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Honma et al.

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[54] **DESCALING SYSTEM FOR CONDENSER COOLING TUBES**

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[52] **U.S. Cl.** **15/3.51**; 165/95

[51] **Int. Cl.**[2] **F28G 1/12**

[58] **Field of Search** ..... 15/3.5, 3.51, 104.06 A; 134/8; 165/95

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[57] **ABSTRACT**

A descaling system for condenser cooling tubes having numerous descaling elements consisting of sponge balls forced through said cooling tubes, wherein a vessel for receiving said descaling elements to soak them with cooling water is fitted with a cage member which is designed to allow the passage of cooling water along and provided at the bottom with a pipe communicating with a 3-port switching valve; the 3-port switching valve is connected to the end of a feed pipe for delivering descaling elements to a cooling water circulation line and that of a discharge pipe for drawing out used descaling elements; and these feed and discharge pipes are made to communicate with the cage member according to the selective operation of the 3-port switching valve.

5 Claims, 6 Drawing Figures

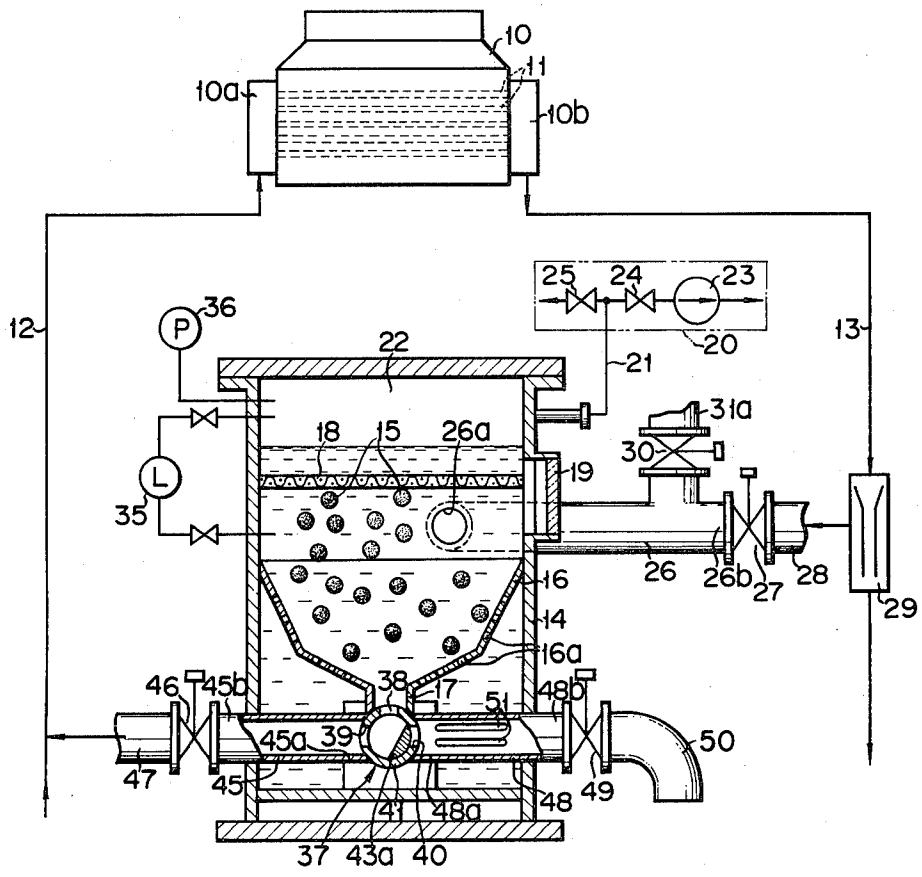

FIG. 1

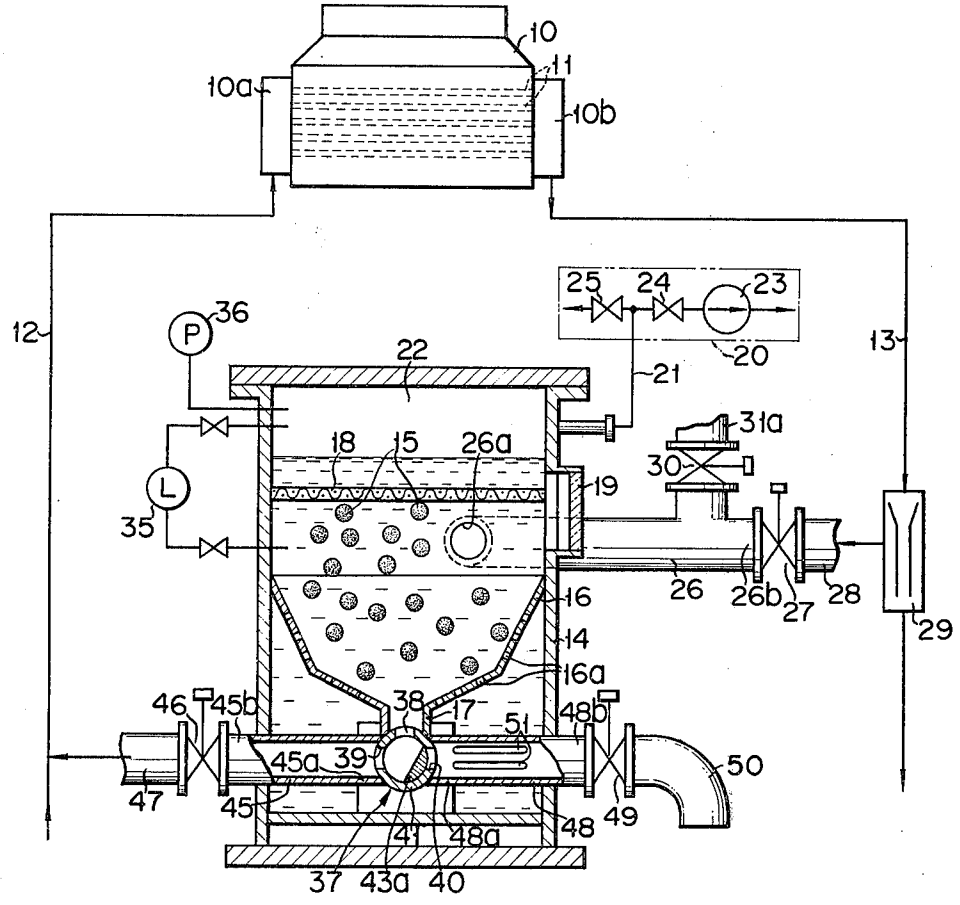
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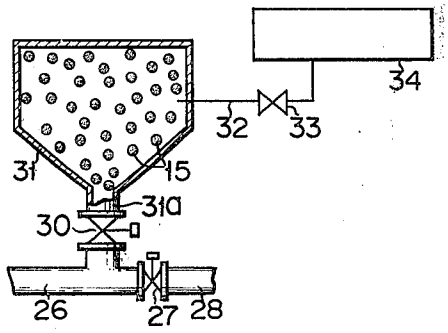
FIG. 2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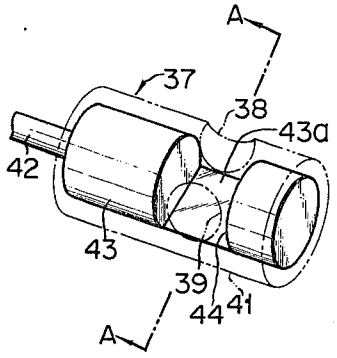


FIG. 3

FIG. 4

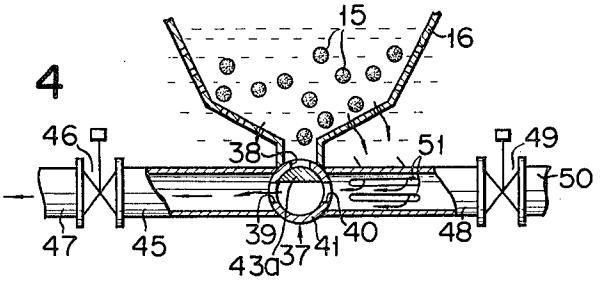


FIG. 5

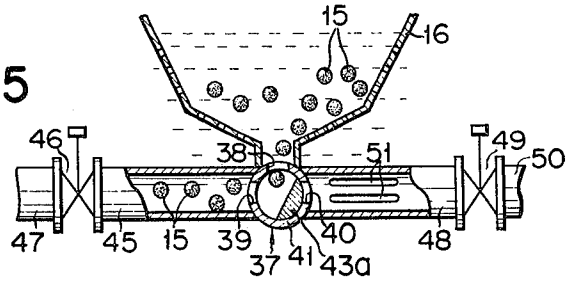
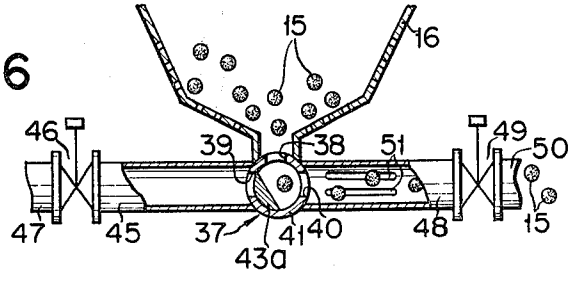


FIG. 6



DESCALING SYSTEM FOR CONDENSER COOLING TUBES

BACKGROUND OF THE INVENTION

This invention relates to a descaling system for cleaning the interior of the cooling tubes of a condenser by conducting numerous descaling elements therethrough.

For such type of descaling system, numerous sponge balls are used as descaling elements. The sponge balls are received in a water soaking vessel, where the balls are fully soaked with cooling water by the action of evacuating means disposed therein. The water-soaked sponge balls are delivered to a cooling water circulation line through a passageway communicating with the water soaking vessel. The sponge balls are carried several times through the cooling water circulation line and passageway for a prescribed length of time to descale the interior of the cooling tubes of a condenser. Upon completion of descaling, the used sponge balls are collected in a reservoir provided in the passageway, and discharged therefrom to the outside. Fresh sponge balls are charged into the water soaking vessel manually by an operator.

With the prior art descaling system, the operation of soaking sponge balls used as descaling elements with cooling water and the operation of recovering and discharging used sponge balls have been effected by the water soaking vessel and reservoir respectively.

Further, the prior art descaling system had the drawbacks that fresh sponge balls were manually charged by an operator each time and the descaling system had to be stopped during said charging operation, rendering this operation time-consuming and preventing the descaling operation from being continuously carried out with high efficiency.

SUMMARY OF THE INVENTION

The descaling system of this invention for the condenser cooling tubes has the features that the operations of soaking descaling elements with water, recovering and discharging them are undertaken by a unitary device equipped with a 3-port switching valve, so as to concurrently carry out these operations.

This invention has the advantages of simplifying the arrangement of a descaling system with the resultant prominent decrease of manufacturing cost and effecting various operations associated with descaling elements by a single device with increased efficiency. Further feature of the invention is that a holder stored with a prescribed quantity of fresh descaling elements communicates with a descaling line through a valve and a proper amount of fresh descaling elements can be supplied to the descaling line by selective operation of said valve, thereby eliminating the necessity of stopping the descaling operation during the charge of fresh descaling elements and consequently elevating the descaling efficiency.

According to a preferred embodiment of this invention, a wire net is stretched substantially in a horizontal direction in a tightly closed vessel to prevent descaling elements from floating up to the surface of cooling water, thereby enabling the descaling elements to be fully soaked with water. The peripheral wall of the vessel is provided with a peep window for an operator to observe the interior of the vessel allowing the operator distinctly to recognize the conditions in which the descaling elements charged in the vessel are soaked with water and recovered. The holder stored with fresh descaling elements is fitted with pneumatic means for introducing air into the holder forcefully to deliver fresh descaling elements to the descaling line.

It is accordingly the primary object of this invention to provide an inexpensive descaling system of simple arrangement.

Another object of the invention is to provide a descaling system capable of carrying out an efficient descaling operation.

Still another object of the invention is to provide a descaling system attaining the full soaking of descaling elements with water and the distinct observation of the soaking operation.

Further objects of the invention will be easily understood with reference to the description of the preferred embodimenzt and the appended drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a schematic illustration of the major section of the descaling system of this invention for condenser cooling tubes;

FIG. **2** schematically shows the other minor section of said descaling system on a somewhat smaller scale than in FIG. **1**;

FIG. **3** is a schematic oblique view of a 3-port switching valve used with the descaling system of FIG. **1**; and

FIGS. **4** to **6** present part of the descaling system of FIG. **1** by way of illustrating its operation, showing the manner in which the movement of descaling elements is controlled, with the 3-port switching valve indicated in cross section as in FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, a condenser **10** comprises a plurality of cooling water tubes **11** communicating at both ends with water boxes **10***a*, **10***b*. One water box **10***a* is connected to one end of a feed pipe **12** constituting part of a cooling water circulation line. The other end of said feed pipe **12** (not shown) is dipped in, for example, sea water. The other water box **10***b* communicates with one end of a discharge pipe **13** constituting part of the cooling water circulation line. The other end of said discharge pipe is dipped in, for example, sea water.

The cooling water circulation line is provided inside with a circulation pump (not shown). The pump draws sea water, for example, as cooling water into the cooling tubes **11** of the condenser **10** through the feed pipe **12** and water box **10***a*. The cooling water carries out heat exchange and is transferred to the other water box **10***b* and then drawn out therefrom into the sea through the discharge pipe **13**.

The circulation line of the above-mentioned arrangement is fitted with the later detailed descaling system. In FIG. **1**, a tightly closed cylindrical vessel **14** is indicated in a larger size for better understanding than the condenser **10**. A large number of descaling elements **15** consisting of water-absorptive sponge balls are received in the vessel **14** as later described. This vessel **14** concurrently soaks fresh descaling elements **15** with water and recovers and discharges used descaling elements. A cage member **16** is positioned in the vessel **14** substantially at a vertical midpoint. The upper peripheral edge of the cage **16** is fixed to the inner peripheral wall of the vessel **14**. A pipe **17** having a fully large diameter for passage of descaling elements **15** is inte-

grally fitted to the bottom of said cage member **16.** The cylindrical vessel **14** is divided by the cage member **16** into two upper and lower chambers. The cooling water alone in the vessel **14** can freely pass through both upper and lower chambers due to numerous openings **16***a* being bored in the cage member **16.** On the other hand, descaling elements **15** can not pass through both chambers due to the small diameter of said openings **16***a* of the cage member **16.** In practice, the cage member **16** is formed of wire netting and the openings **16***a* represent the meshes of said netting.

A wire net **18** is stretched above the cage member **16** substantially in a horizontal direction. This wire net **18** extends up to the inner wall of the vessel **14.** The point within the vessel **14** at which the wire net **18** is stretched is made lower than the prescribed height to which cooling water is filled in the vessel **14.** The wire net **18** whose meshes are not large enough to allow the passage of the descaling elements **15** is submerged in water while the descaling elements **15** are being soaked with water, preventing said elements **15** from floating up to the water surface.

A peep window **19** is bored in the peripheral wall of the vessel **14** at almost as high a level as the wire net **18** so as to allow an operator to observe the condition of the interior of the vessel **14.**

An evacuating device **20** (indicated in chain lines) is installed obliquely above the vessel **14.** This evacuating device **20** communicates with a free space **22** provided in the upper portion of the vessel **14** through a pipe **21** so as to evacuate or deaerate the vessel **14** to a prescribed extent. The evacuating device **20** comprises an air ejector or vacuum pump **23** and deaeration valves **24, 25,** and may sometimes be additionally fitted with a water mist operator or fitter.

A descaling element supply pipe **26** is provided on the outer peripheral wall of the vessel **14** between the wire net **18** and cage member **16,** with the forward end **26***a* of the supply pipe **26** opened to the interior of the vessel **14.** The rear end **26***b* of the supply pipe **26** is connected through an inlet valve **27** to an upstream circulation pipe **28** of descaling elements **15,** which in turn communicates through a collector **29** with the discharge pipe **13** constituting part of the cooling water circulation line. Further, the descaling element circulation pipe **28** is provided inside with a circulation pump (not shown) forcefully to conduct descaling elements therethrough.

The descaling element supply pipe **26** is further connected to the outlet end **31***a* of a descaling element holder **31** (FIG. **2**) through a descaling element inlet valve **30.** The holder **31** is stored with a prescribed quantity of fresh descaling elements **15** for replenishment. This replenishment is effected by selective operation of the inlet valve **30** under an operator's manual control. The descaling element holder **31** is provided with an inlet port (not shown) through which descaling elements **15** are charged into the holder **31** up to its capacity.

The descaling element holder **31** is connected through a pipe **32** and valve **33** to an air supply source **34,** which may consist of an air pump, though its concrete arrangement is not shown. The air supply source **34** introduces air into the descaling element holder **31** through the pipe **32,** and, when the valve **30** is opened, forcefully sends forth descaling elements **15** from said holder **31.** Where, as shown in FIG. **2,** the descaling element holder **31** takes a vertical position and the outlet end **31***a* of the descaling element holder **31** is directed downward, then descaling elements **15** may be discharged simply by gravitational fall. However, provision of the air supply source **34** enables the descaling elements **15** to be rapidly delivered to the supply line **26.**

The upper outer peripheral wall of the vessel **14** is fitted with a level gauge **35** for measuring and indicating the water level in the vessel **14** and a manometer **36** for measuring pressure prevailing within the vessel **14.** These instruments enable an operator to recognize the interior condition of the vessel **14** from readings thereon.

The pipe **17** fitted to the bottom end of the cage member **16** is connected to a 3-port switching valve **37,** which comprises, as shown in FIG. **3,** a valve casing **41** bored with three ports **38, 39, 40,** a valve rod **42,** and a cylindrical valve element **43** rotated by said valve rod **42.** As apparent from FIG. **3,** the peripheral wall of the valve element **43** is provided with a notch **44.** The notch **44** and the remainig portion **43***a* of the peripheral wall of the valve element **43** cooperate selectively to open or close the three ports **38** to **40** bored in the valve casing **41** surrounding the valve element **43** according to the rotation of the valve rod **42.** The notch **44** itself acts as a passageway for descaling elements. The pipe **17** fitted to the bottom end of the cage member **16** communicates with the port **38.**

A descaling element feed pipe **45,** one end **45***a* of which communicates with the port **39,** is horizontally disposed in the lower portion of the vessel **14.** The other end **45***b* of said feed pipe **45** is exposed to the outside of the vessel **14** and is connected to a downstream pipe **47** of descaling elements through an outlet valve **46.** Said downstream pipe **47** communicates with the feed pipe **12** constituting part of the cooling water circulation line.

A discharge pipe **48,** one end **48***a* of which communicates with the port **40,** is disposed horizontally in the lower portion of the vessel **14** on the opposite side of the 3-port switching valve **37** to the above-mentioned feed pipe **45.** The other end **48***b* of the discharge pipe **48** is exposed to the outside of the vessel **14** and connected to a pipe **50** through a discharge valve **49.** The rear end of the pipe **50** is bent downward. The peripheral wall of that portion of the discharge pipe **48** which is received in the vessel **14** is bored with a pair of slit-shaped openings **51,** through which the cooling water of the vessel **14** flows into the discharge pipe **48.** The number and size of said openings **51** are not limited to those of this embodiment.

There will now be described the manner in which the descaling system of this invention arranged as described above cleans the interior of the cooling tubes of a condenser.

When the inlet valve **30** is opened, numerous descaling elements consisting of sponge balls are carried along with streams of air supplied by the air supply source **34** from the descaling element holder **31** into the vessel **14** through the forward end **26***a* of the supply pipe **26** to be received in the cage member **16.** At this time, the 3-port switching valve **37** takes the position of FIG. **4** with the port **38** closed, preventing descaling elements from falling downward through the pipe **17.**

When the inlet valve **27** is opened, cooling water is filled in the vessel **14** to a level shown in FIG. **1,** after passing through the circulation line and supply pipe **26,** while an operator observes readings on the level gauge

35. Since the wire net 18 is submerged in the cooling water, descaling elements 15 are held down by the wire net 18 and can not float up to the water surface. At this time, the valves 27, 30 are closed and the evacuating device 20 is actuated to evacuate the interior of the vessel 14 to a prescribed level. Attainment of a prescribed degree of vacuity can be recognized from readings on the manometer 36. When the vacuity of the vessel 14 sufficiently increases, descaling elements 15 are fully soaked with cooling water. Though, at this time, the level of cooling water slightly falls, the wire net 18 is previously so positioned as to be always submerged in the water, thereby preventing the cooling water level from being brought down to said wire net 18. The line 21 of the evacuating device 20 communicating with the space 22 allowed in the upper portion of the vessel 14 enables the evacuating device 20 to exert its action over the free surface of the cooling water, attaining rapid deaeration. As the result, the evacuating device 20 is little soaked with unnecessary cooling water mist, eliminating the provision of any filter or mist separator.

After descaling elements are fully soaked, the evacuating device 20 is stopped, and the inlet valve 27 and outlet valve 46 is opened. Also the 3-port switching valve 37 takes the position as shown in FIGS. 1 and 5, namely, the position in which the port 40 alone is closed and the ports 38, 39 communicate with each other. At this time, the discharge valve 49 still remains closed. When a circulation pump (not shown) is put into operation, descaling elements are conducted, as shown in FIG. 5, from the vessel 14 to the notch 44 constituting a valve chamber through the pipe 17 and port 38 and then to the feed pipe 45 through the port 39 and finally to the00062pipe 12 through the downstream circulation pipe 47. After passing through the feed pipe 12 and the water box 10*a*, descaling elements 15 are scattered into a plurality of cooling tubes 11 and delivered to the water box 10*b*, while scraping off foreign matter deposited on the inner walls of the cooling pipes and then to the discharge pipe 13. Descaling elements 15 running down through the discharge pipe 13 together with cooling water are trapped by the collector 29 and then brought into the downstream circulation pipe 28, and finally into the vessel 14 through the supply pipe 26. After completing the above-mentioned circulation cycle, descaling elements 15 are again delivered to the cooling water circulation line.

The repeated passage of descaling elements 15 through the cooling tubes 11 of the condenser 10 for a prescribed length of time effects the desired descaling operation. Where it is desired to replenish fresh descaling elements 15 during circulation, the inlet valve 30 (FIG. 2) is opened to supply a required quantity of fresh descaling elements 15 from the holder 31 to the circulation line, thereby eliminating the undesirable stoppage of the circulation of descaling elements 15 at the time of replenishment.

Where used descaling elements 15 are recovered from the circulation line upon completion of the descaling operation, it is advised to lock the 3-port switching valve 37 to the position of FIG. 4. Since the port 38 is closed, used descaling elements 15 are all collected in the cage member 16 under an operator's observation through the peep window 19.

On the other hand, cooling water flowing into the vessel 14 through the supply pipe 26 together with descaling elements 15 freely passes downward through the numerous openings 16*a* of the cage member 16 into the discharge pipe 48 through the paired slit like openings 51 bored in the peripheral wall of the discharge pipe 48. The cooling watered arrows of FIG. 4 passes through the port 40 and the notch or valve chamber 44 of the valve element 43 and is delivered to the feed pipe 45 through the port 39, because the discharge valve 49 is closed. Thereafter, the cooling water runs through the outlet valve 46 now left open to the downstream circulation pipe 47.

Used descaling elements 15 which have all been collected in the cage member 16 by the above-mentioned recovering operation are now subjected to the discharging operation. This discharging operation is carried out in the following way. The inlet valve 27 is closed to stop the influx of cooling water into the vessel 14.

The water level within the vessel 14 falls to the position of the slits 51, with the descaling elements 15 alone left in the cage member 16. The outlet valve 46 is closed and the discharge valve 49 is opened, while the 3-part switching valve 37 has its position changed from FIG. 4 to FIG. 6. Accordingly, the port 39 is closed, and the port 38 is opened for communication with the port 40, enabling the descaling elements collected in the cage member 16 to pass through the pipe 17 and port 38 into the notch or valve chamber 44, then to the discharge pipe 48 through the port 40 and finally to be discharged to the outside through the discharge valve 49 now open and the pipe 50. Whether all the used descaling elements 15 have been removed from the cage member 16 can be recognized by an operator's observation of the interior of the vessel 14 through the peep window 19.

Though not shown, the valve rod 42 of the 3-port switching valve 37 extends out of the vessel 14 to be manually rotated by an operator. The 3-port switching valve 37 used in this embodiment may be designed with a different arrangement from FIG. 3. Namely, said valve 37 may consist of a ball type in which the valve element 43 is made into a ball form, instead of the cylindrical type of this embodiment. As used herein, the 3-port switching valve 37 includes a cock.

The rotation of the 3-port switching valve 37 and the operation of the other valves such as the inlet valve 27, outlet valve 46, discharge valve 49 and inlet valve 30 are manually effected by an operator. However, it is possible remotely to control their operation.

Application of the above-mentioned 3-port switching valve 37 enables all the operations of soaking descaling elements 15 with water and recovering and discharging them to be carried out in a single unitary vessel 14, eliminating the necessity of providing a separate reservoir and associated piping and in consequence attaining the simplification of the arrangement of the descaling system, the reduction of manufacturing cost and high operating efficiency.

What we claim is:

1. A descaling system for condenser cooling tubes designed to conduct a large number of descaling elements through the cooling tubes from a cooling water feed line and draw out used descaling elements from the discharge line of cooling water, characterized in that said descaling system comprises a tightly closed vessel; a cage member whose outer peripheral wall is fixed to the inner peripheral wall of the vessel and whose bottom end is fitted with a pipe for passage of descaling elements, and which acts as a receptacle for the descaling

elements and allows the free passage of cooling water alone; a descaling element supply pipe whose forward end communicates with the vessel and whose rear end communicates with a cooling water discharge line; evacuating means for deaerating the vessel; a 3-port switching valve connected to the pipe fitted to the bottom end of the cage member; a feed pipe, one end of which is connected to the 3-port switching valve for communication with the pipe of the cage member by selective operation of said valve and the other end of which communicates with a cooling water feed line; and a discharge pipe for drawing out descaling elements from the vessel, one end of said discharge pipe being connected to the 3-port switching valve for communication with the pipe of the cage member by selective operation of said valve and the other end of said discharge pipe extending outside of the vessel, and said discharge pipe further having its peripheral wall bored with openings for conducting the cooling water of the vessel into said pipe.

2. A descaling system according to claim **1,** which further comprises a descaling element holder whose inlet end communicates with the supply pipe through a second valve, and which is always filled with a prescribed quantity of descaling elements and delivers fresh descaling elements to the supply pipe according to the selective operation of said second valve.

3. A descaling system according to claim **2,** which further comprises air supply means for introducing air into the descaling element holder, thereby forcefully to deliver the descaling elements received in said holder to the supply pipe.

4. A descaling system according to claim **1,** which further comprises a wire net disposed above the cage member substantially in a horizontal direction, said wire net being submerged in the cooling water when descaling elements are soaked therewith, thereby preventing the soaked descaling elements from floating up to the free surface of the cooling water.

5. A descaling system according to claim **1,** wherein the vessel has its peripheral wall bored with a peep window for an operator to observe the interior of the vessel.

* * * * *