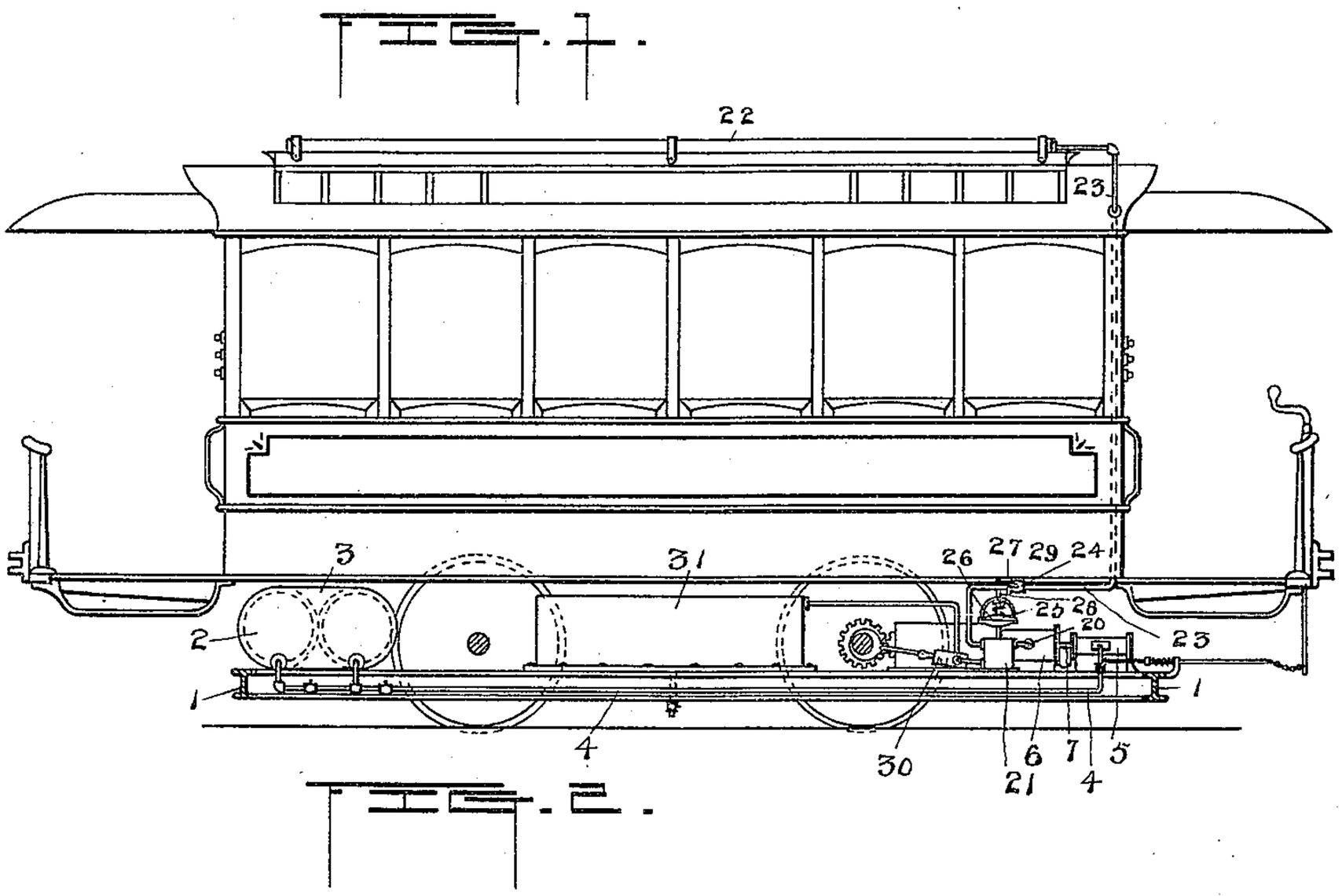
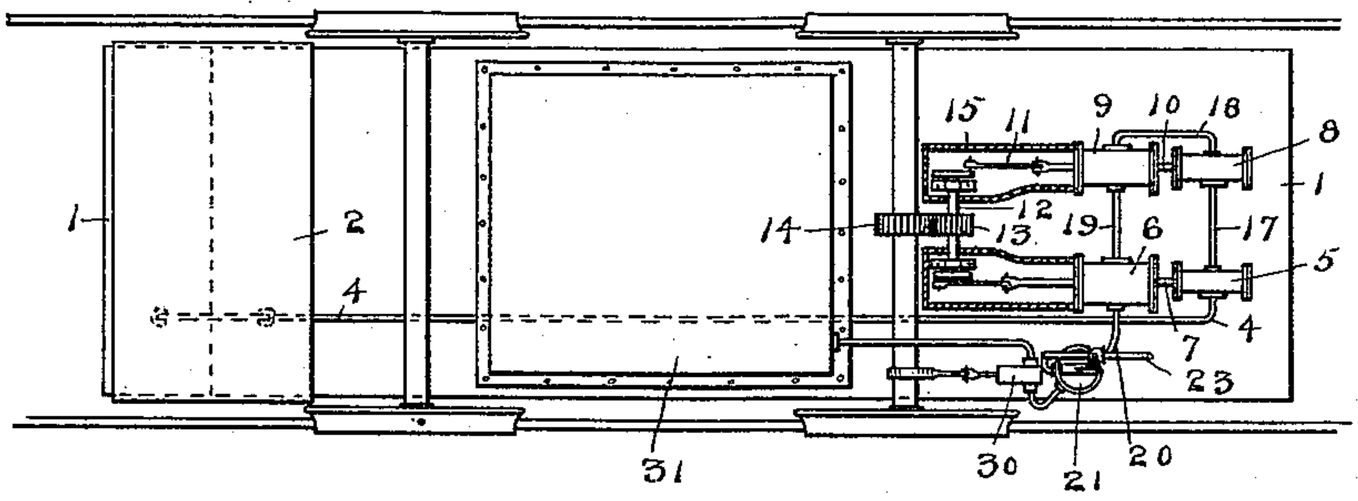
(No Model.) 2 Sheets—Sheet 1.

W. E. PRALL, Jr.

SUPERHEATED WATER MOTOR.

No. 547,089. Patented Oct. 1, 1895.





WITNESSES

Arch. M. Catlin.

Emma G. Brashears.

INVENTOR

William E. Prall, Jr

by Benj. R. Catlin

(No Model.)

2 Sheets—Sheet 2.

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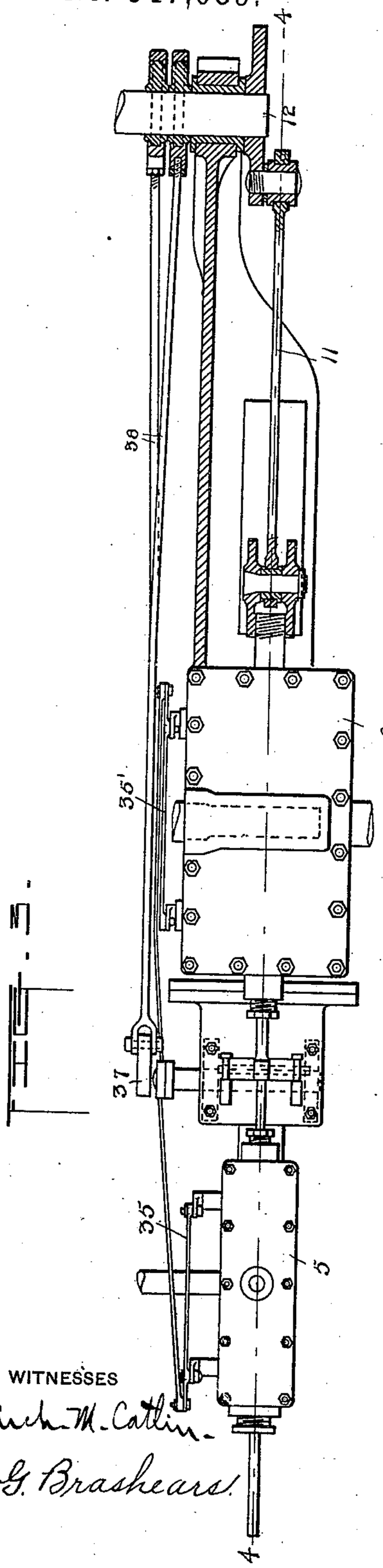

Fig. 1.

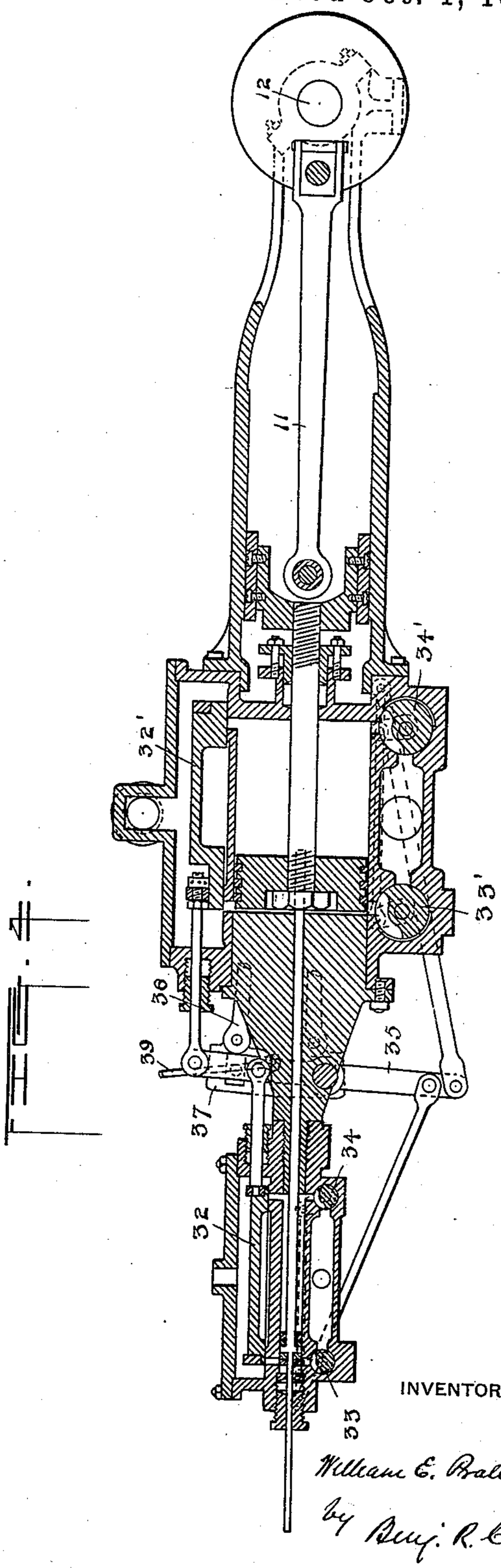

Fig. 2.

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UNITED STATES PATENT OFFICE.

WILLIAM EDGAR PRALL, JR., OF WASHINGTON, DISTRICT OF COLUMBIA,
ASSIGNOR TO WILLIAM E. PRALL, OF SAME PLACE.

SUPERHEATED-WATER MOTOR.

SPECIFICATION forming part of Letters Patent No. 547,089, dated October 1, 1895.

Application filed January 19, 1895. Serial No. 535,477. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM EDGAR PRALL, Jr., a resident of Washington, in the District of Columbia, have invented certain new and useful Improvements in Superheated-Water Motors; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

The invention relates to the use of highly-heated water as a motive power. In prior attempts to use heat stored in highly-heated water for the production of work steam has been taken from above the water and used in a steam-engine. These experiments have not succeeded for the reason, among others, that the pressure in the water-tank soon falls to the minimum necessity for working by steam and much of the pressure also was lost in wire-drawing and but a small portion of the heat of the water actually utilized. These objections it has been proposed to obviate by using water from the hot-water reservoir instead of steam. Such attempts, however, have failed of success by so far as the engines devised have been patterned after steam-engines in respect to the capacity of their cylinders and inlet and exhaust ports, since a steam-engine cannot be operated by hot water nor, indeed, can a hot-water engine, such as the improved engine herein described, be worked by steam.

The present invention therefore has for its object to provide suitable means for taking measured quantities of water and economically expanding them in an engine for the production of work; and it consists in the art and mechanism hereinafter described and particularly pointed out.

In the accompanying drawings, which are partially diagrammatic in character, Figure 1 is a side elevation. Fig. 2 is a plan of a frame or platform supporting an engine and accessories. Fig. 3 is a plan, on an enlarged scale, of a water-measuring cylinder and a working or expansion cylinder and connected parts. Fig. 4 is a vertical section of the same on line 4 4 of Fig. 3.

Numeral 1 denotes a frame or platform of any suitable character supported upon the axles of a car. Upon this frame is sustained the body of a car, these parts being of any known or convenient form.

2 denotes a pair of cylinders for holding water heated preferably to from 400° to 500° Fahrenheit, such temperature being practicable for the purposes of the invention, which, however, is not limited to this particular range of temperature. The hot-water receptacle or receptacles are thoroughly protected against loss of heat by a non-conducting covering 3, as also may be the hot-water pipes, engine-cylinders, and other parts.

4 denotes a pipe to convey superheated water from the cylinders 2, or from one of them, to a water-measuring cylinder 5. This measuring-cylinder is provided with a suitable valve-chest and valve for admitting the water from the pipe to the cylinder, and the valve is provided with means for regulating its movements to vary the opening of the inlet port or ports for the admission of more or less water, as desired.

Water having approximately the temperature above named will have a pressure of several hundred pounds and will in practice be expanded from one to two thousand times. It is, therefore, of great importance that means be provided for separating small and regulable charges before utilizing them by expansion in the engine-cylinders. For this purpose I have discovered that a small cylinder having a diameter of about one inch is practicable. From this measuring-cylinder the fluid is admitted successively to other cylinders, which, as illustrated in the present instance, are three in number, and may have, respectively, the diameters two and a half, three and a half, and seven inches, though the number and size of these cylinders above given need not be exactly followed. As many as three expanding-cylinders, however, are necessary to the best results, and it is important that the measuring-cylinder be small and have a relative capacity, approximately, such as above indicated. Each cylinder has a piston. The pistons of the water-measuring cylinder 5 and of the cylinder 6 are fast on a rod 7, and the pistons of cylinders 8 and 9 are fixed to a single rod 10. These piston-rods are connected by a cross-head and rods 11 to cranks on the

shaft 12 of a pinion 13, which drives a gear-wheel 14, fast on the car-axle, as indicated.

15 15 denote boxes or casings tightly inclosing the rods, cranks, and piston-rods.

17, 18, 19, and 20 denote exhaust-pipes leading from the bottom, preferably, of the respective cylinders to a succeeding cylinder. Pipe 20, however, communicates with a condenser 21 instead of with another cylinder.

22 denotes a cold-water tank, which may be carried above the car or elsewhere.

23 is a pipe conveniently concealed in a post of the car-frame and leading to the condenser, and 24 is an automatically-controlled cock to admit water to condense exhaust-steam in the condenser.

25 is a diaphragm-chamber communicating with the condenser, and 26 is a diaphragm held by a spring 27.

28 is a diaphragm-stem having a jointed connection with a lever 29 attached to the plug of cock 24. The apparatus is set to move the diaphragm by an increase of a subnormal pressure in the condenser. Thus, for example, it may be set so that the spring and diaphragm will be moved to open the cock whenever the pressure in the condenser exceeds three pounds—that is, when it is less than twelve pounds below the atmospheric pressure. As the cylinder 6 exhausts into this condenser, the exhaust-steam will be condensed by admission of cold water as soon as the pressure in the condenser rises above that desired and predetermined. A partial vacuum is thus maintained in the condenser, exhaust-pipe 20, and exhaust end of cylinder 6, whereby a very complete expansion is secured and the large amount of heat in the water charged is thoroughly utilized.

30 denotes a pump operated from the car-axle, removing water from the condenser to a water-tank 31.

The various pipes are provided with suitable cocks, and other parts of the apparatus will have the usual accessories of steam-engines and their connections.

In practice, lubricating-oil will be passed through the cylinders with the water and steam and collected from the tank for condensed steam, and the boxes inclosing the cranks and connecting-rods will contain oil.

In Figs. 3 and 4 is shown suitable valve-gear for operating the valves of cylinders 5 and 6, substantially similar devices (not shown) being used for the valves of cylinders 7 and 8. 32 and 32′ denote slide-valves on the inlet side, and 33 34 and 33′ 34′ cocks or valves on the lower or exhaust side. The plugs of the exhaust-cocks of the cylinders are provided with crank-arms connected by rods 35 and 35′, respectively, and the several valves and cocks are suitably moved by the oscillating-lever 36, which is connected by a link 37 and rods 38 to eccentrics on the shaft, which is driven by the pistons. The link is moved in a well-known manner by a lever (indicated at 39) to vary the throw of the valves or to reverse the engine. As shown, the fourth cylinder 6 is much larger than the water-measuring cylinder 5. The latter, in practice, may have a diameter of about an inch, a length of about five or six inches, and the piston-rod a diameter of one-half inch or more. The valve-ports will also be comparatively small and the valves and valve-gear made regulable and set to open the ports with great nicety and accuracy.

It is obvious that a vapor or gaseous fluid, such as steam or air, could not be made to operate an engine such as described, for the reason that sufficient fluid could not be passed through the first cylinder to overcome the friction of the engine. My first cylinder will have at most a holding capacity for water of from about one-fourth to one-tenth of that necessary for a steam or air engine, and I have found by experiment that a capacity of from one-fifteenth to one-twentieth and even less, as compared with the first cylinder of ordinary compound steam-engines, is an efficient and practicable dimension. By the term "water-measuring cylinder or receptacle" is meant herein a cylinder having substantially the relative dimensions and capacity described, and a measuring-cylinder having sufficient capacity to supply an engine with an operative quantity of steam or compressed air is excluded, the substantial reason being that one could not be substituted for the other, and my combination of such a water-measuring cylinder with the working cylinders of a compound engine is believed to be substantially new, no one having before made or even suggested an engine embodying such combination, notwithstanding its practical importance and utility.

The water-measuring cylinder and its piston being small, as stated, the connection of the piston with a working piston of a larger cylinder is of no importance as regards the amount of work done, neither is it necessary to place the exhaust-port in the lower part of the water-measuring cylinder. As above in effect stated, such dimensions are required because of the very high heat-pressure and expansibility of the water, the quantity of which must be small and regulable to permit the successful utilization of the heat and its conversion into work and to provide for exhausting the water or steam from the engine. Further, the situation of the exhaust-ports at the lower parts of the cylinders is an important aid to the exhaust operation, especially in the larger cylinders, for the reason that in practice only a fraction of the water used can be vaporized, and provision must be made for discharging from the cylinders from one-half to two-thirds or more of the water used, which could not be effected by means of the usual steam-exhaust ports.

It has been found impracticable to successfully drive an engine by superheated water with the use of a single cylinder, even when such cylinder was provided with the essential

feature of an exhaust at or near its bottom, for the reason that water heated to the temperature proposed and having the consequent pressure cannot be effectively converted into steam nor the residue of water controlled and passed out of the cylinder. The steam in such cylinder developed from the superheated water upon opening the exhaust-port exceeds many times the capacity of the cylinder and resists the piston urged on its opposite side by the incoming hot-water charge, with the effect to bring such an engine practically to a standstill.

In a steam or air engine the volume of fluid on the exhaust side is practically at its maximum when the exhaust is opened; but superheated water will develop so much steam that the time required for exhausting would involve a practical stoppage of the engine. If it were attempted to develop and expand this large volume of steam from superheated water in a single cylinder, it would require a cylinder capacity of from fifteen to twenty-five times that of any ordinary steam-cylinder, which would obviously be impracticable on account of the large initial condensation and also for mechanical reasons. This initial condensation would greatly exceed that of a steam-engine for the reason that under any conceivable use of hot water it is required to be cut off much sooner than steam, giving by the usual diagram a much longer expansion curve, so that in a cylinder of the same dimension the initial condensation would be greater in the use of water, which difference would, of course, be magnified if an attempt were made to provide for the expansion of all the steam from superheated water by a cylinder of unusual size. The difficulty of exhausting water and the large volume of steam developed therefrom is also increased by the incompressibility of the water.

A compound engine and a water-measurer to exactly limit the quantity of water charged therein are therefore essential for the utilization of superheated water; but compound engines adapted for steam, air, or the like could not be thus used for the reason that none of them are provided with means for charging heated water into a cylinder in an operative and manageable quantity. Either the clearance necessary in a steam-cylinder or the valve-ports alone would contain much more space than my measurer. Every such engine, therefore, lacks proportions that are essential. Such prior engines also lack a suitable situation of the exhaust-port, which should be at or near the bottom of the several cylinders.

Notwithstanding the special provisions herein described for expanding and utilizing the steam produced by the superheated water it will be necessary to exhaust from the last cylinder one-half to three-fourths of the water employed. This could not be effected by any engine known prior to my invention, and no prior steam or air engine could be adapted to the uses of my invention without destroying its capacity as a steam or air engine, since, if the radically new proportions were given to such prior engine, and especially to the first cylinder thereof, to adapt it to the use of water, it could not then be operated with steam or the like, for not enough high-pressure steam or air could be then introduced into such engine to move it. The dimensions herein described are appropriate for an engine of about ten-horse power and suitable to run a street-car. For engines of higher power larger dimensions will be required, though substantially the same proportions will be used, a larger rather than a smaller extent of expansion being preferred.

Having thus fully described my invention, what I claim is—

1. The improvement in the art of converting heat into work which consists in charging a water-measuring cylinder with superheated water in regulable quantities, successively expanding the fluid in a series of engine cylinders, substantially as set forth.

2. The improvement in the art of converting heat into work which consists in charging a water measuring cylinder with superheated water in regulable quantities, successively expanding the fluid in a series of engine cylinders, and exhausting the last cylinder into a partial vacuum, substantially as set forth.

3. The improvement in the art of converting heat into work which consists in charging a water measuring cylinder with superheated water in regulable quantities, successively expanding the fluid in a series of engine cylinders, and exhausting the last cylinder into a partial vacuum, condensing steam in said vacuum by the admission of cold water to the chamber and removing the water of condensation from the vacuum chamber to a holder, the whole apparatus being carried on a car or like vehicle, substantially as set forth.

4. The combination of a reservoir for superheated water, a water-measuring cylinder, and a series of engine cylinders connected to exhaust in succession from the measuring cylinder and from each other to the last in the series, substantially as set forth.

5. The combination of a reservoir for superheated water, a water-measuring cylinder, and a series of engine cylinders connected to exhaust in succession from the measuring cylinder and from each other to the last in the series, and a condenser provided with means for maintaining therein a partial vacuum to receive the exhaust from said last cylinder of the series, substantially as set forth.

6. The combination of a reservoir for superheated water, a water-measuring cylinder, and a series of engine cylinders connected to exhaust in succession from the measuring cylinder and from each other to the last in the series, a condenser, a cold water tank, and a tank for receiving the exhaust water from the condenser, substantially as set forth.

7. The combination of a reservoir for superheated water carried on or with a street or

passenger car, a water measuring cylinder, and a series of engine cylinders connected to exhaust in succession from the measuring cylinder and from each other until the last in the series provided with cocks or valves to control the admission of water to said cylinders, and the exhaust of the water from said cylinders, and a condenser provided with means for maintaining therein a partial vacuum to receive the exhaust from said last cylinder of the series, substantially as set forth.

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

WILLIAM EDGAR PRALL, JR.

Witnesses:

A. LANSING BAIRD,

W. E. PRALL.