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METHOD OF HEATING THE INTERIOR OF AN ENCLOSURE

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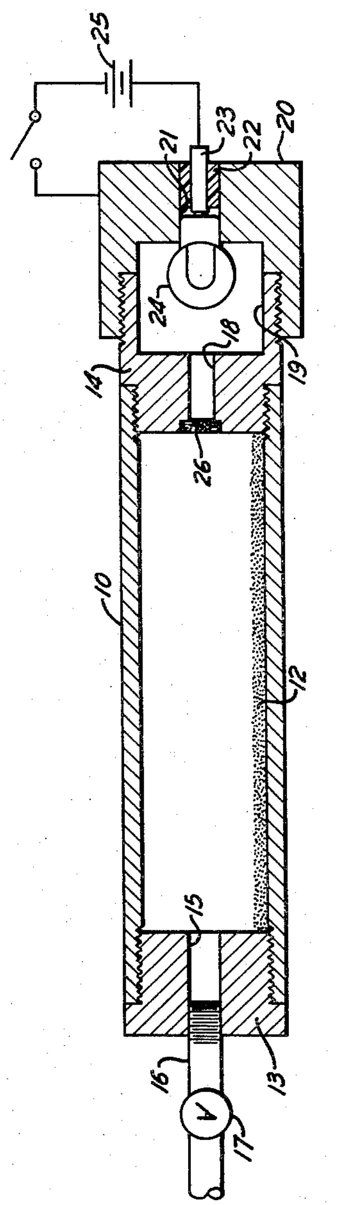

Fig. 1

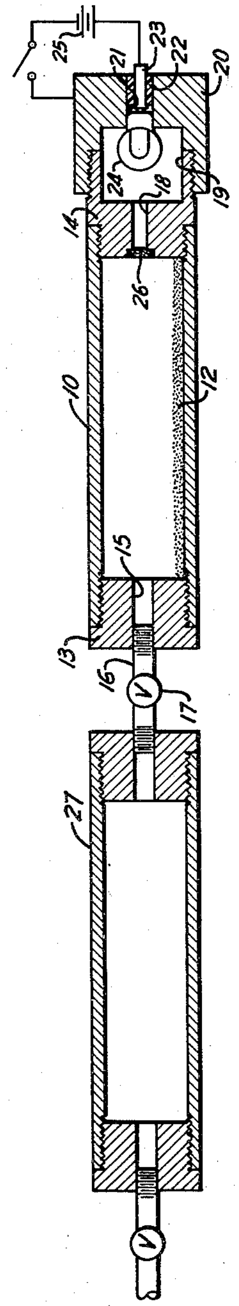

Fig. 2

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METHOD OF HEATING THE INTERIOR OF AN ENCLOSURE

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This invention relates to an improved method of heating the interior of an enclosure.

An object of the invention is to provide a heating method which momentarily develops an extremely high temperature within an enclosure, useful for example for casehardening the inside surface of a metal tube.

A further object is to provide an improved casehardening method applicable to metal tubes in which the inside surface of the tube is heated momentarily above its critical temperature and immediately quenched by conduction of heat to other regions of the tube.

A more specific object is to provide an improved casehardening method in which a suitable fuel is charged into a tube along with sufficient oxygen for complete combustion, the ends of the tube are sealed, and the charge ignited, whereby the inside surface is heated momentarily above its critical temperature and immediately quenched by conduction of heat away from this surface.

In the drawing:

FIGURE 1 is a somewhat diagrammatic longitudinal sectional view of a tube prepared for heating in accordance with my method; and

FIGURE 2 is a similar view showing a modification.

FIGURE 1 shows a metal tube **10** which contains a finely divided solid fuel charge **12**, for example aluminum or magnesium in powder or wool form. Alternatively I can substitute a gaseous fuel, such as propane or butane, or other recently developed high energy solid, liquid or gaseous fuels. Plugs **13** and **14** are fitted into the left and right ends respectively of the tube. Plug **13** contains a bore **15** into which is threaded a pipe **16** containing a valve **17**. The tube is evacuated and charged through pipe **16** with a calculated quantity of oxygen for complete combustion of the fuel, after which valve **17** is closed. If a gaseous fuel is used, it is also introduced through pipe **16**. Plug **14** contains a bore **18** and counterbore **19**. A cap **20** is threadedly engaged with plug **14** and covers the counterbore. The cap contains a bore **21** into which is fitted an electrically insulating seal **22**, an electrode **23** and an ignition means **24**, such as a conventional photographic flash bulb illustrated for igniting solid fuels. The cap and electrode are connected to a suitable current source indicated at **25** for firing the flash bulb.

When the fuel charge **12** is in powder form, the tube is mounted in a conventional lathe or equivalent mechanism for spinning it on its longitudinal axis and thus distributing the powder uniformly over the inside surface by centrifugal force. In this event the end of bore **21** contains an intermediate igniter **26** preferably of aluminum or magnesium wool. When the flash bulb **24** fires, it ignites the intermediate igniter, which in turn ignites the fuel charge. When the fuel charge is aluminum or magnesium wool, it is not necessary to rotate the tube and the intermediate igniter can be omitted, since the fuel charge is exposed directly to the flash bulb. Another possibility with a powdered fuel charge is to direct the bore **21** obliquely at the charge to expose the charge directly to the flash bulb and again omit the intermediate igniter. When a gaseous fuel is used, the ignition means **24** can be a conventional spark plug. The purpose of mounting the ignition means in a separate chamber provided by the counterbore **19** and cap **20** is that otherwise the high temperature developed when the fuel burns tends to fuse the base and seal. Thus considerable trouble would be encountered in reconditioning the equipment for further use.

FIGURE 2 shows a modification in which an auxiliary chamber **27** is connected to pipe **16** at the left end of tube **10**. This chamber can contain part of the oxygen supply and thus lower the pressure within the tube **10** while maintaining the necessary quantity of oxygen. An auxiliary oxygen supply can also serve as a means to regulate the rate of burning and thus control both maximum temperature and maximum pressure obtained for a given fuel charge representing a given amount of energy to be dissipated.

The range of aluminum or magnesium for practical use as fuel in casehardening the inside of a steel tube is about 10 to 75 grams per square foot of surface. The lower limit of the fuel charge is determined by the minimum which produces a useful hardness increase and may involve an extremely thin case. The upper limit of the charge is determined by the maximum which does not cause burning or fusing of the tube surface. The oxygen charged preferably is substantially the quantity required for complete combustion of the fuel without appreciable excess. The case characteristics can be varied by varying the size and shape of powdered fuel particles, as well as the quantity. In general coarser mesh powder burns more slowly than finer mesh, and granular particles more slowly than flaky. The tube can be quenched in water or oil if more rapid cooling is needed.

My instantaneous heating method also produces momentary high pressures within an enclosure at the same instant the temperature is high. Such pressure may also have a beneficial effect along with the temperature. An example is when my heating method is used in the coating of a surface with high melting point enamels, plastics or the like. Such coatings are used to make porous materials impermeable, and the application of pressure along with temperature tends to force the sealing material into the pores of the surface to produce a better bond and a more permanent coating. My method may also be utilized to induce chemical reactions that occur under the simultaneous application of high pressure and high temperature.

Example I

As a specific example of my method, I selected a tube of A.I.S.I. 1045 steel 10 inches long, 1½ inches inside diameter, and having an initial hardness of 20 to 25 Rockwell C. I introduced a fuel charge of 4 grams of minus 60 mesh powdered aluminum along with oxygen at a pressure of 100 p.s.i.g. at 75° F. I prepared the tube as shown in FIGURE 1, spun it in a lathe to distribute the fuel charge, and fired the ignition means. Subsequently I found that the inner surface of the tube had acquired areas hardened to about 55 to 65 Rockwell C.

Example II

As a further example, I introduced to a similar tube a fuel charge of 8 grams of minus 60 mesh powdered magnesium along with oxygen at a pressure of 155 p.s.i.g. at 75° F. I prepared the tube, spun it and fired the ignition means as in the first example. Subsequently I found that the inner surface had acquired a case approximately 1/32 inch deep with a hardness of about 55 to 65 Rockwell C. I found magnesium preferable to aluminum for the reason that I was able to attain a more uniform case with magnesium. I attribute this result to the higher melting point of MgO (5072° F.) compared with Al_2O_3 (3722° F.). The latter forms droplets which tend to create hot spots when they solidify. This characteristic is not observed with MgO, presumably because of its higher melting point.

From the foregoing description it is seen that my invention affords a simple and effective method of flash-heating the interior of an enclosure. The method is especially applicable to casehardening as described in the examples, although it may have other applications.

While I have shown and described certain preferred embodiments of my invention, it is apparent that other modifications may arise. Therefore, I do not wish to be limited to the disclosure set forth but only by the scope of the appended claims.

I claim:

1. A method of casehardening the inside surface of a metal tube comprising introducing to the tube a fuel charge along with sufficient oxygen for complete combustion of the fuel, sealing the ends of the tube, igniting the charge to heat the inside surface momentarily above its critical temperature, and quenching the inside surface by conduction of heat therefrom.

2. A method of casehardening the inside surface of a steel tube comprising introducing to the tube a finely divided solid fuel charge of the group consisting of aluminum, magnesium and combinations thereof in the amount of 10 to 75 grams of fuel per square foot of surface, along with sufficient oxygen for complete combustion of the fuel, sealing the ends of the tube, igniting the charge to heat the inside surface momentarily above its critical temperature, and quenching the inside surface by conduction of heat therefrom.

3. A method of casehardening the inside surface of a

steel tube comprising introducing to the tube a finely divided powdered solid fuel charge of the group consisting of aluminum, magnesium and combinations thereof in the amount of 10 to 75 grams of fuel per square foot of surface, along with sufficient oxygen for complete combustion of the fuel, sealing the ends of the tube, spinning the tube on its longitudinal axis to distribute the fuel charge over the inside surface, igniting the charge to heat the inside surface momentarily above its critical temperature, and quenching the inside surface by conduction of heat therefrom.

References Cited in the file of this patent

UNITED STATES PATENTS

829,117	Maxim	Aug. 21, 1906
2,318,145	Emery et al.	May 4, 1943
2,448,203	Africano	Aug. 31, 1948
2,464,179	Hickman et al.	Mar. 8, 1949
2,596,981	Chennault et al.	May 20, 1952
2,669,511	Whitney	Feb. 16, 1954

OTHER REFERENCES

Johnson: "Metal Working and Heat-Treatment Manual, Volume III," Lib. Call No. TS 205 vc; pages 89, 106, 107, 120 and 121, dated 1948.