F. S. WOODWARD.

CURVE DRAWING MACHINE.

APPLICATION FILED SEPT. 26, 1910.

1,031,034.

Patented July 2, 1912.

2 SHEETS—SHEET 1.

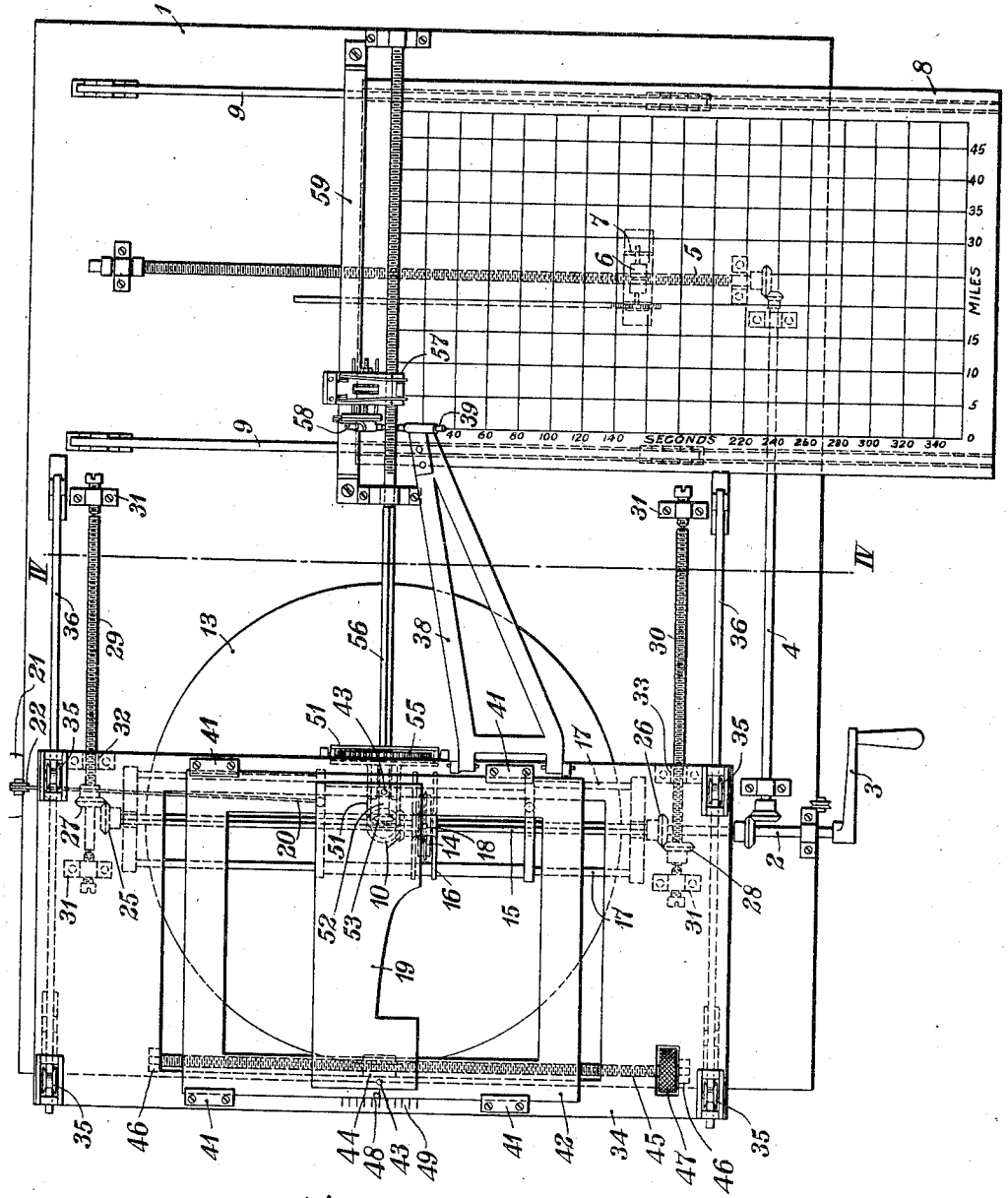

Fig. 1.

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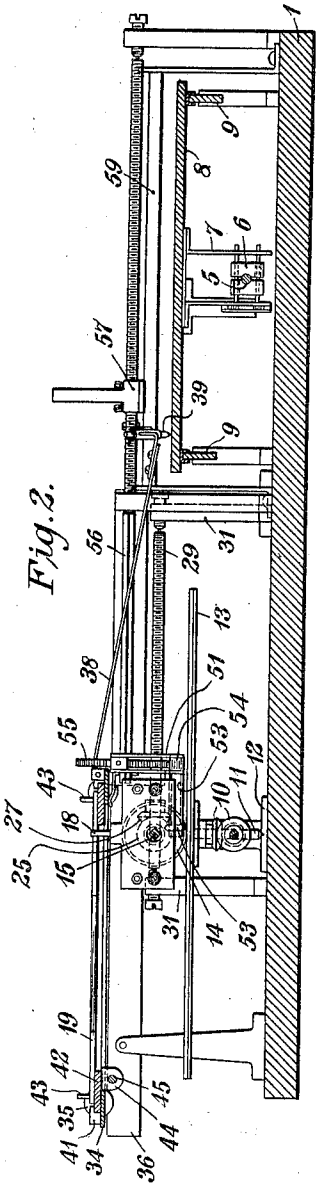

Fig. 2.

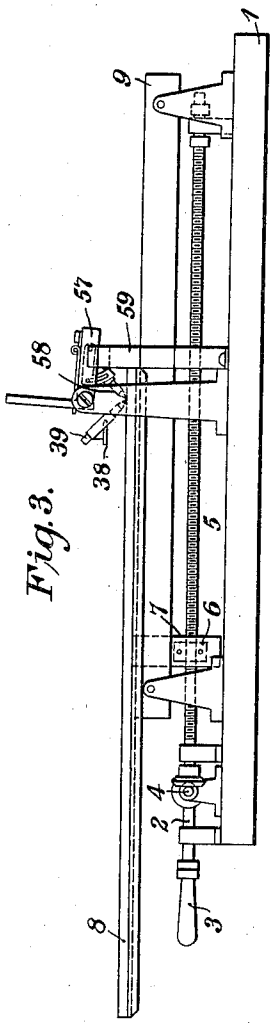

Fig. 3.

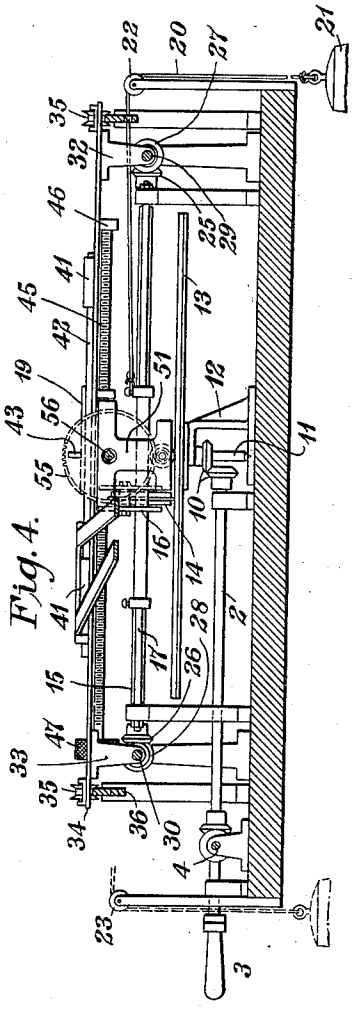

Fig. 4.

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CURVE-DRAWING MACHINE.

1,031,034. Specification of Letters Patent. Patented July 2, 1912.

Application filed September 26, 1910. Serial No. 583,909.

To all whom it may concern:

Be it known that I, FREDERICK S. WOODWARD, a citizen of the United States, and a resident of New York city, in the county of Queens and State of New York, have invented a new and useful Improvement in Curve-Drawing Machines, of which the following is a specification.

My invention relates to curve-drawing machines, and it has for its object to provide a machine whereby the curves usually employed by engineers in studying electric railway and similar problems may be made expeditiously and with a great reduction of the computations that have heretofore been necessary.

In order to determine the adaptability of a given equipment of electric railway motors to proposed or actual service conditions, it is customary, among engineers, to construct what are known as "speed time" and "time distance" curves, which respectively represent the instantaneous relations of speed and distance to the time that has elapsed since starting the motors. Such curves are frequently constructed for each materially different set of service conditions that is met with on a road; that is, for different grades, different track curvatures and different conditions of acceleration, coasting and braking. The preparation of such curves has heretofore required the making of a large number of computations and the exercise of a high degree of skill and patience, and it is the purpose of the present device to provide means whereby the labor and skill required to make the desired curves is very materially reduced, and whereby the curves may be obtained more expeditiously than has heretofore been possible.

Figure 1 of the accompanying drawings is a plan view of a machine that embodies my invention. Fig. 2 is a side view of the machine. Fig. 3 is an end view of the machine, showing only the parts nearest the said end, and Fig. 4 is an end and sectional view, upon the line IV—IV of Fig. 1.

The operating parts of the machine are all mounted upon a common base 1, and the main driving shaft 2 is provided, at one end, with an operating handle 3 and, at an intermediate point, with a bevel gear connection to a shaft 4 that extends at right angles thereto and is similarly operatively connected to a threaded shaft 5 that extends parallel to the main shaft 2.

Threaded upon the shaft 5, is a split nut 6 that is carried by a bracket 7 upon the lower face of a plate 8, the said plate constituting a platen upon which the paper for receiving the curves is mounted and being supported upon the guides 9 which permit longitudinal movement thereof when the shaft 5 is rotated within the nut 6. It is evident that the platen 8 is moved at a rate proportional to the number of rotations of the main driving shaft 2 and that, consequently, its rate of movement is proportional to the lapse of time, and, while any other proportions may be selected, the gear ratio of the several bevel gears is preferably such that one inch of longitudinal movement of the platen corresponds to 20 seconds of time.

The inner end of the shaft 2 is operatively connected, by means of bevel gears 10, to a vertical shaft 11 that is provided with bearings in a bracket 12 and upon the upper end of which is mounted a disk 13 having a plane upper face. Bearing upon the upper face of the disk 13 is a wheel or friction gear 14 that is mounted upon, and is longitudinally adjustable with reference to, a square shaft 15 which is located above and parallel to the main shaft 2. The wheel 14 is mounted in a frame 16 that is carried by parallel guide rods 17 and is movable longitudinally thereof, its position, and likewise the distance of the wheel 14 from the center of the disk 13, being determined by a pin 18 that is carried by the frame 16 and is adapted to engage the edge of a templet 19, which will be hereinafter more fully described. The pin 18 is maintained in engagement with the edge of the templet, by means of a cord 20, that is attached to the frame 16, and a weight 21, that is attached to the end of the cord, the cord passing over a pulley 22. When it is desired that the pin 18 should engage the other edge of the templet, the cord 20 should be arranged to pull the frame 16 in the opposite direction, as by hanging the same over a pulley 23 that is mounted at the other side of the base.

Mounted upon the ends of the square shaft 15 are bevel gears 25 and 26 which respectively engage corresponding bevel gears 27 and 28 with which threaded shafts

29 and 30 are respectively provided. The shafts 29 and 30 are mounted between pedestals 31 that permit of their rotation but prevent longitudinal movement thereof, and they are respectively engaged by nuts 32 and 33 that are attached to the lower face of a table 34 consisting of a plate in the form of a hollow rectangle. The table 34 is provided with grooved rollers 35 that bear upon horizontal guides or tracks 36, so that, as the shafts 29 and 30 are rotated, the table is moved longitudinally of the base 1. Thus, rotation of the wheel 14 effects movement of the table 34, and the rate of movement of the latter depends upon the distance of the wheel 14 from the center of the disk 13. Secured to, and projecting from, one side of the table 34, is an arm 38, carrying a pencil 39, that bears upon the platen 8 and is adapted to draw the speed time curve, since it is moved across the platen at a rate dependent upon the distance of the wheel 14 from the center of the disk 13.

Secured to the upper face of the table 34, by means of guide blocks 41 that permit of, and direct, longitudinal movement thereof with respect to the table, is a plate 42 in the form of a hollow rectangle having a pin or stud 43 extending upwardly from about the middle of each of its longer sides and projecting through holes in the templet 19, for the purpose of securing the templet in position. The plate 42 is provided, upon its under side, with a nut 44 that engages a threaded rod or shaft 45 for which bearings are provided in posts 46 that are secured to the under side of the table 34, the shaft being provided with a thumb nut 47 for rotating the same and thereby effecting movement of the plate 42 longitudinally of the table 34. The plate 42 is provided, near one edge, with an index mark 48, and the adjacent portion of the table 34 is provided with a scale 49 representing percentages of grade that may be found in a railway system, the said percentages being stated in terms of acceleration. The divisions of the scale may also represent acceleration or retardation values corresponding to different degrees of curvature of the track of a railway system. In the use of the machine, the index 48 is brought opposite the division of the scale which corresponds to the grade or track curvature of the portion of the road with respect to which it is desired to obtain a curve or curves.

Secured to one side of the table 34, is a small frame 51 in which is mounted a shaft 52 carrying a beveled friction roller 53 at one end and a small pinion 54 at its other end, the friction roller being adapted to bear upon the upper face of the disk 13 and to be actuated by the said disk. The pinion 54 drives the gear 55 that is mounted in the frame 51, upon the square end portion of a shaft 56, the other end portion of which is threaded for the reception of a nut 57 that carries a pencil 58, or other marking device, whereby a second curve is drawn upon the paper carried by the platen 8. The nut 57 is prevented from rotating, and is guided in its movements, by means of a guide 59 that extends parallel to the shaft 56, and it is provided with suitable means for adjusting the position of the pencil 58. Since the position of the table 34, and likewise of the friction roller 53, with respect to the center of the disk 13, corresponds, at each instant, to the motor speed, the total number of revolutions of the friction roller, and also of the shaft 56, will be proportional to the distance traveled by a vehicle when operated by the motor equipment with respect to which it is desired to obtain curves. Consequently, the position of the pencil 58 will correspond, at each instant, to the said distance, and the curve which it draws upon the record paper will be the time-distance curve.

In the use of the machine, it is first necessary to construct templets, the shapes of the edges of which are determined from the characteristic curves of the motors with respect to which the investigation is to be conducted, a templet being provided for each condition of acceleration, coasting and braking. The shape of the acceleration templet is determined from the data usually employed in constructing the acceleration curve of a particular motor equipment, and its shape will depend upon the characteristic curves of the motors, the weight of the car, the train resistance, the voltage and the driving wheel diameter. The manner of constructing such curves is well understood by those skilled in the art, and moreover, is fully set forth in an article entitled "Electric Railway Engineering" published in the *Electric Journal* of May, 1906, a further description being, therefore, deemed unnecessary. The acceleration curve is preferably plotted by using, as abscissæ, a scale in which one inch represents an acceleration of one mile per hour per second and, as ordinates, a scale in which one inch represents a speed of 10 miles per hour. The centers of the holes in the templet through which the pins 43 project are upon the ordinate axis of the curve, and the zero axis of the abscissæ is arranged to come directly over the center of the disk 13. The templets for different conditions of coasting and braking are constructed in a similar manner.

If the car is started upon a level, straight track, the index 48 upon the plate 42 is placed opposite the division of the scale 49 which corresponds to such a condition, and, with the acceleration templet 19 in position

upon the pins 43, the handle 3 is revolved. The platen 8 is thus moved transversely of the base 1 in proportion to the number of revolutions of the handle 3, and the disk 13 is also rotated at a corresponding rate. The pin 18 upon the carriage 16 is maintained in engagement with the edge of the templet 19 by means of the weight 21, and the wheel 14 will then be rotated at a rate depending upon its distance from the center of the disk 13, as determined by the shape of the templet 19, the position of the table 34, and likewise of the pencil 39, corresponding to the rate of rotation of the wheel 14. If the car encounters a grade or a curve in the track, the plate 42 should be moved until the index 48 is brought opposite the division of the scale 49 corresponding to the said grade or curvature, and the operation of the machine should continue as before. If the power is cut off from the motor or motors, the acceleration templet should be removed and a coasting or a braking templet should be substituted therefor, according to the condition of operation, and, in changing the templets, the frame 16 should be moved to the other side of the center of the disk 13, so that the pin 18 may bear against the opposite edges of the coasting and braking templets, the cord 20, or another one that is attached to the frame 16, being hung over the pulley 23, in order that the weight 21 may serve to maintain the pin 18 in engagement with the said templets. The curves that are drawn upon the record paper carried by the platen 8 will respectively represent the speed-time and time-distance curves, under the assumed conditions of operation. A great variety of curves may, obviously, be obtained without making computations other than those necessary for once determining the shapes of the acceleration, coasting and braking curves or templets.

I claim as my invention:

1. A curve-drawing machine comprising an actuator, a platen, means for imparting motion to the platen proportional to that of the actuator, a carriage movable in a direction normal to the direction of movement of the platen and carrying a pencil that bears upon the platen, a templet mounted upon the carriage, and means whereby the actuator drives the carriage at a rate dependent upon the shape of the templet.

2. A curve-drawing machine comprising an actuator, a platen, means for imparting motion to the platen proportional to that of the actuator, a carriage movable in a direction normal to the direction of movement of the platen and carrying a pencil that bears upon the platen, a templet mounted upon the carriage, a disk driven by the actuator, a wheel driven by the disk and movable radially thereof in accordance with the shape of the templet, and means whereby the said wheel drives the carriage.

3. A curve-drawing machine comprising an actuator, a platen, means for imparting motion to the platen proportional to that of the actuator, a carriage movable in a direction normal to the direction of movement of the platen and carrying a pencil that bears upon the platen, a templet mounted upon the carriage, means whereby the actuator drives the carriage at a rate dependent upon the shape of the templet, a second pencil bearing upon the platen and movable in a direction normal to the direction of movement thereof, and means whereby the actuator moves the second pencil at a rate dependent upon the position of the carriage.

4. A curve-drawing machine comprising an actuator, a platen, means for imparting motion to the platen proportional to that of the actuator, a carriage movable in a direction normal to the direction of movement of the platen and carrying a pencil that bears upon the platen, a carriage having a member that is adjustable in a direction normal to its direction of movement, a templet mounted upon the said member, and means whereby the actuator drives the carriage at a rate dependent upon the shape of the templet.

5. A curve-drawing machine comprising an actuator, a platen, means for imparting motion to the platen proportional to that of the actuator, a carriage movable in a direction normal to the direction of movement of the platen and carrying a pencil that bears upon the platen, a templet mounted upon the carriage, a disk driven by the actuator, a wheel driven by the disk and movable radially thereof in accordance with the shape of the templet, means whereby the said wheel drives the carriage, a second pencil bearing upon the platen and movable in a direction normal to the direction of movement thereof, a second wheel driven by the disk and carried by the carriage, and means whereby the same actuates the second pencil.

In testimony whereof, I have hereunto subscribed my name this 16th day of September, 1910.

FREDERICK S. WOODWARD.

Witnesses:
JOHN E. SHIELDS,
F. B. NUNNS.