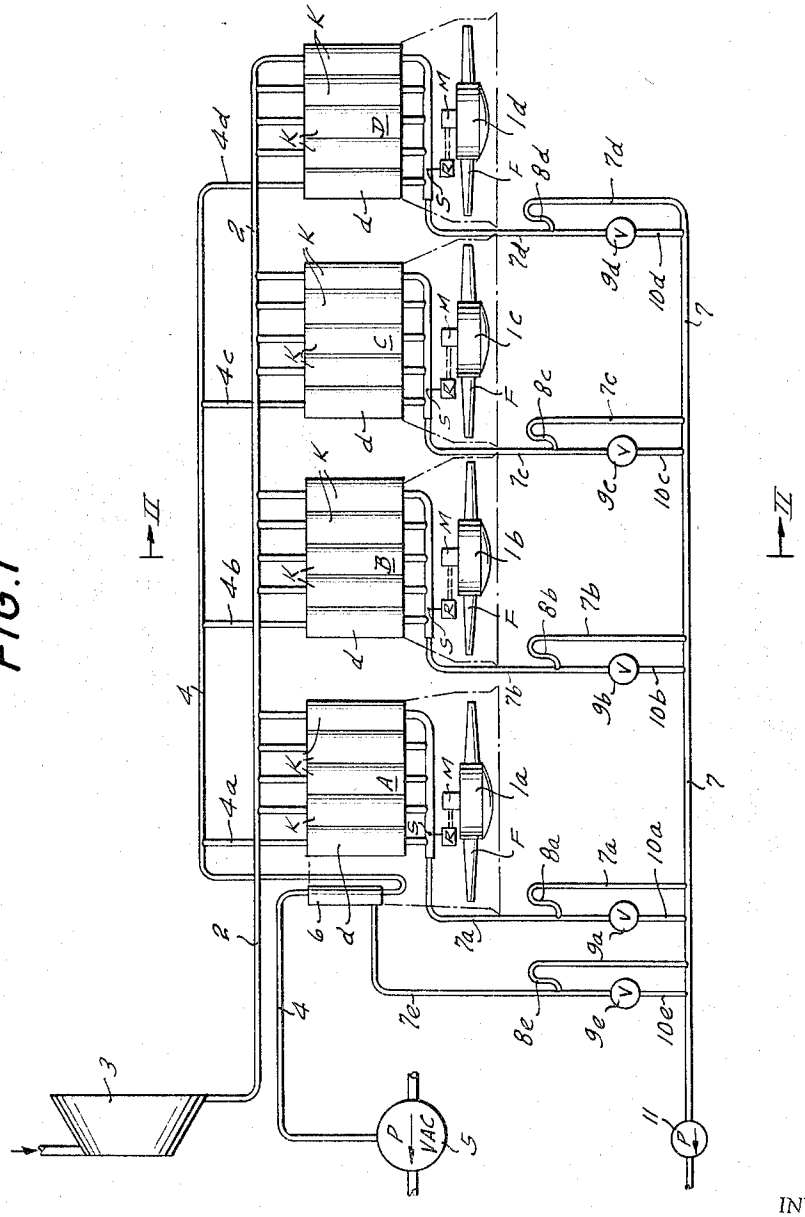
Dec. 6, 1966 J. C. NIEMANN 3,289,742

AIR COOLED SURFACE CONDENSER AND METHOD OF OPERATING THE SAME

Filed Feb. 4, 1966 6 Sheets-Sheet 1

FIG. 1



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AIR COOLED SURFACE CONDENSER AND METHOD OF OPERATING THE SAME

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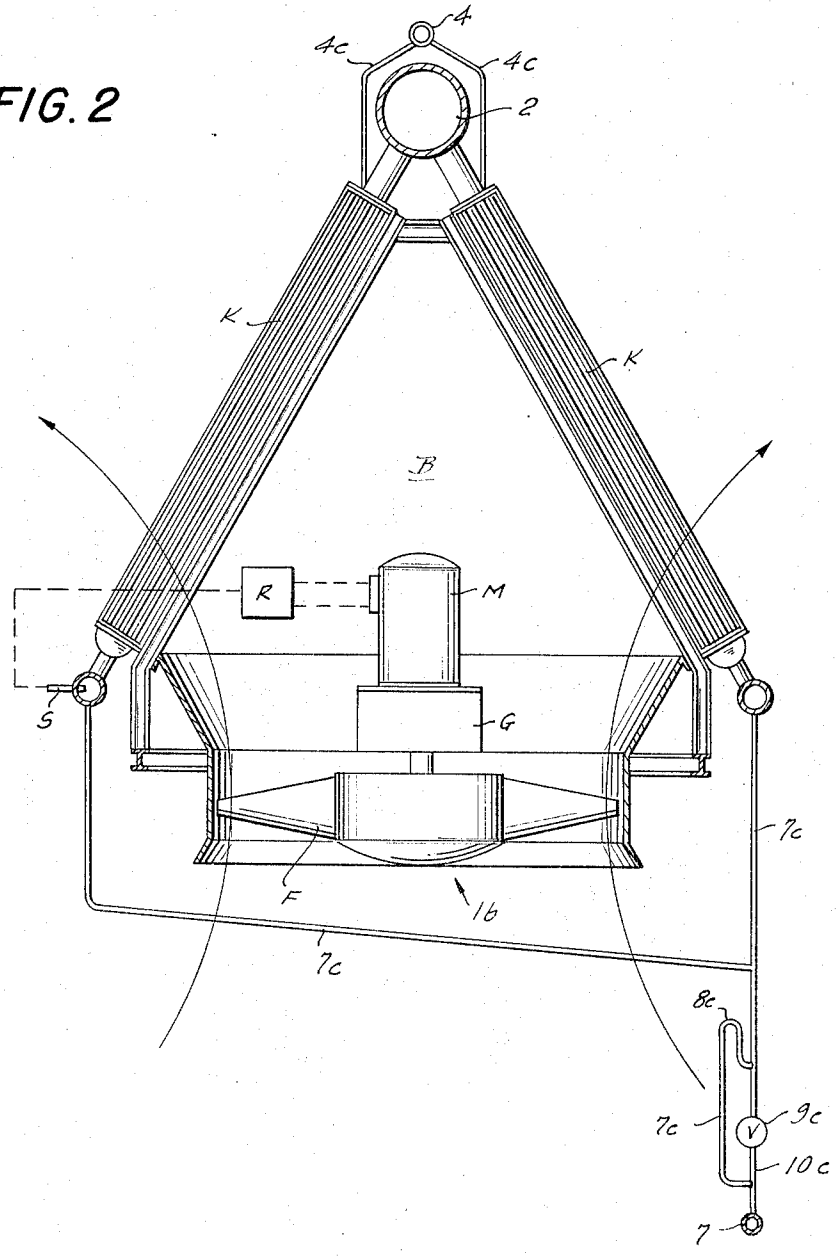
FIG. 2



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AIR COOLED SURFACE CONDENSER AND METHOD OF OPERATING THE SAME

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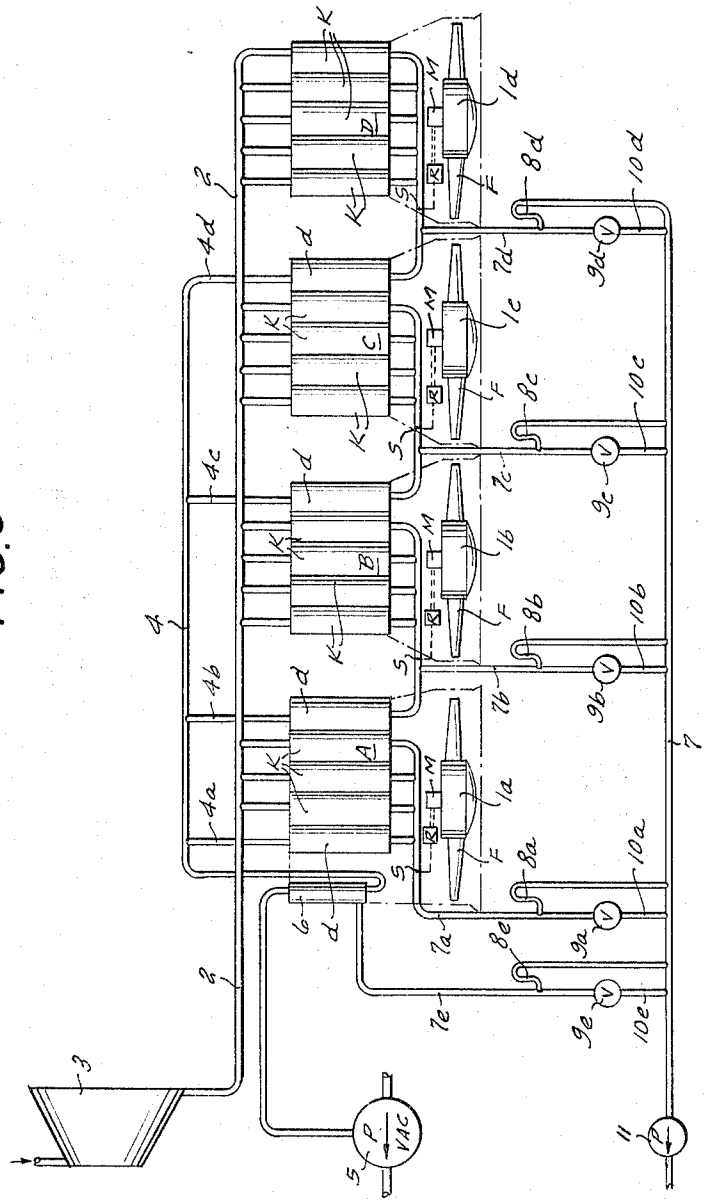
FIG. 3



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AIR COOLED SURFACE CONDENSER AND METHOD OF OPERATING THE SAME

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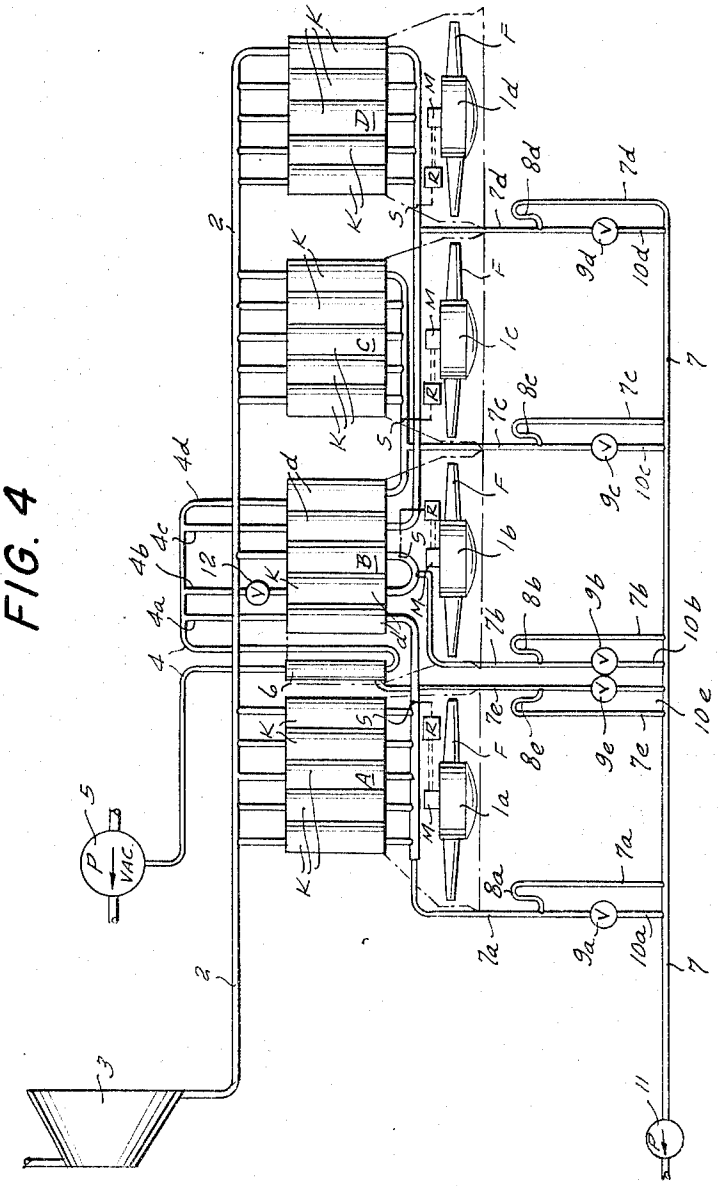
FIG. 4



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AIR COOLED SURFACE CONDENSER AND METHOD OF OPERATING THE SAME

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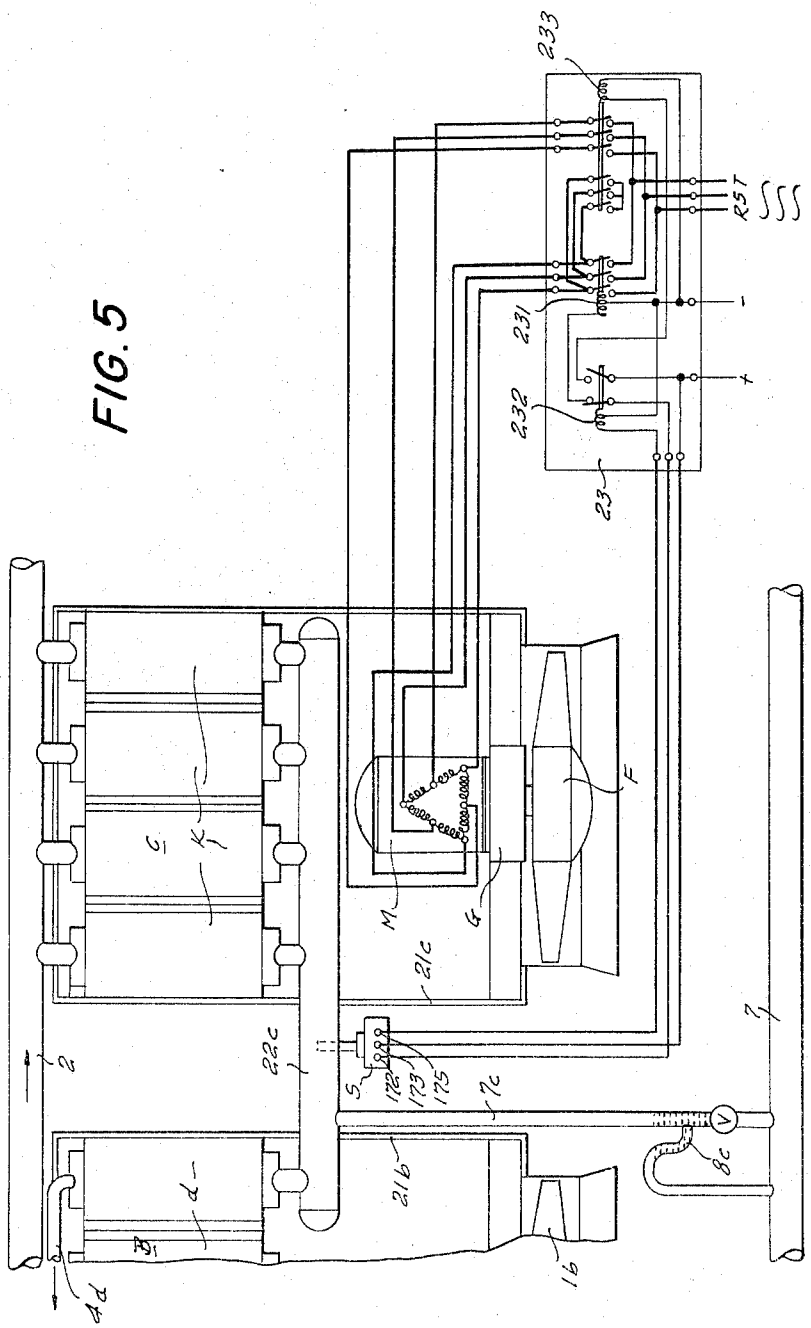
FIG. 5



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AIR COOLED SURFACE CONDENSER AND METHOD OF OPERATING THE SAME

Filed Feb. 4, 1966 6 Sheets-Sheet 6

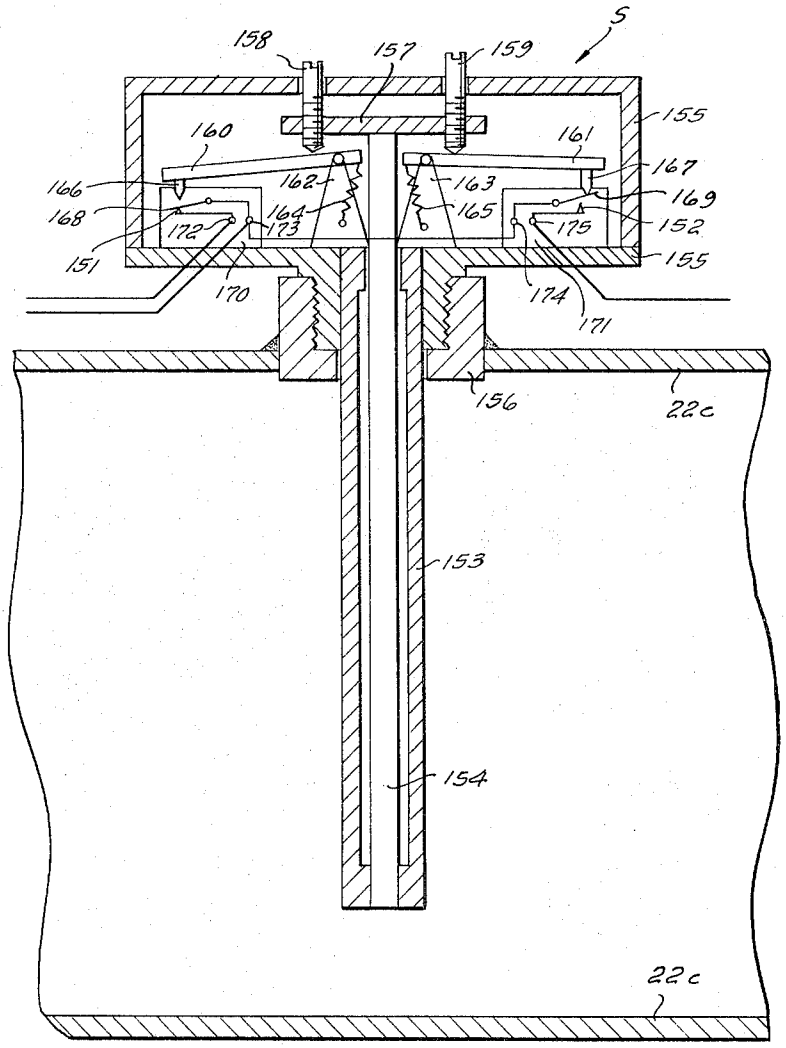

FIG. 6

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United States Patent Office 3,289,742 Patented Dec. 6, 1966

3,289,742

AIR COOLED SURFACE CONDENSER AND METHOD OF OPERATING THE SAME

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Filed Feb. 4, 1966, Ser. No. 525,169
Claims priority, application Germany, Sept. 19, 1962, G 35,949
23 Claims. (Cl. 165—1)

This present application is a continuation-in-part application of the application filed with the same title under the Serial No. 308,261 on September 11, 1963, now abandoned.

The present invention relates to an air-cooled surface condenser which comprises heat exchange elements which are connected in parallel both on the steam side and on the air side and which are acted upon by a constrained stream of cooling air. The heat exchange elements are arranged in a plurality of groups spaced from each other and the elements in each group are preferably arranged in two rows which are inclined with respect to each other to define between themselves a V-shaped upwardly tapering space and air blower means are arranged one for each group beneath the V-shaped space for blowing air upwardly into the space so that the air will pass through the space and past the elements forming the respective group. These air blower means can be switched off and on separately or they are constructed in such a manner that the delivery of cooling air can be regulated separately for each air blower means. At least one dephlegmator element is arranged to follow, with respect to the steam flow, each group of elements connected as condensers. In this conventional class of air cooled surface condensers, the groups of elements consisting of cendenser elements and dephlegmator elements are connected together at the lower ends by conduits of large cross section, and this circuit principle is not invalidate even if, in the case of an installation consisting of a plurality of branches, the lower connecting conduits of the individual branches communicate mutually through condensate collecting conduits which are incompletely filled with water.

If an air condenser of this type, consisting for example of two groups of elements and air blower means, has its capacity controlled down in that one of the air blower means operates at half speed, whereas the other air blower means continues to run at full speed, the quantity of steam condensed by the more weakly cooled part of the installation diminishes. Inasmuch the pressure at the inlet end of all the condenser elements is substantially the same, due to the common steam distributor conduit, and inasmuch the pressure at the outlet end of all condenser elements is the same, due to the conduits of large cross section connecting the outlet ends of all the condenser elements and the inlet ends of all the dephlegmator elements, the pressure loss of the steam flow through the condenser elements will remain the same for all condenser elements. This will result that more steam flows through the more weakly cooled group than can be condensed therein whereas simultaneously less steam will flow through the more strongly cooled group than could be condensed therein. The first mentioned effect has the result that surplus steam is exhausted through the exhaust conduit to the vacuum pump and the vacuum is impaired by the strong increase in the delivery of the vacuum pump. On the other hand, the insufficient delivery of steam to the more strongly cooled group will have the result that the condenser element in this part of the installation will not be acted upon sufficiently with steam along their total length, and subcooling of the condensate, or even freezing of the condensate under frost conditions may occur.

Despite a number of advantages possessed by this conventional arrangement in other respects, it is apparent from the foregoing that the conventional circuit imperfectly fulfills the task of equalizing the distribution of the steam to the existing heat exchange surfaces, especially in the case of operation under partial load and differential control of the air blower means.

It is an object of the present invention to overcome the above-mentioned disadvantage of air cooled surface condenser arrangements of the aforementioned kind.

It is an additional object of the present invention to provide for an air cooled surface condenser arrangement of the aforementioned kind in which subcooling of the condensate is positively avoided under all operating conditions of the arrangement.

It is a further object of the present invention to provide for an aircooled surface condenser arrangement of the aforementioned kind which will automatically adapt itself to all operating conditions and which is constructed of relatively few and simple components so that the arrangement may be constructed at reasonable cost and will stand up perfectly under extended use.

With these objects in view, the air cooled surface condenser arrangement according to the present invention mainly comprises a plurality of condenser elements having each an inlet end and an outlet end and a plurality of dephlegmator elements having each an inlet end and an outlet end, wherein the elements are arranged in a plurality of groups of elements spaced from each other. The arrangements further comprises steam distributor conduit means connecting the inlet ends of all condenser elements in parallel, condensate collecting conduit means for each group containing condenser elements and connecting the outlet ends of the condenser elements of the respective group in parallel, and the inlet ends of the plurality of dephlegmator elements being respectively connected to the downstream side of the aforementioned condensate collecting conduit means so that at least one dephlegmator element is connected to each condensate collecting conduit means. The arrangement includes further exhaust conduit means connected to the outlet ends of the dephlegmator elements, condensate discharge means for discharging condensates from the aforementioned condensate collecting conduit means constructed and connected to the latter so as to prevent flow of steam from one condensate collecting conduit means to the other, air blower means for each group of elements of blowing air over the elements in each group, and means for regulating the output of the air blower means for at least one group of elements so as to blow a variable amount of air against the elements of said one group.

In this arrangement, the steam which is not condensed in the condenser elements of the respective group of condenser elements is able to pass into the following dephlegmator element of the respective group and to condense there. Furthermore, inasmuch as the absorption capacity of the dephlegmator is limited, particularly at low air temperatures, and the pressure loss of the dephlegmator on the steam side rises steeply and abruptly when the absorption limit is reached, the surplus steam is thus simultaneously prevented from penetrating into the exhaust conduit and impair the vacuum, without the necessity of complicated circuits liable to break downs and large fittings for this purpose, such as are otherwise required to obviate this disadvantage.

Since in the arrangement according to the present invention subcooling or even freezing of the condensate is prevented even when the differences between the air velocities and air quantities of the individual groups of elements of the arrangement are large, it is not necessary, in contrast with conventional arrangements, to make all air blower means adjustable. To the contrary, it is usual-

ly sufficient to equip the greater part of the installation with air blower means without speed variation and to provide only for those groups of heat exchange elements which remain in operation under partial load and low outside temperature with air blower means, the output of which may be varied. A more expensive arrangement in which all air blower means are provided with speed regulator means to vary the output thereof will be necessary only in exceptional cases where there is reason for anticipating extraordinary fluctuations in the quantity of steam and/or greater variations in the temperature of the ambient air which is blown by the air blower means over the heat exchange elements.

Although the dephlegmator element connected to the downstream side of the condensate collecting conduit means connecting the outlet ends of the condenser elements of a group of elements in parallel may be arranged to form a component of the respective group of condenser elements, special advantages are produced within the scope of the invention if the dephlegmator element on the downstream side of the group of elements connected as condensers constitutes a component of another group of elements, since it is possible by this means to improve further and substantially the regulation capacity and hence the adaptability of the installation, especially in conjunction with the adaptation of a specific switching sequence for the individual air blower means. It is especially advantageous in this case if at least a part of the dephlegmator elements of the groups of elements connected at condensers are combined either alone or in conjunction with one or more condenser elements into a separate independent group equipped with its own air blower means.

In all cases, the elements which are arranged in individual separated groups may have a different number of elements connected as condensers and/or dephlegmators and the specific arrangement of condenser elements and dephlegmator elements in each group will be governed by particular circumstances and by the requirements for the partial load conditions resulting from these circumstances.

However, since the air temperature at which a dephlegmator reaches its absorption limit depends not only upon its construction and dimension, but also upon the magnitude of the air velocity, namely in the sense that it rises with increasing air velocity and declines with decreasing air velocity, and since the dimensioning of the dephlegmator part may also be influenced by other considerations, especially in the case of small installations, in the sense that the desired blocking action of the dephlegmator may become effective only at a relatively low air temperature when the air velocity is throttled, it may furthermore be desirable to interpose additionally in the common exhaust pipe an aftercooling element connected as dephlegmator, which need only be sufficiently large to be able to precipitate the small quantity of steam which possibly passes through dephlegmators which are subjected to a weaker action of cooling air. Since the exhaustion of air from the elements connected as condensers takes place over the dephlegmator elements respectively following the condenser elements, the air exhaust pipes of the dephlegmator elements are connected in parallel arrangement to the common exhaust pipe in which the additional aftercooling element is interposed within the sphere of influence of that air blower means which, even during a partial operation of the installation will always supply an adequate amount of cooling air. This may be achieved, for instance, by disposing the aftercooling element over the air blower means which is switched on first when the installation is taken into service and which is switched off last when the installation is shut down.

Since the aftercooling element acts mainly as an additional safety device against penetration of steam to the vacuum pump in small installations, or in such installations where nonpenetration of steam into the vacuum pump is not insured solely by the blocking action of the dephlegmator which depends upon utilizing the absorption limit, they may be made of substantially smaller dimensions, or may be even totally omitted in those cases where the dephlegmators of each group of condenser elements are cooled by air blower means of an adjacent condenser group since the dephlegmators in such an arrangement may still be cooled by the air blower means of the adjacent group which is still running, even if the air blower means associated with the condenser group to the downstream side the reflective dephlegmator is connected has already been stopped. In the case of such an arrangement, the aftercooling element is preferably arranged to form a component of the group of elements which contains elements connected as dephlegmators of the adjacent condenser groups.

When operating the surface condenser according to the present invention, it is convenient to adapt the procedure that in the case of increase or reduction in the air cooling requirements, the air blower means associated with the individual groups of the installation are switched on or off or regulated in the sense of adapting the deliveries of cooling air successively in stages and in such a manner that the air blower means acting on dephlegmator elements combined into a separate group and/or the air blower means acting on aftercooling elements will always deliver an equal or a greater quantity of air than the other air blowing means and so that the one air blower means is switched on first when the installation is taken into service and switched off last when the installation is taken out of service.

According to the present invention it is also possible to fully automatically regulate at least one, or all of the air blower means in dependence on the temperatures in the condensate collecting conduit between the condenser and dephlegmator elements of each group. To this end, the temperatures in the conduits between the outlet ends of the condenser elements and the inlet ends of the dephlegmator elements of each group of elements are sensed by means of temperature sensing means, and the air blower means are preferably provided with electric motors having regulators which are connected to the temperature sensing means to be regulated thereby according to the temperatures sensed by the sensing means.

The condensate discharge means for discharging condensate from the condensate collecting conduit means preferably comprise a main condensate collecting conduit, a connecting conduit connecting the condensate collecting conduit means of each group with the main collecting conduit, and means preferably in the form of water seals in each of the connecting conduits for preventing passage of steam therethrough. Because the water seals may be subject to frost danger when the installation or individual parts of the installation are shut down in winter, a bypass conduit is preferably provided for draining the water seal. Each of the bypass conduits is provided with a cutoff element and a similar automatic control system as above described may also be provided for the cutoff elements in the bypass conduits in such a manner that the cutoff elements are automatically closed when the first air blower means of the installation is started and are automatically opened when the last air blower means is stopped.

Another possibility is to control the cutoff elements of the bypass conduits in dependence upon the temperature so that they are closed when the temperature of the condensate in the water seals is above a specific limit value, and are automatically opened as soon as the temperature falls below this limit value. The level of the limit temperature value in this case is conveniently between the freezing point and the lowest condensate temperature which occurs in service. The last mentioned possibility of control for the cutoff elements of the bypass conduits can be realized in an especially simple manner,

known per se, by the use of bimetallic strips as an actuating element for the cutoff elements.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a schematic elevational view of an air-cooled surface condenser arrangement according to the present invention;

FIG. 2 is a section through the surface condenser arrangement taken along the line II—II of FIG. 1;

FIG. 3 is a schematic elevational view of another form of construction of the air-cooled surface condenser;

FIG. 4 is a schematic elevational view of a further form of construction of the air-cooled surface condenser;

FIG. 5 is a partial schematic elevational view of one form of construction of the air-cooled surface condenser according to the present invention and showing the means for regulating the output of one of the air blower means in further detail; and

FIG. 6 is an enlarged sectional view of a temperature sensing means forming part of the means for regulating the output of at least one of the air blower means.

Referring now to the darwings, and more specifically to FIGS. 1 and 2 of the same, it will be seen that the air-cooled surface condenser arrangement may comprise four spaced groups of heat exchanger elements namely the groups A, B, C and D. The heat exchange elements in each group are arranged in two rows of elements which are inclined with respect to each other to form an inverted V in cross-section, as best shown in FIG. 2, so as to define between themselves an upwardly tapering V-shaped space. Air blower means 1*a*, 1*b*, 1*c* and 1*d* are respectively arranged beneath the V-shaped space thus defined by the groups of A, B, C and D of elements so as to blow air into respective V-shaped space and so that the air passes between the elements of the respective group as indicated by the arrows in FIG. 2. In the embodiment illustrated in FIG. 1 each group of elements comprises eight elements *k* connected as condensers, which are connected in parallel at the upper inlet ends thereof to a common steam distributor conduit 2 which in turn is connected to the steam discharge outlet end of a steam turbine 3. The lower outlet ends of the condenser elements *k* of each group are connected in parallel by condensate collecting conduit means 7*a*, 7*b*, 7*c* and 7*d*, respectively, which in turn are connected to a main condensate collecting conduit 7, and a pump 11 in this main collecting conduit 7 serves to pump the condensate to a place of use. Each of the group of elements A, B, C and D includes also a pair of dephlegmator elements *d* having lower inlet ends which are connected downstream of the connection of the outlet ends of the condenser elements forming the respective group of the condensate collecting conduit means 7*a*, 7*b*, 7*c* and 7*d*, respectively. The upper outlet ends of the dephlegmator elements *d* of each group are respectively connected by conduits 4*a*, 4*b*, 4*c* and 4*d* to a common exhaust conduit 4 and an aftercooling element 6 is arranged in the exhaust conduit 4 between the conduit 4*a* and a vacuum pump 5. The aftercooling element 6 forms a component of the group of elements A and is subjected to the influence of the air stream produced by the air blower means 1*a*. A condensate collecting conduit 7*e* connects the lower end of the aftercooling element 6 with the main condensate discharge conduit 7.

Means in the form of water seals 8*a*, 8*b*, 8*c* and 8*d* are provided in each of the condensate collecting conduit means 7*a*, 7*b*, 7*c* and 7*d* respectively and a similar water seal 8*e* is provided in the conduit 7*e* to prevent any passage of steam from the outlet ends of the condenser elements K of one group and from the inlet ends of the dephlegmator elements *d* of the respective group to pass into the elements of the other groups. Each of the water seals is provided with a bypass conduit 10*a*, 10*b*, 10*c*, 10*d*, 10*e*, respectively, in which cutoff elements 9*a*, 9*b*, 9*c*, 9*d* and 9*e* are respectively arranged to open and close the bypass conduits. In this way the water in the water seals may be discharged to prevent freezing thereof when the temperature of the ambient air is below 0° C., or the cut-off elements may be closed so that the water seals will be filled with water to perform the desired function.

Each of the air blower means includes a fan F and an electromotor M driving the fan and at least the motor of the air blower means 1*a* for the group of elements A of which the after cooling element 6 forms a component includes also speed regulating means R for controlling the speed of the motor in dependence on the temperature in the condensate collecting conduit means upstream of the dephlegmator element *d* connected thereto, sensed by sensing means S arranged at this location and connected to the regulator means R. In the arrangement shown in FIG. 1 the motors of all air blower means are provided with speed regulating means and sensing means located in the respective condensate collecting conduit means of each group.

The construction of a preferred temperature sensing means to be used in this arrangement, the construction of the regulator means R and the motor M regulated thereby will be described later on in detail.

In the above-described embodiment illustrated in FIGS. 1 and 2, the air blower means 1*a* which is associated with the group of elements A and also with the aftercooling element 6 and which may of course also be replaced by a plurality of air blower means, is adjusted in such a manner as will be described later on in detail so as to be operated at a higher speed or at least with the same speed as the other air blower means and so that the air blower means 1*a* is switched on first when the installation is taken into service and stopped last when the installation or a particular part of the installation is taken out of service.

The heat exchange elements, including the aftercooling elements, conveniently consist in a known manner, irrespective of their mode of connection as condenser or dephlegmators, of banks of finned tubes with collecting and distributing chambers disposed at the ends thereof, or the elements may be in the form of plate heat exchangers or heat exchangers of chamber shaped construction, wherein the cooling air is passed through tubes extending transversely through the chambers, and wherein the precipitation of the steam is effected on the outside of the tubes inside the chambers.

FIG. 3 shows a preferred embodiment which differs from the above described embodiment illustrated in FIGS. 1 and 2 by the specific arrangement of the dephlegmator element *d* in the various groups of elements. In the arrangement shown in FIG. 3 the dephlegmator element *d* which is connected at the downstream side to the condenser elements *k* of the group of elements D does not form a component of the group of elements D but is combined in a group with and forms a component of the group of condenser elements *k* forming the group of condenser elements C and is therefore subjected to the influence of the air blower means 1*c* coordinated with the group of elements C. Likewise, the dephlegmator elements *d* connected to the downstream side of the condenser elements *k* forming the group C forms a component of the group B and the dephlegmator element *d* connected at the downstream side to the condenser elements forming the group B is combined with and forms a component of the condenser elements *k* forming the group A. This group of condenser elements has also a dephlegmator element *d* connected to it on the downstream side and forming a component of the group of elements A. The dephlegmator element *d* of the group B as well as the de-

phlegmator element *d* of the group A is therefore subjected to the influence of the air blower means **1***a* which also blows cool air over the aftercooling element **6** which likewise forms a component of the group A. In this arrangement the air blower means **1***d* associated with the group D is to be switched on last when the installation is taken into service and switched off first when the installation is taken out of service, whereas the air blower means **1***a* associated with the group A is switched on first when the installation is taken into service and switched off last when it is taken out of service.

As is evident from FIG. 3, in the arrangement illustrated therein, the condensate collecting conduit means for each group provides a direct steam carrying connection between the lower outlet ends of each group of condenser elements with the lower inlet ends of dephlegmator elements connected thereto on the downstream side, even though the respective dephlegmator elements are not arranged in a group with the respect condenser elements. However, as in the preceding arrangement illustrated in FIGS. 1 and 2, there is no steam carrying connection between the groups of condenser connecting elements including their dephlegmator elements due to the water seals provided in the connection between the steam collecting condensate conduit means of each group and the main condensate collecting conduit **7**.

FIG. 4 shows a further especially advantageous arrangement according to the present invention. In this arrangement the groups A, C and D contain only condenser connected elements *k* and the dephlegmator elements *d* which are connected by the steam carrying condensate collecting conduits to the downstream side of each group are combined into the group B which in addition contains also condenser connected elements *k*, the inlet ends of which are connected to the steam distributing conduit 2 and the outlet ends are connected by means of a steam carrying condensate collecting conduit **7***b* to the inlet ends of dephlegmator connected elements *d* subjected to the influence of the air blower means **1***b* which blows cooling air over the dephlegmator elements of all groups and also over the aftercooling element **6** forming a component of the elements of the group B.

Water seals **8***a*–**8***d* are again interposed in the connection between the condensate collecting conduit means of each group to the main condensate conduit **7** and water seal **8***e* is likewise interposed in the condensate collecting conduit **7***e* connecting the inlet end of the aftercooling element **6** with the main condensate conduit **7**. A cutoff element **12** in the form of a valve is interposed in the air exhaust conduit **4***b* of the dephlegmator elements following the condenser elements of the group B on the steam side, which cutoff element upon failure of the air blower means **1***b* prevents steam from penetrating to the vacuum pump **5**. The cutoff element may be automatically controlled in a conventional manner in the same way as the remaining cutoff elements of the installation.

As mentioned before each air blower means comprises a fan F, an electromotor M driving the respective fan and preferably also reduction gearing G, as shown in FIG. 5, between the electromotor and the respective fan. At least the electromotor of the air blower means coordinated with the group of heat exchange elements containing also the aftercooling element **6**, or the electromotors of all airblower means are automatically regulated in dependence on the temperature in the condensate collecting conduit means of the respective group and for this purpose temperature sensing means S are arranged in each condensate collecting conduit means for each group preferably upstream of the inlet ends of the dephlegmator elements connected to the respective condensate collecting conduit means of the respective group.

The arrangement for automatically regulating the motor M in dependence on the temperature sensed in the respective condensate collecting conduit means is shown at an enlarged scale in further detail in FIG. 5 for the motor M coordinated with the group C of the arrangement illustrated in FIG. 4.

The condensating capacity of each group of heat exchange elements may be regulated by automatic regulation of the motor of the air blower means for each group of heat exchange elements and each motor may be regulated automatically between standstill, low speed and high speed. The motor M for each air blower means is preferably a multispeed squirrel cage motor having a stator winding permitting change of the number of poles thereof as indicated in FIG. 5. Switching on and off of the motor as well as changing the number of poles thereof is automatically produced by the temperature sensing means S which is electrically connected to a relay **23** as shown in FIG. 5 to automatically switch the motor M on and off and to change the number of poles thereof according to the temperature sensed. As shown in FIG. 6 the temperature sensing means S includes two contacts **151** and **152** which will close when a sensed predetermined temperature is surpassed and which will open at a temperature which is slightly lower than the temperature at which the contacts will close. The temperature sensing means S can for instance be adjusted in such a manner that the contact **151** will close when a temperature of 29.7° C. is surpassed and will open when the temperature falls below 29.2° C., whereas the contact **152** may be adjusted to close when a temperature of 30.9° C. is surpassed and will open when the temperature falls below 30.4° C.

As is evident from FIGS. 5 and 6, the contacts **151** and **152** of the temperature sensing means S are connected with the relay **23** of the motor M coordinated with the group C of condenser elements in such a manner that the motor will remain at standstill as long as both contacts **151** and **152** are open. When the temperature in the conduit **22***c* rises and surpasses the temperature at which the contact **151** closes (for instance 29.7° C.) the contact **151** will close, to energize the coil **231** closing thereby the switch coordinated with the coil **231** which in turn will start the motor M at low speed. When the temperature in the conduit **22***c* rises further to surpass the temperature at which the contact **152** closes (for instance 30.9° C.), the contact **152** will close to energize thereby the coil **232** in the opposite direction deenergizing thereby the coil **231** and opening the switches coordinated therewith and energizing thereby the coil **233** and closing the switches coordinated therewith, changing thereby the number of poles of the stator winding of the motor M and switching the motor to high speed.

Correspondingly, subsequent dropping of the temperature in the conduit **22***c* will first switch the motor to low speed and subsequently, upon further drop of the temperature will disconnect the motor from the network.

Each group of heat exchange elements is preferably enclosed by a housing as schematically illustrated in FIG. 5 by the housing **21***c* and **21***b* for the groups C and B and each of the housings is open at opposite ends so that the respective fan sucks cooling air through the lower open end of the housing and blows it over the heat exchange elements of the respective group and the air passes then between the heat exchange elements and out of the open upper end of the housing.

FIG. 6 illustrates the temperature sensing element S for the respective motor and the contacts coordinated therewith in further detail. As shown in FIG. 6 the temperature sensing means S includes a metal tube **153** made of material for instance copper having a high coefficient of thermal expansion in which a metal rod of a material having a very low coefficient of thermal expansion, for instance Invar, is located. The two elements **153** and **154** are fixedly connected at the lower ends thereof to each other. The tube **153** is fixedly connected at its upper end to the housing **155** which is screwed into a socket **156** of the respective condensate collecting conduit, for instance the conduit **22***c*. The rod **154** passes with clearance through the upper end of the tube **153** and carries

at its upper end a metal plate **157** into which two adjusting screws **158** and **159** are screwed, spaced from each other. When the temperature in the conduit **22***c* rises the tube **153** and the rod **154** will expand differently and the lower fixedly connected ends of elements **153** and **154** will move downwardly. Since the elongation of the tube **153** will be much larger than that of the rod **154**, the upper end of the rod and the plate **157** connected thereto will thereby move downwardly so that the adjusting screws **158** and **159** will act on the levers **160** and **161** which are respectively pivotally mounted on bearing blocks **162** and **163**. Springs **164** and **165** respectively connected to the levers **160** and **161** assure thereby that the upper surfaces of the levers are held in engagement with the lower ends of the adjusting screws **158** and **159**, respectively. At their outer ends the levers **160** and **161** act through pressure pins **166** and **167**, respectively, against spring contacts **168** and **169** of the switches **170** and **171** which when a certain pressure is imparted thereon will close the contacts **151** and **152** and which when the pressure is reduced will open the contacts again. The terminal contacts **173** and **174** of the switches **170** and **171** are connected within the switch housing **155** and the terminal contacts **172**, **173** and **175** are connected to the relay **23** as shown in FIG. 5.

By properly adjusting the adjusting screws **158** and **159** it is possible to adjust the temperatures at which the switches **170** and **171** will close and open independent from each other so that each motor will be switched on and off and changed from low speed to high speed and vice versa at a desired temperature. Evidently, in the same way the various motors for the respective groups of heat exchange elements can be adjusted in such a manner that the motors and the air blower means driven thereby will be switched on and off and the speed thereof regulated in the desired sequence fully automatically according to the temperature sensed in the respective condensate collecting conduit means for each group of elements.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of air cooled surface condensers differing from the types described above.

While the invention has been illustrated and described as embodied in an air cooled surface condenser arrangement in which the heat exchange elements are arranged in different groups and in which the air blower means for each group is automatically regulated, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. An air-cooled surface condenser arrangement comprising, in combination, a plurality of condenser elements having each an inlet end and outlet end and a plurality of dephlegmator elements having each an inlet end and outlet end, said elements being arranged in a plurality of groups of elements spaced from each other; steam distributor conduit means connecting the inlet ends of all condenser elements in parallel; condensate collecting conduit means for each group containing condenser elements and connecting the outlet ends of the condenser elements of the respective group in parallel, the inlet ends of said plurality of dephlegmator elements being respectively connected to the down stream side of said condensate collecting conduit means so that at least one dephlegmator element is connected to each condensate collecting conduit means; exhaust conduit means connected to the outlet ends of said dephlegmator elements; condensate discharge means for discharging condensate from said condensate collecting conduit means constructed and connected to the latter so as to prevent flow of steam from one condensate collecting conduit means to the other; air blower means for each group of elements for blowing air over the elements in each group; and means for regulating the output of the air blower means for at least one group of elements so as to blow a variable amount of air against the elements of said one group.

2. A condenser arrangement as set forth in claim **1**, wherein the elements in each group are arranged in two rows which are inclined with respect to each other to define between themselves a V-shaped upwardly tapering space.

3. A condenser arrangement as set forth in claim **2**, wherein said air blower means are arranged beneath said V-shaped space for blowing air upwardly into said space so that the air will pass through said space and past said elements.

4. A condenser arrangement as set for in claim **1**, wherein said condensate discharge means comprise a main condensate collecting conduit, a connecting conduit connecting the condensate collecting conduit means of each group with said main condensate collecting conduit, and means in each of said connecting conduits for preventing passage of steam therethrough.

5. A condenser arrangement as set forth in claim **4**, wherein said means for preventing passage of steam through said connecting conduits are formed by a water seal in each of said connecting conduits.

6. A condenser arrangement as set forth in claim **5**, and including by-pass means connecting the lowest point of each connecting conduit of the water seal to said main condensate collecting conduit, and a valve in said by-pass means.

7. A condenser arrangement as set forth in claim **1**, wherein the dephlegmator element which is connected at the inlet end thereof to the condensate collecting conduit means of one group of condenser elements forms a component of said one group of condenser elements.

8. A condenser arrangement as set forth in claim **1**, wherein the dephlegmator element which is connected at the inlet end thereof to the condensate collecting conduit means of one group of condenser elements forms a component of another group of condenser elements.

9. A condenser arrangement as set forth in claim **1**, wherein the dephlegmator elements which are respectively connected at the inlet ends thereof to the respective condensate collecting conduit means are combined in a separate group of elements and wherein one air blower means is coordinated with said separate group of elements.

10. A condenser arrangement as set forth in claim **9**, wherein said separate group of elements includes at least one condenser element having the inlet end thereof connected to said steam distributor conduit means and the outlet end thereof connected to said condensate discharge means, and including means in the connection between said outlet end and said condensate discharge means for preventing flow of steam from said one condenser element to said condensate discharge means.

11. A condenser arrangement as set forth in claim **1**, wherein the number of condenser elements in at least one group of elements is different from the number of condenser elements in the other groups.

12. A condenser arrangement as set forth in claim **1**, wherein at least one group of elements has a different number of dephlegmator elements than the other groups.

13. A condenser arrangement as set forth in claim **1**, wherein said exhaust conduit means includes a main exhaust conduit for all dephlegmator elements and conduits

connecting the outlet ends of all dephlegmator elements in parallel to said main exhaust conduit.

14. A condenser arrangement as set forth in claim 13, and including one dephlegmator connected after-cooling element in said main exhaust conduit downstream of the conduits connecting the outlet ends of said dephlegmator elements to said main exhaust conduit, said after-cooling element being arranged in the region of influence of one of said air blower means.

15. A condenser arrangement as set forth in claim 14, wherein said after-cooling element forms a component of a group which includes at least one dephlegmator element.

16. A condenser arrangement as set forth in claim 14, wherein the dephlegmator elements which are respectively connected at the inlet ends thereof to the respective condensate collecting conduit means are combined in a separate group of elements, wherein one air blower means is coordinated with said separate group of elements, and wherein said after cooling elements forms a component of said separate group of elements and is subjected to the influence of said one air blower means.

17. A condenser arrangement as set forth in claim 1, wherein the air blower means for at least one group of elements includes fan means and a motor of variable speed, and including speed regulating means for automatically regulating the speed of the motor of the air blower means of said one group in dependence on the temperature in the condensate collecting conduit means of said one group of elements.

18. A condenser arrangement as set forth in claim 17, wherein said speed regulating means include temperature sensing means arranged in the condensate collection of conduit means of the respective group of elements and means operatively connected to the temperature sensing means and the motor of the air blower means of said one group for automatically changing the speed of the motor in dependence on the temperature sensed by the temperature sensing means.

19. A condenser arrangement as set forth in claim 18, wherein said motor is a multi-speed squirrel cage motor having a stator winding permitting to change the number of poles thereof, and wherein said means for changing the speed of said motor include switch means operatively connected to the temperature sensing means and to the stator winding of the motor for changing the number of poles thereof in dependence of the temperature sensed by the temperature sensing means and to connect and disconnect the motor in such a manner that at a selected minimum temperature in the respective condensate collecting conduit means the motor is disconnected and upon increase of the temperature to a selected increased temperature the motor is operated at low speed and upon further increase of the temperature to a selected further increased temperature the motor is operated at high speed.

20. A condenser arrangement as set forth in claim 1, wherein the air blower means for each group of elements includes fan means and a motor of variable speed, and including speed regulating means for automatically regulating the speed of the motor of each air blower means in dependence on the temperature in the respective condensate collecting conduit means.

21. A condenser arrangement as set forth in claim 20, wherein said exhaust conduit means includes a main exhaust conduit for all dephlegmator elements and conduits connecting the outlet end of all dephlegmator elements in parallel to the main exhaust conduit and including one dephlegmator connected after-cooling element in said main exhaust conduit down stream of the conduit connecting the outlet ends of said dephlegmator elements to said main exhaust conduit, said after-cooling elements being arranged in the region of influence of one of said air blower means, and wherein said means for regulating the speed of the motor of said one air blower means is adjusted in such a manner that said one air blower means will deliver an equal or a greater amount of air than the other air blower means and that the motor for said one air blower means is switched on before the other motors and switched off only after all other motors have been switched off.

22. A method of operating an air-cooled surface condenser having a plurality of groups of heat exchange elements including condenser elements, dephlegmator elements and an after-cooling element for one of the groups, comprising the steps of blowing air by means of an air blower for each group over the elements of each group; and regulating the air blower means for each group in such a manner that the air blower means for said one group always delivers an equal or a greater quantity of air than the other air blower means and is switched on first and switched off last.

23. A method as set forth in claim 22 and including the steps of passing the steam from the condenser elements of each group to one dephlegmator element; sensing the temperature of the steam passing to the respective dephlegmator element, and automatically regulating the output of each air blower means in dependence on adjustable limit temperatures sensed.

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