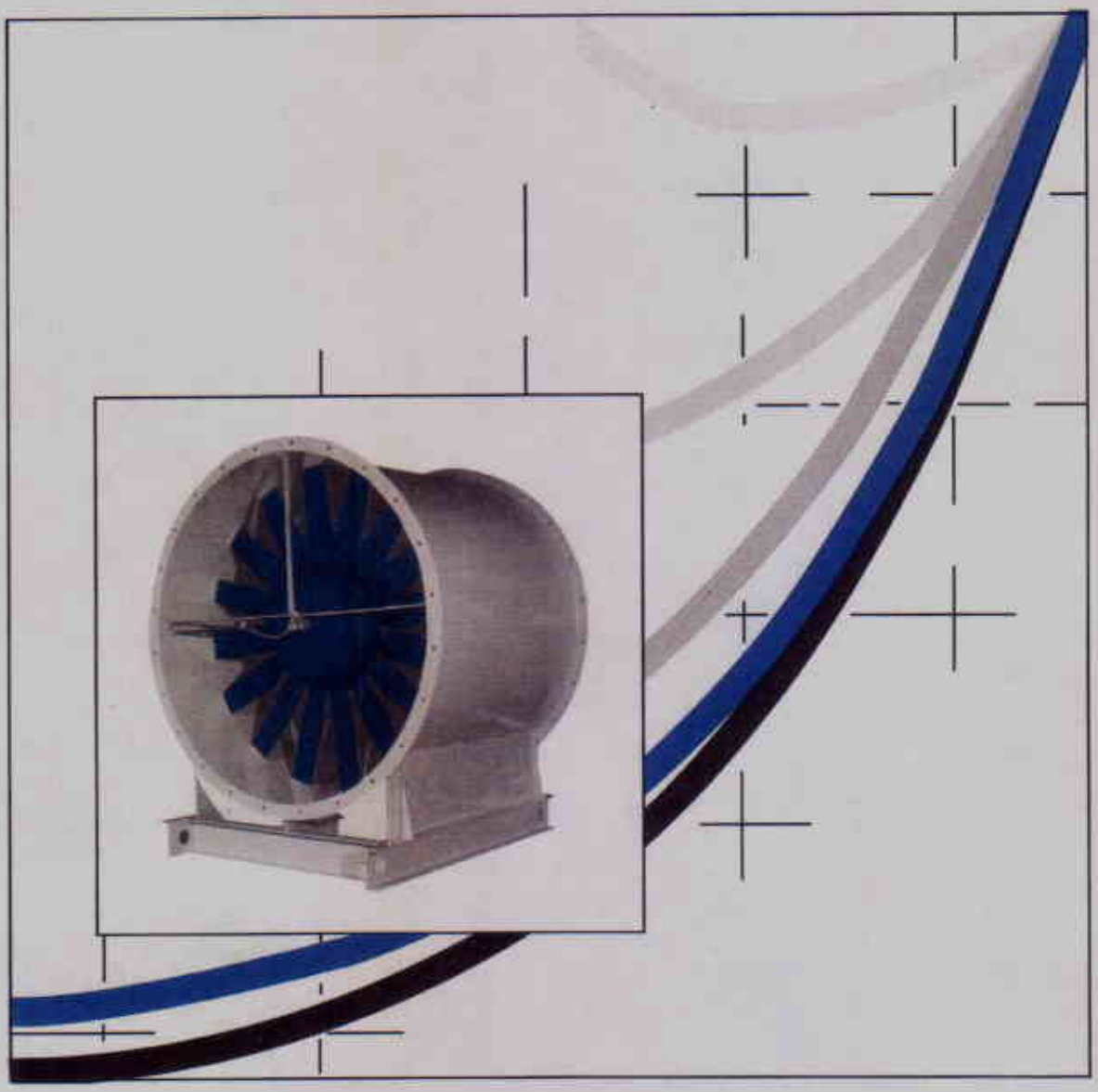
American Fan Company

Bulletin-VF2000

CONTROLLABLE PITCH



THE ADVANCED VAROFOIL

Index

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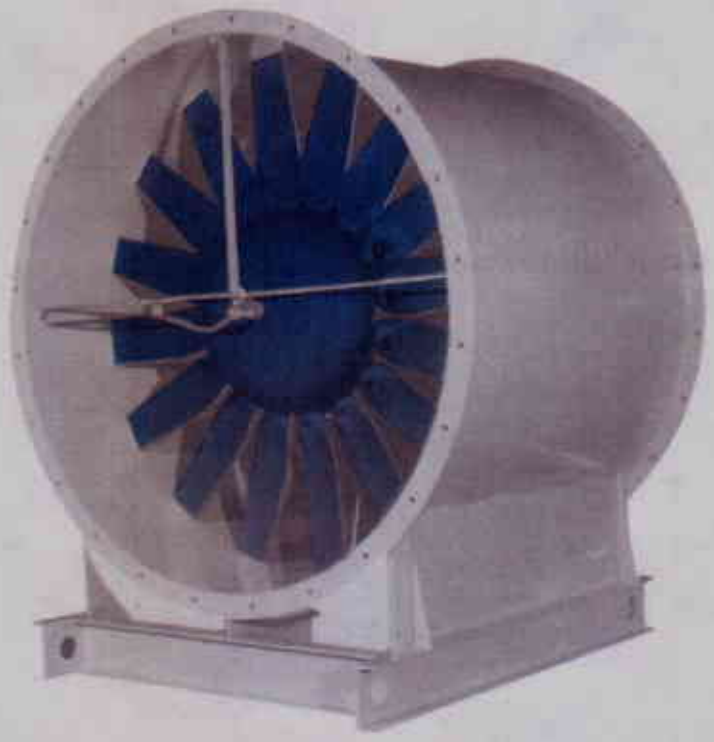
The Advanced Varofoil



The VAROFOIL, variable-pitch-in-motion fan has been operating successfully for many years in a wide variety of variable duty air system applications. The very significant power savings, reliability, and negligible maintenance requirements forecast with Varofoil are now a reality to owners and operators in schools, hospitals, office buildings, theatres, car plants, mines, glassworks, tunnels and many other commercial and industrial applications throughout the world.

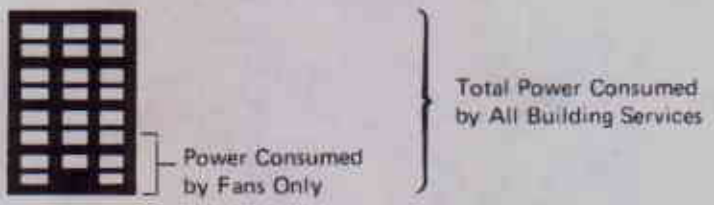
From this well-proven background and the use of the latest computer aided aerodynamic-design techniques, Woods have developed the ADVANCED VAROFOIL, a new generation of variable-pitch-in-motion fans, providing optimum control, power savings, and reliability in a range of easily installed and maintained low-weight axial fans.

Power Savings through Variable Duty Air Systems

The high cost of electrical power is now a major criterion in the selection and operation of plant and equipment in every industry Predictions on future energy costs make the selection process even more critical.

Air conditioning systems for human comfort or for industrial process control are no exception and can account for a high proportion of the total power consumed by services in a commercial or industrial building.

A large proportion of this power is consumed by the fans moving the air through the systems.



At constant efficiency the power absorbed by the fan impeller in moving air would normally reduce in proportion to the cube of the airflow rate.

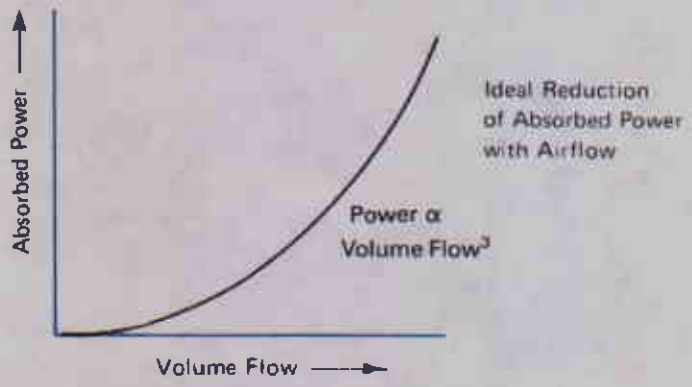


Fig. 1

20% Reduction in Air Volume – approximately 50% Reduction in Absorbed Power

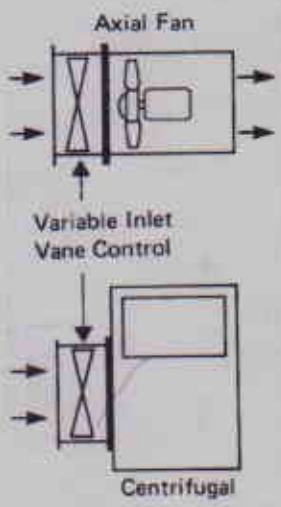
50% Reduction in Air Volume – approximately 87% Reduction in Absorbed Power

Methods of reducing Volume flow

Traditional methods of reducing air volume have included dampers in the duct system, fan variable inlet vanes and fan speed control.

Damper Control in the duct system, whether used as an artificial resistance or to provide a by-pass of part of the airflow provides little or no saving in power consumption at reduced airflows, and often generates noise.

Fan Variable Inlet Vane Control can provide a relatively more efficient method of reducing airflow than straight dampering in the duct system. The vanes pre-rotate the air thus reducing the work done in the fan impeller and so provide a moderate reduction in power consumption (Fig. 2).



Its inherent disadvantages are that sound power level rises as airflow is reduced, instability can occur if flow is reduced below approximately 50% of maximum and response to control is not linear.

There is also a pressure loss across the inlet guide vane, which represents an additional power requirement to operate the fan.

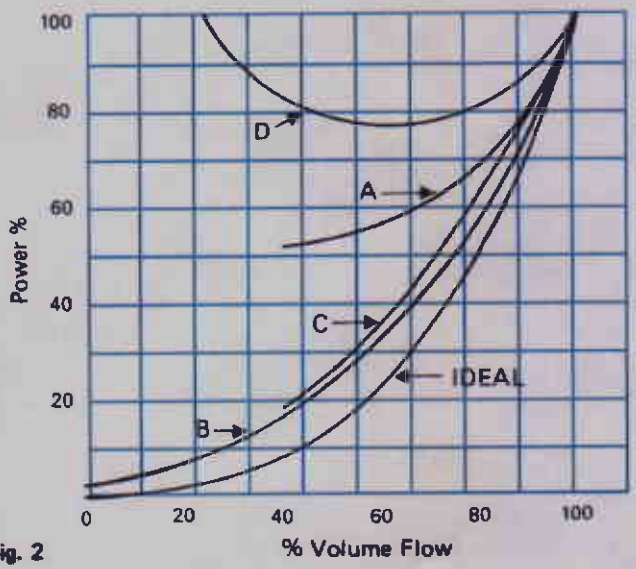


Fig. 2

Various methods of volume regulation:

A. Inlet vane control on Centrifugal fan
B. Variable pitch Axial flow fan
C. Variable speed, Axial and Centrifugal fan
D. Inlet Vane Control. Axial Flow Fan

Fan Speed Control offers an efficient method of reducing airflow. Reduction in power consumption with reduced flow only differing from the ideal cube law by the amount of mechanical and/or electrical control losses (Fig. 2).

Its use in fan applications has been limited by high initial cost and space demands. With change in electronics technology, frequency control of AC motors may provide a more economical means of speed control for some variable volume systems.

Not all systems in industrial or commercial applications necessarily follow the well known square law i.e. system pressure drop varying as $(\text{volume})^2$.

The fan pressure development also reduces as $(\text{speed})^2$ and therefore means that this form of control may not be suitable for systems requiring an element of constant pressure.

The Variable-Pitch-In-Motion axial flow fan will match the demand of any system characteristic [Fig. 3(c)] whether the application requires

– Constant Pressure maintained with Varying Volume

– Constant Volume maintained with Varying Pressure

– Pressure varying normally with Volume (as square of Volume)

– Part of system with constant pressure requirement, remainder with pressure varying normally with Volume (as square of Volume)

This is achieved very simply. The pitch angles of the impeller blades are automatically and simultaneously varied while the fan is running, to achieve the airflow and pressure demand of the system.

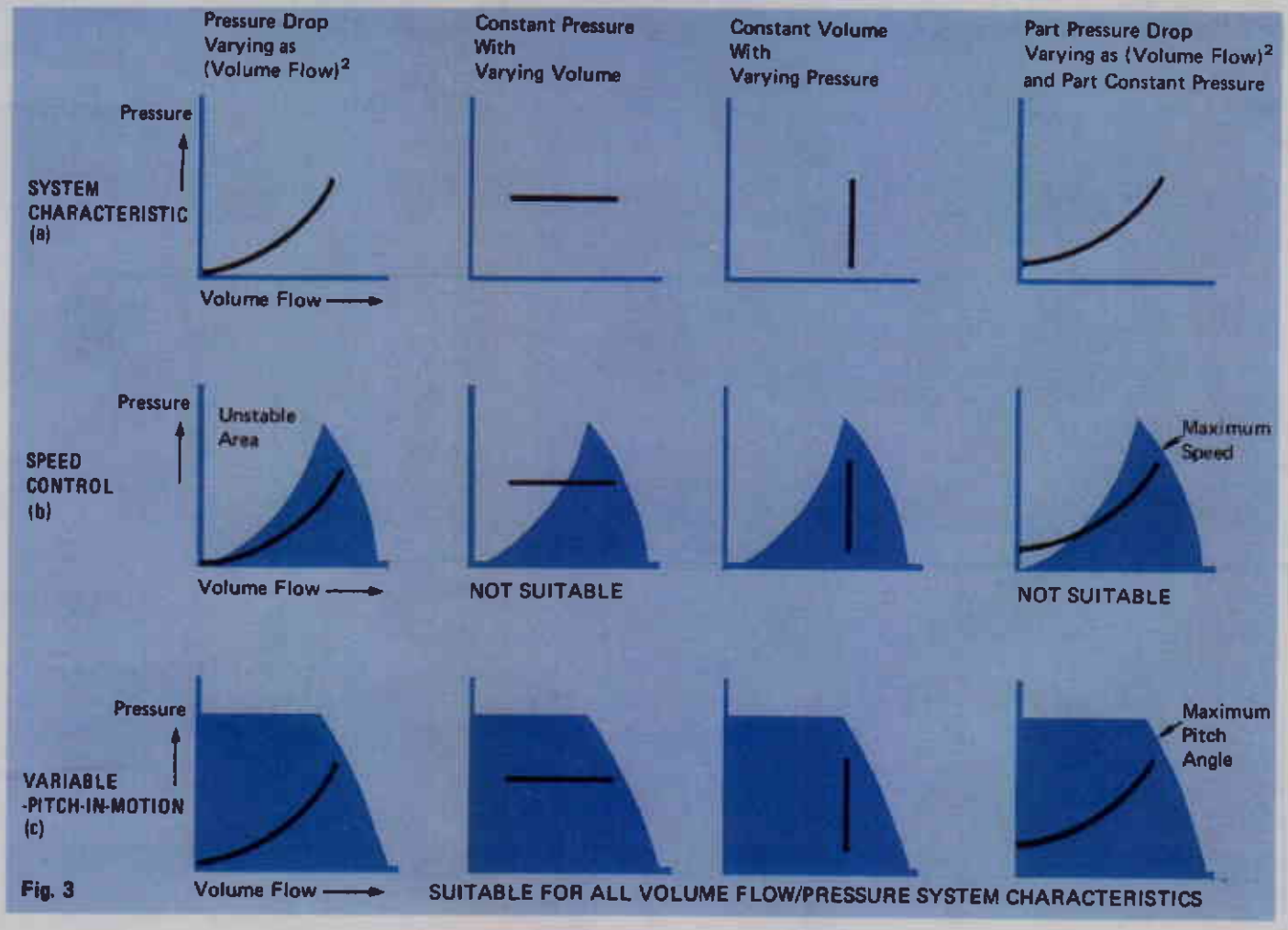
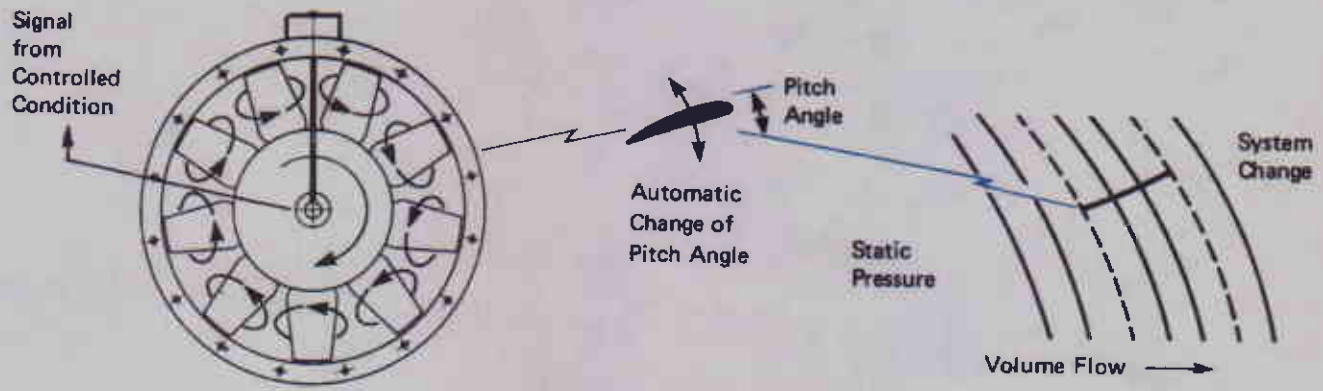


Fig. 3



There is no dampering or throttling process taking place to reduce airflow or absorbing unnecessary power, this being achieved by the fan taking up a new characteristic which satisfies the system demand.

The result is in a reduction in power consumption, far more significant than other methods of volume control and close to the theoretical ideal. (Fig. 2)

Fig. 4 shows a typical power reduction characteristic of a Varofoil Variable-Pitch-In-Motion fan.

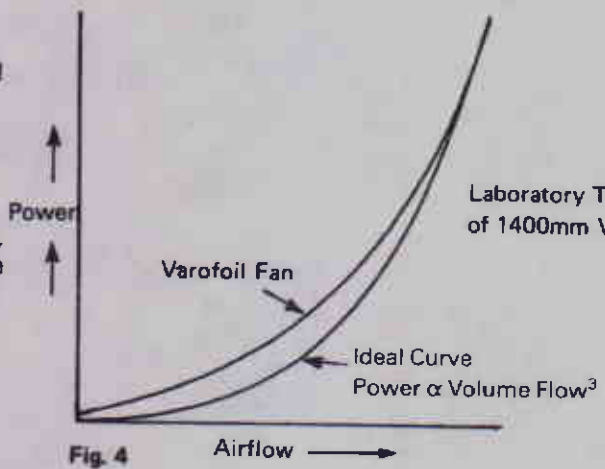


Fig. 4

The Varofoil Variable-Pitch-in-Motion Fan

The ADVANCED VAROFOIL is the result of WOODS long experience in the development and application of variable-pitch-in-motion fans combined with the use of the latest computer aided techniques for aerodynamic, acoustic and structural design and testing.

The advantages to the designer, installer and user are

Maximum Power Savings
Maintenance of High Efficiency throughout the working range provides
– Low Power Consumption for a given air performance
– Greater Reduction in Power Consumption as airflow reduces, greater than obtained by other methods of reducing airflow
– Rapid payback of first cost through savings in Power Consumption

Low Installed Cost
The Advanced Varofoil is a composite low-weight unit. Installation involves no additional work beyond fitting directly in the duct system and connecting electrical power and controls, unlike the centrifugal fan with inlet guide vanes.

No work is required to assemble the fan from parts, fit and line up drives and motor, or fit guide vane units.

With minimal vibration, sufficient isolation can usually be achieved by the use of simple low deflection mountings, even in critical building locations. Large deflection spring mounts and special steel or concrete inertia bases are generally unnecessary, significantly reducing installation cost and time.

Minimum Building Space and Structural Support
The Advanced Varofoil has all the advantages of the axial flow type fan compared to a centrifugal fan, i.e., low space factor, low weight, minimal vibration.

Reliability
The Advanced Varofoil can be relied upon in the most demanding and critical installation. This is ensured by checking the steady and fluctuating stresses on the impeller under operating conditions at the design stage. At the production stage all rotating components are X-rayed and the complete fan tested.

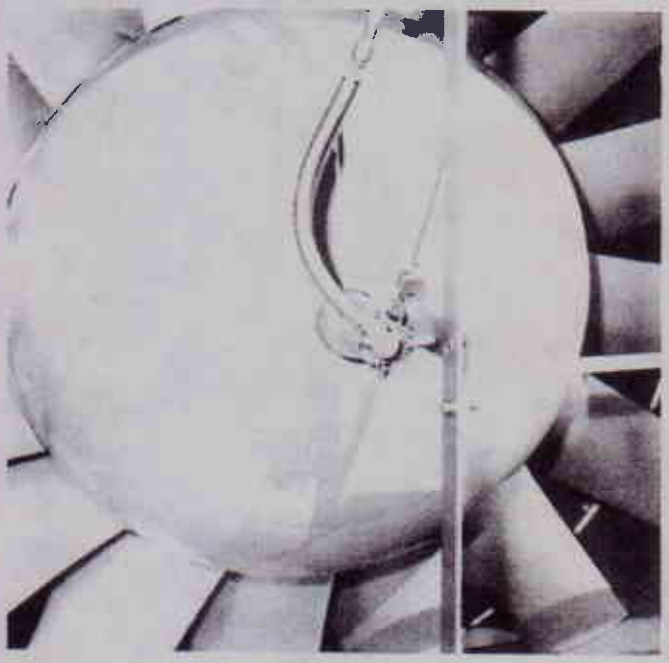
Service
When eventually carried out, servicing is simple, fast and at minimal cost. With the absence of linkages and bearing arrangements associated with external actuators, with the minimum number of moving components for actuation, and with special patented wing thrust bearings, periods of operation between services are long.

Sound Characteristic
Overall Sound Power levels are comparable to the most efficient of alternative fan types.
Predominance of high frequency content ensures that where sound is to be reduced to meet a particular criterion this can generally be achieved with less silencing.

Performance Characteristics
The Varofoil has an Axial fan type performance with non-overloading power characteristic.

The response to control is linear and operation is completely stable as the pitch angle is reduced through the range to minimum airflow.

Application Flexibility
The Varofoil is ideally suited to the vast majority of industrial process or comfort conditioning air systems because the Variable-Pitch-In-Motion fan has the ability to match, automatically, the system demand for any combination flow pressure and flow rate.



Varofoil Fans–Applications

The following examples illustrate the wide range of applications of the Advanced Varofoil fan.

The Advanced Varofoil caters for the specific and varying requirements of different applications and brings to them all the common benefit of – MAXIMUM SAVINGS IN POWER CONSUMPTION

Air Conditioning of Industrial and Commercial Buildings

Constant Air Volume Systems

In the constant air volume system, variations in heating or cooling load are satisfied by varying the temperature of the air supply. The Varofoil is also readily applicable in constant volume systems where the number of zones of a building in operation at any one time varies dependent upon occupancy. With the air supply cut off to zones not in use the Varofoil will change pitch angle to meet the varying total air requirement. Control is achieved by sensing pressure in the duct system.

Variable Air Volume (VAV) Systems

In the VAV system the temperature of the air supplied to the space to be conditioned is constant but the air flow is varied according to the cooling load. With many benefits, the use of VAV systems has increased widely throughout the world particularly where energy saving is a major consideration.

The fast and accurate response, the stable operation and the very significant reduction in power consumption with reduced flow make the Varofoil ideally suitable for the Variable Air Volume System.

Varofoil fans would also be selected for the associated return air systems, controlled in conjunction with the supply air fans.

Woods Airpac AHU's using Varofoils being lowered on rooftop site in London.

Central Hospital, Lahti, Finland. VAV system uses four Varofoil fans.

Central Pre-Conditioning Plant

The Varofoil can be usefully applied in a pre-conditioning plant connected to a number of individual air handling units. It will adjust airflow so that a constant pressure is maintained at the entry to each A.H.U., thereby ensuring a constant volume through each unit irrespective of the number of units operating.

Constant Air Volume Filtration Systems

In medical and chemical applications air may be supplied or extracted through absolute or high efficiency filters to remove bacteria or fumes. The pressure loss through these filters is high and when dirty can increase to several times the clean pressure loss. The Varofoil maintains constant airflow in the system with the changing pressure.

Laboratory Supply Systems

In a laboratory containing a number of fume cupboard exhaust systems, the quantity of air to be supplied to the laboratory will depend upon the number of cupboards in operation.

The Varofoil will provide a variable volume flow of supply air maintaining a pre-set negative pressure in the laboratory, as the number of cupboards in use varies.

Mines

Ventilation of mines ensures safe working conditions by removal of exhaust gases from machinery, contamination from fumes and dust due to blasting, fog due to humidity, excessive heat, radioactive or inflammable gases.

The Varofoil should be installed in relatively clean dry areas, and would most commonly be employed as the main ventilation fan located above ground, with booster and auxillary Aerofoil type fans located in the mine airways. It provides a variable