupied by such devices and their weight are necessarily matters of special consideration, the space being limited and it being desirable to reduce the load carried to a minimum.

My several devices and combinations have special application for use in connection with the driving of street and other cars; but I contemplate as well the use thereof for the driving of all forms of vehicles whatsoever, such as elevators, road-wagons, boats, &c.

It is important, in order to prevent wear and strain, that the motor should be run at a constant speed, and to maintain an even rate of speed in the motor both when the car is running slowly in starting or ascending a grade and rapidly when under way it is necessary to provide a variable motion-reducing mechanism. I make this provision in part by the use of a friction-clutch for controlling the mechanism, whereby, by permitting slip and regulating the amount of slip, the rate of transmission may be varied within wide limits, but primarily by providing two or more sets of reducing mechanism of different speeds, either of which may be thrown into connection, as required. By the combined use of these two provisions for change of speed I am enabled to start the car without reducing the revolution of the motor-shaft—that is, I am enabled to perform the most difficult portion of the work (that of starting the car) with a motor working under the most favorable conditions.

My invention further consists in certain features and details of construction hereinaf-

ter fully described, and pointed out in the claims.

In the drawings annexed to this specification my inventions are shown as applied to a street-car propelled by an electric motor and batteries, and Figure 1 is a side view, partly in section, of a car to which my invention has been applied. Fig. 2 is a side view of the motor and power-transmitting devices mounted upon the shaft thereof. Fig. 3 is an end view of the motor-shaft and a part of the power-transmitting device upon an enlarged scale. Figs. 4 and 5 are details on the same scale of mechanism for controlling the movement of the car. Figs. 6, 7, and 8 represent on the same enlarged scale a torsional spring-connecting device between the motor and the driven axle, Fig. 6 being a side view, Fig. 7 a vertical section on the line 7 7, Figs. 6 and 8, and Fig. 8 a side view, partly in section, on the line 8 8, Fig. 7; and Figs. 9 and 10 are detail views on an enlarged scale of the motion-reducing device, Fig. 9 being a section on line 10 10, Fig. 2, the point of view being to the right of said line, and Fig. 10 a section taken on same line, the point of view being to the left of said line.

Suspended beneath the frame-work of the cars is the motor A, the main shaft of which is connected through the motion-reducing mechanism with the axle of the car-truck. This motion-reducing mechanism will first be described.

The shaft 1 of the motor carries fast upon it an eccentric 2, which moves freely in a circular opening within gear-wheel 3, which gear-wheel constitutes the fixed or initial member of the sun-and-planet series of gears above referred to. Outside of and above this gear-wheel is an annular gear 4, concentric with the driving-shaft 1 and bolted to a flange 5 of a sleeve or hollow shaft 6. (Shown in Fig. 2 partly by broken lines mounted upon the main shaft and carrying at its inner end a flange 7, upon which is formed a sprocket-wheel 8, from which the power is transmitted to one of the car-axles.) The sleeve 6 rests in suitable bearings 10, secured to the car-frame.

On the inner side of sprocket-wheel 8 is arranged upon the motor-shaft another sprocket-wheel 9, rigid with wheel 8, and a second series of devices identical with those above described, except that the ratio between the inner and outer gear-wheels is varied, this additional mechanism being provided in order that it may be possible to change the speed of the car without changing that of the motor.

Upon the inner gear-wheel 3 (see particularly Figs. 2, 9, and 10) are cast lugs 12, fitted to and adapted to slide in a recess or channel 13, formed in a cross-head 15. This cross-head 15 is in turn provided with cylindrical lugs 19, fitting cylindrical sockets 16, formed in a pulley 17, mounted upon and rotating freely about the main shaft. Pulley 17 has a rim 17′, which serves as a friction-wheel. The cross-head 15 has an oblong central opening which permits it to move in the direction of its lugs 19 over the main shaft 1.

It is obvious that the gear 3 and the pulley 17 will maintain fixed positions relative to each other as regards rotation, their absolute relative positions changing as the shaft 1 revolves to the extent of the sliding motion of the cross-head 15 and in pulley 17 and of lugs 12 in channel 13, caused by the eccentric position of the gear 3 with reference to the axis of the pulley 17, the lugs 12 and cross-head 15 constituting double slides, moving in right lines, and uniting the gear and the pulley as regards circular motion. Consequently, when the pulley 17 freely moves about its axis, the gear 3 is also free and will convey no power from the shaft to the outer gear 4. When, however, the pulley 17 is locked or held fast in one position, the gear 3 will be restrained by the cross-head 15 and lugs 12 acting as guides and carried about by the eccentric in a position constantly parallel to itself, and will communicate to the outer gear 4 a rotating motion reduced to an extent dependent upon the ratio between the two gears. The amount of this reduction may be readily calculated according to well-known rules, which require no special explanation here.

It is necessary to provide devices for the locking of the pulley 17 in order to effect the transmission of power through the gears, and for this purpose I prefer to use a friction-clutch, although any other form of clutch mechanism may be employed, as illustrated in Figs. 1, 2, 3, 4, and 5, wherein brake-shoes 20 are shown attached to pivoted hangers 20′, the lower ends of these hangers being connected by rods 21′ to a cross-piece 21, fastened upon a shaft 22, mounted in bearings 23, which shaft is revolved as desired to throw the shoes to or from the rim 17′ by rods 24 and 25, two sets of which are provided, passing from cross-piece 22′, fixed upon shaft 22, to each end of the car and connecting at each end with a cross-bar 26 upon a shaft 27, the latter shaft being connected by bevel-gears 28 with a shaft 29, attached to a lever 30, adapted to move along a segmental bar 31 and to be arrested by a spring-catch 32 at any desired point thereof in the manner usual in railroad-switch and similar levers. In the mechanism shown two of these sets of brake-shoes are employed, one for each of the pulleys 17, so connected with their cross-pieces 21′ that in one position of the shaft 22 one of the said pulleys is arrested and the other released, and in the other position thereof the action of the shoes upon the pulleys is reversed. The arrangement of the second set of rods 21′ is shown in broken lines in Fig. 3. By the use of this mechanism the position of the controlling-shaft 22 may be determined and adjusted from either end of the car by the use of the appropriate lever, and either

one of the two sets of gears may thus be brought into operation, according to the speed to be given to the car, and both may be thrown out of operation in order to arrest the action of the motor upon the car-axles by causing the shaft to assume an intermediate position wherein neither of the pulleys will be held. If more than two speeds are desired for the car, the number of sets of gears and controlling mechanisms will be accordingly increased. The motor is driven by the current from storage-battery B or other source of electricity. The usual springs are shown between the car-body and the truck.

Power is transmitted from sprocket-wheel 8 to one of the car-axles, and from wheel 9 to the other, by means of chains 36, passing one to the forward and the other to the rear axle, and engaging with other sprocket-wheels 37, mounted thereon in a manner and with connected parts which will now be described. The sprocket-wheel 37 consists in each case of a circular flange carrying the sprocket-teeth and integral with a hub 38, mounted so as to revolve freely upon the axle 39. Adjoining the hub 38 is a sleeve 40, keyed to the axle and provided with two circular flanges 41, parallel to each other and a short distance apart. To the flange 37 is bolted a circular cap 42, having two inwardly-projecting flanges 43 embracing the flanges 41. Flanges 41 are provided with a suitable number of recesses or openings 44, of which four are shown in this instance, and the flanges 43 are provided with an equal number of similar openings so placed as to accurately register with the recesses 44. In both the flanges 41 and 43 and in the sides of the openings above described are placed notches 45, registering with each other in all the flanges and adapted to serve as bearings for transverse rods 46, which rest in them, and which rods are connected in pairs by springs 47, which springs will normally hold the two sets of flanges in such relation to each other that the openings or recesses therein will precisely register, as shown in Fig. 8. With this construction the stress of the motor when thrown upon the flange 37 will tend to turn the flange 37 and the hub 38 upon the axle, and this tendency will be resisted by the rods 46 and the springs 47. The springs are of such tension as to permit a certain small amount of movement between the parts which they connect; but after permitting such slight movement their strength is sufficient to transmit the driving-power of the motor. It results that the flange 37 and the sleeve 40, and consequently the axle 30, after the play of the spring is exhausted, move together and give motion to the car; and it will be observed that it is immaterial in which direction the flange 37 is caused to revolve, the result with either direction of motion being the same so far as the action of the springs and flange is concerned. In other words, the car may be caused to move forward or backward with precisely the same operation in each case of the power-transmitting mechanism by reversing the direction of rotation of the motor-shaft. The rods 46 constitute double opposite bearings for the springs, permitting the bearing-points of the springs to be shifted from one end thereof to the other, according to the direction in which the car is moving. This capacity of reversibility in these springs is a feature of importance in my invention.

The springs serve to prevent irregular or jerking action in the transmission of the power of the motor to the axles and take up the jar and strain which would otherwise be present in the starting and stopping of the car. This capability of the springs is particularly important where the power is transmitted through the medium of chains, since chains in such mechanism, where the mountings are rigid, are caused to slacken by any irregularities in the connected parts caused by imperfect construction or resulting from wear, and as a result the chains are rapidly and irregularly worn and create a constant clanking. With this device, however, perfect tension is at all times maintained in that portion of the chain which transmits the power from the motor-shaft to the traction shaft or axle and a minimum of wear results whatever variations are caused in the distance between the driving and driven shafts by the bearing-springs between the car-body and the truck. These variations are reduced to a minimum by the relative position of the driving and driven shafts, as will appear by inspecting Fig. 1, wherein the chains are seen to be nearly horizontal, and such as remain are effectually taken up by these springs. These springs have the further function of enabling the car to be practically driven by connection with both the truck-axles. As is well known, it is impracticable to connect one driving-shaft with two connected driven shafts by means of chains in ordinary rigidly-mounted mechanism, for the reason that it is impossible to maintain exactly the same adjustment for both chains and connected parts, and a certain amount of binding is certain to result—sufficient at length to absolutely arrest the operation of the mechanism. This is particularly true where, as in this case, the two driven shafts are connected through the medium of an uneven track whereon there is a constant liability on the part of one shaft to gain or lose upon the other. The springs above described, however, serve to neutralize also these relative irregularities, and the two axles are simultaneously driven without in the least interfering with each other. This is a feature of very considerable importance in many applications of power, but of special value in the driving of cars, for the reason, as above suggested, that it is desired in this case to obtain a maximum amount of friction between the drive-wheels and the track.

It will be observed that a single spring—to wit, between the motor-shaft and one of the axles only—would relieve the mechanism from binding, and I therefore do not limit myself to the use of two springs.

The motion-reducing mechanism above described has a signal advantage over similar devices with which I am acquainted, in that it enables the power of the motor-shaft to be applied with the utmost advantage to the starting of the car. At this moment great power, as well as the gradual application of that power, is a necessity. My friction-brake, controlling the operative engagement of the driving-gear, permits the entire force of the motor-shaft rotating at full speed and the full momentum of the rotating parts to be applied with as gradual an accession of speed as is advantageous. The usual short stops are made without arresting the rotation of the motor, and thus a considerable amount of power is stored in these revolving parts as momentum, which can be applied at the moment of starting. The control exercised over the whole mechanism is absolute, and its operations can be precisely and delicately modulated. These advantages flow directly from the fact that the peculiar reducing-gear employed is out of operation when one of its members revolves freely, and that consequently it may be made operative by the application of brakes to the revolving member, the mechanism to which the brake is applied becoming on their complete application a fixed part of the frame-work of the machine—an abutment upon which the transmitting-gear rests while operative.

The sun-and-planet arrangement of connecting-gears has particular adaptation to the driving of vehicles, in that it is in the highest degree compact for the amount of reduction which it effects, and I do not limit myself to the particular arrangement shown of the several parts of that gear, as the relation of the driving to the driven gear may be reversed or variations made in the number or arrangement of the several parts without departing from the main features of my invention. Neither do I limit myself to the peculiar form of guides shown for controlling the operative engagement of the gear-wheels. In this case these guides consist of double slides moving in right lines; but any other form of mechanism by which the position of the driving member of the series of gear-wheels may be controlled may be used without departing from the invention herein described and claimed; also, the various parts of my invention herein shown and described may be used each independently and separate from the others, and I do not limit myself to their conjoint use.

By the expression "traction-shaft," as used in the claims, I intend either the vehicle-axle itself or any intermediate shaft between the vehicle-axle and the speed-reducing mechanism.

Having thus described my invention, what I desire to claim and secure by Letters Patent of the United States is—

1. The combination, with a vehicle, of a motor therefor, a chain for transmitting power from the motor, a traction-shaft, a gear-wheel mounted so as to turn upon said traction-shaft and engaging with the chain, and springs connecting the gear-wheel with the traction-shaft, said springs having a reversible action and forming a springy connection between the gear-wheel and the traction-shaft in whichever direction the gear-wheel tends to revolve, substantially as set forth.

2. In a vehicle-propelling apparatus, the combination, with the traction-shaft, of a driving gear-wheel mounted thereon and driven from the vehicle-motor, a flange keyed to said traction-shaft, and springs connecting the gear-wheel with the flange, provided at each end with bearings upon the flange and the gear-wheel, whereby the operation of the springs may be reversed on the reversal of the rotation of the gear-wheel, substantially as set forth.

3. In a vehicle-propelling apparatus, the combination, with the traction-shaft 39, of gear-wheel 37 38, mounted thereon and driven from the vehicle-motor, sleeve 40, provided with flanges 41, cap 42, provided with flanges 43, and springs 47, substantially as set forth.

4. In a vehicle-propelling apparatus, the combination, with the traction-shaft 39, of a gear-wheel 37 38, mounted thereon and driven from the vehicle-motor, flanges 43 41, recessed as shown and described, and rods 46, substantially as set forth.

5. The combination, with a vehicle, of a motor therefor, a motor-shaft, a traction-shaft, two sprocket-wheels, one on each shaft, one of said sprocket-wheels being mounted so as to turn upon its shaft, a chain connecting said sprocket-wheels, a sleeve fixed to the shaft alongside of the freely-revolving sprocket-wheel, and flexible connections uniting said sleeve and freely-revolving sprocket-wheel in such manner as to normally tend to hold the hub and wheel in a certain fixed relation to each other and to permit a limited relative motion between them in either direction under tension, substantially as set forth.

6. The combination, with a vehicle-body, of a motor mounted thereon, two traction-shafts, and sprocket-chains connecting the motor-shaft with the traction-shafts, one of the sprocket-chain wheels having a springy connection with its shaft, substantially as described.

7. The combination of a vehicle-body with a truck for supporting the same, springs between the vehicle-body and the truck, a motor mounted upon the vehicle-body, two traction-shafts mounted in the truck, and sprocket-chains connecting the motor-shafts with the traction-shafts, one of the sprocket-chain wheels having a springy connection with its shaft, substantially as described.

8. The combination of a vehicle-body with a truck for supporting the same, springs between the vehicle-body and the truck, a motor mounted upon the vehicle-body, two traction-shafts mounted in the truck, and sprocket-chains connecting the motor-shaft with the traction-shafts, a sprocket-chain wheel for each of the said chain-wheels, having a springy connection with its shaft, substantially as described.

9. The combination of a vehicle-body with a truck for supporting the same, springs between the vehicle-body and the truck, an electric motor mounted upon the vehicle-body, two traction-shafts mounted in the truck, and sprocket-chains connecting the electric-motor shafts with the traction-shafts, one of the sprocket-chain wheels having a springy connection with its shaft, substantially as described.

10. The combination of a vehicle-body with a truck for supporting the same, springs between the vehicle-body and the truck, an electric motor mounted upon the vehicle-body, two traction-shafts mounted in the truck, sprocket-chains connecting the electric-motor shafts with the traction-shafts and a sprocket-chain wheel for each of said chain-wheels, having a springy connection with its shaft, substantially as described.

11. The combination of a vehicle, an electric motor mounted thereon, sun-and-planet gear-wheels connecting the motor-shaft with the driving-axle of the vehicle, and guides for securing a constant parallel motion of the driving member of the sun-and-planet gear, substantially as set forth.

12. The combination of a vehicle, a motor mounted thereon, sun-and-planet gear-wheels connecting the motor-shaft with the driving-axle of the vehicle, and a friction-brake connected with one of the said gear-wheels, whereby the said gear-wheel may be thrown into or out of operative engagement, substantially as set forth.

13. The combination of a vehicle, a motor mounted thereon, a shaft for said motor, provided with an eccentric, a train of sun-and-planet gear-wheels between said shaft and the driving-axle of the vehicle, one wheel of said train being loosely mounted upon said eccentric, and a friction-brake connected with said wheel, whereby the said wheel may be locked, so as to partially or wholly check its rotation about its own center, substantially as set forth.

14. The combination of a vehicle, a motor mounted thereon, a shaft for said motor, provided with an eccentric, a train of sun-and-planet gear-wheels connecting said shaft with the driving-axle of the vehicle, one wheel of said train being loosely fitted upon said eccentric and adapted to rotate about the same as a center, a friction-pulley mounted to revolve freely, and guides connecting the wheel fitted upon the eccentric and the pulley, whereby they are caused to revolve together, substantially as set forth.

15. The combination of a vehicle, a motor mounted thereon, a shaft for said motor, two or more sets of sun-and-planet gear-wheels between the shaft and the driving-axle of the vehicle, the wheels of each set being differently proportioned to each other, guides for securing parallelism of motion of one member of each of said sets of gear-wheels, and means for bringing into operation either of said guides, substantially as set forth.

16. The combination of a vehicle, a motor mounted thereon, a shaft for said motor, two or more sets of sun-and-planet gear-wheels between the motor-shaft and the driving-axle of the vehicle, the wheels of each set being differently proportioned to each other, guides for securing parallelism of the driving member of each of said sets of gear, and means for controlling said guides, by which either of said guides may be thrown into operation, each of the other guides being in such position of the controlling mechanism thrown out of operation, substantially as set forth.

17. The combination of a vehicle, a motor mounted thereon, a train of gear-wheels between the motor-shaft and the driving-axle of the vehicle, one member of said train being normally rotated by the motor-shaft when the train is out of operative engagement therewith, a rotating pulley connected by guides with the normally-rotating gear, and friction-brakes for arresting said pulley, and thereby bringing the train of gear into operative engagement with the motor-shaft, substantially as set forth.

18. The combination of a vehicle, a motor therefor, a rotating brake device mounted upon the motor-shaft, a set of differential gear-wheels between the motor-shaft and the driving-axle of the vehicle, and guides connecting said gear-wheels and said rotating device, whereby the operation of the gear-wheels may be controlled, substantially as set forth.

19. The combination of a vehicle, a motor mounted thereon, and a train of sun-and-planet gear-wheels between the motor-shaft and the driving-axle of the vehicle, the initial wheel of said train maintaining in its movements positions of parallelism with itself when transmitting power, substantially as set forth.

20. The combination of a vehicle, a motor mounted thereon, a series of sun-and-planet gear-wheels between the shaft of the motor and the driving-axle of the vehicle, the initial wheel of said series maintaining positions of parallelism with itself while operative to transmit motion, and guides for partially suspending the operation of said initial wheel, and thereby creating changes of speed in the transmitted motion, substantially as set forth.

21. The combination of a vehicle, a motor mounted thereon, a train of gear-wheels con-

necting the shaft of the motor with the driving-axle of the vehicle, and a friction-brake controlling the operative engagement of the shaft with the gear-wheels, the transmitted speed increasing relatively to the amount of pressure applied to the brakes, substantially as set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

WILLIAM MAIN.

Witnesses:
J. J. KENNEDY,
T. H. PALMER.