

Feb. 7, 1967

F. BOEHM

3,302,702

STEAM JET VACUUM PUMP

Filed June 14, 1965

2 Sheets-Sheet 1

FIG. 1.

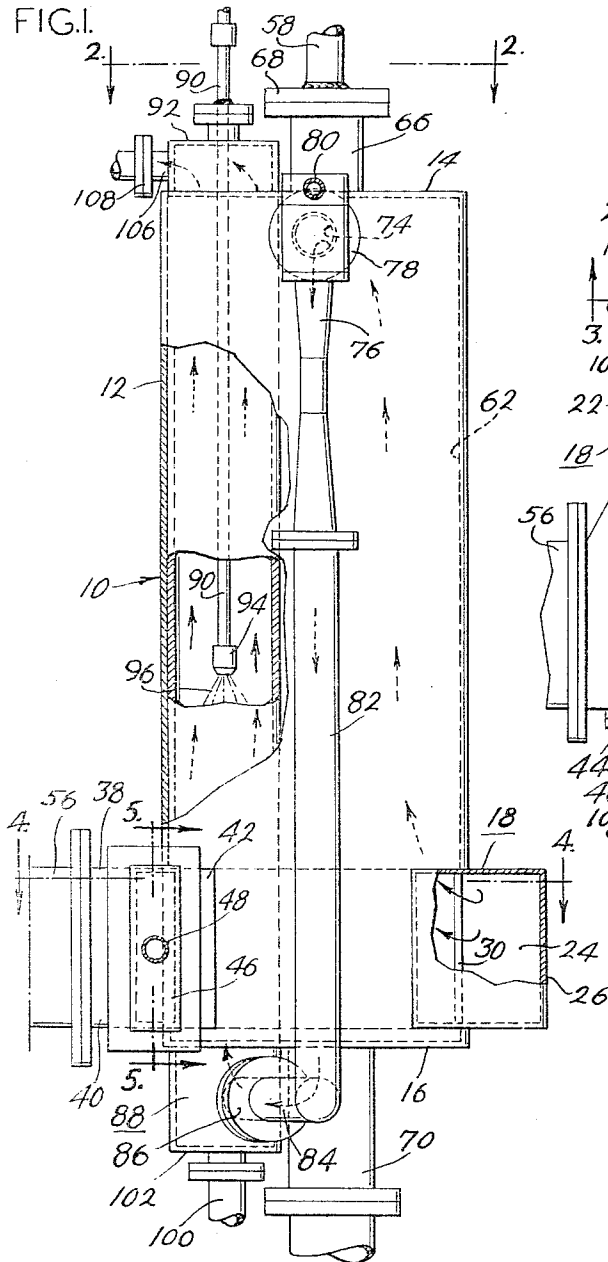


FIG. 2.

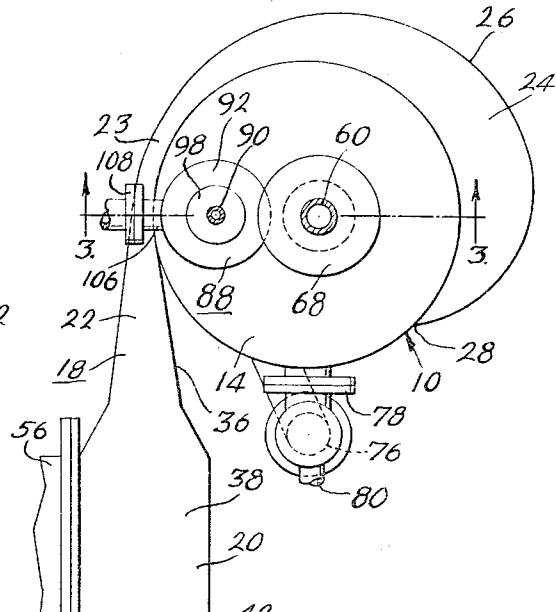
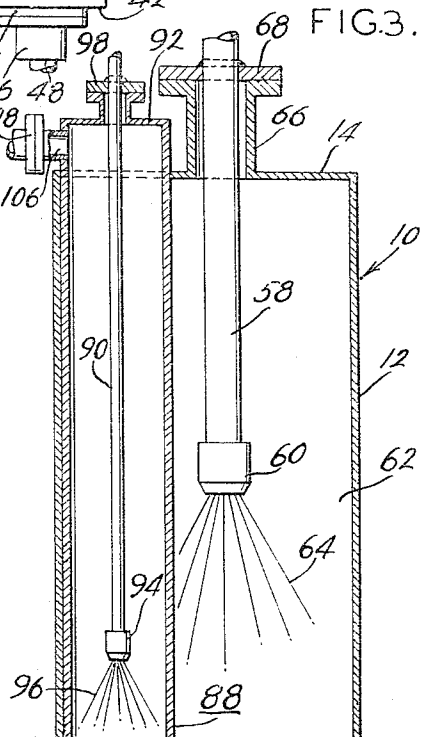


FIG. 3.



INVENTOR: FREDERICK BOEHM
BY *Howson & Howson*
ATTYS

Feb. 7, 1967

F. BOEHM

3,302,702

STEAM JET VACUUM PUMP

Filed June 14, 1965

2 Sheets-Sheet 2

FIG. 6.

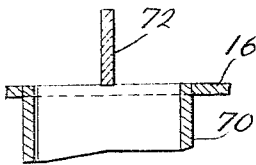


FIG. 4.

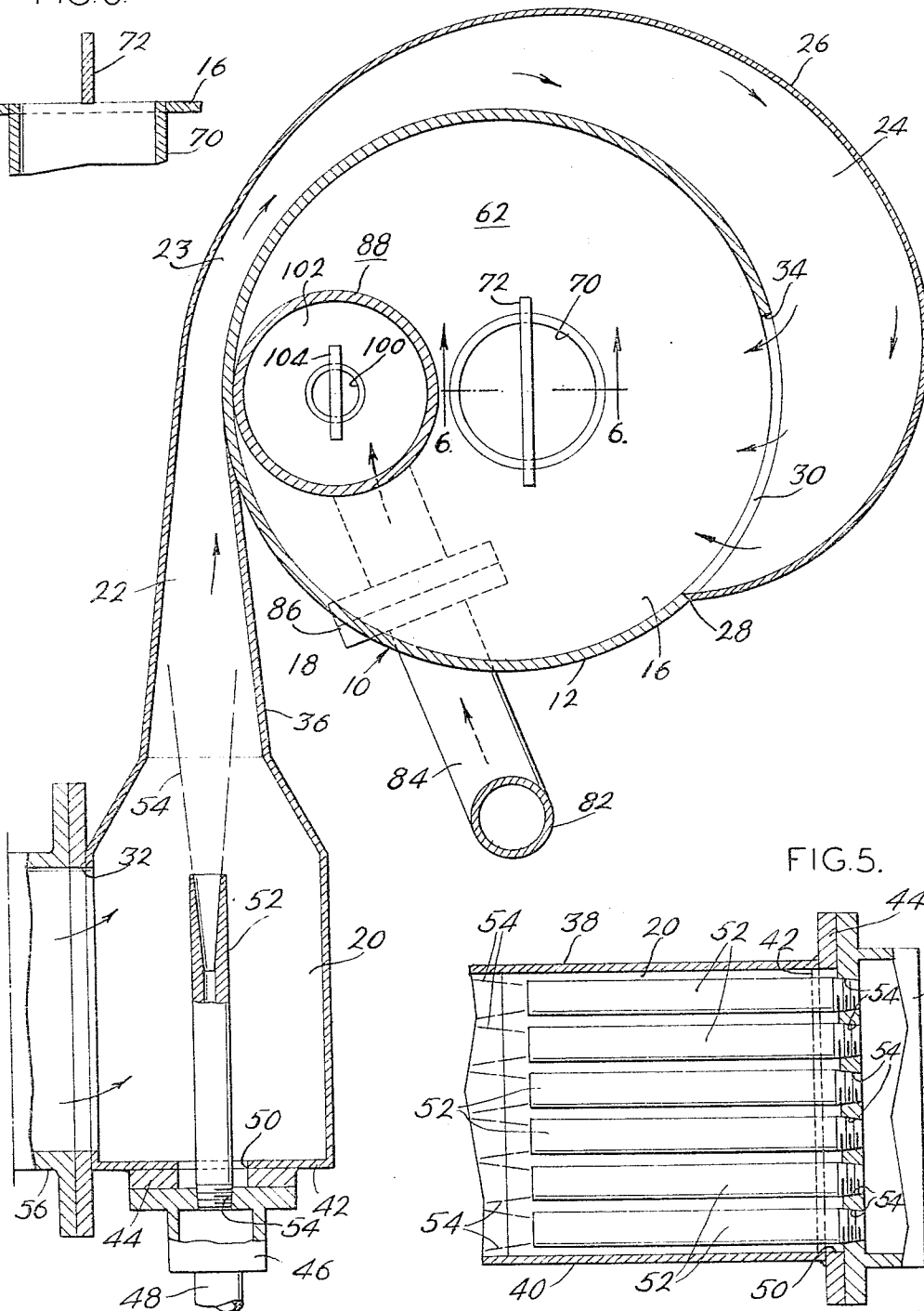
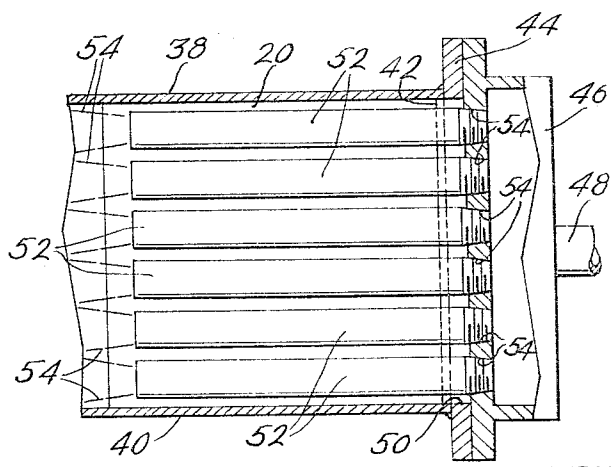


FIG. 5.



INVENTOR
FREDERICK BOEHM
BY
Howson & Howson
ATTYS

1

3,302,702

STEAM JET VACUUM PUMP

Frederick Boehm, Philadelphia, Pa., assignor to Schutte and Koerting Company, Cornwells Heights, Pa., a corporation of Pennsylvania

Filed June 14, 1965, Ser. No. 463,551

10 Claims. (Cl. 165-112)

The present invention relates generally to steam jet vacuum pumps and more particularly to a unitary steam jet vacuum pump and condenser of a compact, expense-saving construction.

Steam jet vacuum pumps, also known as ejectors or exhaustors, enjoy wide-spread industrial usage due principally to their simplicity, ease of operation, and low maintenance requirements. Such pumps may be arranged in one, two, three, four, or five-stage units depending on the vacuum required, and condensers are normally utilized between the stages to provide an increased efficiency. Where saturated air-vapor mixtures are involved, two or three-stage condensing vacuum pumps are commonly used. In the process, food, and allied industries for such operations as filtration, distillation, absorption, drying, mixing, vacuum packaging, dehydrating and other operations which require the producing of a high vacuum and the handling of large volumes of air and vapor, a condensing three-stage vacuum pump is generally employed, the first stage of which is commonly known as a booster in view of its function of boosting the pressure to a sufficient degree to permit condensing of the vapor.

A typical conventional three-stage steam jet vacuum pump includes a straight, lengthy booster connected to and separable from a direct-contact, barometric counter-current condenser. The second stage pump, intercondenser and third stage pump extend successively and separably from the booster condenser, the whole comprising a sizeable and cumbersome installation. Since the majority of the condensing type vacuum pumps are mounted at barometric heights of water above the ground, approximately 35 to 50 feet in the air, an extensive, costly supporting structure is required for conventional pumps. In addition, such units, due to their assembled bulk, must be shipped in a piecemeal fashion and assembled upon installation, thus further increasing the installation costs.

In the present construction, the booster and booster condenser, rather than the usual separate units, are incorporated in a novel unitary design wherein the booster, having an arcuate rather than straight configuration, circumferentially overlies the cylindrical booster condenser shell. The intercondenser between the second and third stage vacuum pumps is included within the booster condenser shell to provide a more compact installation.

In view of the above, it is a first object of the present invention to provide a novel condensing steam jet vacuum pump of a compact construction which may be inexpensively manufactured, transported and installed.

Additional objects and advantages of the invention will be more readily apparent from the following detailed description of an embodiment thereof when taken together with the accompanying drawings in which:

FIG. 1 is a side elevational view of a steam jet vacuum pump embodying the present invention with portions cut away to show interior details thereof;

FIG. 2 is a plan view of the vacuum pump taken along line 2-2 of FIG. 1;

FIG. 3 is a sectional view taken along line 3-3 of FIG. 2 showing the details of the booster condenser and the intercondenser;

FIG. 4 is a sectional view taken along line 4-4 of FIG. 1 showing the arcuate configuration of the booster and its unitary construction with the booster condenser;

2

FIG. 5 is a sectional view taken along line 5-5 of FIG. 1 showing the multiple steam nozzles mounted within the booster suction chamber; and

FIG. 6 is a sectional view taken along line 6-6 of FIG. 4 showing the details of the booster condenser drainpipe.

Referring to the drawings, the illustrated steam jet vacuum pump 10 is based around the booster condenser cylindrical shell 12 which is vertically disposed and which is closed at its upper and lower ends respectively by the top 14 and bottom 16. As shown most clearly in FIGS. 2 and 4, a booster 18 is integral with the condenser shell and is of an arcuate configuration so as to extend around a substantial portion of the circumference of the lower end of the condenser shell. The booster 18 has a rectangular cross section and includes, as shown in FIGS. 4 and 5, a suction chamber 20 communicating with a converging combining or entrainment chamber 22, a throat 23, and a diffuser 24 opening into the condenser shell.

As shown in FIG. 4, the inner wall of the diffuser throat and part of the entrainment chamber is formed by the exterior of the condenser shell. The booster includes a curved outer wall 26 extending from an edge 28 of the opening 30 in the condenser shell to the end of the suction chamber and includes a flanged suction port 32 in the side of the suction chamber 20. The wall 26 is so shaped as to provide a constant cross sectional area in the throat and an increasing area throughout the diffuser, being spaced a maximum distance from the shell 12 at a point radially opposite the edge 34 of the opening 30 in the shell. Extending tangentially from the condenser shell 12 is the wall 36 opposed from the outer wall 26 and forming therewith the sides of the converging entrainment chamber 22 and the suction chamber 20. Top and bottom walls 38 and 40 of the booster perpendicular to the walls 26 and 36, and end wall 42 of the suction chamber perpendicular to the centerline of the entrainment chamber complete the booster closure.

The end wall 42 is provided with a flange 44 to which is connected the flanged steam manifold 46 connected to the steam conduit 48. The end wall 42 and the flange 44 include a vertical slot 50 to permit the passage into the suction chamber of the steam nozzles 52 which are threadedly connected to ports 54 in the manifold. The steam nozzles are arranged in vertical, spaced alignment and are aligned with the converging entrainment chamber 22 so as to direct a high velocity steam jet 54 into the entrainment chamber. A flanged conduit 56 is connected with the flanged suction port 32 of the suction chamber to connect the booster with the vessel or chamber to be exhausted.

Referring to the sectional view of FIG. 3, a spray nozzle 58 having a spray head 60 is directed downwardly into the condensing chamber 62 of the booster condenser to provide a downward spray of water 64 therewithin. The nozzle 58 passes through the top 14 of the condenser and is secured in sealed relation by means of the flanged vertical connector 66 to which is secured the flange 68 of the nozzle. The water from the spray head 60 and the condensed vapors pass from the bottom of the condensing chamber through the drainpipe 70, a baffle 72 across the drainpipe opening preventing the passage of large inadvertently entrained foreign objects.

As shown most clearly in FIGS. 1 and 2, the air and noncondensable vapors passing upwardly through the condensing chamber 62 pass out of the condensing chamber through the port 74 in the upper end of the condenser shell 12 into the suction chamber of the second stage steam jet vacuum pump 76 which connects with the port 74 by means of the flanged connection 78. The second stage pump 76 is downwardly directed in closely adjoining

parallel relation with the booster condenser shell and is provided with a steam inlet conduit 80. The lower end of the second stage pump diffuser 82 includes a horizontal section 84 which connects by means of flanged connection 86 with the lower end of the cylindrical intercondenser 88. The intercondenser extends through both the top and bottom of the booster condenser shell in sealed relation with the condensing chamber 62. A spray nozzle 90 extending downwardly through the upper end 92 of the intercondenser and having a spray head 94 is adapted to direct a water spray 96 into the lower end of the intercondenser. As shown in FIG. 3, the entrance of the nozzle 90 in the end 92 of the intercondenser is sealed by means of the flanged connector arrangement 98. The spray water and condensates are removed from the intercondenser through the drainpipe 100 in the bottom 102 thereof. As shown in FIG. 4, a baffle plate 104 across the drainpipe opening prevents foreign matter from passing into the drainpipe.

An outlet port 106 near the upper end of the intercondenser is connected by means of the flanged connector 108 to a third stage steam jet vacuum pump (not shown) of conventional design. The third stage pump is preferably disposed in parallel relation with the booster condenser shell in a manner similar to the second stage pump to provide a compact assembly.

For operation, the conduit 56 is connected with the vessel or chamber to be exhausted and the steam conduits 48 and 80 are connected to a supply of high pressure steam. A flow of water is introduced into the nozzles 58 and 90 to provide water sprays in the respective condensing chambers. The steam nozzles 52 provide expanding high velocity jets of steam 54 across the suction chamber 20, and the gas and vapors from the conduit 56 are entrained by the steam jets in the entraining chamber and carried into the diffuser wherein the kinetic energy of the mixture is transformed into an increased pressure. The mixture passes through the opening 30 into the condensing chamber 62 of the booster condenser at a sufficiently high pressure to permit the condensable vapors and steam to be condensed by the water spray 64. The water and condensates drain from the condensing chamber through the drainpipe 70 while the gases and noncondensable vapors pass upwardly through the port 74 into the second stage vacuum pump 76.

A further compression is provided by the second stage vacuum pump and a second mixture of steam, gas and noncondensable vapors passes from the diffuser 82 of the pump into the lower end of the intercondenser 88 wherein the water spray 94 effects a condensation of the steam. The water spray and condensate collect in the bottom of the intercondenser and pass out through the drainpipe 100, while the gases and noncondensable vapors pass upwardly to the port 106 in the upper end of the intercondenser and into the third stage vacuum pump.

The arcuate shape of the booster and its combination in a unitary structure with the booster condenser provides a more simplified and substantially less expensive unit to manufacture than the conventional, separable booster and condenser. The incorporation of the intercondenser within the booster condenser shell provides additional compactness which is an important consideration in both the transporting and installing of a multistage pump. With the present unit, since the third stage vacuum pump may be connected to and supported by the flanged connector 108, it is possible to assemble and ship for installation a complete three stage condensing steam jet vacuum pump unit which in a conventional construction must generally be shipped and installed in a piecemeal fashion with the vacuum pumps and condensers disassembled. Special supports for the various elements of the unit are unnecessary with the present unitary design, all of the elements being carried by the booster condenser shell 12.

The novel use of a rectangularly-sectioned booster permits the manufacture of pumps of different booster ca-

pacities simply by increasing the height of the booster cross section and adding additional steam nozzles as required. The capacity may thus be increased without increasing the width or length of the booster or any parts thereof. This results in substantial savings in comparison to conventional straight-type boosters in which the capacity is increased by increasing the length and diameter of all of the elements.

Tests have revealed that the operating efficiency of the arcuate vacuum pump is approximately equivalent to those of conventional straight units. As an example of the compactness provided by this arcuate pump construction, a steam jet pump of the present design occupies a space of approximately 44" x 58" x 36" high while a conventional straight type unit of the same capacity and having the same flow passage length requires an installation space of approximately 180" x 24" x 36" high. In view of the barometric heights at which these units are normally installed and considering the saving of the usual expense of assembling the pumps and condensers at the installation site, it can be readily understood that the present invention provides significant advantages over conventional pump constructions.

Manifestly, changes in details of construction can be effected by those skilled in the art without departing from the spirit and the scope of the invention as defined in and limited solely by the appended claims.

I claim:

1. A combined steam jet vacuum pump and condenser comprising a condenser having a cylindrical condenser shell, a steam jet vacuum pump comprising aligned linear suction and entraining chambers, said entraining chamber being tangentially aligned with respect to said cylindrical condenser shell, and arcuate-shaped throat and diffuser sections of said pump connected with said entraining chamber, said arcuate-shaped sections overlying said cylindrical condenser shell with the diffuser opening into said shell.

2. A combined steam jet vacuum pump and condenser comprising a condenser having a cylindrical condenser shell, a steam jet vacuum pump comprising aligned linear suction and entraining chambers, said entraining chamber being tangentially aligned with respect to said cylindrical condenser shell, and arcuate-shaped throat and diffuser sections of said pump connected with said entraining chamber, said arcuate-shaped sections overlying said cylindrical condenser shell with the diffuser opening into said shell, the outer wall of said condenser shell forming the inner wall of the throat and diffuser sections of said pump.

3. A multistage steam jet vacuum pump comprising an arcuate-shaped booster, a booster condenser having a cylindrical condenser shell, said booster circumferentially overlying and opening into said cylindrical condenser shell, a second stage vacuum pump adapted for exhausting said booster condenser, said second stage pump being disposed parallel to and closely adjacent said booster condenser shell, an intercondenser extending within said booster condenser shell, and means connecting said second stage pump with said intercondenser.

4. A multistage steam jet vacuum pump comprising an arcuate-shaped booster, a booster condenser having a vertically disposed cylindrical condenser shell, said booster circumferentially overlying and opening into said cylindrical condenser shell at the lower end thereof, said booster having a rectangularly shaped cross section, the outer wall of said condenser shell forming a substantial part of the inner wall of said booster, a second stage vacuum pump adapted for exhausting said booster condenser, said second stage pump being disposed parallel to and closely adjacent said booster condenser shell, an intercondenser extending within said booster condenser shell, and means connecting said second stage pump with said intercondenser.

5. A multistage steam jet vacuum pump as claimed in

5

claim 4, including an outlet port in said intercondenser adapted for connection to a third stage vacuum pump.

6. A multistage steam jet vacuum pump as claimed in claim 5, said intercondenser extending through the top and bottom of said booster condenser shell in sealed relation thereto, said intercondenser being connected to said second stage pump below the bottom of said booster condenser shell, and said outlet port in said intercondenser being located above the top of said booster condenser shell.

7. A combined steam jet vacuum pump and condenser comprising a condenser having a cylindrical condenser shell, a steam jet vacuum pump comprising aligned linear suction and entraining chambers, said entraining chamber being tangentially aligned with respect to said cylindrical condenser shell, arcuate-shaped throat and diffuser sections of said pump connected with said entraining chamber, said arcuate-shaped sections overlying said cylindrical condenser shell with the diffuser opening into said shell, a second stage vacuum pump adapted for exhausting said condenser, said second stage pump being disposed parallel to and closely adjacent said condenser shell, an intercondenser extending within said condenser shell, and means connecting said second stage pump with said intercondenser.

8. A combined steam jet vacuum pump and condenser comprising a condenser including a vertically disposed cylindrical condenser shell, a steam jet vacuum pump comprising aligned linear suction and entraining chambers, said entraining chamber being tangentially aligned with respect to said cylindrical condenser shell, arcuate-shaped throat and diffuser sections of said pump connected with said entraining chamber, said arcuate-shaped sections overlying the lower end of said cylindrical condenser

6

shell with the diffuser opening into said shell, said vacuum pump having a rectangularly shaped cross section, the outer wall of said condenser shell forming the inner wall of the throat and diffuser sections of said pump, a second stage vacuum pump adapted for exhausting said condenser, said second stage pump being disposed parallel to and closely adjacent said condenser shell, an intercondenser extending within said condenser shell, and means connecting said second stage pump with said intercondenser.

9. A multistage steam jet vacuum pump as claimed in claim 8, including an outlet port in said intercondenser adapted for connection to a third stage vacuum pump.

10. A multistage steam jet vacuum pump as claimed in claim 9, said intercondenser extending to the top and bottom of said condenser shell in sealed relation thereto, said intercondenser being connected to said second stage pump below the bottom of said condenser shell, and said outlet port in said intercondenser being located above the top of said condenser shell.

References Cited by the Examiner

UNITED STATES PATENTS

1,197,148	9/1916	Parsons et al.	165—112
1,394,748	10/1921	Ljungstrom	230—102
1,810,873	6/1931	Sim	230—102
2,808,195	10/1957	Boehm	230—102
2,993,639	7/1961	Foster	230—95

FOREIGN PATENTS

16,590 10/1912 Denmark.

DONLEY J. STOCKING, *Primary Examiner*.

W. J. KRAUSS, *Assistant Examiner*.