C. S. PIESTRAK.

COMBUSTION ENGINE.

APPLICATION FILED MAY 28, 1908.

940,474. Patented Nov. 16, 1909.

Fig. 1

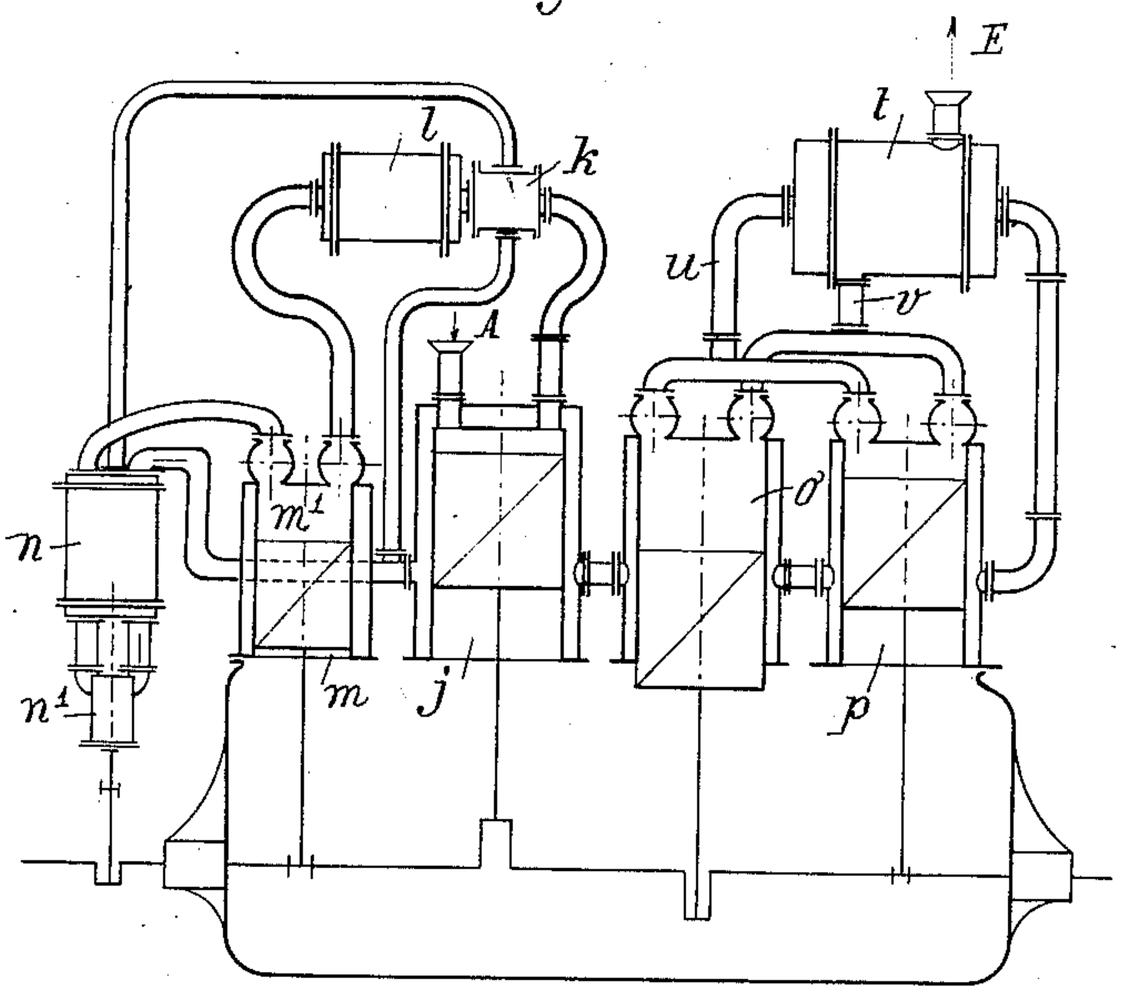
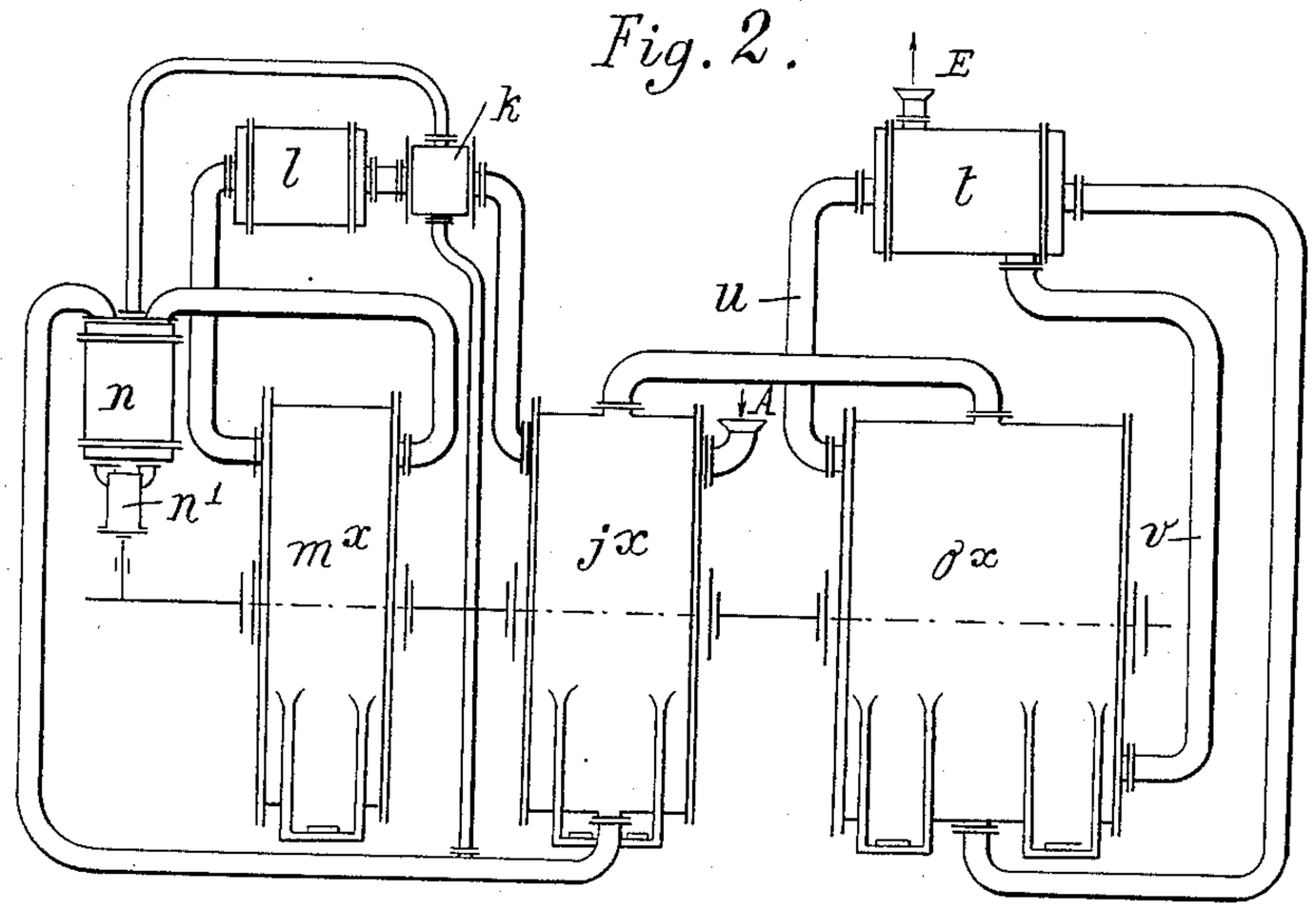


Fig. 2.



Witnesses.

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COMBUSTION-ENGINE.

940,474. Specification of Letters Patent. **Patented Nov. 16, 1909.**

Application filed May 28, 1908. Serial No. 435,600.

To all whom it may concern:

Be it known that I, CASIMIR STANISLAS PIESTRAK, a subject of His Majesty the Emperor of Austria-Hungary, residing at 97 Fleet street, London, E. C., England, civil engineer, have invented a new and useful Internal-Combustion Engine, of which the following is a specification.

My invention relates to internal combustion engines of the type in which combustion takes place at constant pressure and in which the air for combustion is compressed in a separate air compressor outside of the working motor or motors, and has for its object the recovery of a portion of the waste or lost heat of such an engine, *i. e.* the heat of compression, the heat passing to the cooling fluid in the jackets of the cylinders or motors, and the heat of the exhaust gases.

This invention contemplates the realization of this object by the production of intense cold with liquefaction of the air prior to combustion in the engine cylinders, thereby making possible the heat transference above referred to.

Under the invention either reciprocating compressors and motors, or turbine compressors and motors, or a combination of both may be used, the operation thereof being as follows:—

Air is drawn in and compressed in an air compressor in one or more stages and cooled to a temperature about or below that of the atmosphere, and is then used as the working fluid in a compressed air motor which is insulated to prevent the flow of heat into the expanding air, and this air in expanding cools itself to a temperature approaching that of the liquefaction point of air.

The pressure to which the air is compressed, the temperature to which it is cooled before entering the compressed air motor and the volume to which it expands in the compressed air motor are so proportioned that this result is obtained. The cooled air then passes into a temperature exchanger, wherein the whole or a portion of it is further cooled and liquefied and the liquid air is then pumped into a receiver or system of piping at a pressure rather higher than the initial pressure in the internal combustion motors. The liquid air is then volatilized at this pressure and heated by passing it through a series of temperature exchangers, wherein it receives heat from the compressed air, the compressor jackets, the motor jackets and the exhaust gases, or some of them. Into the air thus heated is injected fuel which may be in the form of compressed gas, or a spray of liquid, or of coal dust, combustion taking place spontaneously, or if necessary with the assistance of an igniting mechanism of any suitable known kind, such combustion taking place either in an external chamber or inside the motor or motors themselves. The hot gases then operate in the working motors in the usual manner and exhaust to the atmosphere after parting with a portion of their heat to the compressed air.

In the accompanying drawings Figure 1 is an elevation showing diagrammatically the arrangement of a piston engine according to this invention. Fig. 2 is a similar view representing a turbine engine of this kind.

Referring to the drawings, air is drawn at A into the compressor *j* by which it is compressed, and is cooled by the volatilized liquid air in a temperature exchanger *k*. The compressed and cooled air is stored up in a receiver *l*, from which it passes into any suitable and well known expansion cylinder *m*, wherein it expands to about the point of liquefaction of air and, in acting on the piston *m'*, produces effective work. On leaving the expansion cylinder *m*, the air passes to a temperature exchanger *n*, which may be of any appropriate or known type, and wherein the whole or a portion of the air is liquefied, and through which it is forced by means of a pump *n'*. It is then pumped into the temperature exchanger *k*, into the jacket of the compressor *j*, and into the cooling jackets of the engine cylinder or cylinders *o*, *p*, wherein it takes up heat given off by the walls of said cylinders. From the engine jackets the air produced by the volatilization of the liquid air and now heated enters the chamber *t*, wherein take place, at the same time as the transference to the air of heat from the exhaust gases of the engine, the mixing of the air with the fuel, and also the combustion of the mixture thus obtained, in the case in which the combustion takes place outside of the cylinder. From such chamber *t* the gases of combustion pass through a pipe *u* to the engine cylinders *o*, *p*, the exhaust of which is connected by a pipe

v, with the said chamber *t*, from which the exhaust products escape at E after giving up a portion of their heat to the compressed air.

The engine represented in Fig. 2 is similar to that shown in Fig. 1 and operates in like manner, with the difference that the cylinders *j*, *m*, *o*, *p* and the pistons working therein are replaced by turbines $j^{\times}$, $m^{\times}$, $o^{\times}$ which constitute respectively the compressing turbine, the expansion turbine, and the motive-power turbine.

While I have described in the foregoing specification the construction of parts essential to the operation of this invention, I am aware that numerous changes of construction and operation may be made without departing from the spirit and scope of the invention, and I therefore do not wish to be understood as limiting myself by the positive terms employed in connection with the description, excepting such as the state of the art may require.

I claim:

1. In an internal combustion engine, the combination of means provided with a jacket for compressing air; means for cooling said air to a temperature substantially equal to that of the surrounding atmosphere; a compressed air motor; means for insulating the same against an inflow of heat; means for conducting said cooled air into said motor, whereupon said air is caused to do work and to be further cooled; a temperature exchanger; a connection between said motor and said temperature exchanger; a second temperature exchanger; a connection comprising a pump between said temperature exchangers; a connection between said second temperature exchanger and said jacket by which said compressing means may be surrounded by cooled air; an engine having a cylinder and a jacket; a connection between said engine jacket and said compressor jacket; and means by which said air may be mixed with fuel and utilized in said engine cylinder, substantially as described.

2. In an internal combustion engine, the combination of a jacketed air compressor; a temperature exchanger *k* connected with said compressor; a motor *m* connected with said exchanger; a temperature exchanger *n* connected with said motor; connections between said exchanger *n* and the jacket of said compressor; jacketed cylinders *o* and *p*; connections from said compressor jacket to the jacket of said cylinders; a chamber *t*; connections between said cylinder jackets and said chamber *t*; and connections between said chamber and said cylinders *o* and *p*, substantially as described.

3. In an internal combustion engine, the combination of means to liquefy air; a temperature exchanger *k*; a connection between the same and said air liquefying means; engine cylinders *o* and *p* each provided with a jacket; connections between said exchanger and the jackets of said cylinders; a chamber *t*; connections between said jackets and said chamber; means for mixing said air with fuel in said chamber; and connections between said chamber and the interior of said cylinders, substantially as described.

4. In an internal combustion engine, the combination of means to liquefy air; jacketed engine cylinders; connections between said means and the jackets of said cylinders; a chamber *t* in which said air may be mixed with fuel; a jacket for the same provided with an exhaust escape E; a connection *u* between said chamber and the interior of said cylinders for the gases of combustion; and an exhaust connection *v* between said chamber jacket and said cylinders, substantially as described.

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In presence of—
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