Sept. 30, 1930. J. G. WEIR 1,777,239

EJECTOR IN SERIES

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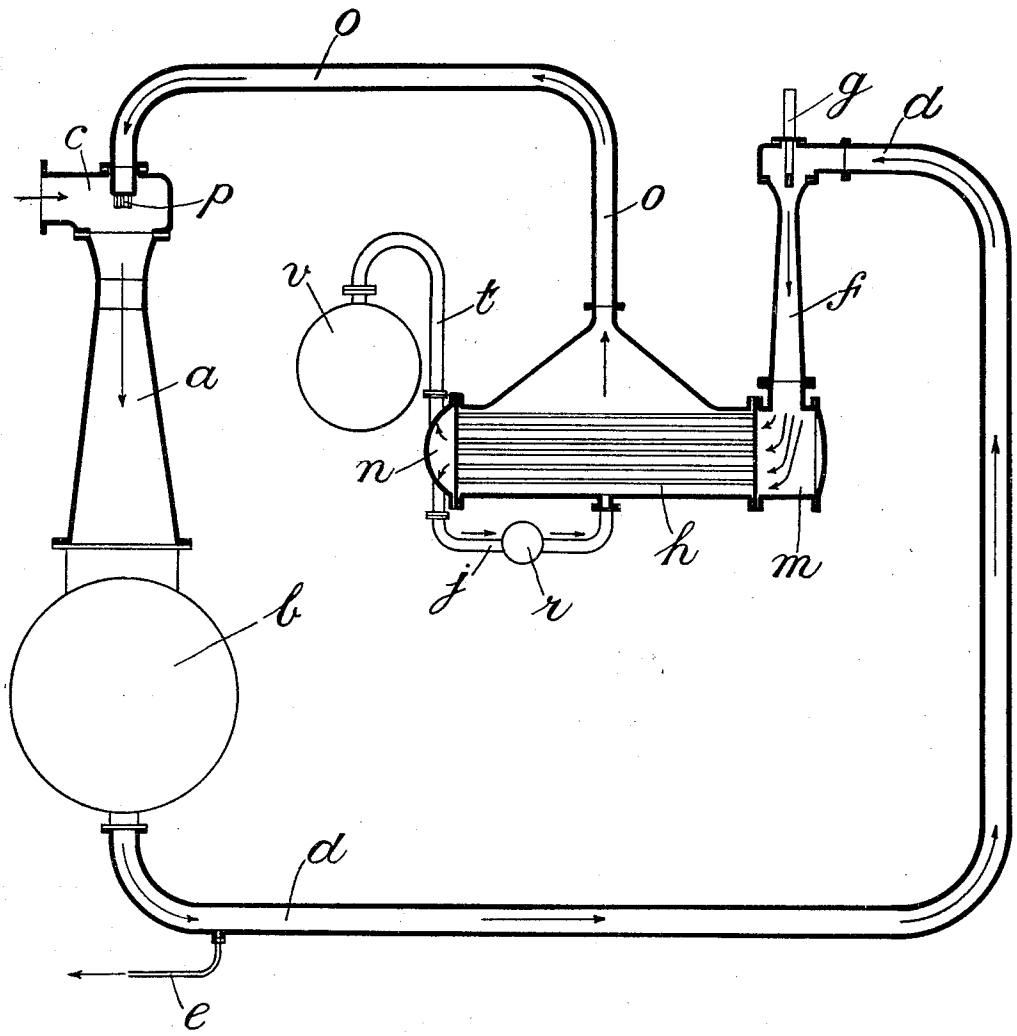

FIG : 1.

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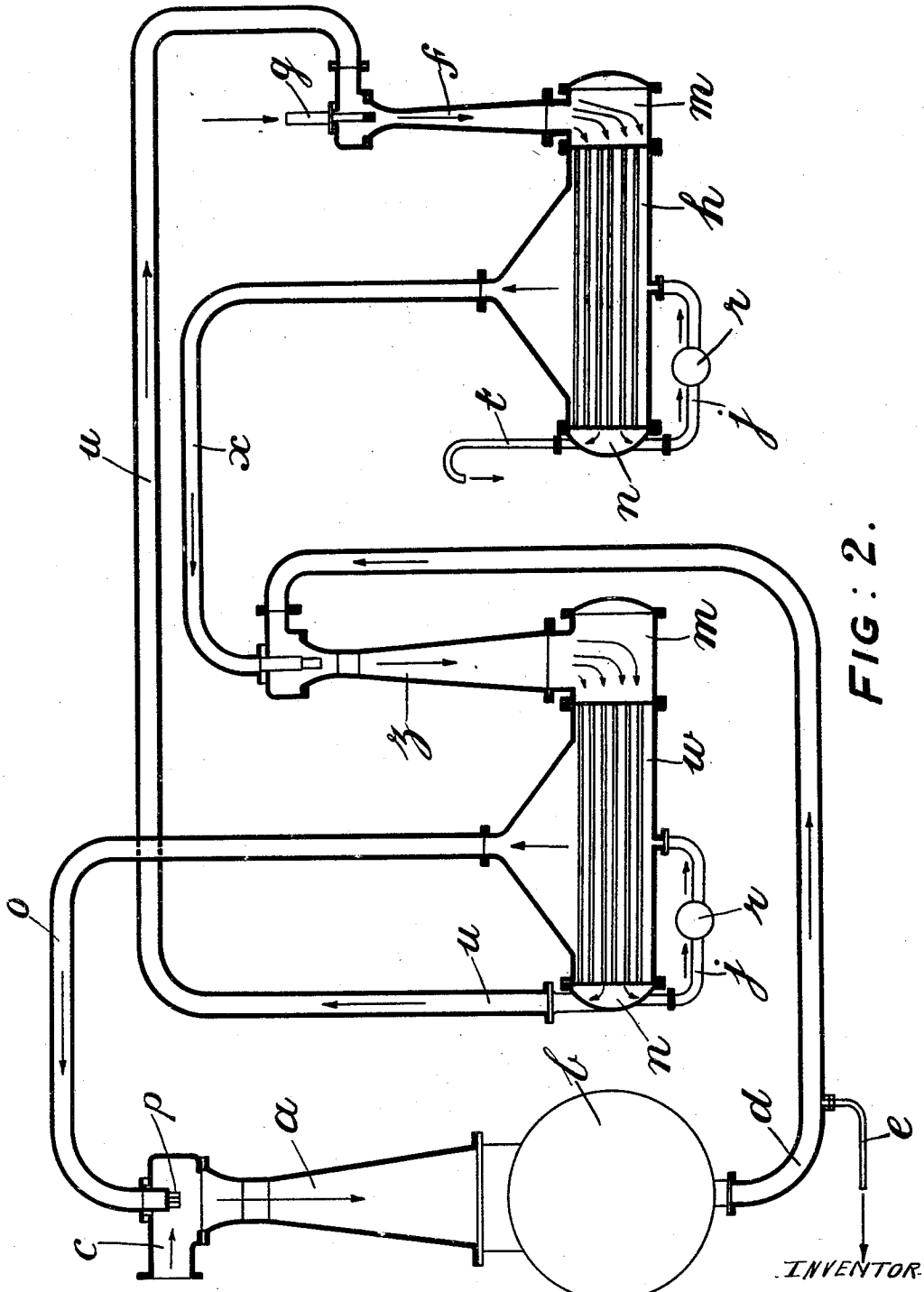

FIG: 2.

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UNITED STATES PATENT OFFICE

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EJECTOR IN SERIES

Application filed November 10, 1928, Serial No. 318,466, and in Great Britain December 9, 1927.

The present invention relates to the employment in series of ejectors in which the aspirating or impelling fluid is steam and/or air.

There has already been employed an arrangement of ejectors in series in which some of the discharge from one of the ejectors is employed as aspirating or impelling fluid in a preceding ejector, that is, in an ejector nearer to the vessel being evacuated by the ejector system.

The objection to the arrangement described in the specification aforesaid is that the steam which is taken from the discharge of an ejector for use in a preceding ejector has mixed with it a large percentage of air. This is objectionable. It is the object of the present invention to avoid this objection.

It may be stated in brief that the present invention consists in an arrangement of two or three ejectors in series in which the discharge (or some of it) from the second and/or third ejector of the series is passed through a condenser-evaporator apparatus in which the steam, (or much of it), is condensed, the air (or most of it), liberated, and the condensate, (or a large portion of it), led back to the same apparatus and evaporated by the heat given up by the steam in condensing, and the generated steam led back to the primary or second ejector and employed as the aspirating or impelling fluid in that ejector.

The invention will be defined in the annexed claims. It can, however, be best explained by describing with the aid of drawings an example of the carrying of the invention into effect.

The accompanying drawings which are diagrammatic are provided to illustrate the carrying of the invention into effect, each illustrates a convenient manner of execution—Fig. 1 in a case where two ejectors in series are employed and Fig. 2 where there are three ejectors in series.

Referring in the first place to Fig. 1, *a* is the primary or first-stage ejector. *c* is the suction of the same from the vessel being evacuated, *e. g.* the condenser of a steam turbine. *b* is an inter-condenser of the surface type employed to condense (as far as possible) the aspirating or impelling steam of the nozzles *p* and the steam drawn in at *c* (with the air). The air and uncondensed steam from the condenser *b* are led along the pipe *d* to the secondary or second-stage ejector *f*. *e* is a drain, back to the vessel being evacuated.

Live steam is employed as aspirating or impelling fluid, in the nozzle *g* of the secondary ejector *f*. The discharge from this ejector is into the end-box *m* of the condenser-evaporator *h*. This is a tubular apparatus like a surface steam condenser, but with the steam inside the tubes and the water outside the tubes. The steam is condensed, or largely condensed, in the tubes *h*. The steam, air, and condensate pass through the tubes into the end-box *n*. The uncondensed steam and the air may be discharged through the pipe *t* to the atmosphere or they may be led to a supplementary condenser *v* where the steam (or most of it) is condensed for the sake of recovering the feed water. The condensate is discharged by way of the pipe *j* into the water space of the apparatus. A trap *r* is arranged on the pipe *j* to prevent the passage of steam or air.

The heat given up by the steam in condensing in *h* is employed to evaporate the water outside the tubes; and steam is generated approximately equivalent in amount to the steam condensed. The steam evaporated is discharged by the pipe *o* to the nozzles *p* of the primary ejector *a* to be there employed as the aspirating or impelling fluid.

The steam generated in *h* is air-free unless for what is held in solution in the pipe *j*, whereas the steam discharged by *f* has a large percentage of air mixed with it. The apparatus therefore partakes of the nature of a steam air filter.

The apparatus *h* may be constructed differently from that described and illustrated, which is only to be taken as one convenient form.

Referring now to Figure 2, a consideration of this figure will render very little explanation necessary. As regards the first stage and the last stage, the parts have been lettered similarly to the corresponding parts

in Figure 1. An intermediate stage has been interposed between the first and last stages. The aspirating or impelling fluid for this, the second stage, is obtained (by the pipe *x*) from the condenser-evaporator of the last stage. This second stage *z* is provided with a condenser-evaporator *w* similar to the condenser-evaporator *h*. The air (with uncondensed steam) from this condenser-evaporator *w* is drawn, as shown, by way of the pipe *u*, to the last stage ejector.

The supplementary condenser *v* shown in Figure 1 is not shown in Figure 2 as receiving the discharge from the pipe *t*. Such a condenser may be provided, if desired, but, with three stages, as in the present case, it may not be necessary. The air, with what little steam it contains, may be discharged direct to atmosphere.

With a three-stage arrangement, the steam from the condenser-evaporator of the last stage may, if desired, be employed as the aspirating or impelling fluid in the first-stage instead of in the second-stage ejector. In such a case, the second stage would not be provided with a condenser-evaporator but with a simple condenser like the condenser *b* of the first stage.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. An arrangement and combination of ejectors in series comprising a first-stage ejector, an inter-condenser for condensing the steam from the said ejector, a second-stage ejector, a pipe connection whereby the said second-stage ejector can withdraw the air and uncondensed steam from the said inter-condenser, a condenser-evaporator for condensing the steam from the said second-stage ejector and subsequently re-evaporating the resulting water of condensation, and means for discharging the air contained in this steam between the said condensing and the said re-evaporating.

2. An arrangement and combination of ejectors in series comprising a first-stage ejector, an inter-condenser for condensing the steam from the said ejector, a second-stage ejector, a pipe connection whereby the said second-stage ejector can withdraw the air and uncondensed steam from the said inter-condenser, a condenser-evaporator for condensing the steam from the said second-stage ejector and subsequently re-evaporating the resulting water of condensation, means for discharging the air contained in this steam between the said condensing and the said re-evaporating, the said condenser-evaporator being formed with a receiving end-box and a delivery end-box with a tubular body between them having a steam space and a water space, and a duct for the discharge of the said water-of-condensation from the said delivery end-box to the said water space.

3. An arrangement and combination of ejectors in series comprising a first-stage ejector, an inter-condenser for condensing the steam from the said ejector, a second-stage ejector, a pipe connection whereby the said second-stage ejector can withdraw the air and uncondensed steam from the said inter-condenser, a condenser-evaporator for condensing the steam from the said second-stage ejector and subsequently re-evaporating the resulting water of condensation, means for discharging the air contained in this steam between the said condensing and the said re-evaporating, the said condenser-evaporator being formed with a receiving end-box and a delivery end-box with a tubular body between them having a steam space and a water space, a duct for the discharge of the said water-of-condensation from the said delivery end-box to the said water space, and a steam and air trap on the said duct.

4. An arrangement and combination of ejectors in series comprising a first-stage ejector, an inter-condenser for condensing the steam from the said ejector, a second-stage ejector, a pipe connection whereby the said second-stage ejector can withdraw the air and uncondensed steam from the said inter-condenser, a condenser-evaporator for condensing the steam from the said second-stage ejector and subsequently re-evaporating the resulting water of condensation, means for discharging the air contained in this steam between the said condensing and the said re-evaporating, a third-stage ejector, and a pipe connection whereby the said third-stage ejector can withdraw the air and uncondensed steam from the said condenser-evaporator.

5. An arrangement and combination of ejectors in series comprising a first-stage ejector, an inter-condenser for condensing the steam from the said ejector, a second-stage ejector, a pipe connection whereby the said second-stage ejector can withdraw the air and uncondensed steam from the said inter-condenser, a condenser-evaporator for condensing the steam from the said second-stage ejector and subsequently re-evaporating the resulting water of condensation, means for discharging the air contained in this steam between the said condensing and the said re-evaporating, a third-stage ejector, a pipe connection whereby the said third-stage ejector can withdraw the air and uncondensed steam from the said condenser-evaporator, a condenser-evaporator for condensing the steam from the said third-stage ejector and subsequently re-evaporating the resulting water-of-condensation, and means for discharging the air contained in this steam between the said condensing and the said re-evaporating.

6. An arrangement and combination of

ejectors in series comprising a first-stage ejector, an inter-condenser for condensing the steam from the said ejector, a second-stage ejector, a pipe connection whereby the said second-stage ejector can withdraw the air and uncondensed steam from the said inter-condenser, a condenser-evaporator for condensing the steam from the said second-stage ejector and subsequently re-evaporating the resulting water of condensation, means for discharging the air contained in this steam between the said condensing and the said re-evaporating, the said condenser-evaporator being formed with a receiving end box and a delivery end box with a tubular body between them having a steam space and a water space, a duct for the discharge of the said water-of-condensation from the said delivery end-box to the said water space, a third-stage ejector, a pipe connection whereby the said third-stage ejector can withdraw the air and uncondensed steam from the said condenser-evaporator, a condenser-evaporator for condensing the steam from the said third-stage ejector and subsequently re-evaporating the resulting water-of-condensation, means for discharging the air contained in this steam between the said condensing and the said re-evaporating, the said last-mentioned condenser-evaporator being formed with a receiving end box and a delivery end box with a tubular body between them having a steam space and a water space, and a duct for the discharge of the said last-mentioned water-of-condensation from the said last-mentioned delivery end box to the said last-mentioned water space.

7. An arrangement and combination of ejectors in series comprising a first-stage ejector, an inter-condenser for condensing the steam from the said ejector, a second-stage ejector, a pipe connection whereby the said second-stage ejector can withdraw the air and uncondensed steam from the said inter-condenser, a condenser-evaporator for condensing the steam from the said second-stage ejector and subsequently re-evaporating the resulting water of condensation, means for discharging the air contained in this steam between the said condensing and the said re-evaporating, the said condenser-evaporator being formed with a receiving end-box and a delivery end-box with a tubular body between them having a steam space and a water space, a duct for the discharge of the said water-of-condensation from the said delivery end-box to the said water space, and a steam and air trap on the said duct, a third-stage ejector, a pipe connection whereby the said third-stage ejector can withdraw the air and uncondensed steam from the said condenser-evaporator, a condenser-evaporator for condensing the steam from the said third-stage ejector and subsequently re-evaporating the resulting water-of-condensation, means for discharging the air contained in this steam between the said condensing and the said re-evaporating, the said last-mentioned condenser-evaporator being formed with a receiving end-box and a delivery end-box with a tubular body between them having a steam space and a water space, a duct for the discharge of the said last-mentioned water-of-condensation from the said last-mentioned delivery end-box to the said last-mentioned water space, and a steam and air trap on the said last-mentioned duct.

I hereby sign my name to this specification.

JAMES GEORGE WEIR.