Jan. 21, 1964 G. HAGBY 3,118,495

METHOD OF CLEANING HEAT EXCHANGERS

Filed Nov. 12, 1957 5 Sheets-Sheet 1

FIG.1

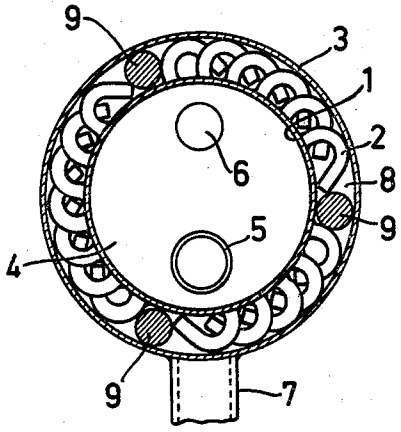



FIG. 2

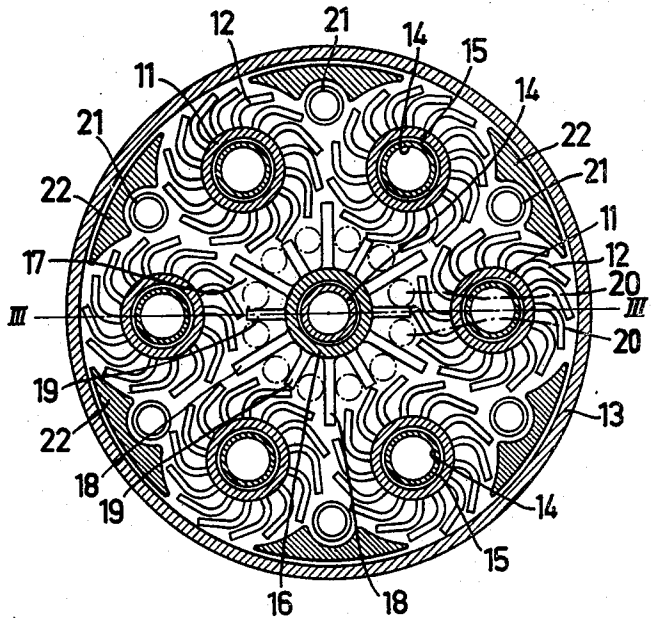


FIG.3

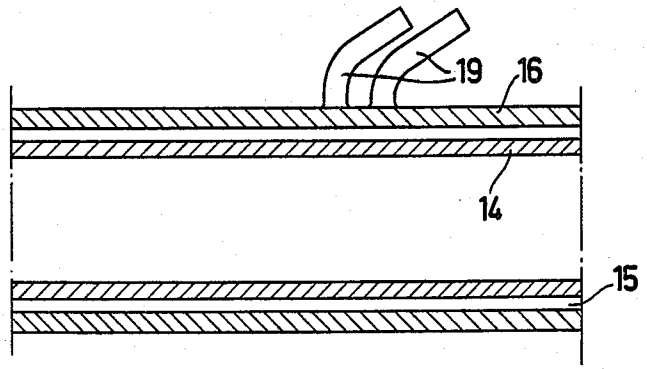
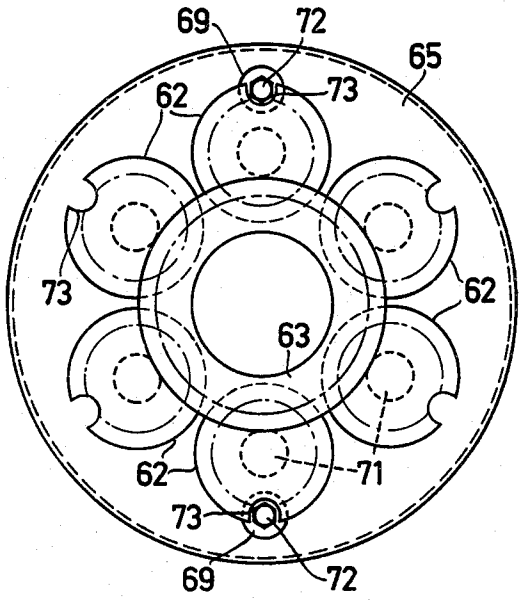



FIG.5



METHOD OF CLEANING HEAT EXCHANGERS

Filed Nov. 12, 1957 5 Sheets-Sheet 3

FIG.4

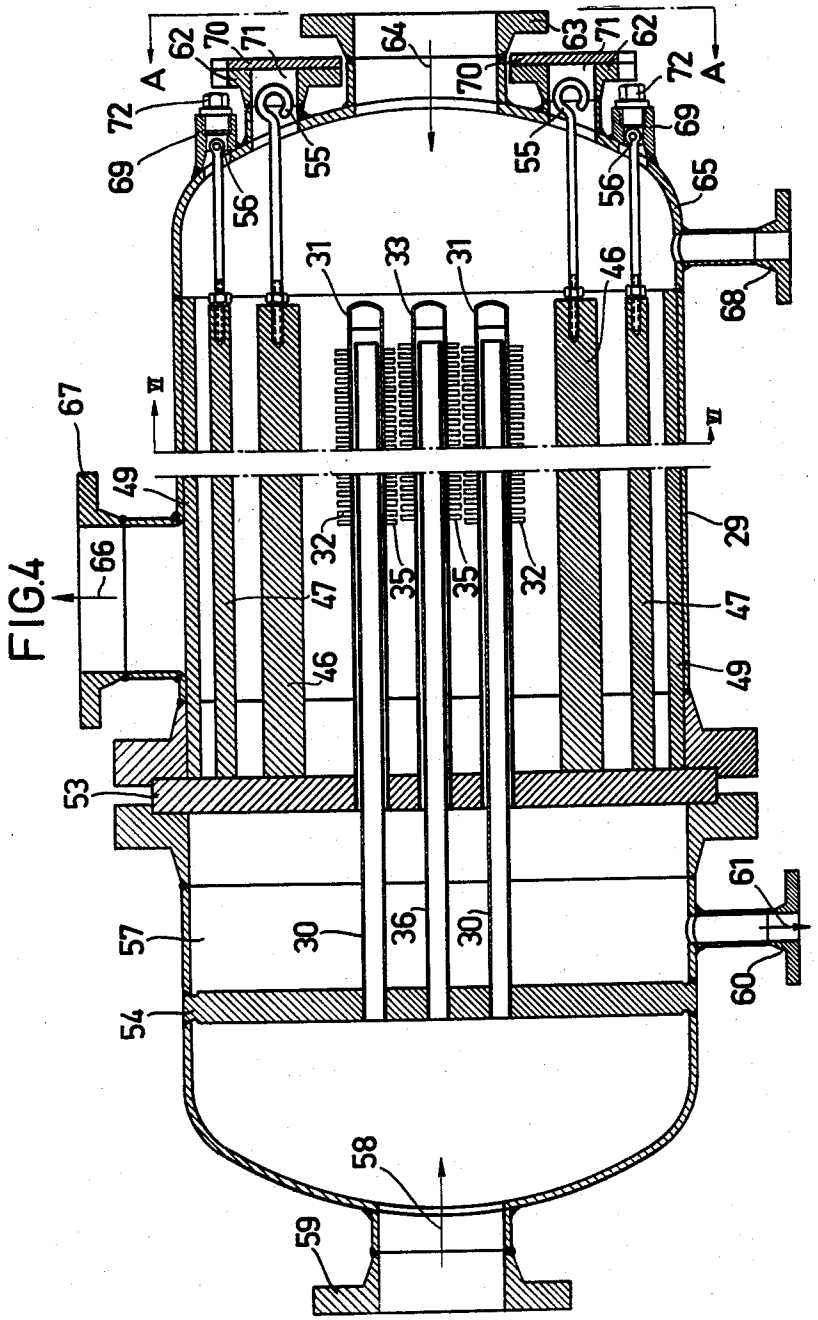
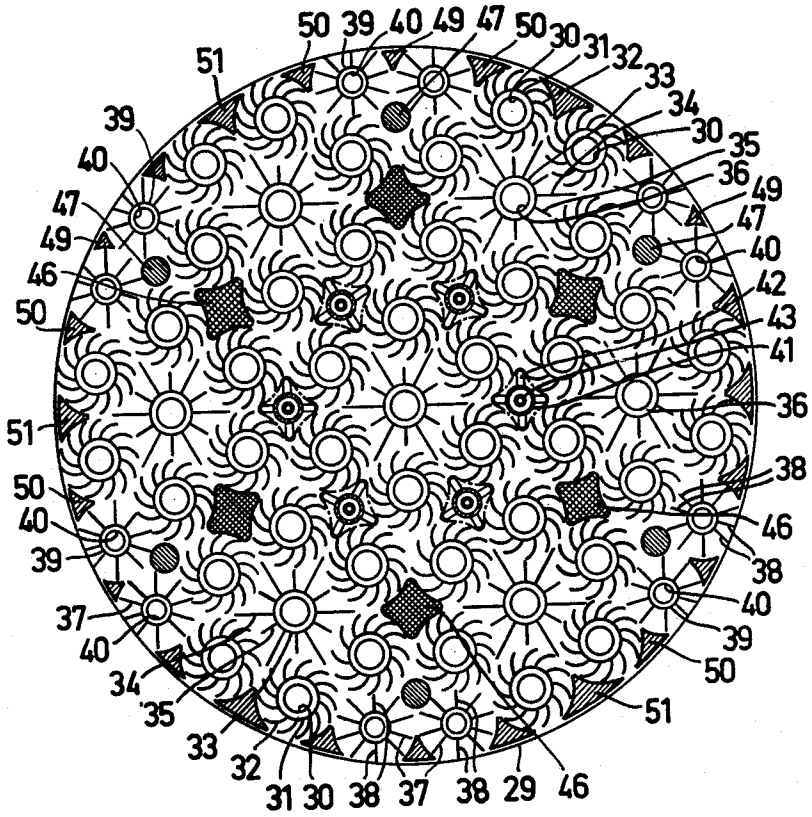
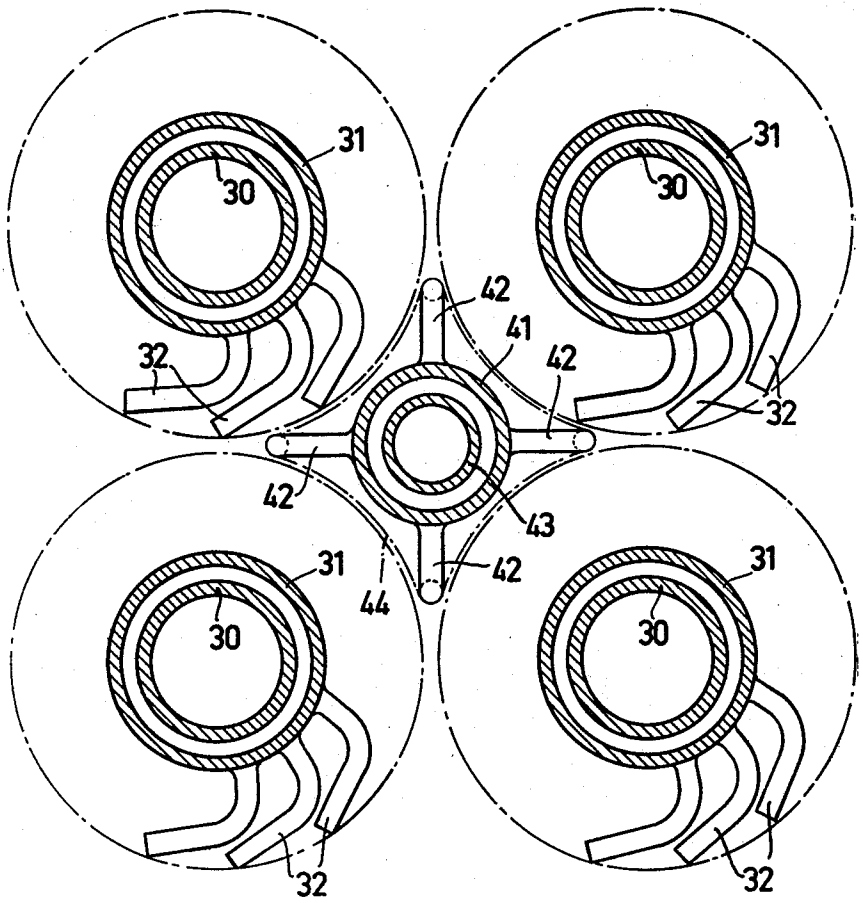


FIG.6


50 39 40 49 47 50 30 31 32 33 34 30 35 36 49 47 40 42 43 41 36 38 46 38 40 39 50 51 29 46 38 37 38 30 31 32 33 35 34 40 37 39 40 50 51 46 49 47 39 40 51 50

Jan. 21, 1964 G. HAGBY 3,118,495
METHOD OF CLEANING HEAT EXCHANGERS
Filed Nov. 12, 1957 5 Sheets-Sheet 5

FIG.7



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3,118,495

# METHOD OF CLEANING HEAT EXCHANGERS

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Claims priority, application Sweden Nov. 12, 1956
1 Claim. (Cl. 165—1)

The present invention relates to a method of cleaning heat exchangers of the type in which one or more tubes (preferably arranged in groups) having heat transmission surfaces which are enlarged by means of straight and/or bent pins or rods of a heat conductive material connected to the said tubes, are arranged within a common casing through which a gaseous or liquid medium intended for heating or cooling purposes is to flow in contact with the said pins. The invention relates particularly to heat exchangers in which one flowing medium is oil heated for example by means of steam or hot water, when oil preheaters are concerned, and which is cooled by water or air, when oil coolers are concerned.

In Sweden and in several other countries such oil preheaters are used to a large extent, where the heat transmission surface between heating medium and oil is enlarged by means of pins of copper or some other heat conductive material welded thereto, both for heating of oil for an oil firing plant and for heating of oil to be pumped from large oil cisterns.

For smaller quantities of oil a type of oil preheaters is as a rule used which is disclosed in the Swedish patent specification No. 157,483, from which it will be seen that the pins are bent towards the tube wall obliquely forwards in the direction of flow of the oil. The preheaters are constructed in such a manner that the tube provided with pins may be taken out of the casing of the preheater in order to clean the pins. When the largest preheaters made in accordance with the said construction are concerned, however, the tube provided with pins is rather heavy, and therefore the operation of cleaning it will be time-wasting and troublesome.

When large quantities of oil are concerned and when the oil need not be heated much, for example in the case of heating oil to be pumped from cisterns, the pins are usually radially attached to the tube. In most cases special filling bodies are disposed axially between the rows of pins in order to give the oil greater turbulence and the preheaters greater effect. Also this type of preheaters is constructed in such a manner, that the tube may be taken out of the casing of the preheater in order to be cleaned. The disadvantage of these heat exchangers is that the tubes provided with pins and with filling bodies are very heavy and difficult to handle.

In later years it has appeared that oil used in Sweden have contained great quantities of impurities which have deposited on the pins of the preheaters and have obstructed the passage of the oil. Owing to this the oil preheaters and coolers must be cleaned often, which has caused great inconvenience, particularly when large heat exchangers are concerned, for which even special cranes, travelling cranes and the like must be used for taking the tube provided with pins out of the outer casing. The difficulties of cleaning in fact make an upper limit for the capacity of such heat exchangers.

The object of the present invention is primarily to eliminate these drawbacks of well-known heat exchangers of the kind in question and to provide a compact and efficient tube heat exchanger provided with an outer casing, which has a great capacity and the heat transmission surface of which may be cleaned without being taken out of the casing.

In the heat exchanger according to the invention the purpose in the previous paragraph is substantially obtained by filling the whole flow section between the tube or tubes and the casing by surface extending elements and filling bodies, which are disposed between surface extending elements belonging to the same tube and/or different tubes and/or between the casing and surface extending elements, and of which at least some consist of or may easily be replaced by cleaning lances provided with nozzles, which lances are connectable to a source of steam or some other cleaning medium of high pressure. The heat exchanger is provided with means which facilitate the removal of the filling bodies from the heat exchanger in order that the cleaning lances substituted therefor will be similarly disposed so that substantially all surface extending elements can be swept by means of cleaning sprays flowing from the nozzles of the lances.



By the word "envelope surface" used below and in the claims is meant the projection of the surface which is limited by an (imaginary) casing which is tangent to those points of the pins which are most remote from the tube, in a plane perpendicular to the longitudinal axis of the tube.

Embodiments of the invention are shown as examples in the accompanying drawings.

FIG. 1 illustrates a cross section through a heat exchanger made in accordance with Swedish Patent No. 157,483, to which the invention has been applied.

FIG. 2 illustrates a cross section through an oil preheater according to another embodiment of the invention.

FIG. 3 illustrates a partial longitudinal section along the line III—III of FIG. 2.

FIG. 4 illustrates a longitudinal section through an oil preheater of a very great capacity and constructed in accordance with still another embodiment of the invention.

FIG. 5 illustrates an end view of the heat exchanger according to FIG. 4.

FIG. 6 illustrates a cross section through the heat exchanger according to the second embodiment and shown along the line VI—VI in FIG. 4.

FIG. 7 illustrates on a larger scale a partial cross section through a group provided with surface enlarging elements and shows in full lines a tube located therebetween, which is provided with surface extending elements and the envelope surface of which is substantially in conformity with the envelope surfaces of the tubes.

The heat exchanger shown in FIG. 1 contains an inner heat exchanger tube **1** which is provided with a bottom located below the plane of the paper and with external surface extending elements which consist of bent copper or aluminum pins **2**, which are welded endwise to the tube **1**. The tube **1** and the pins **2** welded thereto are enclosed in an outer casing **3** the bottom of which is located below the bottom of the tube **1**. The opposite end of the heat exchanger in relation to these bottoms is closed by means of an end flange **4** through which there extends a tube **5** opening near the bottom of the inner tube **1**. The flange **4** is provided with an opening **6**. Steam used as heating medium is supplied through the tube **5** and the condensate formed during the heat exchange is removed through a tube connected to the opening **6**. The medium to be heated (for example oil) is introduced through the tube **7** located near the end flange **4** of the heat exchanger, flows through the channel **8** of annular across section between the tube **1** and the casing **3** while sweeping the pins **2**, and flows out through a tube located at the opposite end of the heat exchanger in relation to the end flange **4**. Impurities entering with the medium flowing through the channel **8**, deposit on the pins **2**. The end flange **4**, the steam supply tube **5** and the heat transmitting tube **1** with the pins **2** therefore, according to the abovementioned patent, are removable, so that the pins can be cleaned outside the casing **3**. A more complete

description of the heat exchanger hitherto described is to be found in the abovementioned Swedish Patent No. 157,-483.

According to the present invention three filling bodies **9** which in the embodiment shown are homogenous bars, are placed between the inner tube **1**, the pins **2** and the outer casing **3**. The filling bodies **9** which also may be tubes closed in one end or both ends are preferably provided with eyes or hooks at the end located nearest the end flange **4**. The said eyes or hooks serve the purpose of facilitating removal of the filling bodies **9** when the end flange **4** has been removed, without it being necessary to remove the heavy tube **1** provided with the surface extending pins **2** from the casing **3**. When the filling bodies **9** have been removed, rotatable cleaning lances provided with one or more rows of nozzles, are introduced, which are connected to a source of steam or some other cleaning medium with high pressure, instead of the filling bodies **9**. By means of the steam flowing from the nozzles of these lances the heat transmission surface can be efficiently cleaned without it being necessary to take the tube **1** with the pins out of the casing **3**. During operation the filling bodies **9**, which of course may have a shape that is in better conformity with the free interspace between the tube **1**, the pins **2** and the casing **3**, prevent greater quantities of oil from passing directly through the channel **8** without being heated through intimate contact with the pins **2** which enlarge the heat transmission surface and make the conditions of flow more favourable in respect to the heat transmission.

The filling bodies may as an alternative consist of cleaning lances already inserted, the ends of which facing the end flange are closed, for example by means of screw plugs which can easily be removed and replaced by pressure line connections. Of course the number of lances need not be three but may also be e.g. two, four or six.

In FIGS. 2 and 3 a cross section is shown through another heat exchanger made in accordance with the present invention, but which has greater capacity than the heat exchanger shown in FIG. 1 but like the latter is intended for oil preheating.

As will be seen from FIG. 2 the heat transmitting surface consists substantially of six heat exchanger tubes **11** arranged in a ring and provided with surface extending elements in the shape of bent metal pins **12** and arranged within a common casing **13**. Each of the abovementioned units **11—12** corresponds to the tube **1** provided with pins **2** in FIG. 1, and has an approximately circular envelope surface. In each tube **11** a steam supply tube **14** is provided, which together with its tube **11** forms a channel **15** through which the condensate formed during the heat transmission flows. The casing **13** and one or both sides thereof are provided with suitable connections for supply and removal of oil, supply of steam and removal of condensate.

In the space **17** in the middle of the casing **13** there is room for a tube provided with pins of the same kind as the six tubes **11**. If such a tube with circular envelope surface were arranged coaxially with the casing **13**, six passages substantially triangular in cross section should be formed between the envelope surfaces of the seven tubes. Such passages are not desirable, as they easily let pass a great amount of oil, which thereby should not be heated. In view of this, a central tube **16** is provided which, like the tubes **11**, contains an inner steam supply tube **14** but which has surface extending pins **18**, **19** arranged in a special way. In FIG. 2 the pins **19** seem to be shorter than the pins **18**, but in fact they are of the same length. How the pins **19** are arranged will be apparent from FIG. 3, which shows that like the pins **18** they are attached endwise, but contrary to the said pins **18** they are bent in the direction of the longitudinal axis of the tube **16**. However, it is evident that the pins **19** can be shorter than the pins **18** and radial like these. In this manner the surface extending elements of the tube **16** will get an envelope surface limited by six arcs located on the axes of the outer tubes **11** and which thus are in conformity with the envelope surfaces of the surface extending elements of the outer tubes **11**.



In order to reduce the free flow passages between the pins **18** and **19** filling bodies **20**, which may be homogenous barns, or as an alternative may be tubes closed in one or both ends, may be disposed between the said rows of pins **18** and **19**, as shown in dash-and-dot lines in FIG. 2.

Each of the six triangular passages formed between the envelope surfaces of the surface extending pins **12** of the tubes **11** and the casing **13** is filled up by two filling bodies **21** and **22** respectively. The filling bodies **21** correspond to the filling bodies **9** in FIG. 1 and according to the invention they are tubes or rods, which during operation have the posiiton shown, but, during cleaning operation are replaced by cleaning lances which are connected to a source of steam, water or some other cleaning medium of high pressure. The filling bodies **22** are not to be taken out of the casing **13** and may be cast or made of sheet-metal bent in a suitable manner. They need not be homogenous, but must be closed at least at one end, so that no flow channels for the oil are formed, which oil then would not be heated to the desired extent.

FIGS. 4–7 illustrate an oil preheater with a very great capacity. As will be particularly seen from FIG. 6 it is formed substantially of seven groups each comprising six heat exchanger tubes **31** provided with surface extending pins **32**, and located within a casing **29**, which heat exchanger tubes **31** are arranged in a ring around a central tube **33**, which is also provided with surface extending pins **34**, **35**. Within the tubes **31** and **33** steam supply tubes **30** and **36** respectively are provided. Besides, around the circumference twelve tubes **39** are arranged provided with radially bent and axially bent surface extending elements **37** and **38** respectively. In the said tubes **39** steam supply tubes **40** are located. Finally there are further six heat exchanger tubes **41** which are provided with straight or bent pins **42** and arranged between the innermost one and the six outermost remaining ones of the seven groups of tubes **31** and **33** surrounding the said group. Within the heat transmitting tubes **41** steam supply tubes **43** are provided. The construction of the tubes **41**, their pins **42** and the steam supply tube **43** as well as the position of these elements in relation to the four surrounding heat exchanger tubes **31** and appurtenant pins **32** and steam supply tube **30** will be seen from FIG. 7 which illustrates an enlargement of a part of the cross section of FIG. 6. The elements **41—43** may be replaced by filling bodies **44** as indicated by dash-and-dot lines in FIG. 7. The filling bodies **44** may be cast or fabricated of sheet-metal. They may be homogenous or hollow, but they must be closed at least at one end, so that no flow passages for oil are formed in the filling bodies **44**.

In addition to the abovementioned filling bodies three additional rows of filling bodies arranged in a ring fill up the remaining free flow passages between the envelope surfaces of the heat exchanger tubes and the casing. The innermost one of these rings comprise six filling bodies **46** which have the same shape and construction as the alternative filling bodies **44** in FIG. 7. These filling bodies **46** are arranged between adjacent pairs of heat exchanger tubes **31** in the six outer groups. The number of filling bodies in the intermediate ring is also six, and these comprise according to FIG. 6 homogenous rods **47**, but they also might comprise tubes closed at one or both ends. Between the heat exchanger tubes **31** and **39** respectively located nearest to the casing **29**, and the casing **29** there are three groups of filling bodies **49**, **50**, **51**. The number of filling bodies **49** which are located between adjacent heat exchanger tubes **39**, amount to six. The number of filling bodies **50** amount to

twelve, and they are located between adjacent heat exchanger tubes 31 and 39. The number of filling bodies 51 which are located between adjacent heat exchanger tubes 31 amount to six. All the filling bodies 49, 50, 51 have approximately the same triangular form, as they substantially are limited by three arcs of circles. The filling bodies 49 which are of the same size, are smaller than the filling bodies 50, which are also of the same size. The filling bodies 51 are larger than the filling bodies 50 and are of the same size. All the filling bodies 49—51, the number of which are 24, may be made of sheet-metal and closed at one or both ends or as an alternative they may be cast. In the latter case they may be homogenous or closed at one end. How the tubes and filling bodies provided in the casing 29 are arranged will also be seen from FIGS. 4 and 5 which now are referred to.

FIG. 4 illustrates an axial longitudinal section through the oil preheater in accordance with the preceding embodiment of the invention, the central portion of the preheater being omitted, so that only the parts located nearest the ends of the preheater are shown in the drawing, the purpose being that the figure shall not be unnecessarily large.

In the casing 29 two partition walls 53 and 54 are provided. The heat exchanger tubes 31 and the tubes 33, 39 (see also FIG. 6) and also the heat transmitting tubes 41 which as an alternative replace the filling bodies 44, are attached in the partition wall 53. These tubes are closed at the end remote from the partition wall 53.

The filling bodies 49—51, 47, 46 and the filling bodies 44, if provided, abut against the partition wall 53. The filling bodies rest on and are carried by the surface extending pins. The ends of the filling bodies 46 and 47 which are remote from the partition wall are provided with hooks 55 and 56 respectively, which facilitates the removal of the filling bodies when they are to be replaced by cleaning lances when cleaning the extended surfaces.

In the partition wall 54 the steam supply tubes 30, 36, 40 and also the alternative tubes 43 are attached, all being open at both ends. In FIG. 4 only three steam supply tubes are shown.

The heat-emitting steam is introduced in the direction of the arrow 58 through the flange 59 and flows through the steam supply tubes 30, 36, 40, 43 to the closed ends of the heat exchanger tubes 31, 33, 39 and 41, where the steam returns and flows under condensation back through the interspace between the respective steam supply tubes and heat exchanger tubes. The condensate formed by the condensation of the steam and the consequent heating of the oil, is removed from the interspace 57 between the partition walls 53, 54 through the connection 60 in the direction of the arrow 61.

Cold oil is introduced in the direction of the arrow 64 through the connecting flange 63 in the head of the casing 65 which is provided with six flanges 62 arranged in a ring and six connection pieces 69 also arranged in a ring. The oil heated in the heat exchanger is taken out in the direction of the arrow 66 through the connecting flange 67 which is located near the partition wall 53.

The impurities washed off during the cleaning operation are removed through the connecting flange 68.

How the head 65 is constructed and how the filling bodies 46, 47 can be removed can also be seen from FIG. 5, which is an end view of the oil preheater, seen in the direction of the arrows A—A in FIG. 4. As will be seen from FIGS. 4 and 5 each filling body 46 with appurtenant hook 55 is arranged exactly opposite the opening 71, normally covered by a lid 70, in the flange 62. In the same way each of the filling bodies 47 with appurtenant hook 56 is arranged exactly opposite the corresponding connection piece 69 which normally is closed by means of a threaded plug 72. In order to make it possible to remove the plugs 72 and the hooks 56 with attached filling bodies 47, in spite of the flanges 62, the latter are provided with recesses 73.

When the oil preheater shall be cleaned, the supply of oil is first shut off, and oil in the preheater is drawn off through the flange 68. Thereafter the lid 70 and the plugs 72 are removed, whereafter the filling bodies 46 and 47 can be pulled out with the aid of the hooks 55 and 56 respectively. Instead of the filling bodies 46 and 47 cleaning lances provided with nozzles are now introduced which are connected to a source of steam or some other compressed cleaning medium, which flows out of the nozzles and cleans the surface extending pins. The impurities are drawn off through the flange 68. When the cleaning operation has been completed, the lances are drawn out, the flange 68 is closed, the filling bodies 46 and 47 are inserted, the lids 70 and the plugs 72 are put into place, and the communication with the source of oil is opened.

In comparing a preheating system according to the invention with one comprising preheaters having straight pins as formerly used, it has been found that the weight and the volume of oil preheaters according to the invention are not more than about 60% of the weight and the volume respectively of oil preheaters of earlier construction. The price of oil preheaters according to the invention is much lower than the price of the preheaters manufactured at present.

The embodiments described and shown in the drawings are of course only to be considered as examples, and the details thereof can be modified in several ways within the scope of the claims. Thus, details from different embodiments can be combined into new modifications. Furthermore the heat exchangers can be used for heating and cooling other fluids than oil by means of steam respectively cooling water. Finally the tubes can be replaced by plain or possibly curved walls, which on one or possibly both sides are provided with pins or other surface extending elements and form alternating passages between them for the different heat exchanging media.

What I claim is:

The method of cleaning a heat exchanger apparatus which includes a cylindrical casing with a plurality of spaced tubes therein arranged substantially parallel to the axis of said casing, each of said tubes having a plurality of heat conductive pins extending outwardly from the periphery thereof, longitudinal filling bodies removably mounted in said casing, means for introducing a heat exchanging fluid within said tubes, and means for introducing a fluid the temperature of which is to be varied within the casing about said tubes in contact with the tube pins, said filling bodies being provided in number and size to substantially fill all the free space between the envelopes defined by the free ends of the tube pins and the walls of the casing to urge substantially all of the fluid into close contact with the effective heat exchanging areas of said tubes, comprising the steps of axially removing said filling bodies from said casing, axially inserting rotatable nozzled cleaning lance means in the spaces vacated by the removal of said filling bodies, and forcing cleaning fluid means through said lance means and the nozzles thereof to clean the adjacent surface areas of said tubes.

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