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INSTANTANEOUS HEATING OF A FLUID CIRCULATING IN A TUBE

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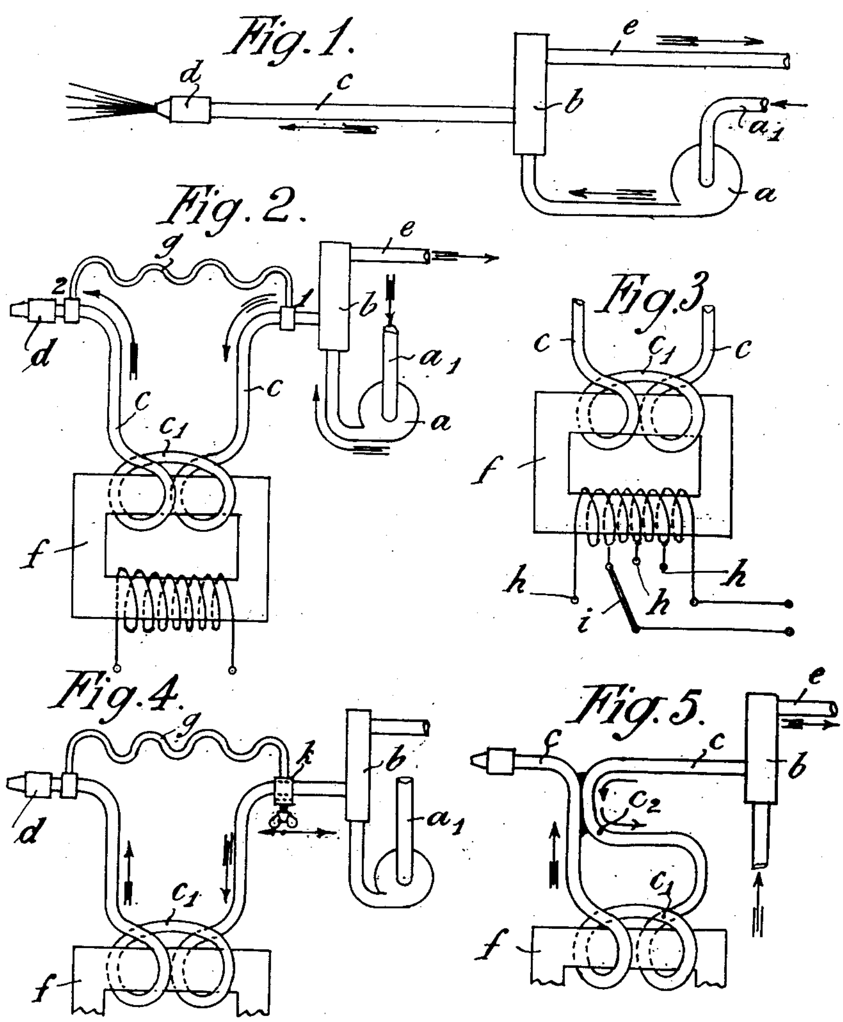

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Fig. 6.

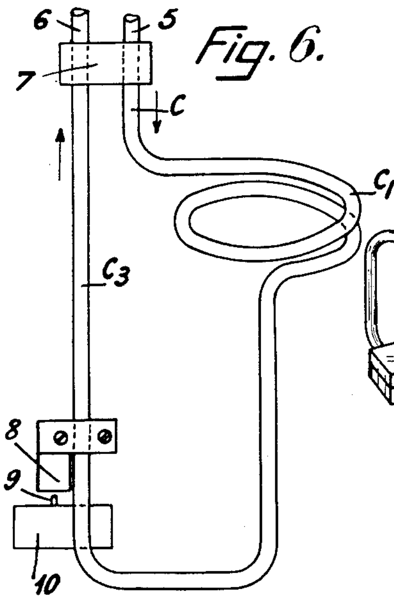


Fig. 7.

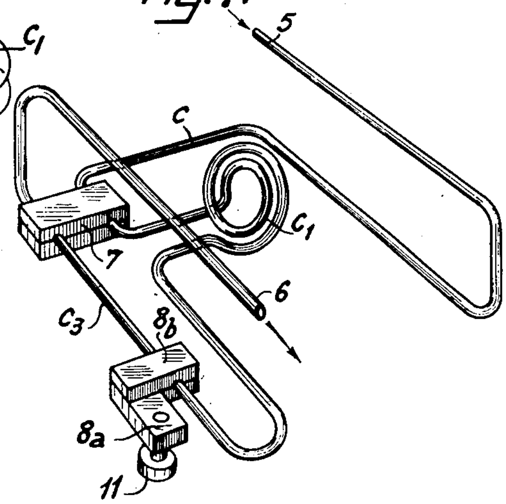


Fig. 8.

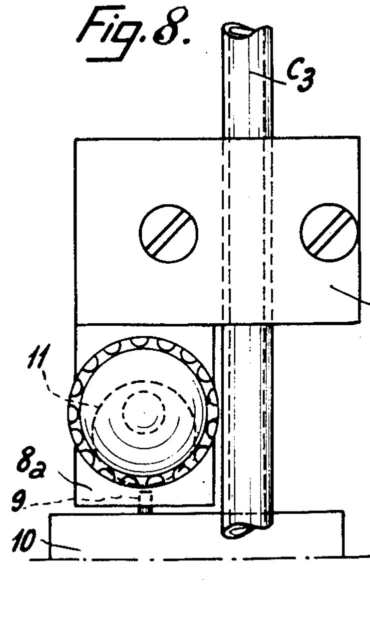
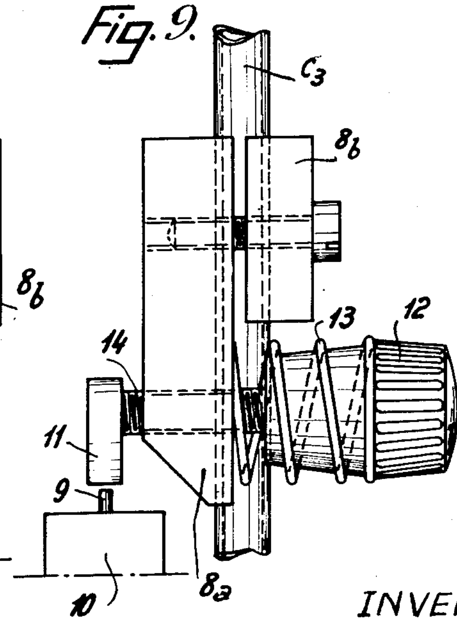


Fig. 9.



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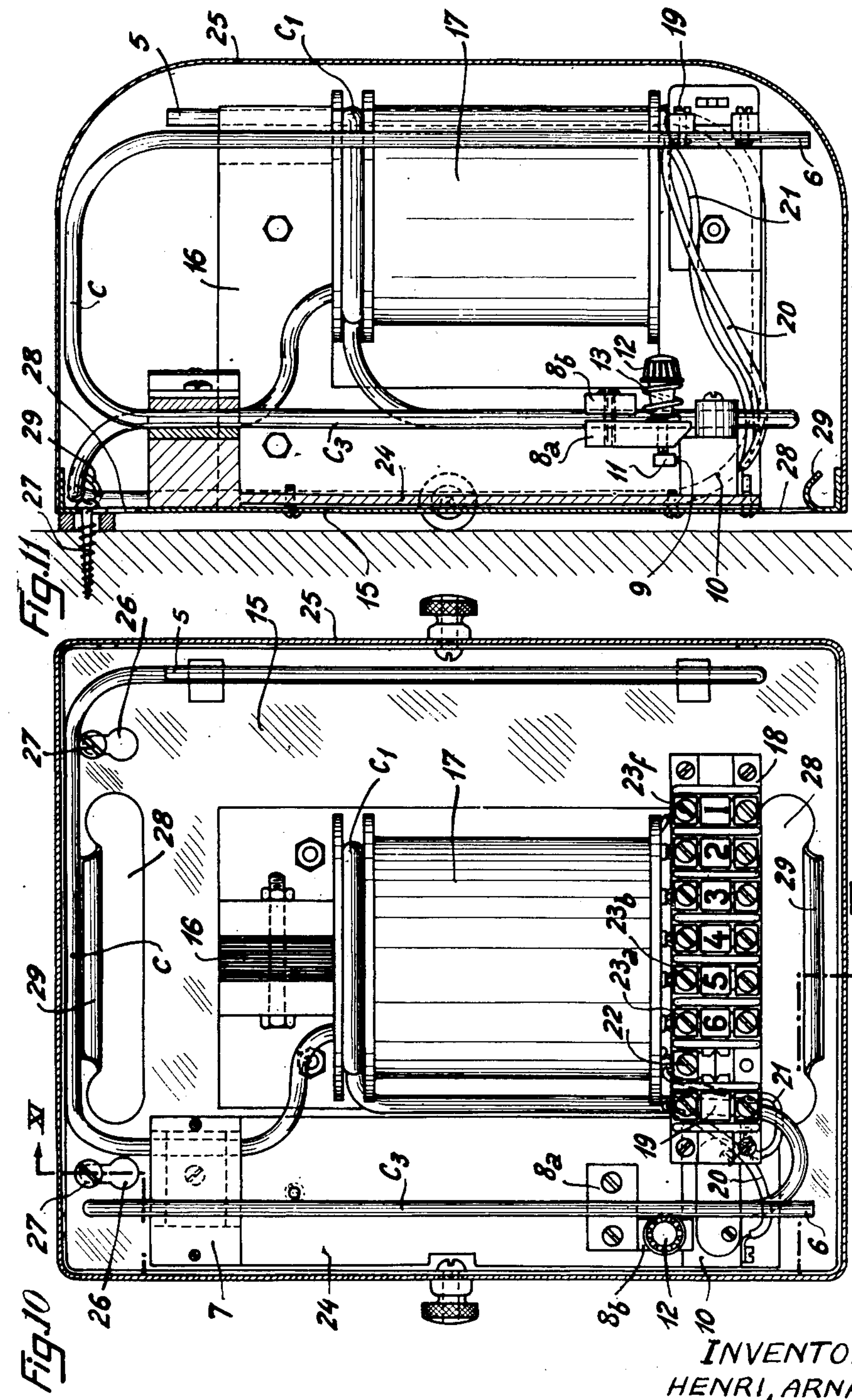

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INSTANTANEOUS HEATING OF A FLUID CIRCULATING IN A TUBE

Henri Arnaud, Paris, France

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2 Claims. (Cl. 219—38)

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Fuel oil burners require, for giving a satisfactory efficiency and an even working, a perfect atomizing of the fuel oil condition which can be obtained only with fuel oils having a low viscosity.

On the other hand it is useful for a few reasons, to use heavier fuel oils which are cheaper.

The viscosity of fuel oils decreasing when the temperature increases, it is already known to previously heat them in order to bring the viscosity down to an appropriate value, the heating temperature being a function of the used fuel oil. However, the heating method generally used and which is based on heating plugs, has drawbacks, particularly because of the brittleness of plugs and of their high calorific inertia.

The present invention relates to an improvement in oil burners in order to overcome these drawbacks, which includes heating the tube feeding fuel oil to the nozzle and using the portion of the tube connected with the nozzle as an electric heating resistance.

According to an embodiment of the invention, said portion of the tube forms the secondary coil of a transformer, the primary coil of which is fed by the power of the mains.

According to another embodiment, the linear expansion of the tube feeding and heating said fuel oil is used for actuating a switch ensuring the switching off of the circuit feeding the transformer. With that object the tube comprises, at an appropriate point, a lug or stop arranged in front and at a certain distance of the member controlling the switch, in such a way that due to the expansion of the tube, the lug or stop may come into contact with said member, and by acting upon it actuate the switch.

Means are provided for adjusting the distance, at rest, between the lug and the member controlling the switch.

The lug is for instance provided with a cam which is rotatably movable by hand.

Finally the heating device is arranged as a set or block comprising the transformer, the part of the tube forming the heating element, the switch of the feeding circuit and the control device of that switch, these different parts being secured on a plate and protected through an easily detachable casing.

The invention is not relative only to the heating of fuel oil in fuel oil burner devices but its scope is extended to the instantaneous heating of any fluid or liquid circulating in a metallic tube having a small section, the portion of the tube to be heated forming, according to the invention, a heating resistance and more particularly forming the secondary coil of a transformer.

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The foregoing objects and advantages will be made fully apparent from the following description reference being had to the accompanying drawings, and it will be understood that the devices shown are only given by way of example, the actual scope of the invention being determined by the appended claims.

Fig. 1 is a diagrammatic view of an equipment of conventional fuel oil burner.

Fig. 2 is a diagrammatic view of an equipment of fuel oil burner according to the invention.

Figs. 3 to 5 show different embodiments of the invention.

Fig. 6 is a diagrammatic view showing the control of the switch.

Fig. 7 is a perspective diagrammatic view showing the shape of the tube in which flows the fluid to be heated.

Fig. 8 shows, on a larger scale, a device for the adjusting of the distance between the lug of the switch control and the rod of said switch.

Fig. 9 is a side view of said device.

Fig. 10 is a front view of the heating apparatus according to the present invention.

Fig. 11 is a cross-section of Fig. 10 along the line XI—XI of said figure.

In order to well understand the advantage of the device described hereafter, the equipment of a burner with automatic atomizing will be first recalled. This equipment comprises, as shown in Fig. 1, a motor driving a fuel pump *a* which, through a pressure valve *b*, delivers at a constant pressure, through a tube *c*, the liquid fuel to a member *d* called jet which atomizes said fuel, the surplus fuel being returned, through tube *e*, to the inlet a_1 of the pump.

In the embodiment shown in Fig. 2, the tube *c* feeding the fuel oil from valve *b* to jet *d* is made of a metallic tube having a small section coiled at c_1 around the core of a voltage transformer *f* of the conventional type, and thus forms the secondary coil of said transformer. A copper wire *g* having a very large section connects points 1 and 2 in such a manner that the secondary and the cable form a circuit 1, *g*, 2, c_1, 1 having a low resistance.

The length of the tube, the number of turns of the secondary circuit will evidently be a function of the power to be dissipated in that tube for ensuring the required heating.

As the resistance of the secondary circuit is very low and the power evolved as heat is directly proportional to Ri^2, consequently the intensity of the current circulating in said circuit is considerable. The tube will be heated through Joule's effect as soon as the primary coil of the transformer is energized. The fuel will thus progressively be heated from point 1 up to point 2. The exchange of heat between the fuel oil circulating in the tube and the wall of said tube heated by Joule's effect will be made easier due to the relatively high speed of said fuel oil.

The very low calorific inertia of the portion of tube c_1 and of the small quantity of fuel oil therein contained is such that the above described heater is a heater giving an almost instantaneous heating.

For instance, in the case of a burner which should deliver 30 litres of light fuel per hour, heated from 10° C. to 60° C., a simple computation shows that the power evolved as heat is of about 875 watts (the total efficiency being 60% according to an estimate).

The heating circuit may be in practice made of a 4/6 copper tube (that is having an inner diameter of 4 millimetres and an outer diameter of 6 millimetres) having a length of 1.75 metres and comprising two turns, the number of turns of the primary circuit of the transformer fed with alternating current 220 volts 50 cycles being 300.

The voltage at the secondary is about 1.6 volts which is extremely low and gives full protection from the point of view of safety.

The regulation of the temperature of the fuel oil at point 2 may be obtained in different ways either using a transformer *f* having a plurality of connection contacts *h* with a moving handle *i*, Fig. 3, and varying the voltage at the primary winding, or modifying the length of the heating portion c_1 of tube *c* (Fig. 4), through a moving jaw *k*, provided at the end of wire *g* and which may slide on the portion of tube *c* connected with valve *b*.

The instantaneousness of the heating of the described device has a great advantage in so called "make-and-break" burners which stop and start when operated by a self control (through temperature, pressure, etc. . . .). It is indeed possible to connect in parallel the motor and the primary coil of the transformer in order to obtain at the same time the atomizing and the heating of the fuel.

Although the inertia of the heating device is extremely low, it is possible to practically cancel it, when starting, by means of a contactor with an adjustable retarding device which sets the motor to work a few seconds after the primary coil of the transformer is energized.

The closing of the secondary circuit for heating, instead of being made through wire *g*, might be obtained through the tube for the circulation of the fuel oil which, with that object, is for instance curved as shown at c_2 in Fig. 5, the curved portion being welded at the end of tube *c* connected with jet *d*. Any other arrangement could of course be provided.

According to another embodiment, a portion of tube *c* is rectilinear as shown at c_3 (Figs. 6 and 7) and near one of the ends of this rectilinear portion a collar or double clamp 7 is provided which rigidly binds the two branches of tube *c* and thus closes the secondary circuit, in the same way as wire *g* (Figs. 2 and 4) or as the welding designed in Fig. 5.

Near the other end of the rectilinear portion c_3 a lug or stop 8 rigidly locked with the tube is provided, said lug being arranged in front of a sliding rod or lug 9 which is the member operating the switch provided for switching off the primary coil of the transformer.

The collar 7 and the casing 10 of the switch are mounted on a same support, which defines a constant spacing between these two parts in spite of the expansion of the tube.

In that way, it is easy to understand that when the portion c_3 of the tube increases in length, due to the expansion resulting from the heating of the tube, the lug 8 may come into contact with lug 9 and push it in order to actuate switch 10 and thus switch off the feeding circuit of the transformer, avoiding any excessive increase of temperature. The circuit will be closed again when the lug 9 can, under the action of a return spring, take back its initial position, that is when the tube is cooled enough for allowing lug 8 to be brought back to its initial position.

The contactor 10 will be of the "micro contact-breaker" type (which is commercially manufactured) and in which a displacement of a few hundredths of a millimetre of its operating lug 9 produces a sharp break of current.

In order to allow an accurate trigger action of the micro contact-breaker and to make easier the adjusting of the temperature of the tube above which the current should be switched off, a device enabling to accurately adjust the distance between lug 8 and the end of lug 9, is designed between both parts.

With that object, the lug 8 (which is made of a collar in two portions 8_a, 8_b) instead of being located immediately in front of the lug 9 of the switch, is laterally shifted with respect to that lug and bears a small cam 11 (Figs. 8 and 9) arranged in front of said lug. That cam may be angularly moved by operating a thumb screw 12 which protrudes over portion 8_a. According to the angular position of the cam, the distance between said cam and lug 9 is increased or decreased. A spring 13 is designed for braking the rotation of screw 12 and consequently of the cam in order to ensure a perfect stability of the angular position of said cam.

That cam 11 may be made simply with a disc in an offset arrangement with respect to its center of rotation, and the latter may be a screw 14 rigidly locked with screw 12 and screwed in the portion 8_a of lug 8.

According to a modification of the above embodiment, the above described members are arranged as shown in Figs. 10 and 11, in which said members are mounted on a plate 15.

The whole set of the transformer, laminated core 16 and coil 17 is arranged approximately at the center of plate 15. The bobbin 17 comprises, in the conventional way, several coils, and a terminal plate 18 enables to insert in the circuit a variable number of these coils in order to adjust at will the intensity of the current and consequently the production of heat through Joule's effect. One of the wires feeding the current is connected to the terminal 19 which is connected through the wire 20 with one of the contacts of the micro contact-breaker 10, the other contact being connected through the wire 21 with the terminal 22 connected with the inlet of bobbin 17.

By connecting the other wire of the feeding to any one of terminals 23_a, 23_b . . . 23_f, it is possible to modify at will the intensity of the current, the maximum intensity being obtained by connecting that second wire to terminal 23_a.

The tube *c* has the shape shown in perspective view in Fig. 7, the inlet of the fuel oil is at the end 5 of this tube, while the end 6 is connected with the jet of the burner. The portion c_1 of the tube which forms the secondary coil is arranged as shown in Figs. 10 and 11.

The jaw or double strap 7 and the stop 8_a, 8_b are secured to a plate 24 ensuring the setting of these members with a defined spacing. This plate 24 is secured to plate 15.

A cover 25 covers the whole plate 15 and ensures an efficient protection for the members secured to said plate. Of course holes are designed in that cover for the passage of the connections with the ends 5 and 6 of tube *c*.

It is convenient to vertically arrange plate 15, as it is shown in the drawing. That plate is for instance secured to a wall or to a vertical support, and with that object, holes 26 are designed at its upper end, said holes enabling to secure it with screws 27.

Holes 28 are designed at the upper end and at the lower end of plate 15, in order to enable the circulation of air inside of the cover. It is convenient to cut and shape these holes in order to obtain a rounded portion as shown at 29, in such a way that these holes may be conveniently used as handles for the handling of the apparatus.

It is to be noted that the present heater may be used to instantaneously heat any other fluid than fuel oil and may thus be used in other scientific or commercial equipments.

It is also to be understood that the above shown and described embodiments have been stated only as examples and could be modified, particularly in substituting equivalent technical means without departing from the scope of the subjoined claims.

What I claim is:

1. An electrical liquid heating apparatus comprising in combination an electric transformer provided with means for energizing its primary winding, a metallic tube comprising a coiled portion forming the secondary winding of said transformer, a rectilinear portion and a connecting portion connecting one end of the coiled portion and the rectilinear portion, a stationary support secured to said rectilinear portion, a lug secured to said rectilinear portion at a distance from said stationary support, means spaced from the connecting portion for electrically connecting two points of said tube respectively before said coiled portion and after the part of said rectilinear portion to which said support and lug

are secured to establish a secondary circuit consisting of the coiled portion, connecting portion, rectilinear portion and electrically connecting means, and switch means actuated by said lug for switching off the current in the primary winding of said transformer for a predetermined heat expansion of said rectilinear portion.

2. An electrical liquid heating apparatus comprising in combination an electric transformer provided with means for energizing its primary winding, a metallic tube comprising a coiled portion forming the secondary winding of said transformer and a rectilinear portion, a stationary support secured to said rectilinear portion, a lug provided with an aperture therethrough secured to said rectilinear portion at a distance from said stationary support, means for electrically connecting two points of said tube respectively before said coiled portion and after the part of said rectilinear portion to which said support and lug are secured, a pin mounted for rotation in said aperture of said lug and provided at one end with a cam and at the other end with a thumb piece, a spring between said thumb piece and said lug for braking the rotation of said pin and ensuring a stable position of said cam, and an electric switch in series with the primary winding of said transformer supported by said stationary support and arranged and adapted to be actuated by said cam for a predetermined expansion of said rectilinear portion.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,122,892	Farrand	Dec. 29, 1914
1,402,021	Snelling	Jan. 3, 1922
1,474,777	Jarkovsky	Nov. 20, 1923
1,513,087	Buhl et al.	Oct. 28, 1924
1,951,649	Delano	Mar. 20, 1934
2,104,940	Woolery	Jan. 11, 1938

FOREIGN PATENTS

Number	Country	Date
461,568	Germany	May 31, 1928