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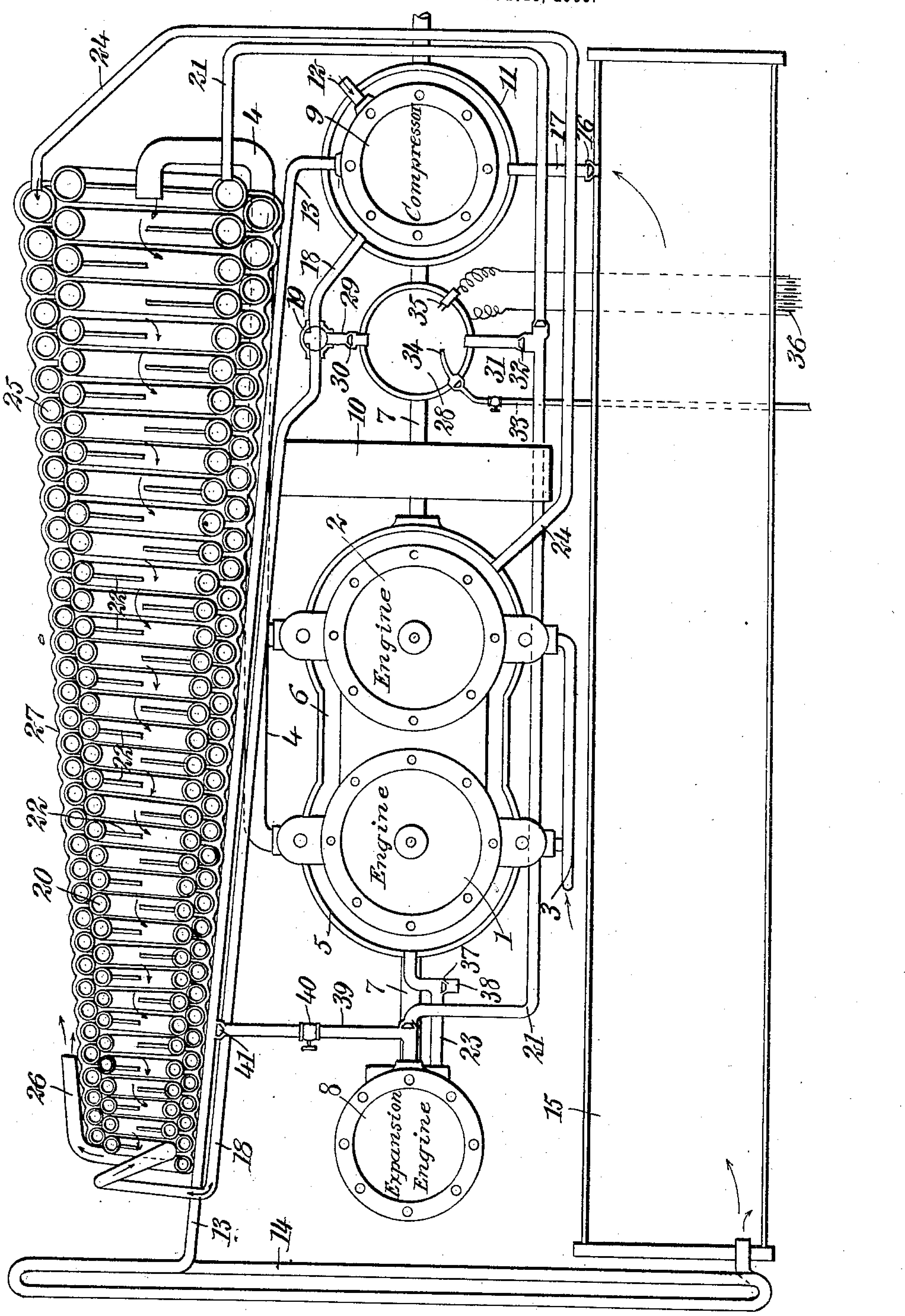
J. L. TATE.

GAS ENGINE SYSTEM.

APPLICATION FILED OCT. 18, 1906.



WITNESSES

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GAS-ENGINE SYSTEM.

No. 862,677. Specification of Letters Patent. Patented Aug. 6, 1907.

Application filed October 18, 1906. Serial No. 339,491.

To all whom it may concern:

Be it known that I, JOHN LINCOLN TATE, a citizen of the United States, and a resident of Jersey City, in the county of Hudson and State of New Jersey, have invented a new and Improved Gas-Engine System, of which the following is a full, clear, and exact description.

This invention relates to certain improvements in means for generating power and more particularly to means adapted to be used in combination with an internal combustion engine, whereby the efficiency of the engine is greatly increased.

The object of the invention is to provide improved means for cooling the cylinder of the engine by the circulation of cold air through the jacket, thus eliminating the water jacket commonly used and avoiding the necessity of maintaining a constant supply of cooling water.

A further object of the invention is to provide means for utilizing the heat of the exhaust gases from the engine and converting this waste heat into mechanical energy.

A further object of the invention is to provide auxiliary power producing means capable of use in addition to the main gas engine, and capable of use in conjunction with the engine or independent thereof, thus permitting its employment as a starter for said engine.

A further object of the invention is to provide means whereby I may utilize the motion of a vehicle when traveling down hill to store up power for use at other times, and to simultaneously act as a brake upon the vehicle.

Further objects of the invention will be hereinafter set forth, and the structure by which said objects are accomplished defined in the claims.

Reference is to be had to the accompanying drawing forming a part of this specification, and which represents diagrammatically an apparatus for accomplishing the objects herein enumerated.

My improved apparatus is particularly designed for employment upon a motor vehicle, but certain features of it are equally adaptable for use in connection with any internal combustion engine. In the specific arrangement illustrated in the drawings I employ an internal combustion engine having cylinders 1 and 2, provided with a common fuel supply pipe 3 and a common exhaust pipe 4. Surrounding the two cylinders is a casing 5 spaced from the cylinder walls, so as to leave a cooling jacket 6 through which the cooling agent circulates. A crank shaft 7 extends beyond the engine in each direction, and is provided at one end with an air expansion engine for an air motor 8, and on the other end with an air compressor 9. Each of these is preferably connected to the crank shaft by any suitable form of clutch, not shown, whereby the motor or air compressor may be disconnected from the shaft independent of the other and independent of the main internal combustion engine. A fly wheel 10 is secured to the drive shaft adjacent the engine, and one end of the drive shaft extends to any suitable point at which it is desired to utilize the power generated, as, for instance, the gear box of a motor vehicle. A jacket 11 surrounds the air compressor and is placed a short distance therefrom, whereby a cooling medium may be circulated within the casing to remove the heat of compression generated in the compressor. The compressor is provided with an inlet pipe 12 communicating with the atmosphere, and a discharge pipe 13 by which the compressed air is delivered to a radiating coil 14, within which the hot compressed air is cooled to the temperature of the outside atmosphere. In case the apparatus is employed upon a motor vehicle, this radiating coil would preferably extend across the front end of the vehicle and occupy a position commonly occupied by the radiating coil of an engine employing a water jacket and water circulating system. The discharge end of this coil delivers to a compressed air storage tank 15, said tank being of strong construction and capable of withstanding a high pressure. The compressed air after being cooled to the temperature of the outside atmosphere by reason of the radiation from the coil 14 and the wall of the tank 15, is delivered through a check valve 16 and a pipe 17 to the jacket of the air compressor 9.

Within the jacket the air becomes heated by radiation from the compressor cylinder and the hot compressed air is normally delivered through an outlet pipe 18 and a three-way valve 19 to the heat interchanging coil 20. This coil is formed of a pipe of gradually increasing diameter, and the coils of the pipe are likewise formed of gradually increasing diameter, whereby the space within the pipe and also the cross sectional area of the pipe and of the coil varies as the fluid within said pipe and coil passes from one end to the other. The pipe 18 communicates with the jacket of the air compressor and delivers to the heat interchanging coil 20 at the smaller end of said coil, which is likewise the smaller end of the pipe forming said coil, and is drawn off at the opposite end through a pipe 21. The inner side of the coil is provided with a plurality of baffle plates 22, and the exhaust pipe 4 of the gas engine delivers to the larger end of the coil and among the baffle plates. The exhaust gas from the engine is at a very high temperature and it is this heat which I desire to utilize and convert into mechanical energy to assist the main engine. As the hot exhaust gases pass downward through the heat interchanging coil and among the baffle plates, the temperature becomes very materially reduced and by the time the gas reaches the smaller end of the coil and is exhausted into the atmosphere, it is reduced to substantially the temperature of the outside atmosphere, while the gas traversing the pipe forming the coil 20 enters at a comparatively low temperature and is delivered into the pipe 21 adjacent the outlet from the exhaust pipe at a very high temperature. By decreasing the cross section of the coil from the delivery end of the pipe 4 to the outlet into the atmosphere, I permit the exhaust gas from the engine to travel through the coil at a uniform speed, while by increasing the diameter of the pipe forming the coil in the direction in which the contained gas flows, I also permit a uniform rate of speed within the pipe, due to the fact that one gas is continually increasing in temperature, while the other gas is continually decreasing in temperature.

The pipe 21 which receives the heated air from the coil 20, delivers this air at a high temperature and a high pressure to the cylinder of the air expansion engine 8, where it expands to atmospheric pressure, and the heat contained therein is converted into work available for use upon the drive shaft 7 to assist the main internal combustion engine. By the expansion of the air and the conversion of the heat into work, a great reduction of temperature occurs within the expansion engine, and the air delivered therefrom through the pipe 23 is at a very low temperature. This air may under favorable circumstances be reduced to a temperature far below that of the atmosphere and thus becomes available for use in cooling the main engine cylinder. The cold air from the pipe 23 is delivered into the jacket 5 of the internal combustion engine and after becoming heated by the radiation from the engine cylinder it is permitted to escape through a pipe 24 leading to a second coil 25 surrounding the coil 20, and preferably in direct contact therewith. The air within the pipe 24 is at a high temperature and serves to heat the air within the coil 20, thus acting in conjunction with and in addition to the heat of the exhaust gas delivered through the pipe 4 to the interior of the coil 20. The pipe forming the coil 25, is of gradually reducing diameter as the gas contained therein is of gradually reducing temperature, and the smaller end of the coil communicates with the atmosphere through a discharge pipe 26. To prevent radiation to the atmosphere from the coil 25, this coil may, if desired, be entirely surrounded by an asbestos jacket 27.

In the normal operation of the improved apparatus above described, the shaft 7 is caused to rotate by the main internal combustion engine, and both the compressor and motor are connected to said shaft. The air compressed in the compressor 9 is cooled in the coil 14 to the temperature of the atmosphere and the cooled compressed air circulated through the jacket of the compressor to remove the heat of compression at this point. The heated compressed air is still further heated in the coil 20 and then delivered to the air expansion engine 8 where work is done in assisting the main engine, and the cold exhaust is delivered to the jacket of the main engine to reduce the temperature. The air of low pressure but high temperature is conducted from the jacket of the engine to the coil 25 where it aids the exhaust gas from the main engine to heat the compressed gas delivered to the air expansion engine, and in doing so the air from the engine jacket, as well as the exhaust gas from the main engine, is cooled to a temperature but slightly higher than that of the atmosphere.

In conjunction with the apparatus above described, I may, if desired, employ a combustion chamber 28 connected by a pipe 29 and check valve 30 to the three-way valve 19, and connected by a pipe 31 and check valve 32 to the pipe 21. A small pipe 33 leading from the fuel supply tank enters the combustion chamber and terminates in a small spray nozzle 34. A spark plug 35 is inserted within the wall of the combustion chamber and connected to a battery 36, whereby the explosive mixture produced within the chamber 28 may be ignited.

A supply of compressed air is normally contained within the tank 15 and by means of this supply of compressed air the main engine may be started in operation. To start the engine the compressor is disconnected from the drive shaft 7 and by turning the three-way valve 19 so that the jacket of the compressor may communicate with the chamber 28, the compressed air within the air tank may escape through the pipes 17, 18, 29, 31 and 21 to the air expansion engine 8. This engine being connected to the drive shaft 7, as is also the main internal combustion engine, the latter is started in operation, and thus all necessity for cranking the engine is obviated. As soon as the internal combustion engine is started, the three-way valve 19 is turned to the position illustrated in the drawings and the compressor is connected to the drive shaft 7 to restore the pressure in the tank 15 and enable the parts to carry on the functions above described.

In case the apparatus above described is employed upon a motor vehicle and the vehicle is traveling down-hill, at which time it is unnecessary to apply any power to the drive shaft and it is desirable to apply a brake, the internal combustion engine and the air expansion engine may be disconnected from the drive shaft, leaving the compressor in operation. The motion of the vehicle will be transmitted through the gearing to the shaft 7 to operate the compressor and as high a pressure of air may thus be created within the storage tank 15 as is desired, and the work done in compressing this air will be derived directly from the motion of the vehicle, and the action of the compressor will serve to retard the vehicle and act as a brake. Instead of leaving the compressor in operation, it may be disconnected instead of the air expansion engine 8 and the main gear of the vehicle reversed, whereby the air expansion engine will be converted into an air compressor, receiving its air through a check valve 37 in a branch pipe 38 communicating with the atmosphere, and delivering this compressed air through a pipe 39, a valve 40, and a check valve 41 into the pipe 13 and radiating coil 14. If desired, reversing gears may be provided in the connection of the air expansion engine to the shaft 7, whereby the air compressor and the expansion engine may be simultaneously employed to compress air and deliver it to the storage reservoir while the vehicle is traveling down-hill, thus a double brake would be provided and energy stored up which could be utilized for running the air expansion engine whenever it is desired to employ said engine in addition to the main internal combustion engine.

The air expansion engine may be employed to run the vehicle entirely independent of the internal combustion engine for a limited length of time depending upon the size of the tank 15 and the pressure to which the gas has been previously compressed therein. Thus in case the supply of fuel should become exhausted before the vehicle had reached its destination, it might be possible to complete the trip merely by the use of the supply of compressed air operated within the expansion engine. If a supply of fuel is not exhausted but the main engine is disabled, or it is desired to operate the apparatus at a slower speed than that at which the main engine normally runs, I may disconnect the main engine from the drive shaft but leave the air compressor and motor in operation. By turning the three-way valve 19 through an angle of ninety degrees from that shown in the drawings, whereby the air from the jacket of the compressor may deliver to the chamber 28, and by opening a valve in the small fuel supply pipe 33, an explosive mixture may be formed in the chamber 28 and ignited by the spark plug 35. As soon as this ignition takes place the pressure rises and the check valve 30 would be closed and the hot compressed gas would escape through the pipes 31 and 21 to the expansion engine 8 to rotate the shaft 7 and operate both the compressor and the vehicle. As soon as the pressure within the chamber 28 decreases to the pressure in the tank 15 more compressed air and more fuel would be admitted to the tank 28, and as these become ignited the pressure would again rise and exhaust through the air expansion engine. Thus the engine would be capable of operating the compressor and doing outside work, due to the increased volume of the gas produced at the time of the ignition and also by reason of the increased temperature.

The apparatus above described is only diagrammatically illustrated in the drawing, and it will, of course, be understood that various changes and modifications in the size and relative arrangement of the parts may be found necessary during the practical employment of the invention. I claim all such changes and modifications falling within the terms of the claims, as within the scope of my invention.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. In combination, an internal combustion engine, an exhaust pipe leading therefrom, an air expansion engine, means for compressing air, means for heating the compressed air by the exhaust from said internal combustion engine, said means comprising a pipe coil of gradually increasing diameter and having the enlarged end thereof surrounding the exhaust pipe of the internal combustion engine and having the opposite end of said coil open to the atmosphere, and means for delivering the compressed air heated within said coil by the exhaust from the internal combustion engine to said air expansion engine.

2. In combination, an internal combustion engine, an exhaust pipe leading therefrom, an air expansion engine, means for compressing air, means for heating the compressed air by the exhaust from said internal combustion engine, a pipe coil of gradually increasing diameter and formed of a pipe of gradually increasing diameter and baffle plates between said coil, means for delivering the exhaust of the internal combustion engine to the larger end of the coil, means for delivering the compressed air to the smaller end of the pipe forming the coil, and means for delivering the heated compressed air from the larger end of the pipe forming the coil to the air expansion engine.

3. In combination, an internal combustion engine having a jacket, an air expansion engine, an air compressor, a conduit delivering compressed air from said compressor to said expansion engine, means for heating said conduit by the exhaust gas from said internal combustion engine, and means for also heating said conduit by the air previously heated in the jacket of the internal combustion engine.

4. In combination, an internal combustion engine having a jacket, an air expansion engine, means for compressing air, a countercurrent heat interchanger having a plurality of passages therethrough, means for delivering compressed air from said compressor through one of the passages of said countercurrent apparatus to the air expansion engine, and means for delivering the exhaust gas from said internal combustion engine and the fluid heated in the jacket of said engine to separate passages of said countercurrent apparatus, whereby the compressed air is heated by passing in a reverse direction to the heated fluid and exhaust gas.

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

JOHN LINCOLN TATE.

Witnesses:
F. M. DECKER,
C. M. HAGUE.