Feb. 20, 1968 G. HOFFMEISTER 3,369,735
GAS-JET SUCTION DEVICE, PARTICULARLY FOR CONNECTION TO A VACUUM PUMP
Filed June 20, 1966 2 Sheets-Sheet 1

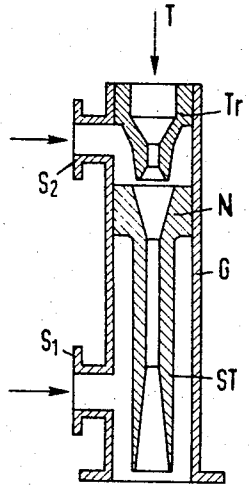

Fig. 1
PRIOR ART

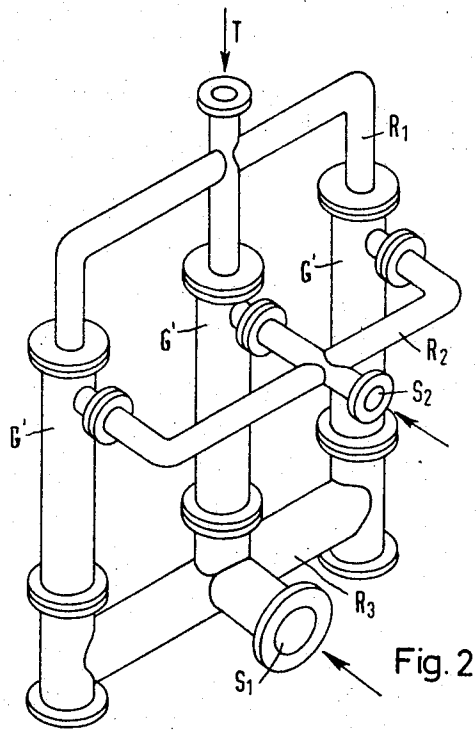

Fig. 2

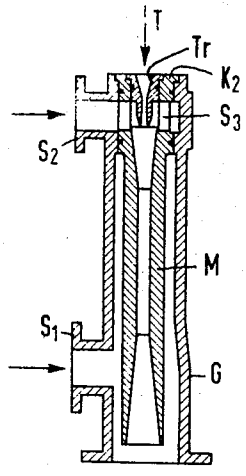

Fig. 3

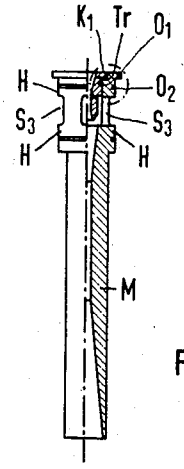

Fig. 4

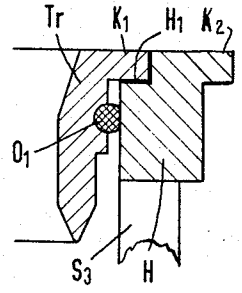

Fig. 4a

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GAS-JET SUCTION DEVICE, PARTICULARLY FOR CONNECTION TO A VACUUM PUMP
Filed June 20, 1966 2 Sheets-Sheet 2

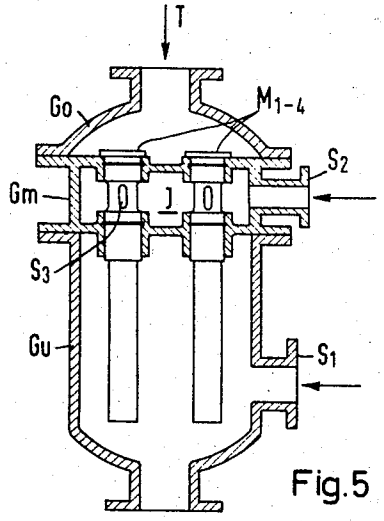

Fig.5

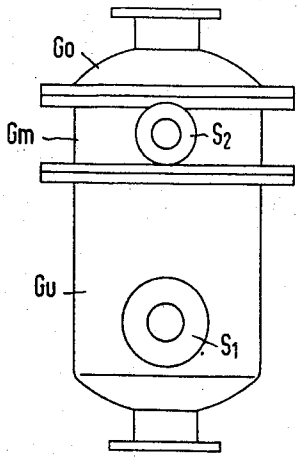

Fig. 6

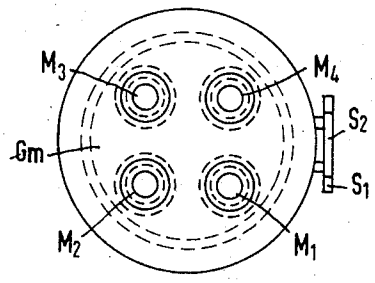

Fig. 7

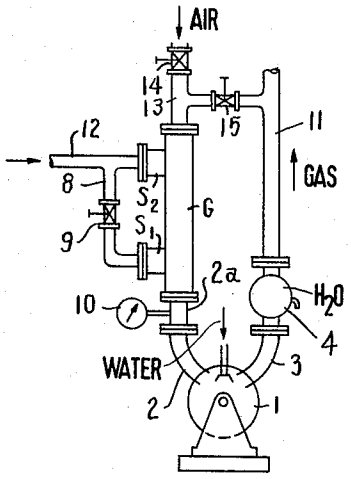

Fig. 8

United States Patent Office 3,369,735 Patented Feb. 20, 1968

3,369,735

GAS-JET SUCTION DEVICE, PARTICULARLY FOR CONNECTION TO A VACUUM PUMP

Günter Hoffmeister, Mulheim (Ruhr), Germany, assignor to Siemens Aktiengesellschaft, Berlin and Munich, Germany, a corporation of Germany

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Claims priority, application Germany, June 19, 1965, S 97,695
9 Claims. (Cl. 230—95)

ABSTRACT OF THE DISCLOSURE

Gas-jet suction device, particularly for connection to a pump inlet of liquid ring gas pumps in shunt with a controllable bypass includes a housing structure having a suction inlet and a bypass inlet and an outlet, and an injector unit formed of a mixing tube and a jet nozzle located within the mixing tube, the injector unit being mounted in the housing structure, the mixing tube and the housing structure defining therebetween an interspace communicating with the bypass inlet and with the outlet, the mixing tube having a neck portion seated and peripherally sealed in the housing structure at a locality remote from the outlet, the neck portion separating the interspace from the suction inlet, the jet nozzle being coaxially seated in the neck portion for driving a gas jet through the tube toward the outlet. the neck portion having lateral openings through which the suction inlet communicates with the interior of the tube near the jet nozzle.

Specification

My invention relates to gas-jet suction devices, particularly for use in vacuum pump systems in which the suction device is connected to the inlet of a rotor-type pump together with a controllable bypass which permits placing the suction device in and out of operation.

In known systems of this type (German Patent 968,232) the gas-jet device is connected to a liquid-ring pump, and the bypass is provided with a valve for opening the bypass and thereby inactivating the suction device under given operating conditions, for example, when the pump is being started up.

In such systems, the ejector device involves a relatively large share of the production and maintenance cost. Particularly any exchange of individual components of the ejector device, such as the jet driving nozzle, causes considerable difficulties and loss of time.

It is therefore an object of the invention to devise an improved gas-jet suction device, particularly for use on the inlet side of liquid-ring vacuum pumps, that minimizes the above-mentioned shortcomings.

To this end, and in accordance with the invention, I provide the suction device with a mixer tube which has a neck portion in peripheral sealing engagement with the housing structure at a locality remote from the outlet to be connected to the inlet of the pump, and I insert the nozzle for issuing the driving jet of gas coaxially into the neck portion of the mixing tube. Furthermore, the neck portion of the mixing tube is provided with openings through which the suction inlet duct of the housing communicates with the jet nozzle and the inserted tube, the housing having a second inlet through which the above-mentioned bypass communicates with the outlet through an interspace formed between the housing and the mixing tube.

The invention will be further described and explained with reference to the accompanying drawings in which—

FIG. 1 shows for comparison a sectional view of a known gas-jet suction device;

FIG. 2 is a schematic perspective view of a multiple gas-jet suction assembly which may be composed of individual devices according to the prior art or according to the present invention as exemplified in FIGS. 3 and 4;

FIG. 3 is a sectional view of a gas-jet suction device according to the invention;

FIG. 4 shows partly in section a mixing tube which forms part of the device shown in FIG. 3; and

FIG. 4*a* shows in section a detail of FIG. 4;

FIG. 5 is a partly sectional view of another embodiment of a device according to the invention;

FIG. 6 is a side elevation of the latter embodiments;

FIG. 7 is a plan view corresponding to FIGS. 5 and 6; and

FIG. 8 is a lateral view of a vacuum pump system comprising a liquid-ring pump in combination with an ejector device according to the invention.

Referring to FIG. 1, there is shown a suction device of the ejector type for use with a motor-driven pump. The device comprises a tubular housing G formed of a casting or a welded tubular structure which has two lateral flanged inlets S_1 and S_2 for the direct or indirect connection of the feeder line leading, for example, to a vessel to be evacuated. Pressed into the housing G is a mixing tube ST so that a diametrically wider neck portion N of the tube is firmly and tightly seated between the two inlets S_1 and S_2. Separately inserted into the upper end of the housing G is a coaxial driving nozzle Tr which is pressed into the tubular housing and thus firmly seated therein.

During operation, and assuming the supply of gas to the bypass inlet S_1 to be shut off, a jet of gas supplied in the direction indicated by T entrains gas through the inlet S_2 and through the interior of the mixer tube ST to the outlet opening at the bottom of the housing G, whence it enters into the inlet of the motor-driven pump under the pre-vacuum produced by the ejector device.

For a larger delivery or efficacy of the system, several suction devices G′, such as those shown in FIG. 1, may be connected in parallel relation to each other through conduit connections R_1, R_2 and R_3, as shown in FIG. 2. This assembly has two suction inlets S_1, S_2 and an inlet for supplying the driving gas, such as air, as is indicated by an arrow T. It should be understood that a similar parallel arrangement of ejectors is applicable with individual devices according to the present invention, such as the one described presently.

The suction device according to the invention illustrated in FIG. 3 comprises a mixing tube M whose upper end forms a neck portion H which is tightly pressed into the upper end of the tubular housing G. The neck portion H of the mixing tube M has an annular coaxial flange K_2 held in position on an annular shoulder formed by an internal peripheral recess at the top opening of the housing G (FIGS. 3, 4*a*). Pressed into the upper end portion of the neck portion H is the driving jet nozzle Tr. The nozzle has an annular flange K_1 (FIGS. 4, 4*a*) seated on an annular shoulder formed by a recess H_1 of the neck portion H.

The nozzle Tr and the upper cylindrical end of the neck portion H are provided with respective peripheral grooves located opposite each other and forming a seat for a gasket or sealing ring O_1 of silicone rubber or other elastically deformable material. In lieu of a single ring, several such gaskets may be located coaxially one above the other with reference to the illustration in FIG. 4*a*. Sealing or gasket rings O_2 of elastically compressible material are provided in the same manner between the top portion H of the mixing tube M and the correspondingly machined sealing surface of the housing G.

The neck portion H of the mixing tube has slot-shaped openings S_3 peripherally distributed and arranged near the orifice portion of the driving nozzle Tr so that the gas entering through the inlet S_2 into an annular recess

formed by the housing G around the slots S_3 can pass through the slots to be inducted into the mixing tube M by the jet of driving gas issuing from the nozzle Tr.

As shown in FIG. 3, the mixing tube M with the firmly inserted driving nozzle Tr is inserted as a unit (FIG. 4) into the housing G which in this case is formed by a casting. The second inlet S_1 for connection to a bypass is located near the lower end of the mixing tube. The purpose of the bypass inlet will be apparent from the following description of the complete vacuum pump system shown in FIG. 8, of which the gas-jet suction device according to FIGS. 3 and 4 constitutes a component. The system, otherwise similar to that shown and described in the above-mentioned German Patent 968,232, comprises a motor-driven liquid ring pump 1 whose inlet 2 is connected to the outlet end of the tubular housing G through an intermediate flanged connecting piece 2*a* to which a manometer 10 or other pressure sensor is attached. The outlet 3 of pump 1 is connected through a water separator 4 to an outlet conduit 11. The inlet S_2 of the suction device is connected to a gas inlet conduit 12. The above-mentioned bypass 8 connects the same inlet conduit 12 with the bypass inlet S_1 of the suction device through a shut-off valve 9. Driving gas is supplied to the nozzle Tr (FIGS. 3, 4) through a conduit 13 (FIG. 8) under control by a valve 14. Selectively, however, the driving-gas conduit 13 may be connected through a valve 15 with the outlet conduit 11 of the pump 1 to receive driving gas therefrom.

During the starting-up period of the pump system, the valve 9 is kept open so that the suction device is bypassed since the gas passes directly through the bypass inlet S_1 into the inlet 2 of the pump 1. Now the suction device is inactive. After the pump 1 has reached the rated values of speed and vacuum pressure, this pressure being indicated by the manometer 10, the valve 9 is closed and one of the valves 14, 15 is opened. This puts the suction device in operation for reducing the vacuum pressure of the system below the value otherwise attainable.

According to a feature of my invention, embodied in the above-described device according to FIGS. 3 and 4, the driving nozzle is seated in the mixing tube by a sliding fit, and the mixing tube is seated in the housing of the gas-jet suction device likewise by a sliding fit. This permits axial displacement and mutual disengagement of the respective two parts engaging each other, the necessary seal between the interengaging parts being effected by the peripheral grooves in which the sealing rings of elastic material are seated.

From manufacturing viewpoints, an ejector suction device according to the invention affords considerable advantages. In the first place, it obviates the necessity of pressing the jet nozzle and the mixing tube separately into the housing at respective localities that are located axially one behind the other and have respectively different diameters while being required to satisfy each the exacting tolerance requirements of a tight press-fit. The use of accurately fitting surfaces to provide a tight seal is eliminated since the insertion of the elastic sealing rings, subjected only to the rather slight pressure obtaining within the ejector suction device, reliably secures the required seal under all operation conditions, even in the event of small gaps remaining between driving nozzle and mixing tube or between mixing tube and housing. Furthermore, an ejector suction device according to the invention readily affords the possibility of exchanging the driving nozzle as well as the mixing tube. Such exchange may be needed, for example, in order to adapt the vacuum pump system to seasonal changes in pumping conditions or other inconstancies. The driving nozzle and the mixing tube need not necessarily consist of metal, as is the case in the known devices, but may also be made of synthetic plastics, for example polyester resins or epoxy resins reinforced by embedded glass fibers or other filler media, without entailing the danger of damaging the mixing tube when the driving nozzle is being inserted into the housing of the ejector device, or the mixing tube is being disassembled from, or inserted into, the housing which may consist of steel or cast iron with or without a coating of rubber or other elastomer material.

As briefly mentioned above with reference to FIG. 2, ejector suction devices according to the invention are also applicable in groups of parallel connected units. In this respect, and in accordance with another feature of my invention, the design of the ejector suction devices for very large gas quantities or very low negative pressures, can be further improved according to the following features. Several mixing tubes, each having an inserted driving nozzle, are bunched together in parallel connection within a common intermediate housing portion which is connected with the suction inlet conduit for the gaseous medium to be pumped, this housing portion being arranged within or between other components of the housing.

An embodiment of such parallel connected ejector devices with a common housing structure is exemplified in FIGS. 5 to 7. Four mixing tubes M_1 to M_4, each designed as illustrated in FIGS. 4 and 4*a*, are mounted in parallel relation within the enclosed interior space of a mixer housing G*m*, which is provided with the lateral inlet duct S_2 for supplying the gaseous medium to be pumped. The mixer housing G*m* is designed as an intermediate structure and is disposed between a lower housing portion G*u* and an upper housing portion or cover G*o*. The lower housing portion G*u* is provided with the second inlet for connection to the bypass. The lower housing portion G*u* has a bottom outlet for connection to the inlet of a motor-driven pump.

It will be recognized that when the bypass conduit connected to inlet S_1 is closed and the pump is in operation while driving gas is supplied through the top opening of the cover G*o*, as indicated by the arrow T, the gas to be pumped will be drawn through the inlet S_2 into the interior space J of the housing G*m* from which it passes through the slots S_3 into the parallel connected ejector suction devices. Upon removal of the cover G*o*, the driving nozzles Tr or the mixing tubes can be pulled out for such purposes as inspection or replacement. If desired, the mixer housing G*m* may be made of a single piece with the lower housing portion G*u*, for example by welding both housing portions together.

As will be recognized from the illustrations, the invention affords composing such multiple-device assemblies and systems from uniform component parts, thus further reducing the manufacturing cost.

To those skilled in the art, it will be obvious upon a study of this disclosure that my invention permits of various modifications with respect to details of the devices and arrangements described. This applies to the gas-jet suction devices themselves as well as to the housings in which they are mounted or groupwise assembled. The invention is applicable in all cases where a controllable ejector suction device is connected into a fluid-flow path or circuit.

I claim:

1. A gas-jet suction device, particularly for connection to a pump inlet of liquid ring gas pumps in shunt with a controllable bypass, comprising a housing structure having a suction inlet and a bypass inlet and an outlet, and an injector unit formed of a mixing tube and a jet nozzle located within said mixing tube, said injector unit being mounted in said housing structure, said mixing tube and said housing structure defining therebetween in interspace communicating with said bypass inlet and with said outlet, said mixing tube having a neck portion slidingly fitted and seated and peripherally sealed in said housing structure at a locality remote from said outlet, said neck portion separating said interspace from said suction inlet, said jet nozzle being coaxially seated in said neck

portion for driving a gas jet through said tube toward said outlet, said neck portion having lateral openings through which said suction inlet communicates with the interior of said tube near said jet nozzle.

2. In a suction device according to claim 1, said housing structure being tubular and having an open end which forms said outlet, said mixing tube extending coaxially in said housing and having said neck portion coaxially seated and peripherally sealed in said housing structure near the other end thereof so that said interspace is annular and extends from said neck portion toward said outlet end, and said jet nozzle being seated in said neck portion at said other housing end.

3. In a suction device according to claim 2, said neck portion and said tubular housing structure forming an axially sliding fit relative to each other, said nozzle and said neck portion forming an axially sliding fit relative to each other, sealing ring means coaxially disposed between said neck portion and said housing structure, and sealing ring means coaxially disposed between said neck portion and said nozzle.

4. In a suction device according to claim 1, said openings in said neck portion forming respective slots peripherally distributed and extending parallel to the axis of said mixing tube.

5. In a suction device according to claim 2, said mixing tube and said jet nozzle being formed of filler-reenforced synthetic plastic.

6. In a suction device according to claim 1, said housing structure comprising a plurality of said mixing tubes having respective neck portions, said mixing tubes extending parallel to each other, said openings of all of said neck portions being in communication with said suction

7. In a suction device according to claim 6, said housing structure having an intermediate portion, a cover portion on top of said intermediate portion, and a lower portion connected to the bottom of said intermediate portion, said intermediate portion forming an enclosed inner space with which said suction inlet and said openings in said neck portions communicate, said lower portion being provided with said bypass inlet and said outlet, and said top portion having an inlet for the supply of driving gas to said jet nozzles.

8. In a suction device according to claim 2, said mixing tube having an inner peripheral shoulder at said other end of said housing, and said jet nozzle having a flange in engagement with said shoulder.

9. In a suction device according to claim 8, said housing having an inner peripheral shoulder at said other end, and said neck portion of said mixing tube having a flange in engagement with said shoulder.

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ROBERT M. WALKER, *Primary Examiner.*

DONLEY J. STOCKING, *Examiner.*

W. J. KRAUSS, *Assistant Examiner.*