(No Model.)

A. SCHMID & J. C. BECKFELD.

AIR ENGINE.

No. 421,525. Patented Feb. 18, 1890.

Fig. 2.

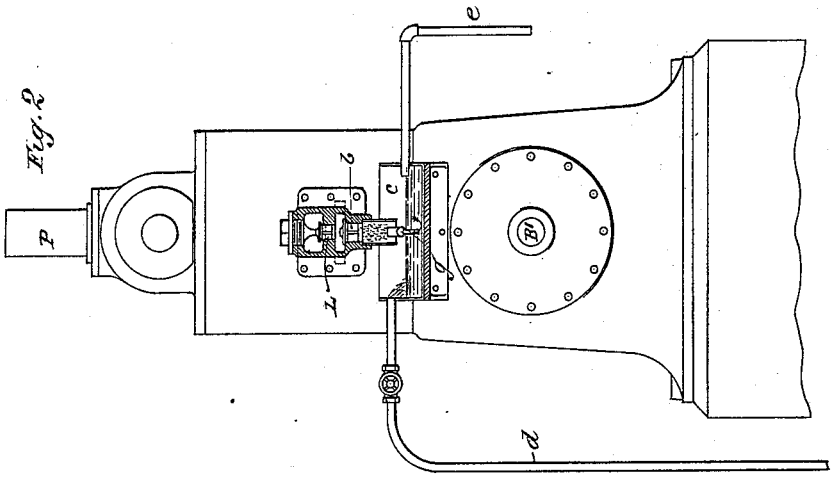

Fig. 1.

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UNITED STATES PATENT OFFICE.

ALBERT SCHMID AND JOHN CHARLES BECKFELD, OF ALLEGHENY, PENNSYLVANIA.

AIR-ENGINE.

SPECIFICATION forming part of Letters Patent No. 421,525, dated February 18, 1890.

Application filed August 28, 1889. Serial No. 322,202. (No model.)

To all whom it may concern:

Be it known that we, ALBERT SCHMID, a citizen of the Republic of Switzerland, and JOHN CHARLES BECKFELD, a citizen of the United States, both residing at Allegheny, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Air-Engines, of which the following is a specification.

This invention relates to engines or motors operated by compressed air, the main object of said invention being to provide a better and more practicable means of counteracting or lessening the objectionable effects produced in such motors by the intense cold developed by the expansion of the air. Our plan for accomplishing this is to compress, by means of the motor itself, or by the energy of the compressed air by which it is operated, a given volume of air, and to utilize the heat developed by such compression to counteract the cold, either by raising the temperature of those parts of the motor most exposed to the refrigerating effects of the expanded air or to impart warmth to the compressed air on its way into the motor or both. We also provide for the utilization of the air thus compressed in driving the motor, and in other respects hereinafter set forth improve the construction and operation of the motor.

In carrying out this invention we may employ any suitable form of compressed-air engine; but we have illustrated the application of the principle of the same in a form of compound engine, to which the description will be confined. In conjunction with said engine or forming a part thereof, we employ a compression-cylinder and piston of relatively small capacity, in which, by the operation of the engine, and preferably at each stroke, the air is compressed and forced through a suitable valve or valves, through passages which conduct it around or in close proximity to the exhaust ports, valves, or other parts most exposed to the cold, and then into the main which supplies the motor with the compressed air which drives it.

For the sake of greater economy of mechanical construction and for avoiding loss of mechanical energy, we construct the driving-cylinder—or the expansion-cylinder in the present case—with two compartments, one for the development of power by the expansion of the compressed air, the other for the compression by the piston on its forward or down stroke of the air to be subsequently utilized, as above set forth. We also provide for the introduction into said latter compartment and along with air drawn into the same by the return of the piston a spray of water or other fluid, using two valves, one closing on the downstroke to prevent the escape of the air, the other opening when the pressure in the compression-chamber becomes sufficiently high to admit the compressed and heated air to the valves and the main supply-pipe, as above set forth. Thus we utilize a supply of compressed air for operating a motor and for counteracting the refrigerating effects of its own expansion, which heretofore have been found so objectionable in motors of this character. We consider that our invention comprehends this broadly, and our intention is to cover this broadly by the claims which are hereto subjoined.

To illustrate the practical construction and working of our invention, we now refer to the drawings annexed, and in which is shown, as we have stated above, the particular form of motor which in practice we prefer.

Figure 1 is a vertical central section of a complete motor embodying our improvement. Fig. 2 is an end elevation of the same.

The main portions of the motor, having been described in former patents to us and elsewhere, require a less detailed description than the particular features of novelty which distinguish our invention, and such parts may be very greatly varied. These consist of a high-pressure cylinder A, with a piston B working therein, and a low-pressure or expansion cylinder C, containing a piston D. The pistons connect by piston-rods with cranks A′ on the main shaft B′, on which is fixed the fly-wheel G″. The valve mechanism which controls the admission of the compressed air from the main pipe E into the high-pressure cylinder A, the expansion of the air therefrom into the low-pressure cylinder C, and the final exhaust of the expanded air, is located above the cylinders and is con-

trolled by a bell-crank lever or rock-shaft D′, operated by an eccentric E′ on the main shaft B′. The valve mechanism is shown as composed of a cylindrical valve F, arranged to slide in a bushing F′ in an outer valve-casing G, containing passages or chambers with ports in or through said bushing, the character and location of which will be understood from the subsequent description of the operation of the motor. Below the cylinders is a chamber G′ for containing water and oil which are splashed up by the piston-rods and cranks against the under sides of the pistons and the walls of the cylinders.

The larger or expansion piston D is made up of two parts of unequal diameter. The wider portion or head fits the walls of the cylinder proper, while the reduced portion or body H works air-tight in the part I, forming the open end of the cylinder C, and having a smaller diameter than the main portion. Thus two working-compartments are formed on opposite sides of the piston, the lower of which, for convenience, may be designated the "cylinder" J. Communication from the outside to the cylinder J is secured through a passage K, containing a valve *b*. Below the valve is a receptacle *c*, containing water, the level of which is maintained constant by a supply-pipe *d* and overflow-pipe *e*. A small tube *f* from the main E is bent down over the water in receptacle *c* and opens immediately below the valve *b*. A short tube *g* extends from the interior of the pipe *f* into the water, thus forming a spray or atomizer by means of which, when the valve *b* is open and air is being drawn into the cylinder J, a spray of water is thrown into the passage K and the cylinder. A passage is also formed from the cylinder J through a valve L and pipe M to a jacket or chamber N, surrounding more or less the exhaust-port P and the main valve F. A pipe O connects this chamber with the main E.

The operation of this device is as follows: The compressed air from the main E being admitted to the motor, it passes through ports *h* and *i*—assuming the valve F to be in position to permit this—into the cylinder A. This drives down the piston B until by the movement of valve F the air-supply is cut off. Communication between cylinders A and C is then established through the valve F and ports *i* and *n*. The compressed air, then expanding, forces down the piston D until by the valve F the exhaust through ports *n* and *o* is opened, when the cycle of operations above described is repeated. In its downward movement the piston D compresses the air in cylinder J and raises its temperature. As soon as the pressure equals that in the main E the valve L is raised and the heated air passes up through the pipe M and chamber N, where it imparts a portion of its heat to the surrounding walls and then enters the main E, to pass through the engine-cylinders, together with the main supply. Each time the piston D rises a fresh supply of air is drawn into the cylinder J, and together with the air the spray of water. This latter, on the descent of the piston D, is converted into steam. The advantages and useful effects of this are numerous. The expansion of the vapor is utilized in the subsequent working of the motor. The steam absorbs and retains much of the heat that would otherwise be lost by radiation and conduction, and serves the better to raise the temperature of the parts with which it subsquently comes in contact, and, furthermore, on reaching the cylinder G with the compressed air after passing through the high-pressure cylinder A, considerable heat, including that which is latent, is withdrawn therefrom by the sudden expansion of the air, which assists materially in maintaining the desired temperature and preventing too great a degree of cold.

It will of course be understood that due consideration must be had to the proper relative capacities of the two cylinders C and J to render the plan herein described practicable and useful. With an engine or motor constructed substantially as shown in the drawings, very good results may be obtained, the loss of power in the compression of the air in cylinder J being, under the circumstances, comparatively slight and due mainly to friction.

We do not limit or confine ourselves to the special devices herein shown, nor to the special manner of combining and operating the motive devices and the means for compressing the air to impart warmth to such devices; but

What we claim is—

1. The method of preventing the effects due to expansion of the air in compressed-air engines, which consists in compressing air in a suitable device by the compressed air supplied to the engine and conducting the air thus compressed around or in proximity to such parts of the engine as it may be necessary to warm.

2. The method of preventing the effects of cold due to expansion of the air in compressed-air engines, herein set forth, which consists in compressing air in a suitable device by the compressed air supplied to the engine, conducting the air thus compressed around or in proximity to such parts of the engine as it may be necessary to warm, and then uniting such compressed air with the main supply, as described.

3. The combination, with an engine or motor operated by compressed air, of an air-compressor operated by the same, and a passage of communication between the cylinder or chamber of the said compressor and the main pipe by which compressed air is supplied to the engine, as and for the purpose set forth.

4. The combination, with an engine or motor adapted to be operated by air supplied

under pressure thereto, of an air-compressor operated by the compressed air supplied to the engine, and passages for conducting the air compressed thereby around or near to those parts of the engine which it is necessary to warm, as set forth.

5. The combination, with an engine or motor adapted to be operated by air supplied under pressure thereto, of an air-compressor operated by the compressed air supplied to the engine, and a passage conducting the air from said compressor to the main supply-pipe, said passage being around or in proximity to those parts of the engine which it is necessary to warm, as set forth.

6. The combination, with a compressed-air engine, of a compression cylinder or chamber in which the air is compressed by the operation of the engine, and a valve-controlled passage for conducting the compressed air around or near to such parts of the engine as it may be necessary to warm, as set forth.

7. In a compressed-air engine, the combination, with a cylinder and piston, of valve-ports at one end controlling the admission and exhaust of the air, a valve-controlled opening at the other end, and a valve-controlled passage therefrom back to the main air-supply passing around or near such parts of the engine as it may be necessary to warm.

8. The combination of a compressed-air engine, an air-compressor operated thereby, means for introducing a spray into the compressor-cylinder, and a passage from the said cylinder back to the main supply-pipe, said passage being around or near to the parts of the engine to be warmed, as set forth.

9. The combination, with a piston of a compressed-air engine, of a compression-chamber beneath said piston, a valve-controlled port opening to the atmosphere, and a valve-controlled passage leading back to the main supply-pipe and around or in proximity to the parts of the engine to be warmed, as set forth.

10. The combination, with a compressed-air engine, of a compression cylinder or chamber in which air is compressed by the operation of the engine, a passage of communication from said cylinder or chamber to the main supply of compressed air, and a device for introducing water into said chamber, as herein set forth.

11. The combination, with an air engine or motor, of an air-compressor operated thereby, a device for introducing a spray into the compressor to be converted into steam by the heat developed by the compression, and a valve-controlled passage from said compressor back to the main air-supply, as set forth.

In testimony whereof we have hereunto subscribed our names this 20th day of August, A. D. 1889.

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Witnesses:
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