Dec. 6, 1927. 1,652,026

S. LÖFFLER

PUMPING PLANT FOR HIGH PRESSURE STEAM GENERATORS

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Fig.1.

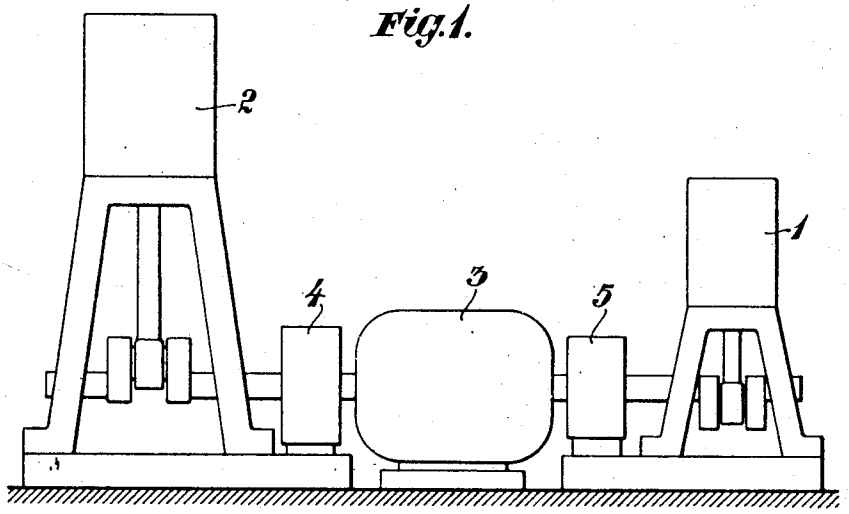

Fig.2.

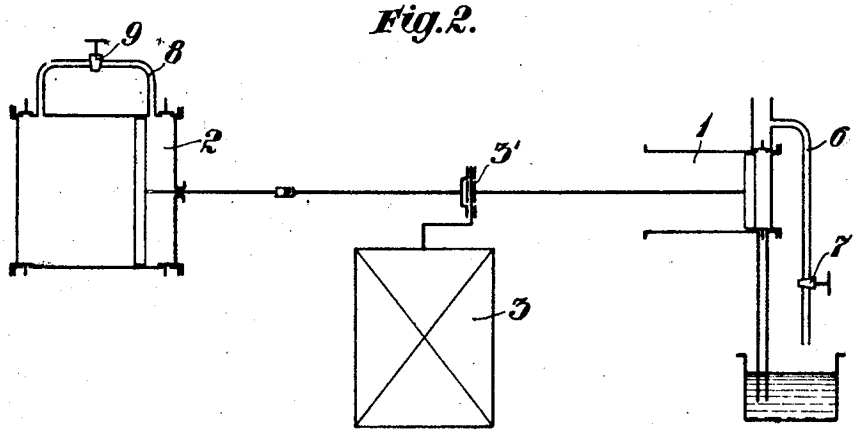

Fig.3.

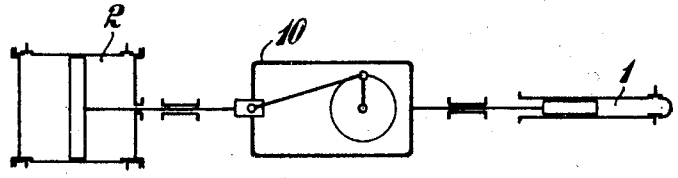

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Fig.4.

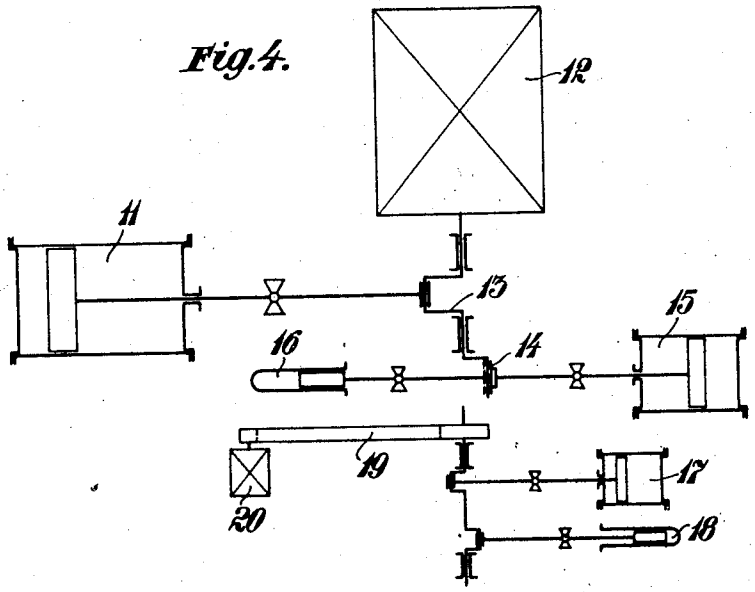


Fig.5.

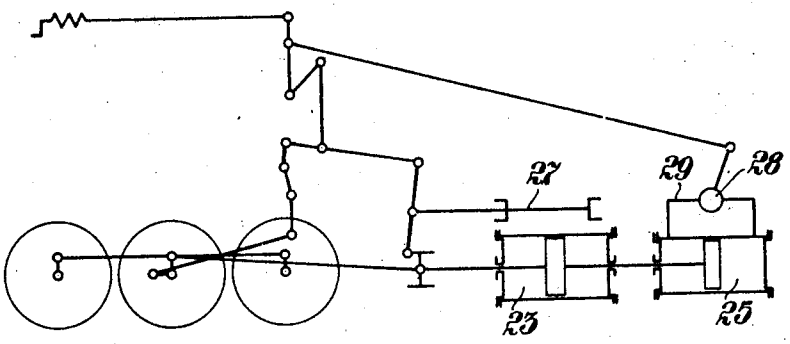
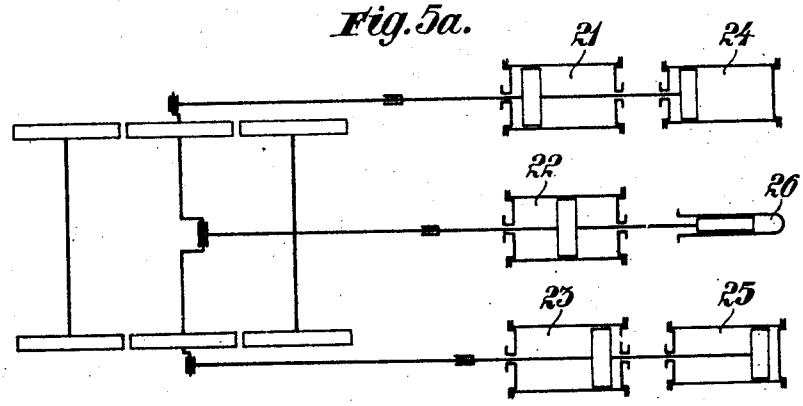


Fig.5a.



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PUMPING PLANT FOR HIGH PRESSURE STEAM GENERATORS

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Fig. 6.

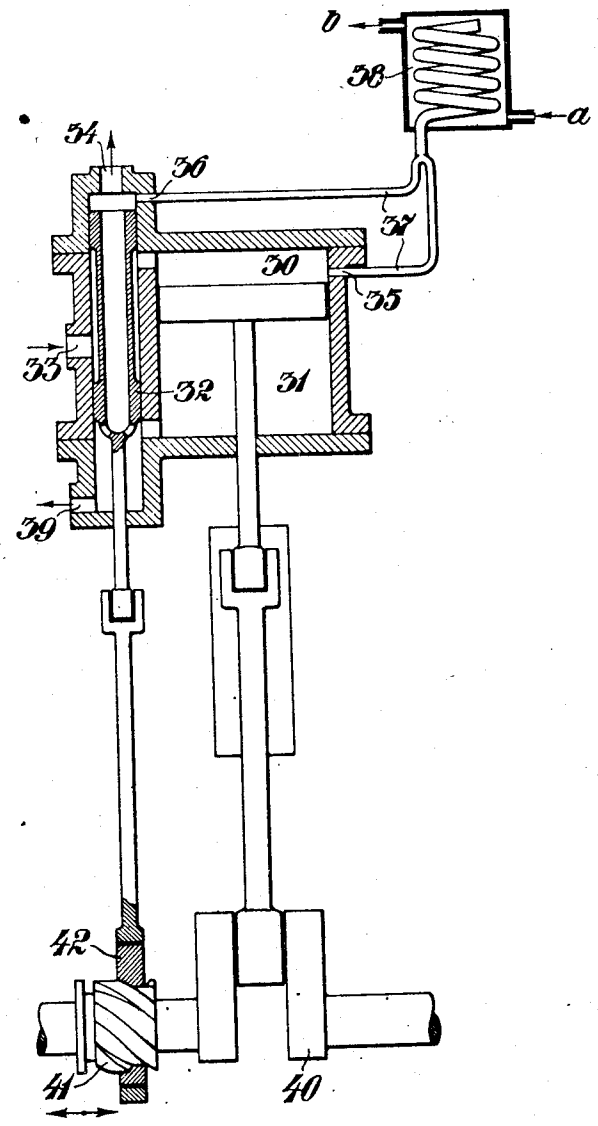
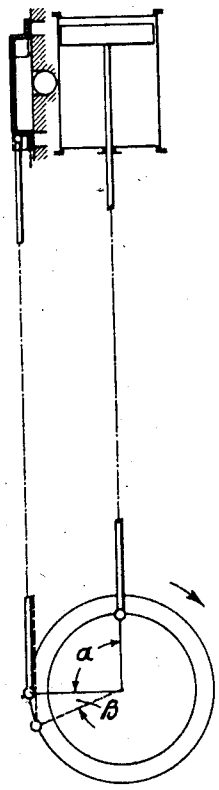


Fig. 7.



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Patented Dec. 6, 1927. 1,652,026

UNITED STATES PATENT OFFICE.

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PUMPING PLANT FOR HIGH-PRESSURE STEAM GENERATORS.

Application filed May 11, 1926, Serial No. 108,387, and in Germany May 16, 1925.

This invention relates to a pumping plant intended for use in connection with high-pressure steam generators; more especially it is intended for assisting in carrying into practice the method of generating high-pressure steam described in my United States application, Serial Number 701,855, filed March 25, 1924, in which steam produced in a boiler is further heated outside, and then re-introduced into, the same in order to transmit the added heat to the boiler water and convert this into steam, all as more fully described in said former application.

The invention may be embodied in several constructional forms, the common characteristic feature of which resides therein that the pumps constituting the pumping plant, namely, a steam conveying pump and a boiler feed pump, are driven by an engine or a motor common to them both, and which is directly connected thereto or geared thereto, the output of the two pumps being regulable by varying the number of revolutions of the engine or motor. Means may be provided by which the output or delivery of the boiler feed pump can be regulated independent of the steam conveying pump, as is also more fully described hereinafter.

The invention is illustrated diagrammatically and by way of example on the accompanying drawings on which Figure 1 is a front view of a pumping plant designed according to this invention; Figure 2 is a plan of a modification, the two cylinders being shown in horizontal section; Figure 3 shows another modification in vertical section; Figure 4 shows again a modification, in horizontal section; Figs. 5 and 5ª show the invention applied to a movable plant, viz to a locomotive, Fig. 5 showing the arrangement and combination of the parts concerned partly in vertical section and partly in side-view, and Fig. 5ª showing it partly in horizontal section and partly in plan; Figure 6 is a separate section solely through the steam conveying pump, together with its valve-gear and some other parts; and Figure 7 is a diagrammatic representation of the valve-gear motion, all as more fully dealt with hereinafter.

Referring to Fig. 1, 1 denotes the boiler feed pump, 2 the steam conveying pump, and 3 the engine which is common to both pumps and is assumed, in the example shown, to be an electromotor. The dimensions of the pump cylinders are preferably such that the size of the feed pump is chosen dependent upon the size of the steam conveying pump, that is to say, if there are two or more steam conveying pumps there should be also two or more feed pumps, always an equal number of pumps of both kinds.

In the constructional form shown in Fig. 1, the power is transmitted from the electromotor 3 to the pumps 1 and 2 by the intermediary of gearings 4 and 5. The output or delivery of both pumps can be varied by varying the number of revolutions of the motor, so that if the pumps are piston pumps the relation between them is always the same, whereas if they are turbine pumps the appertaining gearings may be designed with consideration of the difference of the characteristics of the two pumps so as to permit to vary the output. But instead of particularly designed gearings, a by-pass pipe provided with a throttling valve may be employed, especially if the pumps are driven by a primary engine, as will be the case with a locomotive. A by-pass pipe becomes, in fact, necessary if the boiler feed pump is somewhat larger than actually required which is to be preferred from certain reasons; that pipe serves also for regulating the output. It is, of course, possible to combine the two modes of regulation, viz that by varying the number of revolutions of the driving shaft, as well as that by employing a by-pass pipe with a throttling valve or equivalent member. Varying the number of revolutions of the shaft may be effected by varying either the number of strokes of the engine or the number of revolutions of the motor, or by the intermediary of a suitable gearing, and as regards solely the boiler feed pump its output may be varied by varying its stroke.

In the modified constructional form illustrated in Fig. 2 the two pumps 1 and 2 are operated simultaneously by a crank 3′ rotated by the engine 3. The pumps are arranged co-axially. The boiler feed pump is provided with a return pipe 6 into which a regulating member 7 is inserted, and the steam conveying pump is provided with a by-pass pipe 8 provided with a regulating member 9. The return pipe 6 and the regulating member 7 may be designed similarly to the fuel pumps used in connection with Diesel engines.

In Fig. 3 the steam conveying pump 2 is driven directly by the crank of the engine,

whereas the boiler feed pump 1 is driven indirectly from the same crank by the intermediary of a frame 10, whereby the journal pressure is diminished.

In order to reduce the cost-price of the plant, also to diminish the space required for it, the pumps may be operated directly by a primary engine or main engine or motor, whereby the attainment of several service advantages resulting from the use of high-pressure steam is warranted.

While the main engine is at a stand-still, the steam generation can be maintained, with a correspondingly diminished heating effect, by separate auxiliary pumps driven separately, for instance by a steam engine, an electromotor, or the like. According as the conditions of service at the time being may be, the auxiliary pumps may run also while the main engine is working, in which case said pumps will run continuously; or they are made use of only in the case of overloading of the plant in order to increase the steam production. It is suited to the purposes of the entire plant to employ the auxiliary pumps also for starting the high-pressure steam generator. The pumps are to be driven in such case by the driving means or medium available while the main engine is at a stand-still, for instance by a low-pressure engine if low-pressure steam is available either in a boiler or in an accumulator; or an electromotor is used and is fed from a net or a storage battery. The auxiliary pumps constitute in every case, irrespective of whether they run continuously or not, a safety contrivance for the service, apart from the other stand-by or spare means and safety appliances perhaps provided.

The output of the main pumps is being varied by varying the number of revolutions relatively to the main engine, or by means of a return device operating in the direction from the delivery side to the suction side of the pumps, or by varying the control gear of the pumps, or in any other suitable manner. The auxiliary pumps may work, however, without any regulation if the conditions are normal. The service is rendered particularly favorable and simple if the variation of the output or delivery of the main pumps is effected in dependency of the steam consumption of the main engine, i. e. in dependency of the valve control gear thereof.

Referring now to Fig. 4, 11 denotes the cylinder of a high-pressure steam engine constituting the main engine and driving directly a dynamo 12. At the free end of the crooked shaft 13 is provided an overhung crank 14 driving the boiler feed pump 16, as well as the steam conveying pump 15 (may be, also other pumps required for the proper operation of the high-pressure steam generator, as for instance a pump for conveying cooling water to the stuffing boxes of the piston rod or rods, to the measuring instruments, or gauges and the like).

For starting the high-pressure steam generator and for maintaining the production of steam while the main engine is at a stand-still, an auxiliary steam conveying pump 17 and an auxiliary boiler feed pump 18 are provided and are driven separately by means of an electromotor 20 by the intermediary of a belt 19 or any other suitable power transmitting means. Other auxiliary pumps perhaps required, as for instance an auxiliary cooling water pump and the like, may be also driven by the electromotor 20 or any other motor or engine. In many cases solely an auxiliary steam conveying device will be required.

In Figs. 5 and 5a the high-pressure steam generator is assumed to be a locomotive boiler having three main driving cylinders, two main steam conveying cylinders, and a main boiler-feed pump 21, 22, 23 are the main driving cylinders, of which one (22) is located between the wheels; 24, 25 are the steam conveying cylinders, and 26 is the feed cylinder or pump. The cylinders 21 and 24, as well as 23 and 25, are arranged co-axially, the respective pistons being secured to a continuous piston rod. Also the cylinders 22 and 26 are arranged co-axially as shown. The valve control gear of the main driving cylinders has piston slides designed according to Heusinger. When the admission to these cylinders is varied, also the delivery of the main pumps is being varied positively by the valve control gear of the main driving cylinders. This may, with the main steam conveying pumps, be effected, for instance, by varying the position of a control member 28 located in a by-pass pipe 29. The control valve gears have been omitted in the figure.

The steam conveying pump is designed preferably in a manner specially suited for its purpose, in that the two cylinder sides or ends of the double-acting pump are controlled by a positively operated piston slide (without any additional members, such, for instance, as return valves and the like) common to both sides or ends of said cylinder, this slide being so designed that its lap is nearly zero or, perhaps, even negative. By "zero lap" I comprehend that simultaneously with the closing of the suction pipe the pressure pipe is opened, and reversely. The advantage of this constructional form over those that have become known hitherto resides in its simple construction and in the reliable avoidance of the formation of loops in the diagram, the loops appearing otherwise especially when the output or delivery of the pump is diminished. The possibility of the formation of loops in the diagram

means, especially as regards pumps working with a very high pressure, as for instance with a suction pressure of say 100 atmospheres, a big danger for the driving gear, in fact for the entire pump, as already quite small loops which are without importance as regards the delivery loss cause a strong increase of the pressure by reason of the steep rise of the compression line. Designing the control slide valve in the manner stated warrants very great security of the pumping service under all conditions, down to the lowermost stages of regulation; and as separate auxiliary members, as, for instance, return-valves and the like, may be dispensed with, high numbers of revolution can be employed.

An example of a steam conveying pump designed in accordance with the above statements is shown in Fig. 6 in which 30 and 31 denote the two sides or ends of a double-acting pump, and 32 denotes a piston slide which is common to both said sides or ends of the pump. This slide is designed as a hollow slide so that the casing for it requires only on supply opening 33 and only one delivery opening 34 for the steam.

The lubrication of the guide faces for the piston and the piston slide is effected chiefly by condensate drawn, for instance, from the cylinder and being then cooled by a suitable means. In the example illustrated in Fig. 6 bores 35 and 36 of the cylinder and the valve casing are connected by pipes 37 with a helical tube 38 located in a vessel through which cooling water is conducted, this water being supplied, for instance, at *a*, and withdrawn at *b*. The condensate forming in said helical pipe flows down to the guide faces of the cylinder and the valve casing.

The condensate forming in the cylinder and in the valve casing and the condensate supplied perhaps too amply by the helical tube 38 collect at the lowermost point of the valve casing and leave it through the aperture 39; this aperture may be employed preferably also for the discharge of the steam from the valve casing.

The pump cylinder and the valve casing are manufactured preferably from a solid piece of steel if the pump is to work with a pressure of, say, 100 or even more atmospheres.

The variation of the amount of steam conveyed by the steam conveying cylinder may be brought about by a phase-shift between the pump piston and the slide valve, for instance with the aid of an adjusting eccentric. In the constructional form shown in Fig. 6 the crank shaft 40 is provided with a worm-like sleeve 41 which can be shifted axially on said shaft, and is encompassed by an eccentric 42 prevented from axial displacement by any suitable means (not shown). The eccentric can be moved more or less in the direction to or from the valve casing by a corresponding axial shifting of said worm-like sleeve, whereby the phase-shift is produced.

Figure 7 shows a diagram of the valve gear. At the maximum output or delivery the angle α between the crank and the eccentric amounts to 90°. If the eccentric is re-adjusted by an agle β, as indicated in the figure, the suction pipe remains open when the suction stroke is commencing, and a part of the amount sucked is re-conveyed into the suction pipe. The action taking place when the piston performs its return movement proceeds correspondingly. By varying the angle between 0° and any maximum degree, delivery quantities of any desired amount may be had between those limits. In order to prevent the arising of pressure shocks while the plant is in operation, as may occur especially if the amount delivered is somewhat considerably diminished, the laps of the slide valve are adjusted to zero or even to negative, that is to say, as already explained, the delivery pipe is closed simultaneously with the opening of the suction pipe, and reversely, or, in other words, the cylinder is connected with the suction pipe, as well as with the delivery pipe when the suction stroke is changed into the delivery stroke, and reversely.

A control gear of this kind is suited especially in those cases in which the steam conveying pump is to be driven by the main engine, but, then, of course, an auxiliary pump with a separate driving engine or motor must be provided for the starting of the steam generator.

I claim:

1. A pumping plant for high-pressure steam generators of the kind in which the steam is generated by steam heated outside the boiler and introduced or reintroduced into the water of the same, said plant comprising a steam conveying pump, a boiler feed pump, an engine or a motor adapted to drive both said pumps, and means for varying the output or delivery of the same, substantially as set forth.

2. A pumping plant for high-pressure steam generators of the kind in which the steam is generated by steam heated outside the boiler and introduced or reintroduced into the water of the same, said plant comprising a steam conveying pump, a boiler feed pump, an engine or a motor adapted to drive both pumps, and means for varying the output or delivery of both said pumps separately, substantially as set forth.

3. A pumping plant for high-pressure steam generators of the kind in which the steam is generated by steam heated outside the boiler and introduced or reintroduced into the water of the same, said plant com-

prising a piston pump adapted to be used as steam conveying pump, another piston pump adapted to be used as boiler feed pump, an engine or a motor adapted to drive said steam conveying pump, means for transmitting the driving power from the driving gear of said latter pump to said feed pump, and means for varying the output or delivery of this pump, substantially as set forth.

4. A pumping plant for high-pressure steam generators of the kind in which the steam is generated by steam heated outside the boiler and introduced or reintroduced into the water of the same, said plant comprising a double-acting steam conveying pump, a positively moved piston slide valve adapted to co-operate with both sides or ends of said pump and having laps amounting to zero or being even negative; a boiler feed pump, an engine or a motor adapted to drive both said pumps, and means for varying the output or delivery of the same, substantially as set forth.

5. A pumping plant for high-pressure steam generators of the kind in which the steam is generated by steam heated outside the boiler and introduced or reintroduced into the water of the same, said plant comprising a double-acting steam conveying pump, a positively moved piston slide valve adapted to co-operate with both sides or ends of said pump and having laps amounting to zero or being even negative, and a condensate collecting chamber having a discharge opening; a boiler feed pump, an engine or a motor adapted to drive both said pumps, and means for varying the output or delivery of the same, substantially as set forth.

6. A pumping plant for high-pressure steam generators of the kind in which the steam is generated by steam heated outside the boiler and introduced or reintroduced into the water of the same, said plant comprising a double-acting steam conveying pump, a positively moved piston slide valve adapted to co-operate with both sides or ends of said pump and having laps amounting to zero or being even negative; a steam condensing device so arranged as to be adapted to deliver lubricating condensate to the guide surfaces of the pistons ; a boiler feed pump, an engine or a motor adapted to drive both said pumps, and means for varying the output or delivery of the same, substantially as set forth.

7. A pumping plant for high-pressure steam generators of the kind in which the steam is generated by steam heated outside the boiler and introduced or reintroduced into the water of the same, said plant comprising a double-acting steam conveying pump, a positively moved piston slide valve adapted to co-operate with both sides or ends of said pump and having laps amounting to zero or being even negative; means for varying the output of the steam conveying pump by varying the phase-shift between the piston and the valve gear thereof; a boiler feed pump, an engine or a motor adapted to drive both said pumps, and means for varying the output or delivery of the same, substantially as set forth.

In witness whereof I have hereunto set my hand.

STEPHAN LÖFFLER.