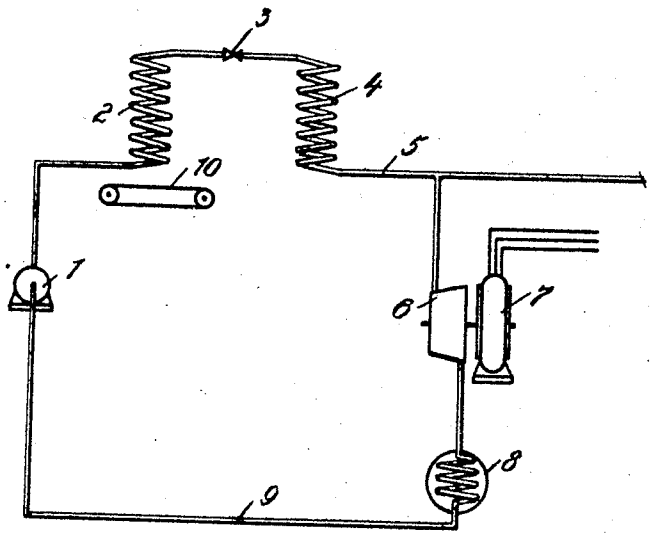
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STEAM POWER PLANT FOR HIGH PRESSURE

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STEAM POWER PLANT FOR HIGH PRESSURE

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My invention relates to improvements in steam power plants for high pressure and in which the steam is generated at very high pressures and temperatures, for instance above the critical pressure and above the critical temperature and is then reduced to the pressure suitable for general use.

The diagram of such a plant is shown in the drawing affixed to my specification and forming part thereof.

Referring to this drawing 1 is a feed pump which forces the water through the steam generator 2 at a pressure for instance above the critical pressure. This generator 2 consists of a system of tubes which is heated by a furnace 10 to such an extent that the temperature exceeds the critical temperature. In this manner the water is directly converted into steam. By means of a throttle valve 3 the steam pressure was usually heretofore reduced already to the pressure suitable for general use before it entered the superheater 4. This superheater serves in such a case only the purpose of superheating and of preventing the condensation of the steam owing to the reduction of the pressure. The steam now enters the live steam pipe 5, passes through the steam power engine (turbine) 6, which may drive an electric generator 7, and then enters a condenser 8 from which the condensate is withdrawn again by the pump 1. The operating medium thus describes a complete cycle.

It has also been suggested in the prior art to construct the superheater in tubular form and of such dimensions, that the generated steam is throttled in the tubular superheater from the generated pressure directly down to working pressure by virtue of the friction encountered in the tubes. This latter method of throttling utilizes the well-known recognition that the transfer of heat from a medium, flowing through a tube, to the wall of said tube, or vice versa, is a function of the speed of flow and increases substantially linearly with it, while the resistance to the flow increases substantially with the square of the velocity of the medium. Both prior art methods have disadvantages. The first method forces the throttle valve under all operating conditions to negotiate the full pressure drop between the steam pressure generated and as required by the consumer. This entails undue wear on the valves and requires a superheater of very large dimensions. The second method is only feasible if absolutely constant steam generating and consumption conditions exist, which does not happen under practical operating conditions. This is particularly the case with generators of small capacity and when the steam is generated at high pressures. If in such a plant the output is reduced, the steam flow through the superheater is correspondingly reduced, and owing to the square flow law above-mentioned, the tube resistance is reduced to a still larger degree, thereby causing undesirable pressure conditions in the steam generator. Similar results exist in such a plant if at full output the steam conditions (temperature and thus specific steam volume) should vary due to improper heat supply.

According to my invention the superheater is so proportioned that when it carries maximum load the available drop of pressure is approximately consumed by the flow resistance. The limit values between which the pressure reduction occurs are the pressure at the point of steam generation and the pressure in the live steam pipe.

Consequently at full load the entire pressure reduction occurs in the superheater alone. To overcome the above stated difficulties in case of inconsistent steam generating conditions, I provide the throttle valve 3, which in a supplemental way takes care of the desired pressure reductions, which under practical operating conditions cannot be accomplished by the superheater for the reasons above stated. This also insures a more constant steam velocity in the superheater at varying output conditions and thus maintains, also for the reason above stated, the heat transfer at all operating conditions at a high level. The material of the superheater 4 is in a thus dimensioned superheater utilized to the highest extent possible in practice.

The invention may be employed in all cases in which vaporous media are to be superheated at simultaneous reduction of pressure. The application of my invention is of course not limited to steam plants but may equally well be employed when liquid media other than water are used.

What I claim as my invention is:—

1. A steam generating plant having means for generating steam at high temperatures and high pressure conditions and in which the generated steam is consumed at a working pressure substantially below the generating pressure, and including in combination, a superheater for superheating the steam, said superheater being of the tubular type and having tubes of such small cross-section that the entire pressure reduction to the lower working pressure when the plant is operated under high load conditions is effected by the gradual throttling action of the tubes themselves which throttling action occurs simultaneously with the superheating of the steam passing through the tubes, and a supplemental throttle for effecting supplemental pressure reduction of the generated steam when the plant operates under lower load conditions and when the velocity of the steam through the tubes of small cross-section is reduced to such a degree that the desired pressure reduction cannot be effected by the sole throttling action of the tubes themselves.

2. A steam generating plant having means for generating steam at high pressure and temperature and in which the steam is consumed at a working pressure which is substantially below the generating pressure and including in combination, a superheating means comprising tubes of such small cross-section as to afford gradual throttling of the steam to the lower working pressure when the plant operates under full load conditions, and to simultaneously effect superheating with the maximum efficiency of heat transfer to the steam when the plant operates under such full load conditions, and also including a supplemental throttle for effecting a part of the pressure reduction when the plant operates under relatively lower load conditions for the purpose of maintaining good heat transfer conditions in the superheater.

3. A steam generating plant having means for generating steam at high temperatures and at substantially critical pressure conditions and in which the generated steam is consumed at substantially lower working pressure conditions and including in combination, a superheating means of tubular type for superheating the steam after its generation, said tubes being of such small dimension that the entire pressure reduction to the lower working pressure when the plant is operated under high load conditions is effected by the gradual throttling action of the tubes themselves, which throttling takes place simultaneously with the superheating of the steam passing through the tubes, and also including a supplemental throttle disposed between the generator and the consumer for cooperating with the tubes to effect further and additional throttling necessary when the plant is operated under lighter load conditions, said supplemental throttle also serving to maintain critical pressure conditions for steam generation which cannot be maintained by the throttling action of the tubes alone when the plant is so operated under relatively lower load conditions.

4. A steam generating plant, having a steam generator for generating steam at high pressure, which steam is to be supplied at lower pressure to a steam consumer, and including in combination a tubular superheater so proportioned in tube size that when the generator operates at maximum output, the high pressure of the steam is gradually reduced to the desired working pressure during the superheating process substantially by the resistance offered by the superheater to the flow of the steam, and a throttle valve between the generator and the superheater for compensating for small pressure variations due to practically unavoidable inconsistent steam or load conditions, to which the superheater cannot respond.

In testimony whereof I affix my signature.

WALDEMAR STENDER.