No. 868,560. PATENTED OCT. 15, 1907.

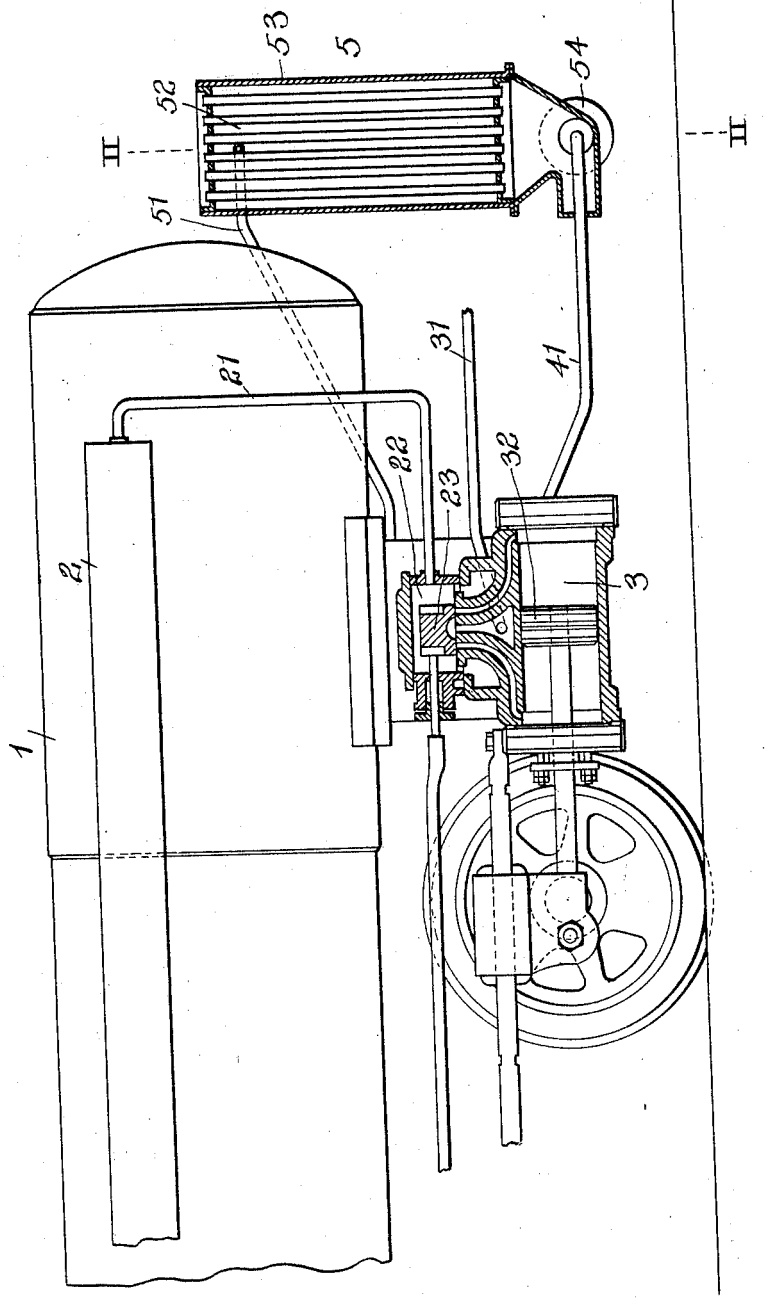
C. B. HODGES.

INTERHEATER FOR COMPOUND COMPRESSED AIR ENGINES.

APPLICATION FILED OCT. 10, 1904.

2 SHEETS—SHEET 1.

FIG. 1.



WITNESSES:
Herbert Bradley.
Fred Kirchner.

Charles B. Hodges INVENTOR
by Christy and Christy
Atty's.

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2 SHEETS—SHEET 2.

FIG. 2.

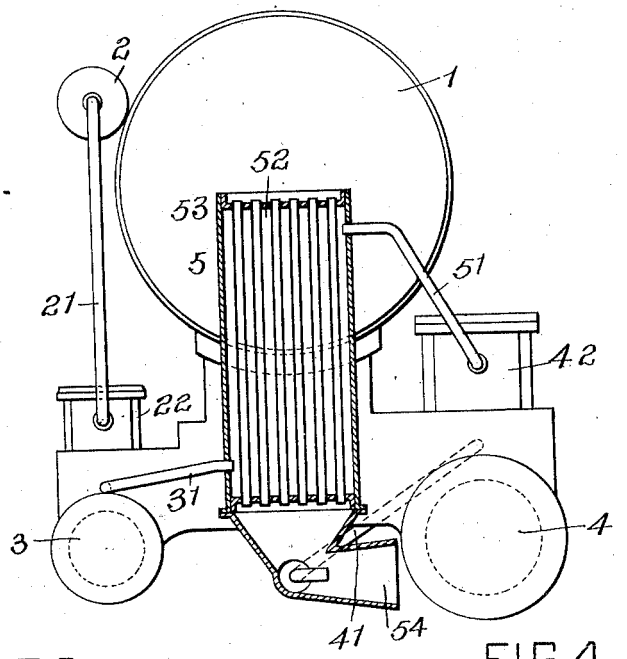


FIG. 3.

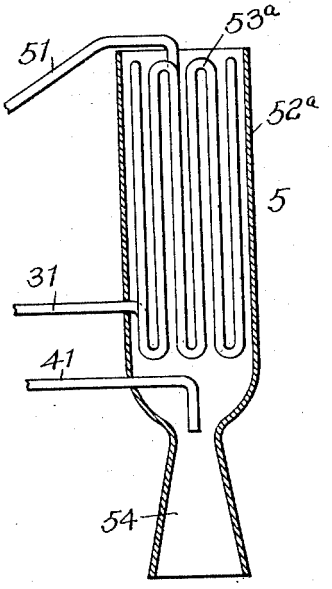
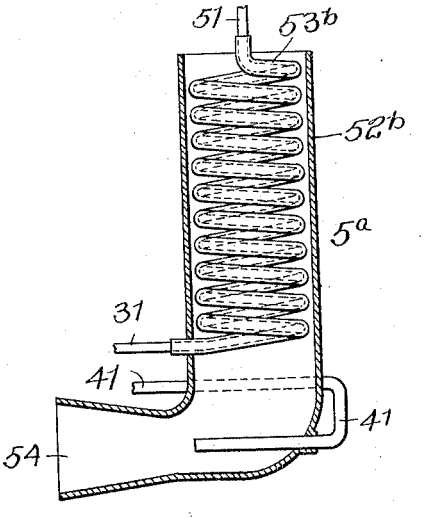


FIG. 4.



WITNESSES:
Herbert Bradley.
Fred Kirchner.

INVENTOR
Charles B. Hodges
by Christy and Christy,
Atty's

UNITED STATES PATENT OFFICE.

CHARLES BOWEN HODGES, OF PITTSBURG, PENNSYLVANIA.

INTERHEATER FOR COMPOUND COMPRESSED-AIR ENGINES.

No. 868,560. Specification of Letters Patent. Patented Oct. 15, 1907.

Application filed October 10, 1904. Serial No. 227,862.

To all whom it may concern:

Be it known that I, CHARLES BOWEN HODGES, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, a citizen of the United States, have invented or discovered a certain new and useful Improvement in Interheaters for Compound Compressed-Air Engines, of which improvement the following is a specification.

My invention concerns interheaters for compound compressed-air engines, and the object of my improvements is an interheater designed and adapted to take heat from the atmosphere in such quantities as to be efficient in service.

In the accompanying drawings which form part of this specification, Figure 1 shows diagrammatically and in longitudinal elevation a compound compressed-air locomotive engine to which my improvement is applied. In this figure the valve-chest and cylinder, at one side of the locomotive and the interheater are shown partly in section. Fig. 2 is a transverse vertical section on the line II—II, Fig. 1. Fig. 3 is a vertical sectional view showing my interheater in detail, and illustrating a modification of the form shown in Figs. 1 and 2. Fig. 4 is a view similar to Fig. 3, illustrating a further modification. Parts which are repeated in the several figures bear the same reference numerals in each case.

In the drawings, 1 represents the main storage tank of a compressed-air locomotive, arranged after the manner of and resembling in shape the boiler of a steam locomotive; 2 is the auxiliary reservoir; 3 is the high-pressure cylinder; and 4 the low-pressure cylinder; 5 is the interheater.

From the auxiliary reservoir, 2, a pipe, 21, leads to the high-pressure valve-chest, 22, whence it passes on the appropriate shifting of the valve, 23, to high-pressure cylinder, 3, and drives the piston, 32, therein. Upon the appropriate movement of valve 23, the air (having done its work in cylinder 3) passes from cylinder 3 through a pipe 31 to interheater 5. From interheater 5 the air passes through a pipe, 51, to valve-chest, 42, of low-pressure cylinder 4. The appropriate movement of the valve in valve-chest 42 admits the air into the low-pressure cylinder, where it performs its work in driving the piston contained therein, and whence it escapes on the further shifting of the valve and passes into an exhaust pipe, 41, through which it escapes to the atmosphere. I preferably carry the air through pipe 41 to interheater 5, where it performs the office which I shall presently describe.

The interheater consists in general terms of a receptacle for the compressed air as it passes from the high-pressure cylinder, and before it enters the low-pressure cylinder, such receptacle having a surface of relatively great extent, for the purpose of receiving and imparting to the compressed air contained within it, the heating effect of the atmosphere. It will be understood that this receptacle may be of any suitable or desired construction, and so arranged in relation to the engine that a movement of atmospheric air along its surface will be caused by or during the operation of the engine. I have found it preferable to make this receptacle cylindrical in form, and to furnish it with a plurality of longitudinally extending tubes through which atmospheric air is caused to pass. This is illustrated in Figs. 1 and 2 of the drawings, wherein the receptacle itself is indicated at 53, and the tubular flues for the atmospheric air are indicated at 52. This receptacle being so disposed and arranged that atmospheric air is caused to flow over the surface, and thus to impart a substantial amount of heat to the chilled air contained within it, various means may be employed for causing this flow of atmospheric air over the surface. The drawings show the invention applied to a locomotive engine, and while any desired construction and arrangement of atmospheric heating receptacle may be employed, it is preferred to employ the exhaust from the low-pressure cylinder to produce the draft of air over the heating surface of the receptacle. In Figs. 1 and 2 I have shown a flared orifice, 54, into which the flues 52 open. Into this I conduct, through pipe 41, the exhaust from the low-pressure cylinder, and by causing this exhaust to be projected into the flared orifice 54, I produce the desired draft of atmospheric air through the flues 52 and over the heating surfaces of the receptacle 53.

An alternative construction is shown in Fig. 3, where, in place of a cylindrical receptacle provided with longitudinal flues, the receptacle consists of a coil of pipe, 53^a, arranged within a casing, 52^a, and the draft is caused to flow through this casing. As before, I employ the flared orifice 54, which in this case forms a continuation of the casing 52^a.

In Fig. 4 a further modification is illustrated; the receptacle consists of a fluid-enveloped coil of pipe, 53^b, contained within a casing, 52^b, and so arranged that a current of atmospheric air may be caused to pass through the casing and over the extended surface of the coil. As in Fig. 3, the casing 52^b is continued in a flared orifice, 54, into which the exhaust from the low-pressure cylinder is directed for the purpose of causing a flow of air. The object of the fluid envelop is to equalize the heating effected. It will be understood that, as the engine starts and stops and changes its speed, the amount of cold air flowing from the high-pressure cylinder to be regenerated in the interheater will vary, and accordingly the amount of heat absorbed in the interheater will vary in quantity. By providing a liquid envelop for the receptacle I am able to store the heat of the atmosphere in this liquid envelop, and hold it that it may be available when there is an increase in the flow of cold compressed air. In this case I not only take advantage

of the equalizing influence of the liquid envelop, but at the same time I take advantage of the actual heating power of the liquid itself, and this is a matter of considerable moment. While the relative volumes of the liquid which forms the envelop and of the air which passes within the receptacle are very unequal, the number of heat units in a given volume of liquid is immensely greater than in an equal volume of air.

As a certain volume of water contains more heat units than an equal volume of air at the same temperature, by increasing the volume of the liquid envelop, it will not only transmit the heat received from the atmosphere to the compressed air, but will also impart some of its heat to the compressed air, and in this way the heating action of the air is supplemented. If for example the liquid envelop contains 500 lbs. of water at the beginning of a run and the engine moves up a grade using large volumes of compressed air, the latter in its flow to the low pressure cylinder will not only absorb heat units from the air but also serve to take heat units from the envelop reducing the temperature of the envelop. When the engine moves down grade, there will be opportunity for at least a partial restoration to the envelop of normal temperature. In other words this envelop which will not have a temperature above normal atmospheric temperature, acts as a fly wheel to maintain approximately uniform conditions. This liquid envelop may be constructed in any desired manner; as it is illustrated in Fig. 4, it surrounds a coil of pipe in a familiar form of water-jacket.

The flared orifice 54 of the interheater is shown in the several figures of the drawing as directed in several different directions. The direction in which it is pointed is immaterial to my invention, although practical conditions will determine the direction in specific cases.

In describing the construction of my improved apparatus, I have made plain its operation. When the air passes from the high-pressure cylinder of a compound engine, it is greatly reduced in temperature, and since the volume of a body of gas and the pressure which it exerts are dependent upon its temperature, this very low temperature which the air flowing from the high-pressure cylinder possesses, reduces its expansive power, and makes it accordingly less efficient for further work. The interheater serves the purpose of regenerating this air in this sense, that it restores heat to it; and, in so doing, increases its expansive power and makes it more efficient for work in the low-pressure cylinder. In my apparatus the cold compressed air as it passes from the high-pressure cylinder is, in the interheater, subjected to a heating influence, which causes a rise in the temperature, and increases its efficiency; and, since the source of the increase in temperature is the heat of the atmosphere itself, my device besides being simple is economic, and demands little or no attention.

In the drawings I have shown my invention applied to a locomotive engine, because that is the application in which I have found practical operation. I do not, however, limit myself thereto; and it will be understood that the invention is applicable generally to compound compressed-air engines.

I claim herein as my invention.

1. In a compound compressed-air engine in combination with the high-pressure and low-pressure cylinders and their inlets and exhausts, of a receptacle for compressed air connected with the exhaust from the high-pressure cylinder and with the inlet to the low-pressure cylinder, and means for causing a current of air to flow over the surface of the said receptacle operative on the exhaust of air from the low-pressure cylinder, substantially as described.

2. In a compound compressed-air engine, in combination with the high-pressure and low-pressure cylinders and their inlets and exhausts, of a receptacle for compressed air connected with the exhaust from the high-pressure cylinder and with the inlet to the low-pressure cylinder, and a passage for atmospheric air through said receptacle, the exhaust from the low-pressure cylinder being so arranged at the discharge end of said air passage as to draw atmospheric air therethrough, substantially as described.

3. In a compound compressed air engine in combination with the high-pressure and low-pressure cylinders and their inlets and exhausts, of a receptacle for compressed air connected with the exhaust from the high-pressure cylinder and with the inlet to the low-pressure cylinder, passages for atmospheric air through said receptacles, the exhaust from said low-pressure cylinder being arranged to cause a flow of atmospheric air at normal temperature through the passages, substantially as described.

4. In a compound compressed-air engine, the combination with the high-pressure and low-pressure cylinders and their inlets and exhausts, of a casing arranged to permit the passage of a current of atmospheric air therethrough and provided with a flaring outlet, a receptacle for compressed air arranged within said casing and connected with the exhaust from the high-pressure cylinder and with the inlet to the low-pressure cylinder, the exhaust from the low-pressure cylinder being arranged to discharge into the flaring outlet of said casing, substantially as described.

5. An interheater for a compound compressed-air engine which consists of a receptacle receiving air from the high-pressure cylinder and delivering air to the low-pressure cylinder, said receptacle being provided with a surrounding fluid envelop, such fluid-enveloped surface being of relatively great extent and arranged and adapted to absorb heat from the atmosphere, substantially as described.

In testimony whereof, I have hereunto set my hand.

CHARLES BOWEN HODGES.

Witnesses:

ALICE A. TRILL,

BAYARD H. CHRISTY.