System for purifying air.

A system for purifying and possibly conditioning of air in buildings and suchlike is shown, having a feeding duct (16) to the building, an exhaust duct (22) from the building and a recirculation connection (23), blowers (1,2) and filter means (4,5,6) in which the feeding duct contains a dust filter (4), an electronic filter (5) having a fibre mat in an electric field without causing ionisation, and an active carbon filter (6), the system being suitable to recirculate all the exhaust air.
With air conditioning in buildings and suchlike in many cases results are dissatisfying in spite of considerable efforts. This shows up in so-called "sick building" phenomena. Apart from psychological factors, such as separation from the open air, the cause of them, which is not completely known, may be mainly due to the actual condition of the air.

The air is mainly sucked in from the open, heated or cooled, possibly submitted to humidity control and fed into rooms in which persons are present. Filtering of the air is normally carried out with rather coarse filters. Moreover costs for conditioning the large quantity of outside air, which is sucked in, are considerable.

With cooling of the outside air in many cases it is reheated a little in order to reduce the relative humidity and to avoid blowing in of air of a too low temperature.

Partial recirculation of air from the user's rooms has been shown in the college dictate of Prof. Ir. A.W. Boeke et al, in which recirculation air together with fresh air is conditioned by heating and moistening, after which the air stream is split in a branch which is additionally heated and a branch which is not subject to additional treatment.

A mixture of air from the branches is used in the user's rooms. The results of this system were not always satisfying, which may be due to the fact, that only a limited recirculation percentage is allowed in order to prevent smells and odours to be introduced into conditioned rooms. This means a relatively high energy consumption.

It has already been proposed to improve filtering of the air by means of an electrostatic filter. This induces the disadvantage that ions and possibly ozone and nitrogen oxides are generated, which is considered to contribute to the "sick building syndrome".

Starting from a system for purifying air in a building or suchlike, provided with an air inlet, an air feed duct, an air exhaust, an air exhaust duct and a recirculation connection between the exhaust duct and the feed duct, which system is provided with control means for the feed, the exhaust and the recirculation connection, as well as blowers to maintain an air circulation from the feed duct towards the building or suchlike, through the building or suchlike and from there to the exhaust duct, the exhaust and/or the recirculation connection, the invention aims to provide a system, which consumes relatively little energy and suppresses or at least reduces to a considerable extend the phenomena of the "sick building syndrome", such as headache, irritation of the skin, eyes and bronchial tubes, dizziness and nausea, frontal sinus inflammations, coughing, sore throats, shortness of breath and allergic complaints.

According to the invention this aim is realized in that the filter means contains-successively a dust filter, an electronic filter and an active carbon filter and in that the recirculation connection is adapted to recirculate a fair amount such as at least 80% of the air from the exhaust duct and preferably 100%.

With the invention the air fed into the building is free or almost free from bacteria, viruses, dust particles and fungi. It is remarked that with the actual systems fungi flourish well, especially in systems containing air humidification apparatus.

Further an electronic filter, which in this specification means a filter having at least one layer of electrically polarized fibres of insulating material, such as glass fibres, has a high filtering capacity, relatively low stream resistance and none or only very little ionisation of the air fed through the filter.

A further advantage of the invention is, that the recirculated air, which according to the invention is used to a considerable extend, is already conditioned relatively well for the used in the building by f.i. the people in the building, plants and so on, which humidify the air in a very mild way. Moreover this air is already at or very near to the desired temperature, so that energy consumption is low. The most important advantage is, however, that people feel far better in buildings served by an inventive system. In this respect it may be pointed to the fact that the said publication of Prof. Ir. W.A. Boeke et al describes actual practice, in which recirculation, if any, has to be at a very reduced scale.

Further it has appeared that with use of the indicated filter means inconvenient smells disappear, that bacteria or viruses brought in by human beings in the building are caught effectively, the purified air is experienced to be agreeable and that differences between the condition of air already present in a room and of air fed in, are so small, that no disturbing effects occur.

With respect to the filter means used in the inventive system it is remarked that electrostatic filters having one or more ionisation sections and a permeable structure of insulating material are known from f.i. the article "Portable purifiers ecologize the home" of Westinghouse, from 903 Machine Design, vol. 43, July 8, 1971, nr. 17.

NL-A-8200382 shows a transportable filter unit having a prefilter, an electrostatic filter and a carbon filter.

Finally NL-A-7206447 shows a portable air filter-blower combination having an ionization section and a dust catching section of insulating material, which sections are integrated.

An electronic filter as used with the invention has been developed by Engineering Dynamics Ltd in Canada. When applied with the invention it is preferred that the electronic filter contains the suc-
cession of a grid, a fibre mat of insulating material, a second grid, a second fibre mat of insulating material, a third grid and electrical connections for at the one hand the first and third grids and at the other hand the second grid. Besides a good filtering capacity, this procures the possibility to connect the outer grids with earth, so that no danger exists for people contacting the filter layer.

When the inventive system also has to serve the purpose of heating the building or suchlike, it is to be preferred that the feed duct by means of a plurality of branch ducts is connected to a plurality of rooms, which each are connected to the exhaust duct, whereby according to a further elaboration of the invention heating means are inserted in the branch ducts. Because with the invention the total added quantity of energy is considerably less than with systems in which almost the total quantity of circulating air has to be replaced, the heating capacity may be smaller. By reason hereof separate heating means can easily be realized. The most important advantage of this feature is, however, that people in the building may control the temperature in their own room independently from the other conditions in the building.

According to a further elaboration of the invention in the feed duct a cooling device with a droplet captor are provided. Though such a feature is known per se in air conditioning systems, it should be remarked that with the invention no reheating by means of separate heaters is used to lower the relative humidity or to prevent that air is blown in, which is too cold. Heating of the air in the duct occurs by heat transmittance from the duct itself and/or the higher temperature in the rooms into which the air is fed.

Applying the invention means recirculation of a very important portion of the air exhausted through the exhaust duct. In practice it often may be provided that the total air quantity from the exhaust duct is recirculated, because no building is really air-tight. With application of the invention things are such that with all or nearly all weather conditions at least 80% of the air from the exhaust duct is recirculated.

According to a further aspect the invention provides a method for using the inventive system, which method is characterized in that at least 80% of the air from the exhaust duct via the recirculation connection is fed into the feed duct.

In the following the invention is elucidated on hand of the drawing in which a scheme of an inventive system has been shown.

In the drawing 1 is a feeding blower, which preferably can be adjusted on two rotational speeds. Reference 2 indicates the exhaust blower, which also preferably can be adjusted on two rotational speeds. Reference 3 is a valve section which is served by the control unit M to control in mutual agreement the percentage recirculation air and newly fed in air as will be discussed further on. In the feed duct 16 successively are present a prefilter 4 (class F1), an electronic filter 5, an active carbon filter 6, a space 7 for an optional heating battery, if any, an optional cooling device, the cool medium evaporator 8 of which is in heat exchanging relation with the air in the duct 16, whereby the evaporated cooling medium is compressed by compressor 9 to condense in condenser 10, which is cooled by means of a condenser blower 11 and may stream via the expansion device 17 towards the evaporator 8. After the section with the evaporator 8 follows a condense discharge 18, which also services the purpose of droplet captor.

After this follows the already mentioned feeding blower 1 with a sound damper 15. There beyond the feeding duct 16 is divided into two ducts 16a and 16b to feed the air into two rooms 19a and 19b via small heating elements 20a and 20b respectively, which preferably are controlled by a thermostat in the rooms 19a or 19b. The air is exhausted via the partial exhaust ducts 21a and 21b towards the exhaust duct 22 in which the exhaust blower 2 and a further sound damper 15 are mounted. The air coming from the exhaust duct to a considerable extend is fed towards the recirculation connection 23 and a relatively small part which may be zero with a leak building or under suitable conditions is carried off to the outside via exhaust 24. The air which is exhausted via 24 is replaced by air fed in through inlet 25. The control apparatus M controls valve groups 3 to realize the desired recirculation.

Further the system contains an outside air temperature sensor 14, a sensor 13 for the air fed into the building and a temperature/hygienic feeler 12 for measurement of the temperature and in some way or the other determining the quality of the exhausted air or at least some property of it. With the data from 12,13 and 14 the valve groups 3 may be controlled as well as in case of cooling the system 8,9,10,11 and 17 and/or any heating element present in 7.

It will be clear that the above described system contains only an embodiment of the invention. In many applications in f.i. the Netherlands the cooling sections need not to be present, whereas it is also possible not to apply the division of the building in different circuits, i.e. in simple buildings.

Generally the air recirculation through 23 will amount at least 80% of the air volume flowing through exhaust duct 22. If, however, an excessive pollution occurs, which difficulty can be removed by the filters 4,5 and 6 (smoke generation with a fire), then groups 3 may see to a lower recirculation percentage. With normal use in buildings in
which people are present, such as hospitals, offices, workshops, hotels and suchlike a recirculation amount of more than 80% is normally allowable and therefore desired.

Claims

1. Air purifying system for a building or suchlike, provided with an air inlet (25), an air feed duct (16), an air exhaust duct (22), an air exhaust (24) and a recirculation connection (23) between the air exhaust duct and the air feed duct, the latter containing filter means and control means being present for the inlet, the exhaust and the recirculation connection, and further blowers (1,2) to maintain an air circulation through the air feeding duct, the air exhaust duct and the recirculation connection, characterized in that the filter means contain in succession a dust filter, an electronic filter and an active carbon filter.

2. System according to claim 1, characterized in that the recirculation connection has the capacity to recirculate the total air flow through the exhaust duct.

3. System according to claim 1, characterized in the electronic filter (5) contains in succession a grid, a fibre mat of insulating material, a second grid, a second fibre mat of insulating material, a third grid and electrical connections for the first and third grids at the one hand and the second grid at the other hand.

4. System according to claim 1, in which the feeding duct is connected to a plurality of rooms by means of a plurality of branch ducts, characterized in that heating means are mounted in the branch ducts.

5. Systems according to claim 1, characterized in that a cooling device with a droplet captor device (18) are mounted in the feed duct.

6. Method for using the device according to claim 1, characterized in that at least 80% of the air flowing through the exhaust duct (22) is recirculated through the recirculation connection (23) to the feed duct.