(No Model.) 2 Sheets—Sheet 1.

W. SCHMIDT.

APPARATUS FOR REGULATING SUPERHEATED STEAM.

No. 604,547. Patented May 24, 1898.

Fig. 1.

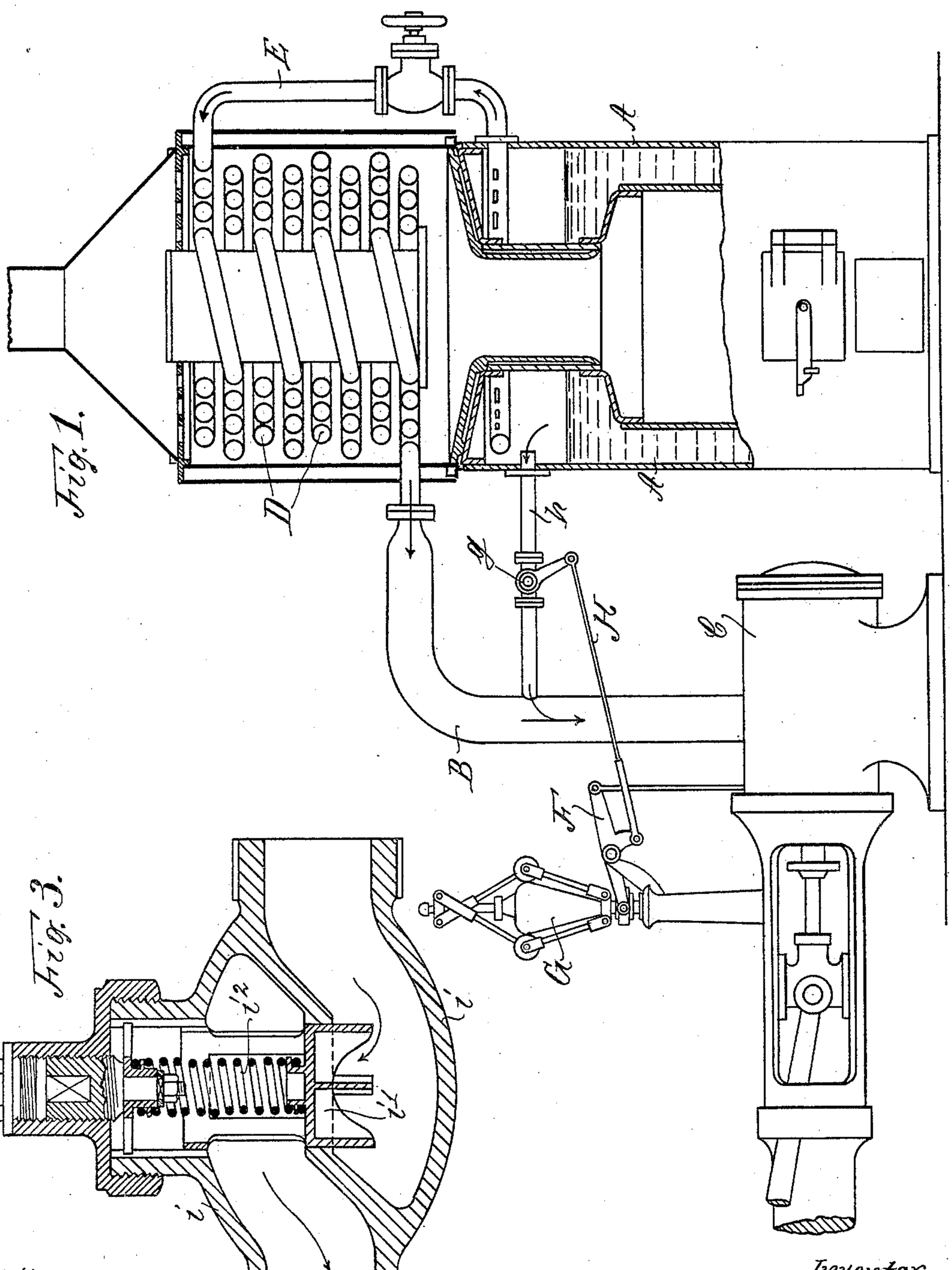

Fig. 2.

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(No Model.) 2 Sheets—Sheet 2.

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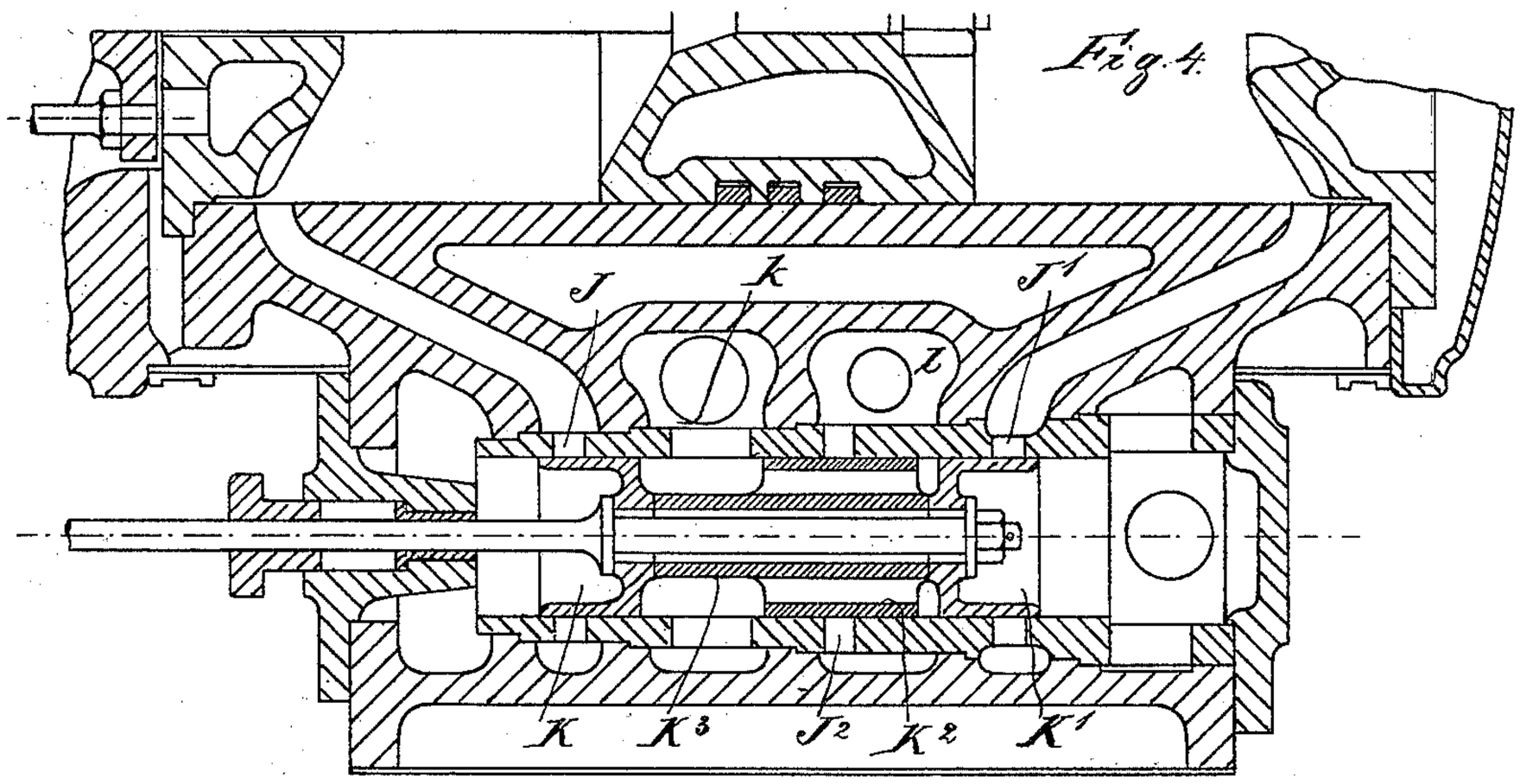
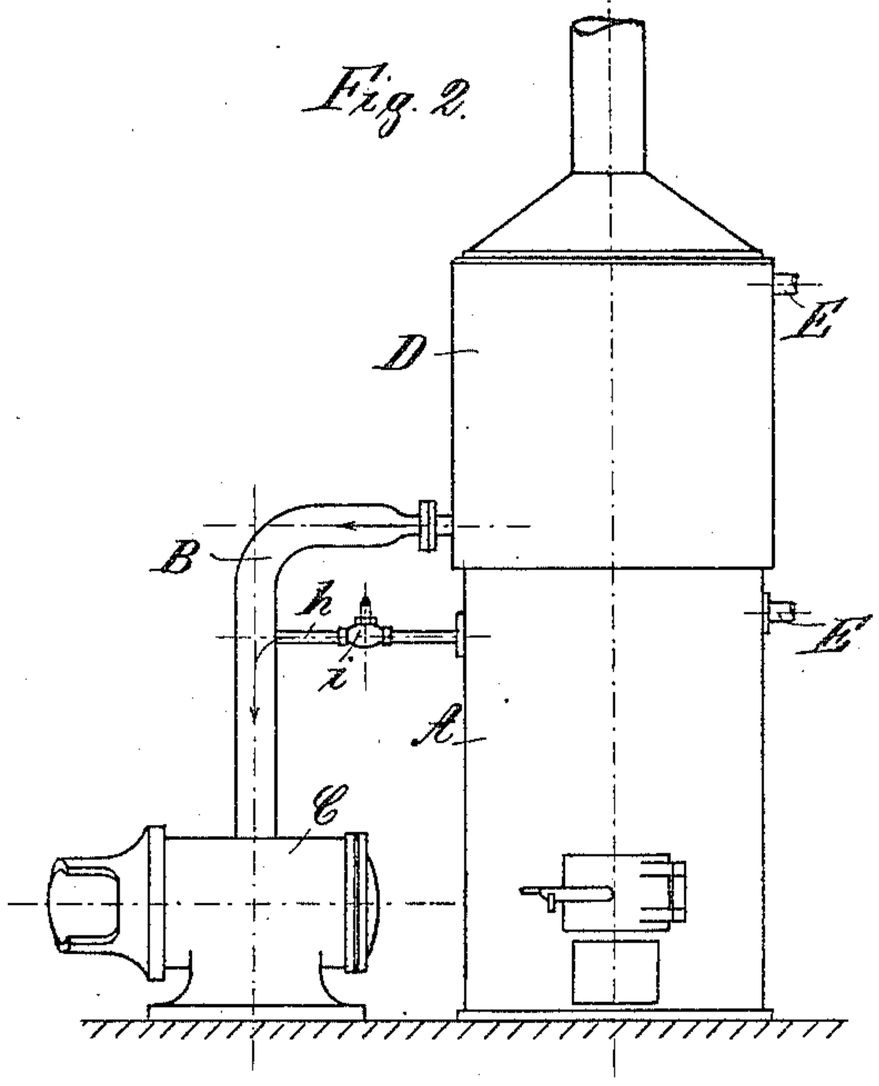


Fig. 4.

Fig. 2.



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UNITED STATES PATENT OFFICE.

WILHELM SCHMIDT, OF BALLENSTEDT, GERMANY.

APPARATUS FOR REGULATING SUPERHEATED STEAM.

SPECIFICATION forming part of Letters Patent No. 604,547, dated May 24, 1898.

Application filed July 17, 1896. Serial No. 599,549. (No model.) Patented in Switzerland June 3, 1896, No. 12,584; in France June 22, 1896, No. 257,458; in Belgium July 2, 1896, No. 122,307; in Italy July 6, 1896, LXXXII, 324; in Hungary July 8, 1896, No. 7,415, and in Canada November 27, 1896, No. 54,185.

To all whom it may concern:

Be it known that I, WILHELM SCHMIDT, a subject of the King of Prussia, German Emperor, and a resident of Ballenstedt-on-the-Harz, in the Duchy of Anhalt, German Empire, have invented an Improved Apparatus for Regulating Superheated Steam, (for which patents have been obtained in Switzerland, No. 12,584, dated June 3, 1896; in France, No. 257,458, dated June 22, 1896; in Belgium, No. 122,307, dated July 2, 1896; in Italy, No. 324, Vol. LXXXII, dated July 6, 1896; in Hungary, No. 7,415, dated July 8, 1896, and in Canada, No. 54,185, dated November 27, 1896,) of which the following is an exact specification.

This invention refers in general to steam-power plants the engine or engines of which are driven by superheated steam, and in particular to providing such plants or engines with a device for regulating the temperature of the superheated steam, said regulating device being adjustable according to the degree of filling of the cylinder of the engine, or, in other words, the adjustment of said device being dependent on the degree of filling or on that part of the plant or engine by which the degree of filling of the cylinder is determined. The purpose of this arrangement consists in general in regulating the temperature of the superheated steam, especially the inlet temperature of the same, according to the degree of filling of the engine, and in particular in obtaining by said regulation a practically perfect exhaustion of the energy of the superheated steam in such a manner that, first, the greatest part of the work of steam that can be rendered at a stroke of the piston is rendered by dry steam, whereas the rest of the work is rendered by expanding saturated steam, and, second, the steam remains dry at least during the first half of the stroke.

A practically perfect exhaustion of the theoretical energy of the steam in double-acting engines is, as is known, with any of the ordinary modes of employment of the steam not attained, and it is further known that the ground of this imperfect exhaustion resides in the loss of heat caused by the condensation of steam within the cylinder. The means for reducing such loss (furnishing the cylinders with steam-jackets, using the steam three or four times in engines with three or four cylinders, and heating the receivers even up to a slight superheating of the receiver-steam) have practically come to a limit already.

The present invention now affords a means of going far beyond that limit of the exhaustion of steam within double-acting engines, said means consisting, as already mentioned, in combining the steam-power plant of the engine or engines of the same with a device for making the inlet temperature of superheated steam dependent on the degree of filling of the cylinder of the engine.

In view of the object of the invention, as aforestated, the regulating device should be able to act in such a manner that on a decrease of the degree of filling an increase of the inlet temperature takes place, or, reversely, in either case, in such a way that that part of the stroke on which the expanding steam remains dry may be of a uniform length in spite of changes in the degree of filling of the respective cylinder. If the regulation of the temperature of the superheated steam is effected in the manner afore explained, then the expansion of the steam is accompanied by only a very slight condensation of the latter, because the saturated steam arising on the piston traveling through the second half of its path is strongly heated by those parts of the cylinder that had been heated by the superheated steam during the time in which the piston performed the first half of its stroke. In fact, no more than four per cent. of the steam gets condensed, and the small quantity of water of condensation resulting from said four per cent. of steam is, with regard to the whole work rendered by the steam during a stroke of the piston, of so little importance that said quantity of water of condensation may be practically perfectly neglected. Therefore by providing the steam-power plant with a regulating device of the kind mentioned there is afforded a possibility of a practically full exhaustion of the theoretical energy of the steam.

Another advantage resulting from the ar-

rangement of the regulating device in question or from effecting the regulation according to the principle of the present invention consists in the contact-surfaces of the cylinder and the piston being perfectly secured against any injurious effect of the superheated steam even if this latter be superheated up to the highest attainable degree. This advantage, which is far from being insignificant, is a consequence of the great fall of temperature resulting from the manner of regulation in question. This fall of temperature is considerably greater than can be attained with the use of saturated steam of the same tension, and in spite of the use of highly-superheated steam that part of the cylinder which the packing-rings of the piston pass through assumes a medium temperature of such a degree that this part as well as the packing-rings are perfectly secured against any deleterious influence of the heat of the steam. This is the case in the highest attainable degree, especially if the piston receives a greater length than has been customary up to now and if the length of the cylinder, too, is correspondingly increased. I have found it advantageous to let the piston have a length of at least thirty per cent. of the length of the way which the piston is traveling through; but this minimum of length should be employed only if a piston and cylinder of a greater length cannot be used for want of space or if one is satisfied with the expanding superheated steam remaining dry only for forty per cent. of the whole length of the way of the piston. If, namely, this steam is to remain dry considerably beyond the middle of the stroke, then the inlet temperature must be greatly increased. The employment of the superheated steam is made unnecessarily difficult and a corresponding increase (corresponding to the higher inlet temperature) in the exhaustion of the energy of the steam is not obtained. If, on the other hand, the regulation is effected in such a way that the superheated steam turns into saturated steam already considerably before the piston has finished the first half of its stroke, then the exhaustion of the energy of the steam is greatly reduced, because the proportionately greatest condensation of the steam occurs during the first half of the stroke. Therefore the device for regulating the temperature of the steam must (with regard to the degree of filling of the cylinder with that steam) be able to be adjusted in such a manner that the steam does not remain dry considerably beyond the middle of the piston-way and does not get saturated considerably before said middle, and, further, the cylinder (after the degree of filling by which the adjustment in question is effected) should have such a length that the packing-rings of the correspondingly longer piston move mainly in that zone of the cylinder in which the steam has got saturated already.

In the preceding paragraphs it had been mentioned already that the regulating device for the temperature of the steam could be combined either with the boiler of the steam-power plant or with the engine of the same. In the first of these cases the regulation (according to the degree of filling) would thus be effected directly in the generator for the superheated steam, whereas in the other case the regulation is effected by removing from the superheated steam the respective excess of heat before the steam enters the cylinder of the engine. Of course this removal of heat will in any case be effected in the useful way—for instance, by transmitting the excess of heat to steam having a temperature lower than that requisite with regard to the degree of filling of the cylinder. Generally this steam will be saturated steam, and the regulation of the inlet temperature may thus be effected by mixing the too-highly-superheated steam with as much saturated steam as is necessary for bringing about such a course of work of the steam within the cylinder as corresponds to the principle of the present invention. This admixture of saturated steam to the superheated steam or the corresponding adjustment of the respective valve may well be effected in an automatic manner. There may be employed, for instance, an automatic valve the movements of which are dependent on the tension of the steam present within or flowing into the cylinder, or the valve may be actuated compulsorily by connecting it to the governor or to the steam-distributing device of the engine, or the steam-distributing valve itself may be so constructed as to be able to work according to the idea of invention. Finally, the useful removal of the excess of heat may be effected not solely by steam of a lower temperature, but also by water—for instance, by feed-water—which then is preliminarily heated by the said excess of heat.

In order to make my invention more clear, I refer to the accompanying drawings, in which similar letters denote similar parts throughout the different views and in which—

Figure 1 shows a vertical section through a generator for superheated steam, together with some parts of an engine intended to be driven by such steam and together with the mechanisms for regulating the inlet temperature of the superheated steam according to the principle of the present invention. Fig. 2 is an outer view of the steam-generator shown in Fig. 1, the mechanism for effecting the said regulation being, however, another one. Fig. 3 is a vertical longitudinal section through the valve *i* of Fig. 2 and being drawn on a larger scale, and Fig. 4 is a longitudinal section through a particular construction of a steam-distributing valve and through the adjacent portions of the cylinder having that valve.

Referring to Fig. 1, *h* is a pipe that connects the steam-space of the boiler proper, A,

with the steam-inlet pipe B for the cylinder C. The pipe B is connected to one end of the superheater D, the other end of which is connected with the steam-space aforementioned by means of the pipe E. The pipe *h* is furnished with a valve *g*, that is connected to the lever F of the regulator G by means of the rod H. Supposing the regulator be caused to act in such a manner as to cause in its turn an increase of the degree of filling, the valve *g* will be opened in a corresponding degree, so as to allow of a certain quantity of wet steam to pass over into the pipe B and to mix with the superheated steam flowing through said pipe. The temperature of the superheated steam is therefore reduced in a measure corresponding to the increased degree of filling. If, on the other hand, the degree of filling is reduced, the regulator acts upon the valve *g* in the reverse way—*i. e.*, closes said valve either nearly or wholly.

In the form of construction shown in Figs. 2 and 3 the variations of pressure caused within the pipes B and *h* by the influence of the regulator in question are made use of. For this purpose the pipe *h* is furnished with an automatic valve *i*, the valve proper, *i'*, of which is suspended by a spring i^2. The tension of said spring is so chosen that the pressure of the wet steam (within the boiler proper, A) is not sufficient to open the valve proper, *i'*. If, however, the pressure within the pipe B gets reduced in consequence of a sudden increase in the degree of filling of the cylinder C, the valve proper, *i'*, is raised by the wet steam and a certain quantity of the latter passes through the pipe *h* into the pipe B. The temperature of the superheated steam passing through the pipe B into the cylinder is therefore reduced in a measure corresponding to the increased degree of filling.

Another construction for admixing wet steam with the superheated steam is represented in Fig. 4, in which *k* is the inlet for the superheated steam and *l* the inlet for the wet steam. The ports J J', through which the superheated steam passes into the cylinder or to one or the other side of the piston, respectively, are opened and closed by the end portions K K' of the piston-valve K^3. The annular port J^2, through which the wet steam may pass over from the aperture *l* into the valve-casing, is controlled by the portion K^2 of the piston-valve. The extent of motion of said portion K^2 of the piston-valve is controlled by the regulator, according to the degree of filling of the cylinder. If the degree of filling is but small, the port J^2 will not be opened at all, whereas it is automatically opened if a greater degree of filling is required. Of course the piston-valve K^3 should be connected either to a link motion or to a fly-wheel regulator, so that the extent of motion of said valve may be made dependent on the degree of filling of the cylinder, as aforedescribed.

Having thus fully described the nature of this invention, what I desire to secure by Letters Patent of the United States is—

1. The combination with a generator for superheated steam, and with an engine adapted to be driven by such steam, of a regulator for the temperature of that steam; said regulator being adapted to be automatically adjusted according to the degree of filling of the cylinder of said engine, for the purpose as described.

2. The combination with a generator for superheated steam, and with an engine adapted to be driven by such steam, of a regulator for the temperature of said steam; said regulator being connected to the means that determine the degree of filling of the cylinder of said engine, for the purpose as described.

3. The combination with a steam-generator, a superheater for the steam, an engine adapted to be driven by the superheated steam and a connection between said superheater and said engine, of a connection between the latter and said generator so as to allow of the admixing of non-superheated steam to the superheated one, and a steam-distributing device adapted to control said admixing and connected to the means that determine the degree of filling of the cylinder of the said engine, for the purpose as described.

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

WILHELM SCHMIDT.

Witnesses:
W. HAUPT,
R. HERPICH.