June 17, 1958 R. A. MARTIN 2,839,155

THERMAL PRECIPITATOR

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Fig. 1

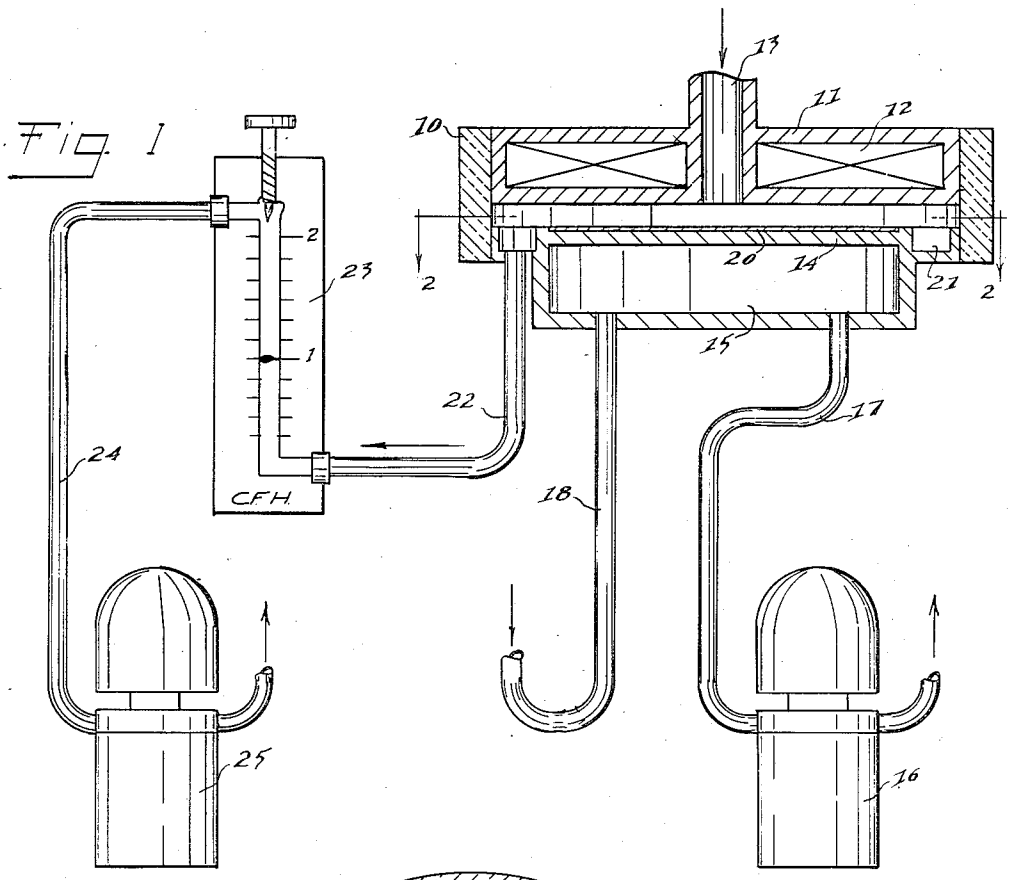
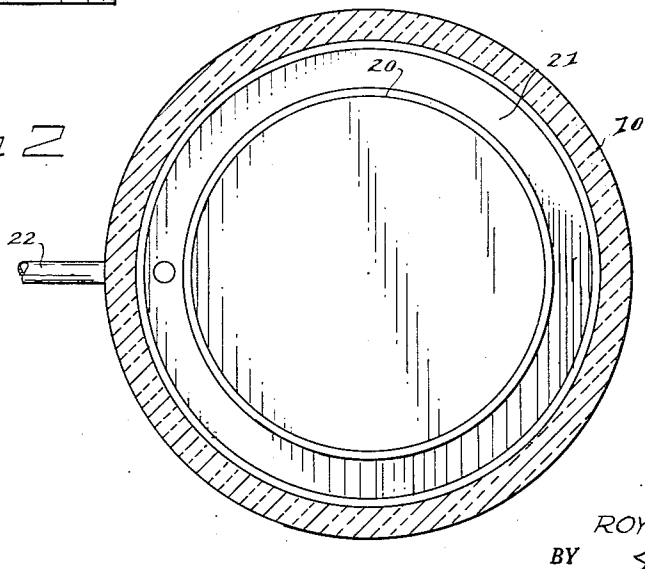



Fig. 2




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# THERMAL PRECIPITATOR

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This invention relates to thermal precipitators and is particularly concerned with aerosol samplers operating on the phenomenon of thermal repulsion.

The phenomenon of thermal repulsion by which small particles tend to migrate from hotter regions to cooler regions has long been recognized. The currently accepted explanation for the motion for the suspended particle in a thermal field presumes that the fluid actually flows around the particle from the colder side to the warmer side. It is the reaction of this fluid which causes the motion of the particle toward the cooler region. The present invention utilizes this phenomenon for the precipitation and collection of aerosol particles in the nature of one micron in size and less where the gravitational force on the particle is negligible. Such sampling of aerosol particles in air is an important factor in air pollution studies, smoke abatement surveys, research in micromeritics, bacterial monitoring and pollen counts as well as other important uses. While laboratory precipitators of the type herein referred to have been used for experimental purposes and for the development of the theory of the thermal repulsion, there is a need for apparatus operating on this theory which may be successfully used by unskilled personnel and which will be efficient, fast and preferably portable. The present invention has been developed as a means for answering this need.

It is therefore among the primary and general objects of the present invention to provide a thermal precipitator for aerosol sampling which is simple, efficient, fast, versatile and preferably portable.

A further object of the present invention is to provide a device of the character described which will provide for the separation of all or substantially all of the aerosol particulate matter in fluid passing therethrough.

Another object of the present invention is to provide a device of the character set forth which is compact and hence readily portable and in which means are provided for conveniently attaching the device to required sources of power and coolant material.

It is also an important object of the present invention to provide a novel and improved air chamber through which the fluid vehicle of the aerosol particles passes and by which such particles are collected for the inspection.

It is further an object of the present invention to provide in the collection chamber of a device of this type a peripheral air receiving annulus by which the air is withdrawn in such manner as to insure high efficiency of the collecting operation.

Numerous other objects, features and advantages of the present invention will be apparent from consideration of the following specification taken in conjunction with the accompanying drawings in which:

Fig. 1 is a diagrammatic view of the present apparatus, the separation chamber and associate parts being shown in two sections.

Fig. 2 is a horizontal cross-sectional view taken on the line 2—2 of Fig. 1.

While certain aspects of the present inventive concept may be carried out in various structural forms and arrangements, that embodiment of the invention here presented by way of example may be generally defined as providing a flat circular chamber to which the airborne aerosol is admitted from a central opening, the upper face of the chamber is defined by a hot plate which is



heated preferably by electrical means while the face therebelow is formed by a cold plate cooled by fluid coolant. The central portion of the lower face is recessed to receive a removable collection surface for the material separated while the peripheral boundary of the chamber is provided with a depressed air receiving annulus from which the air is withdrawn preferably through a flow meter. Small air and coolant pumps, electrically driven, are provided, the structure being such as to be adapted for location as a unit within a portable carrying case provided with a simple standard electrical connection for energization of the heater and the pumps and simple connecting means for a source of cooling fluids.

Referring more particularly to the drawings, in that form of the invention here presented, the chamber is formed within a circular thermal insulator ring **10** having a low coefficient of expansion to conform with the range of operating temperatures between the heated side and the cool side of the chamber. The upper face of the chamber is formed by a hot plate **11** provided with internal electrical resistance heating means indicated at **12** which is arranged in annular relation about a central vertical inlet tube **13**. The lower face of the chamber is formed by a cool plate **14**, a coolant chamber **15** being formed therein to which cooling medium may be supplied from an electrically driven coolant pump indicated at **16**. Coolant medium may be withdrawn through the tubing **17** from the chamber **15**, a supply being provided through a parallel supply tubing **18**.

The upper central surface of the cold plate **14** is provided with a circular depression **20** adapted to removably receive a particle reception disc of glass, paper, plastic or the like. At the outer edge of the cold plate **14**, there is formed an annular air receiving annulus **21** from which air, after entering from the tube **13** and passing radially between the hot and cold surfaces, is withdrawn through tubing **22**, the air flow control being provided by a flow meter indicated at **23** from which it is exhausted through tubing **24** by an electrically driven air pump indicated at **25**.

As will be noted, the annulus **21** is formed in the cold plate and surrounds the depression **20**. The cross-section of the annulus **21** is substantially large as compared to the narrow passage between adjacent surfaces of the hot and cold plates thus forming an expansion chamber, hence the air after separation will lose velocity at the edge of the chamber as it enters the annulus. The air may thus be drawn off downwardly from a single point in the plenum and with a minimum of turbulence in the chamber due to the free and equal radial flow in all directions.

In the operation of the device with the air pump energized, air will enter through the tube **13** passing radially therefrom between the hot and cold plates to the annulus **21** from which it is withdrawn under the control of flow meter **23**. The phenomenon of thermal repulsion will cause the aerosol particles contained in the fluid drawn through the tube **13** to be repulsed by the hot plate and to be precipitated upon the collection surface mounted on the cold plate **14**. In the operation of the device, it will be understood that the hot plate may be maintained at temperatures ranging between 100° F. and 200° F. through energization of heating coil **12** while the cold plate will be maintained at an appropriately lower level controlled by the temperature of the coolant fluid admitted thereto from the tube **18**. The spacing between the lower surface of the hot plate **11** and the upper surface of the cold plate **14** may be from approximately five-thousandths to fifteen-thousandths of an inch; and in commercial operation of machines of this character, 100% collection efficiency has been achieved at a flow rate of 500 cc. per minute.

In the construction of the present invention, it has been found that accurately machined brass pieces may be used for the cold plate and the hot plate, and that small compact solenoid type electrical pumps energized from conventional voltage systems may be compactly arranged with the separator and the flow meter. Simple connections by which the coolant may be supplied from tap water and current from doestic supply provide for a compact and easily portable structure. In one commercial adaptation of the invention, a carrying case roughly 10" x 10" x 7½" has been provided for the equipment. In this same embodiment, the electrical heating element draws approximately 100 watts from a normal alternating current source; overload fuses are provided in the circuit, and a standard A. C. line cord and plug are provided. The coolant connections are ¼" rubber tubing. The coolant supply pump has a capacity of ¼ gallon per minute, and the air inlet tube is ½", while the air outlet tube is ¼". The air flow meter is calibrated from 0 to 2 cubic feet per hour and is designed for a flow rate of 500 cubic centimeters per minute.

From the foregoing, it will be seen that the present invention provides a novel, simple and improved structure for carrying out precipitation by thermal repulsion, and that the arrangement provides for high efficiency in a small compact structure readily designed for field operation. It will of course be understood that the invention is not limited nor confined to the specific structural details herein presented but that numerous changes, modifications and the full use of equivalents may be resorted to in the practice of the invention without departing from the spirit or scope thereof as defined in the appended claims.

I claim:

1. A thermal repulsion separation device including a housing, an electrically heated hot plate forming one surface of a separation chamber within said housing, a water cooled cold plate forming another surface of said separation chamber, and a recess formed in said last mentioned surface for the reception of a removable sample collecting disc.

2. A thermal repulsion separation device including a housing, an electrically heated hot plate forming one surface of a separation chamber within said housing, a water cooled cold plate forming another surface of said separation chamber, and a recess formed in said last mentioned surface for the reception of a removable sample collecting disc, said recess being surrounded by an air receiving annulus.

3. The structure as set forth in claim 1 in which the housing, plates, chamber and recess are circular.

4. The structure as set forth in claim 2 in which the housing, plates, chamber and recess are circular, and in which the annulus is a continuous groove encircling said depression forming an expansion chamber for fluid after passage through said chamber.

5. A separation device comprising a circular housing, a centrally apertured circular hot plate mounted in said housing with its lower face defining the upper wall of a separation chamber, and an opposed circular cold plate mounted in said housing with its upper surface defining the lower wall of said separation chamber, said cold plate including a water coolant chamber, said hot plate including an electrical heating element, said cold plate defining an air outlet annulus.

6. A separation device comprising a circular housing, a centrally apertured circular hot plate mounted in said housing with its lower face defining the upper wall of a separation chamber, and an opposed circular cold plate mounted in said housing with its upper surface defining the lower wall of said separation chamber, said cold plate including a water coolant chamber, said hot plate including an electrical heating element, said cold plate defining an annular plenum chamber and having a central depression for the reception of a removable material receiving disc.



7. A thermal precipitator including a hot plate having a hot surface, a cold plate having a cold surface closely adjacent said hot surface to form a thin separation chamber therebetween, means for delivering aerosol particle bearing fluid to said separation chamber, and an expansion chamber adjacent said cold plate having an opening communicating with the periphery of said separation chamber for receiving fluid after separation of aerosol particles therefrom by passage through said separation chamber.

8. A thermal precipitator including a hot plate having a hot surface, a cold plate having a cold surface closely adjacent said hot surface to form a thin separation chamber therebetween, means for delivering aerosol particle bearing fluid to the center of said separation chamber, and a peripheral expansion chamber surrounding said cold plate communicating with the periphery of said separation chamber for receiving fluid after separation of aerosol particles therefrom by passage through said separation chamber.

9. A thermal precipitator including a circular hot plate having a circular hot surface, a circular cold plate having a circular cold surface closely adjacent said hot surface to form a thin separation chamber therebetween, means for delivering aerosol particle bearing fluid to the center of said separation chamber, and an annulus surrounding said cold plate constituting an expansion chamber communicating with the periphery of said separation chamber for receiving fluid after separation of aerosol particles therefrom by radial passage thereof through said separation chamber.

10. A thermal precipitator including a hot plate forming a flat high-temperature surface, a cold plate forming a flat low-temperature surface parallel with said high temperature surface, means for delivering aerosol particle bearing fluid to be sampled between said surfaces, and a fluid receiving expansion chamber formed by said cold plate communicating with the space between said surfaces.

11. A thermal precipitator including a hot plate forming a flat circular high-temperature surface, a cold plate forming a flat circular low-temperature surface parallel with said high temperature surface, means for delivering aerosol particle bearing fluid to be sampled axially of said surfaces, and an annular fluid receiving expansion chamber formed by said cold plate communicating with the space between said surfaces.

12. A thermal precipitator including an electrically heated hot plate forming a flat circular high-temperature surface, a water cooled cold plate forming a flat circular low-temperature surface parallel with said high temperature surface, means for delivering fluid to be sampled axially of said surfaces, and an annular fluid receiving expansion chamber formed by said cold plate communicating with the space between said surfaces.

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