April 24, 1934. C. F. ROSENBLAD 1,956,133

CONDENSER

Filed June 12, 1933 3 Sheets-Sheet 1

Fig. 1.

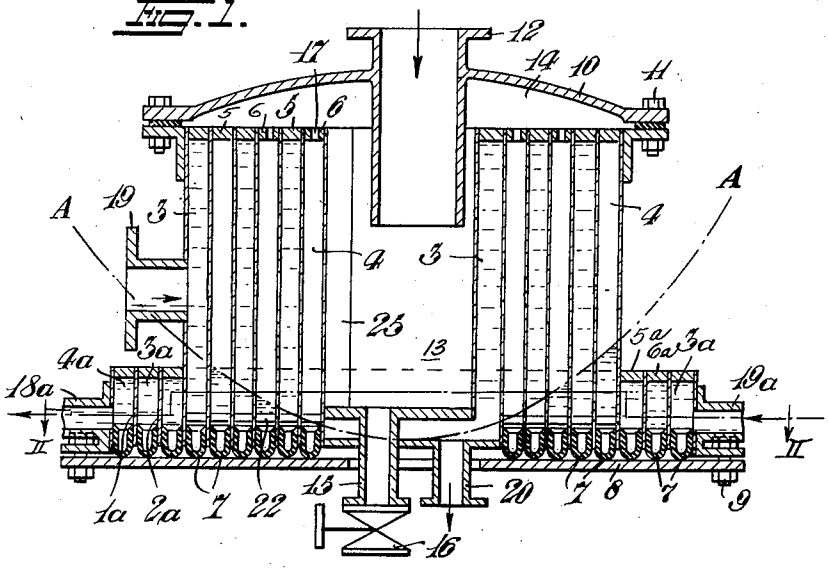


Fig. 2.

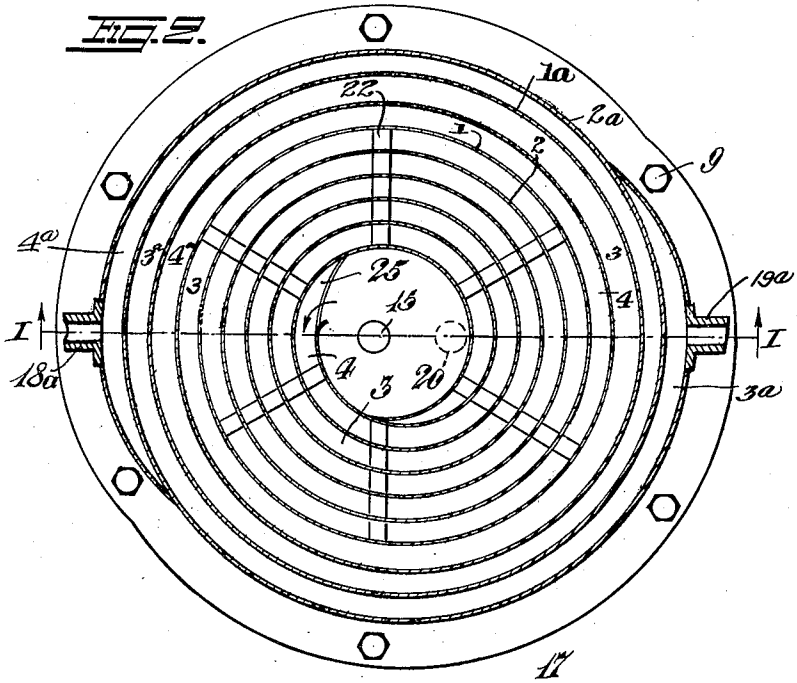
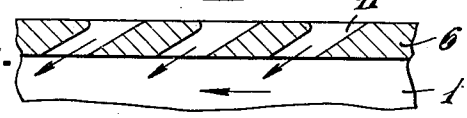


Fig. 3.



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Fig. 4.

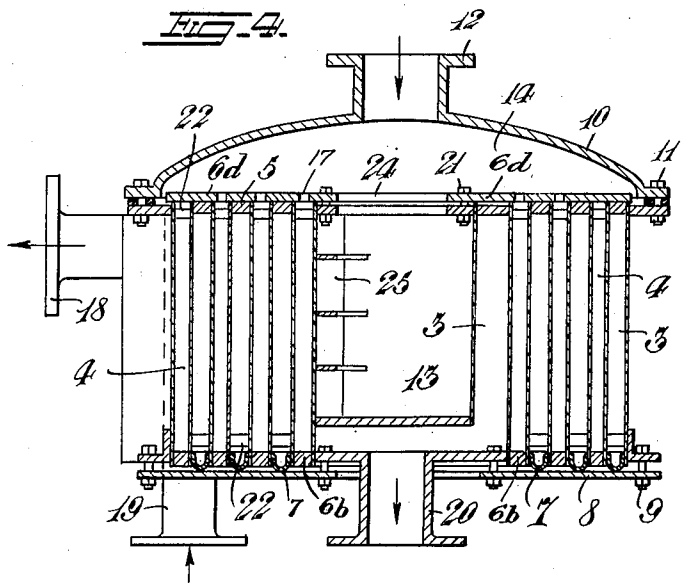


Fig. 5.

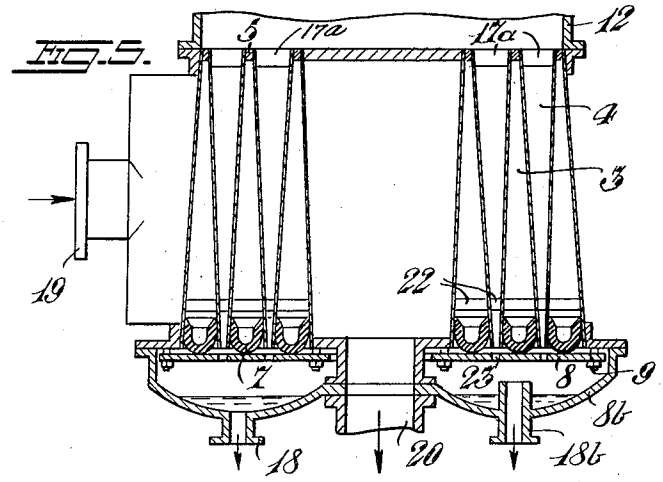
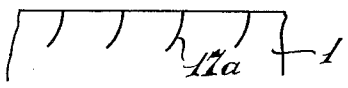


Fig. 6.



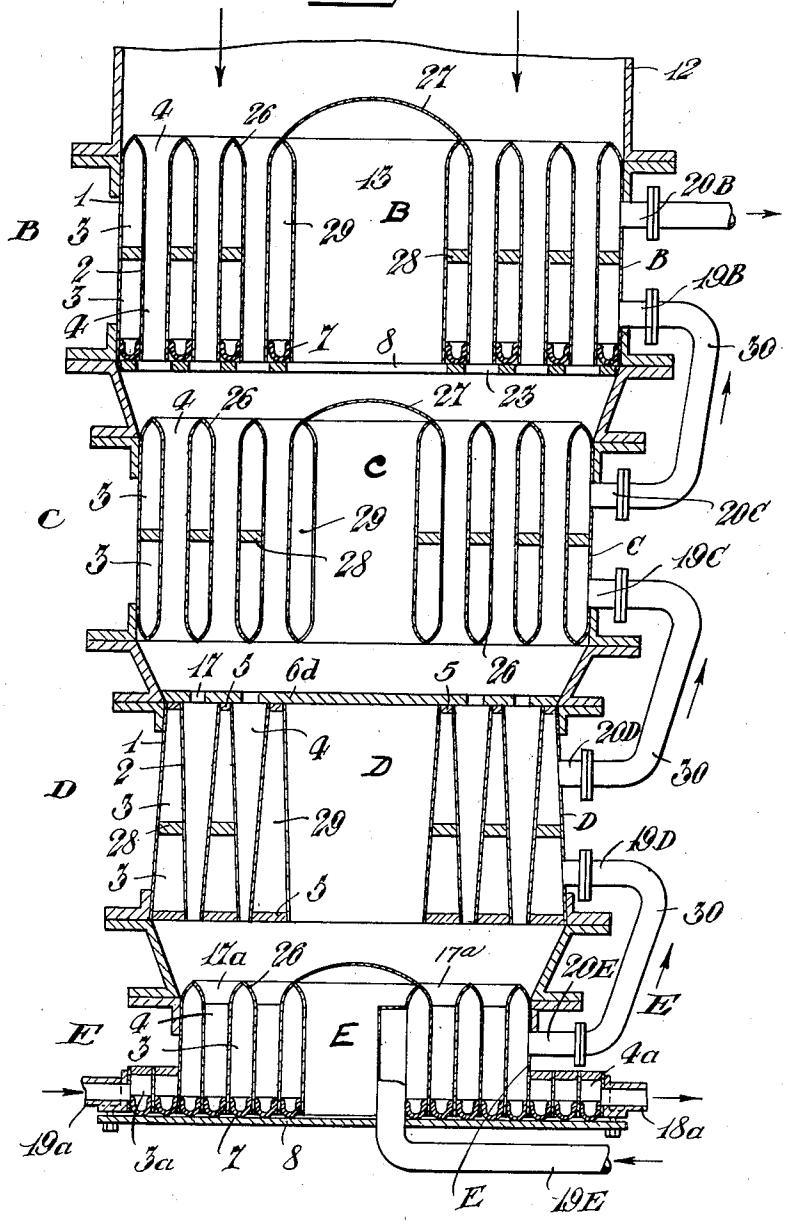
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Fig. 7.



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UNITED STATES PATENT OFFICE

1,956,133

CONDENSER

Curt Fredrik Rosenblad, Sodertalje, Sweden

Application June 12, 1933, Serial No. 675,481
In Sweden June 16, 1932

14 Claims. (Cl. 257—32)

This invention refers to condensers, whose heat-transmitting surfaces consist of one or more sheet metal plates bent to spirals and forming walls of the channels, in which the steam (or vapour) and the cooling medium flow, between which heat is to be transmitted. The invention refers more particularly to that type of such conductors which have steam inlets to the steam (or vapour) channel or channels from one or both of the two plane short sides or ends of the apparatus.

The chief object of this invention is to construct a condenser having a condensing effect as high as possible within a certain volume.

Another object of this invention is to cool the condensate formed to a very low temperature to attain a high vacuum and to recover as much as possible of the heat contained in the steam (or vapour) and condensate.

Another purpose of this invention is to increase the velocity of flow in such condensers to increase the coefficient of heat transmission. Thus, the efficiency of the whole apparatus is increased.

A further purpose of this invention is to construct a condenser of this type, in which one or more parts may be disconnected for cleaning or repairing purposes, while the other may be still operated.

Another purpose of this invention is to control the distribution of steam supplied to the steam (or vapour) channel or channels in such manner that a high velocity of flow is maintained in the whole steam channel or channels or the greatest part thereof. Simultaneously a part of the steam channel or channels may be cut off from any direct supply of steam so as to permit the condensate formed to be cooled to a low temperature (far below the boiling point).

Other purposes of this invention will be evident from the following specification.

Some embodiments of condensers in accordance with this invention are shown in the annexed drawings.

Fig. 1 shows a central, vertical section on the line I—I in Fig. 2 through a spiral condenser in accordance with this invention.

Fig. 2 shows a horizontal section on the line II—II in Fig. 1.

Fig. 3 shows a section in the peripheral direction through a detail in Fig. 1, on a larger scale.

Fig. 4 shows a central vertical section through another embodiment and

Fig. 5 shows a similar section through still another embodiment.

Fig. 6 shows a peripheral section—similar to that shown in Fig. 3—through the distributive guide blades in Fig. 5, on a larger scale.

Fig. 7 shows a central section through still another embodiment, having sections connected in series.

Referring now to Figs. 1–3 of the drawings, 1 and 2 indicate two sheet metal plates bent to substantially parallel spirals having vertical generatrices. Thus, two spiral channels 3, 4 are formed between said plates. Said channels are at the top closed by spiral flat iron bars or strips 5, 6 inserted between the spiral plates 1, 2 and welded to them. At their lower ends said channels 3, 4 are closed by means of U-, V-, or ⊔-shaped sealing strips 7 of resilient material, such as rubber or leather. Said strips abut against an outer, detachable cover or bottom 8 secured by means of bolts 9 to prevent the packings 7 from being pressed out by the internal pressure above atmospheric in the apparatus.

On the upper, plane end of the apparatus an outer detachable cover 10 is secured by means of bolts 11, and provided with an inlet tube 12 for the steam to be condensed. The tube 12 discharges into a central chamber 13 in direct communication with the chamber 14 within the cover 10. Said chamber 13 is at its bottom provided with a tube 15 having a valve 16.

The spiral strip or band 6 (see also Fig. 3) is provided with a number of holes 17 forming a communication between the chamber 14 and the steam channel 4. Said holes 17 are preferably oblique or bent, as shown in Fig. 3, to give the steam a component of velocity along the spiral channel 4, i. e. in the peripheral direction, when it flows into said channel.

To the main condenser formed by the plates 1, 2 an additional cooler for the condensate is annexed, having a smaller area of passage than that of the channels 3, 4. In the embodiment shown in Figs. 1 and 2 said cooler is formed by extended portions 1*a*, 2*a* of the plates 1, 2, said extensions 1*a*, 2*a* having a smaller height than the plates 1, 2, as measured in the axial direction. The channels 3*a*, 4*a* formed between the plates 1*a*, 2*a* are at the top closed by metal strips 5*a*, 6*a* welded thereto and at the bottom by means of the sealing strips 7.

The outermost winding of the channel 4*a* is connected to an outlet tube 18*a* for the condensate formed and also for permanent gases possibly contained in the steam. The cooling medium, for instance cooling water, is supplied to the channel 3 from an inlet tube 19 and to the chan-

nel 3*a* through an additional inlet tube 19*a*. The water supplied through the tube 19*a* will in the channel 3 mix with water supplied through the tube 19 and after being heated by the condensing steam and the condensate the cooling water is drawn off through the tube 20, connected with the inner end of the channel 3.

Distance pieces 22 are inserted into the lower ends of the channels 3, 4 to keep the plates 1, 2 at their correct distance.

The chamber 13 is provided with an axial slot 25 constituting a direct communication from the chamber 13 to the channel 4. Said slot may, however, be dispensed with.

The steam (or vapour) to be condensed is supplied via the tube 12 to the chamber 13 in which solid impurities possibly contained in the steam will settle and may be blown out through the valve 16. The steam thus purified enters the chamber 14 and from there flows through the holes 17 into the channel 4 to be condensed.

The number, the size and the arrangement of the holes 17 are chosen in such manner that a uniform drop of pressure, by preference, a substantially constant drop of pressure will be attained from the innermost winding of the channel 4 to the periphery thereof. Said drop of pressure will give the steam, as well as the condensate formed therefrom, a high velocity of flow along the spiral channel 4 in the periphery direction, and thus, the efficiency of the heat transmission is essentially increased. The velocity of flow of the steam in the peripheral direction is further increased by the fact that the steam distributing holes 17 are oblique to give the steam a component of velocity in the peripheral direction. In the embodiment shown in Figs. 1 to 3 the outermost windings of the strip 6 have no holes 17 and, thus, there is no supply of fresh steam from the top to the outermost windings of the channel 4. In said outermost windings the condensate may therefore be cooled below the boiling point of the steam or vapour condensed and also the permanent gases possibly contained in the steam or vapour will be cooled below that point.

In the additional cooling part 4*a* the condensate and the permanent gases will be further cooled by the fresh (cold) cooling medium supplied to the tube 19*a* and, consequently, the condensate and permanent gases drawn off through the tube 18*a* are cooled to a low temperature.

Some steam will also enter the innermost winding of the channel 4 through the slot 25.

After removing of the bottom 8 and the resilient packings 7 the interior of all the channels 3, 4, 3*a*, 4*a* are easily accessible for cleaning and inspecting purposes.

The steam let in at the centre of the apparatus is cooled by cooling water already heated to a point in the vicinity of its maximum temperature, and for that reason said steam will condense at a slower rate than the steam let in through holes 17 further from the centre. The condensate formed falls down to the bottom of the channel 4 and forms a layer having an increasing height from the centre towards the periphery, as indicated by the curve A if the velocity is constant. A constant velocity is attained if the drop of pressure in the channel 4 is rendered somewhat higher towards the periphery as a compensation for the greater height of the water column there. The rotation of the steam (in the peripheral direction) will facilitate the removal of the condensate. The curve A is shown at a very exaggerated scale, because the condensate will have a very little volume as compared with that of the steam, from which it was formed.

In the part 3*a*, 4*a* a very efficient additional cooling of the condensate is attained, because the cooling medium will have a higher velocity in that part on account of the smaller area of passage.

In the embodiment shown in Fig. 4 the channel 3 is closed at its top by the spiral iron 5 and at the bottom by the packing 7 kept in its place by the detachable bottom 8. At its bottom the channel 4 is closed by a spiral iron band 6*b* welded to the plates 1, 2, while said channel is at its top closed by a detachable cover 6*d* in which the holes 17 are cut. The cover 6*d* is secured by means of bolts 21. Said cover 6*d* has a central hole 24 constituting a direct communication from the chamber 13 to the chamber 14. In this embodiment there is no extension of the channels 3, 4 but in other respects it is quite analogous to that shown in Figs. 1–3 and corresponding parts carry the same reference characters. Also in this embodiment the interior of the channels 3 is accessible for cleaning after removing the packing 7 and the bottom 8, while the interior of the channels 4 is accessible after removing the covers 10 and 6*d*.

In this embodiment the distribution of the steam may be altered by opening or closing some of the holes 17 in the cover 6*d*.

The cooling effect may be controlled in the usual manner by controlling the quantity of cooling medium supplied per unit of time.

In the embodiment shown in Fig. 5 the sheet metal plates have generatrices forming an angle to each other. As a result thereof channel 3, closed at the top by the welded pieces 5, is narrower at the top and broader at the bottom at which it is closed by the packing 7 and the bottom 8. On the contrary the spiral steam channel 4 is broader at its top and narrower at its bottom.

In addition curved or oblique guide blades 17*a* may be inserted into the upper portions of the channel 4 i. e. in the inlet to said channel from the steam supply tube 12. The shape of said blades is also shown in Fig. 6 which shows a section in the peripheral direction through the blades to illustrate their curvature and arrangement. The blades will give the steam a component of velocity in the peripheral direction and thus, the velocity of the steam and the condensate will be further increased.

In this case there will be a high velocity of the steam also at the lower, narrower portion of the channel 4, even if no guide blades 17*a* are used, and said high velocity of the steam will increase the condensing efficiency. The steam is let in through the tube 12 and the condensate will, through the holes 23 of the bottom 8 fall down into the curved bottom 8*b*, from which the condensate is drawn off through the tube 18 and the non-condensed gases contained in the steam will be drawn off through the tube 18*b*.

The guide blades 17 may be omitted or for them spiral strips 6 having holes 17 or a cover 6*d* having holes 17 may be substituted. Said blades may also be combined with the holes 17 to give the steam a velocity in the peripheral direction.

The apparatus shown in Fig. 7 has a number of sections B, C, D, and E, connected in series. The first section B is connected with the steam inlet 12 and has a steam channel 4 and a channel 3 for the cooling medium, formed by the plates 1,

2. At the top the plates 1, 2 are bent and welded together to a stream-line shape as indicated at 26, to decrease the resistance to the flow as much as possible. The central chamber 13 of the apparatus is shut off by means of a cupola 27. In the middle of the channel 3 metal strips 28 are welded to the plates 1, 2 and thus, the channel 3 is divided into an upper portion and a lower portion, which communicate with each other at 29, where the strip 28 is cut away. The cooling medium enters at the periphery through the connecting tube 19B, flows through the lower portion of the channel 3 to the centre, enters the upper portion of the channel 3 at 29 and is drawn off through the outlet tube 20B.

The lower portion of the channel 3 is closed at the bottom by a packing 7, kept in its place by a detachable bottom 8 having apertures 23 for letting through the steam and condensate from the channel 4 to the section C.

Said section C is in all essential respects similar to the section B and corresponding parts carry the same reference characters. The cooling medium is let in through the tube 19C to the lower portion of the channel 3, which is also at its bottom closed by the plates 1, 2 being bent and welded together to form stream line ends 26. The cooling medium discharged from the outlet tube 20C is supplied to the inlet tube 19B via a connecting tube 30. The next section D is constructed substantially in agreement with the condenser shown in Fig. 5, i. e. the generatrices of the plates 1, 2 are at an angle to each other. The upper end of the channel 3 is closed by metal strips 5 welded to the plates 1, 2, while the upper end of the channel 4 is closed by a cover 6*d* having holes 17, by preference, oblique.

The section E is provided with guide blades 17*a* secured into the inlet of the channel 4. The channel 3 of this section has only half of the height of the channels 3 of the sections B—C, and for this reason the cooling liquid let in through the tube 19E and drawn off through the tube 20B will along its total path through the four sections have substantially the same area of passage. The last section E is provided with an additional cooling part 3*a*, 4*a*, having a separate inlet 19*a* for the cooling medium. The condensate formed in all the sections and the permanent gases possibly contained in the steam will be drawn off through the outlet 18*a*.

It is to be observed that the area of passage for the steam is greatest in section B and decreases in each following section and is, consequently, smallest in section E. Thus, in spite of the reduction of the volume of the steam caused by the condensation the velocity of the steam may be maintained at a high value and a high efficiency will be attained.

It is to be observed, that any section, for instance the section C may be detached from the other and put out of operation for cleaning and repair. In such case the tube 30 between the sections C and D will be altered to connect the tubes 20D and 19B, so that the three sections B, D, E may be operated as before, until the fourth section is again restored.

It is evident that the number of the sections is arbitrary. The apparatus may be used for condensing steam as well as other vapours or mixtures thereof. The distance pieces 22, the slots 25 and the packings 7 etc. are shown and claimed in my co-pending U. S. patent application No. 638,222.

What I claim is:—

1. In a condenser, in combination, heat transmitting surfaces of sheet metal bent to a spiral shape to form channels for a vapour to be condensed and a cooling medium, inlets to said vapour channel from at least one of the plane ends of the spirals, and screening devices for said vapour channel to cause the essential drop of pressure along at least the greatest part of the peripheral length thereof.

2. In a condenser, in combination, one or more metal plates bent to spirals forming channels between themselves for the vapour to be condensed and for the cooling medium, one or more inserts at least at one of the ends of said spiral channel for the vapour, and oblique surfaces on said inserts to give the vapour a component of velocity in the peripheral direction of said channels, said oblique surfaces being arranged along the peripheral length of said vapour channel in such manner as to cause an essential drop of pressure along at least the greatest part of said vapour channel.

3. In a condenser, in combination, one or more metal plates bent to spirals forming channels between themselves for the vapour to be condensed and for the cooling medium, one or more inserts at least at one of the ends of said spiral channel for the vapour, and oblique holes in said inserts to give the vapour a component of velocity, in the peripheral direction of said channels, said oblique holes being arranged along the peripheral length of said vapour channel in such manner as to cause an essential drop of pressure along at least the greatest part of said vapour channel.

4. In a condenser, in combination, two or more metal plates bent to spirals forming channels between themselves for the vapour to be condensed and for the cooling medium, a vapour inlet tube to at least one of the plane ends of said vapour channel, a condensate outlet from said vapour channel, and a plate inserted between said steam inlet tube and the adjacent plane end of said vapour channel, said plate having oblique holes along the greater part of the peripheral length of said vapour channel.

5. In a condenser, in combination, heat transmitting surfaces of sheet metal bent to a spiral shape to form spiral channels for a vapour to be condensed and a cooling medium, a vapour inlet tube to a plane end of said vapour channel, a condensate outlet from said vapour channel, and a detachable plane plate between said vapour inlet tube and said plane end, said plate having oblique holes arranged in a peripheral row along at least a substantial part of the peripheral length of said vapour channel.

6. In a condenser, in combination, heat transmitting surfaces of sheet metal bent to a spiral shape to form spiral channels for a vapour to be condensed and a cooling medium, a vapour inlet tube to a plane end of said vapour channel, a condensate outlet from said vapour channel, oblique guide blades at a plane end of said vapour channel, and a detachable plane plate between said vapour inlet tube and said plane end, said plate having oblique holes arranged in a peripheral row along at least a substantial part of the peripheral length of said vapour channel.

7. In a condenser, in combination, heat transmitting surfaces of sheet metal bent to spirals having at least some of their generatrices at an angle to the axis of the spirals, to form channels of a variable radial width for a vapour to be condensed and a cooling medium, a vapour inlet to

that one of the plane ends of said vapour channel which has the greatest radial width, and a condensate outlet from said vapor channel.

8. In a condenser, in combination, heat transmitting surfaces of sheet metal bent to spirals having a least some of their generatrices at an angle to the axis of the spirals, to form channels of a variable radial width for a vapour to be condensed and a cooling medium, a vapour inlet to that one of the plane ends of said vapour channel which has the greatest radial width, an insert at a said plane end of the greatest radial width, oblique surfaces on said insert to guide and distribute said vapour flowing into said vapour channel, and a condensate outlet from said vapour channel.

9. In a condenser, in combination, heat transmitting surfaces of sheet metal bent to a spiral shape to form channels for a vapour to be condensed and a cooling medium, means for closing said channel for the cooling medium at both plane ends of the spiral, an inlet tube for said vapour to a plane end of said vapour channel, a condensate outlet tube from said vapour channel, guiding and distributing devices for said vapour channel to cause an essential drop of pressure along a substantial part of the peripheral length thereof, and additional cooling channels connected in series with said other channels and having a smaller area of passage than that of the latter.

10. In a condenser, in combination, heat transmitting surfaces of sheet metal bent to a spiral shape to form channels for a vapour to be condensed and a cooling medium, means for closing said channel for the cooling medium at both plane ends of the spiral, an inlet tube for said vapour to a plane end of said vapour channel, a condensate outlet tube from said vapour channel, guiding and distributing devices for said vapour channel to cause an essential drop of pressure along a substantial part of the peripheral length thereof, and an additional vapour inlet from the centre of the condenser.

11. In a condenser in combination, a number of sections connected in series, each section having heat transmitting surfaces of sheet metal bent to spiral shapes to form channels for a cooling medium and a vapour to be condensed, means for closing said channels for the cooling medium at both plane ends of said sections, an inlet tube for said vapour to a plane end of said vapour channel of the first one of said sections, and a condensate outlet tube from the last one of said sections, said sections having an area of passage for said vapour decreasing from said first section to said last section.

12. In a condenser in combination, a number of sections connected in series, each section having heat transmitting surfaces of sheet metal bent to spiral shapes to form channels for a cooling medium and a vapour to be condensed, means for closing said channels for the cooling medium at both plane ends of said sections, an inlet tube for said vapour to a plane end of said vapour channel of the first one of said sections, dividing metal strips in at least some of said channels for said cooling medium, and a condensate outlet tube from the last of said sections, said sections having an area of passage for said vapour, which in any section is smaller than the corresponding area of the preceding section.

13. In a condenser, in combination, a number of sections detachably connected in series, each section having heat transmitting surfaces of sheet metal bent to spiral shapes to form spiral channels for a cooling medium and a vapour to be condensed, said channels for the cooling medium being bent and welded together to a streamline shape at the plane end of said section, an inlet tube for said vapour to a plane end of said vapour channel of the first section, and a condensate outlet from the last section, said sections having a decreasing area of passage for the vapour from said inlet to said outlet.

14. In a condenser, in combination, heat transmitting surfaces of sheet metal bent to a spiral shape to form channels for a vapour to be condensed and a cooling medium, inlets to said vapour channel from at least one of the plane ends of the spirals and distributing and guiding devices for the vapour to said vapour channel to give the vapour a high velocity of flow in the greatest part of said vapour channel.

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