Oct. 1, 1968 R. L. JONES ET AL 3,403,726

SPRAY AND NEGATIVE PRESSURE COOLING SYSTEM

Filed Dec. 20, 1965 4 Sheets-Sheet 1

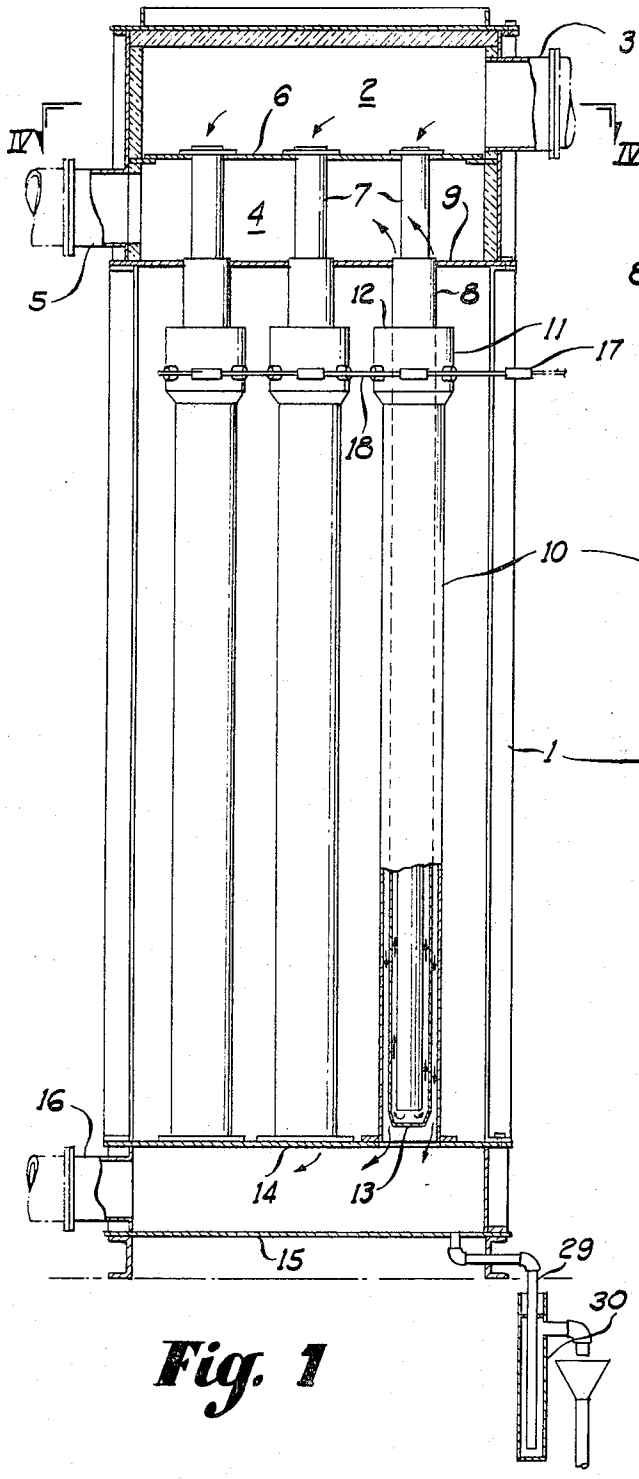


Fig. 1

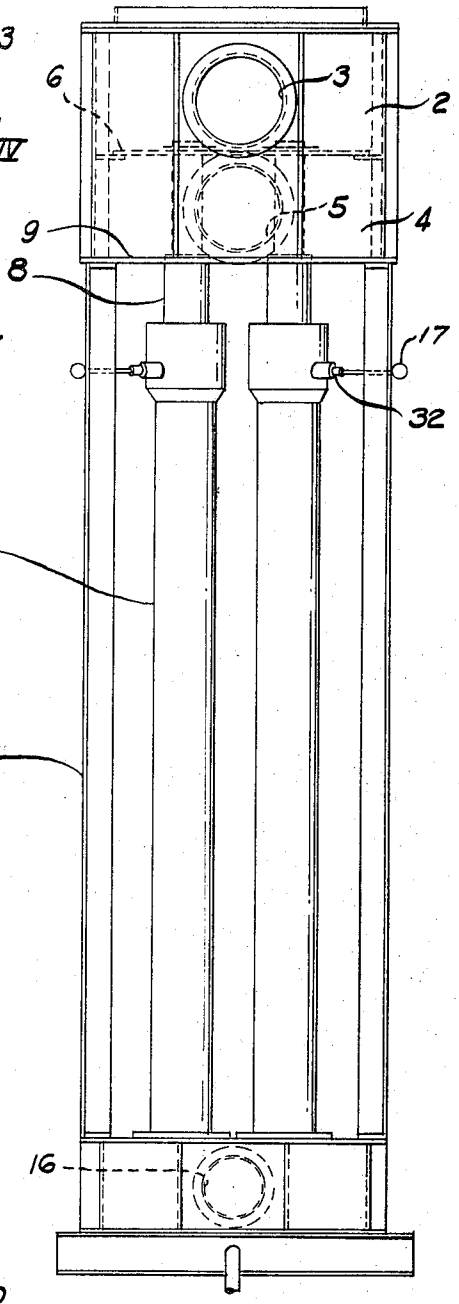


Fig. 2

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SPRAY AND NEGATIVE PRESSURE COOLING SYSTEM

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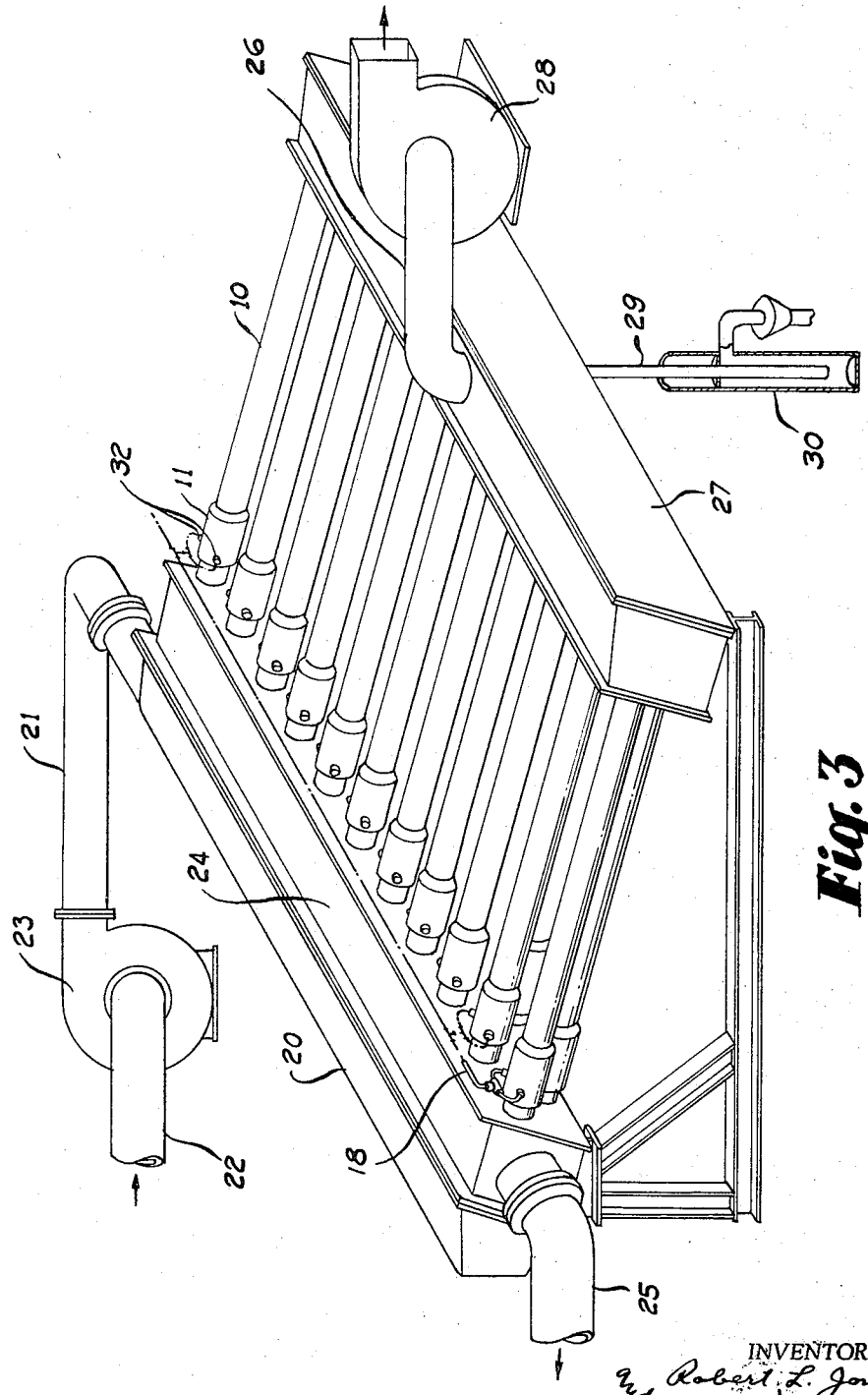


Fig. 3

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SPRAY AND NEGATIVE PRESSURE COOLING SYSTEM

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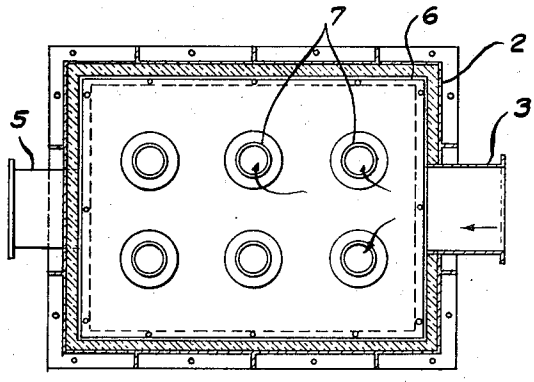


Fig. 4

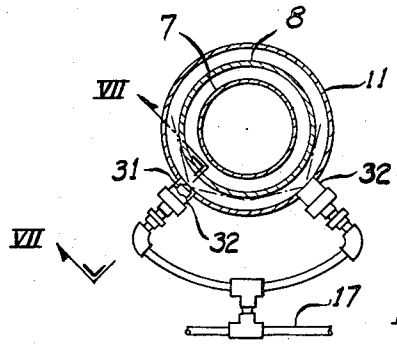


Fig. 6

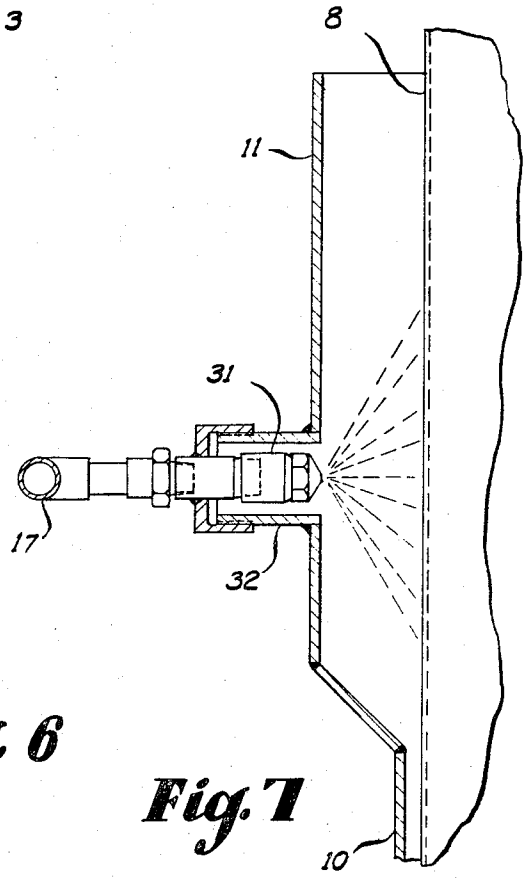


Fig. 7

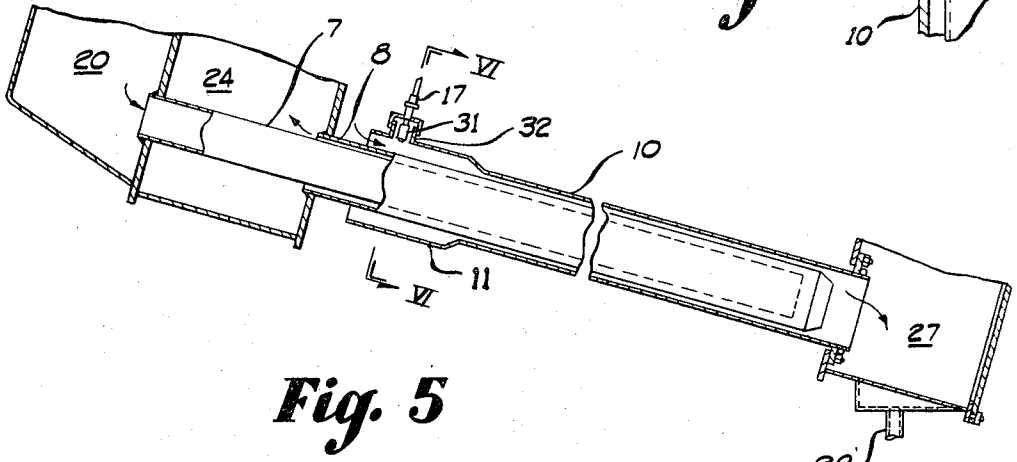


Fig. 5

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SPRAY AND NEGATIVE PRESSURE COOLING SYSTEM

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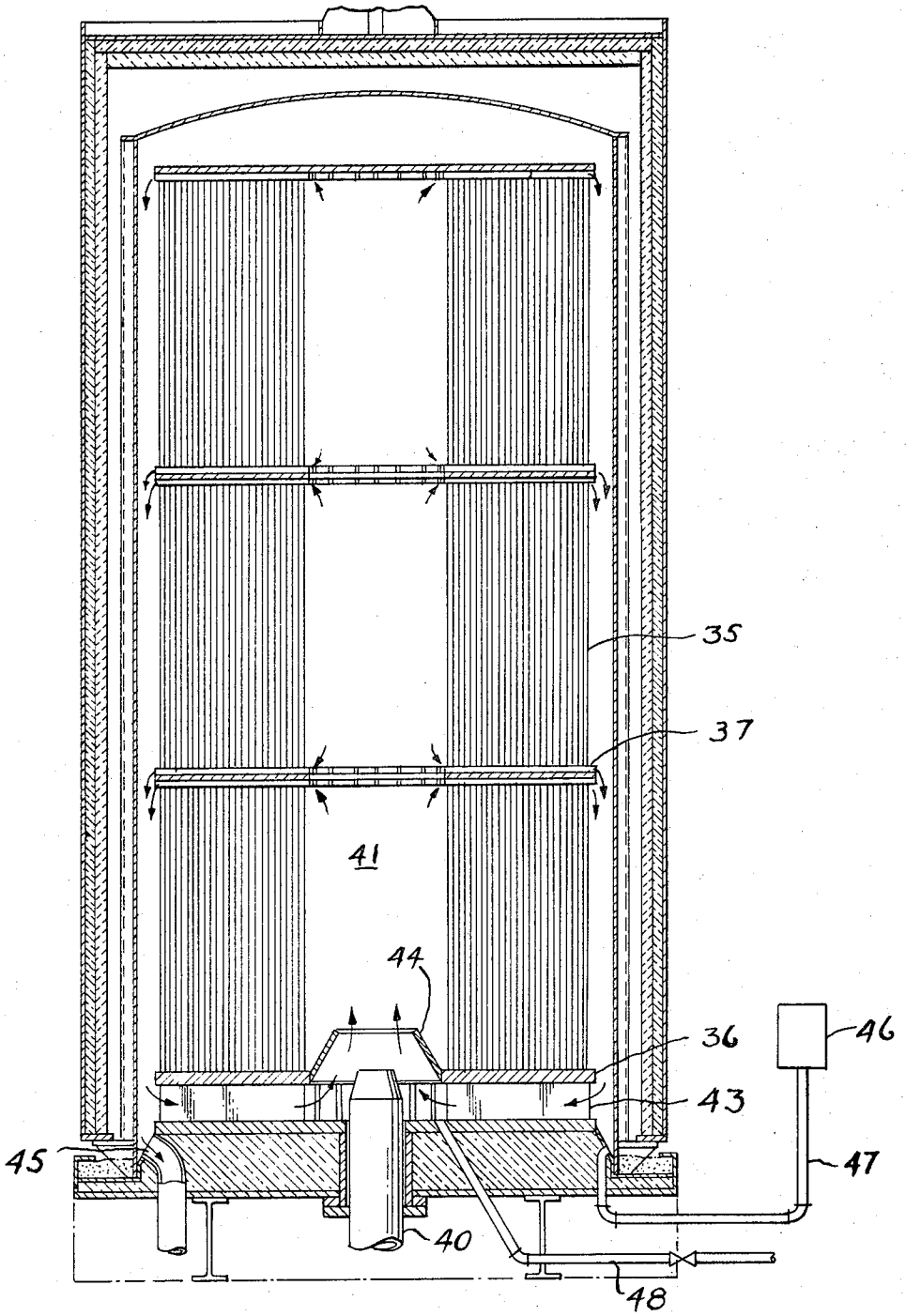


Fig. 8

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3,403,726

SPRAY AND NEGATIVE PRESSURE COOLING SYSTEM

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Filed Dec. 20, 1965, Ser. No. 515,262
1 Claim. (Cl. 165—142)

ABSTRACT OF THE DISCLOSURE

In the annealing of steel coils, for example, where the annealing temperature is supplied to an annealing chamber by delivering hot gases thereto, the present invention provides for the cooling of such gases after they have heated the coils. This greatly increases the capacity of the annealing apparatus, as otherwise it would take an excessive amount of time to lower the temperature of the coils below the critical range, after which they can be exposed to the atmosphere. Various problems such as the use of inert gases to avoid coloration of the coiled steel strip require that the same gas used for supplying the heat is also employed for lowering the temperature, and in accordance with the present invention, a cooling system is provided for rapidly cooling the gases that are withdrawn from the annealing apparatus and return the gases to the annealing chamber in which the coils are stacked.

A feature of the invention is a pressure differential between the gases flowing into the cooling chamber and the coolant surrounding the flow tubes of the gases so that it would be impossible to contaminate the gases by the coolant flowing into the tube.

The invention relates to new and useful improvements in cooling systems for gases by the use of sprays and negative pressure, and it is particularly useful where the fluid to be cooled flows through a tubular enclosure which is encased at least partially by a coolant tube open to the atmosphere at one end. A coolant such as water is sprayed into the annulus between the flow tube and coolant tube and air saturated with the coolant is exhausted at the end opposite the end that is open to the atmosphere.

The invention will become more apparent from a consideration of the accompanying drawings constituting a part hereof in which like reference characters designate like parts and in which:

FIGURES 1 and 2 are side and front elevational views, respectively, of a cooling and circulating system embodying the principles of this invention;

FIGURE 3 is an isometric view of a modified form of the apparatus shown in FIGURES 1 and 2.

FIGURE 4 is a cross section taken along the line **4—4** of FIGURE 1;

FIGURE 5 is a side elevational view, partially in section, of one of the circulating and cooling tubes of FIGURE 3;

FIGURE 6 is a cross section taken along the line **6—6** of FIGURE 5;

FIGURE 7 is a cross section through one of the spray heads and a portion of the tube taken along the line **7—7** of FIGURE 6; and,

FIGURE 8 is a vertical cross-sectional view, partially in elevation, of a coil annealing apparatus embodying the principles of this invention.

With reference to FIGURES 1 and 2 of the drawing, the apparatus consists of a housing **1** having a header chamber **2** connected to an inlet **3** and having a chamber **4** connected to an outlet **5**. A partition **6** supports a plurality of tubes **7** open at the end in communication with the

chamber **2**, the tubes extending downwardly substantially the length of the housing. A plurality of tubes **8** are suspended from a partition **9** and provide an annular space around the inner tube **7**, the tubes **8** being closed at the bottom, as shown at **13**, FIGURE 1, to cause circulation of gases from the chamber **2** through tube **7**, then around the annular space and out into the header chamber **4**, as shown by the arrows in FIGURE 1. Coolant tube **10** having a bell-shaped end **11** is open to the atmosphere at **12** and extends the length of the tubes **7** and **8**, and beyond to rest upon and be supported by a partition **14** that forms a chamber with a bottom plate **15** having an outlet **16** for the flow of the coolant. A plurality of spray pipes and nozzles are connected to a supply line **17**, the spray line and nozzles being generally designated by the numeral **18**.

In the modification shown in FIGURE 3 of the drawing, the tubes are in an inclined instead of a vertical position, but otherwise function the same as the apparatus shown in FIGURES 1 and 2. As shown, a header box **20** is connected to a conduit **21** through which hot gases from a supply line **22** are conducted by a fan or blower **23**. A second manifold **24** is connected to a conduit **25** which delivers the cooled gases to a point of use. The numeral **26** designates the outlet for a manifold chamber **27** with a fan **28** exhausting the chamber **27** to the atmosphere. An excess water drain **29** is provided with a water seal **30**.

The spray apparatus for supplying the coolant to the fluid tube in which the hot gas tubes are enclosed is shown in FIGURES 5 to 7, respectively. In FIGURE 6 the outer or coolant tube **10** is spaced from tube **8** that encases the inner tube **7** through which the gases flow under pressure and from which they pass through the annular chamber between the tubes **7** and **8** to the cooled gas outlet **5**, FIGURE 1, or **25**, FIGURE 3. A water spray **31** is mounted on a piece of pipe **32** welded to the coolant tube **10** in the bell section **11** thereof, and the spray nozzle **31** is connected to the water supply line **17** which supplies water under pressure to produce a very fine spray, as shown in FIGURE 7, there being two nozzles shown on each each of the tubes **10**.

The fine spray of coolant, such as water, into the bell-shaped end of the tubes **10** is drawn through the tubes by the exhaust fan **28** and the air saturated with the coolant is exhausted into the chamber **27**. The annulus between the fluid tube **10** and the shroud tube **8** is sized so that a measurable pressure drop occurs in the air-coolant mixture flowing through the annular space between the tube.

This pressure drop plus any rise in temperature of the air coolant mix in the annulus evaporates the coolant and the latent heat of vaporization contributes largely to the cooling of the tube through which the hot gases flow. The air at the exaust end of the tube is lower in pressure and is saturated to about 90% relative humidity or more if 15 inches of water negative pressure occurs at the exhaust end with 350 s.c.f.m. of air exhausted. The volume of the spray nozzle will be about 100 pounds of coolant per hour with the air entering at 85° F. at a relative humidity of 70% if the coolant is water. The 100 pounds of water of the spray nozzle is evaporated in the annulus. If the outer tube is insulated, the latent heat evaporation would have to come from the gases in the inner tube. This cooling effect, together with the convection cooling of the air cooling mixture traveling rapidly in the annulus between the water tube and shroud tube causes very rapid cooling of the gases in the inner tube.

An advantage of this type of fluid cooling is that if the gases in the inner tube are under positive pressure, the coolant cannot contaminate the gases being cooled in case of any leaks in the system.

The coil annealing apparatus with which the cooling system is used, is shown in FIGURE 8 in which coils **35** of steel or other metal sheet material are mounted on a hearth plate **36** on base **10** and are separated by convector plates **37**. The coils are mounted in a metal housing **38** constituting an inner shell or cover surrounded by an insulating jacket **39** in spaced relation therewith. Hot gases are supplied through a nozzle **40** to the eye **41** of coils **35** from which they pass through convector plates **37** to the space **42** between the coils **35** and housing **38**, thence through radial passages **43** in hearth plate **36** to be recirculated through injector nozzle **44** and pass out through outlet **45**. A burner **46** and pipe lines **47** and **48** are utilized for purging the annealing chamber of atmospheric gases such as air, which is no part of the present invention.

It is evident from the foregoing description of this invention that spray and negative pressure cooling systems described therein provide a simple and efficient means for cooling hot gases in industrial heating systems such as annealing apparatus and the like, or in heat exchangers.

Although one embodiment of the invention has been herein illustrated and described, it will be evident to those skilled in the art that various modifications may be made in the details of construction without departing from the principles herein set forth.

We claim:

1. Cooling system for coil annealing apparatus in which hot gases withdrawn from the coil annealing chamber are delivered to a header box having flow tubes open at both ends, extending therefrom the flow tubes being contained within outer tubes closed at one end against which the gases impinge to be diverted and caused to flow in the reverse direction through the space between said tubes to a second header box having a flow passage back to the coil annealing chamber, and coolant tubes surrounding said outer tubes and extending substantially the full length of said tubes having a bell-shaped portion at the end adjacent said last named header box and having the other end opening to an exhaust chamber, means for spraying a coolant into said bell-shaped portion and means for maintaining negative pressure in said exhaust chamber to draw air from said bell-shaped portion through the space between said outer tube and coolant tube to cause rapid cooling of the gases flowing through the first-named tubes.

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