July 16, 1968 J. E. CHAMBERS ET AL 3,392,655

AIR HANDLING UNIT FOR INDUSTRIAL PLANTS

Filed Jan. 3, 1967 3 Sheets-Sheet 1

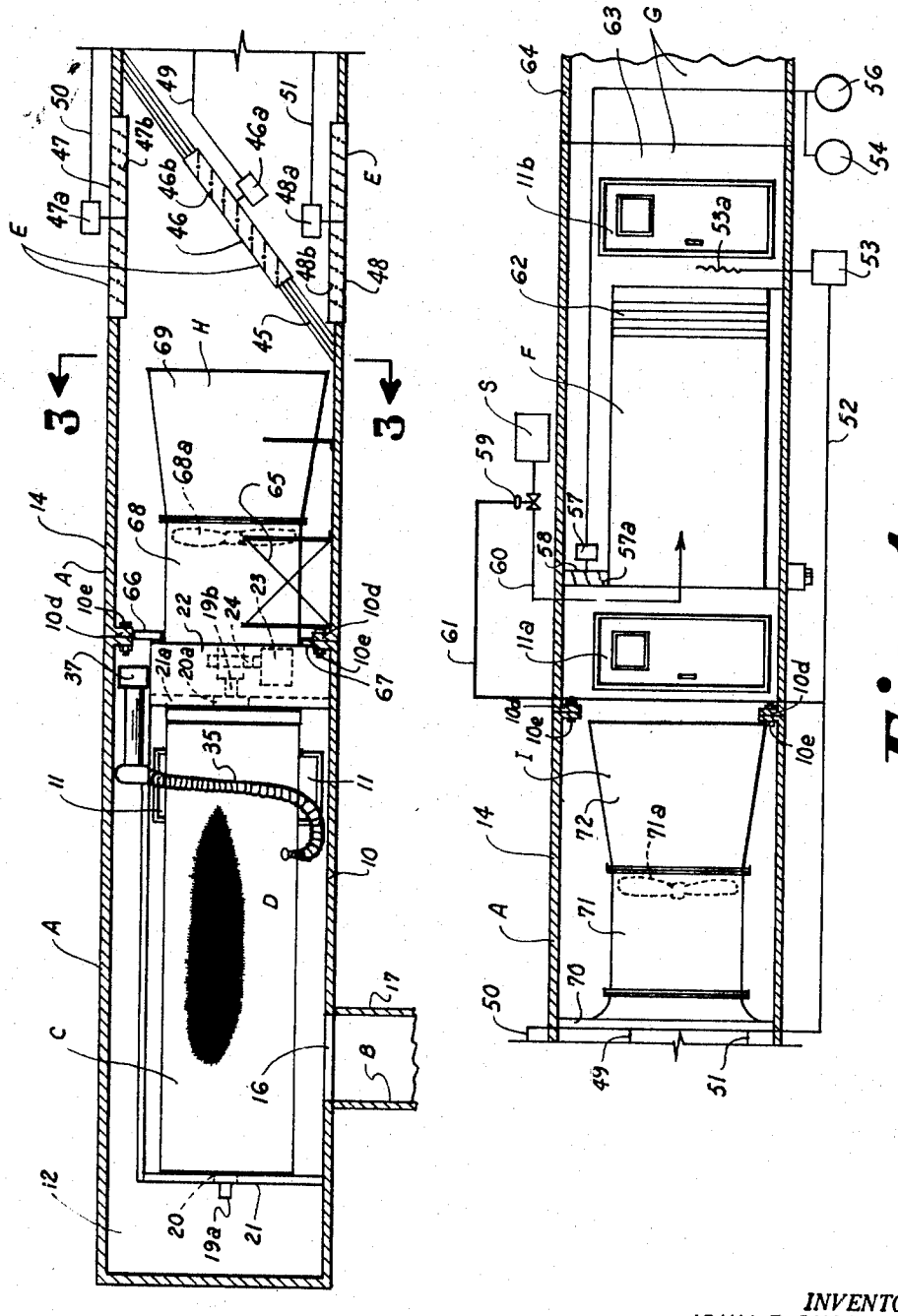


Fig. 1.

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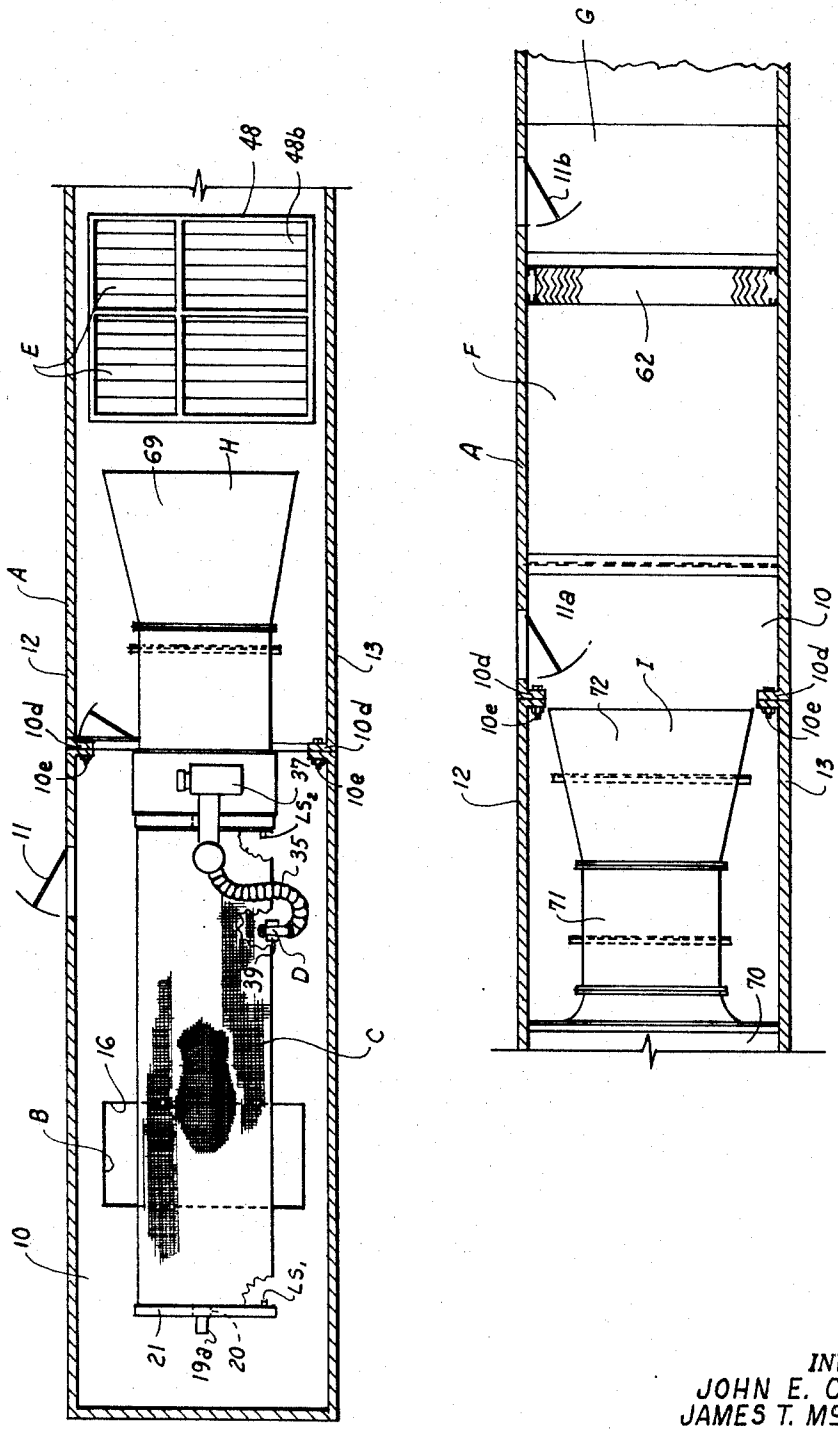


Fig. 2.

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Filed Jan. 3, 1967 3 Sheets-Sheet 3

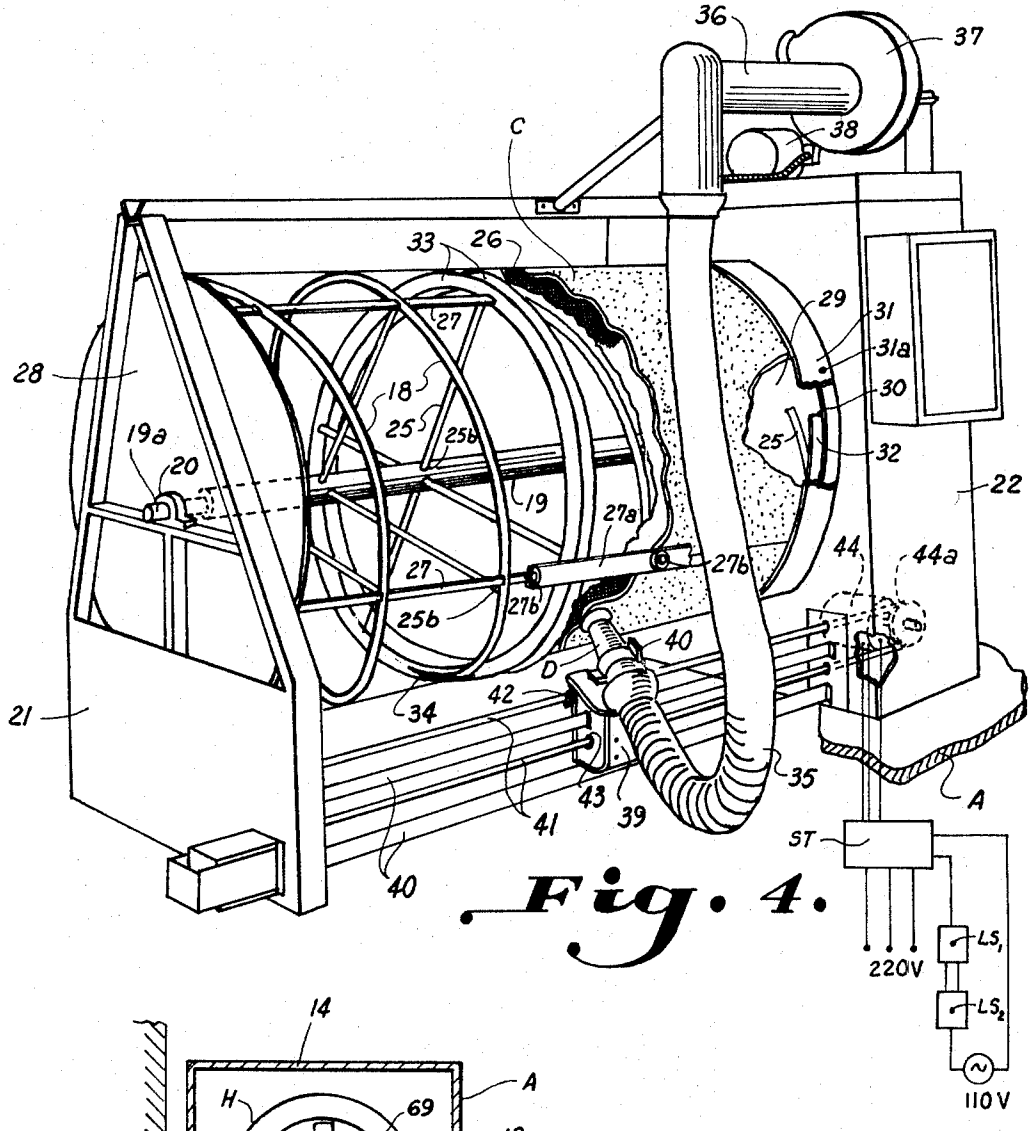


Fig. 4.

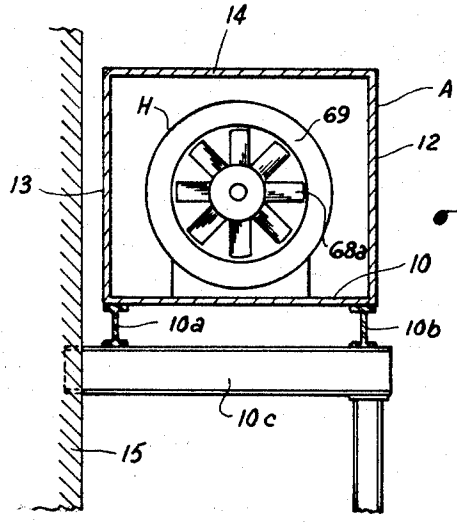


Fig. 3.

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AIR HANDLING UNIT FOR INDUSTRIAL PLANTS

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ABSTRACT OF THE DISCLOSURE

A curved filter medium offering large surface area which may be cleaned by a suction nozzle moved across such surface and which may be contained in a reduced space together with an air damper positioned between a supply air fan and a return air fan is provided permitting the filter together with an air washer and associated equipment to be contained and the air flow to such components controlled within a single substantially continuous plenum of substantially uniform cross-sectional area. The filter has a spirally wound frame affording uniformity of surface and strength against collapse.

This invention relates to air handling equipment for industrial plants, and more particularly to a unitary construction which carries the necessary filtering and washing equipment for conditioning plant air permitting unitary installation, minimization of space requirements, and minimization of power consumption.

It has formerly been the practice, for example, in textile plants, to install large flat filtering units employing a disposable filter medium for use with air washing equipment located elsewhere within the plant. The familiar apparatus tower and apparatus room are excessively large and unsightly in addition to being expensive and inefficient. Although, modern mill design has long ago provided an improved, clean line and attractive appearance and increased overall efficiency, the use of such air handling equipment persisted without substantially being changed over the years. Due to the rather haphazard arrangement of the components of plant air handling systems, many changes of direction of air flow have been necessary, resulting in loss of velocity pressure occasioning higher power consumption. Space requirements dictate such arrangement and require the construction of special installations for accommodating the excessively large working units or components of the air handling system, thus occasioning additional expense in installation, both from the standpoint of labor and material.

Accordingly, it is an important object of this invention to provide a unitary construction comprising the necessary air handling equipment for an industrial plant permitting same to be mounted on the exterior of the plant where the placement of operating machinery within the plan will not interfere with the proper arrangement of the components of the air handling equipment.

Another important object of the invention is to reduce the cost of labor and materials necessary for installing air handling equipment in industrial plants by providing a unitary construction which may be prefabricated and shipped to the plant site for unitary installation.

Another object of the invention is the minimization of space requirements by constructing a unitary air handling device which houses the components in such a way that the air may be controlled accurately with less loss of velocity pressure resulting in a more positive control of plant air conditions.

Another important object of the invention is the minimization of space requirements by providing a unitary construction which may be installed exteriorly of the

plant permitting more operating equipment to be placed within the plant.

Another object of the invention is to provide an air handling unit for industrial plants which is capable of unusually efficient operation and which is easily operated and maintained.

Another important object of the invention is to improve the appearance of industrial plants by providing a unitary air handling device of reduced size and permitting an appearance compatable with the simple clean lines of modern architectural mill design.

Another object of the invention is to provide an improved permanent filter which may be contained within a reduced space for continuous operation.

Another important object of the invention is to provide an air filter for industrial plants utilizing a permanent non-woven medium which may be fixed to an arcuate element for cleaning by a suction nozzle moved across the surface thereof.

Still another object of the invention is to provide an improved air filter for conditioning industrial plant air wherein a hollow cylindrical filter element may be easily constructed through the use of a spirally wound cylindrical structural shape achieving a uniform diameter with sufficient strength to permit substantial air flow without collapsing.

The invention contemplates the use of a curved filter medium offering large surface area which may be cleaned by a suction nozzle moved across such surface and which may be contained in a reduced space together with an air damper positioned between a supply air fan and a return air fan, permitting the filter together with an air washer and associated equipment to be contained and the air flow to such components controlled within a single substantially continuous plenum of substantially uniform cross-sectional area.

The construction designed to carry out the invention will be hereinafter described, together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown and wherein:

FIGURE 1 is a schematic longitudinal sectional elevation, with parts omitted, illustrating the plenum and interior components together with control devices for regulating air flow in an air handling unit constructed in accordance with the present invention,

FIGURE 2 is a schematic sectional plan view of the components illustrated in FIGURE 1.

FIGURE 3 is a transverse sectional elevation taken on the line 4—4 in FIGURE 1 illustrating the manner of mounting same for plant operation, and

FIGURE 4 is an enlarged perspective view illustrating the filter unit shown schematically in the left-hand end of the plenum of FIGURE 1.

Referring more particularly to the drawings, an air handling unit for conditioning air for an industrial plant and the like is illustrated. An elongated unitary plenum A includes a structural base, means for mounting the plenum exteriorly of the plant, and an access opening permitting a worker to enter and walk within the plenum for servicing purposes. A return air inlet B is provided in the plenum adjacent one end thereof for introducing air from the plant into the plenum. An arcuate filter medium C is mounted within the plenum adjacent the return air inlet for receiving air from the return air inlet for filtering same. A suction nozzle D is movable across the surface of the medium for cleaning same on the return air inlet side thereof. A damper section E receiving air after the air has passed through the filter medium includes a

wall extending across the interior of the plenum, an air passageway in the wall, a relief air outlet in the plenum on the return air inlet side of the wall, an outside air inlet in the plenum on the return air outlet side of the wall remote from the relief air outlet, and means partially and fully opening the passageway and the relief air outlet and the outside air inlet. An air washer section F receives air after it has passed through the damper section. A supply air outlet G adjacent the other end of the plenum discharges conditioned air into the plant. A return air fan H within the plenum positioned on the return air inlet side of the damper section moves air through the filter medium. A supply air fan I within the plenum positioned on the supply air outlet side of the damper section moves air through the washer section. Thus, the plenum carries the necessary filtering and washing equipment for conditioning plant air permitting unitary installation, minimization of space requirements, and minimization of power consumption.

The elongated unitary plenum A includes a structural base **10** which is capable of supporting the equipment contained therein and permitting a man to walk within the plenum. For maintenance purposes a worker may gain entrance into the plenum through the doors **11**, **11***a* and **11***b* (FIGURES 1 and 2) on one side of the plenum **12**. By reference to FIGURE 3, it will be noted that the plenum has a side **13** opposite the side **12** and a top **14**. The base **10** is preferably constructed of insulated sheet material and has longitudinal structural supports **10***a* and **10***b*, together with a suitable base support **10***c* for attaching the entire unit to the exterior wall **15** of a plant or similar structure. The insulated sheet material preferably has sufficient rigidity to support a man without excessive flexing.

Referring to FIGURES 1 and 2, it will be noted that a return air inlet B is provided in the plenum A in the base **10** adjacent the left-hand end thereof for introducing plant air into the plenum. The air inlet B includes a rectangular passageway **16** within the base **10**, together with a plant air duct **17** for bringing air from the plant and through the exterior wall thereof into the plenum A.

An arcuate filter medium C is mounted within the plenum adjacent the return air inlet B for filtering air received from the plant. It is significant that the filter medium assumes an arcuate configuration, thus making possible an increased area of filter surface for the space occupied thereby as compared to the flat filters customarily in use. The filter is thus capable of accommodating a relatively large volume of air for the space occupied thereby permitting the unitary construction described herein. Were it not for the relatively small space occupied by the filter it would be impractical to house the filter element within an enclosure of a practical size which would permit its use with the other elements of the unit. It is also significant that the suction nozzle D is movable across the surface of the curved filter medium for cleaning the filter medium. Otherwise, it would be necessary to change the filter medium when such became charged with lint or other particles filtered from the plant air. The nozzle D is mounted for longitudinal reciprocating motion relative to the arcuate filter medium which is illustrated here in the form of a rotating drum. The filter medium itself is preferably non-woven polyester such as Viskon-aire, manufactured by Chicopee Mills, Inc., 1450 Broadway, New York, N.Y.

It will be noted that the arcuate filter medium C is in the form of a hollow cylinder which includes an elongated spirally wound structural element **18** which generates the substantially cylindrical configuration (FIGURE 4). Preferably, the spiral element **18** is constructed from a hollow pipe material on a spiral forming machine. A centrally disposed shaft **19** extends axially through the spirally wound element and is journalled as at **19***a* within a bearing stand **20** which is carried by an end support **21**. The shaft **19** is journalled within a complementary bearing stand **20***a* carried within an end support **21***a* carried within the housing **22** (FIGURE 1). The housing **22** supports a motor **23** for driving a journalled portion of the shaft **19***b* through suitable gearing **24**.

Referring now to FIGURE 4, it will be observed that a plurality of spaced radially extending spokes **25** are each fixed on one end of the shaft **19** as by welding **25***a*, and on the other end to the adjacent portion of the spiral element as at **25***b*. A wire mesh, which may be in the form of woven wires or flat expanded metal as is illustrated at **26**, covers the cylinder. The mesh is suitably secured on the exterior of the spirally wound element **18** as by welding (not shown). Preferably, spaced longitudinal supports **27** are fixed on each end between the spiral element to provide rigidity and strength against collapsing of the cylinder. The filter medium C may be secured to the mesh **26** as by a flat longitudinal gripping strip **27***a*, which is secured as by a threaded fastening means **27***b* which threadably engages the adjacent support **27** so that the strip may be pulled up tightly confining the medium between the strip and support.

It will be observed in FIGURE 4 that the cylinder is closed on one end as at **28**. The other end of the cylinder is open as illustrated at **29**. The housing **22** has an annular outwardly extending flange **30** carried thereby for carrying an annular leather portion **31** secured on the outside thereof, as by rivets **31***a*. An annular rim **32** is carried by the adjacent spiral portion **18** and defines the opening **29**. The rim **32** turns within the leather portion **31** to provide a substantially air tight bearing. It will be observed that the spiral portions are constructed in sections, each provided with a circular end piece as at **33**. These end pieces are butted together and welded. The spiral is brought to a taper as at **34** at each end thereof, and welded to its respective end piece as described above. Thus, any desired number of sections may be employed as called for by the volume of air to be filtered.

The nozzle D is attached to flexible tubing **35** on one end and on the other through a suitable chamber **36** to an impellar fan **37**. The fan may be driven through any of the usual suitable means (not shown) by the motor **38**. The nozzle D is fixed upon a carriage **39** as by the strap **40**. The traversing carriage **39** is mounted for sliding movement upon the spaced parallel bars **40**. A looped belt **41** has fixed connection with the carriage as by the bracket **42**, and is slidable through the opening **43** within the carriage **39**. A reversing motor **44** drives the belt **41** through the pulley **44***a* for traversing movement back and forth across the entire length of the cylinder.

The motor **44** is energized from a 220 volt three phase source through a conventional starter ST. The controls for the starter include a pair of conventional three-way limit switches LS_1 and LS_2. The limit switches are wired together in a conventional manner and connected to a 110 volt source so that when one of the limit switches is closed by engagement by the carriage **39** the motor **44** will rotate in one direction to move the carriage across the filter and when the other limit switch is closed the motor will change direction.

It is important that the cylinder maintain a uniform cylindrical configuration in order to permit the nozzle to pass closely adjacent the surface of the filter medium as it traverses linearly back and forth across the filter surface. This is made possible through the spiral construction which offers such resistance to axial forces as tend to crush the cylinder as to effectively minimize the need for longitudinal braces, thus simplifying and lightening the construction which would otherwise be necessary. It has been found, for example, that it is impractical to use circular hoops tied by spokes to the central shaft and joined with longitudinal bracing because such cylinders would crush under the air pressure beginning with axial displacement of the hoops nearest the end closure

28 where the force is greatest. Then too, it is difficult to maintain a reasonably true cylindrical configuration with such a construction.

A damper section E receives air after it has passed through the filter medium for the purpose of controlling the amount of outside air which is added to the air going to the plant dependent upon conditions desired in the plant. The damper section E includes a wall **45** which extends across the interior of the plenum A, and is preferably inclined at about a 45 degree angle, as illustrated in FIGURE 1. An air passageway **46** is carried within the wall. A relief air outlet is illustrated at **47** on the return air inlet side of the wall. An outside air inlet **48** is provided in the plenum on the return air outlet side of the wall remote from the relief air outlet **47**. It is important that the outside air inlet and the relief air outlet are remote from each other to avoid short circuiting of the air and preferably this is accomplished by placing them opposite each other as illustrated in FIGURE 1.

Means are provided for controlling the extent of opening of the passageway **46**, the relief air outlet **47**, and the outside air inlet **48** in the form of motors **46***a*, **47***a* and **48***a* which control louvers **46***b*, **47***b* and **48***b*, respectively. These motors are controlled pneumatically through the lines **49**, **50** and **51**, respectively, which connect through the line **52** to a dew point control **53**, the bulb **53***a* of which extends adjacent the discharge portion of the air washer F. While pneumatic controls are illustrated, it is to be understood that any of the usual controls including those of the electric type may be used. A plant temperature control **54** is associated with the humidity control **56** which controls a motor **57** for controlling the louvers **57***a* of the air bypass **58**. A water temperature control valve **59** controls the temperature of the water taken from a suitable supply S through the line **60** while being controlled through the line **61**. The air washer section F, which may be of standard type, receives air after it has passed through the damper section E. The air washer section includes the usual sprayers (not shown), and is provided with a high velocity eliminator **62** which may be of the type sold under the trademark Luwa, manufactured by the Pneumafil Corporation of Charlotte, N.C. The air discharged from the washer section into the plant may be moisture saturated but should not contain free moisture. With this damper section bypass and the controls and parts associated therewith any control sequence can be accomplished as dictated by desired mill conditions.

An air supply outlet G includes an opening **63** in the plenum and a duct section **64** for carrying air from the plenum through the plant wall into the plant.

A return air fan H is positioned within the plenum on the return air inlet side of the damper section for moving air through the filter medium. The fan H is preferably of an axial flow type and is provided with a suitable support within the plenum illustrated at **65**. Partitions **66** and **67** are provided so that air coming through the inlet B must pass through the filter C before entering the fan housing **68** which carries the blades **68***a*. The outlet diffser **69** of the fan discharges air in a path to pass linearly through the opening **46** in the wall **45** and when the relief air port **47** is opened a curved path is provided for the air which minimizes turbulence and permits a smooth flow of air within a minimum loss of velocity pressure.

The fan I draws air through the wall **70** and again a smooth path is provided for the air by the inlet opening **48** which is positioned opposite the passageway **46** on the supply air side of the plenum. The supply air fan I has a housing **71** carrying the blades **71***a*, and an outlet diffuser **72** for discharging air into the washer section of the plenum. It is important that the damper section E be positioned between the return air section H and the supply air fan I, although these fans could be in a somewhat different physical position with respect to the adjacent filter and washer, respectively.

It is thus seen that the air handling apparatus tower, apparatus room and associated equipment so often seen in industrial plants have been replaced by a simple well accommodated device. The working parts are efficient and well controlled, making it possible to accomplish conditioning of a given quantity of air with equipment of minimum rating. The plenum A may be constructed and transported to the job site in several unitary sections wherein the adjoining ends to the plenum form inturned flanges **10***a* joined in the field as by bolts **10***b*. The unitary installation thus achieved greatly minimizes installation problems and frees space within the plant to be put to other uses.

In one particular embodiment a heating coil is placed in the plenum A between the damping mechanism and the supply air fan for raising the temperature of the air before supplying such to the washer. Such aids in controlling the humidity of the air by increasing the temperature thereof.

In another embodiment a reheat coil is positioned in the air bypass, or such can be placed in the air supply outlet G for increasing the temperature of the air passing therethrough prior to entrance into the mill. The purpose for raising such temperature is to maintain the proper humidity and temperature within the mill. Normally, the heat from the machines being used within the mill is sufficient to maintain the temperature at a proper level. However, when the machines have been shut-down the temperature within the mill drops below the desired operating level and such can be raised by the heated air passing thereinto.

Another means for increasing the temperature of the air passing through the plenum is by inserting live steam into the water being circulated through the washer system. Such can be accomplished by the use of a steam pipe supplying the steam directly into the water associated with the washer.

While a preferred embodiment of the invention has been described using specific terms, such description is for illustrative purposes only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following claims.

What is claimed is:

1. An air handling unit for conditioning air for an industrial plant and the like comprising: an elongated unitary plenum; said plenum including a structural base, means for mounting said plenum exteriorly of the plant, and an access opening permitting a worker to enter and walk within the plenum for servicing purposes; a return air inlet in the plenum adjacent one end thereof for introducing air from the plant into the plenum; a filter having an arcuate filter medium mounted within the plenum adjacent the return air inlet receiving air from the return air inlet for filtering same; a suction nozzle movable across the surface of said filter medium for cleaning same on the return air inlet side thereof; a damper section receiving air after the air has passed through the filter medium, said damper section including a wall extending across the interior of the plenum, an air passageway in said wall, a relief air outlet in the plenum on the return air inlet side of the wall, an outside air inlet in the plenum on the return air outlet side of the wall remote from said relief air outlet, and means partially and fully opening said passageway and the relief air outlet and the outside air inlet; an air washer section within the plenum receiving air after the air has passed through the damper section; a supply air outlet adjacent the other end of the plenum for discharging conditioned air into the plant; a return air fan within the plenum moving air through the filter medium positioned on the return air inlet side of the damper section; and a supply air fan within the plenum moving air through the washer section positioned on the supply air outlet side of the damper section; whereby the

plenum carries the necessary filtering and washing equipment for conditioning plant air permitting unitary installation, minimization of space requirements and minimization of power consumption.

2. The structure set forth in claim 1, wherein said wall is inclined across said plenum, said relief air outlet and said outside air inlet being substantially opposite each other and substantially opposite said air passageway.

3. The structure set forth in claim 1, wherein said plenum is substantially straight and of continuous substantially uniform cross-section.

4. The structure set forth in claim 1, wherein said filter medium is a non-woven fibrous synthetic polymeric material.

5. The structure set forth in claim 1, wherein said air filter includes, a rotatable hollow cylinder having, an elongated spirally wound structural element generating a substantially cylindrical configuration, a central shaft extending axially through said spirally wound element, a plurality of spaced radially extending spokes each extending from and being fixed to said shaft on one end thereof and being secured to the spirally wound element on the other end thereof, and a wire mesh covering and being secured to the spirally wound structural element; said filter medium covering said wire mesh and being supported thereby; said suction nozzle being movable longitudinally of said filter medium closely adjacent the outer surface thereof; and means rotating said cylinder.

6. The structure set forth in claim 2, wherein said air filter includes, an industrial plant and the like comprising; a rotatable hollow cylinder having, an elongated spirally wound structural element generating a substantially cylindrical configuration, a central shaft extending axially through said spirally wound element, a plurality of spaced radially extending spokes each extending from and being fixed to said shaft on one end thereof and being secured to the spirally wound element on the other end thereof, and a wire mesh covering and being secured to the spirally wound structural element; said filter medium covering said wire mesh and being supported thereby being a non-woven fibrous synthetic polymeric material; said suction nozzle being movable longitudinally of said filter medium closely adjacent the outer surface thereof; and means rotating said cylinder.

7. The structure set forth in claim 2, wherein a heating element is carried within said plenum for raising the temperature of the air passing therethrough.

8. An air filter for use in conditioning air for an industrial plant and the like comprising; a rotatable hollow cylinder including, an elongated spirally wound structural element generating a substantially cylindrical configuration, a central shaft extending axially through said spirally wound element, a plurality of spaced radially extending spokes each extending from and being fixed to said shaft on one end thereof and being secured to the spirally wound element on the other end thereof, and a wire mesh covering and being secured to the spirally wound structural element; a non-woven filter medium covering said wire mesh and being supported thereby; a suction nozzle movable longitudinally of said filter medium closely adjacent the outer surface thereof; means rotating said cylinder; and means creating a negative air pressure within the cylinder.

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