Sept. 29, 1953 R. C. ORTGIES 2,653,674

SUPPRESSOR FOR SOLID PARTICLES AND FUMES

Filed Nov. 10, 1949 2 Sheets-Sheet 1

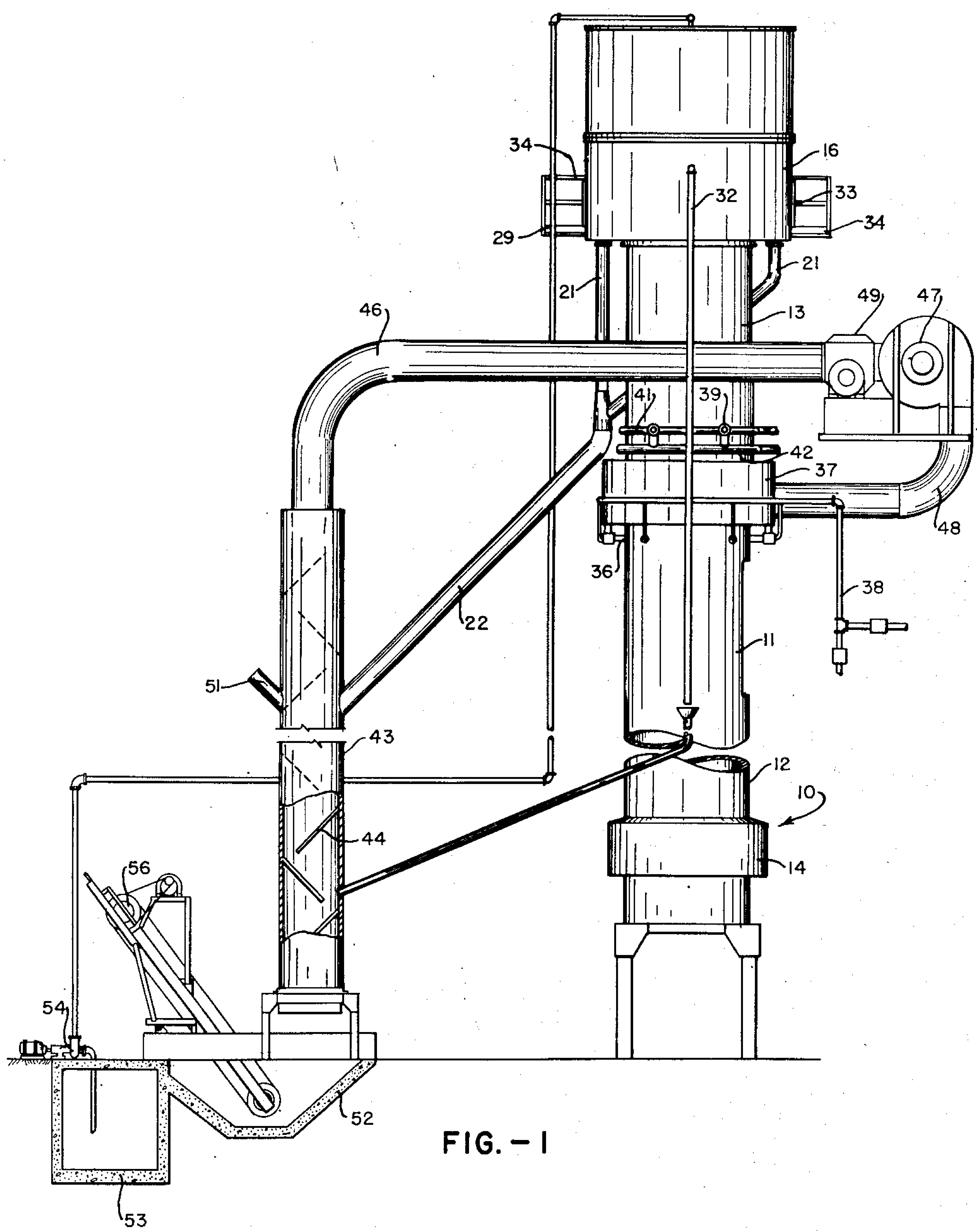

FIG. - 1

INVENTOR.
Raymond C. Ortgies

BY [signature]

ATTORNEY

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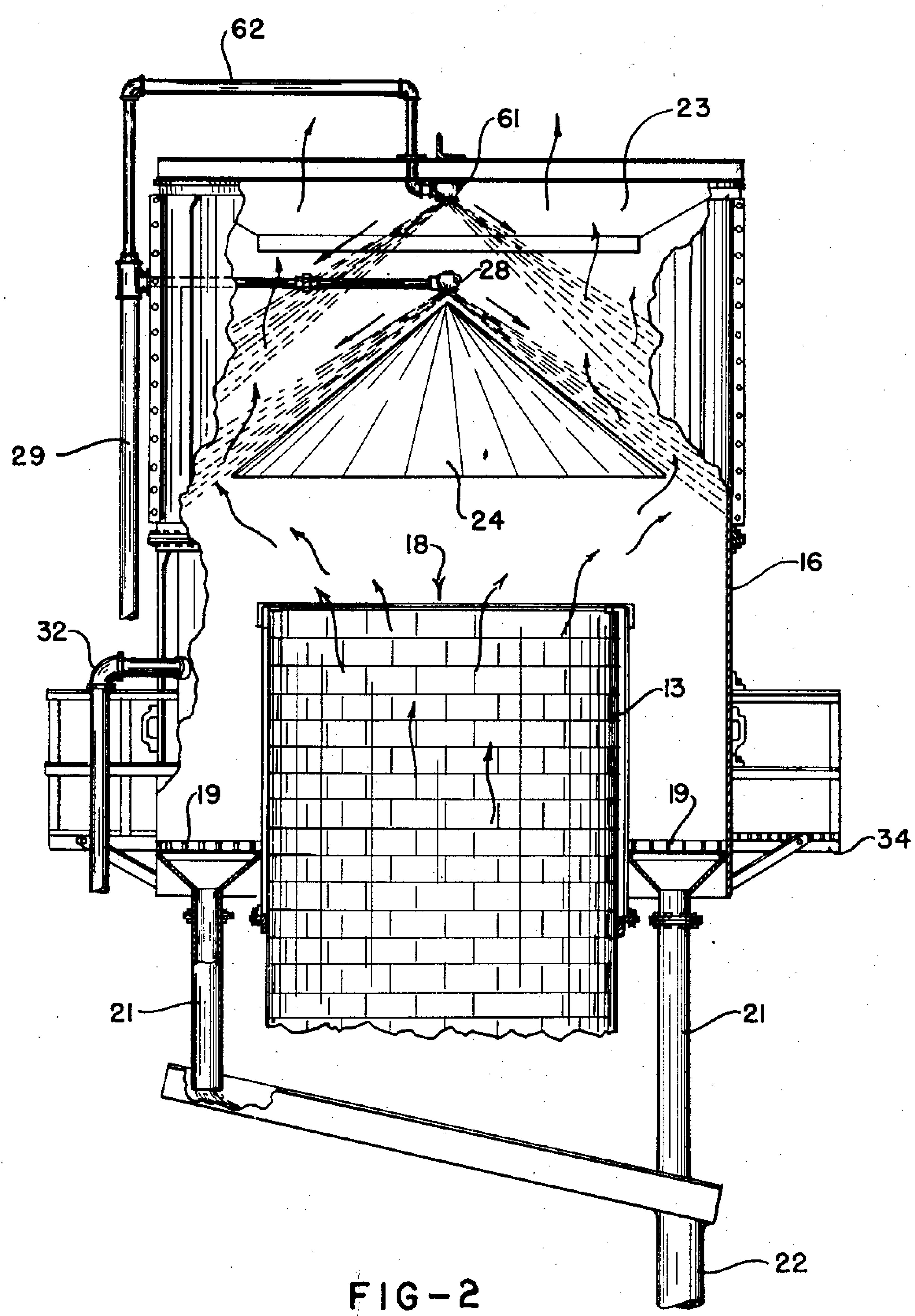

FIG-2

INVENTOR.
Raymond C. Ortgies

BY [signature]

ATTORNEY

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2,653,674

SUPPRESSOR FOR SOLID PARTICLES AND FUMES

Raymond C. Ortgies, Homewood, Ill., assignor to the Whiting Corporation, a corporation of Illinois

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4 Claims. (Cl. 183—6)

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My invention refers to suppressors, particularly of the type adapted for attachment to an industrial furnace stack, such as a cupola, which removes sparks and other solid particles carried by the escaping gas from the exhaust and also reduces or eliminates the smoke and noxious fumes ordinarily liberated by the stack into the atmosphere.

Industrial communities, which frequently include residential areas, have become increasingly concerned with the air pollution problem created by nearby industrial furnaces. In some areas, the pollution has progressed beyond the point of being simply a serious nuisance having an indirect effect upon public health to one in which the smoke, fumes and dust are considered the direct causes of several deaths. Public officials are currently attempting to reduce this menace by the passage of anti-smoke ordinances designed to protect the public but at the same time avoid penalizing industry too severely.

Unfortunately the suppressor equipment previously available for the satisfactory solution of this problem is complex, bulky and expensive to a degree which renders its application impracticable in all but a few instances. The simpler forms of suppressor devices have, in the past, either been relatively ineffective or have adversely effected furnace operations to such an extent as to render them unsatisfactory from an industrial standpoint. The immediate need for a simple, effective, compact and inexpensive suppressor is therefore obvious.

Of the many various types of industrial furnaces, cupolas present one of the most serious air pollution problems, not only because of their great number and frequent proximity to residential areas, but also because of the character of their discharge which ordinarily includes sparks, cinders, dust, fly ash, large volumes of smoke and objectionable gases, such as carbon monoxide.

One of the principal objects of my invention is to provide a satisfactory suppressor, particularly adapted for use with cupolas, which will eliminate or reduce to an unobjectionable level the sparks, cinders, fly ash, smoke, dust combustible gas discharged by cupolas and the like, which is relatively simple, inexpensive and adaptable to existing equipment but which does not adversely affect furnace operation.

Several further important objects of my invention, as well as the structure and method of operation of my preferred form of suppressor are

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disclosed in the following detailed description and in the appended drawings, in which:

Fig. 1 is a diagrammatic, partially sectioned elevation of a cupola illustrating the application of my suppressor apparatus thereto; and

Fig. 2 is a diagrammatic vertical cross section through my suppressor.

In brief my suppressor utilizes a spray of water to wet the solid particles carried up the furnace stack by the exhaust gases and collects these wet solids in a settling pool for disposal. This general principle of operation is not in itself novel and has been utilized in several prior art suppressors, but has not been considered fully satisfactory because of the difficulty experienced in thoroughly wetting and precipitating all of the solids in the exhaust gases without adversely effecting furnace operation. In my suppressor, however, this difficulty is overcome by controlling the relative velocity of the exhaust gases and the droplets making up the water spray or curtain, as well as the shape and extent of the area through which the gases and solids pass in such manner that each particle of solid matter is forcibly impinged by water droplets traveling across the gas stream at a velocity greater than the velocity of the solid particles, thus insuring an essentially complete wetting of all solid particles and their subsequent precipitation without destroying or materially reducing the furnace draft.

In addition to cooling the solids, my suppressor is made effective in the reduction of noxious fumes by utilizing vents formed in the stack below the spray through which air and/or flame is introduced. The exhaust gases of a cupola consists principally of carbon dioxide and carbon monoxide, the latter having only a limited solubility in water and being of a poisonous nature. The air and/or flame entering the stack through the vents oxidizes the carbon monoxide to carbon dioxide, which not only changes the gas from a poisonous to a non-poisonous nature but also increases the solubility of the gas in water, thus enabling the spray to more completely collect the gas. Means are also provided for cooling the spray water, which increases its ability to absorb carbon dioxide and other gaseous acid anhydrides and also aids the furnace draft by contracting the gas volume. As a result the stack discharge is almost completely free of solids and objectionable gases and the operation of the furnace is in many instances actually improved rather than reduced in efficiency.

The general arrangement of my suppressor device is illustrated in Fig. 1 wherein I have illustrated a cupola, generally designated 10, having a charging door 11 disposed above a body portion 12 and below a stack portion 13. Metal, coke and limestone which comprise the charge are fed to the cupola through the charging door 11, the charge being supplied with air for combustion through a suitable conduit 14. A hollow cylindrical drum 16 is secured near its lower extremity to an inwardly extending ring 17, the inner periphery of which is secured to the furnace stack 13 a short distance below the stack mouth, indicated at 18, and is provided with a plurality of drains 19 which discharge through conduit 21 into a primary drain pipe 22. The upper end of the drum 16 is open and may be provided with an inwardly and downwardly extending peripheral flange 23 which defines a central opening through which the gases escape to the atmosphere.

Spaced upwardly from the mouth 18 and within the drum 16, I provide a baffle 24 in the form of a hollow, upright cone, the base of which extends across and is slightly larger than the diameter of the stack 13. Since the diameter of the baffle 24 is substantially less than the diameter of the drum 16, an annular passage, indicated at 26, is defined between the drum 16 and baffle 24. The total area of the passage 26 at its most restricted point should be at least equal to and preferably larger than the total cross sectional area of the stack 13 to avoid adversely effecting the furnace draft. Furthermore, the lower edge of the baffle 24 should be spaced upwardly from the mouth 18 a distance greater than the maximum width of the passage 26. Stay bolts 27 may be employed to secure the baffle 24 in position.

I have found that the apex angle of the baffle 24 is important and for best results should be greater than 85° but not more than 120°. Furthermore, since the baffle is continuously subjected to the action of acidic fumes, I prefer to form the baffle of stainless steel or other corrosion resistant material which is not sensitive to thermal shock.

Immediately above the apex of the baffle 24, I mount one or more spray nozzles, 28 and 61, supplied with water under pressure through a pipe 29 and supported by a suitable bolt 31. The orifice of the nozzle 28 is shaped in such manner as to deliver a high velocity cone shape spray of water at the same angle as the apex angle of the baffle 24. The general flow of the spray is therefore parallel to and slightly above the upper surface of the baffle 24, which is continuously bathed and cooled by stray droplets from the spray. The major portion of the water spray travels in a generally straight line outwardly over the edge of the cone, across the passageway 26 and into contact with the inner walls of the drum 16. Since the spray is in the form of a continuous curtain of droplets, the gases emerging from the mouth 18 can escape upwardly through the passage 26 without difficulty. The velocity of the droplets in the spray must be reasonably high and preferably should be such as to impart to the water droplets an average velocity greater than the average velocity of solid particles passing upwardly with the exhaust gases through the annular passageway 26. The droplets in the spray, therefore, forcibly impinge each of the solid particles in the gases, wetting them and driving them outwardly and downwardly into contact with the walls of the drum 16 from which they are washed into the drains 19 and through the pipe 21 into the pipe 22. Since the diameter of the baffle 24 is greater than the diameter of the mouth 18, the relatively small amount of water contacting the surface of the cone also drips downwardly into the drains 19 without entering the stack 13.

Although I prefer to provide several drains 19 in the ring 17 it is possible that these may on occasion clog in such manner as to prevent the adequate discharge of water from the drum 16. I therefore provide an emergency overflow drain 32 which extends through the drum 16, above the ring 17, but below the mouth 18 of the stack 13. Access doors 33 for cleaning the drains may be formed in the drum 16 at or near the level of a catwalk 34.

The gases passing upwardly through the stack portion 13 vary somewhat in analysis at different periods during the operation of the cupola but ordinarily include substantial quantities of both carbon dioxide and carbon monoxide. In ordinary operation, the carbon monoxide, which is poisonous, is often discharged without ignition and in some instances constitutes a hazard. Since carbon monoxide is not absorbed to an appreciable degree by water, it can pass through the spray without effect. This gas is, however, combustible if sufficient oxygen is present and the temperature is raised to the ignition point. I, therefore, prefer to form a series of openings 36 in the stack 13, above the charging door 11, into which air may be blown from a wind box 37 surrounding the stack 13 immediately above the openings 36. As disclosed in my co-pending application Serial No. 32,965 filed June 14, 1948, now abandoned, water in the form of a spray may be also supplied to the openings 36 through a suitable pipe 38.

When the cupola is thoroughly heated and in full operation, the temperature of the gases in the stack 13 above the charging door is usually above the ignition point of carbon monoxide, so that the addition of air is all that is required to burn the carbon monoxide to carbon dioxide, the latter being much more soluble in water. As the cupola is starting, however, the quantity of carbon monoxide present tends to be quite high and the temperature in the stack 13 relatively low, so that the combustible mixture of gases and air formed in the stack will not ignite unless the temperature is increased. I therefore provide a plurality of gas burners 39 or other gas ignition devices extending into the stack 13 for igniting the combustible mixture of carbon monoxide and oxygen. Gas may be fed to the burners 39 through a suitable pipe 41 and air under pressure may also be fed to the burners 39 through a second pipe 42.

Near the cupola I provide an upright cylindrical tower 43 having a plurality of overlapping, downwardly sloping, internal baffles 44 and open at its lower end to the atmosphere. The upper end of the tower 43 discharges into a conduit 46 which is connected to the intake of a fan 47, the latter discharging through a conduit 48, into the wind box 37. A water eliminator 49 may be employed before the fan to remove excess water. The primary drain pipe 22 discharges all of the water from the nozzle 28 into the tower 43, allowing it to fall along the baffles 44, against the rising current of air induced by the fan 47. If desired, a secondary air intake 51 may also be provided approximately midway between the top and bottom of the tower.

Immediately below the tower 43, I provide a settling pit 52 in which the solid particles precipitated by the spray in the drum 16, are allowed to settle. An overflow is provided for passing water from which the solids have settled from the pit **52** into a clear water sump **53** from which it may be recirculated by a pump **54** into the spray feed line **29**. An elevator **56** of conventional design may be employed for periodically or continuously discharging settled solids from the pit **52**. The emergency overflowing **32** is also connected to discharge into the pit **52**, preferably through the tower **43**.

From the foregoing it may be seen that water for the spray in the drum **16** is continuously recycled and is cooled by its passage through the tower **43**. Cooling the water is of substantial assistance in operating my suppressor since it not only increases the ability of my suppressor to absorb gases such as carbon dioxide, sulphite dioxide, sulphur trioxide, hydrogen sulphite and other noxious acid anhydrides but also cools and contracts the hot gases and reduces carry over of water by the exhaust gases. The wetting action of my high velocity spray is unusually effective in suppressing and collecting the solid particles passing upwardly through the stack **13** but since the spray is in the form of a curtain of discrete droplets, there is very little, if any, reduction in the furnace draft. The air passing through the tower **43** and injected into cupola stack **13** not only provides sufficient oxygen for the combustion of carbon monoxide but also further reduces the temperature of the exhaust gases. It may also be noted that the introduction of air greatly aids in the oxidization of smoke particles, which when oxidized may be discharged or absorbed by the spray as carbon dioxide. The fan **47** and the pits **52** and **53** may serve a plurality of cupolas if desired, and provision may be made for the addition of predetermined quantities of water-soluble alkaline material, such as soda ash, to the sump **53** to counteract the acidity of the water and reduce corrosion in the system.

Although single and spray arrangement is highly satisfactory in a majority of systems, it is sometimes inadequate to suppress the discharge of foreign material to the extent required by certain severe municipal ordinances when the furnace or cupola is operated under adverse conditions. When such a situation is encountered, I may utilize a second nozzle **61** as disposed within the drum **16** above the nozzle **28**. The nozzle **61** may be identical with nozzle **28** and supplied with water under pressure from a pipe **62**, which communicates with the pipe **29**. In most instances the nozzle **61** will be above the lower level of the lower edge of the flange **23**, but the position is selected in such manner that the spray discharged from the nozzle **61** is carried across into direct contact with the inner walls of the drum **16** without contacting the flange **23** or the baffle **24**. Thus the gases escaping through the drum **16** are forced to pass through two rather than one curtain of water droplets, the second curtain being effective to adequately suppress the small proportion of foreign matter allowed to escape through the water curtain formed by the nozzle **28**.

When constructed and operated as hereinbefore described, it will be found that my suppressor is highly efficient in the performance of its function and will give trouble-free service for an extended period of time. It is of course possible to vary certain of the details herein described without departing from the true spirit and scope of my invention and I do not, therefore, limit myself to the precise construction illus-

trated except insofar as defined in the appended claims.

I claim:

1. A suppressor for cupolas having a stack and a charging door in the stack comprising a cylindrical drum, a ring sealed to the lower edge of the drum and to the stack at a point below the stack mouth, an external air supply conduit communicating with the interior of the stack below the ring and above the charging door, blower for passing air under pressure through said conduit, gas ignition means in the stack between the ring and the charging door, an imperforate baffle in the drum above the mouth of the stack defining an annular passage between the baffle and the drum, said passage having an area at least equal to the cross sectional area of said stack, spray means for projecting a continuous curtain of water droplets across the passage above the baffle at a velocity at least equal to the velocity of solids carried upwardly by the exhaust gases, and a drain in the ring for discharging water and solids from the drum.

2. A suppressor for cupolas and the like having a stack comprising a drum for attachment to the stack around the stack mouth, the cross sectional area of the drum being at least twice the cross sectional area of the stack, an upright imperforate conical baffle in the drum extending across and spaced upwardly from the stack mouth, said baffle and drum defining an annular passage for rising exhaust gases, a spray in the drum above the baffle for projecting a continuous curtain of water droplets laterally across the passage onto the drum walls, an air conduit communicating with the interior of the stack, a fan for passing air through said conduit, a conduit for discharging water from the drum into the air conduit for movement in a direction opposite the direction of air flow and means for recirculating the cooled water to the spray.

3. A suppressor for furnace stacks and the like comprising a cylindrical drum for attachment to a stack around the stack mouth, a ring secured to the lower portion of the drum and to the stack below its mouth, a drum drain conduit extending through the ring, an upright imperforate conical baffle within the drum extending across and spaced upwardly from the stack mouth, said conical baffle having an apex angle of not less than 85° nor more than 120° and defining with the drum an annular passage for exhaust stack gas having an area greater than the cross sectional area of the stack, means immediately above the baffle and including a spray nozzle having a single orifice for projecting a continuous curtain of water droplets across said passage at an average velocity not less than the average velocity of solid particles carried upwardly therethrough by the exhaust gases, an air conduit communicating with the interior of the stack, a fan for forcing air through the conduit, an upright tower having its lower end open and upper end communicating with the fan inlet, conduit means connecting the drum drain with the tower above the lower end thereof, gas ignition means in the stack, a settling pit below the tower, a clear water sump communicating with the pit, and pump means for forcing water at a predetermined pressure from the sump to the spray nozzle.

4. A suppressor for furnace stacks and the like comprising a cylindrical drum, a ring sealed to the lower edge of the drum for attachment to a furnace stack at a point below the stack mouth, an upright conical baffle within the drum dis-

posed across and in spaced vertical relation to the stack mouth, defining with the drum walls an annular passage for exhaust gases having an area at least approximately equal to the cross sectional area of the stack, a stationary spray nozzle in the drum spaced upwardly a short distance from the peak of the conical baffle, said nozzle having a single orifice disposed and arranged in such manner as to project a continuous conical spray of water outwardly to the drum walls across the annular passage generally parallel to but spaced slightly above the upper surface of the baffle, a second stationary spray nozzle in the drum having a single orifice in axial alignment with the said first nozzle spaced upwardly from the first mentioned nozzle, said second nozzle also having its orifice disposed and arranged in such manner as to project a continuous conical spray of water outwardly and downwardly on to the walls of the drum, thereby defining two substantially similar vertically spaced and continuous curtains of water droplets across the path of the escaping gases, means including a conduit for supplying water to the spray nozzles at a pressure at least sufficiently great to project a major portion of the water directly from the nozzles to the drum walls, and drain means in the ring.

RAYMOND C. ORTGIES.

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