An apparatus for ventilating kitchen exhaust fumes and treating the effluent from kitchens to remove air polluting constituents from the effluent. The apparatus includes a housing through which the exhaust is pulled by a fan at the outlet side of the housing. The housing has an inertial impingement degreaser section with means for collecting and disposing of grease and other aerosols extracted from the fumes. The exhaust then passes through an electrostatic precipitator section which removes remaining contaminants after which the treated exhaust is exhausted to the atmosphere or partially recirculated through the kitchen cooking area. If required, a device for odor removal by absorption, adsorption or ozone treatment is added in a plenum after the fan.

3 Claims, 3 Drawing Figures
EFFLUENT VENTILATION AND CLEANING APPARATUS

BACKGROUND OF THE INVENTION

The present invention is intended primarily for the cleaning, treating and recirculation of fumes emanating from institutional and commercial cooking facilities. The typical stove for a restaurant or large kitchen is a long counter with heated cooking locations on its cooking surface. The cooking surface typically is long and narrow with a front edge at which the cook stands and a back edge within their reach during cooking operations. It is conventional to allow the cooking surface with a ventilator hood provided with an exhaust duct to the outside atmosphere with an exhaust fan connected thereto for continuously removing cooking vapors which arise from the cooking surface. As used in this specification cooking vapors is intended to include all of the air contaminants which it is customary and desirable to remove from a kitchen and eating area, including primarily vaporized grease which will condense and accumulate on the first cool surface it reaches.

Removal of cooking vapors from a large cooking area presents two major problems, one being the exhaust of contaminant-laden air to the atmosphere and the second being the heating and air-conditioning problems caused by the large amount of make-up air required to compensate for the exhausted air. In a typical large restaurant kitchen, adequate removal of cooking vapors requires the exhaust to the outdoors of several thousand cubic feet of air per minute. The continuous removal of such volumes of air necessitates some means for introducing make-up air from the outdoors or recirculating cleaned exhaust air. None of the ventilation systems of the prior art have satisfactorily solved these problems.

The apparatus of the present invention provides an improved means for extracting contaminants from kitchen exhaust to prevent pollution of the atmosphere from cooking operations. The exhaust of normal effluents by exhaust systems heretofore utilized, particularly where broiling, grilling and frying are done, would not pass air quality standards established by most air pollution authorities. Additionally, such systems of the prior art are inefficient in the use of fuel and provide no satisfactory means for disposal of extracted contaminants.

SUMMARY OF THE INVENTION

The present invention comprises a treating and cleaning unit normally positioned upon the roof of the restaurant or cooking area and connected by duct work to an exhaust and make-up air hood positioned above the cooking surface. The apparatus of the present invention contains the exhaust fan and the complete air-cleaning means. By means of the present invention the exhaust air from the hood is sufficiently cleaned that a large portion (from zero up to 80 percent) of the exhaust air can be recirculated over the cooking surface through the exhaust hood. The air-cleaning means includes seriatim an inertial impingement grease extraction unit, an electrostatic precipitation unit followed by the air exhaust fan, and a means for automatically cleaning the pollution-extracting devices. The inertial impingement grease extraction unit provides a series of impingement surfaces which air borne particulate materials strike in a throttling path.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in section showing the apparatus of the present invention in combination with an exhaust hood over a cooking surface;

FIG. 1A is a partial sectional view taken along line 1A—1A of FIG. 1; and

FIG. 2 is a view in perspective partly in section of the apparatus of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, there is shown in FIG. 1 a presently preferred embodiment of the present invention. The apparatus of the present invention in its presently preferred form includes a housing 10 shown supported upon the roof 11 of the kitchen and connected by a suitable inlet duct 12 and recirculating duct 14 to an exhaust and make-up air hood 15 supported above the cooking surface 16 of a stove 17. The housing 10 is typically constructed of sheet metal and, for purposes of illustration only, is approximately 9 feet in length, 4 feet in width and 4½ feet in height. Although the present invention is shown as roof-supported, it is not restricted to this location although it will be the most common.

The exhaust and air make-up hood 15 is of the type heretofore known to the art, such as for example, that shown in U.S. Pat. No. 3,457,850 by ALBERT SWEET and ARNOLD KAUFMAN assigned to the assignee of the present invention. When combined with the air treatment and cleaning unit of the present invention, a complete kitchen exhaust and air cleaning system is provided.

The housing 10 has a cooking vapor inlet 18 which is connected by duct 12 to the air outlet opening 19 from the hood 15. The air inlet side of the apparatus is referred to herein as the upstream end of the apparatus while the air outlet 20 and air recirculation outlet 21 are at the downstream end of the apparatus.

An air exhaust fan 22 is positioned at the downstream end of the apparatus and the outlet from the fan provides the outlet to atmosphere of the apparatus. The fan is sized to balance the system and is dependent in its capacity with the overall load requirements of the system. By positioning the fan at the downstream end of the apparatus the cooking vapors are pulled through the cleaning system rather than being pushed through in the conventional manner. The fan is thus subject to less cleaning and maintenance problems since the air passing through the fan has been cleaned of contaminants and aerosol greases before reaching the fan inlet 24. The fan shown is of the typical centrifugal type.

Immediately inwardly of the air inlet to the housing 10 there is provided the grease extraction section 25 in accordance with the present invention. The grease extraction section contains one or more plate sections 26. Only one such section is shown in the drawing for purposes of clarity. The section 26 includes a plurality of adjacent but spaced apart plate members 27 and 29 which define between their juxtaposed surfaces 30 a series of tortuous throttling paths 28 through which the cooking vapors must pass. Thus, referring to FIGS. 1 and 1A the members 27 and 29 are affixed to end members and are so constructed and arranged that the only path from the upstream to the downstream side of the
section 26 is through the tortuous paths 28. Each member 27 and 29 in the presently preferred embodiment is an elongated member formed of sheet metal with a cross-section as shown in FIG. 1 wherein both upstream 27 and downstream 29 members are of generally trapezoidal configuration with transversely stepped sides 30 and an open base. Thus, as shown in FIG. 1A, the downstream member has a closed base 31 of greater width than the closed upstream base 32 of the upstream member such that the members 27 and 29 can be nested. The sides of both members are convergent toward the closed base with transverse steps 33 along the sides 30. When nested the sides 30 of the respective members 27 and 29 are spaced apart to thereby form the tortuous paths 28, which are the only paths from the upstream to the downstream side of the grease extractor section. Each member 27 and 29, by reason of the transverse steps 33 in the sides 30 defines a large number of impingement surfaces 33 which are substantially transverse to the direction of air flow as the contaminant laden air passes through the grease extraction section. A substantial throttling effect is provided between the adjacent points of each pair of steps in the path due to the reduction in cross-section of the path at each of these adjacent points. Further, although not apparent from the drawings, the paths can be made convergent toward the downstream side of each path by reason of the slope of the sides to provide a further throttling effect. Thus, air laden with grease particles is directed into the grease extractor at a high velocity; the step-down design of the front face of the extractor offers a multitude of surfaces in the path of the initial approach and an equal number of surfaces at 90 degrees to this path. It can be seen by reference to the figure that the contaminant laden air is reversed in direction by impingement on the base 31 of the downstream member, then forced to flow in throttling movement through the path 28 after which it is again reversed in direction by impingement on the base 32 of the upstream member. The aerosols in the air are thus impinged upon a series of surfaces transverse to their inertial direction. The grease aerosols have a greater mass than the air molecules. Hence, when the moving air strikes the impingement surfaces, the aerosols due to their high inertial force are splattered thereon. The surfaces of the members 27 and 29 are preferably coated with a low friction material such as Teflon to aid in cleaning. Due to the slippery coating of the surfaces, the grease cannot adhere and runs down to a collection trough beneath the grease extraction section 26.

As stated previously, only one baffle section is shown sectionally in FIG. 1. In the presently preferred embodiment only one such section is employed although a plurality of such sections in the grease extraction section can be utilized when necessary.

The air continues through the baffle the design, offering a progressively smaller space between each adjacent pair of "steps." causes the air stream to increase in velocity. Since the heavier aerosols impinge first, the increase in velocity imparts a heavy inertial force on the lighter remaining aerosols, this force being a function of both mass and velocity.

After passing through the step-down baffle system presented by the front face of the extractor, the air is forced between the front and rear baffles. This presents a tortuous, zig-zag path of extremely narrow width, causing the velocity to increase even more rapidly and presenting several more surfaces for grease aerosol impingement.

Thus, the present invention provides a large number of surfaces in the direct path of the air flow, providing additional surfaces at 90° to these surfaces in order to provide for impingement when turbulence occurs, and in progressively accelerating the air as it passes through the system in order to create a high inertial force in the remaining smaller aerosols.

There is shown schematically in the figures a series of water nozzles 36 which form a part of a self-contained and automatically actuated washing apparatus of the system. The washing apparatus includes a water pump 37 and suitable plumbing 38 which together with electrical control and cycling apparatus of the type well known to the art, provides a wash cycle for all of the surfaces which become contaminated. In the presently preferred embodiment apparatus and controls comparable to the conventional dishwasher are utilized to subject all of the grease extraction surfaces to a one-half hour detergent wash period, followed by a 10 minute rinse cycle and a 45 minute drying cycle.

Immediately downstream of the grease extraction section 26 is an electrical precipitator section 40 which is connected to a power supply within the apparatus. As the air passes through the precipitator section any remaining particulate material in the air is electrostatically precipitated in the manner well known to the art.

Downstream of the electrostatic precipitation section 40 there is, in the presently preferred embodiment, a deodorizing section through which the air must finally pass to complete the cleaning operation. In many applications a deodorizing section will not be necessary. In the embodiment shown a charcoal filtering material is arranged within the section to extract any remaining odor causing contaminants or aerosols.

Any desired amount of recirculation of the cleaned air can be utilized in accordance with the present invention by recirculating the clean air through the recirculating duct 14. By operation of the dampers 42, one of which is shown at the air outlet duct up to 80 percent of the air passing through the cleaning apparatus of the present invention can be recirculated over the cooking area. By the use of conventional dampers in the outlet duct 20 or in the recirculating duct 14, air can be recirculated through the recirculating duct such that from 0 to 80 percent of the make-up air requirements is recirculated cleaned air. The proportion of recirculation will depend upon climatic and cooking conditions. The air which is exhausted from outlet 20 is clean and non-polluting.

What is claimed is:

1. An apparatus for ventilating and cleaning kitchen exhaust fans having aerosol greases and contaminants exhausted from a cooking surface comprising:
a housing;
an air inlet to the housing connected to the exhaust from an air hood over the cooking surface;
an air outlet from said housing;
an exhaust fan at said outlet to pull air through the apparatus;
a grease extraction section in the housing inwardly of the exhaust air inlet, said grease extraction section including a series of baffle plates which define a plurality of air flow paths through which the exhaust air must pass, said baffle plates being so con-
structured and arranged as to provide a plurality of transverse surfaces in said air flow paths upon which air borne contaminants are impinged and collected, said baffle plates defining air flow paths having at least first and second air flow path segments, said first air flow path segment being substantially unidirectional and said second air flow path segment being substantially multidirectional, said transverse surfaces defining a progressive step-wise reduction in air flow cross sectional area along said first air flow path segment to thereby throttle the exhaust fumes passing through said grease extraction unit, said multidirectional flow consisting of a steplike path of substantially constant cross sectional area between opposing baffle plates, said second flow path opening to the exhaust outlet side of said baffle plates.

2. The apparatus as defined in claim 1 which also includes an electrostatic precipitation unit positioned to receive the air passed from the grease extraction unit.

3. The apparatus as defined in claim 2 which also includes automatic cleaning means for removing the collected grease from the grease extraction unit.

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