(No Model.) 3 Sheets—Sheet 1.

R. R. ZELL.

METHOD OF OPERATING MOTORS.

No. 453,333. Patented June 2, 1891.

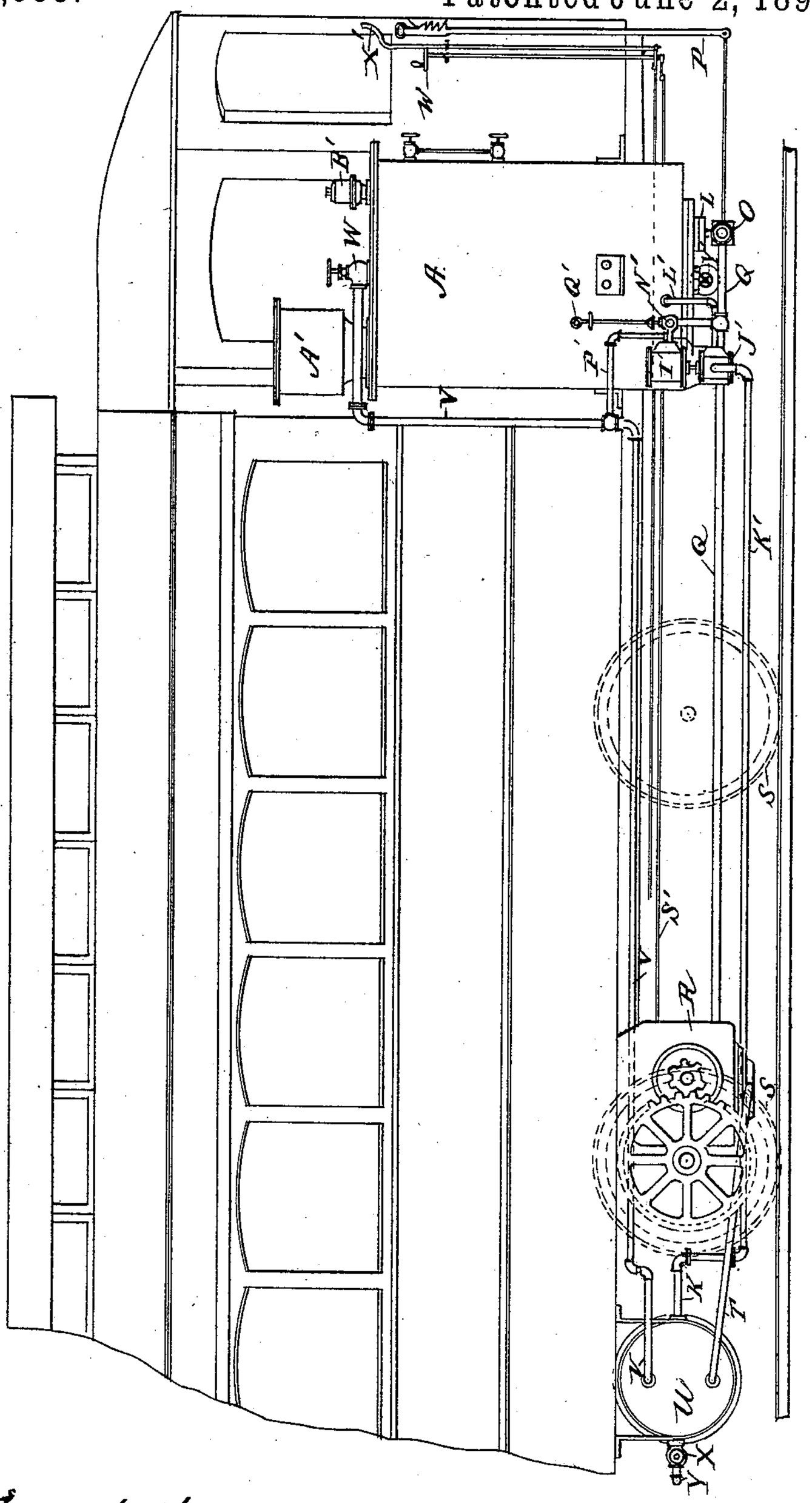


Fig. 1.

Witnesses
Thomas Campbell
Harry L. Gill.

Inventor
Robert R. Zell
By J. Stuart Rusk.
Attorney

(No Model.) 3 Sheets—Sheet 2.

R. R. ZELL.

METHOD OF OPERATING MOTORS.

No. 453,333. Patented June 2, 1891.

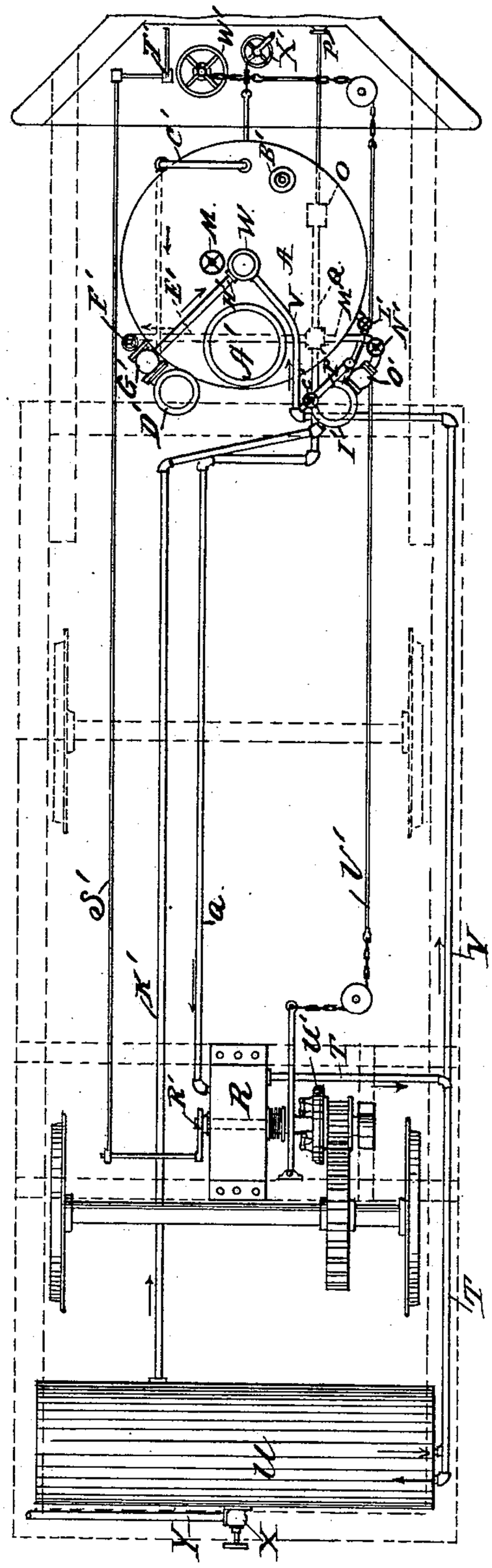


Fig. 2.

Witnesses
Vernon Campbell
Harry L. Gill.

Inventor
Robert R. Zell.
By J. Stuart Rusk
Attorney

(No Model.) 3 Sheets—Sheet 3.

R. R. ZELL.

METHOD OF OPERATING MOTORS.

No. 453,333. Patented June 2, 1891.

Fig. 4

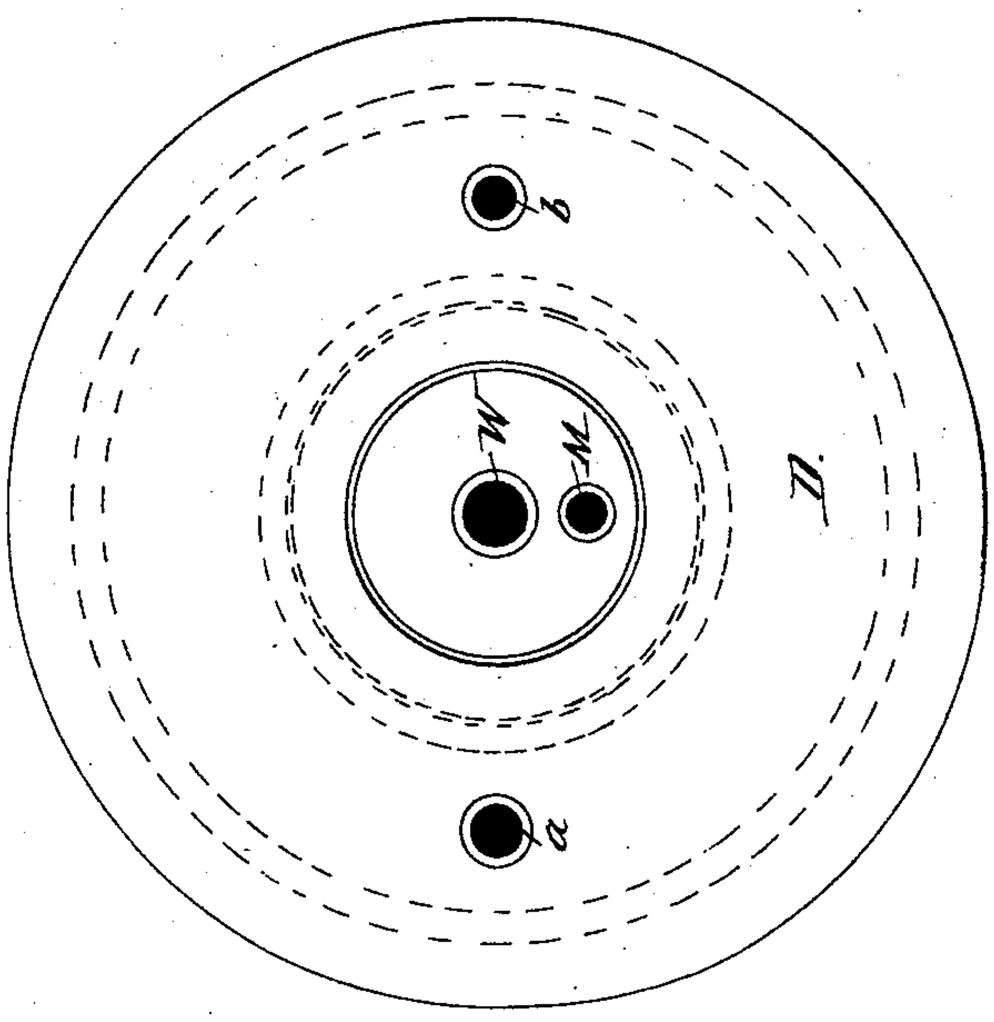
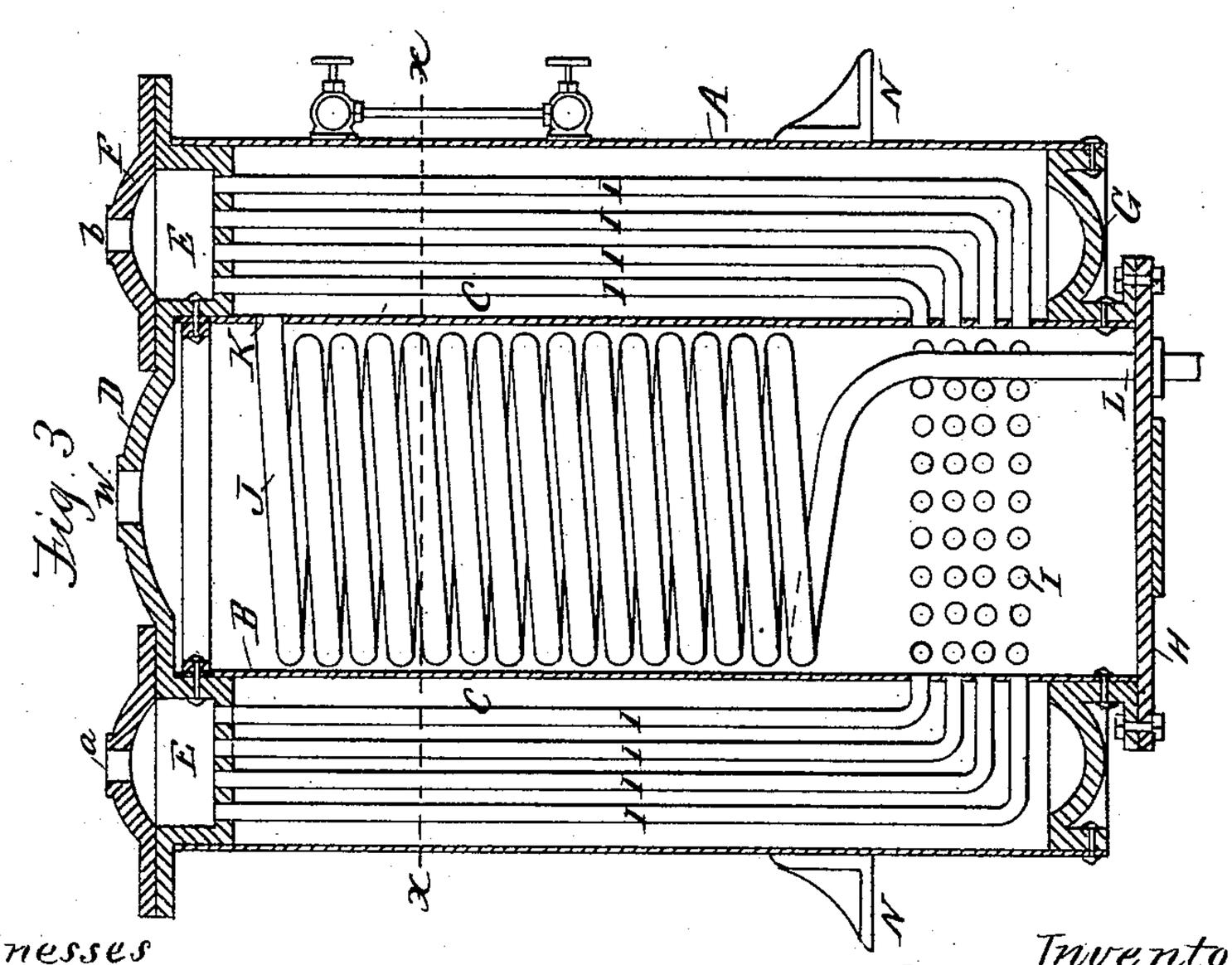


Fig. 3



Witnesses
Thos. Campbell
Harry L. Gill

Inventor
Robert R. Zell.
By J. Stuart Clark,
Attorney

UNITED STATES PATENT OFFICE.

ROBERT R. ZELL, OF BALTIMORE, MARYLAND, ASSIGNOR TO THE ZELL STORED POWER COMPANY OF BALTIMORE CITY, OF SAME PLACE.

METHOD OF OPERATING MOTORS.

SPECIFICATION forming part of Letters Patent No. 453,333, dated June 2, 1891.

Application filed November 6, 1890. Serial No. 370,512. (No model.)

To all whom it may concern:

Be it known that I, ROBERT R. ZELL, a citizen of the United States, and a resident of Baltimore, in the State of Maryland, have invented a new and useful Improvement in the Method of Operating Motors, of which the following, taken in connection with the accompanying drawings, is a specification.

My invention relates to improvements in the method of operating motors in which the exhaust-steam of the motor is absorbed in a body of caustic soda, caustic potash, chloride of calcium, quicklime, strontia, or any other substance which has a strong affinity for water and which, therefore, readily absorbs the steam from the motor. As is well known, all such substances, during the process of absorption of the steam, liberate the heat which is latent in the water or steam, and consequently a rise in temperature takes place. The heat thus set free is utilized in generating a quantity of steam from a certain bulk of water which is brought into contact with the water-absorbing and heat-liberating soda. This well-known property of the caustic alkalies of absorbing steam and liberating heat which can be practically employed in heating water and generating steam for motive power is especially well adapted for use in motors which are to be used in street-car service, in tunnels, &c., or wherever it is desired to use motive power without the usual smoke or noise of exhaust. Therefore the object of my invention is to use this valuable property of the alkalies to the best advantage, and is to render the absorption of the exhaust-steam more speedy and more certain, to produce a circulating-current in the steam to be absorbed, to produce a movement in the absorbing medium conducive of a rapid absorption of the steam, so as to bring a larger amount of absorbing-surface in contact therewith and to produce a correspondingly large heating-surface in contact with the water which is to be heated by the latent heat of absorption, and, further, to produce a good partial vacuum in the absorbing-vessel, and thereby to reduce the amount of back-pressure upon the piston of the motor from which the exhaust-steam emanates.

A further object of my invention is to utilize the heat retained in the exhaust-steam for heating the feed-water of the generator, thereby reducing its temperature and rendering it more readily absorbed by the alkali.

The nature of my invention will fully appear from the description set forth in the annexed specification and fully illustrated in the accompanying drawings, which form a part thereof, and which will be particularly pointed out in the claims.

In the drawings my invention is shown as applied to a street-car, although its general application to all motive-power purposes will be self-evident from the description and the drawings, in which—

Figure 1 is a side elevation of a car provided with the motor. Fig. 2 is a plan of the same. Fig. 3 is a central vertical section through the steam absorber and generator, and Fig. 4 is a plan of the cover of the generator.

The same letters of reference indicate the same parts in all the views.

A is the combined condenser, absorber, and steam-generator; and it consists of the outer shell A and an inner shell B, which is centrally located, leaving an annular space C. At the top the condenser-generator is provided with a head D, which has an annular trough at its outer edge, forming a chamber E. The chamber E is closed by an annular cover F. At the bottom the chamber C is closed by means of an annular head G, and the chamber B is closed by means of a head H.

In the annular chamber C there are arranged a series of vertical tubes I, which are beaded through holes in the tube-sheet or cover D, and which are bent at the bottom to enter holes in the shell B, thus establishing a communication between chamber B and the chamber E through the tubes I. Coiled about the interior of B and lying close to it is a coiled pipe J, which enters the shell B at a point K, and which leaves the chamber B at the bottom through a hole at L. Any number of coils may be used, and by this construction the shell B may be made thin and the external pressure thereon will be fully taken up by the resistance of the coil, thus

rendering further internal bracing unnecessary and deriving the benefit of a high degree of conductivity due to the thinness of B.

The chamber B is charged with the alkali up to a certain point, say to the line *x x*, and the chamber C is likewise filled with water up to the line *x x*. The alkali is filled into the vessel through a convenient opening and stop-valve at M.

N are convenient brackets for supporting the generator on the floor of the car. At the station the chamber C is filled with hot water under considerable pressure, so that sufficient steam fills the space above the water-line *x x* to supply the motor-engine at starting.

The steam passes through the coil J, which leads to a throttle-valve O, said throttle-valve being conveniently operated from the platform by means of the hand-rod P. The throttle O opens into the main steam-pipe Q to a motor-engine R. The power is transmitted from the motor to the car-wheels S by means of suitable gearing.

The exhaust-steam from the motor passes through the pipe T into a feed-water tank and heater U, and is provided with a coil inside to present a large heating-surface to the feed-water. After coiling through U the exhaust-pipe T emerges at V and continues back to the generator A.

The tank U, instead of being provided with the internal coil, may be built like an ordinary tubular condenser, with the exhaust-steam on one side of the tubes and the feed-water on the other side thereof. The exhaust-pipe V enters the chamber B at a point W, where a valve is provided.

The tank U is filled with feed-water at the station through a pipe Y and valve X.

a is an opening into the chamber E, at which communication is effected with a box A′, which contains a gas-absorbing substance—as, for instance, lime or oxide of iron—which is to absorb the carbonic-acid gas or other gases which may arise in E.

B′ is any convenient safety-valve, a "pop-valve" being preferred.

b is an opening in the cover F, at which a pipe C′ is attached, leading to the suction-valve of a vacuum-pump D′. The steam-cylinder of this vacuum-pump D′ receives its steam from the main steam-pipe Q through a branch pipe E′, which leads to a throttle-valve F′ and then into the valve-chamber G′ of the cylinder.

H′ is the exhaust-pipe of the steam-pump cylinder, and it also leads into chamber B at the valve W. This pump D′ when in operation produces a vacuum in the chamber E.

I′ is the steam-cylinder of a feed-pump for the generator, and J′ is the water-cylinder thereof.

K′ is a pipe through which the feed-water is brought from the tank U to the suction-valve of the cylinder J′, and L′ is the feed-pipe leading from the delivery-valve of the pump to the water-space C.

M′ is a steam-pipe leading from the main steam-pipe Q to the throttle-valve N′, and from thence to the valve-chest O′ of the steam-cylinder I′.

P′ is the exhaust-pipe of the steam-cylinder I′, and it leads into the main engine-exhaust V, and thus to the alkali-chamber B. Instead of leading into the pipe V, the pipe P′ may lead directly into the valve W. A stop-valve is located at *c′*, so that the pipe P′ may be disconnected from the main exhaust V when the feed-pump is not in operation.

Q′ is the handle, by means of which the throttle N′ is manipulated.

R′ is the stem of a reversing valve or mechanism for reversing the engine R, and S′ is the connection leading to the handle T′ on the platform.

U′ is a clutch by means of which the engine may be disconnected from the running-gear of the car, and V′ is the connection leading to the hand-wheel W′ on the platform.

X′ is a hand-wheel for controlling the brakes of the car.

Y′ is a valve by means of which the alkaline solution in B is drawn off for refilling.

The following is the operation of my device: At the station the chamber B is filled with a concentrated solution of an alkali which will readily absorb steam or water, and the chamber C is filled with hot water under pressure of several atmospheres capable of starting and running the motor until the generation of the steam through chemical action takes place by means of the steam rising from the hot water. The steam from the hot-water chamber C passes to the motor R through the throttle O, and then through the live-steam pipe Q. The exhaust from the motor passes by the pipe T through the coil in the feed-water tank, heats the feed-water therein, and at the same time is partially condensed, thus rendering the exhaust cooler and more readily absorbed by the alkali. The partially-condensed exhaust-steam passes to the surface of the alkali in B, and by means of the vacuum in E it is drawn down into the body of the alkali and is absorbed. Heat of absorption is liberated owing to the chemical union of the water with the alkali, and the alkali becomes highly heated and imparts this heat to the water surrounding B and the tubes I. Each stroke of the vacuum-pump causes a pulsation to take place in the alkali, so that its level is lowered in B and is raised in the tubes. These pulsations of the absorbing medium cause a still more thorough intermixture with the entering exhaust-steam, and also increase the temperature of the alkali and produce a corresponding increase in the heating effect on the water in the generator C. As the steam in passing through the coil J has to pass through the highly-heated alkaline solution it is not alone thoroughly dried, but is also superheated, thus making it more efficient in the motor itself, and partially reducing the temperature of the absorbing medium

and rendering said absorbing medium more efficient. Any noxious gases which may be present in the alkali are absorbed in the gas-absorber at *a*. By means of the combined action of the cooling in the feed-water tank, the absorption in the condenser, and the effect of the vacuum-pump a very good vacuum is produced, and there is therefore little back-pressure on the piston of the motor. The exhaust-steam from the feed and vacuum pumps is also absorbed in the condenser, and yields its heat to the water in the generator, and these pumps also work with little back-pressure. At the end of the route the alkaline solution, having become saturated with water, is too weak to absorb more steam, and at the station it is therefore drawn off at the bottom through valve Y′, and refilled with a fresh solution at M. The solution which is withdrawn is reconcentrated in a specially-devised apparatus.

It is obvious that the methods herein disclosed may be carried into effect by stationary machinery not mounted upon a car, as in pumping, &c.

I do not herein claim the particular construction of the apparatus shown, as I have made application for the same in application for United States Letters Patent, filed November 6, 1890, Serial No. 370,513; but

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

1. The method of operating a soda-motor, which consists in generating steam by means of the heat of absorption of exhaust-steam from the motor in an alkaline solution, drawing the exhaust-steam through the body of the alkaline solution, and causing a movement of the solution upon the heating-surfaces, thereby accelerating the absorption, substantially as described.

2. The method of operating a soda-motor, which consists in passing the exhaust-steam of a motor to the surface of an alkaline solution, drawing the exhaust-steam through the solution, and generating steam by means of the heat liberated by the consequent absorption of the steam, substantially as described.

3. The method of operating a soda-motor, which consists in cooling the exhaust-steam of the motor, passing it to an alkaline solution, wherein it becomes absorbed, and then generating steam from water by means of the heat liberated by the absorption, substantially as described.

4. The method of operating a soda-motor, which consists in cooling the exhaust-steam of the motor, then passing it to the surface of an absorbing medium, and drawing it through said medium, whereby the steam is more readily absorbed, substantially as described.

5. The method of operating a soda-motor, which consists in cooling the exhaust-steam thereof, then passing it to the surface of an absorbing medium and drawing it through the body of said medium, whereby the rapidity of absorption is increased, and then generating steam from water by means of the liberated heat of absorption, substantially as described.

6. The method of operating a soda-motor, which consists in cooling the exhaust-steam therefrom by contact with the feed-water for a steam-generator, passing the cooled steam to an absorbing medium, and passing the heated feed-water to a generator surrounding said medium, whereby the heat of absorption is utilized in generating live steam for the motor, substantially as described.

7. The method of operating a soda-motor, which consists in passing the exhaust-steam of the motor through a feed-water heater, then passing the cooled steam to the surface of an absorbing solution, passing the heated feed-water into a generator surrounding said solution, then drawing the exhaust-steam through the body of the solution, and generating steam by means of the liberated heat of absorption, substantially as described.

8. The method of producing back-pressure in a soda-motor, which consists in passing the exhaust-steam of the motor to the surface of an absorbing solution, then drawing the steam through said solution, thereby increasing the absorption, and then drawing off the excess of vapor by means of a vacuum-pump, substantially as described.

9. In a soda-motor, the method of increasing the efficiency of the heating medium, which consists in placing said medium, which is an absorbing solution, in contact with the heating and steam-generating surface and then passing the exhaust-steam of the motor into the absorbing solution and producing a thorough intermixture therewith and an agitation of the solution in contact with the heating-surface by means of pulsations produced by a vacuum-pump, substantially as described.

10. The method of operating a soda-motor, which consists in reducing the back-pressure on the motor-piston by passing the exhaust-steam thereof into an absorbing solution, drawing the steam through said solution by means of a vacuum-pump which draws off the non-absorbed excess, and absorbing the gases liberated from the solution by means of a suitable gas-absorber, substantially as described.

11. In a soda-motor, the method of increasing the efficiency of the live steam, which consists in generating live steam by placing water in contact with the vessel containing an absorbing solution, liberating heat of absorption by passing the exhaust-steam from the motor into said solution and imparting it to the water, and then superheating the steam by passing it through pipes in contact with said hot absorbing solution, substantially as described.

12. In a soda-motor, the method of superheating the live steam, which consists in passing the exhaust of the motor into an absorbing solution, generating steam from water in

contact with said solution, and superheating said steam by contact with the heated absorbing solution, substantially as described.

13. In a soda-motor, the method of rendering the live steam more efficient, which consists in utilizing the exhaust-steam to produce heat by being absorbed in an alkaline solution and utilizing said heat of absorption in generating steam, and then superheating said steam by passing it in contact with the heated absorbing solution, substantially as described.

14. The method of operating a soda-motor, which consists in cooling the exhaust-steam of said motor, then passing it into an absorbing solution, whereby heat is liberated, generating live steam for the motor by means of said heat, then passing said steam through said heated absorbing solution, whereby it becomes superheated, and then utilizing it in the motor, substantially as described.

15. The method of operating a soda-motor, which consists in passing the exhaust-steam of said motor through a feed-water heater, thereby cooling it and rendering it more capable of being absorbed, passing said heated feed-water into a generator which receives the heat of absorption, thereby generating steam, then passing the steam from said generator through the hot absorbing solution, thereby superheating it, and then utilizing said superheated steam in said motor, substantially as described.

16. The method of operating a soda-motor, which consists in passing the exhaust-steam of said motor through a feed-water heater, thereby cooling it and heating said feed-water, then passing the steam to an absorbing solution and the feed-water to a vessel surrounding said solution, whereby the water is turned into steam, passing the steam through the absorbing solution, thus superheating it for use in the motor and producing a rapid absorption of the exhaust-steam and an agitation of the absorbing and heating medium by drawing the exhaust-steam through the absorbing medium by means of pulsations produced by a pump, substantially as described.

ROBERT R. ZELL.

Witnesses:
I. VERNON CAMPBELL,
J. B. EVANS.