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G. O. DE SANDERVAL.

MOTOR AND ENGINE.

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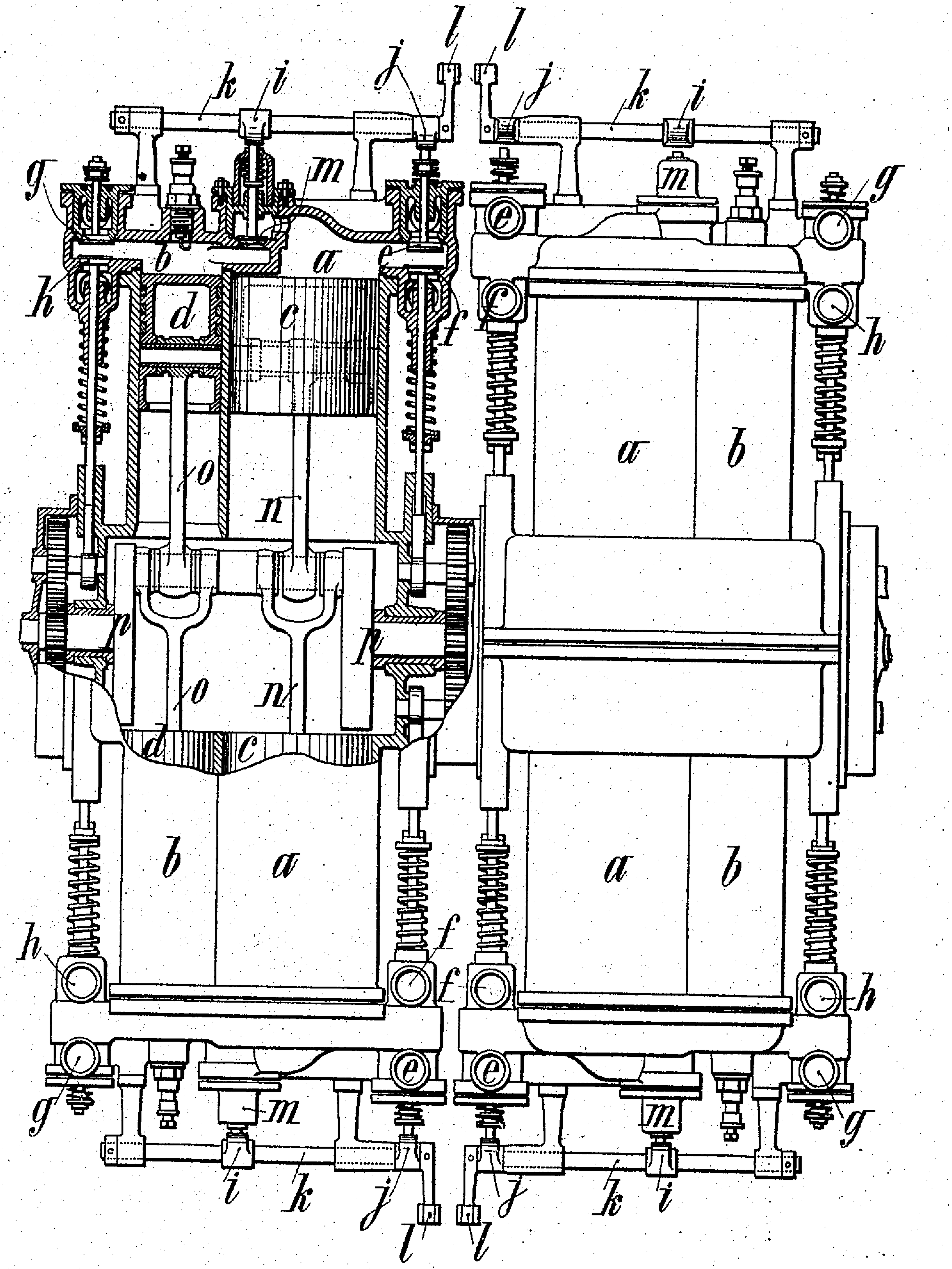

Witnesses:

[illegible]

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MOTOR AND ENGINE.

No. 806,195. Specification of Letters Patent. Patented Dec. 5, 1905.

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To all whom it may concern.

Be it known that I, GEORGES OLIVIER DE SANDERVAL, a citizen of the Republic of France, residing at Mont-Redon, France, have invented certain new and useful Improvements in Motors and Engines, of which the following is a specification.

Hot-air engines working in accordance with the laws defined by Mariotte and Gay-Lussac comprise a compression-pump and a hot-air cylinder; but the separation of these two parts is the cause of losses of heat. A good method of heating consists in effecting the combustion (source of heat) and the compression in the same cylinder, which then would simultaneously form the pump and hot-air cylinder; but the proportion required for good combustion allows the admission of only a very small quantity of air relatively to the quantity of heat generated, the result being that the temperature produced is too high. This pump-furnace would therefore merely be a good heating device, and it would be necessary to have a pump for compressing the air to be heated.

According to this invention I have devised an improved form of engine or motor employing gas, vapor, or steam and compressed air or gas of the four-stroke description, (pumping or suction, compression, combustion, and expansion and exhaust,) only one of which strokes (the expansion) is a driving stroke. In order to make the compression as great as possible, it is necessary that the whole apparatus (the mechanical unity) should comprise four pairs of combustion-cylinders and air-cylinders combined on the same shaft in order that a compression-stroke should be always effected by an expansion-stroke.

The accompanying drawing shows an engine with four pairs of combined cylinders arranged according to this invention.

It will be seen from the figure that one of the four elements of the engine illustrated comprises two twin cylinders *a* and *b* of different diameters, in which travel pistons *c* and *d*, the rods *n* and *o* of which are keyed to the same crank-pin of the crank-shaft *p*. The large piston *c*, through an automatic inlet-valve *e*, draws in air (or other gas—such as, for instance, a mixture taken from the exhaust-gases of an engine.) The smaller piston *d* acts, like the piston of an ordinary explosion or combustion engine, under the impulse of a mixture of air and fuel admitted through an automatic supply-valve *g*. The two pistons *c* and *d* work simultaneously in the same direction, (insuring the same compression or a slightly-stronger compression in the air-cylinder than in the combustion-cylinder,) so that when the piston *d* draws in a certain quantity of explosive or combustible mixture the piston *c* draws during the same time a certain volume of air or other gas, which will thus be compressed on the return of the pistons.

The cylinder *b*, in which the combustion takes place, is placed in communication with the cylinder *a* by means of a valve *m*, the spring of which is slightly stronger than that of the valves *e*, so that the vacuum produced by the piston *c* during its pumping period will be unable to raise this intermediate valve.

The cylinder *b* comprises, independently of its automatic inlet-valve *g*, an exhaust-valve *h*, which is operated by the engine. The two valves *m* and *e* of each of the four pairs of cylinders *a b* are automatic. They can be locked when desired, so that the valve *m* is closed and the valve *e* opened by cams *i* and *j* or by a bar *k*, operated by hand, either for starting the engine or for reducing its power.

f is an exhaust-valve for the escape of heated air. The two exhaust-valves *f* and *h* are opened at the same time by their respective cams during the expulsion-stroke. This expulsion could be effected entirely through the valve *f*; but it is preferable that it should take place through the valves *f* and *h*, both open at the same time. The cams for operating the valves *f* and *h* are of the kind commonly used in gas-engines, and therefore need not be specifically described.

The locking of the valves *m* and *e* enables the combustion-cylinders *b* to be temporarily separated from the corresponding air-cylinders *a*. In fact, when the air-inlet valve *e* is locked in open position, the communication-valve *m* being forced against its seat, the piston *d* works like the piston of an ordinary explosion-engine. The piston *c*, driven from the piston *d* by the shaft, draws in and forces out air without producing any mechanical work in the cylinder *a*. As soon as the engine is working normally the cams *i j* or the common bar *k* are turned back, so as to release the valves *e* and *m*. In this position the calorific mixture drawn in by the piston *d* and the air drawn in by the piston *c* will be simultaneously compressed in their respective cylinders *b* and *a*. When the next explosion takes place, the valve *h* remaining closed, the combustion

products will open the valve *m* and carry the great quantity of heat they contain into the cylinder *a*, suddenly raising the temperature of the volume of compressed air contained in the said cylinder. In accordance with the laws of Mariotte and Gay-Lussac, owing to the great expansion of compressed air thus heated, there takes place an increase of mechanical power in the cylinder *a*, which is transmitted by the piston *c* to the shaft *p* simultaneously with the mechanical effect of the explosive mixture in the cylinder *b*. The two pistons *c* and *d* become thus driving parts of proportionate power working by combined expansion and temperature.

The size of the cylinder *a*—that is to say, the volume of air to be put in action—is determined by the calorific power of the combustible used and by the maximum temperature that is admissible in the apparatus, the air very appropriately acting as a cooling medium.

According to the laws mentioned the power of the engine will be the greater within certain limits the greater the compression of air. The compression of air must be, therefore, fairly strong, the limit being obtained by calculating the corresponding strains and temperatures due to the compression. The compression, which must be considerable in order to be useful, must therefore be effected direct by a combustion or expansion stroke—that is to say, the least possible action should be demanded from the fly-wheel, which would otherwise have to be of inordinate size in order to be of use.

The apparatus being a four-stroke apparatus it is necessary, in order that a compression-stroke in the cylinder *a* should always be assisted in compression by an explosion-stroke in one of the cylinders *b*, that the whole engine (the mechanical unity) should consist of four pairs of two cylinders each—that is to say, four air-cylinders and four hot-air cylinders—communicating two and two, as shown, by way of example, in the accompanying drawing. The apparatus thus presents at each of its four strokes an expansion in one pair at the same time as a compression in the same or in another pair. The mechanical connection between them is established by a shaft common to all the eight cylinders.

It must be pointed out that a certain efficiency may be obtained (and I reserve to myself this construction of apparatus) with a mechanical unity composed of three pairs of two cylinders each; but the action is less efficient, the engine borrowing one compression-stroke from the fly-wheel.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. A combined internal-combustion and hot-air engine comprising side-by-side gas and compressed-air cylinders, pistons reciprocable in said cylinders, a common crank-shaft, a valve intermediate the two cylinders adapted to open automatically under the effect of an explosion in the internal-combustion cylinder, exhaust-valves for said cylinders and an air-inlet valve for the hot-air cylinder, and positive means for cutting out the hot-air cylinder and allowing its piston to run free when the gas-cylinder is working substantially as set forth.

2. A combined internal-combustion and hot-air engine comprising side-by-side gas and compressed-air cylinders, pistons reciprocable in said cylinders, a common crank-shaft, a valve intermediate the two cylinders adapted to open automatically under the effect of an explosion in the internal-combustion cylinder, exhaust-valves for said cylinders and an air-inlet valve for the hot-air cylinder, and positive means for simultaneously closing the intermediate valve and opening the air-inlet valve of the hot-air cylinder, substantially as set forth.

3. A combined internal-combustion engine and hot-air engine comprising side-by-side gas and compressed-air cylinders, pistons reciprocable in said cylinders, a common crank-shaft, a valve intermediate the two cylinders, exhaust-valves for said cylinders, an air-inlet valve for the hot-air cylinder, a shaft outside the cylinders, and cams thereon for simultaneously closing the intermediate valve and opening the air-inlet valve of the hot-air cylinder substantially as set forth.

4. A compound balanced internal combined combustion engine and hot-air engine comprising a crank-shaft, a pair of oppositely-disposed internal-combustion engines, pistons therefor and piston-rods connected to the said crank-shaft, a valve intermediate each pair of side-by-side internal-combustion and hot-air cylinders, an air-inlet valve for each hot-air cylinder and positive means for simultaneously closing the intermediate valves and opening the air-inlet valves of the hot-air cylinders, substantially as set forth.

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

GEORGES OLIVIER DE SANDERVAL.

Witnesses:
M. HUBERT,
A. MILLER.