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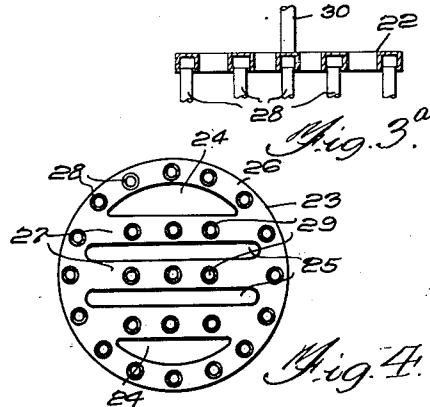
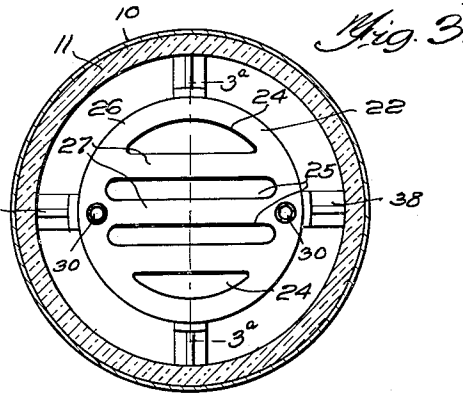
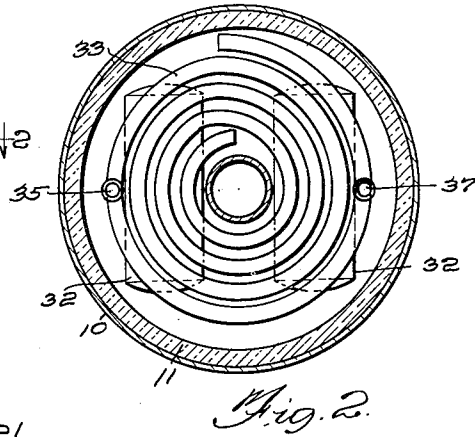
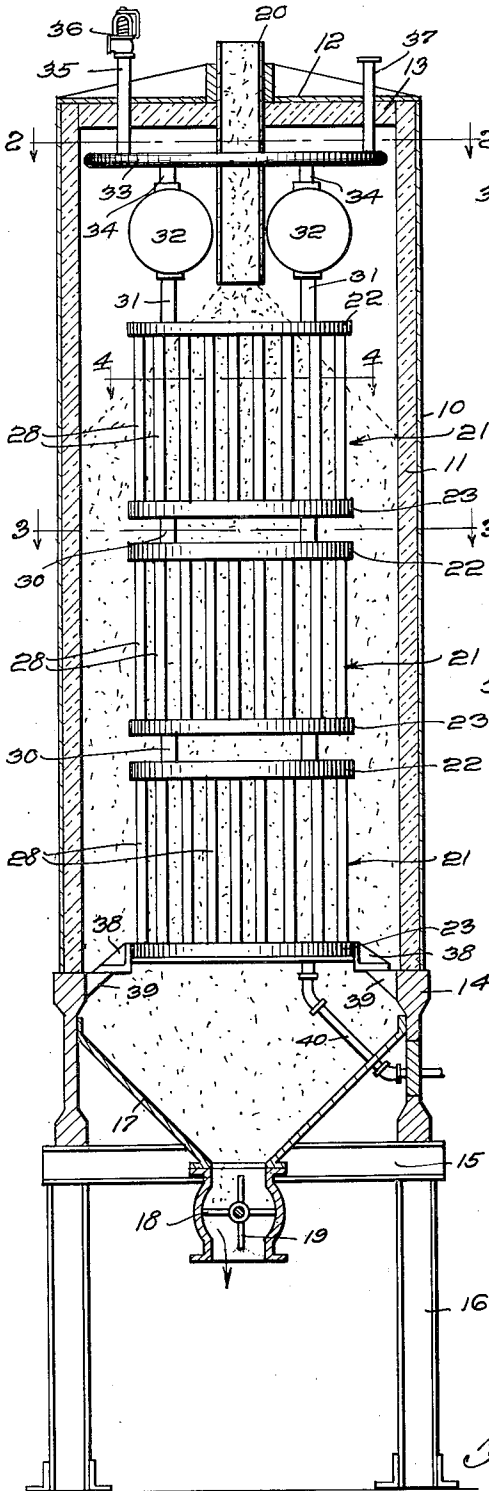
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1,803,081

HEAT EXCHANGE APPARATUS

Filed March 19, 1928

2 Sheets-Sheet 1



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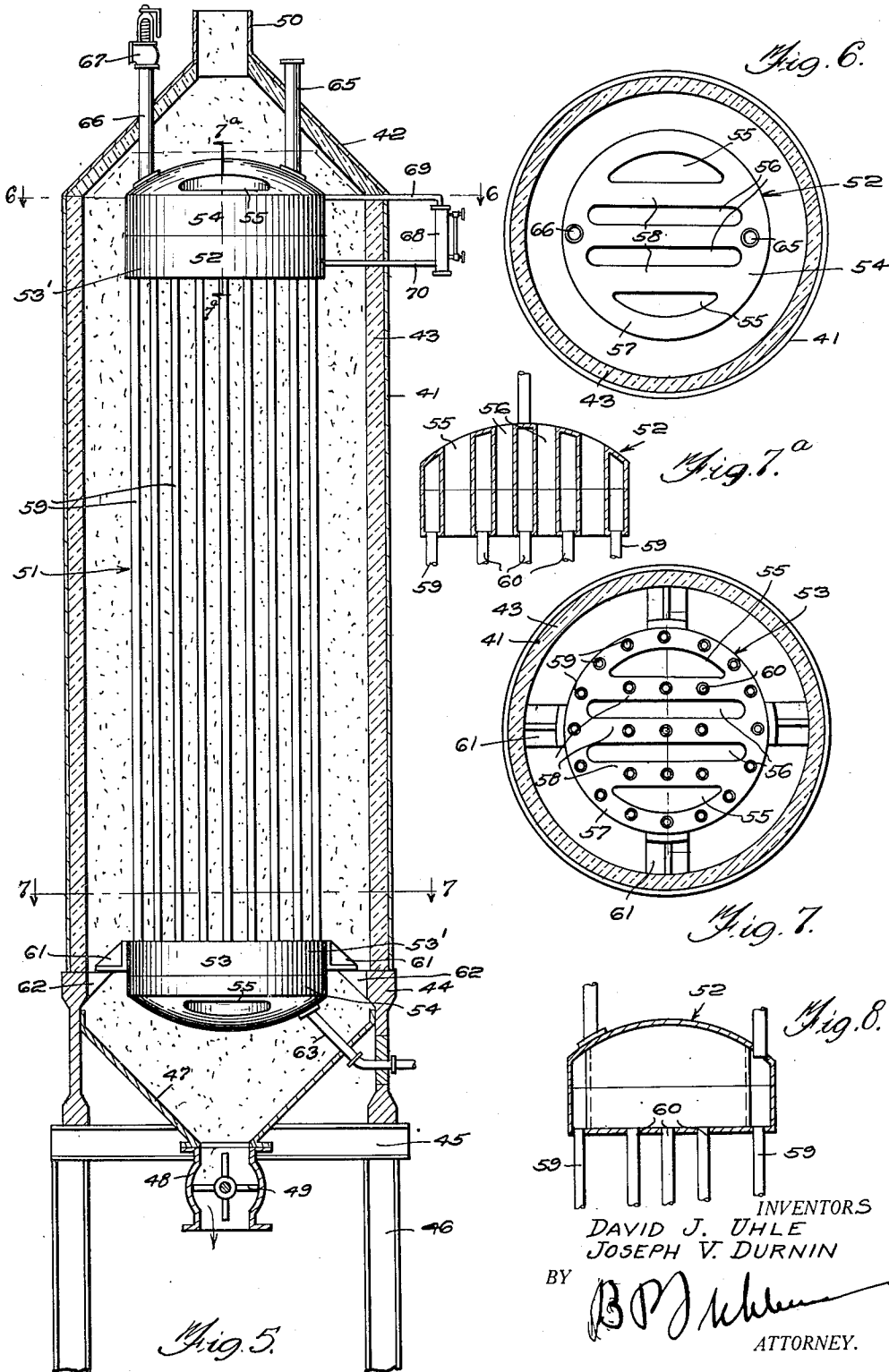
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

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HEAT-EXCHANGE APPARATUS

Application filed March 19, 1928. Serial No. 262,739.

The present invention relates to heat exchange apparatus.

In accordance with our invention, an apparatus is provided whereby a heat exchange is effected between heated or incandescent solid material, such as, Portland cement, clinkers and water. The heat exchange is effected in such a manner that the water or other volatile liquid is converted into steam or gas, and this steam or gas is raised to a high temperature, and preferably superheated, before being discharged from the apparatus, and is at a high pressure for operating prime movers, such as steam engines. The apparatus has its various parts so constructed and arranged that the maximum heat exchange may be effected between the two materials.

In the accompanying drawings, forming a part of this specification, and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a central vertical longitudinal section through apparatus embodying our invention, the liquid holding unit being shown in elevation,

Figure 2 is a horizontal section taken on line 2—2 of Figure 1,

Figure 3 is a similar view taken on line 3—3 of Figure 1,

Figure 3^a is a transverse section taken on line 3^a—3^a of Figure 3,

Figure 4 is a similar view taken on line 4—4 of Figure 1,

Figure 5 is a central vertical longitudinal section through a modified form of the invention, the liquid holding unit being shown in elevation,

Figure 6 is a horizontal section taken on line 6—6 of Figure 5,

Figure 7 is a similar view taken on line 7—7 of Figure 5,

Figure 7^a is a transverse section taken on line 7^a—7^a of Figure 5, and,

Figure 8 is a central vertical section through the upper drum.

Attention being called first to Figures 1 to 4, inclusive, the numeral 10 designates an outer casing or shell, having a lining 11 of heat insulating material. The casing 10

has its upper end closed by a cover 12, also having an inner lining 13, of heat insulating material. At its lower end, the casing or shell 10 is supported upon a base 14, arranged upon a supporting frame 15, having vertical legs 16. A downwardly tapering discharge hopper 17 is arranged within the base 14 and in communication with the interior of the shell 10, as shown. The hopper is provided at its lower end with an outlet valve or gate 18, within which is mounted a rotary valve element 19, to control the discharge of the cooled clinkers or the like from the hopper.

The heated or incandescent solid material or clinkers is fed into the upper end of the casing 10 by means of a feed tube or pipe 20, passing centrally through the cover 12. It might be stated at this point that the incandescent material is fed through the inlet pipe or tube 20 at the same rate that it is discharged from the valve 18, and this feeding action may be regulated, as desired.

Arranged within the casing 10 are a plurality of liquid holding units 21. Each unit embodies an upper hollow header or drum 22 and a lower hollow header or drum 23. Each drum is provided with passages 24 and 25, through which the incandescent solid material may feed or gravitate, it being understood that these drums are, of course, closed. Each drum, therefore, embodies an outer circular rim portion 26 and straight spaced parallel portion 27. The outer circular portions 26 of the drums 22 and 23, in each unit, are connected by vertical spaced tubes 28, producing an outer annular group of these spaced tubes. The straight portions 27 of the upper and lower headers 22 and 23 are connected by sets of spaced tubes 29 arranged in straight groups. The tubes 29 are arranged within the annular group of tubes 28 and are spaced therefrom. The tubes in each group 29 are spaced from each other and from the tubes in the other straight groups, the same being arranged upon opposite sides of the passages 24 and 25. It is thus apparent that incandescent or heated solid material, in relatively small aggregates, such as, incandescent Portland cement clinkers, may readily pass about various tubes 28 and 29, and through the open-

ings 24 and 25. The upper header 22, in each unit, excepting the uppermost unit, has connection with pipes 30, preferably two of these pipes being employed and diametrically oppositely arranged. The pipes 30 are connected with the lower header 23 of the next upper superposed unit. The header 22 of the uppermost unit 21 is connected with pipes 31, corresponding in number and arrangement with the pipes 30. These pipes 31 lead into the bottom of horizontally arranged drums 32, disposed upon opposite sides of the feed tube or pipe 20, as shown. Arranged above the drum 32 is a horizontally arranged superheater 33, preferably in the form of a spiral coil. This superheater is connected with the top of the drums 32 through the medium of pipes 34. The superheater or coil 33 surrounds the feed tube 20, as shown. A pipe 35 leads into one portion of the superheater 33, and is equipped with a safety valve 36, regulating the maximum pressure of the steam or the like within the superheater. A steam or gas outlet pipe 37 leads into the superheater 32 and is adapted for connection with any suitable prime mover, such as, a steam engine.

The lowermost unit 21 has its lower header 23 equipped with spaced brackets 38, supported by brackets 39, carried by the base 14. Leading into this last named header 23 is a water supply pipe 40, having connection with a suitable source of water, and which may be equipped with any suitable valve, not shown.

In the use of this form of apparatus, a suitable water level is maintained in the units 21, it being preferred that the level of the water be maintained at an elevation adjacent the upper header 22 of the uppermost unit 21, while the invention is not restricted to any particular water level. The heated or incandescent solid material, such as, incandescent Portland cement clinkers is now fed into the top of the casing 10, through the tube 20, and discharges downwardly by gravity outwardly of and about the units 21, to substantially completely surround the same and also passes through the passages 24 and 25 of the units. It is thus seen that the water tubes 28 and 29 are substantially completely surrounded by the incandescent solid material as it gravitates longitudinally through the casing 10. This incandescent material discharges into the hopper 17 and is then removed through the valve 18, the passage of the incandescent material through the apparatus being regulated at the tube 20 and also at the valve 18, as explained. The water in the units 21 is converted into steam and passes upwardly into the steam drums 32, and then discharges into the superheater 33, and may be removed therefrom through the pipe 37. The water is not only converted into steam but a dry steam at high pressure

is obtainable, which may be employed in running a prime mover, such as, a steam engine. It is thus seen that a heat exchange has been effected between the solid incandescent material and the water, the water being converted into high pressure steam, and the temperature of the incandescent solid material being lowered sufficiently, by the time it is ready for discharge through the valve 18, that it may be handled in grinding or other treatment.

Attention is now called to Figures 5 to 8, inclusive, wherein is shown a modification of apparatus embodying the invention. This apparatus embodies an outer casing or shell 41, having a conical top 42, this casing being lined with heat resisting material 43. The casing 41 is mounted upon a base 44, arranged upon a supporting frame 45, having legs 46. At the bottom of the casing 41, and in communication therewith, is a tapered hopper 47, equipped with a valve casing 48, having a rotary valve 49. The top 42 has a feed tube 50, and incandescent solid material, such as, Portland cement clinkers, is fed into the apparatus through the tube 50 and is discharged from the hopper 47, through the valve casing 48, the supply of the incandescent material and its discharge, being at the same rate, and being preferably regulated, as desired.

The numeral 51 designates a water holding unit, embodying upper and lower headers 52 and 53, which are substantially identical. Each header is preferably made in inner and outer sections 53' and 54. The headers are cylindrical and are disposed in spaced concentric relation within the casing 41. Each header is provided with spaced parallel passages 55 and 56, whereby the drum embodies an outer annular rim portion 57 and straight parallel intermediate portions 58, spaced as shown. The outer annular rim portions 57 of the two drums are connected by an annular set or group of spaced vertical tubes 59, and the straight portions 58 are connected by straight sets of vertical tubes 60, the tubes 60 being arranged within the annular set of tubes 59 and spaced therefrom.

The outer sections of the upper and lower drums are spherically curved, as shown.

The lower drum 53 is equipped with spaced brackets 61, supported upon brackets 62, carried by the base 44.

Water is introduced into the water holding unit through a pipe 63, leading into the lower header 53, and equipped with a suitable valve, not shown. The steam discharges from the upper header 52 through a pipe 65. A second pipe 66 leads into the upper header 52 and is equipped with a safety valve 67. A water gauge 68 is connected with the upper header 52 by pipes 69 and 70, as shown.

In the operation of this form of apparatus,

the water holding unit 51 is suitably filled with water, preferably at an elevation whereby the upper header 52 will be partly filled with water, leaving a space in the upper portion of this header, for holding steam. The level of the water is indicated by the gauge 68. The heated or incandescent solid material is introduced through the tube 50, and by gravitating downwardly first strikes the spherically curved outer end of the upper header 52. A portion of this material is deflected outwardly by the spherically curved outer end of the upper header 52 and travels downwardly exteriorly of the headers 52 and 53, and tubes 51, between the same and the casing 41. A portion of the incandescent material also passes downwardly through the openings 56, passing between the tubes 59 and tubes 60. It is thus seen that the headers and tubes are surrounded upon their inner and outer sides by the descending incandescent material. The material finally discharges into the hopper 47 and is withdrawn through the valve casing 48. By virtue of the intimate and thorough contact of the incandescent material with the headers and tubes, the maximum heat exchange is effected between the incandescent material and the water. The water is heated and converted into steam, having a high pressure, which may be employed to drive a prime mover, when withdrawn through the pipe 65. By the time the clinkers reach the hopper 47, they are cooled sufficiently whereby they may be properly handled in grinding or other treatment.

It is to be understood that the forms of our invention, herewith shown and described, are to be taken as preferred examples of the same, and that various changes in the shape, size and arrangement of parts, may be resorted to without departing from the spirit of our invention, or the scope of the subjoined claims.

Having thus described our invention, we claim:

1. Apparatus for utilizing the heat contained within hot divided solid material, comprising a substantially vertical casing provided at its top and bottom with inlet and outlet means, said means being so constructed that the hot divided solid material may be introduced into the casing and discharged therefrom at substantially the same rate, and a water holding unit arranged within the casing and extending longitudinally of the same with its ends arranged inwardly of the inlet and outlet, said water holding unit comprising generally horizontally arranged drums having passages formed therein, the drums being disposed in the path of travel of the descending material and serving to somewhat obstruct such travel, some of the material traveling through the passages of the drums.

2. In apparatus for utilizing the heat contained within hot divided solid material, comprising a substantially vertical casing, inlet means arranged centrally at the top of the casing, a hopper at the bottom of the casing in free communication therewith, a regulating outlet device for the hopper whereby the solid material may be discharged from the hopper at substantially the same rate that it is fed into the upper end of the casing, and a water holding unit arranged within the casing and extending vertically thereof in spaced concentric relation for providing an annular passage between the unit and the casing, the passage being in free communication with the hopper, said unit embodying substantially horizontal drums and vertical tubes connecting them, said drums having passages formed therein, the drums being disposed at substantially a right angle to the direction of travel of the hot solid divided material and serving to obstruct such travel to some extent and thereby aid in maintaining the heated material in the solid divided condition.

3. In apparatus for utilizing the heat from hot solid divided material for heating fluids, a generally vertical casing, inlet means for feeding the hot solid divided material into the upper portion of the casing, outlet means for withdrawing the solid material from the lower portion of the casing, and hollow fluid holding obstruction elements arranged in the casing within the path of travel of the hot solid divided material to directly contact with such material and deflect the same.

4. In apparatus for utilizing the heat from hot solid divided material for heating fluids, a generally vertical casing, inlet means for feeding the hot solid divided material into the upper portion of the casing, outlet means for withdrawing the solid material from the lower portion of the casing at substantially the same rate as the feeding of the material into the casing for maintaining the level of the material substantially constant, and hollow fluid holding obstruction elements arranged in the casing within the path of travel of the solid divided material to deflect the same.

5. In apparatus for utilizing the heat from hot solid divided material for heating fluids, a generally vertical casing, inlet means for feeding the hot solid divided material into the upper portion of the casing, outlet means for withdrawing the solid divided material from the lower portion of the casing, and hollow fluid holding obstruction elements arranged in the casing generally at a right angle to the direction of travel of the solid divided material and within the path of travel of the same to directly contact with the hot solid divided material and to deflect the same.

6. In apparatus for utilizing the heat from hot solid divided material for heating fluids, a generally vertical casing, inlet means for

feeding the hot solid divided material into the upper portion of the casing, outlet means for withdrawing the solid divided material from the lower portion of the casing, and a fluid tube boiler in the casing within the path of travel of the solid divided material to directly contact with the solid divided material and to deflect the same.

7. In apparatus for utilizing the heat from hot solid divided material for heating fluids, a generally vertical casing, inlet means for feeding the hot solid divided material into the upper portion of the casing, outlet means for withdrawing the solid divided material from the lower portion of the casing, and a fluid tube boiler in the casing within the path of travel of the solid divided material to directly contact with the same, said tube boiler having passages for the descending solid divided material and also serving to stir the same.

8. In apparatus for utilizing the heat from hot solid divided material for heating fluids, a closed generally vertical casing, inlet means for feeding the hot solid divided material into the upper portion of the casing, outlet means for withdrawing the solid material from the lower portion of the casing, and fluid holding device arranged within the casing in the path of travel of the hot solid divided material to directly contact therewith, said device embodying a plurality of spaced tubes between which the material passes.

9. In apparatus for utilizing the heat from hot solid divided material for heating fluids, a generally vertical casing, inlet means for feeding the hot solid divided material into the upper portion of the casing, outlet means for withdrawing the solid divided material from the lower portion of the casing, and a tube boiler within the casing, said tube boiler including spaced hollow headers and spaced tubes connecting the headers, the tube boiler being arranged within the path of travel of the solid divided material to directly contact with the same, and serving to deflect such material.

10. In apparatus for utilizing the heat from hot solid divided material for heating water, a generally vertical casing, inlet means for feeding the hot solid divided material into the upper portion of the casing, outlet means for withdrawing the solid divided material from the lower portion of the casing, a tube boiler within the casing, said tube boiler including spaced hollow headers and spaced tubes connecting the headers, the tube boiler being arranged within the path of travel of the solid divided material to directly contact with the same, and serving to deflect such material, and a steam storage receiver having communication with the tube boiler for receiving steam therefrom.

11. In apparatus for utilizing the heat from incandescent Portland cement clinkers, a generally vertical casing, inlet means to

feed the incandescent Portland cement clinkers into the upper portion of the casing, outlet means for the casing, and a boiler within the casing between the inlet and outlet means, said boiler having passages sufficiently large for the travel of the clinkers through such passages, said boiler being arranged to directly contact with the clinkers and deflect the same,

12. In apparatus for utilizing the heat from incandescent Portland cement clinkers, a generally vertical casing, inlet means to feed the incandescent Portland cement clinkers into the upper portion of the casing, outlet means for the lower portion of the casing, and a boiler within the casing between the inlet and outlet means, said boiler embodying spaced hollow headers and spaced tubes, so constructed and arranged that passages are afforded which are sufficiently large for the travel of the clinkers by gravity through the same, said boiler being arranged to directly contact with the clinkers and deflect the same.

13. The method of cooling incandescent Portland cement clinkers and effecting heat exchange with a fluid, comprising collecting the incandescent Portland cement clinkers in a generally vertical enclosed space by feeding such clinkers into the upper portion of the enclosed space, causing the collected mass of clinkers to travel downwardly by gravity within the enclosed space and regulating the downward travel by discharging the clinkers from the lower portion of the space in a regulated manner, and causing the clinkers, during their downward travel, to pass through sufficiently large passages in hollow fluid holding elements for effecting a direct contact with the hollow fluid holding elements and deflecting the clinkers while they pass in contact with the hollow fluid holding elements.

14. The method of cooling incandescent Portland cement clinkers and effecting heat exchange with a fluid, comprising introducing the incandescent Portland cement clinkers into the upper portion of a generally vertical enclosed space and causing the same to travel downwardly therein through sufficiently large passages in hollow fluid holding elements for effecting a direct contact with the hollow fluid holding elements and deflecting the clinkers while they pass in contact with the hollow fluid holding elements, and removing the cooled clinkers from the lower portion of the passage.

In testimony whereof we affix our signatures.

DAVID J. UHLE.
JOSEPH V. DURNIN.