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STEAM POWER INSTALLATIONS

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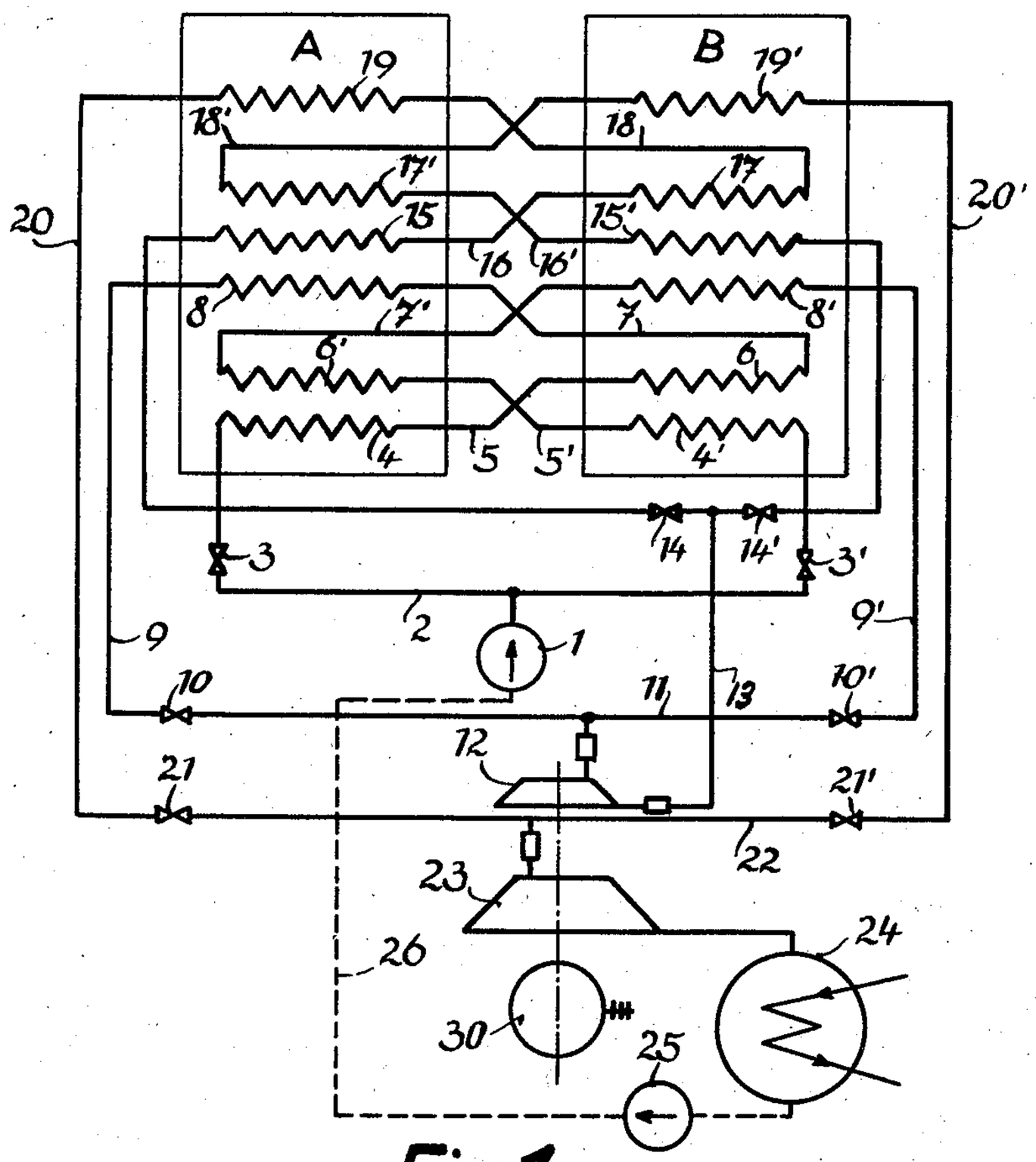

Fig.1

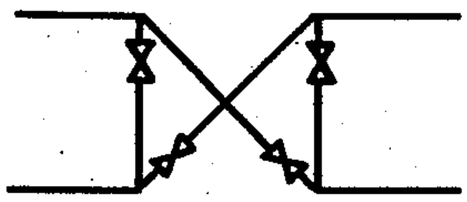

Fig.2

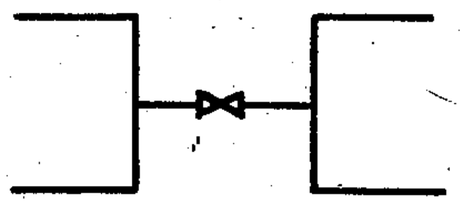

Fig.3

Inventor:

FRANZ GERHARD SCHRÖDER

BY: Cushman, Darby & Cushman
ATTORNEYS

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STEAM POWER INSTALLATIONS

Franz Gerhard Schroder, Wiesbaden, Germany

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The invention relates to steam power installations, more especially for the generation of electrical energy, comprising steam boilers, preferably of the type operating with forced throughflow of the water, and steam turbines connected thereto, which drive the generators or the like.

Large installations of this type, for example for an output of 50,000 kw. and more, are generally so constructed that they form units each consisting of a steam boiler, a steam turbine and a current generator. However, this arrangement, which is often called the unit plan arrangement, has various disadvantages.

Steam boilers are more susceptible to breakdown than steam turbines and the current generators coupled therewith. For repairing or cleaning the steam boilers, the entire unit must be placed out of operation. Recent boilers, more especially those operating on the forced-flow once-through principle, for example of the Benson type, cannot be operated with a steam generation of less than about 25–30% of the full output. Therefore, difficult operating conditions arise at night and on Sundays and holidays. It must also be borne in mind that large steam turbines and current generators often cannot be placed out of and into service in sufficiently rapid succession. The pressure loss in the circulation of the water is so considerable in the case of forced-through flow once-through boilers of large dimensions that the pumping work becomes considerable when the steam generation is reduced.

It has been proposed for the purpose of avoiding the aforesaid disadvantages to provide large turbo-sets with two boilers, or so, to subdivide a single boiler designed for the full output of the turbo-set that two boiler sections disposed immediately adjacent one another on the same foundation are formed, which operate in parallel on one turbo-set.

The aforesaid disadvantages are avoided in such arrangements, since when repairs and cleaning are necessary only one boiler or one boiler half need be placed out of operation, and the turbo-set can be maintained in operation with about 60% of its output. However, in such cases certain disturbances have occurred at the turbo-sets, such for example as unsteady running, damage to the high-pressure housings, and the like, for which it has not hitherto been possible to find any satisfactory explanation.

An essential object of the invention is to improve the aforesaid energy-generating installations that such disturbances and disadvantages are obviated.

The inventor has found that these disturbances are due substantially to the fact that with the arrangement of the steam pipes of multiple boiler systems hitherto employed steam currents at non-uniform temperature are fed to the steam-consuming installations, even when mixing pipes or mixing chambers of a type known per se are connected on the input side of the latter. This is due more especially to the fact that the combustion in the different boilers or boiler parts, cannot be maintained so uniformly in practice that the state of the steam, and more especially the steam temperature at the boiler outlet remains constant. The difficulties thereby involved are multiplied with single and even more so with double intermediate superheating of the steam.

Briefly stated, the underlying idea of the invention resides in supplying steam currents at substantially uniform temperature to the steam-consuming installations, and in providing for this purpose an arrangement, which may briefly be called "cross-connection," for the water and steam pipes extending through all the boilers or boiler parts connected to the turbo-set. The invention therefore resides in that the pipes for water and steam extend from one boiler or boiler part to the consumer or to the mixing chamber, not directly, but through the other boiler or boiler part and preferably back to the first boiler or boiler part, to which the steam consumer is then connected. In regard to the other boiler part, the pipes extend in the inverse fashion, so that the pipe systems of the two boilers or boiler parts are arranged in crossed relationship to one another. The pipes extend through the two coupled boilers or boiler parts in such fashion that the effective heat absorption of each pipe length in the two boilers or boiler parts is substantially equal.

The primary result of the invention is that the state of the steam and more especially the steam temperatures at the outlet of all the boilers or boiler parts is always substantially the same, regardless of the heat output of the associated furnace. This is particularly important for boilers which operate with modern cyclone furnaces, the operating state of which may sometimes undergo considerable fluctuations without any readjustment being immediately possible. With the ever increasing steam temperatures employed in modern engine sets, lower temperatures in the steam of the two boilers or boiler parts are sometimes sufficient to cause considerable damage and possibly even destruction of the high-pressure part of the turbine connected thereto. Similar results may arise in the case of other consumers which require steam at absolutely uniform temperature, for example in the heating of apparatus in which endothermic chemical reactions must be carried out in a very narrowly limited, elevated temperature range.

In the case of turbo-generator sets for power plants, the invention is of importance in that it further permits of placing a boiler or boiler part out of operation at any time with reduction of the output, but without varying the state of the steam (pressure, temperature, etc.) for the purpose of adaptation to altered loading conditions or for carrying out repairs to a boiler or boiler part. The same considerations also apply to the form of the superheater and intermediate superheater systems.

With a view to the aforesaid object of the invention and other objects which will be apparent from the description, various preferred embodiments of the invention will now be described, which are illustrated diagrammatically in the accompanying drawings.

Figure 1 shows the lay-out of an installation which broadly consists of the two forced-flow once-through steam boilers A and B and of a turbine having a high-pressure stage **12** and a low-pressure stage **23** and a turbo-generator **30** coupled therewith.

Fig. 2 shows valve means for disconnecting boiler units A and B of Fig. 1. Fig. 3 shows a modified arrangement for interconnecting boiler units A and B of Fig. 1.

The water flows from the feed pump **1** common to the two boilers A, B through the feed pipe **2** and the valve **3**, first through the feed water preheater set **4** situated in the boiler unit A, and then through the pipe **5** into the boiler unit B, in which it passes through the evaporator set **6**, through the connection **7** and back to A, and through

the set of superheater tubes 8 and further through the pipe 9 and the valve 10 to the collecting pipe 11, from which it flows into the high-pressure part 12 of the steam turbine. The opposite pipe and valve connections 3', 4', 5', 6', 7', 8', 9' and 10' are of similar form.

The steam flows from the high-pressure turbine 12 into the distributing pipe 13, which conducts it by way of the valves 14 and 14' through the tube set connections 15—15' to 19—19' of the reheater stage to pipes 20—20', whereafter it is collected in the pipe 22, which feeds the steam to the low-pressure stage 23 of the steam turbine. The expanded steam flows from the said turbine into the surface condenser 24 and the condensate flows through the condensate pump 25 and the pipe 26 back to the boiler feed pump 1.

The heating surfaces are so constructed and arranged that steam in the same state always flows through the pipes 11 and 22 respectively regardless of the firing of the two boiler units. Although this takes place without the use of regulators or the like, the use of regulators is not excluded, for example for compensating for small deviations. An important requirement for producing steam in the same state is that the heating surfaces should be of like construction, or briefly that the heating surfaces should be designed in a geometrically and thermally symmetrical fashion.

If it is desired to be able to operate the two boiler units individually, there must be provided in the transverse connections shut-off means and in addition short circuits adapted to be shut-off as shown in the example of a cross-connection illustrated in Figure 2. In addition, the valves 3, 3', 10, 10' and 21, 21' serve this purpose. A simplified lay-out is illustrated in Figure 3, which shows the parallel connection of a number of individual corresponding tube sets of the individual boilers, in which a complete temperature equalization is not effected, but only a pressure equalization in each individual set. In this case, equal loading and equal firing would be required, as otherwise the temperature equalization would not be achieved.

I claim:

1. A steam power installation, including at least two spaced steam boiler units; a turbine having a high pressure stage and a low pressure stage, said boiler units operating in parallel to said turbine; each of said units having a primary heating stage and a reheater stage; the primary heating stage of each of said units comprising a preheater tube set, an evaporator tube set, and a superheater tube set; the reheater stage of each of said units comprising first, second, and third, reheater tube sets; a common feed pump communicating with the inlet of each preheater tube set; cross means communicating the preheater set in each of said units with the evaporator set in the other unit; cross means communicating the evaporator set in each of said units with the superheater set in the other unit; means communicating the superheater set in each of said units with said high pressure stage; means communicating the outlet of said high pressure stage with the inlet of the first reheater tube set in each of said units; cross means communicating the first reheater tube set in each of said units with the second reheater tube set in the other unit; cross means communicating the second reheater tube set in each of said units with the third reheater tube set in the other unit; and means communicating the third reheater tube set in each of said units with said low pressure stage, the parts of each unit being homologous so that the heat absorption in each is substantially the same.

2. A steam power installation as called for in claim 1, in which valve means are provided so that one boiler unit and its associated parts can be placed out of operation while the other boiler unit and its associated parts remain in operation.

3. A steam boiler installation as called for in claim 1 in which means are provided for communicating the low outlet of said pressure stage with said feed pump.

4. A steam power installation as called for in claim 1 in which valve control means are provided for connecting a preheater set in one boiler unit to an evaporator set in the same boiler unit, valve control means for connecting an evaporator set in said one boiler unit to the superheater set of the same boiler unit, and valve means for shutting off communication of the tube sets in one boiler unit from the tube sets in the other boiler unit.

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