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BLOWPIPES

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Fig. 1.

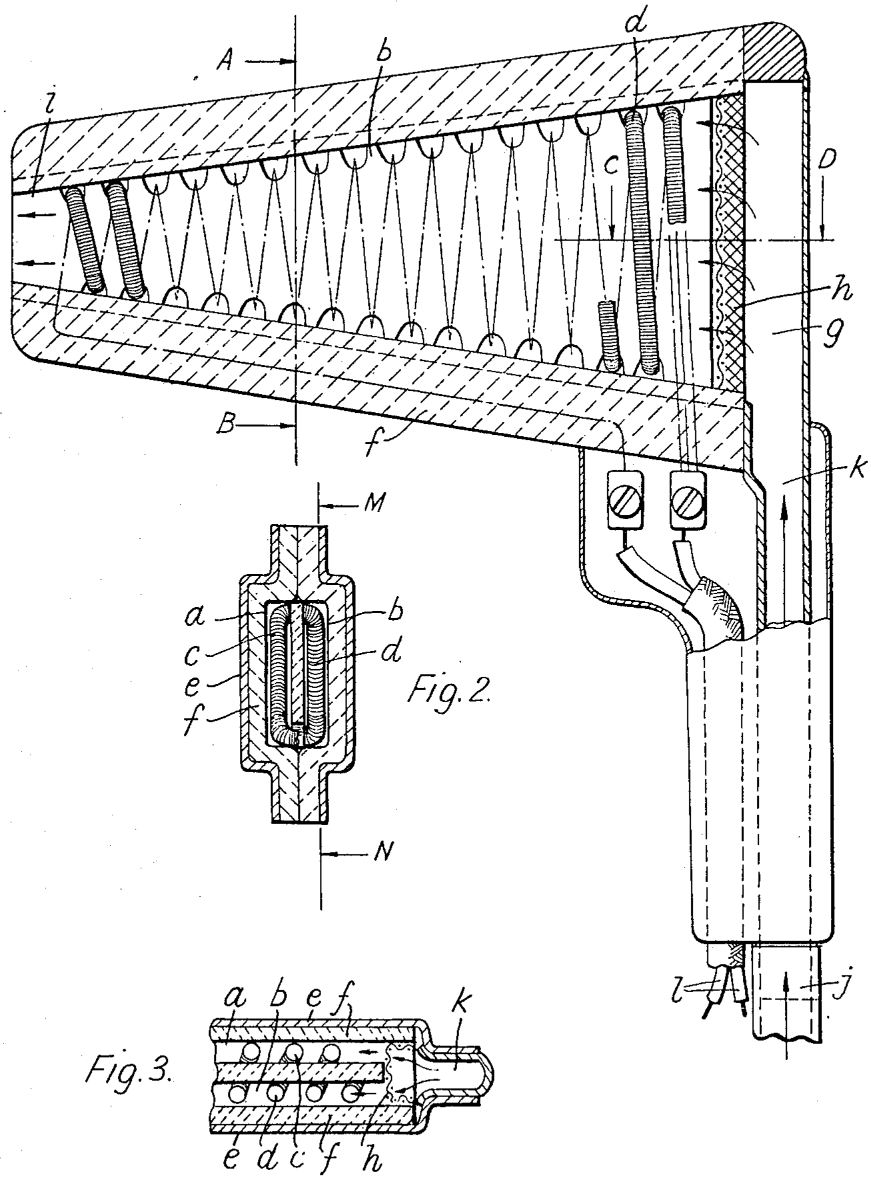

Fig. 2.

Fig. 3.

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BLOWPIPES

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13 Claims. (Cl. 219—39)

This invention relates to heat transfer devices, and more particularly to blowpipes. It is applicable to blowpipes generally but is particularly designed for use in plumbing, annealing, smelting and similar operations.

It is the object of this invention to provide a blowpipe or lamp heated from an electrical source and intended to produce localised intensive heat for the above and other purposes particularly in situations where a naked flame is undesirable.

A blowpipe made in accordance with this invention comprises an outer shell, an air inlet, an air outlet, an electric motor or other prime mover feeding air in through the inlet and through a channel to the outlet and an electric heating element disposed in the path of the air, the channel through which the air passes being progressively reduced in cross-section with consequential acceleration of the flow of air.

The electrical heating element will normally be a resistance wire coiled about a refractory core or stretched on a supporting form and the stream of air may either be impelled by a small centrifugal blower or fan driven by an electric motor or alternatively the electric motor may be replaced by an "ejector-injector" activated by high pressure fluid such as steam jet, the suction side of the ejector being connected to the air outlet and the injector side being connected to the air inlet of the blowpipe.

The electric resistance element will preferably be composed of refractory material surrounded with a heating coil in such a way that, after deducting the section and space occupied by the resistance element of the coil, the net section of the air path from inlet to outlet follows a definite diminishing law.

It is important that all the air stream passing over the resistance wires should be flowing in intimate contact at all places right through the hot wire coils as distinct from merely passing by as would be the case if the air passage were substantially larger than the space occupied by the coils of the resistance element. The effective and progressive heating of the air stream in a blow pipe made in accordance with this invention depends essentially on convection and unless the air particles in contact with the hot resistance maintain a high and progressive speed, the correct exchange of calories is vitiated and the resistance wires cannot lose uniformly their calories and may burn out at one place while not reaching a high temperature at other places.

Therefore the construction should be such that in every cross section of the heating space, there are no free passages for the air stream to pass by without penetrating intimately the hot wire coils with the prescribed and progressive speed.

It follows that it is not sufficient to have inside the torch an accelerated air stream, but that at all points this stream should penetrate in intimate convection contact with the hot resistance coils so that the calories exchange can follow the correct thermodynamic conditions required for a uniform final temperature of the coils.

By this arrangement the speed of the air or other fluid

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to be heated or cooled is gradually and considerably increased over the surface of the heating resistance or other thermal device from a low speed at the inlet to a high speed at the outlet, in addition to the natural increase of speed due to the expansion of the fluid under increasing temperature. This substantial acceleration of the fluid stream flowing over the heating surfaces of the resistance element, results in the effective equalising of the final temperature of the resistance element at various sections along its axis. The velocity of the air or other fluid is thus progressively increased in accordance with decreasing temperature differential between the fluid whose temperature is to be changed and the thermal device which effects the temperature change, thereby making it possible to maintain a uniform rate of heat transfer between the fluid and the thermal device.

It can be shown by thermodynamic analysis and by practical experiment that this method of heating the fluid stream makes it possible to maintain the resistance element at the highest practicable temperature uniformly along its whole length, thus securing the maximum flux of calories from the incandescent resistance element at all the intermediary sections of the flowing fluid. In such conditions the resistance element can be heated electrically with a very much higher current density without the risk of overheating any part or underheating other parts. This results in robust and short lengths required for the resistance wires for a given heating energy required and a compact light implement.

To obtain the above result, the relative values for the net section of a heating chamber S for the inlet of the cold fluid and the net section s for the last heating section of the fluid, depend on the maximum uniform temperature of the heating element, the initial fluid temperature and the final temperature of the outflowing fluid according to a definite law which can be expressed for all practical purposes by the relation $S/s=K.\sqrt[4]{K}$, in which K is the ratio between the initial difference of temperatures between the uniform temperature of the heating resistance element and the cold air, and the final difference of temperatures.

For example, if the temperature of the heating resistance is to be maintained uniformly at 800° C. at all sections along its axis, and the fluid used is cold air, at 0° C. to be heated finally to 500° C., the ratio between the initial and final heating sections in the flow passage is nearly $S/s=3.4$.

Any substantial departure below or above this ratio will have the result that the electric resistance will be overheated at one end with corresponding underheating at the other end followed by a rapid destruction of the heating resistance at the overheated end and inefficient transference of calories at the underheated end of the heating resistor element.

One particular example of blowpipe made in accordance with this invention (not illustrated) will comprise an outer tubular cylindrical casing preferably wrapped in asbestos padding and surrounded with a common protective metal shield having internally a concentric cylinder of a refractory material. Internally of the inner cylinder along the axis thereof, is a refractory core surrounded by a helix of coiled wire of high electrical resistance the rod being grooved for the proper spacing of the wire if desired.

The outer and inner casings and/or the core may either be cylindrical or conical or prismatic being made of sheet metal if desired and in this way the heated air passages will be given a diminishing cross-section. As an example the net cross-section of the heating chamber of length 20 cm. can diminish from 10 sq. cms. at the inlet and to 3 sq. cms. at the outlet. Such an example can accommodate a resistor absorbing about 2 kwts.

A fan or impeller is provided at one end of the inner cylinder and an electric motor is carried at the end of the outer casing. The cold air inlet is provided at the rear and/or larger end i. e., at the end which carries the electric motor, and the front end of the tube or casing is pointed or otherwise provided with discharge nozzles or caps so as to give a circular outlet with a high localised rate of discharge.

It will be seen that upon the electric motor being operated a supply of cold air will be drawn in through the inlet and impelled through the central inner cylinder around the electric heater and be ejected from the front end of the tube under pressure as a jet from the outlet of the blowpipe. If the conical or prismatic shape is adopted additional speed will be given to the air in passing and a higher pressure blast will tend to be obtained at the outlet.

Moreover, the air or gas entering the inlet end of the heating chamber is preferably admitted through a screen of wire gauze in order to give a more uniform distribution of air current across the section. A similar screen may be used at the outlet end to prevent the accidental ejection of incandescent particles therefrom.

Alternatively the motor and impeller or fan may be dispensed with and there may be provided an ejector-injector actuated by a steam jet.

In an alternative form especially for larger installations the ejector-injector is connected to a supply of compressed steam, air or other incombustible gas through a flexible pipe so that the instrument can be kept as light as possible. In this form the invention will be also applicable to annealing, smelting and the like treatment of substantial masses of metal.

A thermostatic control can be included which will cut off current when the temperature of the atmosphere inside the blowpipe reaches a predetermined value.

By this arrangement, if the electric circuit fails the thermostat will also cut off automatically the steam supply and prevent the water from the container being blown through the injector into the blowpipe.

The form of the invention which is preferred is that shown in the accompanying drawings, of which:

Figure 1 is a vertical cross-section on line M—N (Figure 2),

Figure 2 is a section on line A—B (Figure 1), and

Figure 3 is a section on line C—D (Figure 1).

In this example the channel through which the air passes is divided into two, *a* and *b*, and in each an electrical resistance *c* or *d* is disposed being mounted on any suitable former.

The channels are formed in a heating chamber of prismatic shape (but which might equally well be conical) made of sheet metal *e* lined with a refractory or dielectric resistant material *f*. The heating element is of course formed to the same shape.

In this example the section of the combined heating chambers *a* and *b* at the outlet end total about 3 sq. cms. and at the inlet end the combined channels total about 10 seq. cms. and the total length of the heating chamber is approximately 20 cms. This example can thus accommodate a resistor absorbing about 2 kwts.

Across the inlet end *g* of the heating chamber is a screen *h* of wire gauze intended to prevent a non-uniform distribution of air current. A similar screen, not shown, may be provided at the outlet end *i* to screen out accidental projection of incandescent particles from the hot air stream.

In this example the air compressor is not shown but the air under pressure is fed through the channels *jk* to the inlet of the implement through a flexible or other tube. Electric current to the heater elements is fed through wires *l* which may be fed internally of the passages *j* and *k* if desired. In use air is blown through the channels *jk* through the screen *h*, heated over the elements in a manner hereinbefore described and discharged from the smaller end *i*.

This example of blower and the electric switch controlling the operation of the blower and of the heating element can be strapped and carried conveniently by the operator so as to reduce the weight of the torch.

It will be seen that this example is particularly suitable for a portable light implement. For applications where weight is not of primary importance, the blower can be mounted directly to the inlet end of the implement.

The invention enables the user to obtain a very hot blast of air or other gases or fluids which could be used for rapid heating, boiling, melting or vaporising, by direct contact with the hot blast, all kinds of substances, solid liquid or gaseous, even vaporising inflammable liquids like oils, petrol and ether without undue risk of fire. This is due to the high velocity of the air obtained at the small end of the heating chamber which does not permit a flash back of evaporated inflammable gases to penetrate into the heating chamber.

The invention can moreover be applied to practically every heating purpose in substitution to ordinary flame heat generation from gas, liquids, or solids. The absence of a flame extends the scope of application to places where there is risk of fire. For instance, gas cooking utensils similar to gas stoves could be fed with the hot blast produced by this invention instead of ordinary explosive gas. Stoves for space heating can be made in which the resistances are placed vertically so that the ascending air will gradually accelerate and thus cool uniformly the hot resistance wires. By allowing sufficient vertical lift to the air stream, the compressed air could be dispensed with and in this way simple and efficient domestic space heating can be obtained.

Another application for space heating can be obtained by blowing the hot air from the implement into tubes carrying the hot air to various rooms either for direct heating or indirectly by circulating the hot air through radiators in a similar way as by steam heating.

The above are given only as examples but generally this invention permits the use of electric current in substitution for petrol, oils, gas or solid fuels in every field where safety, cleanliness and an immediate source of heat is required.

By the construction hereinbefore described a large current of air can be heated in a closed circuit and thus reach a higher temperature than will be the case if only cold air is sucked by an apparatus and blown over hot resistance wires directly in to the atmosphere.

It is known that the higher the speed of the air passing over hot surfaces, the higher is the number of calories transferred to the air. This invention permits, therefore, to obtain the benefit of combining the high velocity of the air moving in a closed circuit with the high temperature ensuing from an intensive flow of calories from the hot wires.

A mobile sleeve with holes that can be partially closed may be provided at the suction end so that the amount of fresh cold air sucked in can be regulated at will.

By allowing in a very small amount of air, the jet obtained is of small volume but very hot; by allowing more air to be sucked the volume discharged increases and the temperature diminishes. Thus, by moving one way or the other, the cold air regulating sleeve, a temperature control of hot air jet is obtained without materially changing the velocity ratio of the air circulating in the closed circuit.

However, if desired to obtain from this implement a higher temperature a superheater can be provided in front of the discharge nozzle. This comprises an auxiliary resistance heater which can be adapted at will, so as to pass the hot air through it before reaching the work to be heated. By this attachment, the air can be superheated to the maximum temperature compatible with the safe temperature allowable for the resistance wires of the auxiliary heater. Thus temperatures of the order of one thousand centigrades may be obtained if necessary.

This very hot air can be used very much like the flame of an ordinary blow lamp. If desired, the nozzle can be replaced by a pointed copper block similar to a soldering iron, the block being perforated to allow through some hot air and having fins inside the junction box. The very hot air stream passing the perforations or over the fins will heat the copper block effectively for ordinary soldering operations.

What I claim is:

1. A heat transfer device of the class described, comprising: means defining a passage for a fluid medium whose temperature is to be changed, said passage comprising an inlet portion and an outlet portion, the cross-sectional area of said inlet portion being appreciably greater than the cross-sectional area of said inlet portion being appreciably greater than the cross-sectional area of said outlet portion, the cross-sectional area of said passage being continuously and progressively reduced in magnitude from said inlet portion to said outlet portion; fluid pervious thermal means disposed in said passage for changing the temperature of said fluid, said thermal means substantially entirely filling said passage, the amount of heat transferable per unit of time between said fluid and said thermal means being substantially uniform throughout the entire volume of said thermal means, the rate of said progressive decrease of cross-sectional area of said passage from said inlet portion to said outlet portion being so proportioned that the velocity of said fluid medium flowing therethrough is progressively and continuously increased in accordance with the decreasing temperature differential between said thermal means and said medium throughout said passage, whereby the rate of heat transfer between said thermal means and said fluid medium is made substantially uniform throughout the entirety of said passage and the temperature of said thermal means is maintained substantially constant throughout its entire volume.

2. A device according to claim 1, wherein said thermal means is a heating element adapted to be energized from a source of electrical energy.

3. A device according to claim 2, wherein said heating element is a helically wound resistance wire.

4. A device according to claim 1, in which said cross-sectional area decreases at a constant rate.

5. A device according to claim 1, wherein said fluid medium is air.

6. A device for generating a stream of heated gas comprising a casing with an inlet and an outlet defining a passage for a gas stream, the area of said inlet being substantially greater than the area of said outlet, and the cross-sectional area of said passage being continuously and progressively reduced from said larger inlet aperture to said smaller outlet aperture, means for injecting gas into said inlet and through said passage to said outlet, a tapered former located axially in said passage, adapted to restrict the flow of gas solely through the space between the outer surface of said former and the inner surface of said casing, a coiled electrical resistance heating element helically wound externally on and along the length of said former, the transverse dimension of said heating element being substantially equal to the distance between the surface of said former and the inner surface of said passage, whereby the coils of said heating element extend substantially completely across the area of said passage through which said gas flows, and means for connecting said heating element to a source of electricity, whereby said element can be heated for the purpose of transferring heat to said gas during its flow through said passage in contact with said heating element.

7. A device according to claim 6 adapted to allow said electrical heating element to be maintained at a uniform high temperature throughout the length of said passage wherein the dimensions of the said inlet and outlet are selected in accordance with the formula

$$S/s = K.\sqrt[4]{K}$$

where S and s are the net cross-sectional areas of the said inlet and outlet of said passage, and K is the ratio of the temperature difference between the inflowing cold gas and the electrical heating element at said inlet to the temperature difference between the outflowing heated gas and the electrical heating element at said outlet.

8. A device for generating a stream of heated gas comprising a casing with an inlet and an outlet defining a passage for a gas stream, the area of said inlet being substantially greater than the area of said outlet, and the cross-sectional area of said passage being continuously and progressively reduced from said larger inlet aperture to said smaller outlet aperture, gas-dispersal and filter means located in said inlet, means for injecting gas through said dispersal and filter means into said inlet and through said passage to said outlet, a tapered former located axially in said passage, adapted to restrict the flow of gas solely through the space between the outer surface of said former and the inner surface of said casing, and a coiled electrical resistance heating element helically wound externally on and along the length of said former, the transverse dimension of said heating element being substantially equal to the distance between the surface of said former and the inner surface of said passage, whereby the coils of said heating element extend substantially completely across the area of said passage through which said gas flows, and means for connecting said heating element to a source of electricity, whereby said element can be heated or the purpose of transferring heat to said gas during its flow through said passage in contact with said heating element.

9. A device for generating a stream of heated gas comprising a casing with an inlet and an outlet defining a passage for a gas stream, said casing including an outer metal structure housing a lining of non-electrically-conductive material, the area of said inlet being substantially greater than the area of said outlet, and the cross-sectional area of said passage being continuously and progressively reduced from said larger inlet aperture to said smaller outlet aperture, means for injecting gas into said inlet and through said passage to said outlet, a tapered former located axially in said passage, adapted to restrict the flow of gas solely through the space between the outer surface of said former and the inner surface of said casing, and a coiled electrical resistance heating element helically wound externally on and along the length of said former, the transverse dimension of said heating element being substantially equal to the distance between the surface of said former and the inner surface of said passage, whereby the coils of said heating element extend substantially completely across the area of said passage through which said gas flows, and means for connecting said heating element to a source of electricity, whereby said element can be heated for the purpose of transferring heat to said gas during its flow through said passage in contact with said heating element.

10. A device for generating a stream of heated gas comprising a casing with an inlet and an outlet defining a passage for a gas stream, the area of said inlet being substantially greater than the area of said outlet, and the cross-sectional area of said passage being continuously and progressively reduced from said larger inlet aperture to said smaller outlet aperture, means for injecting gas into said inlet and through said passage to said outlet, means for controlling the rate of inflow of gas into said inlet, a tapered former located axially in said passage, adapted to restrict the flow of gas solely through the space between the outer surface of said former and the inner surface of said casing, and a coiled electrical resistance heating element helically wound externally on and along the length of said former, the transverse dimension of said heating element being substantially equal to the distance between the surface of said former and the inner surface of said passage, whereby the coils of said heating element extend substantially completely across the area of said

passage through which said gas flows, and means for connecting said heating element to a source of electricity, whereby said element can be heated for the purpose of transferring heat to said gas during its flow through said passage in contact with said heating element.

11. A device for generating a stream of heated gas comprising a casing with an inlet and an outlet defining a passage for a gas stream, the area of said inlet being substantially greater than the area of said outlet, and the cross-sectional area of said passage being continuously and progressively reduced from said larger inlet aperture to said smaller outlet aperture, means for injecting gas into said outlet and through said passage to said outlet, a tapered former located axially in said passage, adapted to restrict the flow of gas solely through the space between the outer surface of said former and the inner surface of said casing, a coiled electrical resistance heating element helically wound externally on and along the length of said former, the transverse dimension of said heating element being substantially equal to the distance between the surface of said former and the inner surface of said passage, whereby the coils of said heating element extend substantially completely across the area of said passage through which said gas flows, means for connecting said heating element to a source of electricity, whereby said element can be heated for the purpose of transferring heat to said gas during its flow through said passage in contact with said heating element, and an additional heating element mounted in front of said outlet adapted to superheat the escaping stream of heat gas from said passage.

12. A device for generating a stream of heated gas comprising a casing with an inlet and an outlet defining a passage for a gas stream, the area of said inlet being substantially greater than the area of said outlet, and the cross-sectional area of said passage being continuously and progressively reduced from said larger inlet aperture to said smaller outlet aperture, a tube communicating with said inlet through which gas under pressure is supplied to said inlet and through said passage to said outlet, a tapered former located axially in said passage adapted to restrict the flow of gas solely through the space between the outer surface of said former and the inner surface of said casing, a coiled electrical resistance heating element helically wound externally on and along the length of said former, the transverse dimension of said heating element being substantially equal to the distance between the surface of said former and the inner surface of said

passage, whereby the coils of said heating element extend substantially completely across the area of said passage through which said gas flows, and means for connecting said heating element to a source of electricity, whereby said element can be heated for the purpose of transferring heat to said gas during its flow through said passage in contact with said heating element.

13. A device for generating a stream of heated gas comprising a casing with an inlet and an outlet defining a passage for a gas stream, the area of said inlet being substantially greater than the area of said outlet, and the cross-sectional area of said passage being continuously and progressively reduced from said larger inlet aperture to said smaller outlet aperture, means for injecting gas into said inlet and through said passage to said outlet, a tapered former located axially in said passage, adapted to restrict the flow of gas solely through the space between the outer surface of said former and the inner surface of said casing, a coiled electrical resistance heating element helically wound externally on and along the length of said former, the transverse dimension of said heating element being substantially equal to the distance between the surface of said former and the inner surface of said passage, whereby the coils of said heating element extend substantially completely across the area of said passage through which said gas flows, means for connecting said heating element to a source of electricity, whereby said element can be heated for the purpose of transferring heat to said gas during its flow through said passage in contact with said heating element, and a thermostat adapted to control the current supplied to said heating element according to the temperature of the ambient gas inside said passage.

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