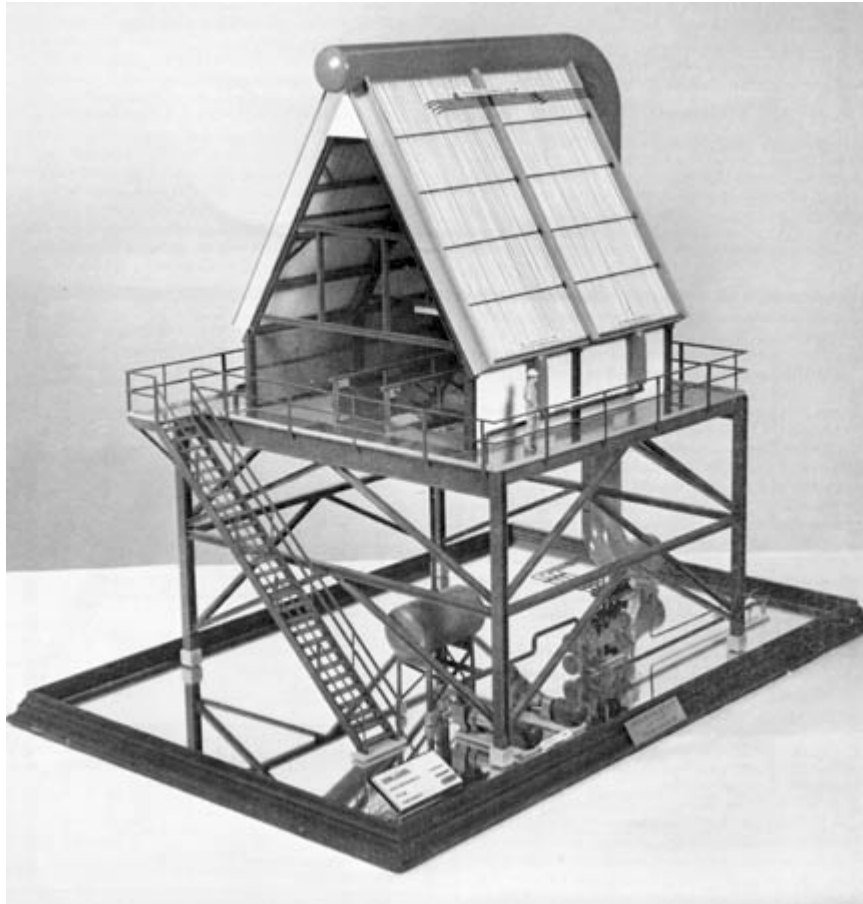


Design and Specification of Air-Cooled Steam Condensers

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Even the nonspecialist purchaser of an air-cooled steam condenser can apply these guidelines to ensure that the unit selected avoids common design deficiencies. The components of a steam condensing system, and the key considerations that should underlie a purchaser's inquiry specifications, are also reviewed.

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Steam turbines are finding increasing use in electric-utility powerplants, industrial plants, process plants and commercial installations. Such turbines drive not only electric generators but also all types of pumps, fans, compressors, shredders, mills, paper machines, and so on.

Steam condensers coupled to the exhaust of these turbines return condensate to the power cycle and boiler. Either surface-type or air-cooled condensers can be selected. The former have once-through or recirculating water as the cooling medium, while the latter are once-through systems employing the atmosphere as the heat sink. Among the advantages of air-cooled steam condensers, compared with wet systems, are elimination of: makeup water supply, blowdown disposal, water-freezing problems, water vapor plumes, and concerns over governmental water-pollution restrictions. Because of the dry nature of the equipment, lower system-maintenance costs also result.

Air-cooled steam condensers have been used since the 1930s. Some are as small as 1 million Btu/h, condensing at 20 psi, while others are as large as 2 billion Btu / h, condensing at 2 in. Hg absolute pressure. Units can be installed at grade, on pipe racks or on top of buildings; they can be mechanical draft or natural draft, their bundle arrangement adapts to mounting vertically, horizontally or on an incline.

A typical A-frame arrangement is shown in Fig. 1. Fig. 2 presents the basic flow diagram of a system.

Many evolutionary design changes have been effected during the past 40 years as a result of field experience. The main problem plaguing the industry has not been how to condense steam but rather how to prevent a unit from suffering a loss in thermal performance during the summer, and freezing during winter.

Today, the mechanics of this steam-condenser problem are understood, fortunately, so that the deficiencies of past designs can be identified and corrected.

Identifying the Steam-Condenser Problem

A successful air-cooled steam condenser must continuously and completely gather and discharge all of the noncondensables in the system. These are the gases that result from atmospheric air leaks into the vacuum portions of the steam-cycle equipment, and from the chemicals used for boiler feedwater treatment. The noncondensables are left behind inside the tubes and headers when the steam condenses. They accumulate if not removed from the system at the release rate.

Such trapping of noncondensables is responsible for the steam condenser problem. During the winter, the trapped nonconclensables can cause freezing of condensate; during the summer, they blanket heat-exchange surfaces and reduce heat-transfer capability. In addition, the noncondensables are absorbed by condensate in the trapped pockets and promote metal corrosion.

How do pockets of trapped noncondensables form? Typically, they arise when steam enters the same area of the condenser from different directions — the most common location is the condenser tubes themselves. Turbine exhaust steam flows into the tubes from the inlet end, while "backflow" steam flows (from higher rows of tubes) into the same tubes from the rear end, via the rear header. With both ends blocked by the flow of steam, the noncondensables become trapped inside the tubes.

Fig. 3 illustrates in more detail the trapping of noncondensables in a simple steam condenser having just two rows of tubes and a conventional, nondivided, rear header. Since the first row is exposed to the lower,

ambient-air temperature, while the second row is contacted by already-heated air, the second row condenses less steam than the first, and therefore has a lower steam-pressure drop. The pressure in the rear header equals the front-header pressure minus the pressure drop in the second row. The pressure in the rear header thus exceeds the pressure at the outlet end of the first row.

So, steam flows into both ends of the first row of tubes, and noncondensables become trapped inside. They cannot flow into the rear header until their pressure equals the rear-header steam pressure (point C in Fig. 3). By then, noncondensables extend for the tube length G-H. Since there is very little steam flowing with the noncondensables, that length of the metal tube becomes cold. Condensate freezes enroute as it flows downward by gravity toward the rear header through this cold section.

Design Alternatives

Some condenser designs try to cope with this backflow problem by steam "blowthrough" to dephlegmators or secondary condensers. The objective is to equalize the steam pressure-drop across each tube row in the main condenser by using larger steam flows, with the remainder of the steam being condensed downstream in the secondary or vent condenser.

Fig. 4 shows a typical arrangement of main and vent condensers. This design has an open rear header on both condenser sections. If any one of the many variables of turbine exhaust-steam flow, ambient-air temperature or air flowrate is upset so that the blowthrough steam quantity is less than it should be, steam backflow to the first row of the main condenser can occur-which is the steam condenser problem. Similarly, steam backflows to the first row in the open rear headers of the vent condenser, thereby trapping noncondensables once more.

A variation to this A-frame configuration is the horizontal bundle arrangement, built with a slight inclination for condensate drain purposes. Here, the vent condenser has cocurrent flow of steam and condensate rather than countercurrent, but the steam condenser problem remains a reality.

Fig. 5 shows a steam condenser in which each bundle has its own main and vent section. The horizontal tubes have a two-pass arrangement and are interposed so as to minimize steam pressure differences in the rear headers and at the connection to the steam-jet air ejector. The 1-4 mains connect to the 2-3 vents, and the 2-3 mains connect to the 1-4 vents. But since the face velocity of the air flow in the upper regions of the bundle exceeds that at the base, where the vent condenser is located, the steam pressures are not completely equal where the tubes are connected to the common exhaust manifold system (leading to the steam-jet air ejector). There can thus be a backflow between the vent condenser manifolds serving rows 3 and 4. Also, the first row of the vent condenser is here exposed to the ambient air (to try to achieve balanced steam pressures at the outlet of the vent condenser), rather than being protected from the cold ambient air, as dictated by the low heat content of the low-partial-pressure steam.

Other designs employ internal flow-control devices in the front header, such as fixed orifices or flapper valves. This equalizes steam pressure drop among rows, but only at the design operating point. A change in any operating variable changes the flow relationship among rows, and thus the steam pressure drops; the net result again is steam backflow in the undivided rear headers.

Still other designs may vary fin height, fin spacing or finned length from row to row in an attempt to achieve balanced steam-pressure drop between rows and avoid rear header backflow.

Summing up, all of the above methods are undesirable because they can degrade the fluid energy on the steam side, and/or are heat-transfer inefficient on the finned side. They function properly at the design point but run into difficulty when any one of several operating variables (ambient air temperature, air flow, steam flow) is changed.

A better steam condenser is the single-row design shown in Fig. 6. As the steam flows through the tubes, it condenses and pushes the noncondensables forward until they reach the rear header. The rear header is purged of noncondensables by means of vent tubes connected to the steam-jet air-ejector system. The vent tubes provide a more effective scavenging action by inducing additional mass flow through the rear header. As a further freeze protection feature, the vent tubes are installed in the warm-air portion of the bundle.

Note that there is no need to balance steam pressure drops because there is only one row, and each tube in the row experiences the same air temperature. The movement of noncondensable gases is always forward because steam backflow does not occur.

To make the single-row concept commercially practical, several such steam condensers must be stacked together, one on top of the other (Fig. 7). The internal fluid flows of this multirow condenser must be completely independent at all times, and the condensate and noncondensables must be withdrawn separately.

A new condenser from Hudson Products Corp. (the Stac-Flo) has such a design. Condensate from each row is withdrawn from the rear headers through hydraulic pressure-seals of a water-leg loop design, into a common, heated drain pot. The noncondensables are removed from each row by individual first-stage ejectors; these connect to a common header for flow to the intercondenser, second-stage ejector and finally the aftercondenser. There is positively no passage of steam, condensate or noncondensables among rows inside the condenser at any time.

Fig. 8 illustrates the operation of a typical divided rear-header vacuum steam condenser in turbine service. Note the wide spread of air temperatures, steam condensing rates and steam pressure drops between the rows.

Scope of the Purchased Package

The purchaser has many options to consider and many questions to answer in preparing the inquiry specification to be presented to manufacturers of air-cooled steam condensers. First, the scope of the system package to be purchased must be decided, and the more important specification details established.

An air-cooled steam condenser system starts at the turbine exhaust flange. It includes all of the equipment necessary to condense the steam and return the condensate to the boiler feedwater piping. These items are:

1. Air-cooled steam condenser tower.
2. Air-flow control equipment.
3. Wind and/or cell-partition walls.
4. Steam-bypass heating system.
5. Air removal equipment.
6. Condensate storage tank.
7. Condensate pumps.
8. Steam ducts and expansion joints.

9. Condensate drain and air-removal piping.
10. Instrumentation, controls and alarms.
11. Pressure-relief device for protection of steam-turbine exhaust casing.
12. Steam-duct condensate drain system.

The purchaser has the option of buying this complete system package, or requesting only a portion of it.

The basic air-cooled steam condenser (Item 1) includes the bundles, steam distribution manifold, fans, motors, gear boxes and supporting steel. In large installations, the cost of the tower structure supporting the condenser bundles can be a substantial portion of the total cost. The structure's design specifications for wind load, snow load, live load and seismic requirements should be carefully chosen. Generally, grade-mounted towers cost less than roof-mounted ones.

Limitations on plan dimensions must be made clear in the inquiry specification. Heat sources located close to the proposed tower and discharging into the atmosphere must be identified. The prevailing wind directions define the proper location and orientation of the tower with respect to other large structures and heat sources. Summer winds are important in the consideration of thermal performance, and winter winds in prescribing freeze-protection measures. Noise limitations should also be stated, since lower fan noise generally requires lower tip speed, more fan blades and possibly wider blades.

The purchaser should specify whether the thermal performance guarantees are to be based on steam pressure measured at the turbine exhaust flange, or at the steam manifold inlet at the condenser. Other options are an all-welded system to reduce the potential for air leaks into the condenser, and the use of extruded aluminum fins (Fig. 9), which provide longer trouble-free operation than embedded or wrap-on fins (these are prone to galvanic corrosion because of their bimetallic tube-to-fin interface).

Airflow control equipment for freeze protection (Item 2), though an integral part of the engineered package supplied by the manufacturer, nevertheless reflects the purchaser's preferences and needs. Consideration should be given to variable-pitch fans, air-flow control louvers, steam isolating valves and two-speed motors. The extra price of electric starters needed for two-speed motors should be included.

Wind walls (Item 3) are sometimes necessary to protect the bundles from wind gusts that can upset equilibrium operating conditions and at times cause freezing in some remote parts of the tower. Partition walls between fan cells isolate operating cells from nonoperating ones. Without partition walls, a nonoperating fan would induce bypass of air intended for the bundles.

Depending upon the minimum design ambient-air temperature, the type of turbine, and the type of plant operation, it may be economic to provide a steam-bypass heating system for cold-weather startup (Item 4). This would operate directly off the boiler, requiring both a steam pressure-reducing station and a de-superheating station, with steam flow exhausting directly into the main steam duct. Part of the condenser heating steam during startup would be supplied by the turbine exhaust, and the remainder from this bypass system. Alternatively, large steam-isolating valves can be installed, to supply condenser sections sequentially, with steam flows only from the turbine exhaust.

The equipment extracting noncondensables from the system (Item 5) consists of the hogging ejector and the operating ejectors. During startup, the hogging ejector removes air from inside the, turbine, steam ducts, steam

manifolds and bundles. It reduces the air pressure within the system from atmospheric to about 10 in. Hg absolute in a time period specified by the purchaser.

For the usual full-vacuum steam condenser, a two-stage operating ejector system complete with condensers is normally provided, with or without standby. Its capacity is generally specified by the purchaser in accord with the Heat Exchange Institute Standards for steam surface condensers. Some purchasers add a safety allowance by doubling the venting capacity recommended in the standard. The costliest parts of the ejector package are the inter- and after-condensers, which are shell-and-tube construction. These can be smaller and lower-cost if a separate, colder, cooling-water supply is used instead of the hot condensate.

Motor-operated vacuum pumps can also be chosen; these adapt readily to automated remote operations.

The purchaser's inquiry specification should establish, for the air removal package, these points: choice of steam-jet air ejector or motor-driven vacuum pump; motive steam pressure and temperature; hogging-ejector minimum operating time; evacuating capacity of operating ejector package (compared with Standards recommendation); standby requirements for condensers and ejectors; and condenser cooling-water supply source and temperature.

The condensate storage tank (Item 6) is generally sized for a 5- to 10-min operating storage capacity. Total tank size exceeds this operating storage capacity by an amount representing the total condensate held in the drain pots and drain piping.

The condensate pumps (Item 7) are generally either two 100%-size units or three 50%-size units, to provide standby capability for emergency situations. The system generally has a very low net positive suction head availability so the pumps should be installed close to the condensate storage tank. The pump's total dynamic head must be sufficient to deliver the condensate into the purchaser's boiler feedwater system.

The steam duct system (Item 8) connects the condenser inlet-steam manifold to the turbine exhaust flange. It includes expansion joints, anchor points, elbows, turning vanes and duct supports. The purchaser should specify the preferred corrosion allowance for the manifolds and steam ducts since this affects system cost.

Economics dictate the steam-duct diameter. The smaller the size, the greater the steam pressure drop and the greater the required heat-transfer-surface area in the condenser. The tradeoff lies between heat-transfer-surface cost and steam-duct cost. (The steam-turbine thermal performance and power output depend on condenser pressure at the turbine exhaust flange, not on the steam pressure at the inlet to the bundles.) Past evaluations for full-vacuum systems have generally indicated an optimum steam velocity of about 200 ft/s at 6 in. Hg absolute steam pressure.

The condensate drain piping and manifold system (Item 9) starts at the bottom of the bundles and ends at the condensate storage tank. The air-removal piping and manifold system starts at the top of the bundles and terminates at the steam-jet air ejector package.

The instrumentation package (Item 10) includes such devices as temperature indicators and thermocouples; pressure indicators and transducers; vibration-pickup transducers; liquid-level devices; status lights; annunciator panel; and recorders. The controls might include storage-tank condensate level; low-flow condensate pump bypass; fan pitch control; air louver control; steam-valve control; and fan-motor control. These controls can be

computerized from startup to shutdown, to maximize the turbine's thermal efficiency and power output, minimize the auxiliary-fan power consumption, and protect the condenser from freezing.

In the event of complete electric-power failure to the steam-condenser fans, an atmospheric-relief diaphragm safety device (Item 11) should be installed in the turbine exhaust system, to protect the turbine exhaust hood from excessive steam pressure. This diaphragm generally ruptures and relieves at about 5 psi for turbines designed for full-vacuum service. Some turbine manufacturers provide such a device on the exhaust hood; if not, the purchaser can provide external protection by installing an atmospheric relief valve(s) in the exhaust steam duct close to the turbine.

The large steam duct connecting the turbine exhaust to the steam-condenser manifold condenses a considerable quantity of steam during a cold startup, while the metal temperature rises to some equilibrium level. This condensate must be drained to an appropriate low point in the duct system and then pumped or ejected (Item 12) into the condensate storage tank.

Thermal Specifications

The more-important thermal data that the manufacturer requires from the purchaser for the design and optimization of the steam condenser are:

1. Exhaust steam flowrate.
2. Exhaust steam enthalpy.
3. Design exhaust pressure.
4. Design ambient-air temperature.
5. Maximum ambient-air temperature.
6. Minimum ambient-air temperature.
7. Lowest optimum turbine-exhaust pressure.
8. Highest permissible turbine-exhaust pressure.
9. Economic optimization of fan power usage.

The first three items define the full-load fluid properties entering the air-cooled steam condenser. If there are any condensate drains or other waste-heat streams entering the condenser, these must of course be detailed.

The design exhaust pressure (Item 3) is measured at the turbine exhaust flange if the manufacturer supplies all of the steam duct from turbine to condenser. When the purchaser supplies the steam duct, the pressure is generally measured at the connecting point of the purchaser's duct to the manufacturer's steam manifold.

The design exhaust pressure is the pressure that exists simultaneously with the design ambient-air temperature (Item 4). Since the heat-transfer driving force of an air-cooled steam condenser decreases with a rising ambient-air temperature, the unit's pressure and temperature design points should be established for the relatively adverse operating conditions. This should be the highest exhaust pressure that can be routinely tolerated by the turbine during a hot summer day. The higher the design exhaust pressure and the lower its companion ambient-air temperature specification, the smaller and less costly the steam condenser.

The upper limit for the design exhaust pressure is set by economic or turbine-mechanical considerations. The higher the value, the lower the horsepower available from the turbine to drive the electric generator, the compressor or the pump. There will be plant constraints or losses if horsepower falls below a prescribed

minimum. Also, the steam-turbine manufacturer may have a turbine-exhaust-pressure limitation for mechanical and metallurgical reasons; typically, the limit may be 5 or 6 in. Hg absolute for a vacuum turbine, which must not be exceeded during normal full-load operation.

The companion design ambient-air temperature (Item 4) can range from 60 to 110°F. It should be selected on the basis of economics; the figure can, but does not always, turn out to be an annual average, a summer peak, or the temperature that is not exceeded more than 5% of the time.

The economic design ambient-air temperature is determined by selecting several potential values, sizing the steam condensers, estimating the capital cost of each, and then calculating their average annual performance. The higher-temperature cases will have larger steam condensers of higher capital cost, which can pay for themselves only by yielding a larger plant output. When the higher annual capital cost for a larger condenser just equals its annual savings, the corresponding ambient-air temperature becomes the economic optimum and establishes the condenser size.

When time restraints do not permit such a comprehensive economic study, the alternative is to select the lowest ambient-air temperature that experience prudently allows. The purchaser must be aware that performance will suffer when that temperature is exceeded (even if for only a few hours a year), and the turbine output may have to be cut back somewhat. The dollar penalty of such cutbacks must be balanced against the higher capital cost of a greater-capacity condensing system that could avoid cutbacks.

The maximum ambient-air temperature (Item 5) establishes the maximum turbine-exhaust pressure at full load for a given condenser. The minimum ambient-air temperature specification (Item 6) determines the type and degree of freeze protection.

The lowest optimum turbine-exhaust operating pressure (Item 7) is a characteristic of the turbine's particular design and construction. Below a given exhaust pressure, the turbine's last-stage leaving losses become so large as to reduce the turbine shaft output. This specification comes from the turbine manufacturer. Similarly, the highest permissible turbine-exhaust operating pressure (Item 8) is set by the turbine maker. This pressure cannot be exceeded during the maximum ambient-air temperature (Item 5) even if it requires reducing the throttle steam flow to the turbine.

The purchaser normally is not concerned with the internal steam-pressure drop of the air-cooled condenser. Such pressure drop is optimized by the manufacturer, taking into account the performance of the steam-jet air ejector and the specification for the lowest optimum turbine-exhaust pressure (Item 7). Purchasers who specify pressure drop can in fact limit the condenser designer's choice of tube diameter and length, and thus prevent the optimum capital-cost selection.

The steam condenser manufacturer optimizes designs by balancing the cost of fan power (Item 9) against the capital cost of heat-transfer surface. The cost of the purchaser's electric power, both demand and energy charges, must be known. This should reflect the actual increase in the annual utility power bill for each brake horsepower of fan power. It should be priced on the basis of the lowest-cost increment on the utility's rate schedule applicable to the purchaser.

This annual power cost must be converted into a lifetime cost figure, by capitalizing it to reflect the present value of all monies to be paid for power over the life of the plant. Adding this capitalized power cost (in \$ per hp-lifetime) to the equipment capital cost gives the total owning and operating cost of the steam condensing

system. Such power cost data submitted by the purchaser allows the manufacturer to trade off between heat-transfer surface and fan power, to provide the purchaser with the most economic condenser design.

If the purchaser does not provide the manufacturer with the dollar value of fan power, an indication should at least be given of whether the steam condenser should be designed for a) lower fan-power cost at the expense of higher capital cost, or b) lower capital cost at the expense of higher fan-power cost.

Cold-Climate Considerations

The factors involved in warmup, startup and freeze protection during cold weather are:

1. Minimum-available steam flow.
2. Bypass steam flow.
3. Air flow control.
4. Ambient air preheat.

In general, the lower the minimum ambient-air temperature, the more costly the system equipment. Similarly, the smaller the minimum-available steam flow from the turbine (for immediate warmup of the condenser surfaces), the more costly the system.

A steam turbine must be started with steam flow to the throttle not exceeding the maximum rate prescribed by the turbine manufacturer. Turbines require careful startup to protect the rotors and stators from thermal distortions, which can occur as a result of too-fast loading that produces large metal-temperature gradients.

While a slow startup is desirable for the turbine, it is, however, undesirable for the condenser. Metal surfaces in the steam condenser must be brought up to a temperature above freezing quickly, to prevent condensate from freezing in some remote part of the tower.

There are several remedies if the immediate, minimum-available steam flow to the air-cooled condenser is too low for safe startup (considering the minimum-controllable airflow and natural-draft effects). One is to isolate the condenser into several sections by means of large steam valves, for sequential startup. Another is to increase the steam available to the condenser by bringing in live bypass steam from the boiler. An occasionally used method is to heat the incoming ambient air with open-flame torches that burn natural gas or fuel oil.

Once the metal of the air-cooled steam condenser is heated, the next hurdle is to condense steam safely on a continuous and controlled basis. Two independent variables that can upset equilibrium conditions are ambient-air temperature and wind. Another upsetting factor is a decreasing exhaust-steam flow rate. Controlling airflow through the bundles is the only technique available to counterbalance these effects.

There are several means for achieving airflow control. The selection depends upon the severity of the cold weather and the minimum-available steam flow. Some of the more common means are listed below, in order of increasing control capability and cost:

Fan-blade Pitch	Motor Speed	Other	Air Flow
Fixed	Single	—	S% or 100%
Fixed	Two	—	S% or 50% or 100%
Variable	Single	—	S% to 100%
Fixed	Single	Louvers	S% to 100%
Variable	Single	Valves	S% to 100%

The air flow quantity S% refers to a "small" amount as induced by natural draft, wind effects, blade eddies, or leakages through louvers. Even this small amount can be critical during extremely cold weather, when the heat-transfer driving force becomes very large and only a very small air flow is needed to maintain the desired thermal equilibrium. However small the air flow, it must be operator controlled at all times, for example by using variable-pitch fans that can be set into negative pitch to counteract natural draft when necessary.

Other Questions

In the review of alternative steam-condenser proposals, the purchaser should question the manufacturers to ensure that their designs do not trap noncondensables under any operating conditions, and thus are not freeze-prone. Typical questions and concerns include:

- Are there open rear headers or common rear manifolds that connect different rows of tubes together? Check both the main condenser bundles (or tubes) and the vent condenser bundles (or tubes).
- If the answer is yes, ask the manufacturer to provide steam flowrates, steam condensing rates and steam pressure drops in each row of the main and vent condensers (for a typical bundle), for the full range of operating steam loads, ambient-air temperatures and air flow velocities. Find out how the manufacturer maintains identical steam pressures in the rear header (or rear manifold) for each row over the full operating range, to avoid steam backflow.
- How does the total travel length of purged noncondensables compare among units? This is the longest distance noncondensables must travel through the rear header of the main condenser before reaching the entrance of the vent condenser tubes. The longer this travel length, the more difficult it is to purge the main condenser tubes that are farthest away from the vent condenser tubes.
- Do the vent tubes contact cold ambient air, or are they installed in a heated section of the bundle where they cannot freeze? Tubes in the vent condenser carry some steam along with the noncondensables. Since the steam partial pressure is low, heat content is low.
- How are the condensate-drain water-seal loops protected from freezing?
- Can the condenser function with all fans off for indefinite periods, without steam backflow?
- What is the degree of steam flow upset that occurs in operating cells when the fan of an adjacent cell is turned off? The nonoperating cell will have a higher steam pressure in its rear headers. How will this higher pressure affect the main and vent condensers of the adjacent operating cells, and what does the manufacturer recommend to relieve steam backflow?

- Does the vent section of the condenser have a separate set of fans from the main condenser? If so, is it necessary to run the vent fans in some prescribed manner in relation to the main condenser fans? What happens when the vent condenser fans are operated differently from the prescribed speed regimen?
- Where will the major components, such as the bundles and the fans, be manufactured, and, if job shops are used, how is quality control maintained?

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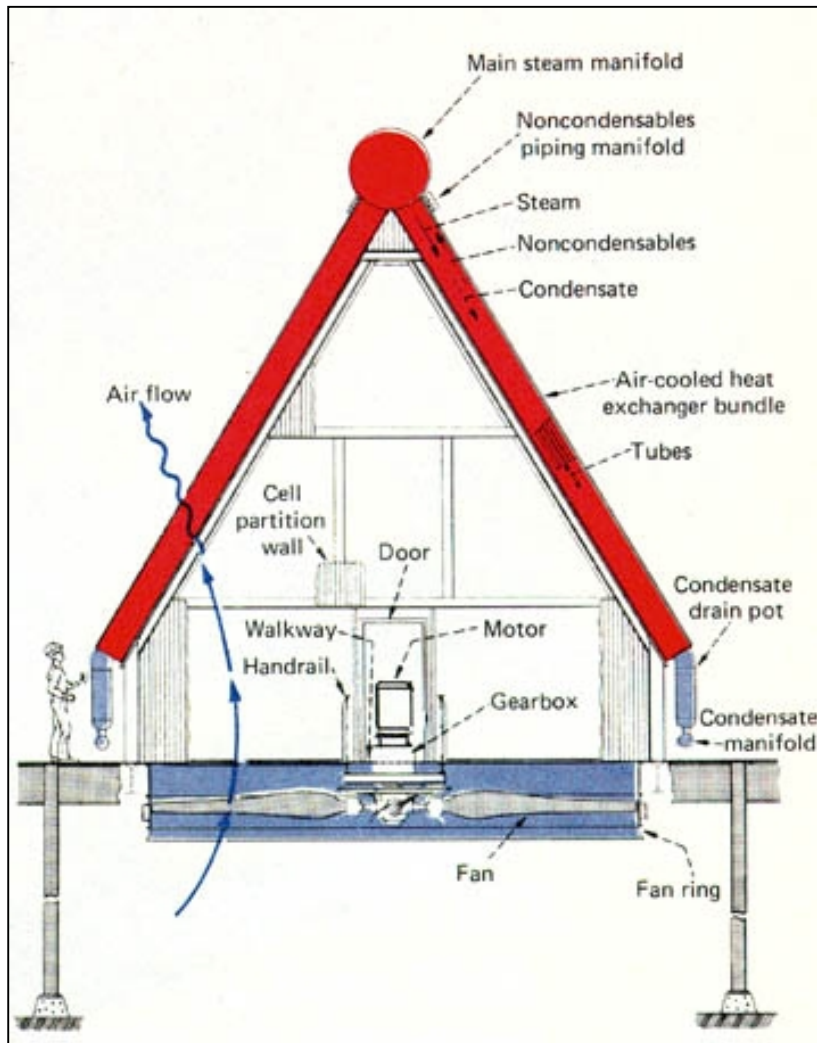


Figure 1 Air-cooled steam condenser of A-frame design

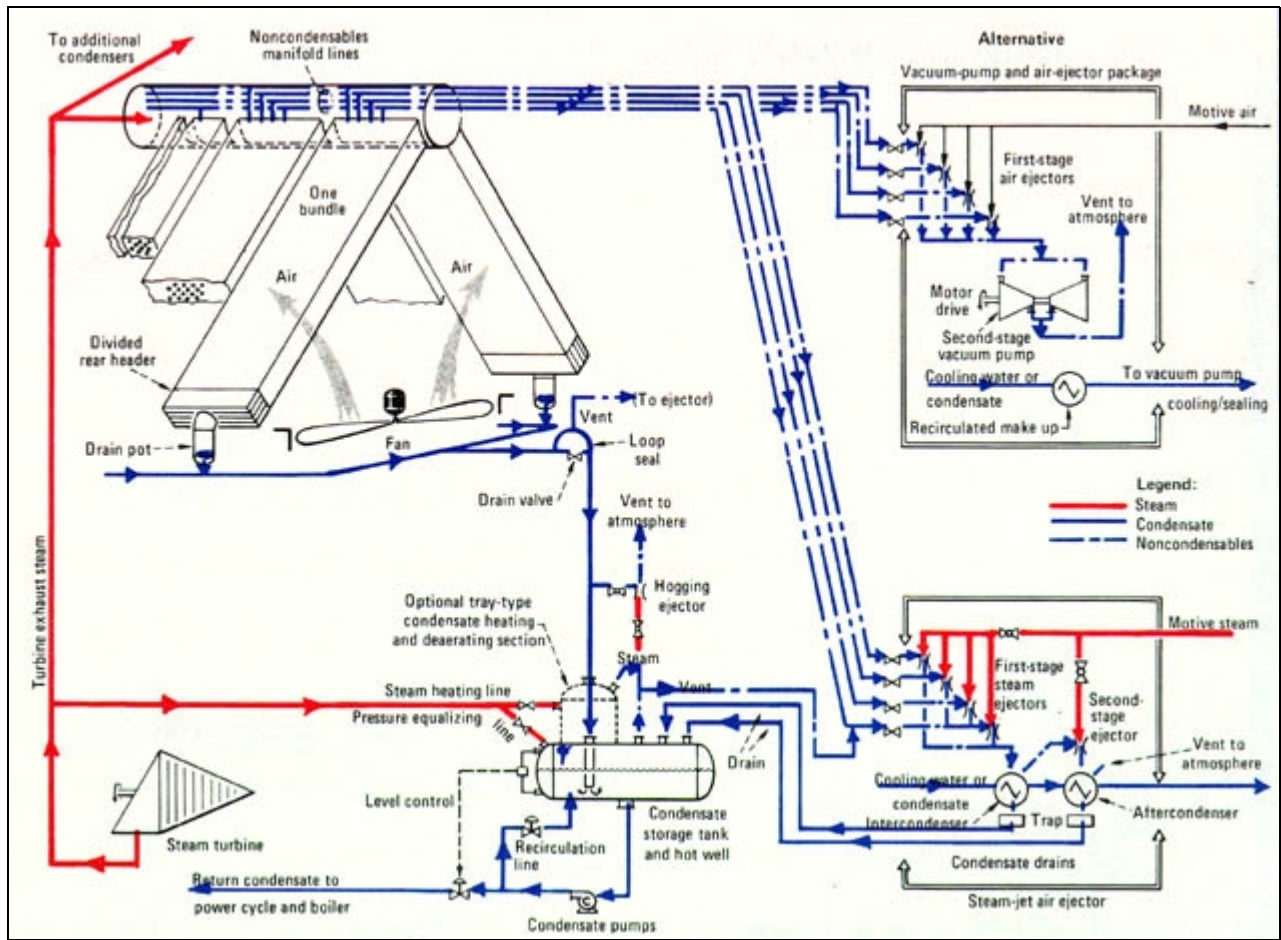


Figure 2 Steam-condensing system ties in with turbine and with air-removal package

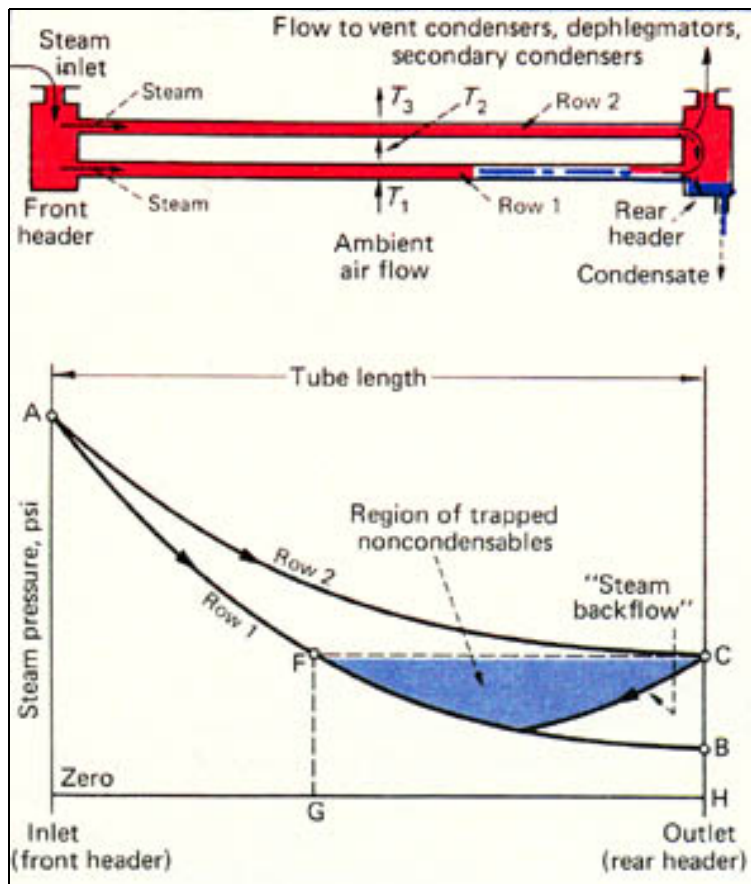


Figure 3 Trapping of noncondensables causes the steam-condenser problem

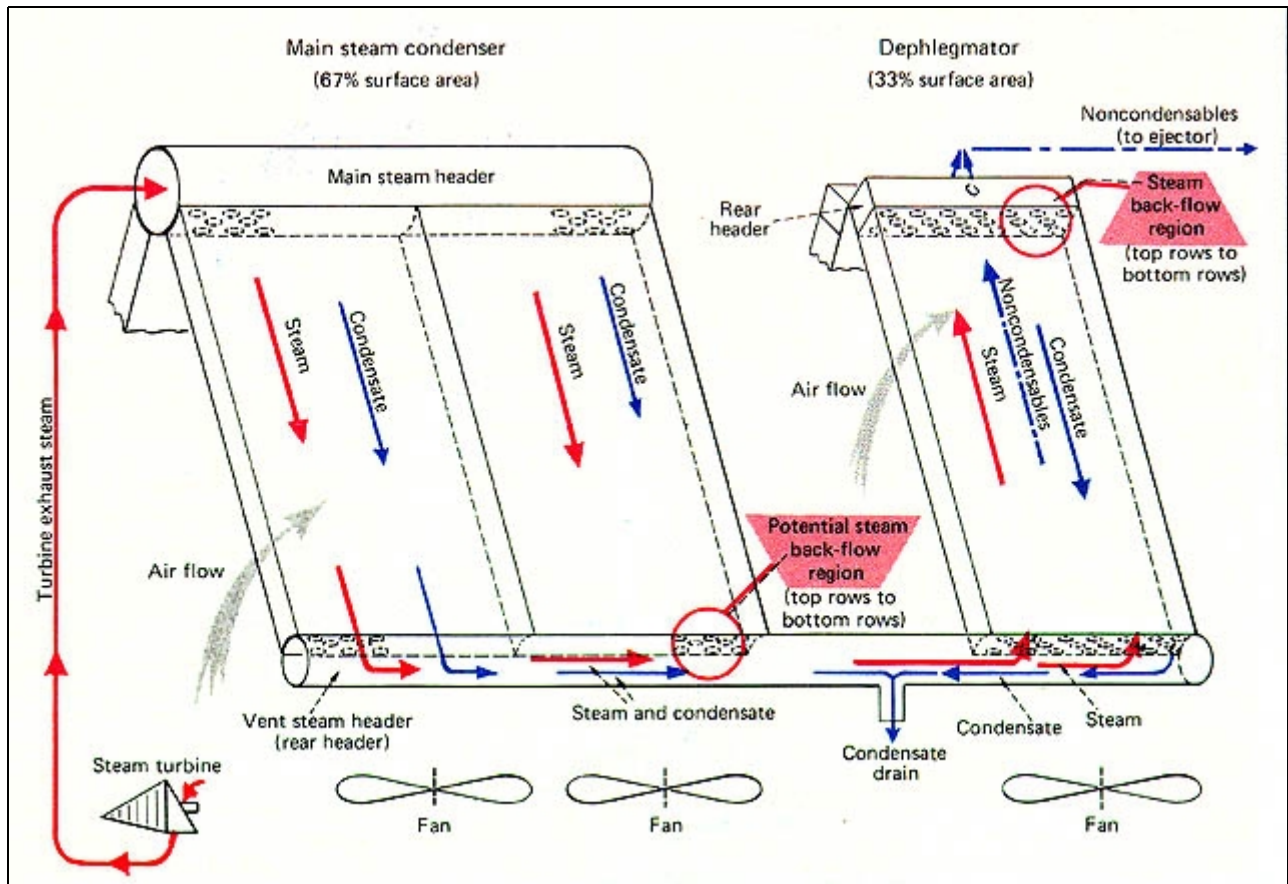


Figure 4 Backflow can result when nondivided rear headers are used

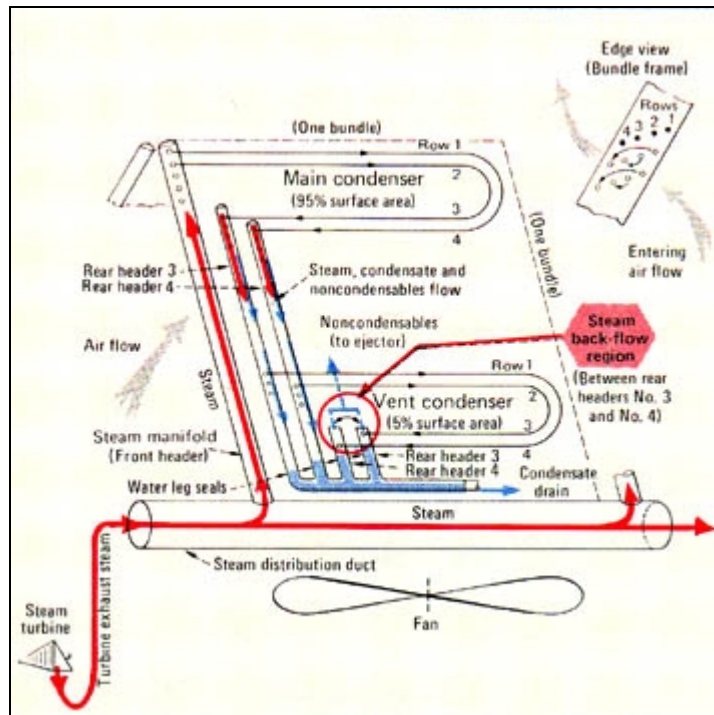


Figure 5 Backflow can also occur with common vent manifolding

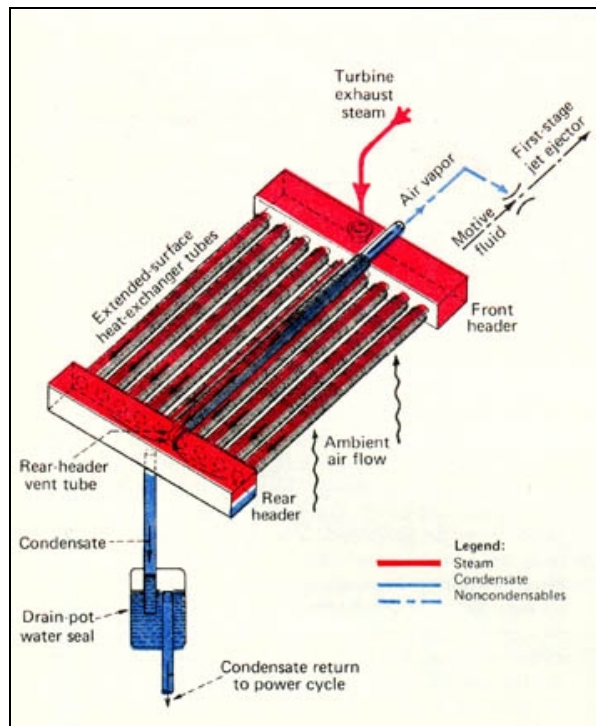


Figure 6 Single-row steam condenser avoids backflow problem

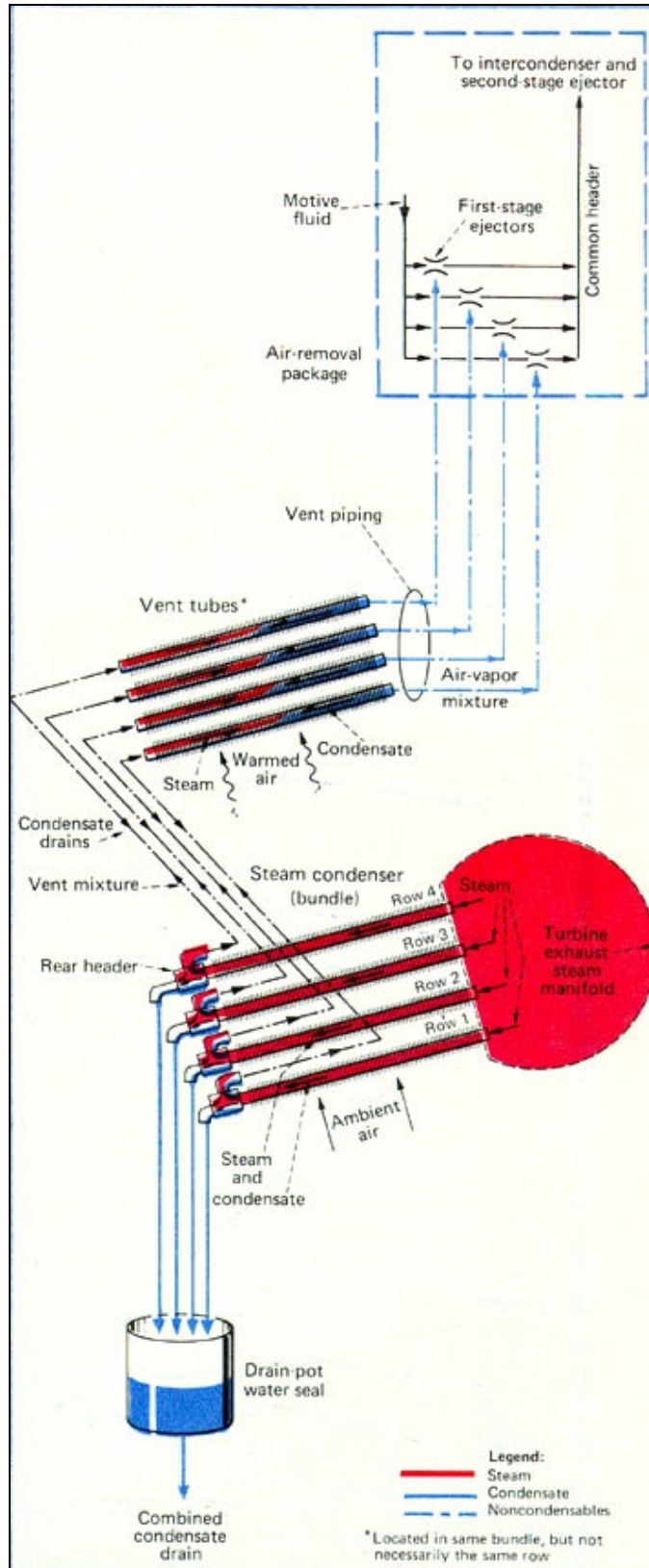


Figure 7 Commercial systems combine several rows of steam condensers

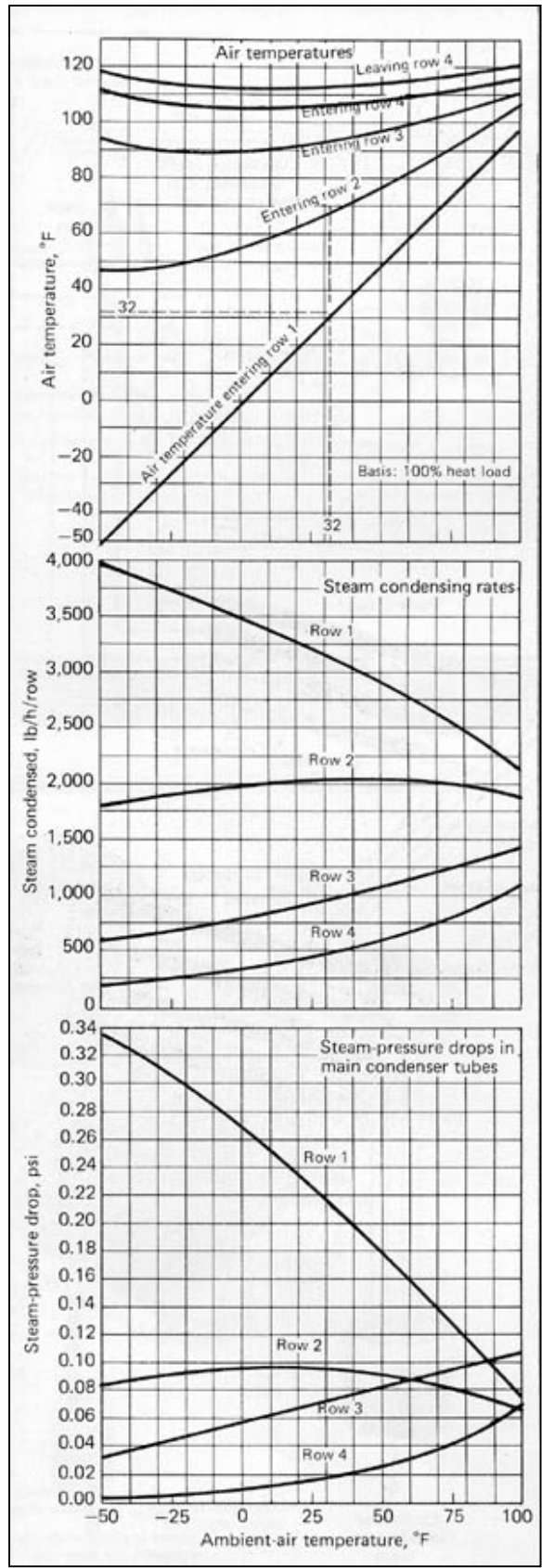
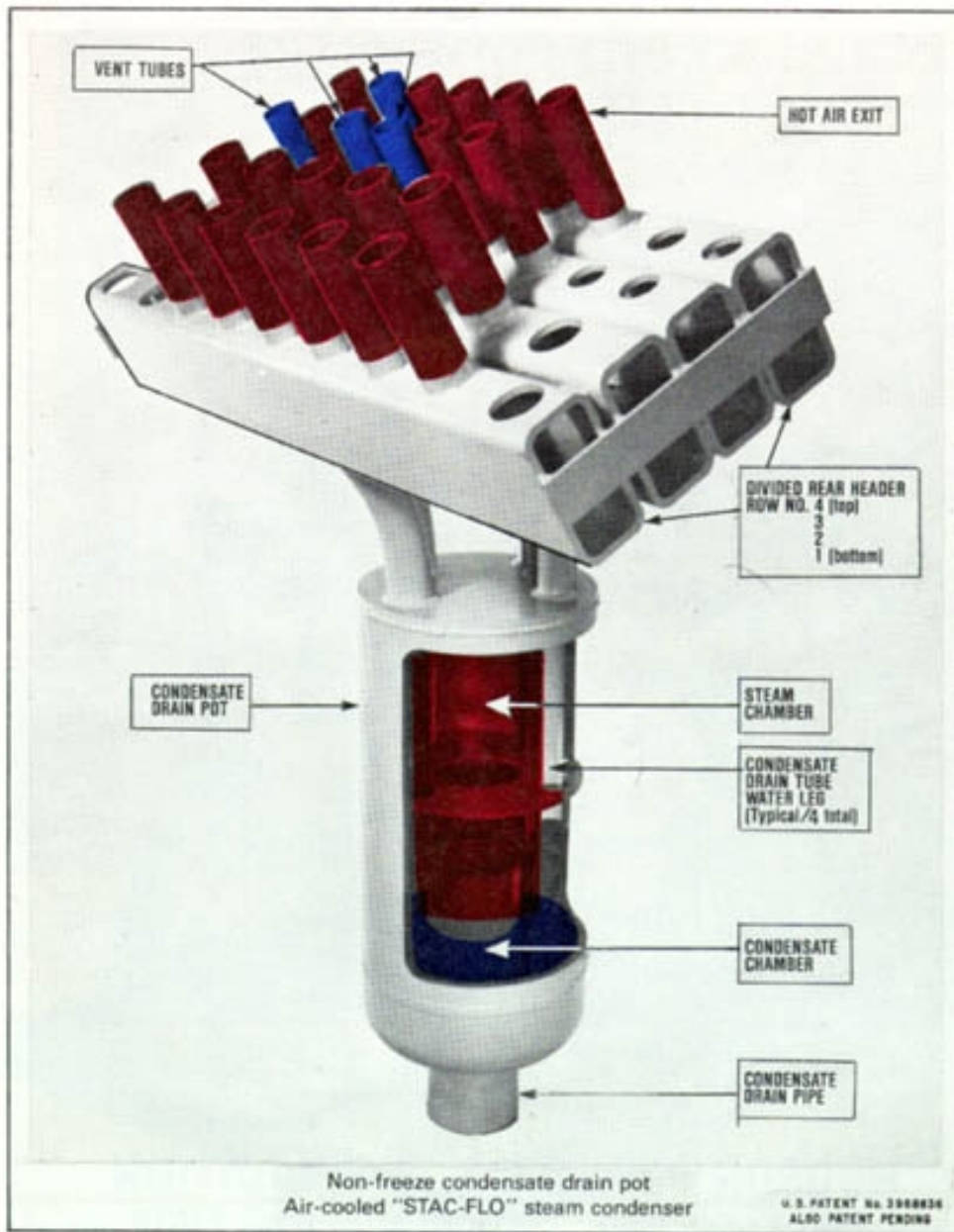


Figure 8 Operating characteristics of an air-cooled steam condenser



Figure 9 Extended heat-exchanger surface consists of extruded aluminum fins over a carbon-steel tube



Non-freeze condensate drain pot
Air-cooled "STAC-FLO" steam condenser