

J. F. HEY.
 APPARATUS FOR REGULATING THE SUPPLY OF STEAM.
 APPLICATION FILED FEB. 3, 1910.

1,001,199.

Patented Aug. 22, 1911.

2 SHEETS-SHEET 1.

Fig. 1.

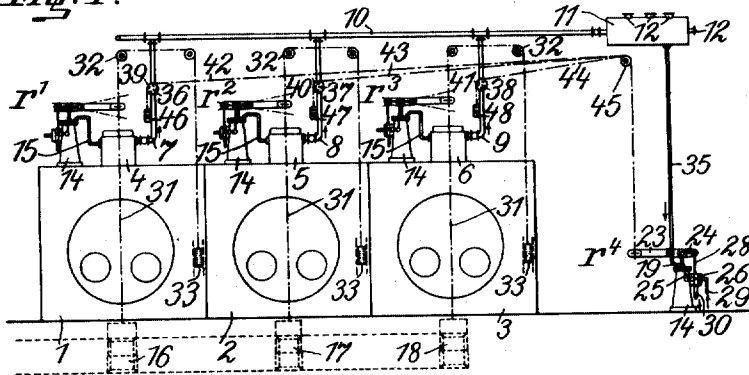
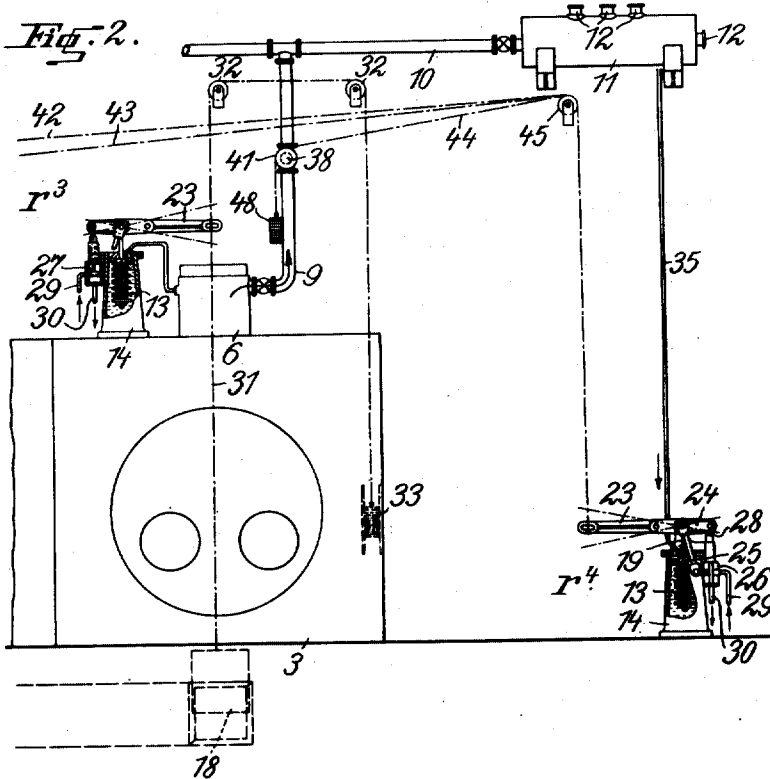


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 3.

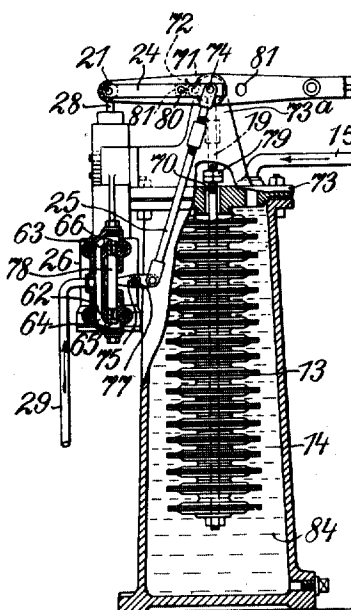


Fig. 4.

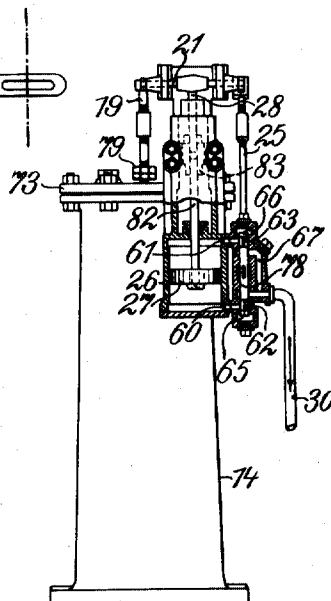


Fig. 5.

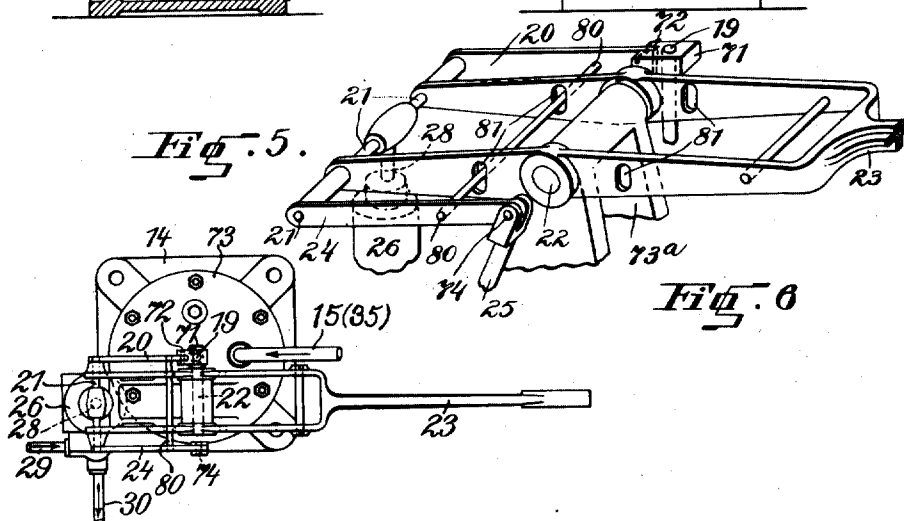


Fig. 6.

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APPARATUS FOR REGULATING THE SUPPLY OF STEAM.

1,001,199.

Specification of Letters Patent. Patented Aug. 22, 1911.

Application filed February 3, 1910. Serial No. 541,757.

To all whom it may concern:

Be it known that I, JOHANN FRIEDRICH HEY, a subject of the German Emperor, and resident of Strassburg, Alsace, Germany, have invented certain new and useful Improvements in Apparatus for Regulating the Supply of Steam, of which the following is a specification.

My invention relates to apparatus for regulating the supply of steam, particularly when a plurality of boilers are connected with a common main from which the steam is led to the place of use. The regulation of steam generation in a boiler has been effected by providing a movable member exposed to boiler pressure and to a counter-acting force, such as a spring, said member controlling the intensity of steam generation by directly or indirectly governing a damper or other draft-regulator, or a device for regulating the supply or the height of the fuel, or any other device which will produce the same effect, that is to say, vary the intensity of steam generation. When a plurality of boilers are connected with a common pipe receiving steam from them all, the pressure will practically become equalized in all the boilers, since those boilers which for the time being produce a large quantity of steam will exert a back pressure upon those boilers which at the same time are producing a smaller amount of steam. Therefore, if each of such boilers is provided with its individual regulating device of the character above referred to (that is, governed by steam pressure), no perfect regulation can be obtained, since it is still possible that some boilers might furnish too large a supply of steam to the collecting pipe, because of too rapid fuel combustion, and others too small an amount of steam, because of too slow combustion.

The difficulty met with in the above case has been overcome, according to my invention, by providing each boiler with its individual regulating device, and in addition thereto disposing dampers or throttling devices in the connections leading from the individual boilers to the common collecting pipe, such throttling devices being controlled simultaneously either by individual regulators or by a master regulator connected with said pipe.

A typical example of my invention is shown in the accompanying drawings, in which—

Figure 1 is a general front elevation of the plant; Fig. 2 shows the right-hand portion of Fig. 1 upon an enlarged scale and with parts in section; Fig. 3 is a side elevation of one of the regulators, with parts in section; Fig. 4 is a front elevation thereof, partly in section; Fig. 5 is a top view of the regulator, and Fig. 6 is a perspective view of the levers forming part of my improved regulator.

Fig. 1 shows a plant comprising three boilers 1, 2 and 3 respectively with their domes 4, 5 and 6 respectively from which steam pipes, 7, 8 and 9 lead to the common collecting pipe 10. The latter may be connected with a steam chamber 11 from which the steam is conveyed to the engines or other places of use, by means of conduits (not shown) starting from the nipples or connections 12.

Each boiler is provided with its individual regulator r^1 , r^2 , r^3 respectively, constructed in any suitable manner so as to be influenced by variations of the boiler pressure. The member exposed to boiler pressure may be, for instance, a spring-controlled steam-piston or an elastic tube of the Bourdon or Belleville type, or a so-called capsular spring. In the particular construction illustrated, the pressure-receiving member is a capsular spring 13 immersed in a liquid contained in a casing 14, which liquid is exposed to the pressure of the steam coming from the respective dome 4, 5, or 6 through a pipe 15 which affords a permanent communication between such steam dome and the interior of the respective casing 14.

An auxiliary regulator r^4 (which may be of the same character as the regulators r^1 , r^2 , r^3) is connected with the collecting pipe 10, either directly or through the intermediate of the steam chamber 11, as by means of the pipe 35. The individual regulators r^1 , r^2 , r^3 govern the positions of individual controllers, such as dampers 16, 17 and 18 respectively, which adjust the intensity of steam generation by regulating the draft for each boiler. The auxiliary regulator r^4 governs three throttling devices 36, 37 and 38 respectively, arranged in the steam pipes 7, 8 and 9 respectively, and as these three devices are governed in unison, the regulator r^4 may also be termed a master regulator.

In the drawings, the four regulators r^1 , r^2 , r^3 and r^4 are of the same construction, and it

will therefore be sufficient to describe one of them in detail. The upper part of the capsular spring 13 is secured to the casing 14 and therefore stationary. This spring consists preferably of a series of elastic diaphragms of arched structure, in contact with each other alternately at their inner and at their outer edges and connected by welding or soldering, or fastened together with the interposition of rubber washers. A bellows-like hollow elastic body is thus formed, which is known as a capsular spring of the Belleville type. This capsular spring is closed at its bottom. The interior of the capsular spring 13 communicates with the surrounding air by means of a central opening 70 in the cover 73. The chamber of the casing 14 exteriorly of the spring is filled with a suitable liquid 84 and communicates, by the pipe 15 or 35, with the steam domes 4, 5 or 6 of the boilers 1, 2 or 3, or with the steam chamber 11 respectively. To the bottom of the spring 13 is secured rigidly a rod 19, passing with some play through the opening 70 and provided with nuts 79 to variably limit its downward movement.

The movement of the capsular spring 13 and of the rod 19, under the influence of pressure variations, is utilized for the purpose of operating a controlling device, for instance a draft regulator. In the construction shown, this operation is effected indirectly through the medium of a relay in which a separate motive agent is employed, such as water under pressure. For this purpose a crosshead 71 is secured to the upper end of the rod 19, and to this head is pivotally connected at 72 a lever 20, rigidly attached to a spindle or rock shaft 21 journaled at one end of a forked lever 23. The latter is fulcrumed at 22 upon a bracket 73 projected from the cover 73. On the rock shaft 21 is further secured rigidly a lever 24 pivotally connected at 74 with a rod 25, the lower end of which has a similar connection with a lever 75. The latter, fulcrumed at 77 upon a cylinder 26 carried by the casing 14, is arranged to operate the vertically movable slide valve 78 controlling the movement of the piston 27. The levers 20 and 24 are preferably connected by a crossbar 80 passing through an opening 81 of the lever 23 so as to afford ample vertical play for an independent movement of the levers 20 and 24 relatively to the lever 23.

The operating piston 27 is shifted by steam or preferably by a liquid (water) under pressure, such motive agent being supplied through a pipe 29 and led away through a conduit 30.

The slide valve 78 is formed with passages 62 and 63 which are always in communication with the inlet and outlet ports 60 and 61 of the cylinder 26. In the central position of the slide valve the ends 65

and 66 of the latter close the passages against the channel 64 which communicates with the inlet pipe 29, and the central part of the slide valve closes the said passages against the channel 67 which communicates with the outlet conduit 30. If the slide valve is shifted downward, pressure fluid flowing through the inlet pipe 29, the channel 64, the port 62 and the port 60 passes into the cylinder 26 and below the piston 27, so as to force the same upward, the liquid above the piston escaping through the port 61, the passage 63 of the slide valve, the channel 67 and the conduit 30. On the other hand, if the slide valve 78 is shifted upward, communication is established between the port 61 and the inlet pipe 29, and between the port 60 and the outlet pipe 30, so that the piston 27 is lowered.

The piston rod 82 attached to the piston 27 is provided with a crosshead 83 from which a connecting rod 28, having pivotal connections at both ends, extends to the rock shaft 21.

Let us assume that the steam pressure increases in one of the boilers, the pressure, being conveyed through the pipe 15 to the liquid 84, will compress the capsular spring 13 and thus move the rod 19 upward. Since the slide valve 78 is in its central position and closes both channels 60 and 61, the piston 27 cannot move, and the shaft 21 forms a stationary fulcrum for the levers 20 and 24 as they are moved upward by the rod 19. The upward movement of the lever 24 lifts the connecting rod 25 and lowers the slide valve 78, allowing the motive agent to pass from the pipe 29 through the port 60 and below the piston 27, while at the same time port 61 is connected with the outlet conduit 30. The piston 27 will then rise, and since the steam pressure holds the spring 13 (and therefore the rod 19) stationary, the upward movement of the piston will cause the levers 20 and 24 to swing about the pivot 72 as a stationary fulcrum, while at the same time the lever 23 swings about its fulcrum 22. By reference to Figs. 3 to 5 it will be seen that the pivotal connections 21 and 74 are on opposite sides of the pivot or temporary fulcrum 72; therefore, when the piston 27 moves upward and raises the rock shaft 21, the pivotal connection 74 and the rod 25 will be lowered, and the slide valve 78 raised to its central position, so that the piston 27 and the parts connected therewith will be held in their raised position. The movement of the lever 23 shifts the damper connected with the chain, in such a manner as to reduce the activity of combustion, that is to say, the damper will be moved toward its closed position. When on the other hand the pressure decreases within the boiler, the capsular spring 13 will expand, causing the

rod 19 to move downward. The piston 27 and rod 28 being stationary at this moment, the connected levers 20 and 24 will be moved downward, imparting a like motion to the rod 25 and raising the slide valve 78 to admit the motive agent from the pipe 29 through the channel 61 above the piston 27. The latter will therefore move downward, carrying with it the rock shaft 21 and causing the lever 23 to swing about the fulcrum 22 in the direction opposite to that first referred to, while at the same time the connected levers 20 and 24 are swung about the pivot 72 as a temporary fulcrum. The lever 23 shifts the damper toward the open position, thus increasing the draft and the activity of combustion, so as to restore the pressure to normal. The left hand portion of the lever 24 moves downward, but the portion to the right of the pivot 72 will move up, thus raising the rod 25 and lowering the slide valve 78 to its central position. The piston 27 is thus again held against upward or downward movement.

The connection of the regulators r^1 , r^2 , r^3 with the respective dampers or controllers 16, 17 and 18 may be effected by means of chains or other flexible connections 31 passing to the levers 23 then over rollers 32 and secured to weights 33 counterbalancing the dampers. These dampers control the draft, in any suitable manner, being for instance located in the smoke flues.

The regulator r^4 has its lever 23 secured to one end of chains or like connections 42, 43 and 44, said connections passing over a pulley 45 and sprocket wheels 39, 40 and 41 respectively mounted on the spindles of the throttle valves 36, 37 and 38 respectively. Counterweights 46, 47, 48 keep the chains taut.

Let us assume that the boiler 2 supplies too large an amount of steam to the collector pipe 10, relatively to the amount coming from the boilers 1 and 3, then, if the pressure in said pipe should remain unchanged, the draft regulators r^1 , r^2 , r^3 and the auxiliary regulator r^4 will not come into operation. If, however, the pressure in the collector pipe increases, say on account of reduced steam consumption, the individual draft regulators r^1 , r^2 , r^3 of the boilers 1, 2 and 3 will tend to close the dampers 16, 17, 18, since the pressure-receiving members 13 have so shifted the slide valves controlling the pistons 27 as to cause water under pressure to pass below the pistons from the pipes 29. At the same time, since the pressure has also increased in the collecting chamber 11, the slide valve of the auxiliary regulator r^4 has been shifted to admit water from the pipe 29 under the piston 27, and the lever 23 moves downward at the end connected with the chains 42, 43, 44. This closes the throttles 36, 37, 38 more or less,

according to the amount of the pressure change.

The throttling of the steam produces a back pressure which varies according to the amount of steam generated in the particular boiler at the time. In boilers in which steam generation proceeds with great intensity (as the boiler 2 in the case assumed) the pressure will be raised to a higher point by this back pressure than in boilers with relatively low intensity of steam generation. The damper 17 corresponding to the boiler 2 will therefore be closed, by the action of the regulator r^2 , to a greater extent than the dampers 16 and 18 of the boilers 1 and 3 respectively. These different movements of the dampers will cause the generation of steam to be reduced in the boiler 2 while in boilers 1 and 3 the generation will not be altered materially. If, on the other hand, steam pressure should decrease in the steam collecting chamber 11, for instance owing to an increase in the consumption of steam, the pressure-receiving member 13 of the auxiliary regulator r^4 will shift the corresponding slide valve to admit water above the piston 27 and thus the throttles 36, 37 and 38 will be opened simultaneously to an extent depending on the amount of pressure reduction.

The reduction of the throttling action will cause the pressure to fall to a smaller extent in the boilers generating steam strongly than in those developing a relatively small amount of steam, for instance when fresh fuel has been put on the grate. The dampers 16 and 18 of the boilers 1 and 3 will therefore be opened wider than the damper 17 of the boiler 2, thus causing the generation of steam to become much more active in boilers 1 and 3, while in boiler 2 the intensity of steam generation is not altered materially.

It will be seen that with the aid of the auxiliary regulator the amount of steam generated in the individual boilers is regulated in such a manner (in the specific instance shown, by regulating the draft) that they will always supply approximately the same amount of steam to the collecting pipe 10. When the pressure-receiving member is constructed as a capsular spring and combined with a relay and a compound lever system which increases the amplitude of the motion (as shown) the apparatus becomes so sensitive that even very small variations of pressure in the pipe 10 and in the boilers 1, 2 and 3 will cause the throttles 36, 37, 38 and the draft regulators 16, 17 and 18 to be shifted.

It will be obvious that the invention is applicable to a plant comprising a greater or smaller number of boilers than shown, and that the manner of connecting the boilers may be varied. These and other modi-

fications may be made without departing from the nature of my invention as set forth in the appended claims.

I claim as my invention:

- 5 1. The combination of a plurality of boilers and a collector arranged to receive steam from each boiler, with separate regulators for governing combustion whereby the generation of steam is controlled in the individual boilers, each regulator being exposed to the pressure of the steam within the respective boiler, throttling devices controlling the connection of the individual boilers with said collector, and auxiliary regulating means, exposed to the pressure of the steam within the collector, for opening or closing said throttling devices simultaneously.
- 10 2. The combination of a plurality of boilers and a collector arranged to receive steam from each of them, with separate pressure-operated regulators, one for each boiler, a connection for leading steam from each boiler to the respective regulator, separate devices governing combustion whereby the generation of steam is controlled in the individual boilers, an operative connection from each of said regulators to the respective controlling device, throttling devices governing the connection of the individual boilers with said collector, auxiliary pressure-operated regulating means in communication with the collector so as to be exposed to the pressure prevailing therein, and operative connections from said regulating means to the throttling devices.
- 15 3. The combination of a plurality of boilers and a collector arranged to receive steam from each of them, with separate pressure-operated regulators, one for each boiler, a connection for leading steam from each boiler to the respective regulator, separate devices governing combustion whereby the generation of steam is controlled in the individual boilers, an operative connection from
- 20
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- 35
- 40

each of said regulators to the respective controlling device, throttling devices governing the connection of the individual boilers with said collector, an auxiliary pressure-operated master regulator, a connection for leading steam from the collector to said auxiliary regulator, and operative connections from said auxiliary regulator to the throttling devices. 45

4. The combination of a plurality of boilers and a collector arranged to receive steam from each of them, with throttling devices controlling the connection of the individual boilers with said collector, and regulating means, exposed to the pressure of the steam within the collector, for opening or closing said throttling devices simultaneously. 50

5. The combination of a plurality of boilers and a collector arranged to receive steam from each of them, with throttling devices controlling the connection of the individual boilers with said collector, pressure-operated regulating means in communication with the collector so as to be exposed to the pressure prevailing therein, and operative connections from said regulating means to the throttling devices. 55

6. The combination of a plurality of boilers and a collector arranged to receive steam from each of them, with throttling devices controlling the connection of the individual boilers with said collector, a pressure-operated master regulator, a connection for leading steam from the collector to said regulator, and operative connections from the regulator to said throttling devices. 60

In testimony whereof, I have hereunto set my hand in the presence of two subscribing witnesses. 65

JOHANN FRIEDRICH HEY. 70

Witnesses:

CARL W. SCHMITT,
AUGUST OOSTERMAN. 75