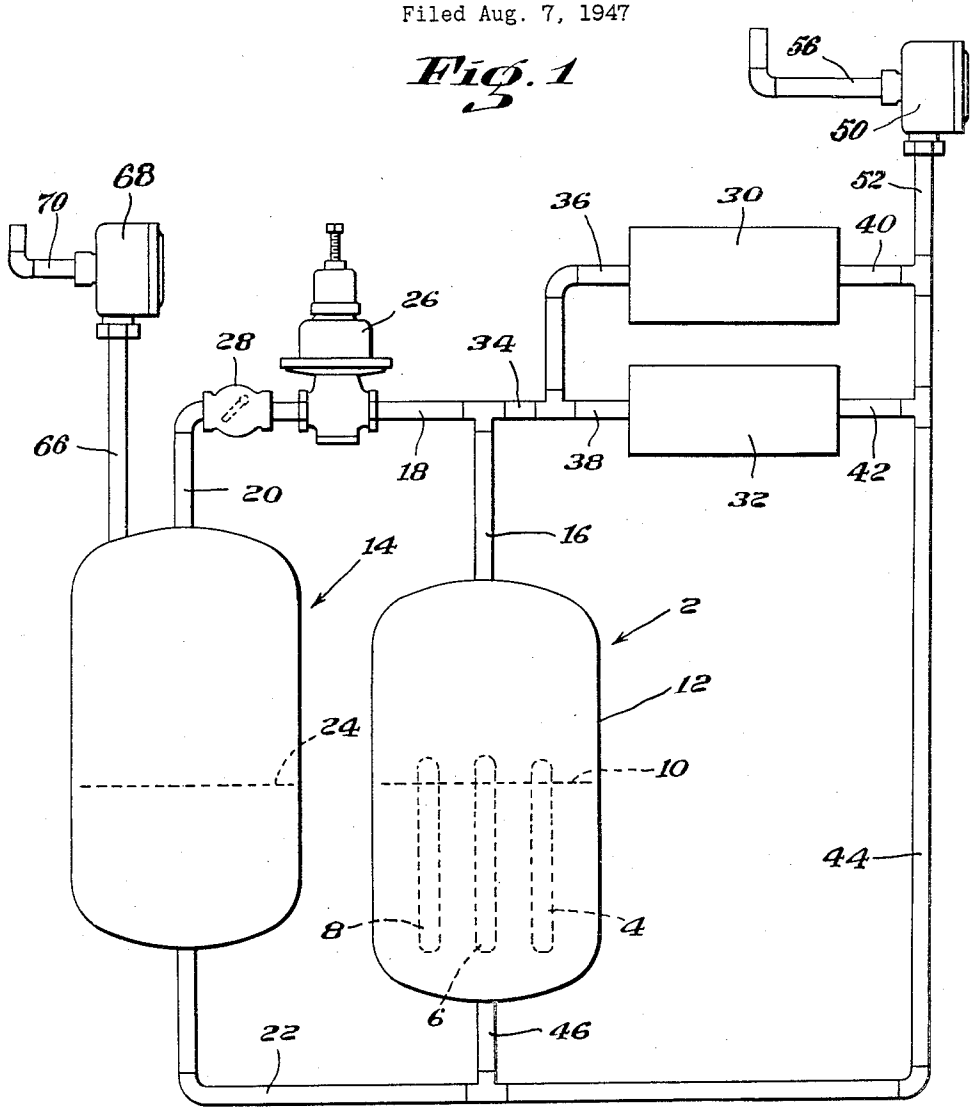
March 27, 1951 S. E. EATON 2,546,889

IMMERSED-ELECTRODE STEAM GENERATING SYSTEM

Filed Aug. 7, 1947

Fig. 1



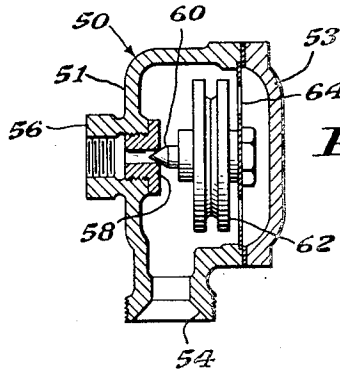


Fig. 2

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Patented Mar. 27, 1951

2,546,889

UNITED STATES PATENT OFFICE

2,546,889

IMMERSED-ELECTRODE STEAM GENERATING SYSTEM

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Application August 7, 1947, Serial No. 767,028

1 Claim. (Cl. 219—40)

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The present invention relates to steam generating systems employing the resistance of an electrolytic solution for the generation of steam at substantially constant pressure for heating purposes.

Steam generators in small sizes are a desirable type of steam supply for various kinds of multi-unit installations, particularly because by their use steam can be conveniently supplied at the particular pressure required by each individual unit.

One type of generator proposed for such use is the immersed-electrode generator. However, in employing immersed-electrode steam generators for heating purposes, it has been found that the temperature at the steam consuming unit tends to be lower than that expected for a given steam pressure, or unexpectedly drops, even when the steam pressure is continuously maintained within close limits, and that such temperature drops will occur independently of heating and cooling cycles of the consuming unit. This problem has been particularly exasperating in the case of platen presses for molding plastic materials.

The optimum temperature for press operation will vary from run to run with the size and shape of the molded article and with the plastic material which is being molded so that it is highly desirable that each individual press or a group of presses be provided with a single steam generator which may conveniently be adjusted independently of the steam supply to other units of the installation to provide steam at the optimum pressure for the job on hand.

Each time one of the described unaccountable drops in temperature occurs, the press operator must adjust his generator to raise the steam pressure above that corresponding to the desired press temperature. Then, when the press temperature rises, it is necessary to readjust the generator to lower the steam pressure. These adjustments, in addition to wasting time and lowering the quality of the molded product, lead to an extreme fluctuation in the electrical demand on the supply mains and make this type of load less attractive to the electrical power companies.

The present invention has as an object the overcoming of the foregoing disadvantages and the provision of an immersed-electrode steam generator which will be operative by pressure control to maintain continuously a predetermined uniform temperature at the steam consuming unit with a relatively steady and minimum electrical consumption.

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I have found that a source of the undesirable drop in temperature at the consuming unit referred to is a more or less continuous liberation within the system during operation of non-condensable gases, probably hydrogen and oxygen, due to electrolysis of the boiler water. These gases mix with the steam in the steam lines and in the steam consuming unit and cause the temperature at the consuming unit to be lower than that corresponding to the gauge pressure, the greater the concentration the less the temperature, despite the constancy of pressure. The steam generating system of the present invention is effective to purge the steam of these contaminating non-condensable gases and thereby overcome the annoying temperature deficiencies heretofore encountered and the fluctuations both in temperature and in current demand caused by these previously uncontrolled variations in temperature. The purged steam thus maintains the temperature at or approximating the highest level attainable at the given gauge pressure, and the temperature is uniform throughout the system because of continuous de-contamination of the steam.

An illustrative embodiment of the steam generating system of the present invention is shown in the accompanying drawings, wherein,

Fig. 1 is a schematic elevation of the electric steam generating system and a connected steam consuming unit; and,

Fig. 2 is a vertical section view of a thermostatic trap forming part of the steam generating and distributing system of Fig. 1.

Referring to the drawings, an immersion-type electric steam generator is shown at 2. This generator comprises essentially a set of three electrodes 4, 6 and 8 which are connected to the electrical supply system, for example by connecting them individually to the three lines of a three-phase power supply. The electrodes 4, 6 and 8 are partially immersed in the liquid electrolyte contained in the closed generator casing 12. When an electrical potential is applied across the electrodes current flows between the electrodes partly from one electrode to the casing and from the casing to another electrode, but mainly directly from one electrode to another. The electrical resistance to passage of current through the electrolyte within the casing 12 heats the water to the steaming point with consequent generation of steam which fills the steam space of the generator casing 12 above the water level 10. The steam space of the generator 2 is connected to the head space of a surge tank 14

through piping 16, 18 and 20 having a pressure regulating valve 26. The surge tank 14 is partially filled with water and its water-space is connected to the water-space of the generator through a line of piping 22 and 46. The surge tank 14 and generator casing 12 are appropriately electrically insulated from the rest of the apparatus. The electrolyte may comprise, for example, an aqueous solution of trisodium phosphate.

The steam generating system described is adapted to supply steam at a relatively constant pressure notwithstanding variations in the steam consumption of the steam-consuming process unit connected to it. The steam pressure within the steam space of the generator 2 rises very rapidly at maximum current consumption until the closed system is brought to a set pressure which closes normally open valve 26. Further pressure rise in the steam space of generator 2 then causes the water level 10 within the generator to be depressed, causing the water level 24 within the surge tank to rise. This depression of water level 10 decreases the immersed area of the electrodes and decreases the current flow and consequently the heat supplied, and thus acts to terminate further increase in steam pressure. As steam pressure within the steam space of the generator 2 falls, it is accompanied by a rise in the water level 10, thus increasing the immersed area of the electrodes and again increasing the heat input.

Line 18 also may contain a check valve 28 so that a sudden pressure drop at the process unit is transmitted primarily to the generator instead of to the surge tank, causing flow through line 22 from the surge tank to the generator to increase the area of the electrodes immersed in the electrolyte. The check valve 28 tends to reduce the tendency of the liquid in the system to surge with changes in load.

The bottom of the surge tank 14 is located slightly above the lower ends of the electrodes, as shown in Fig. 1. In this way maximum use of the electrolyte in the system is obtained because, as the liquid level falls to low levels, the generator is the last part of the system to be emptied of liquid.

The steam consuming unit or load, as shown in this instance comprises a pair of plastic molding platens 30 and 32 connected to the steam space of the generator 2 through line 16, line 34 and branch lines 36 and 38 respectively.

Condensate from the platens may be vented to atmosphere or returned to the water-space of the generator through return lines 40 and 42 leading to a common return 44 connected into the water space of the generator at 46.

The steam generating and distributing system of the present invention is provided with means for bleeding off from the system non-condensable gases which are present in the system when operation is initiated or which escape from the water within the system, such as oxygen or hydrogen liberated at the electrodes of the generator. The system thus provides for effective continuous operation of the generator to provide a constant temperature at the highest level attainable for the pressure for which the valve 26 is set.

The preferred means for purging non-condensable gas from the steam comprises a thermostatic trap connected into the system at an elevated point above the generator and the surge tank and preferably above the connected load.

In the embodiment shown, a thermostatic trap 50 is connected adjacent the steam consuming unit by a line 52 from the junction between returns 40 and 44 so that the trap is positioned above the tops of the surge tank and generator and above the connected load.

The thermostatic trap 50 is shown in greater detail in Fig. 2. As shown, this trap comprises a casing 51, forming, with the cover plate 53, a housing for the trap. The casing 51 is provided with an inlet connection 54 in its bottom, into which is connected the line 52. An outlet connection 56 is located in the side wall of the casing 51 above the inlet 54. This outlet connection leads the separated gases from the casing and may be connected, if desired, by suitable piping to a recovery system in which the separated gases are collected and recovered.

The passage from the inlet connection 54 to the outlet connection 56 is closed by a temperature responsive valve. This valve comprises an annular conical seat 58 surrounding the outlet port 56, and accommodating a horizontal needle valve member 60. The valve 60 is supported on a flexible diaphragm 62 which lies in a generally vertical plane and is supported on a spider disk 64 carried by the casing 51. The diaphragm is so designed that it normally holds the needle 60 out of engagement with the seat 58 at temperatures below the steam temperatures corresponding to the pressures at which the system is to be operated. However, when steam is in contact with the diaphragm 62 the diaphragm expands to cause the valve needle to seat on the seat 58. The general arrangement of the trap parts is such that condensate is fed back into and prevented from escaping from the system. This has the dual advantage of minimizing heat losses and of reducing the period for replenishing the water supply. The function of the trap, by reason of the arrangement of its parts, is thus to bleed off, in the main, only non-condensable gases which would otherwise accumulate in the system. The vertical arrangement of the trap diaphragm with the inlet connection at the bottom of the trap casing and below the outlet connection causes condensate to drain into line 52 and away from the outlet connection 56.

An additional thermostatic trap may be connected to the system at the top of the surge tank. In the installation shown, a line 66 connected into the head of the surge tank carries at its upper end a thermostatic trap 68, identical in construction with the trap 50, and having a vent line 70.

The operation of the system will be generally apparent from the foregoing description of its construction. Passage of current heats the water in the generator 2 to cause generation of steam. Steam from the steam space of the generator passes through the regulating valve 26 to the head space of surge tank 14 to control the steam pressure within the system. The steam for the connected load is drawn off at 34, passes through the platens 30 and 22 and returns, together with condensate formed within the platens, to the water space of the generator through the return line 44. Gases liberated at the electrodes as a result of electrolysis resulting from the passage of electric current through the water are entrained in and impelled by the steam and tend to collect at the highest point in the system. Any dissolved or entrained non-condensable gas brought into the system with the generator feed water and which escapes from the water within the

system, also rises to the highest point. These gases accumulate in the lines **52** and **66** and thence enter one or the other of the thermostatic traps **50** and **68**, which being somewhat remote from the circulating part of the system, tend to permit the gases to cool. These relatively cool gases so cool the diaphragm as to collapse it and cause the valve **60** to lift from its seat. The gases thus escape into vent lines **56** and **70**. When the cool gases which surrounded the diaphragm are replaced by hot steam, the diaphragm again expands and closes the valve **60**. Thus, the condensable gases are separated and discharged from the system while the steam condensate is retained.

The steam generating and supply system described will thus continuously maintain the platen presses described at a substantially uniform elevated temperature with a minimum of pressure and current consumption.

The foregoing disclosure is made by way of illustration and not of limitation and it will be appreciated that various changes therein may be made by one skilled in the art without departure from the spirit of the invention as expressed in the following claim.

I claim:

An electric steam generating system designed to maintain a high level temperature at a steam-consuming unit at substantially constant steam pressure, including a steam generator comprising a casing providing a water space and a steam space, a plurality of electrodes within said casing and immersed in water in said water space, a surge tank having a head space and a water space, first conduit connecting the head space of the surge tank with the steam space of the generator and a second conduit connecting the water space, a first conduit connecting the head space of the generator, a pressure regulating valve in said first conduit, a platen molding press connected to the steam space of said generator to receive steam therefrom, a condensate return line leading from said press to the water space of said generator, a thermostatic trap connected to said return above said press and a second thermostatic trap connected to the head space of said surge tank and located above said tank, said trap serving to purge steam in said system of non-condensable gases.

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