R. SEILLIÉRE & L. M. T. RIOT.

Application of Superheated Steam to Steam-Engines.

No. 202,591. Patented April 16, 1878.

Fig: 1.

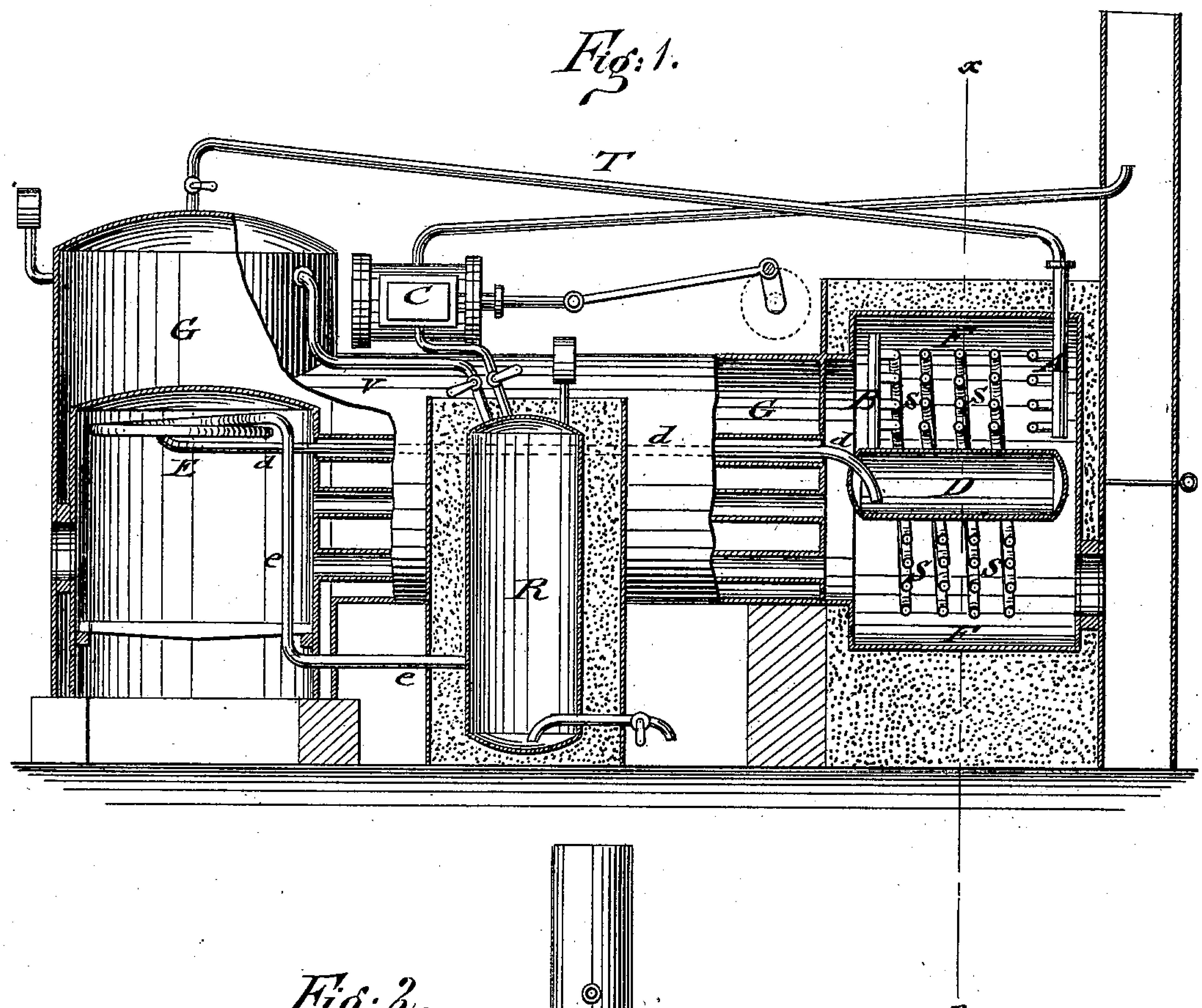
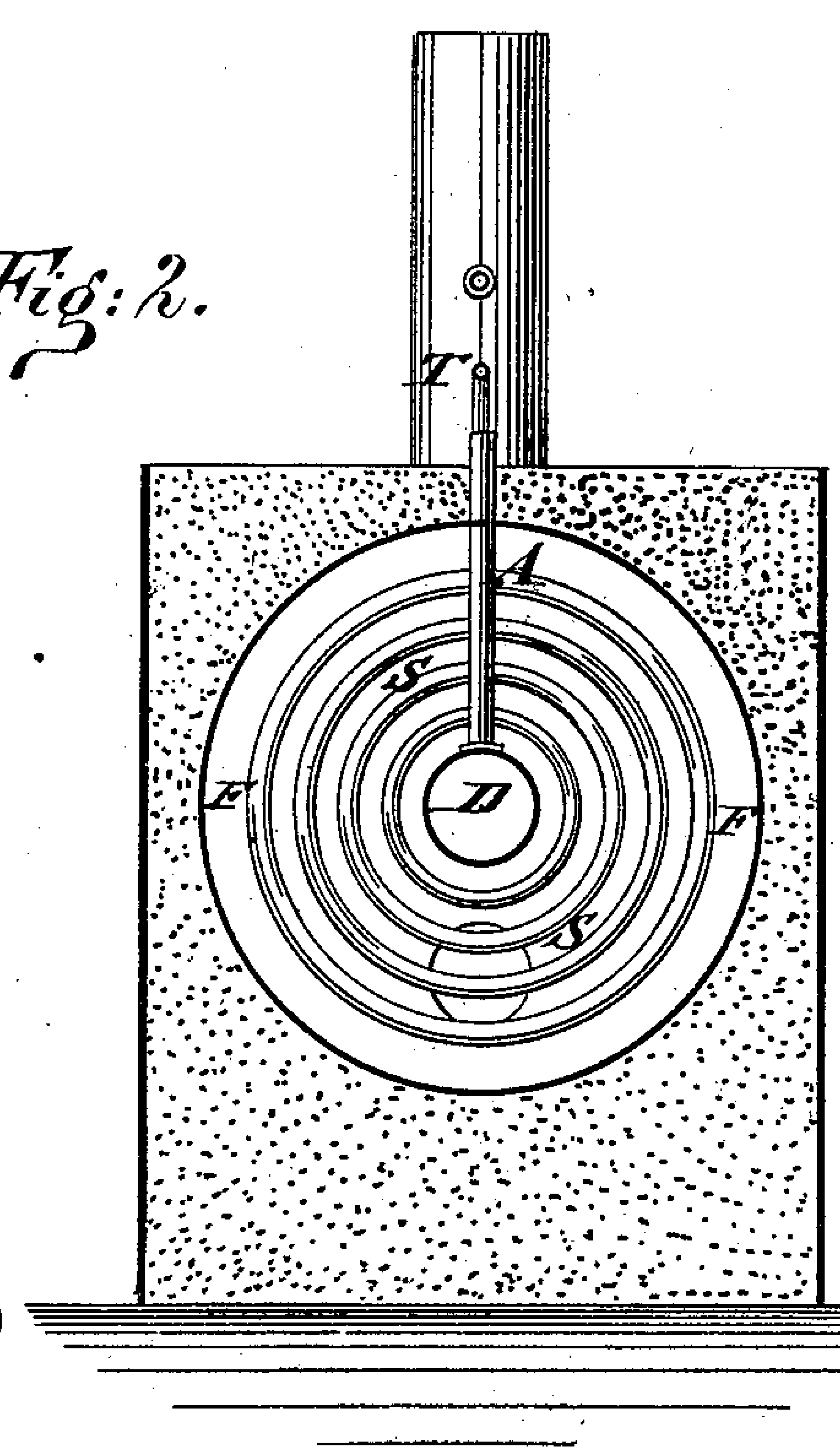


Fig: 2.



WITNESSES:

Chas. Nida

C. Sedgwick

INVENTOR:

R. Seilliere

L. M. T. Riot

BY Munn & Co

ATTORNEYS.

UNITED STATES PATENT OFFICE.

RAYMOND SEILLIÈRE AND LOUIS M. T. RIOT, OF PARIS, FRANCE.

IMPROVEMENT IN APPLICATION OF SUPERHEATED STEAM TO STEAM-ENGINES.

Specification forming part of Letters Patent No. **202,591**, dated April 16, 1878; application filed February 7, 1878.

To all whom it may concern:

Be it known that we, RAYMOND SEILLIÈRE and LOUIS M. T. RIOT, of Paris, France, have invented a new and Improved Application of Superheated Steam to Steam-Engines, of which the following is a specification:

Most of the steam-engines at present employed use saturated steam, although many attempts have been made and apparatus devised to substitute superheated steam for saturated steam as the dynamic agent, with a view to the more perfect utilization of the fuel. The theory of the mechanical equivalent of heat, first established by Jule in 1843, and since then developed by others, proves that one kilogram of saturated steam, having a tension of six atmospheres, for example, contains six hundred and fifty-five units of heat, and that one kilogram of saturated steam at the atmospheric pressure contains six hundred and thirty-seven units. It is also proved that one kilogram of superheated steam at the same tension of six atmospheres, and having a temperature of 300° centigrade, contains seven hundred and twenty-five units of heat. Thus, if one kilogram of saturated steam at six atmospheres be introduced into a cylinder, and if, by means of a suitable expansion mechanism, it be exhausted at the atmospheric tension, the difference between six hundred and fifty-five and six hundred and thirty-seven units—viz., eighteen units—will have been utilized by the engine. If, on the other hand, one kilogram of superheated steam at 300° centigrade be admitted to a cylinder at a pressure of six atmospheres, and if, by a judicious expansion, it be exhausted at the same tension as in the former case, the difference between seven hundred and twenty-five and six hundred and thirty-seven units, or eighty-eight units, will have been utilized by the engine.

Admitting that without any additional expenditure of fuel this kilogram of steam may be superheated to 300° centigrade, which can be readily effected by utilizing the waste heat of the gases of combustion passing off through the chimney, a profit should be realized equal to the difference between eighteen and eighty-eight units. This theoretical result is, however, far from being easy to attain in practice, and the many attempts which have been made to employ superheated steam have failed to give the looked-for results, owing to the phenomena not having been sufficiently studied. Thus, it has been hitherto assumed as a general principle in physics that there is an equality of temperature between steam and its origin, so long as these two remain in contact or in communication, and hence it has been concluded that, in order to superheat steam, it must be isolated or separated from its origin, and all arrangements hitherto devised have been based on these data.

After a lengthened investigation of the subject, we have discovered that the principle in physics above cited is only true so long as the channel of communication between the steam and its source is of sufficient size to allow of an equilibrium of temperature being established, and we have proved experimentally that, contrary to the above principle, steam may be superheated during its passage from the generator to the engine by reducing the area of the outlet from the boiler and augmenting the size of the superheater to the utmost extent possible. By this means we obtain superheated steam having the same tension as the steam in the generator, since it is in communication therewith, but having a higher temperature, notwithstanding. This superheated steam may be compared to steam superheated in a closed receptacle to the same temperature and tension, as it possesses the same density, the same elastic power, and the same temperature in the one case as in the other. We are therefore in exact conformity with the conditions laid down in our theoretical introduction.

We will now proceed to describe the practical means which characterize our invention, and by the aid of which we are enabled to realize the advantages which we have shown, theoretically, are gained.

In the accompanying drawing, Figure 1 represents a vertical longitudinal section of a steam-engine with improved superheating attachment, and Fig. 2 is a vertical transverse section of the same on line x x, Fig. 1.

Similar letters of reference indicate corresponding parts.

The drawing shows, as an example, one means of realizing our invention practically, viz., an ordinary arrangement of portable engine, such as represented in Fig. 1, and, without otherwise altering it, we interpose the superheating apparatus of our invention between the generator G and cylinder C.

This superheating apparatus is, without the interposition of any valves, in constant communication with the generator G by a pipe, T, leading from the steam-dome to a distributing-pipe, A, connected with a suitable number of independent concentric helical coils, S, in the smoke-box F, (see transverse section, Fig. 2,) and connected at their other ends with a collecting-tube, B, in communication with a central chamber, D. The latter communicates with another coil, E, beneath the crown of the fire-box, by means of a pipe, *d*, passing through one of the boiler-tubes, which is plugged to prevent the passage of the flames. The coil E also communicates by a pipe, *e*, with a chamber, R, forming a reservoir of superheated steam, from which the cylinder C is supplied.

From this description it will be seen that the superheating apparatus of our invention commences at the distributing-pipe A and terminates at pipe *e*, and is consequently not only subject to the action of the fire-gases in the smoke-box F, but also to the heat radiating from the furnace itself. By this means the steam may be superheated to a very high degree of temperature; and herein lies the difference between our plan and the plans of others, who have not deemed it proper to exceed the temperatures which the adjuncts of the engine—such as the stuffing-box, packings, and lubricants—are capable of supporting without being destroyed, or which would cause those parts of the engine to be subject to friction so as to stick. We obviate this difficulty by a judicious employment of expansion, based upon a phenomenon we will now explain.

As the expansion of steam causes a diminution of temperature, if this expansion be continued beyond the usual limits—for example, in the case of a non-conducting engine, to seven or eight times its value for superheated steam having a tension of six atmospheres—we cause the condensation of a certain quantity of water upon the sides of the cylinder, which, being heated by the contact of the superheated steam at the moment of admission, immediately vaporizes the water of condensation. The cylinder thus becomes a kind of generator from the moment the steam is cut off until it is exhausted and the surfaces cool sufficiently to insure proper working. It is in consequence of this that we are enabled to take saturated steam from generator G at a tension of six atmospheres, for example, or at a temperature of 155° centigrade, cause it to circulate first through the series of coils S, where it is raised to a temperature of 300° centigrade, and then through coil E, where it is raised to a temperature of 450° centigrade (except in cases where the latter coil cannot be made use of,) the steam retaining throughout a tension of six atmospheres, and being admitted at this temperature into the working-cylinder C, where it is expanded during six-sevenths or seven-eighths of the stroke.

By thus raising the temperature of the superheated steam, its use becomes still more advantageous, and in practice a very large saving of fuel is obtainable by the application of our invention to existing engines. These high temperatures can only be employed in practice by using metals capable of resisting them. For temperatures ranging from 300° centigrade to 400° centigrade, iron may be used, preferably galvanized or coated with zinc, to prevent oxidation and to fill up all cracks which might occasion leakage; but iron, if raised to a red heat, decomposes the steam by combining with its oxygen, and, becoming oxidized, leaving free hydrogen mixed with the steam. This mixture, on the one hand, impedes the phenomenon of condensation by expansion in the cylinder, while, on the other hand, the oxidation is destructive to the metal.

Copper does not oxidize by the contact of the steam; but it is very quickly damaged by the gases and flame of the furnace. We have found that brass resists the above causes of deterioration, especially if coated with zinc, and the use of this metal in the construction of the different parts of the superheating apparatus constitutes a novel application.

It now remains to set forth the great advantages resulting from our improved arrangement of superheater. The coils of pipes S and E, of which the apparatus is composed, must be of very small diameter—two centimeters, for example—in order that the heat of the medium in which they are placed may be transmitted to the whole body of steam to be superheated, as steam is a very bad conductor of heat. We have found that when the superheater is constructed of a single length of pipe, as hitherto, there is a considerable loss of power from the friction of the steam circulating in the pipe. This loss has been found by experiment to amount to at least one atmosphere for every hundred inches in length—that is to say, steam at six atmospheres on leaving the boiler will have a pressure of but five atmospheres on leaving the superheater. This loss is almost entirely prevented by our improvement, which consists in dividing the superheater into a number of tubes—say five—S, in the form of helical coils, which, as each is twenty meters in length, makes up a total length of one hundred meters, whereby four-fifths of the friction is avoided, and the sectional area of the circulating-pipes five times increased. Such form of superheater may be replaced by a rectilinear tubular apparatus, like that in the boiler shown, steam being inside or outside of tubes.

In order to still further maintain the normal tension of the superheated steam, we store it in a reservoir, R, from which but a relatively small quantity is supplied to the cylinder at each stroke of the piston, the result of which is that a regular and constant circulation of the steam in the superheater is insured.

By admitting the superheated steam directly into the cylinder, as heretofore, without using a reservoir, R, we have found that, by placing a gage on the valve-chest, the pressure of the steam may fall as low as one and one-half atmosphere, instead of remaining at the normal pressure of six atmospheres. The reservoir R also enables a mixture of saturated steam and superheated steam to be used by placing it in direct communication with the dome of the boiler G by a pipe, *v*, furnished with a cock, which is opened, for example, in cases where the degree of expansion adopted for working with highly superheated steam is found insufficient, or when it is necessary to obtain more power for starting the engine.

This mixture furnishing steam less highly superheated, the expansion may be less, and greater power consequently obtained, since the pressure of steam, on its admission to the cylinder, is always the same. The direct communication between the dome of the boiler and the reservoir R is also of service when the engine is at rest, as, owing to the difference between the distances to be traversed, the steam from the boiler establishes a current in the opposite direction through the superheater, which prevents overheating.

The practical results of the improvements herein described are, first, to effect a large saving in fuel; and, secondly, as a consequence of such economy, to allow of a reduction in the size of boilers and engines. For example, a four-horse power engine may, with our system of superheating, be made to develop twelve-horse power, and from this may be readily imagined the advantages which would result, particularly in the case of marine-engines, where space is always so very limited.

It will be understood that the arrangement of the various parts constituting the superheater may vary according to the kind of boiler to which it is applied. The superheating-chamber F and reservoir R of superheated steam should always be embedded in sand or other non-conductor, to prevent loss of heat.

To prevent damage to the stuffing-boxes, packings of the piston, and valve-rods, we place at the bottom of these stuffing-boxes, first, a packing made of a mixture of talc, asbestus, and plumbago, over which is placed the ordinary packing of greased hemp, so that the latter packing, being isolated by the lower packing, produces no transmission of heat, being protected against the heat of the superheated steam.

Having thus described our invention, we claim as new and desire to secure by Letters Patent—

1. The combination, with the working-cylinder C, of the steam-generator G and superheating-coils S E, as and for the purpose described.

2. The combination, with the working cylinder C, the superheating-coils S E, and the steam-generator G, of the reservoir R for superheated steam, arranged substantially as and for the purpose specified.

3. The combination, with a steam-generator and cylinder, of a superheating attachment formed of a number of small tubes placed in the smoke-box, of a secondary superheating-coil in the fire-box, and of a storage-reservoir, substantially as and for the purpose set forth.

RAYMOND SEILLIÈRE.
LOUIS MARIE THÉOPHILE RIOT.

Witnesses:
CTE DELAMARRE,
J. MATHIEU.