

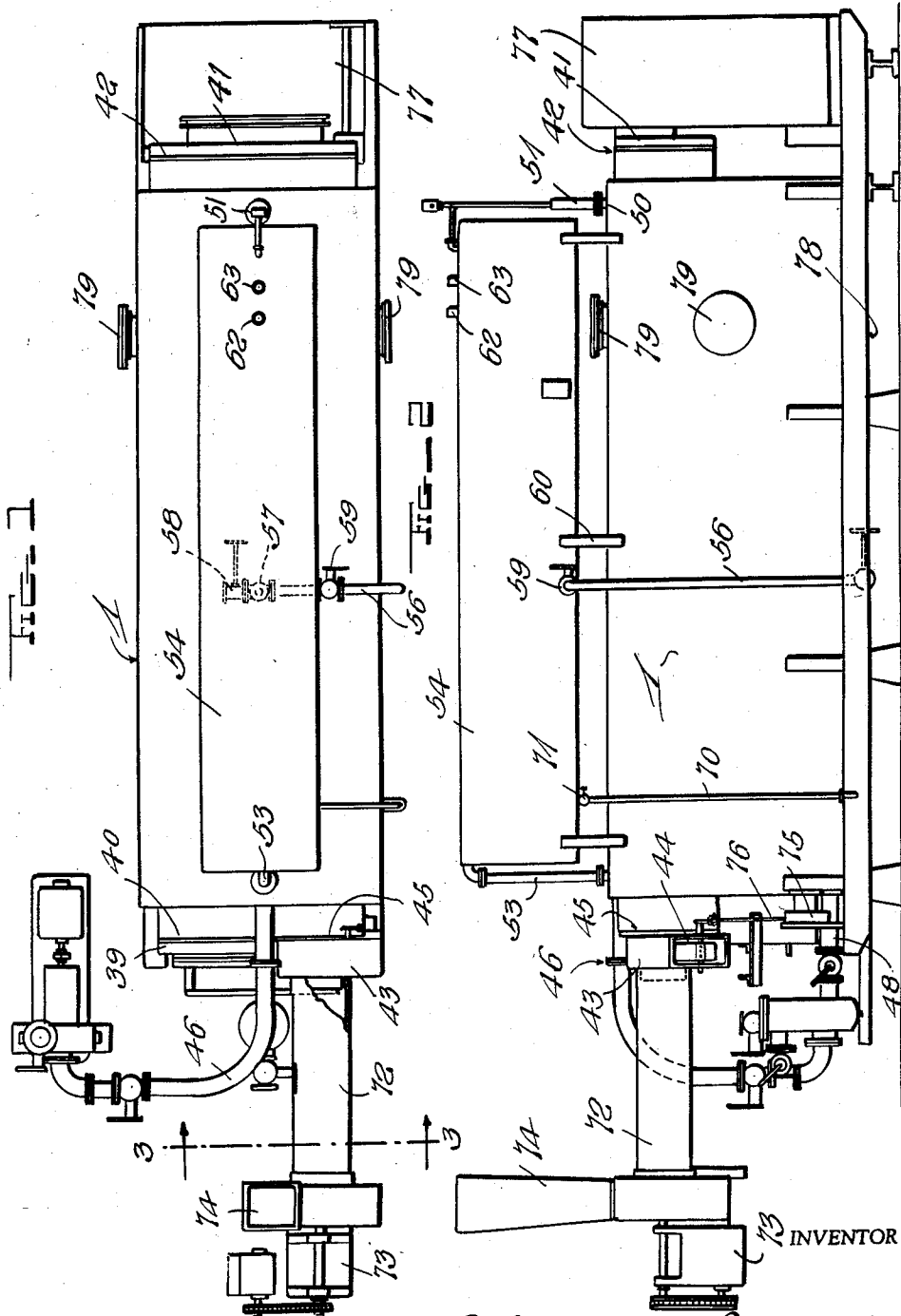
Nov. 3, 1959

R. C. SWANEY
HEAT EXCHANGER SYSTEM

2,910,972

Filed Dec. 5, 1955

8 Sheets-Sheet 1



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HEAT EXCHANGER SYSTEM

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FIG. 3

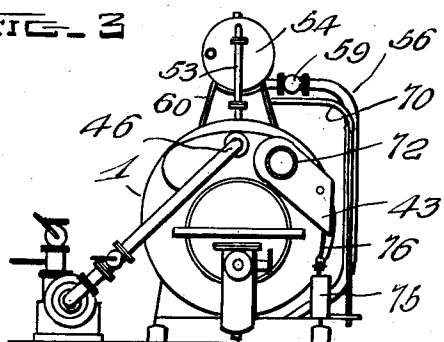
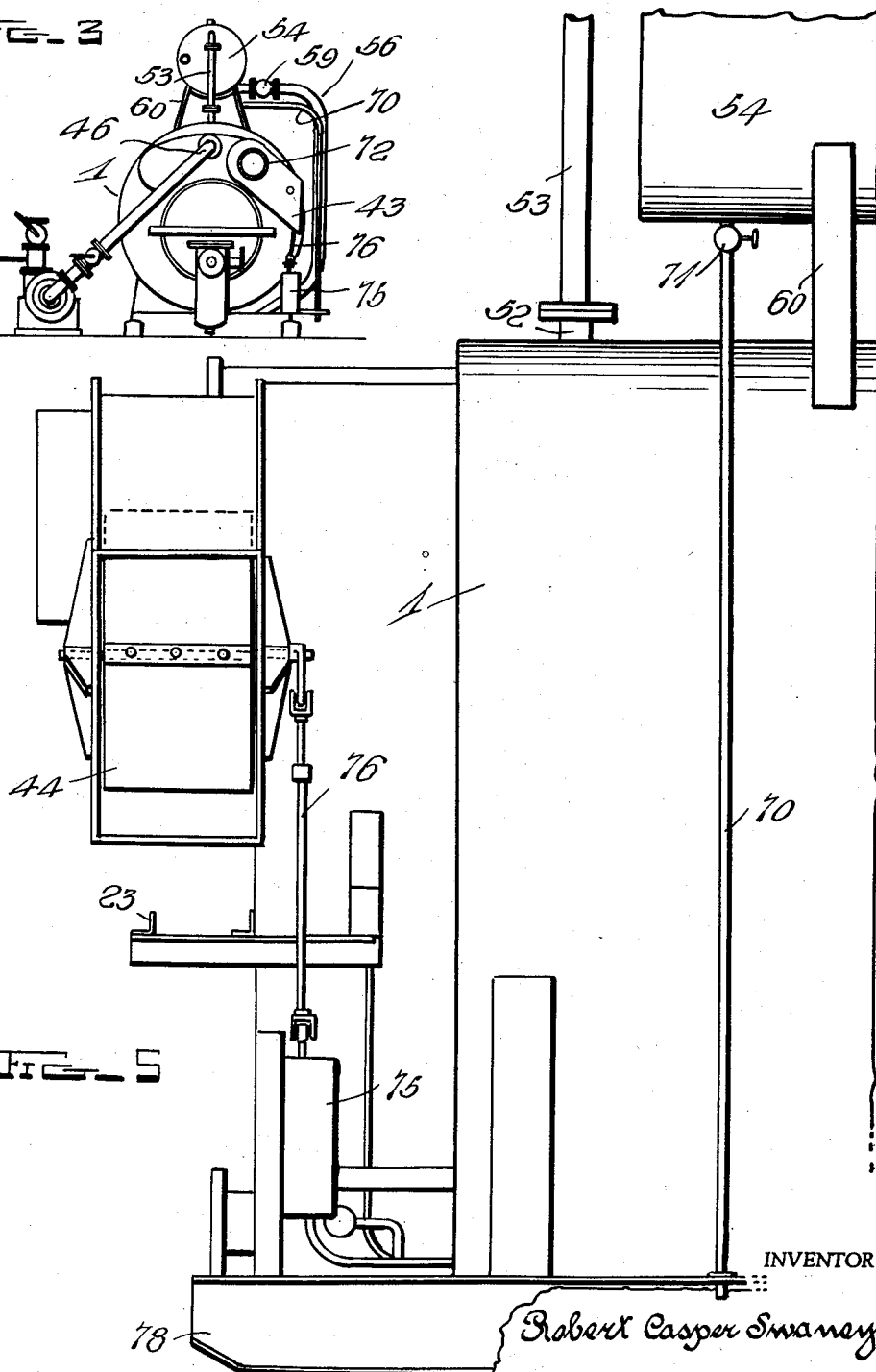


FIG. 5



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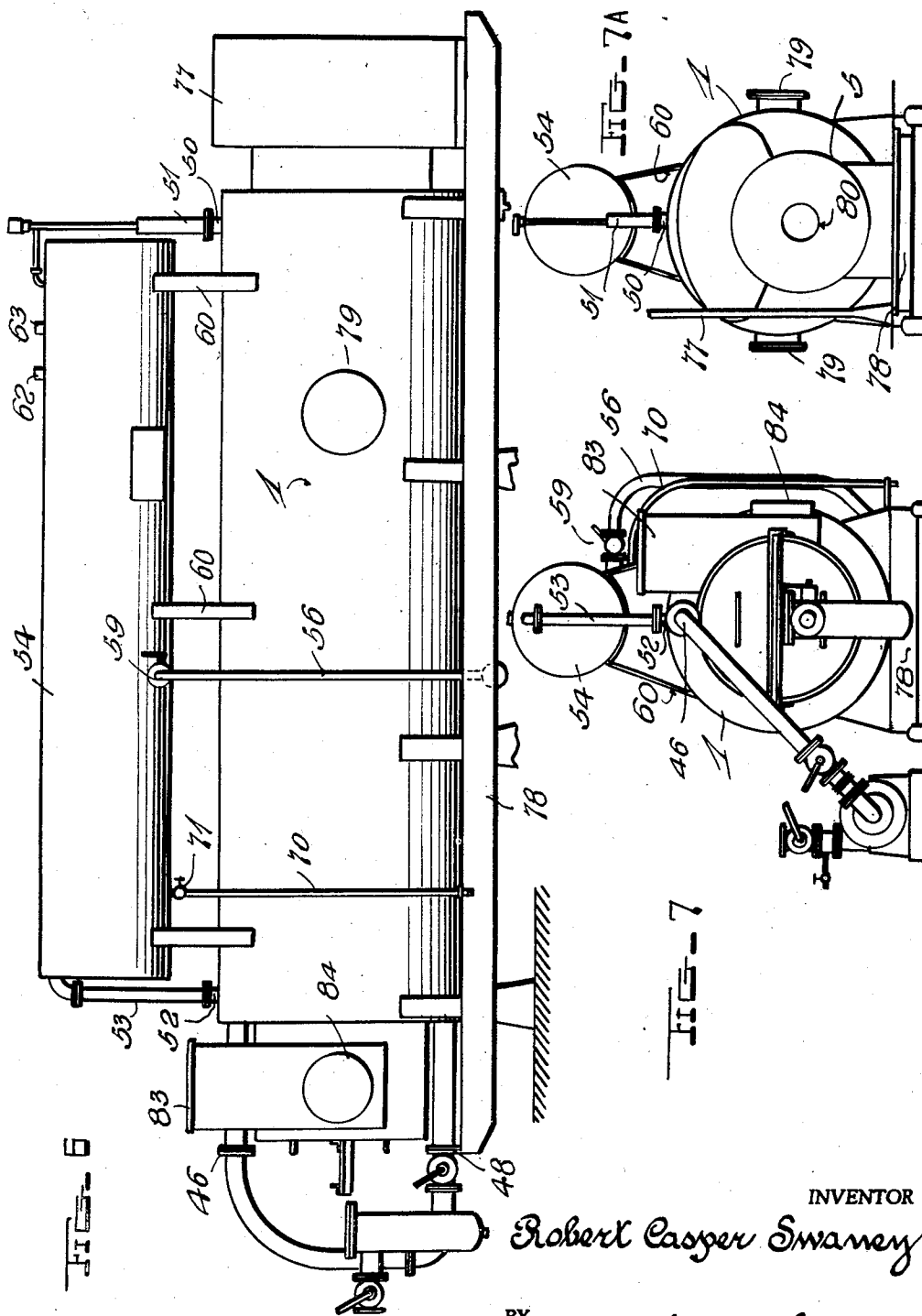
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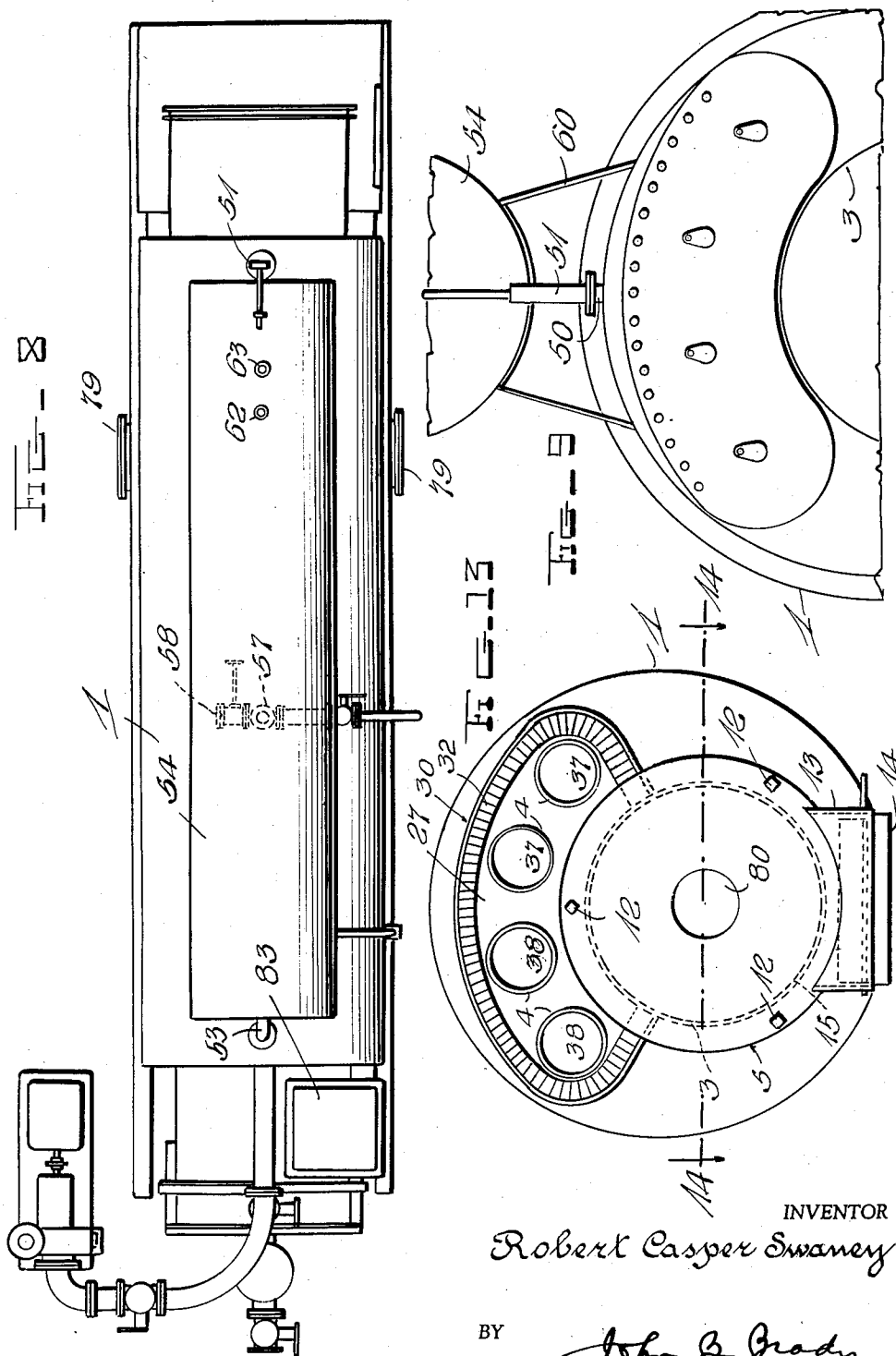
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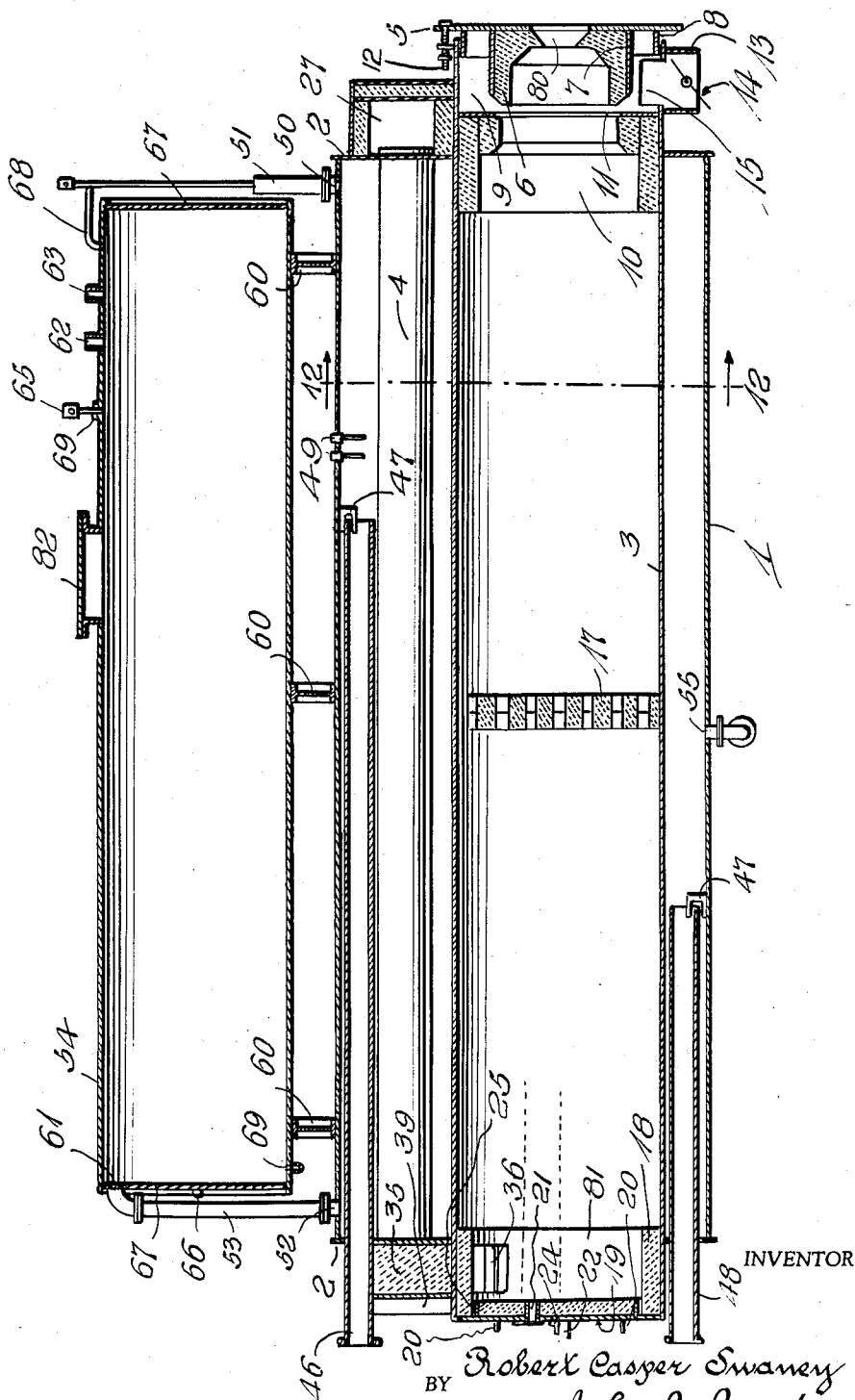
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FIG. 10



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FIG. 11

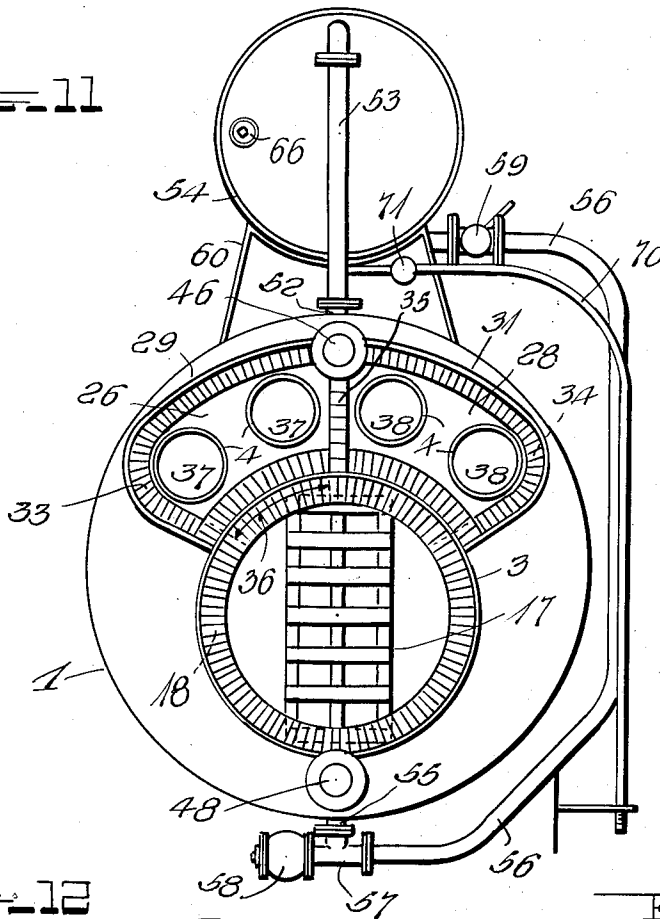


FIG. 12

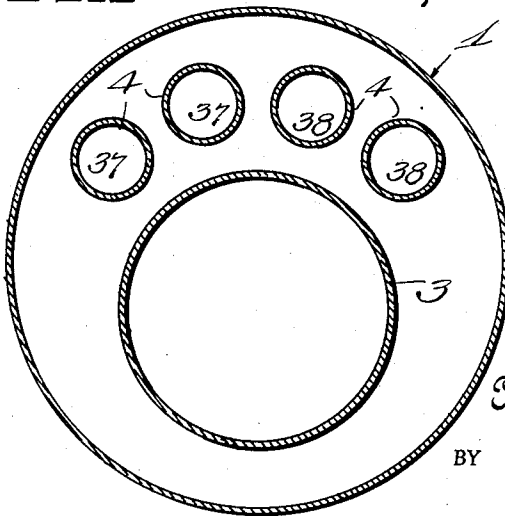
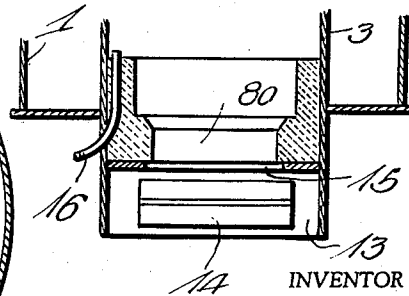


FIG. 14



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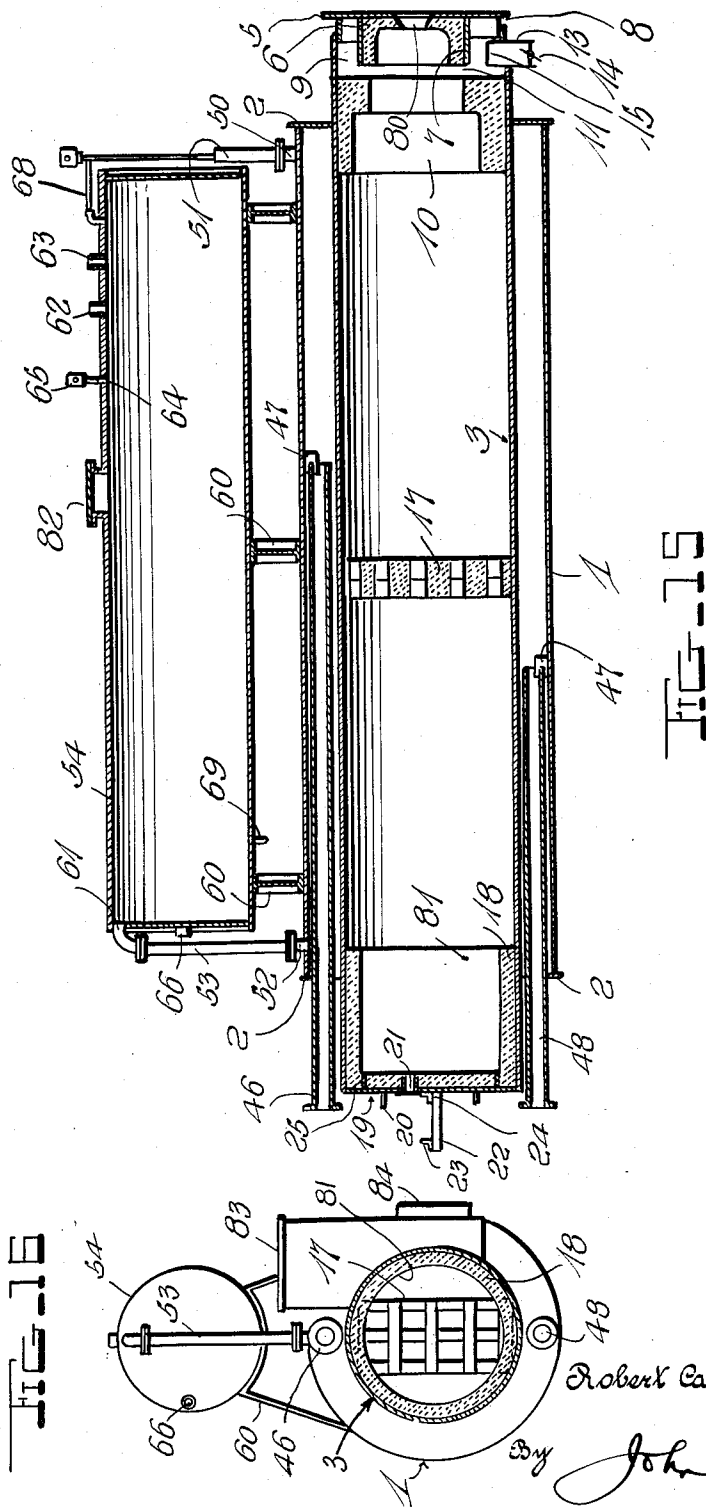
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HEAT EXCHANGER SYSTEM

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8 Sheets-Sheet 8



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2,910,972

HEAT EXCHANGER SYSTEM

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Application December 5, 1955, Serial No. 550,954

8 Claims. (Cl. 122-136)

My invention relates broadly to heat exchanger systems and more particularly to a novel construction and arrangement of improved heat exchanger apparatus and method of operating the same.

One of the objects of my invention is to provide a heat exchanger system which is highly efficient in its operation and utilizes to a maximum extent all of the heat developed by the heat transfer medium.

Another object of my invention is to provide a construction and arrangement of heat exchanger apparatus in which both primary and secondary combustion may be effected and a controlled turbulence of the combustion produced for effecting a maximum utilization of heat in the heat transfer medium.

Still another object of my invention is to provide an arrangement of fuel-fired heat exchanger unit in association with an expansion-seal tank through which the heat transfer medium is passed for fully utilizing heat in the heat transfer medium.

Other and further objects of my invention reside in a novel arrangement of heat transfer units in a heat exchanger system as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

Fig. 1 is a top plan view of one form of heat exchanger system embodying my invention, the view illustrating a three-pass system;

Fig. 2 is a side elevational view of the heat exchanger system shown in Fig. 1;

Fig. 3 is a transverse sectional view taken on line 3-3 of Fig. 1, the view showing the heat exchanger apparatus in end elevation;

Fig. 4 is an end view of the heat exchanger apparatus illustrated in Figs. 1-3, on an enlarged scale, with certain of the parts broken away and illustrated in section to illustrate more clearly the arrangement of flues and the damper control;

Fig. 5 is a fragmentary view of the end of the heat exchanger apparatus, illustrating particularly the damper control mechanism in elevation;

Fig. 6 illustrates a modified form of heat exchanger apparatus embodying my invention, the view showing the application of my invention to a single-pass system;

Fig. 7 is an end elevational view of one end of the apparatus shown in Fig. 6;

Fig. 7A is an end elevational view of a burner of the apparatus shown in Figs. 1, 2 and 10;

Fig. 8 is a top plan view of the heat exchanger apparatus illustrated in Figs. 6 and 7;

Fig. 9 is a fragmentary end elevational view of the exhauster of the heat exchanger apparatus illustrated in Figs. 1, 2 and 10;

Fig. 10 is a vertical sectional view through the heat exchanger apparatus of Figs. 1-5;

Fig. 11 is an end elevational view of the heat exchanger equipment shown in Fig. 10, with the flue box cover bleed-in damper assembly and the furnace end removed;

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Fig. 12 is a vertical sectional view on line 12-12 of Fig. 10;

Fig. 13 is an end view of the heat exchanger apparatus showing as in Figs. 1 and 2 the burner end of the heater with the flue box cover removed;

Fig. 14 is a fragmentary sectional view taken on line 14-14 of Fig. 13; and

Fig. 15 is a fragmentary longitudinal sectional view of the single pass construction heat exchanger shown in Figs. 6, 7 and 8; and

Fig. 16 is an end view of the structure shown in Fig. 15 with the furnace end removed.

Hereinafter I have used the letters HTM to express the meaning "Heat Transfer Medium" or "Heat Transfer Media" as the case may be in order to shorten the description of my invention.

The heat exchanger unit of my invention consists of a cylindrical vessel which I call the drum 1 closed by heads 2 at both ends to contain liquid, extending through both of which heads is a cylindrical tube or furnace 3, and flues 4. The furnace 3 is extended through both heads 2 to accommodate the fuel burner and combustion apparatus hereinafter described and arranged on the one end, and the insulated acceleration chamber with relieving furnace end on the other also as hereinafter described. The fuel burner is mounted externally on or to the burner mounting plate 5 and into the port 80 in which and through which the burner nozzle discharges the fuel and primary combustion air which are ignited in ignition tile 6 mounted inside of burner mounting plate 5. The ignition tile 6 is usually supported in cylindrical tile holder 7. A sealing and support band 8 on the inside of mounting plate 5 supports the complete assembly in the end of the furnace 3 extension (in most cases); and furnace 3 extension, sealing and support band 8 and burner mounting plate 5 in combination with each other form wind box 9. Displaced inwardly from the furnace 3 extension end is a combustion tile 10. Combustion tile 10 is made of refractory material or fire brick installed in the conventional manner. The ignition tile 6 is a refractory material or fire brick and shaped to suit the burner and suitable for the fuel to be burned. Both the ignition tile 6 and the combustion tile 10 are cylindrical in shape. The ignition tile 6 has a peripheral portion thereof longitudinally aligned with a peripheral portion of the combustion tile 10 and the ignition tile 6 may be linearly moved into peripheral abutment with combustion tile 10, or retracted with respect thereto. Secondary combustion air enters the combustion tile 10 through gap or tuyere 11 which is a full circular opening 360° around the end of the ignition tile 6 and the throat of the combustion tile 10. The path along which the combustion air enters the combustion tile 10 converges from the adjacent edges of the peripheral portions of the ignition tile and the combustion tile in an inwardly inclined path which is substantially frustoconical in shape, meeting in an apex or focus within the cylindrical combustion tile. The peripheral end portion of the ignition tile 6 is inclined in the direction of the combustion tile 10 and serves as an annular guide for the movement of the combustion air in the inwardly inclined path of the apex or focus within the cylindrical combustion tile. Burner mounting plate 5 is usually fitted with suitable adjustable or screw devices 12 by which to move the complete assembly of burner, mounting plate 5, ignition tile 6 and sealing and support band 8 inwardly and outwardly of the furnace 3 extension to vary the gap or area of tuyere 11 to provide the proper velocity to the proper amount of secondary combustion air, due to pressure drop through tuyere 11, to create turbulence in the fire. Adjustment of tuyere 11 in combination with the exhauster 73 and draft controls provide a positive, accurate control of the secondary air

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with the correct velocity and attendant turbulence for the most efficient combustion. An entrance box 13 usually rectangular in section, fitted with a damper 14, is joined to the furnace 3 extension and opening 15 in the furnace 3 extension to provide entrance for the secondary combustion air into wind box 9 and to regulate it at the lower firing rates; the tuyere 11 etc. described above being the means for regulation of the secondary air at the higher firing rates. Normal firing is with an automatic fuel burner adjusted and controlled to fire at a low firing rate and at a high firing rate. At the high firing rates the damper 14 opens to a point beyond any controlling of the secondary combustion air and at the low firing rate the damper 14 closes to a point where it limits the secondary air just sufficient for efficient combustion at the low firing rate. Although the entrance box 13 etc. are shown at the bottom of the furnace 3 extension, they may be installed at any other convenient or practicable point opening into the wind box 9. A sample pipe 16 connecting to the draft control apparatus on the power and control panel continuously reports the combustion pressure in the furnace 3 to the instruments for maintaining the proper draft for efficient combustion. The conventional means of introducing or admitting secondary combustion air in fuel burners on similar furnaces, or more in fact most furnaces, is through one large port or a series of ports in the combustion box or furnace. My improvement or invention is very definitely superior because it distributes the secondary combustion air uniformly and completely around the ignition tile and into the combustion zone and there are no rich or lean areas in the fire; and further it provides the only accurate and controllable means by which to vary the velocity of the secondary combustion air into the combustion zone and the turbulence within the fire for the most efficient combustion of the fuel.

A combustion target 17 consisting of fire bricks stacked in a honeycomb manner without mortar is usually placed in the furnace 3 at the optimum distance from the combustion tile 10 to act as a refractory for completing combustion and increase turbulence in the center and part of the furnace 3 zone away from the fuel burner. The other furnace 3 extension which is lined with insulating brick or refractory in a conventional manner defines a zone I called an acceleration chamber 81. I have observed that in similar conventional furnaces the products of combustion must accelerate to get out through the stack or through the furnace exit because the area of the stack or exit opening is always less than that of the furnace which causes the exiting gases to form a vortex in the furnace so they can exit and in so doing also create a dead space in the end of the furnace both of which effect and reduce the heat transfer in that area of the furnace. It is usually desirable and good practice to increase the velocity of the gases in the return flues or passes to improve convection therein. In my invention I provide four to eight times the velocity through the return flues 37 and 38 compared to the velocity through the furnace 3. To obviate lowering the heat transfer efficiency in the exit end of furnace 3 due to the vortex and dead space resulting from the acceleration of the gases, I extend the furnace 3 as described and shown and line it with insulating refractory so not reduce its area too abruptly but to substantially remove the effects of the acceleration out of furnace 3 into the acceleration chamber 81. The furnace end 19 closes the end of the acceleration chamber. The furnace end 19 is lined with insulating brick or refractory in a conventional manner and is provided with handles 20 for easy handling and placing, and having a peephole 21 with movable cover for observing inside the furnace 3. Support rails 22 are attached to furnace 3 extension having their ends tied together with safety angle 23 to support furnace end 19 on its support angle 24. The furnace end 19 serves as an ample access door for servicing and cleaning furnace 3, combustion target 17, combustion tile

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10, etc.; and as an extremely efficient pressure release device for furnace 3 requiring only a very few inches water column pressure to move it outwardly along its support rails 22. It cannot return to the closed or sealing position by itself but must be replaced manually, and it is so balanced that its weight holds it firmly against the seal gasket 25, usually made of asbestos rope, to prevent combustion gas leakage or air infiltration. Further, immediately it is moved outwardly from its normal or closed and sealing position it tips or tumbles to an angle fully relieving any pressure that could be generated within the furnace 3 from whatever cause including false ignition, combustion puff, etc. The effective relief area of the furnace end 19 is equal to the full area of the furnace 3 less the insulating refractory or lining 18 which makes it an extremely efficient relief mechanism. Thus, immediately the furnace end 19 opens the pressure in the combustion zone and the furnace 3 which operates at less than atmospheric pressure immediately increases to atmospheric pressure which is reported by way of the sample pipe 16 to the draft control and safety device which de-energizes all apparatus on the heater and no further operation can occur until the difficulty is rectified, the furnace end 19 replaced to its proper position and the control re-set. This is a very important improvement over the conventional gravity seating or spring loaded relief or explosion doors used on boilers, etc., which close and re-seat or re-seal immediately after performing their relieving function. Such devices are often defective as they permit repetition of the very action they are to compensate for and I have seen them explode several times before other safety devices can come into play and de-energize the apparatus. I know of two such instances where serious damage was caused by such repetition.

The flues 4 extending through the heads 2, which extend through the heads 2 only for efficient mechanical construction, open into flue boxes 26, 27 and 28, constructed of shrouds 29, 30 and 31 (Figs. 11 and 13) and lined with insulating bricks or refractory 32, 33 and 34. Flue box 26 is sealed from flue box 28 by insulating brick or refractory wall 35. An opening 36 permits the products of combustion to leave acceleration chamber 81, after leaving furnace 3 and accelerating in acceleration chamber 81, into flue box 26 and enter first return flues 37. Flue box 27 permits the products of combustion to leave the first return flues 37, cross over the end and through the flue box 27 and enter the second return flues 38.

Hence, it will be seen readily that the fuel and air are burned in the combustion zone and furnace 3, the products of combustion travel through and around combustion target 17 to the end of the furnace 3, where their rate of travel or velocity is accelerated in the acceleration chamber 81, pass through opening 36 into flue box 26, enter and pass through first return flues 37, into and through flue box 27, and enter into and through second return flues 38 and out into flue box 28. Thus, my invention would be nominally termed three-pass construction or a three-pass heater.

Flue box 26 is covered by flue box cover or shroud 29 and sealed by gasket 40. Flue box 27 is covered by flue box cover 41 and sealed by gasket 42. Flue box 28 is covered by bleed-in housing 43 having damper assembly 44 and sealed by gasket 45. Flue box covers are lined with insulating bricks or refractory. The fastenings (nuts, bolts, clips, etc. for holding in place) for the flue box covers and bleed-in housing, etc., are omitted to simplify the drawings and specifications; because they are not generic to the invention.

A suction line nozzle 46 extends through the heat-exchanger head opposite the fuel burner parallel with the axes of the drum 1, furnace 3 and flues 4, the entrance end of which is located at a point displaced between the heads 2. Since this suction line nozzle is usually a long pipe it is not practicable to support it

simply by attaching it to the head 2; therefore, I have invented an expansion-support clip 47 which is attached to the inside of drum 1 and supports the end of the suction line nozzle 46 in its proper position but permits movement slightly in any direction that might develop due to thermal expansion and contraction or distortion in shipping and handling or any other cause which might set up stress within the structure if its ends were securely fastened.

A return line nozzle 48 also extends through the heat-exchanger head opposite the fuel burner, it, too, being parallel with the drum 1, furnace 3, flues 4 and likewise with suction line nozzle 46. The exit end of the return line nozzle 48 is located at a point displaced between the heads 2 and usually displaced away from the entrance end of the suction line nozzle 46, although this is not entirely necessary. The important part of the return line nozzle 48 is that it must extend sufficiently far into the heat-exchanger to allow effective venturi action as a result of the jet like discharge of HTM from it. The return line nozzle 48 also is a relatively long pipe and it is not practicable to support it simply by attaching it to the head 2; therefore, I employ an expansion-support clip 47 for it in the same manner and for the same reasons as for the suction line nozzle 46. The return line nozzle 48 should be long enough inside the heat-exchanger to utilize the effect of the venturi action resultant from the discharge jet like stream of the HTM jetting from the return line nozzle 48. One of the cardinal features of my invention is to perform a rapid and efficient reheating of the HTM and consequently an efficient heat transfer. This is accomplished by a completely and extremely turbulent state of the HTM within the heat-exchanger which occurs at atmospheric pressure during circulation of the HTM to, through and from process. The returning HTM leaves the return line nozzle 48 in a jet like stream which in practically all circumstances has sufficient velocity or more to maintain its identity until it reaches or nearly reaches the head 2 at the burner end although it is slowed and widened to some extent by the viscous drag of the surrounding HTM. As the said jet like stream approaches the said head 2 the resistance there divides it and it sweeps turbulently upwardly on both sides of furnace 3 and around flues 4; then turbulently backward along the top of the heat-exchanger toward the other head 2 through which it entered; as it approaches head 2 through which it entered the resistance there tends to direct it turbulently downwardly and it becomes caught into the venturi effect and action created by the said jet like stream, in that area surrounding the return line nozzle 48. A like volume returns via the return line nozzle 48 as leaves via the suction line nozzle 46 and since the heat-exchanger is at atmospheric pressure no circulating stress can be imparted to the heat-exchanger or heater structure however great the circulating rate. Since turbulence within a liquid, or a gas, is a circular like or type of motion or movement, I have made all the elements of my invention of cylindrical shape except the heads 2 which are flat, to coincide with, aggravate and accelerate as much as possible and preserve that turbulence in the HTM within the heat-exchanger. Thus, the result is a completely and thoroughly turbulent washing of all the heating surfaces of the heat-exchanger: (or, if preferred, all of the heat transfer surfaces of the heat-exchanger). The displacement and relative proportions and positions of the elements of my invention are such that even without circulation of the HTM to, through and from process (with the attendant consumption or transfer of heat) there is adequate natural gravity convection of the HTM within the heat-exchanger (or, if preferred, all of the heat safely and without detriment to the HTM or any of the apparatus within the temperature limits of the HTM and the heater. There is sufficient reserve heat transfer capacity in the complete apparatus, including the HTM

within the heat-exchanger, so that full firing rate of the fuel burner will not overheat the heater or HTM even in any local spot and under such conditions the HTM will rise in temperature faster than when it is circulating and transferring heat to process but there are always adequate margins so the control and limiting instruments fully protect the apparatus and the HTM, which is a very advanced construction and improvement over conventional liquid heat generators and even many vaporizers and boilers. If the heat users or process apparatus are located above the heater, a system could be engineered relatively easily in which complete circulation would result from natural gravity convection; but it is desirable and often necessary because of the heating process or apparatus to be served, to install a circulator(s) or pump(s) in the circuit(s).

The physical arrangement of the drum 1, furnace 3, flues 4, suction line nozzle 46 and return line nozzle 48 should be such that all are parallel with each other but the displacement of their axes with respect to each other as shown and described are not necessarily limited for operation of the apparatus although the arrangement described and disclosed is the best mechanical arrangement and the best for the most efficient heat transfer.

The drum 2 is fitted with dry wells 49 to receive the sensing elements of the instruments, controls, thermostats, etc. They are usually two or three in number but the number is determined by the instrumentation, controls, etc. desired or required. These are usually located in the top of the drum 2 near the entrance to the suction line nozzle 46 for the best results.

An opening or fitting 50 is provided in the top of the drum 2 usually near the end opposite the suction and return line nozzles (near the burner end) for attaching or installing a low HTM level safety switch 51.

An opening or fitting 52 is provided in the top of drum 2 near the same end through which the suction and return line nozzles 46 and 48 enter, for attaching a vent pipe 53 connecting with and opening into the upper part of expansion-seal tank 54. The position of this opening and pipe is important. Since the flow of the HTM in the top of the heat-exchanger is turbulently toward the head 2 through which the suction 46 and return 48 line nozzles enter, any vapors, air, gases, light ends, etc. which might be in, become trapped or enter into the system and find their way to the heat-exchanger will be carried and washed immediately to the area at the top of the heat-exchanger near said head. Thus, with the vent pipe 53 so located said vapors, gases, etc. will be automatically and immediately voided out of the heat-exchanger, through said vent pipe 53 and into the top of the expansion-seal tank 54. I have observed by actual operation and testing of models and heaters that if vent pipe 53 and its opening 52 are at any other area the flow of the HTM along the top of the heat-exchanger is strong enough, even with less than full circulation rates, that an objectionable and troublesome amount of vapors, etc. if present, will be trapped in this area due to the hydraulic velocity and greater density of the HTM, and circulation must be stopped to permit the said vapors, etc. to find their way to the vent.

An opening or fitting 55 is provided in the bottom of the heat-exchanger to which is attached a make-up or equalizing pipe 56 which leads from the opening 55 in the bottom of the heat-exchanger to a point opening into the lower part of expansion-seal tank 54. A T 57 is usually installed between opening 55 and line 56 to the other opening of which T 57 a valve 58, which is usually a slow opening type, is installed for draining or filling the heater. Line 56 is usually fitted with a valve 59. Line 56 is the make-up or equalizing line between the heat-exchanger and expansion-seal tank 54 to keep the heat-exchanger full of HTM at all times and to equalize the HTM level in vent pipe 53 and low level HTM safety switch 51; and to provide for thermal expansion and contraction of the HTM in the system or to accommodate any surging that

might occur. Usually three inspection and access ports are provided in the sides and top of the drum 1 to facilitate inspection and service inside the heat-exchanger. These are usually forged steel flanged devices, gasketed and fastened with stud bolts and nuts. Note: On a single-pass heat-exchanger there are usually one or two inspection and access ports: one on each side.

The expansion-seal tank 54 is a liquid-tight, usually cylindrical, vessel closed by heads 67 at each end, with various openings and fittings as herein described and disclosed. The expansion-seal tank 54 should be installed so that its bottom is equal to or above the height of the highest element or part of the heat-exchanger but never lower. Usually the expansion-seal tank is installed 12 to 24 inches above and supported above the heat-exchanger on saddles 60 on the heat-exchanger or externally or independently supported. The opening or fitting 61 in expansion-seal tank 54 to receive vent pipe 53 should be near the top of expansion-seal tank 54. Fitting or opening 62 is furnished in the expansion-seal tank 54 to fill the apparatus with HTM or to measure the HTM level in the expansion-seal tank—which opening or fitting 62 should always be closed tightly with a plug, cap or similar device. Fitting or opening 63 is provided for attaching a vent pipe which should not have any valves, restrictions or restrictive devices and should be open to atmosphere at all times and never longer or higher than necessary to carry vapors, etc. or HTM that might have to be vented, to a safe space or area. Opening or fitting 64 is often provided for a sensitive pressure switch or safety device 65 which, if pressure in expansion-seal tank slightly exceeds atmospheric such as two oz. per sq. inch, will perform safety shut-down of the apparatus. Although the apparatus operates at atmospheric pressure such mishandling as filling the expansion-seal tank full of HTM to overflowing could be dangerous but the safety switch 65 causes a safety shut-down. Overflow opening or fitting 66 is usually provided in one end or head 67 of the expansion-seal tank 54 but it could be at any convenient point. This overflow 66 determines the maximum height or level of HTM that should be permitted in the expansion-seal tank 54 and experience demonstrates it should not ordinarily be carried over half-full and normal operating level is usually six to twelve inches above the bottom of expansion-seal tank 54. If the expansion of the HTM in the system is so great due to the size of the system and the amount of HTM that the HTM level will rise above the middle of expansion-seal tank 54 or overflow 66, then overflow 66 should be piped to the top of a safe and safely located overflow or storage tank; said pipe from overflow 66 to top of overflow storage tank pitching downwardly. Opening or fitting 68 is provided to receive equalizing connection from low level HTM safety switch 51 on heat-exchanger. The HTM level should not be carried above the half-full point of expansion-seal tank 54 so that any vapors, gases, air, etc. voiding from the heat-exchanger via vent pipe 53 can disperse themselves over the HTM in the expansion-seal tank 54 and pass out through the vent 63 to the atmosphere. Opening or fitting 69 is provided in the bottom of expansion-seal tank 54 to which is attached drain pipe 70 having drain valve 71. Make-up or equalizing pipe 56 enters the expansion-seal tank 54 near the bottom, therefore, if any vapors condense in the expansion-seal tank 54 which are heavier than the HTM they will not enter make-up or equalizing pipe 56, but will be trapped in the bottom of the expansion-seal tank 54 and can be drained off via opening 69 and drain pipe 70 through drain valve 71. This is an important feature of my invention that other liquid heat generators do not have. When vapors, gases, etc. get into the system my invention will void them automatically without foaming and overflowing the HTM into the surrounding area. Whereas, conventional systems relieve themselves through an expansion tank arrangement through which the vapors, gases, etc. must be forced and bubbled through the HTM

in the expansion tank. But in my invention the vent pipe 53 extends from the top of the heat-exchanger to the upper part of the expansion-seal tank 54 so that any vapor, gas, etc. must be voided and spewed over the top of the HTM in the expansion-seal tank 54; thereby not creating a bubbling foaming mass out of the HTM in the expansion-seal tank 54. The relatively cold HTM in the make-up or equalizing line 56 and its length have enough more resistance over that of the relatively hot HTM and the short length or column of HTM in vent pipe 53 that venting via vent pipe 53 is positive, although both are at atmospheric pressure. The expansion-seal tank 54 I so named for another important feature. Since make-up or equalizing pipe 56 connects with the bottom of the heat-exchanger through opening or fitting 55 and connects with expansion-seal tank 54 near its bottom. Heat must, therefore, be conducted downwardly through the bottom of the heat-exchanger, through and along intermediate fittings, pipe and HTM until convection can result vertically in make-up or equalizing pipe 56, and thus the HTM in the expansion-seal tank 54 will normally remain at 200 to 250° F. while heating HTM in the heat-exchanger at 500 to 600° F. I have measured these temperatures under actual operating conditions. This is very important. Many HTM oxidize rapidly at elevated temperatures and the higher the temperature the more rapidly the oxidation occurs. For example: a HTM that will oxidize in two years at 350° F. will oxidize in a very few hours at 600° F. My invention provides and maintains a very effective "cold" seal at atmospheric pressure. Hence, the term expansion-seal tank, or expansion-cold-seal tank as I sometimes call it. Sometimes the expansion-seal tank 54 is provided with an inspection and access port 82, for servicing and inspection and it, too, should be adequately gasketed and fastened.

A breeching 72 is usually provided between bleed-in housing 43 and exhauster 73, with a stub-stack 74 on exhauster 73 to carry away the products of combustion and bleed-in air. Exhauster 73 is usually a conventional industrial exhaust fan running at constant speed which induces the draft through the entrance box 13, wind box 9, tuyere 11, combustion tile 10, furnace 3, acceleration chamber 81, opening 36, flue box 26, first return flues 37, flue box 27, second return flues 38, flue box 28, bleed-in housing 43, bleed-in damper 44 and breeching 72; and exhausts all of the products of combustion and bleed-in air through stub-stack 74.

The bleed-in damper 44 may be positioned manually to bleed-in the proper amount of atmospheric air to create proper draft in the combustion zone, etc. and to cool the products of combustion and prevent overheating of the exhauster 73, although it is usually positioned automatically by an operator 75 through linkage 76 which responds to energy transmitted to it from a draft control and regulating instrument mounted on the power and control panel 77, which receives the measurement of the combustion pressure in furnace 3 through an intermediate piping arrangement connected with sample pipe 16 which terminates and opens into furnace 3. The draft control through the sequences established, positions the bleed-in damper to maintain the proper combustion pressure in furnace 3 whether at high or low firing rate, and the bleed-in housing also serves as a mixing chamber to mix the bleed-in air with the products of combustion thereby reducing the high erosion and chemical action on the steel parts which occurs when handling high temperature products of combustion.

My invention as hereinbefore described and disclosed is a three-pass design; but it may also be made in a single-pass design as shown in Figs. 6, 7, 15 and 16, in which construction the principal parts are the same as on the single-pass design except there is not usually an exhauster or induced draft system—only a natural draft stack added to the stub-stack 83. The single-pass design is usually equipped with a stub-stack 83 at the base of which is a

barometric draft adjuster 84 instead of a bleed-in housing 43 and automatic bleed-in damper 44. The heat-exchanger unit is the basic difference: in which the heat-exchanger consists of a cylindrical vessel which I call a drum 1 closed at both ends by heads 2 to contain a liquid, extending through both of which heads 2 is the furnace 3. The furnace 3 extension, supporting and containing the fuel burner and combustion parts, are all constructed in the same manner and function in the same manner as on the 3-pass design hereinbefore described and disclosed. The other furnace 3 extension accommodates the acceleration chamber 81 and is closed by furnace end 19 the same as on the 3-pass design. Obviously the flue boxes 26, 27 and 28, and the first return flues 37 and second return flues 38, etc. are omitted. Thus, the opening 36 now becomes the exit for the products of combustion out of the acceleration chamber 81 into the stub-stack 83 at the base of which is the barometric draft adjuster 84 which bleeds in air automatically. However, if induced draft is desired or required then, the bleed-in damper 44 with its operator 75 and linkage 76 will be substituted for the barometric draft adjuster 84; and the breeching 72, exhauster 73 and stub-stack 74 in proper sequence and arrangement as hereinbefore described and disclosed will be substituted for or attached to stub-stack 83; and the sample pipe 16 will be provided in the furnace 3 and connected to the necessary automatic controls and instruments as in the case of the 3-pass design. All other features, parts, etc. are and function the same as in the 3-pass design.

The HTM may be circulated to, through and from process indirect heating apparatus in any conventional manner except that outgoing (hot) HTM should be taken through suction line nozzle 46 and returning (cooled) HTM should be returned through the return line nozzle 48, always. Any number of circulators or pumps may be used; as long as the process heat requirements do not exceed the capacity of the heater.

The heat-exchanger, expansion-seal tank, power and control panel, fuel burner and all attendant piping, wiring, instruments, controls, etc. are usually installed in their proper relationships as herein described and disclosed and mounted on a main skid frame 78. The circulator(s) or pump(s) are usually mounted on separate bases and located where good engineering practice dictates although they can be installed in almost any particular location or even on the skid frame 78 by making provision therefor.

The fuel burner is usually a commercial device with the conventional automatic controls and safety devices plus additional controls and safety devices I add to make the best and most efficient apparatus.

While I have described my invention in certain preferred embodiments I realize that modifications may be made, and I desire that it be understood that no limitations upon my invention are intended other than may be imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A fuel-fired heat exchanger consisting of a cylindrical drum closed by heads at both ends and a cylindrical furnace disposed longitudinally inside the cylindrical drum with the ends thereof extending through and projecting beyond the heads of said drum, and forming a space within the interior walls of said cylindrical drum and external to said furnace and confined by said heads in which to heat a heat transfer medium, the heat being generated by means of fuel burning in the furnace and transferred through the furnace wall into the heat transfer medium and wherein one end of said cylindrical furnace wholly encloses and contains an acceleration chamber and a pressure release device in the acceleration chamber substantially coplanar with the end of the furnace.

2. A fuel fired heat-exchanger consisting of a drum closed by heads at both ends, a cylindrical furnace disposed inside the drum and extending through and beyond

the heads, each end of said furnace being formed with a cylindrical extension, and flues disposed inside the drum extending through the heads within the space between the said furnace and the interior of said drum, said furnace and flues operating to heat a heat transfer medium, the heat being generated by fuel burning in the furnace and hot gases flowing through the flues, and the heat being transferred through the furnace and flue surfaces into the heat transfer medium, a nozzle extending into said drum intermediate said flues and the interior surface of the outer wall of said drum for introducing heat transfer medium therein and another nozzle disposed between the outside surface of the wall of said furnace and the interior surface of the outer wall of said drum for discharging heat transfer medium from said drum and a combustion chamber is disposed in one of the said furnace extensions and an acceleration chamber is disposed in the other furnace extension, said chambers being wholly enclosed within the limits of said furnace.

3. A fuel fired heat-exchanger consisting of a drum closed by heads at both ends, a cylindrical furnace disposed inside the drum and extending through and beyond the heads, each end of said furnace being formed with a cylindrical extension, and flues disposed inside the drum extending through the heads within the space between the said furnace and the interior of said drum, said furnace and flues operating to heat a heat transfer medium, the heat being generated by fuel burning in the furnace and hot gases flowing through the flues, and the heat being transferred through the furnace and flue surfaces into the heat transfer medium, a nozzle extending into said drum intermediate said flues and the interior surface of the outer wall of said drum for introducing heat transfer medium therein and another nozzle disposed between the outside surface of the wall of said furnace and the interior surface of the outer wall of said drum for discharging heat transfer medium from said drum and there is an acceleration chamber disposed wholly within one of the extensions of said furnace and wherein there is a pressure release device in the acceleration chamber disposed substantially coplanar with the end of the said last mentioned extension of the furnace.

4. A fuel fired heat-exchanger consisting of a drum closed by heads at both ends, a cylindrical furnace disposed inside the drum and extending through and beyond the heads, each end of said furnace being formed with a cylindrical extension, and flues disposed inside the drum extending through the heads within the space between the said furnace and the interior of said drum, said furnace and flues operating to heat a heat transfer medium, the heat being generated by fuel burning in the furnace and hot gases flowing through the flues, and the heat being transferred through the furnace and flue surfaces into the heat transfer medium, a nozzle extending into said drum intermediate said flues and the interior surface of the outer wall of said drum for introducing heat transfer medium therein and another nozzle disposed between the outside surface of the wall of said furnace and the interior surface of the outer wall of said drum for discharging heat transfer medium from said drum and which includes external flue boxes attached to the said heads and furnace extensions, said flue boxes being located within the limits of the length of said furnace.

5. A fuel fired heat exchanger consisting of a drum closed by heads at both ends, a cylindrical furnace disposed inside the drum and extending through and beyond the heads, each end of said furnace being formed with a cylindrical extension, and flues disposed inside the drum extending through the heads within the space between the said furnace and the interior of said drum, said furnace and flues operating to heat a heat transfer medium, the heat being generated by fuel burning in the furnace and hot gases flowing through the flues, and the heat being transferred through the furnace and flue surfaces into the heat transfer medium, a nozzle extending into said

drum intermediate said flues and the interior surface of the outer wall of said drum for introducing heat transfer medium therein and another nozzle disposed between the outside surface of the wall of said furnace and the interior surface of the outer wall of said drum for discharging heat transfer medium from said drum and a combustion chamber is disposed in one of the said furnace extensions and an acceleration chamber is disposed in the other furnace extension, and wherein there is a combustion target located in said furnace intermediate the said chambers.

6. A fuel fired heat exchanger consisting of a drum closed by heads at both ends, a cylindrical furnace disposed inside the drum and extending through and beyond the heads, each end of said furnace being formed with a cylindrical extension, and flues disposed inside the drum extending through the heads within the space between the said furnace and the interior of said drum, said furnace and flues operating to heat a heat transfer medium, the heat being generated by fuel burning in the furnace and hot gases flowing through the flues, and the heat being transferred through the furnace and flue surfaces into the heat transfer medium, a nozzle extending into said drum intermediate said flues and the interior surface of the outer wall of said drum and introducing heat transfer medium therein and another nozzle disposed between the outside surface of the wall of said furnace and the interior surface of the outer wall of said drum for discharging heat transfer medium from said drum and a combustion target located in said furnace intermediate nace extensions and an acceleration chamber is disposed in the other furnace extension, and wherein there is a combustion target located in said furnace intermediate the said chambers, said combustion target comprising fire bricks stacked in a honeycomb in a plane extending transversely of said furnace.

7. A fuel fired heat exchanger consisting of a drum closed by heads at both ends, a cylindrical furnace disposed inside the drum and extending through and beyond the heads, each end of said furnace being formed with a cylindrical extension, and flues disposed inside the drum extending through the heads within the space between the said furnace and the interior of said drum, said furnace and flues operating to heat a heat transfer medium, the heat being generated by fuel burning in the furnace and hot gases flowing through the flues, and the heat being transferred through the furnace and flue surfaces into the heat transfer medium, a nozzle extending into said drum intermediate said flues and the interior surface of the outer wall of said drum for introducing heat transfer medium therein and another nozzle disposed between the outside surface of the wall of said furnace and the interior surface of the outer wall of said drum for discharging heat

transfer medium from said drum and there are external flue boxes attached to said heads and cylindrical extensions in positions above the longitudinal axis of said furnace and extending transversely across the terminating ends of said flues, said flue boxes being disposed within the diametrical limits of said drum and a division wall in one of said flue boxes intermediate the flues terminating therein.

8. A fuel fired heat-exchanger consisting of a drum closed by heads at both ends, a cylindrical furnace disposed inside the drum and extending through and beyond the heads, each end of said furnace being formed with a cylindrical extension, and flues disposed inside the drum extending through the heads within the space between the said furnace and the interior of said drum, said furnace and flues operating to heat a heat transfer medium, the heat being generated by fuel burning in the furnace and hot gases flowing through the flues, and the heat being transferred through the furnace and flue surfaces into the heat transfer medium, a nozzle extending into said drum intermediate said flues and the interior surface of the outer wall of said drum for introducing heat transfer medium therein and another nozzle disposed between the outside surface of the wall of said furnace and the interior surface of the outer wall of said drum for discharging heat transfer medium from said drum and said first mentioned nozzle is disposed adjacent the top of the outer wall of said furnace and wherein said last mentioned nozzle is disposed adjacent the bottom of the outer wall of said furnace, said first mentioned nozzle being interposed between at least one of said flues and the interior surface of the outer wall of said drum and extending more than one half the length of said furnace and said last mentioned nozzle extending for a distance less than half the length of said furnace.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,910,972

November 3, 1959

Robert Casper Swaney

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 11, lines 29 to 31, for "a combustion target located in said furnace intermediate nace extensions" read -- a combustion chamber is disposed in one of the said furnace extensions --.

Signed and sealed this 8th day of November 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents