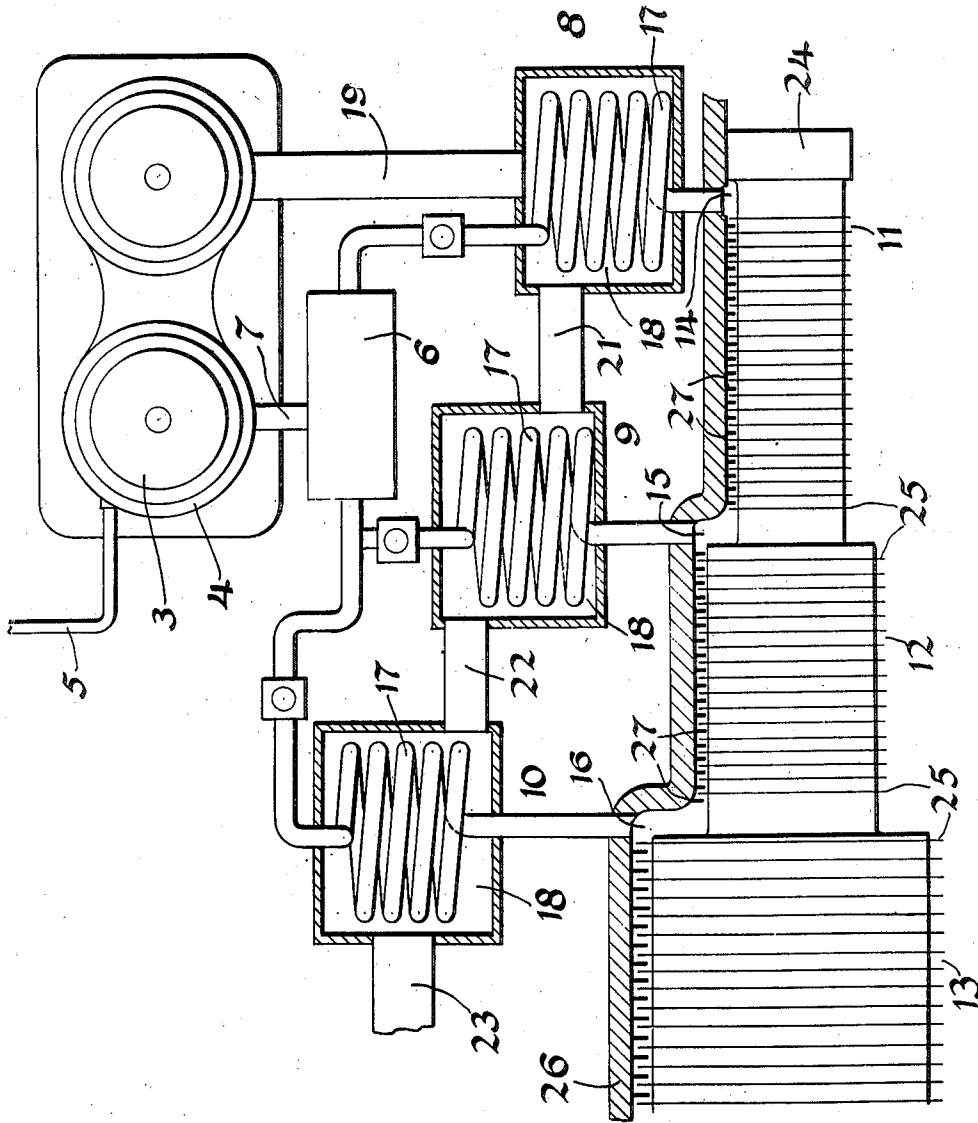


H. H. DOW.
METHOD OF CONSERVING HEAT.
APPLICATION FILED JUNE 23, 1908.

1,103,948.

Patented July 21, 1914.



WITNESSES:

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METHOD OF CONSERVING HEAT.

1,103,948.

Specification of Letters Patent.

Patented July 21, 1914.

Application filed June 23, 1906. Serial No. 323,106.

To all whom it may concern:

Be it known that I, HERBERT H. DOW, a citizen of the United States, and a resident of Midland, in the county of Midland and State of Michigan, have made a new and useful Invention in Methods of Conserving Heat, of which the following is a specification.

This invention relates to a method of conserving and utilizing the heat contained in the exhaust of an internal combustion engine.

An object of this invention is the production of a method of conserving heat energy in which the heat contained in the exhaust of an internal combustion engine and ordinarily lost is rendered available in the production of power.

A further object is the production of a method of conserving heat in which the thermal energy contained in the exhaust of an internal combustion engine is extracted and delivered to an engine in such a manner that the conserved heat will be most effectively and efficiently expended.

These and other objects I attain with the apparatus herein illustrated and described, but I desire it to be understood that the apparatus is merely illustrative and that the invention may be carried out with different and various apparatus and still fall within the spirit and scope of my invention.

A large amount of thermal energy contained in the fuel of an internal combustion engine is discharged through the exhaust ports of the engine cylinders. Various methods have been utilized and proposed for conserving this energy, but none, so far as I am aware, have been wholly successful or practical.

In carrying out my invention the exhaust gases from the cylinder of an internal combustion engine are caused to pass through a number of steam generators arranged in series and adapted to supply steam to the successive stages of a multi-stage turbine. The first generator in the series is exposed to the hottest gases and is capable of producing steam of relatively high pressure, which is delivered to the initial stage of the turbine. The second generator of the series is exposed to partially cooled gases and is capable of generating steam at a lower pressure, which is delivered to a lower pressure stage

of the turbine. As the gas is cooled the steam pressure available in the successive generators is diminished but each generator delivers steam to a stage of the turbine in which the pressure is equal to the pressure of the generator under normal conditions. Under such conditions a relatively large amount of the thermal energy in the exhaust gases is abstracted and delivered to the turbine, where it is efficiently converted into available energy. It would be impractical to reduce the exhaust temperature and thereby increase the thermal range of the exhaust gases by discharging them into a steam turbine operating with a vacuum, since the gases would spoil the vacuum; if the gas engine were used in series with a turbine running non-condensing, there would be no increase in the heat range and consequently no inherent economy.

In the single sheet drawing accompanying this application and forming a part thereof, a preferred arrangement of apparatus for carrying out my invention is diagrammatically illustrated.

The cylinders 3 of a gas engine, which is diagrammatically shown in plan view, are provided with water jackets 4 which receive cooling water from any suitable source through a supply pipe 5. The water from the jackets is conducted to a feed-water heater 6 through a pipe 7. The feed-water heater 6 is arranged to supply feed water to steam generators 8, 9 and 10, which respectively communicate with the initial stage 11, the intermediate stage 12 and the final or low-pressure stage 13 of a steam turbine through the respective ports 14, 15 and 16. Each of the steam generators utilized is provided with a system of water tubes 17, which is provided with adequate heat surface and steam space, and is contained within a heating chamber 18. The heating chamber 18 of the generator 8 communicates with the exhaust of the engine cylinders through a pipe or passage 19, the heating chamber of the generator 9 communicates with the heating chamber of the generator 8 through a pipe or passage 21 and the heating chamber of the generator 10 communicates with the heating chamber of the generator 9 through a passage 22. The heating chamber of the generator 10 is provided with a passage 23 which communi-

cates with the atmosphere or an additional generator.

The steam turbine with which the generators communicate comprises a rotor element 24, provided with annular rows of moving blades 25, and an inclosing stationary casing 26 therefor, provided with annular rows of stationary vanes 27, which alternate and cooperate with the moving blades 25. The exhaust of the high-pressure stage 11 of the turbine communicates with the inlet end of the intermediate stage 12 and the exhaust of the intermediate stage communicates with the inlet end of the low-pressure stage.

The exhaust gases discharged from the cylinders 3 of the engine are led by the passage 19 to the chamber 18 of the generator 8 where a portion of the heat contained in them is delivered to the water tubes 17 of the generator and is effective in generating steam. The exhaust gases are then conveyed to the chamber 18 of the generator 9 and caused to deliver a portion of the remaining heat to the water contained in the tubes 17 of the generator 9. The gases are then led to the chamber 18 of the generator 10 where the remaining available heat is delivered to the water in the tubes 17. The gas discharged through the passage 23 may be conducted to additional generators and further cooled, or it may be utilized in a feed-water heater 6. The heating surface of the generator 8 is so proportioned that a comparatively small amount of high pressure steam is generated by the exhaust gas, the ultimate pressure being, of course, dependent upon the heat of the exhaust. The generator 9, which receives gas from which a portion of the heat energy has been abstracted, is designed to generate a relatively large amount of steam at moderate pressure and the generator 10, which receives heating gases that are comparatively cool, is arranged to generate low-pressure steam in comparatively large amounts.

The steam from the generator 8 enters the turbine through the admission port 14 and in working on the high-pressure or initial stage converts a portion of its heat or pressure energy into velocity energy and is discharged into the intermediate stage at a reduced temperature and pressure. The steam discharged from the high-pressure stage is augmented by live steam from the generator 9 of substantially the same pressure. The steam in working on the intermediate stage of the turbine delivers up heat and is discharged to the inlet of the low-pressure stage at about atmospheric pressure and a corresponding steam temperature, where it is mixed with steam generated by the generator 10. The steam, after working on the low-pressure stage, is discharged into condenser.

It is apparent that with such an arrange-

ment of apparatus the exhaust gases of an internal combustion engine are cooled more effectively than would be the case if cooling were accomplished in one step. It is also apparent that higher pressure steam may be generated than would ordinarily be obtained.

The steam turbine is so constructed that more steam at intermediate pressure is required to produce an efficient operation of the turbine than can be delivered by the high-pressure stage while that stage is working efficiently. The low-pressure stage is so constructed that more low-pressure steam is required for an efficient operation than can be supplied by the intermediate stage. Under such conditions, it is apparent that, with proper governing means, the turbine will operate efficiently throughout greatly varying loads and practically all of the heat ordinarily lost in the exhaust of an internal combustion engine will be utilized.

It is to be understood that the water entering the pipe 5 is supplied under pressure. Ordinarily, this pressure will exceed that in the highest pressure coil 17 as well as that in the reservoir 6. The reducing valves in the connections between the reservoir 6 and the coils 17 will permit proper quantities of water to pass into the coils to be generated into steam. The reducing valve for the first stage will be opened less than the reducing valves in the other two stages, the one for the last stage being opened the greatest amount, and inasmuch as the pressure in 5 and 6 exceeds that in the highest pressure coil, it is obvious that the generated steam will be directed into the turbine.

What I claim is:

1. The method of converting the heat in the exhaust gas of an internal combustion engine into useful work, which consists in abstracting the thermal energy of said gas in a series of successive steps of progressively decreasing temperature, then in converting the abstracted thermal energy into pressure energy, then in converting the pressure energy into kinetic energy in the form of fluid velocity and finally in abstracting the velocity energy by means of a moving mass.

2. The method of converting the heat in any waste gas from any source of combustion into useful work which consists in abstracting the thermal energy of said gas in a series of successive steps of progressively decreasing temperatures, then in converting the abstracted thermal energy into pressure energy, then in converting the pressure energy into kinetic energy in the form of fluid velocity and finally in abstracting the velocity energy by means of a moving mass.

3. The method of converting the heat in the exhaust gases of an internal combustion engine into useful work, which consists in abstracting the thermal energy of said gases

into two or more steps of different temperatures, then in converting the abstracted thermal energy into pressure energy, then in converting the pressure energy into kinetic energy in the form of fluid velocity and finally in abstracting the velocity energy by means of a moving mass.

4. The method of conserving the waste heat of an internal combustion engine provided with a water jacket, which consists in utilizing the exhaust gas from said engine for raising the temperature of all or a portion of the water discharged from said water jacket to successively decreasing temperatures, whereby the thermal energy of said gas is abstracted, then in converting the abstracted thermal energy into pressure energy, then in converting said pressure energy into kinetic energy in the form of fluid velocity and finally absorbing the velocity energy by means of a moving mass.

5. The method of conserving the waste heat of an internal combustion engine provided with a water jacket, which consists in segregating portions of the water discharged from said jacket, then in raising the temperature of the segregated portions of said water to successively decreasing temperatures by means of the exhaust gas from said engine, whereby the thermal energy of said gas is abstracted in as many steps of progressively decreasing temperature as there are segregations, then in converting the abstracted thermal energy into pressure energy, then in converting the pressure energy into kinetic energy in the form of fluid velocity and finally in absorbing the velocity energy by means of a moving mass.

6. The method of conserving the waste heat from an internal combustion engine provided with a water jacket and a circulatory water system therefor, which consists in segregating all or a part of the water discharged from said jacket into two or more portions arranged in parallel, then in raising the temperature of said segregated portions by passing the exhaust gases from said engine in contact with the device containing said segregated portions in series, whereby the thermal energy of said gases is abstracted in as many steps of progressively decreasing temperature as there are segregated portions, then in converting the abstracted thermal energy into pressure energy, then in converting the pressure energy into kinetic energy in the form of fluid velocity and finally in absorbing the velocity energy by means of a moving mass.

7. The method of converting the heat in the exhaust gas of an internal combustion engine into useful work, which consists in abstracting the thermal energy of said gas in a series of successive steps of progressively decreasing temperature and transferring the thermal energy of the gas to a different medium, then in converting the energy in said medium into mechanical work by means of a thermal dynamic engine.

In testimony whereof, I have hereunto subscribed my name this 12 day of June, 1906.

HERBERT H. DOW.

Witnesses:

B. B. BALL,
G. L. CAMP.