A SURVEY OF VENTILATION SYSTEMS FOR NEW HOUSING

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The product information included in this report does not purport to represent a complete listing of all equipment and suppliers, nor do product, performance data or supplier listings represent any form of endorsement by the authors or the Canada Mortgage and Housing Corporation.

The authors wish to invite any ventilation equipment manufacturers or suppliers whose products have not been included here to supply information to them for any future revisions or addenda to this report.

ABSTRACT

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Ventilation has become less straightforward as the needs to meet air quality, safe operation of combustion equipment and control of humidity are being recognized. The intent and result of this survey is to consolidate descriptions of various practical ways of ventilating houses.

The survey particularly recognizes the contents of CSA F 326, as Residential Mechanical Ventilation Requirements, and thus serves an introduction to ways in which these "Requirements" may be realized.

The report places the need for mechanical ventilation into an historical context; discusses code requirements and the physical and physiological constraints which govern. Eleven different systems are illustrated with the pros and cons, characteristics and typical costs of each described.

Further information is provided in the appendices. Of particular interest to contractors is a listing of equipment suppliers and elementary information on their products.

EXECUTIVE SUMMARY

Ventilation in housing serves two major purposes. It is necessary for maintaining indoor air quality for health and comfort, and it is necessary for moisture control to preserve the building and it's contents.

Until recently, residential ventilation in cold climates was achieved accidentally through random building leakage, the exhaust action of chimneys and fans and other means. Opening a window in winter has never been a comfortable option for most Canadians. However advances in building technology and the consequent reduction of building leakage has led to the necessity for designed ventilation in homes. This necessity has been recognized in the 1985 National Building Code and is the subject of a new CSA standard F326.

The impact of these changes on the building industry and provincial and municipal code authorities has been significant. The need for fan operated ventilation systems in new homes has been recognized by most people involved, but the standards, hardware and expertise required to achieve this end are not entirely in place.

The study is a survey of ventilation systems for new housing, particularly with respect to new building code requirements and the CSA draft Ventilation Standard F326.

The study:
- emphasizes the approaches, systems, and hardware in current use.
- assesses design requirements, cost and comparative merit of systems.
- identifies information and technology gaps, field problems, and new directions.

The study covers:

- The requirements for residential mechanical ventilation in terms of code requirements, reliability, compatibility with heating equipment, air distribution, air tempering, capacity, installed cost, energy efficiency, pressure balancing, and control.
- The range of systems in use and the available residential ventilation equipment both here and abroad.
- Compares the systems surveyed with respect to costs and the other identified requirements.
- Products, technology and expertise that are required to produce reliable, cost effective and safe ventilation systems for Canadian housing within new code requirements.

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1.0 INTRODUCTION

Ventilation has always been an important issue in housing. Traditionally, during the heating season in Canada, we closed our houses up as tightly as current building technology would permit, and then applied heating energy as necessary to maintain comfort. Random leakage of the building shell was depended upon to provide air change under Winter weather conditions, and moisture generated indoors was generally removed via combustion appliances and other exhaust routes. Infiltration of cold dry air under these conditions could usually be expected to keep the moisture content of building materials and indoor air very low. The major indoor climate concern was maintaining temperature, humidity and air movement conditions for comfort. Adequate ventilation for maintaining indoor air quality was implicit due to the building technology that was in use, and excess moisture in building structures was usually not a problem.

Since the 1940's, however, the nature of housing has been steadily changing. The introduction of sheet building materials and basic weathersealing measures was the first major step. Somewhat later minimum insulation standards appeared, and the thermal properties and air leakage characteristics of windows and other components began to improve. The next major step occurred in the mid 1970's when insulation standards and envelope airtightness were improved once again. One of the main motivators was the growing use of electric heating in regions with low electricity rates. These developments raised two significant new issues in housing; moisture control both indoors and in building cavities, and adequate air exchange for health and comfort. Tighter and better insulated houses, particularly those without chimneys, are more prone to excess indoor moisture, hidden condensation in insulated cavities caused by exfiltration, and poor air quality due to inadequate air change.

In the 1980's a new generation of housing is maturing. The advances in energy measures and improvements in building technology made during previous decades are being consolidated and are now appearing in all housing. Moisture control is now better accomodated by proper exhaust systems, and the hazard of hidden condensation is reduced by air sealing measures. In this age of energy conservation and advancing envelope tightness, ventilation has also become an increasingly important issue, for while we have been improving our building materials and methods we have also been discovering all of the other factors which must also be managed to ensure a comfortable and healthful indoor environment. The proliferation of synthetic building materials and furnishings, for example, has raised concerns about levels of organic vapors in tight houses. Combustion gas entry is another major area of concern in new housing where conventional fuel burning appliances are in use along with large exhaust fans and traditional fireplaces, both of which can cause de-pressurization and chimney back venting. Accidental ventilation is no longer enough to ensure comfort and indoor air quality in new housing. Controlled ventilation which ensures adequate air change for health, comfort and humidity control is a <u>requirement</u> which follows naturally from the changes that have been occuring in housing technology for two generations.

Code requirements for controlled residential ventilation systems have appeared recently as a response to a recognized need. Though the influence of new regulation is being felt by inspectors, designers, builders, their professional organizations, and by equipment manufacturers and suppliers, there is still a limited pool of experience and expertise with residential ventilation. In many cases, only those professionals with a background in rigorous energy efficient design and construction such as the R2000 program have any experience at all with these systems. Those with experience, however, still represents a small and seperate segment of the housing marketplace, which leaves the majority of participants far behind in grappling with the technical and regulatory issues involved. As all housing becomes more like R2000 housing there will be a great number of gaps to be filled, and a great deal of catching up to do. Fortunately the technology for environmental control is largely available; what remains is to apply it, develop it, and allow time for it's acceptance in housing.

1.1 PURPOSE OF VENTILATION

Ventilation is defined by ASHRAE as the controlled movement of air into and out of a building. The purpose of ventilation as defined in the National Building Code of Canada is to "provide sufficient air change to provide healthful conditions in that occupancy"

Ventilation is necessary to control the buildup of indoor contaminants in order to protect the health and comfort of occupants, and to prevent building damage. The major contaminants of concern are excess water vapor, carbon dioxide, odors, combustion gases such as carbon monoxide and nitrogen oxides, radon gas, particulates including airborne fungi, bacteria and viruses, and volatile organic compounds such as formaldehyde,. The sources of these contaminants are respiration, cooking and bathing, combustion, body odors, soil gases, offgassing of building materials and contents, and various activities such as hobbies, smoking and household maintenance.

A secondary purpose for ventilation is to maintain thermal comfort in summer. Air movement intended for cooling building occupants is not specified in residential codes and standards and will not be discussed here.

1.2 VENTILATION METHODS

Ventilation is achieved by removing a quantity of indoor air and replacing it with outdoor air. This process occurs through a variety of means including exhaust fans, supply fans, and passive means. The mechanical means of ventilating homes are the primary topic of this paper, particularly with regard to ventilation requirements and standards in Canadian Codes and their current field applications. Passive ventilation is driven by temperature differences and wind, and falls into two categories; controlled passive ventilation through opening windows and other vents, and uncontrolled passive ventilation through building leakage. The role of passive ventilation in meeting home ventilation requirements is a very complex subject and is beyond the scope of this project. Suffice it to say that passive ventilation is highly weather dependent, and is prone to excesses during cold weather and windy conditions, and shortfalls occur during warm calm weather, particularly in spring and fall. In the final analysis random leakage and the optional use of windows cannot be relied upon to provide appropriate ventilation conditions for health and safety in most Canadian climatic regions. This is particularly true of new housing stock with improved airtightness.

1.3 RECENT HISTORY OF VENTILATION

Until the postwar period random leakage was generally more than adequate to maintain indoor air quality even in winter with all windows closed, in fact leakage was often great enough to cause comfort problems due to cold drafts and dryness. Prewar housing could be expected to have total leakage rates which would exceed 1 full air change per hour with calm weather conditions, and much higher levels during windy conditions.

The first mechanical ventilation devices used in houses were simple kitchen and bathroom ventilators. These exhaust fans were primarily intended for odor control and were optional except in the case of a bathroom without windows which could be required to have an exhaust fan. Kitchen and bathroom exhaust fans have an additional benefit of removing excess humidity, thus reducing condensation on windows and potentially in building cavities. Chimneys also act as exhaust devices by removing heated air and humidity from the house and, in turn, drawing outside air in through the envelope continually drying it. When moisture escaped into uninsulated cavities, it was not likely to encounter a surface below dew point temperature because the cavities were heated by energy lost from the house. In fact the more common problem was discomfort due to low humidity during the heating season. Uninsulated wood frame houses also could be expected to be very durable in a cold climate due to the extreme drying effect of winter air on wood assemblies as it was drawn in and heated.

The general acceptance of kitchen and bathroom exhaust fans for odor and moisture control has progressed recently to the point where, previous to new building regulations, almost all new construction could be expected to have them. The primary limitations of these devices were that they often were inadequately sized, operated poorly due to restrictive ductwork, or not used because of objectionable noise. However the main limitation of exhaust only measures such as these is that without attention to make up air supply, ventilation effectiveness might be minimal, particularly in a tighter building envelope. If building leakage is great enough it may be adequate to provide make-up air, but the paths by which make-up air enters may not ensure adequate air change in all occupied areas. Bedrooms, for example, are often poorly ventilated for their occupancy even in houses with high overall air change rates.

The technology and practice of building insulation and airtightness today has altered the picture however. Higher insulation levels and low permeability outside finishes require close control of leakage of humid air to prevent condensation damage in building cavities. Furthermore building leakage can no longer be expected to provide adequate ventilation for maintaining air quality, combustion draft air for conventional fuel burning appliances, nor can it be relied upon as make-up air for high capacity exhaust fans. If the only available source of air is through random building leakage, then exhaust fans may be ineffective, or cause hazardous chimney backventing.

The current 1985 National Building Code requires both the sealing of all penetrations of the vapor retarder, and the provision of a ventilation system. At present the basic requirements can generally be met with a slightly modified bathroom and kitchen exhaust system and some form of make-up air inlet. At the same time modified forms of far more sophisticated mechanical ventilation systems developed for energy efficient housing are gaining some acceptance in conventional houses. The advantages of systems such as those utilizing central exhaust fans, or heat recovery ventilators are many. Though primarily thought of as energy efficiency devices, heat recovery ventilators also provide an effective and convenient means of tempering incoming air for comfort. Well designed HRV and central exhaust systems also have the advantage of being able to provide well distributed ventilation for improved air quality in all occupied rooms. The new code and the development of better mechanical systems means that ventilation by design, rather than ventilation by accident will now be an essential part of every new home.

1.4 FUTURE DIRECTIONS

Further airtightness requirements are forthcoming in the new building codes, work is progressing on a CSA standard (F326) to establish more uniform residential ventilation requirements and engineered mechanical systems are becoming more widely accepted. However there are still a number of problems to be solved and hardware gaps to be filled in the area of ventilation and heating systems, and the code can have an active role in motivating change. For example the wider availability and use of induced draft or sealed draft combustion appliances to reduce potential backdrafting problems would be more widespread if encouraged by code provisions. One method would be to make depressurization testing, make-up air requirements as well as other safety provisions more rigorous where naturally aspirated appliances are in use, thereby encouraging the use of safer and far superior technology. The hardware for interlocked make-up air for large capacity kitchen exhausts to prevent excessive depressurization would also develop more quickly if encouraged by code provisions and standards. The same could be said of make-up air tempering devices which are not readily available today for some system types.

2.0 VENTILATION CRITERIA

There are numerous methods for specifying ventilation rates and requirements. Specifying air changes per hour (ACH) for the occupied space is one common method. Ventilation flow rate (L/s or cfm) can also be specified for various occupancies.

If air changes are specified then building volume must be calculated by a given set of rules. With this method there is little means for distinguishing between large houses and small, or between little occupied and heavily occupied rooms. The result is that a required number of air changes per hour may provide inadequate ventilation for a small house, and excessive amounts for a large house. A small house with many bedrooms such as a family oriented townhouse (typically a more airtight form of construction than fully detached houses) would be the least likely to recieve sufficient ventilation for it's occupants based on air change rate alone.

If flow rate is specified, either by number of occupants or by room type and room count, the ventilation rate is far more likely to meet the occupants needs. Ventilation rate calculation by number of occupants such as that specified in ASHRAE standards is the usual method for commercial and institutional buildings, but is not reliably adaptable to housing. Determining the number of occupants expected in a home is just too difficult. For this reason a method based on room classification and number of rooms is preferred. The proposed CSA standard F326 adopts this method for determining base flowrate and local exhaust capacity.

The standard also incorporates a minimum overall air change rate for the whole house which must be satisfied. The requirement arrived at by this sort of calculation is more likely to reflect actual occupancy and ventilation needs than air change rate alone.

2.1 RECOMMENDED RATES

Recommended ventilation levels have shifted dramatically in the past decade. The major debate on this continent has taken place over the changes to the ASHRAE standard 62-1981, Ventilation for Acceptable Indoor Air Quality. This standard which sets recommended ventilation levels for engineering design stood at 7.5 L/s per occupant for a long period, until the energy concerns of the 1970's. At this time the figure was reduced to 2.5 L/s, primarily to allow savings on ventilation energy in commercial buildings. This single act alone is now viewed by many as the major factor in the rash of air quality problems experienced in commercial buildings throughout the 1980's. In fact in the U.S., NIOSH (National Institute for Occupational Safety and Health) investigations of health and comfort complaints in commercial buildings identified inadequate ventilation as the cause of air quality problems in over 50% of cases (1). Work in Canada by Health and Welfare and other agencies has come to similar conclusions (2).

The ASHRAE standard was amended in 1986 and the recommended minimum rate reset at 7.5 L/s, or 10 L/s for some occupancies, though these changes have not yet been ratified.

<u>Recommended ventilation rates</u>

The International Energy Agency has summarized work done on preferences and physiological needs for ventilation as follows (3) :

-For moisture removal: 5.6 to 11 L/s per person. (depending on climate and other factors)
-For body odour: 8 L/s per person. (satisfies 80% of people)
-For CO_2 control: 8 L/s per person (maintains 1000 ppm CO_2) or 4 L/s per person (maintains 1500 ppm CO_2)
-For tobacco smoke control: 8.3 to 19.4 L/s per person.
-For volatile organics control: source control is recommended, not dilution by ventilation.

2.11 ASHRAE recommended rates (4).

Current ASHRAE standards for residential occupancy call for 5 L/s (10 cfm) of installed ventilation capacity per room regardless of room use, 25 L/s (50 cfm) of exhaust capacity per bathroom, and 50 L/s (100 cfm) per kitchen.

2.12 NBC Canada required rates.

The 1985 National Building Code of Canada requires mechanical ventilation of all dwellings capable of providing at least 0.5 ACH based on the volume of the entire dwelling unit. Each occupied room however may be provided with <u>either</u> natural ventilation by means of a minimum area of openable window or a mechanical ventilation system capable of 1 ACH where no summer cooling is provided, or 0.5 ACH where summer cooling is provided.

2.13 B.C. Building Code

The British Columbia Building Standards Branch adopted the air sealing and ventilation provisions of the 1985 NBC without modification, but with an added explanatory appendix. The resulting effect on the B.C. housing industry was great confusion. This led to a proposal developed by the CHBA Technical Advisory Committee which was circulated for public comment and submitted as proposed revisions to the code. The resulting revisions pending (September 1988) are as follows:

- -0.5 ACH ventilation capacity in houses with non-distributed ventilation systems.
- -0.3 ACH ventilation capacity for houses with ducted or distributed ventilation systems.
- -0.25 ACH of the ventilation capacity to be provided by a fan controlled by a dehumidistat located in a common hall. This fan is to be rated at 50 Pa. static pressure (0.2" W.G.) and the exhaust duct is to have no more than two 90 deg. elbows and be no more than 15 m. (50 ft.) in length.
- -All interior doors are to be undercut.
- -No intentional make-up air is required where all combustion appliances are sealed draft, induced draft, or are isolated from the house atmosphere.
- -Where natural draft chimneys are in use, make-up air is to be provided for the 0.25 ACH whole house ventilation fan and any other fan of 0.5 ACH or greater capacity.
- -A series of tables based on house floor area specifying ventilation rate, supply and exhaust duct sizes and make-up air openings are to be incorporated into the code.

The position of the B.C. code amendments is that 0.5 ACH will be the base requirement for non-ducted ventilation systems, and 0.3 ACH for ducted systems. There will also be a minimum portion of the required ventilation which is to be automatically controlled, or a lesser portion which is to be continuous. This is a recognition of the use of two speed gas furnaces in ventilation systems. (See Appendix II)

2.14 CSA Proposed Standard F326

The proposed CSA ventilation standard will require ventilation capacity of 10 L/s (20 cfm) for each double bedrooms or basement, and 5 L/s (10 cfm) for single bedrooms and all other rooms. In addition kitchens will be required to have 30 L/s (60 cfm) of continuous exhaust capacity or 50 L/s (100 cfm) of intermittent capacity, and bathrooms will require 15 L/s (30 cfm) continuous or 25 L/s (50 cfm) intermittent. 0.3 ACH will be the required minimum ventilation capacity based on the conditioned volume of the dwelling unit..

2.15 UBC (US) required rates (5).

The US Uniform Building Code requires a ventilation capacity, whether by natural or mechanical means, of 2 ACH for dwelling spaces and 5 ACH for bathrooms. Minimum openable window areas expected to meet ventilation requirements by natural means are specified in the code, though mechanical means which meet the air change rate may be substituted.

2.16 BPA reccommended rates (6).

The Bonneville Power Authority Super Good Cents program requirements are for 5L/s (10 cfm) ventilation capacity for each bedroom and 5L/s (10 cfm) for other combined living spaces for non heat recovery ventilation controlled by a timer or dehumidistat. For heat recovery ventilation the minimum required continuous ventilation rate is that calculated by the above method, or 0.25 ACH, whichever is greater. In addition there is a requirement for intermittent exhaust capacity of 50L/s (100 cfm) in kitchens and 25 L/s (50 cfm) for bathrooms.

2.17 EMR Canada/R2000 recommended rates (7).

R2000 minimum requirements are for a continuous ventilation system capacity of 5 L/s (10cfm) per occupied room and 10L/s (20cfm) for undeveloped basements and utility rooms. The maximum continuous rate need not exceed 0.45 ACH. In addition, an intermittent capacity of 25 L/s (50cfm) of whole house ventilation is required. Furthermore there are exhaust capacities required for each bathroom of 25 L/s (50cfm) and 50 L/s (100cfm) for the kitchen.

2.18 French Codes required rates.

The 1969 amendments to the French CSTB standards require ventilation rates measured at the air outlet as follows: 12.5 to 25 L/s (25 to 50 cfm) for the kitchen of a dwelling of less than three rooms, 16.6 to 36 L/s (37 to 72 cfm) for the kitchen of a dwelling with three or more rooms. Bathrooms are required to have between 8.3 and 16.6 L/s (17 to 34 cfm) of exhaust capacity depending on their use as laundries and the presence of gas water heaters. Amendments to the code made in 1983 provide a more sophisticated method of calculating ventilation requirements based on dwelling size and room use. The code allows perhaps the widest range of ventilation levels specifically tailored to dwelling size and use of any code in the world.

2.19 Swedish Codes required rates (8).

The current code in Sweden sets basic ventilation requirements at 0.35 L/s per m^2 of floor area (0.07 cfm/ ft^2) for all occupied areas. Individual room requirements are for 15 L/s (30 cfm) exhaust capacity for small kitchens, 10 L/s (20cfm) for small bathrooms and laundries. Increased exhaust rates are required for rooms in each category which exceed a maximum size or occupancy. A maximum annual mean value for radon is also set at 70 Bq./m^3 (2 Pci/L).

It is interesting to note that the Swedish code has linked radon levels with ventilation rates. Though the intent is certainly laudable it is difficult to imagine how a radon limit would be administered without a complete testing program for all houses. Furthermore once construction is complete it is more difficult to reduce radon entry and provide remedial ventilation.

2.2 COMFORT AND HEALTH REQUIREMENTS

2.21 Air change rate

Preference studies done by the BPA show that people given control of ventilation rates will select rates between 0.1 and 0.25 ACH (6) Danish studies show that ventilation preferences average 0.23 ACH.

2.22 Humidity

Comfort studies done for humidity preference have shown that acceptable humidity levels vary with air temperature, air movement, and the activity level and clothing of subjects. ASHRAE standard 55-1981 Thermal Environmental Conditions For Human Occupancy allows Relative Humidity to range between 15% and 85%, depending on season, air movement and other conditions (9). This range is intended to satisfy 80% of occupants under the given conditions. Health studies, however, indicate that humidity extremes contribute to respiratory irritation and may increase respiratory and allergic illness. Based on health considerations alone the ideal range of Relative Humidity is 40% to 60% (10). Maintaining conditions within the narrow range suggested by health considerations alone is very difficult in the Canadian climate and would require close control of building envelope leakage, exhaust rates and other factors. Health and Welfare Canada's exposure guidelines recommend 30-80% RH in summer and 30-55% for winter (10). In many Canadian locales winter humidification and summer de-humidification are necessary even to maintain these broad limits. In new housing the primary ventilation concern for maintaining acceptable humidity is the drying effect of excess winter ventilation. Warm exhaust air transports large amounts of water vapor out of dwellings which is not replaced, in winter, by incoming dry outdoor air.

Humidity Problems:

-Very low humidity (<20%) is associated with uncomfortable skin dryness, irritation of mucous membranes, possible increased susceptibility to respiratory illness and increased levels of airborne dust. Very low humidity also causes damage to wood furniture, paper goods, plants and other household items.

-Very high humidity (>80%) is associated with discomfort during warm weather, increased growth of fungi and dust mites, and prolonged survival of airborne bacteria and viruses. Very high humidity also increases condensation damage to building components, stored goods and other household contents.

-Condensation in building cavities due to air leakage is a cause of moisture and frost damage, and can lead to fungal contamination. Water vapor also causes damage to ventilation equipment when condensation and frost occurs in or on ducts, heat recovery cores and other components.

Ventilation and water vapor control:
-Removal at source is the most effective means of controlling excess water vapor. Kitchen and bathroom exhausts and/or a central exhaust fan are important for this purpose in any home.

-Building air pressure is also an important factor in moisture transport. If buildings are pressurized excessively, exfiltration and moisture transport increases, potentially leading to hidden condensation damage. Buildings operated under excess negative pressure experience increased infiltration and low indoor humidity in winter.

2.23 Tempering and acceptable drafts (See Figs 1-8)

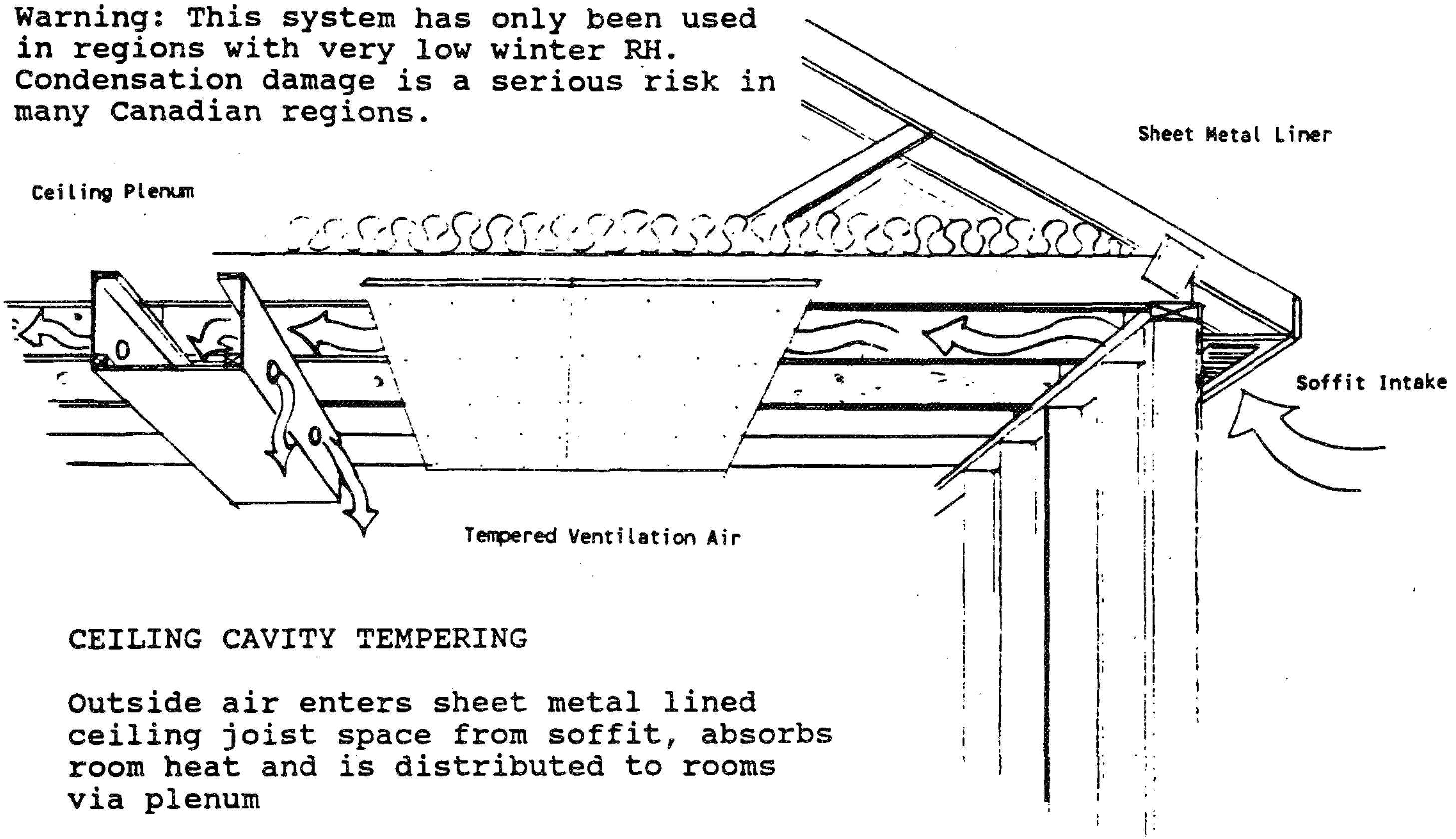
Tempering:
Outdoor ventilation air entering dwellings in winter is a major source of discomfort unless it is pre-heated before entering the occupied zone. Tempering of outside air is necessary for comfort in most, if not all climates. There are examples of direct make-up air through a hole in the wall in an unoccupied room in mild climates like the B.C. lower mainland and Vancouver Island, but even this is doubtful during the coldest season. In nearly all cases tempering will be required to maintain comfort. Tempering can be achieved by preheating with an HRV, central furnace, fan/ duct heater or combination of these, or it can be done by introducing outside air where it will mix with heated air before entering the occupied zone. Novel methods such as tempering air by passing it through pipes buried near foundation footings (See Fig.5), or drawing it through air permeable wall cladding (See Fig.6) are also being tried. Of all the methods listed, tempering with a furnace or HRV are the most widely used. Tempering by mixing using high wall entry slots is also in use (See Fig. 2) though it is generally limited to milder climates (those with design temperatures above -10C.) Fan/duct heater assemblies could be a popular means of tempering, and many are in use for preheating or defrosting in conjunction with HRV's, but electric duct heaters must be used in conjunction with an interlocked fan. This safety requirement is based on electrical and fire hazard protection. Hot water loops mounted in make-up air ducts are in use in some applications (See Fig. 3) and are supplied by a central boiler or domestic hot water supply, but could be prone to freezing problems in severe climates.

In colder regions make-up air supplied to furnaces must be preheated in order to meet furnace manufacturers specifications. Some furnace manufacturers require that air contacting the heat exchanger must be above +12C. in order to prevent condensation corrosion and possible thermal stress cracking. The hardware avialable for meeting this requirement is limited, particularly where supply side fans are not used.

Air movement:
Some degree of air movement is necessary to maintain comfort. Studies show that a room will feel stuffy to occupants if air movement is too low (<0.1 m/s) regardless of CO_2 levels and other air quality measures. Thermal comfort in winter however is dependent on maintaining relatively low air movement rates (<0.2 m/s). At the other extreme, much higher air movement rates are preferrred in summer but will cause discomfort and annoyance above 0.8 m/s. (9). Air

FIG.1

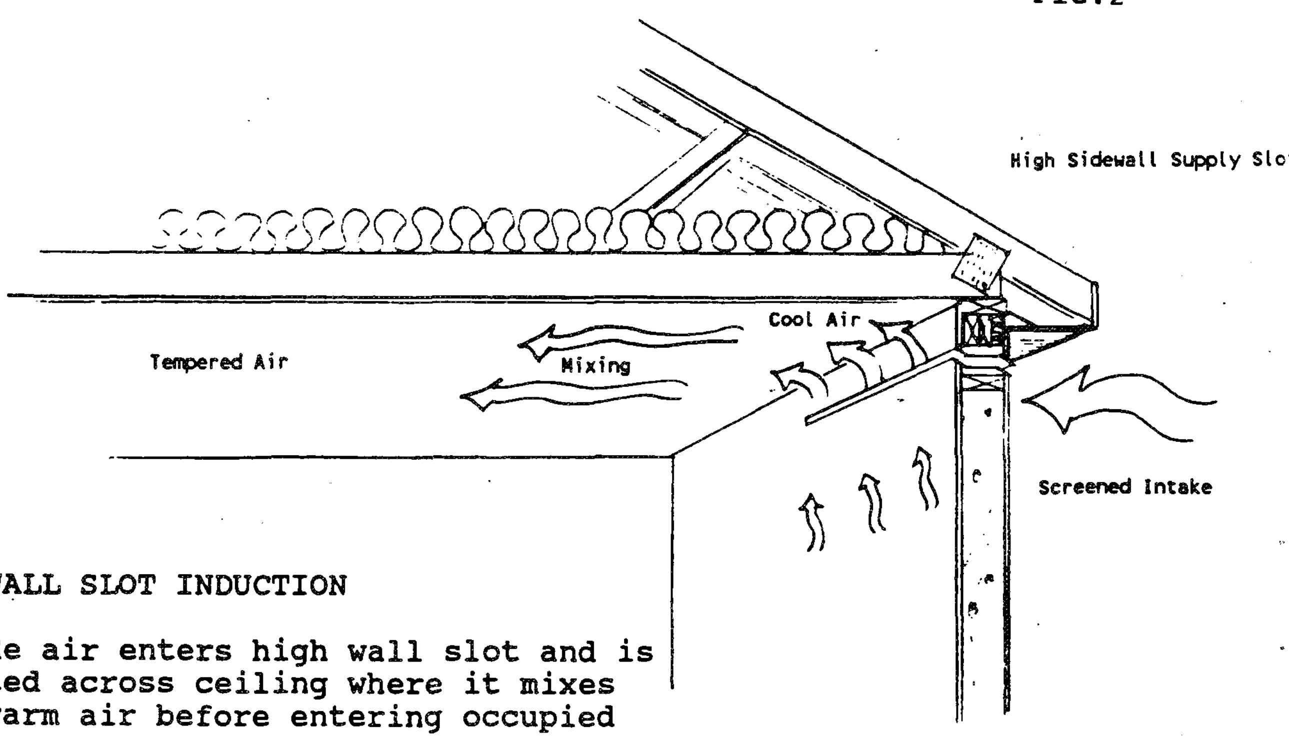
Warning: This system has only been used in regions with very low winter RH. Condensation damage is a serious risk in many Canadian regions.



CEILING CAVITY TEMPERING

Outside air enters sheet metal lined ceiling joist space from soffit, absorbs room heat and is distributed to rooms via plenum

FIG.2



HIGH WALL SLOT INDUCTION

Outside air enters high wall slot and is directed across ceiling where it mixes with warm air before entering occupied zone.

FLOOR CAVITY TEMPERING, HOT WATER UNIT

FIG.3

Outside air is drawn by negative pressure into enclosed joist space, is pre-heated and delivered to house. Useful in moderate climates with zone heating.

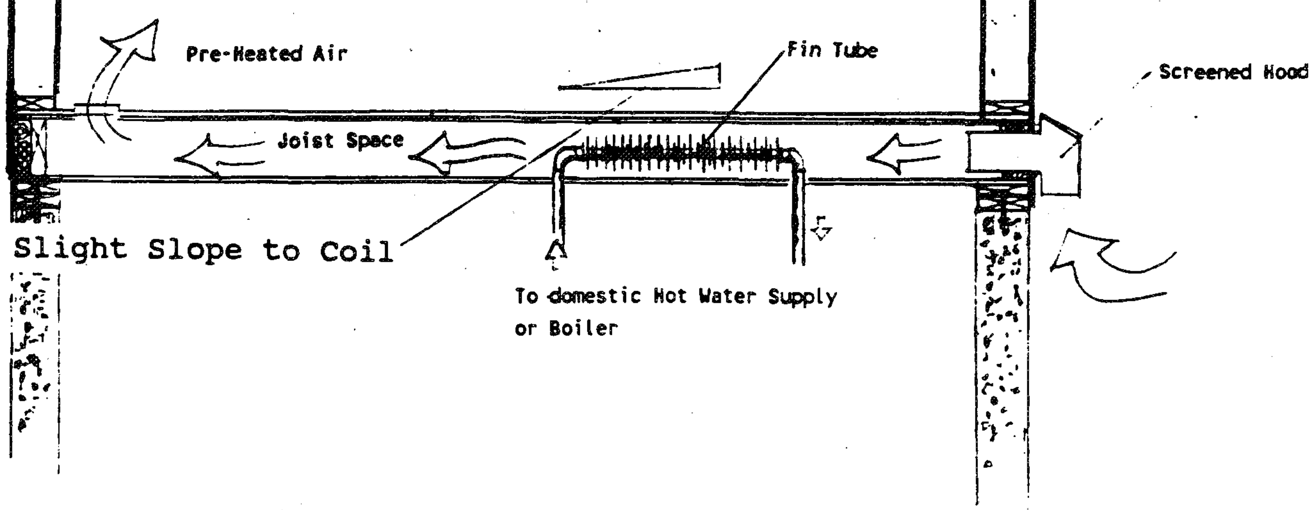
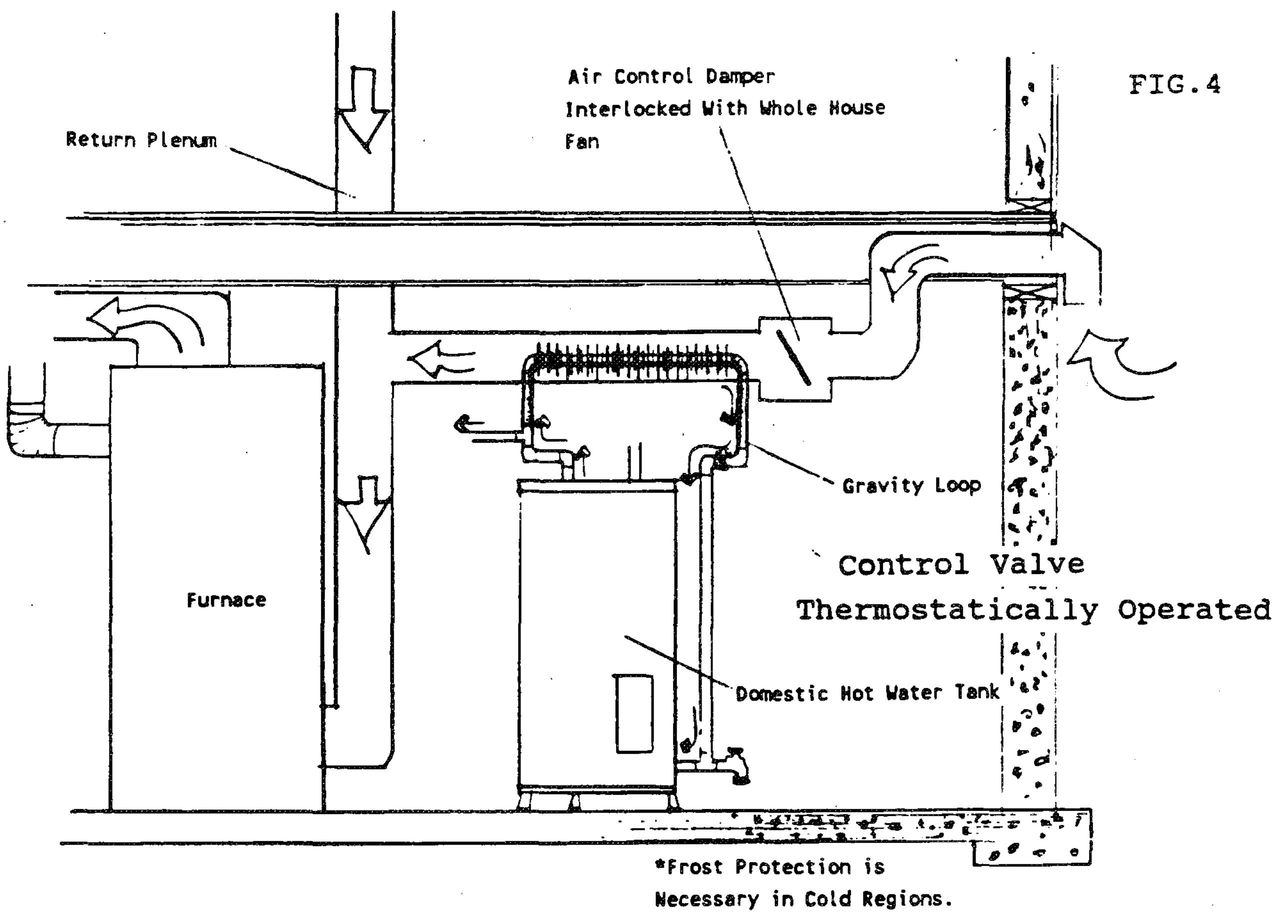


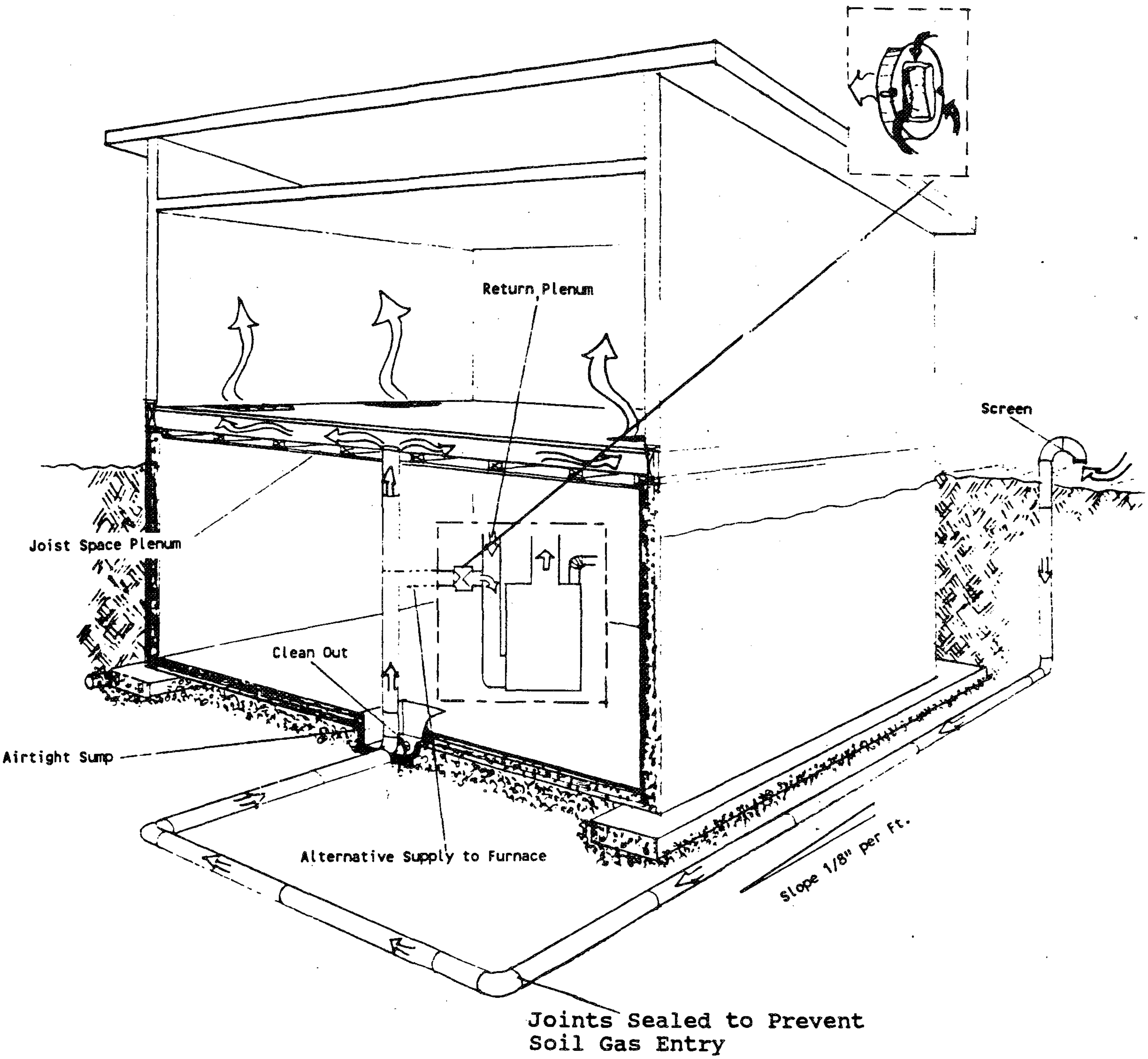
FIG.4



FURNACE INTAKE PRE-HEAT, HOT WATER UNIT

Outside air is drawn by furnace blower past automatic damper and is pre-heated before entering furnace. Useful in colder climates with forced air heat.

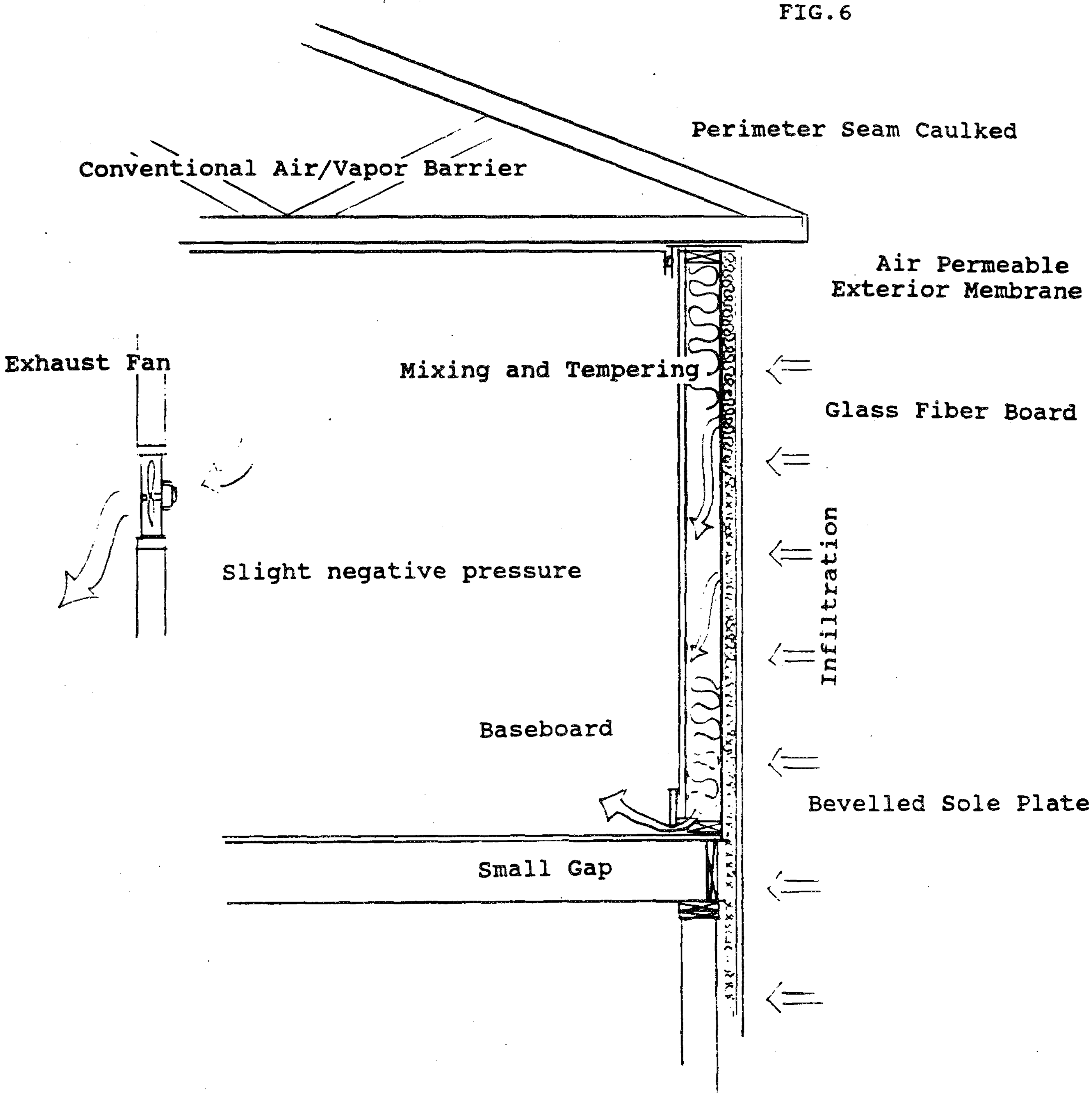
FIG.5 EARTH TUBE TEMPERING



Outside air is drawn by negative pressure through 60-70 ft. of 6" dia. plastic pipe buried at footing level. Heat stored in the earth is transferred to air. Tempered air is delivered either directly to house, or to furnace return. (20)

DYNAMIC WALL TEMPERING

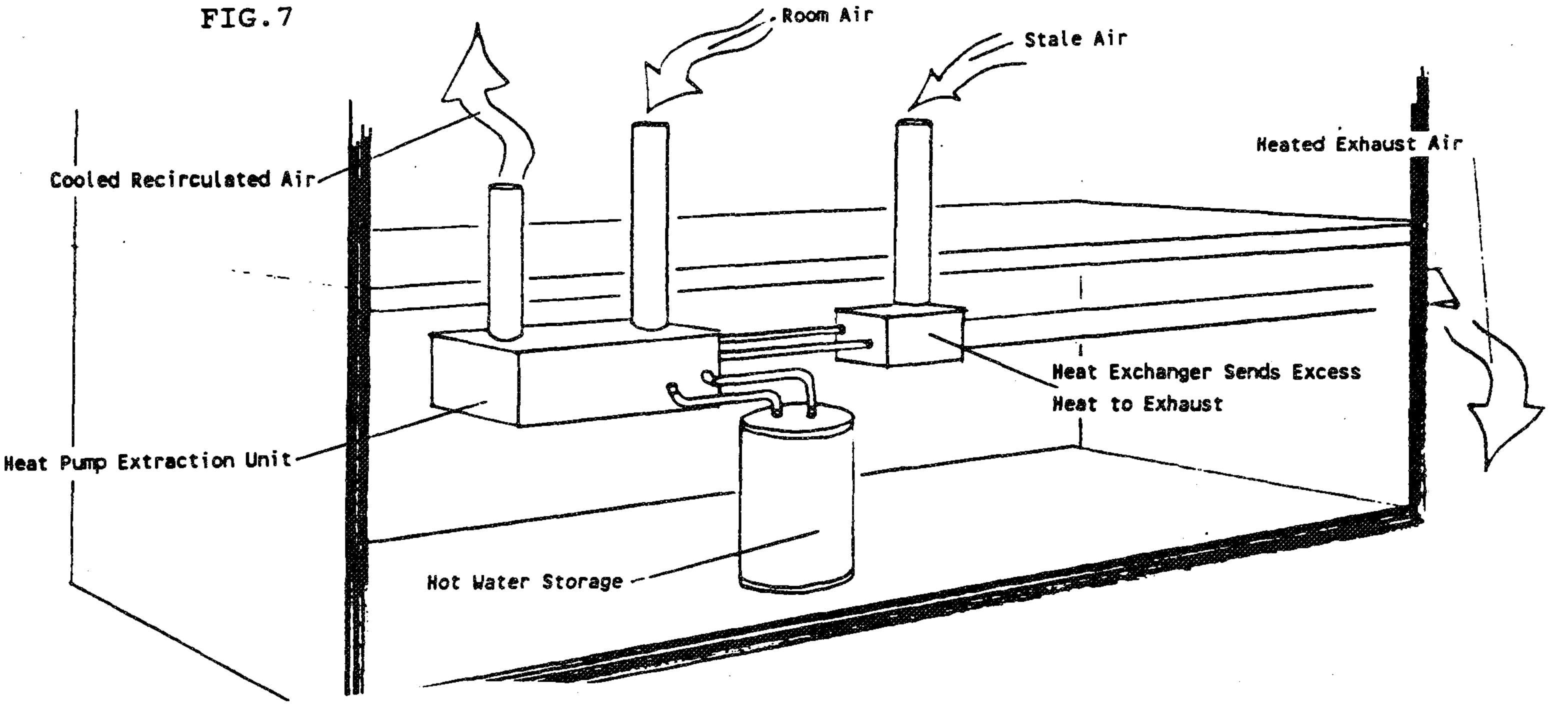
FIG.6



-Whole house operates under a slight negative pressure maintained by a continuous exhaust fan.
-Wall cladding is rigid glass fiber panels covered with an air permeable exterior membrane of spunbonded polyolefin.
-Outdoor air slowly penetrates the entire wall system picking up heat as it mixes with indoor air.
-The wall sole plate is bevelled and the wall finish raised slightly to leave an entry path for tempered air behind the baseboard.
-The ceiling is covered with a conventional air/vapor barrier which is caulked to the air permeable exterior membrane at the perimeter.

EXHAUST HEAT PUMP METHODS

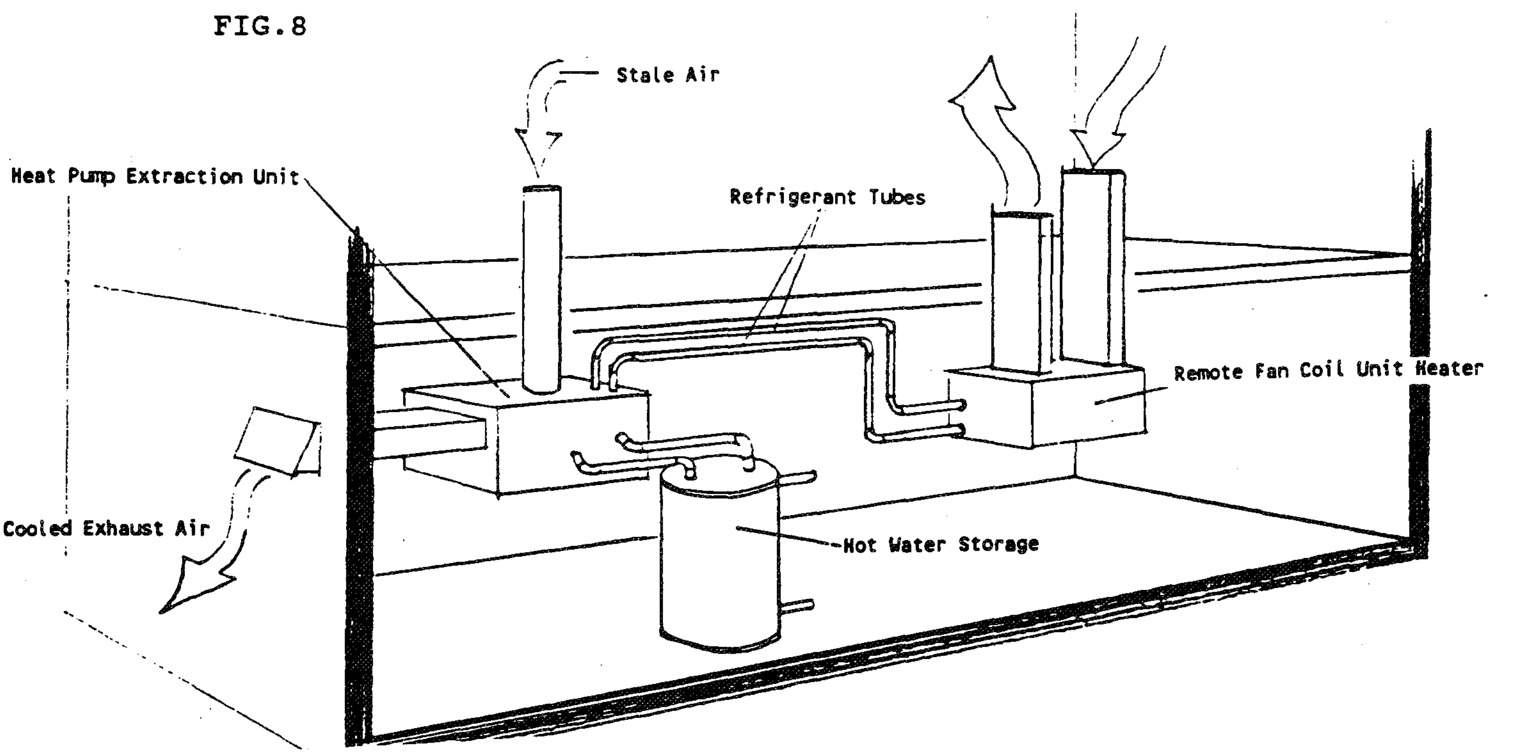
FIG.7



SUMMER MODE, SPACE COOLING AND DOMESTIC HOT WATER HEATING

Heat pump extracts heat from recirculating air and supplies domestic hot water. Excess heat is discharged into exhaust stream.

FIG.8



WINTER MODE, SPACE HEATING AND DOMESTIC HOT WATER HEATING

Heat pump extracts heat from exhaust stream and supplies domestic hot water and space heat.

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15

movement comfort limits are important considerations when designing heating and ventilating systems and choosing locations for diffusers.

2.24 System noise

Many householders and ventilation system installers report that mechanical noise is a major cause of concern and is probably the single largest cause of inadequate use of ventilation systems in homes. Manually operated systems are often not used regularly due to objectionable noise, and automatic systems are sometimes shut down for the same reason. One study, for example, showed that kitchen range exhausts were used only 40% of the time while preparing dinner, and much less often for other meals (11). Anecdotal information points to noise objections as a common cause for readjusting de-humidistats, time clocks, circuit breakers and other controls leading to inadequate ventilation.

System noise control

Ventilation equipment generates vibration which is transmitted to ducting and building structure. Equipment noise is also propogated through the air. A third cause of noise complaints from ventilation systems is the passage of sound between rooms through interconnecting ductwork. The two most important factors in controlling equipment noise are the mechanical quality of the fan and the dampening or isolation of motors from ductwork and structure. Better quality fans are generally centrifugal types with high quality motors and bearings which are inherently less noisy. Motor mountings should all be isolated with rubber bushings, and fan equipment suspended with elastic straps. Furthermore a short piece of flexible duct is often used for isolation where rigid duct connects to equipment. In many central exhaust systems large diameter flexible duct which reduces noise transmission is used almost exclusively. This is also true in some areas where minimum HRV systems are being installed on the ceiling in single storey houses with all the ducting in the attic (See Fig.18). A short piece of special "mufffler" ducting lined with sound absorbing material is also sometimes used adjacent to grilles and diffusers to reduce airborne sound transmission between rooms. Truly effective sound isolation between rooms sharing a common duct is probably not possible with available hardware, though the problem can be largely avoided by providing invidual ducts to each room leading from a common plenum.

A further cause of system noise is "whistling" caused by excessive air velocity or by duct restrictions. Ducts should be sized to maintain air velocities below 2.6 m/s (500 fpm) and grilles, diffusers and dampers selected which do not contribute to noise. CSA Standard 260.1 prescribes the selection of residential exhaust system ducts and fittings to reduce excessive restrictions and air velocities (12). This standard will be adopted as part of CSA F326.2.

Noise rating

There are two noise rating methods in current use for ventilation equipment. The "A scale decibel" rating is a long established method which indicates noise levels on a logarithmic scale with a certain (A scale) frequency weighting. The units of this system are dBA. A very quiet room is about 40-50 dBA, and a quiet fan operates at about about 60 dBA. This ventilation equipment noise rating system is in use in Canada, and is described in the CSA Standard 260.2 (13). The standard governs test methods and calculation procedures for ventilation equipment noise.

The "sone" rating, in use in the U.S., is a different method which indicates noise levels on a linear scale. The units of this system are sones. A very quiet room is about 1 sone and a quiet fan operates between about 1.5 and 4 sones. The ventilation industry generally recommends low noise fans which are rated at 2.5 sones or less for residential applications. Noise testing of fans is voluntary in the U.S. and has been carried out mainly by HVI, an association of equipment manufacturers.

Acceptable ventilation equipment noise is not specified by national codes or standards however, so that noise ratings are generally only used for "rule of thumb" guidance.

2.3 INDOOR AIR QUALITY

There are five major categories of indoor air contaminants. Many of these contaminants can be controlled by ventilation.

1. Water vapor
2. Volatile organic compounds, formaldehyde etc.
3. Combustion gases.
4. Particles, Biological and mineral.
5. Radon, natural radiation (see Appendix III).

SUMMARY IAQ TABLE

TABLE I

SUMMARY INDOOR AIR CONTAMINANTS

CONTAMINANT	MAJOR SOURCE	POTENTIAL HAZARD	CONTROLS	NOTES
EXCESS WATER VAPOR	Respiration, bathing cooking, ground water	Discomfort, condensation damage, fungus bloom microbial proliferation increased off gassing of formaldehyde	Removal at source, moisture barrier beneath slabs, ventilation, dehumidification	Local removal and source control most effective. Continuous air barrier can reduce structural damage, ideal RH range 30 to 60%
ORGANIC COMPOUNDS Formaldehyde	Press board products insulation, adhesives furnishings carpets fabrics, household polishes	Eye, bronchial, skin irritation, possible sensitization and other health problems	Reduce sources, increase ventilation, humidity control.	Source control best, encapsulation possible in in some cases, air cleaning with chemical sorbents possible in some cases, some people highly sensitive to this group of contaminants
Others: Petroleum solvents alcohols, esters polymers, organo-phosphates, etc.	Paints, cleaners, building materials, furnishings, carpets, adhesives, hobby supplies, pesticides etc.	Irritation, intoxication possible toxicity and cancer risk	Reduce sources, increase ventilation, air flushing after use.	Extra ventilation capacity helpful for flushing, spot ventilation for utility and hobby areas.
Odors	Cooking, body odors	Nuisances	Adequate kitchen and bathroom ventilation with manual control	
COMBUSTION GASES Carbon monoxide Nitrogen oxides Carbon dioxide	Chimney backventing, auto exhaust entry, cooking, unvented combustion, faulty chimneys or furnaces. CO_2 from respiration.	Discomfort (CO_2), irritation, asphyxiation and lung damage.	Prevent excess de-pressurization, use sealed or induced draft furnace, isolate garage, use kitchen exhaust, maintain chimneys and burners.	Combustion gases should be excluded, dilution is not appropriate except for CO_2 from respiration.
Polycyclic aromatics (PAH's)	Smoking, woodburning.	Cancer risk.	Restrict smoking, ensure chimney function, increase ventilation.	High performance air filtration can reduce sidestream smoke risk.
PARTICULATES Minerals; soils, fibers, soot, etc.	Outdoor: agriculture, industry, autos, etc. Indoor: cleaning, decay of materials, construction, etc.	Primarily nuisances, some toxic compounds i.e. lead, industrial pollutants etc.	Exclude outdoor sources, filter inlet and recirculating air, use durable materials, isolate construction.	Particles <10 micron are respirable. Medium efficiency air filters are effective in this range. Low RH (<30%) increases dust.
Asbestos	Outdoor: industrial waste, streets. Indoor: old plaster, heating ducts, floor and ceiling tile.	Lung disease and cancer risk.	Exclude outdoor sources, removal by professional of indoor sources. Use respirator and wet down.	Crumbling old building materials present greatest risk. Small amounts can be encapsulated if intact.
Biologicals; pollens fungi, animal dander bacteria & viruses.	Outdoor: plant material agriculture. Indoor: fungus growth, pets, house dust, cough and sneeze, humidifiers	Allergic reactions, sensitization, disease transmission.	Exclude outdoor sources, filter inlet and recirculating air, isolate pets and sick persons, maintain humidifiers.	Humidity control reduces allergens and disease transmission.
RADON	Entry from soil and groundwater. Well water.	Increased lung cancer risk.	Basement and crawl space ventilation, sealing foundations, isolate living area, positive pressurize basement, ventilate bath.	Special sub-slab ventilation and water treatment may be necessary. (see Appendix III).

2.4 VENTILATION EFFECTIVENESS

Ventilation effectiveness is a fundamentally important measure of the value of applied ventilation. The term refers to the efficiency with which ventilation air is mixed in a space and is therefore delivered to people in the occupied zone, and the efficiency with which air contamination is removed. The average ventilation effectiveness in a room can be expressed as the ratio of contaminant concentration in the room exhaust stream to the concentration in the room (14).

$$E = \frac{C_e - C_s}{C_r - C_s}$$

- E = Average ventilation effectiveness.
- C_e = Contaminant concentration in exhaust at equilibrium.
- C_s = Contaminant concentration in supply air.
- C_r = Average contaminant concentration in the room.

All recommended ventilation rates are premised on the assumption of fairly high ventilation effectiveness, that is, if air is delivered effectively to occupants and contaminants are efficiently removed then even very low ventilation rates will be adequate for comfort and health. The problem is that effective distribution, mixing, and contaminant removal in spaces is often difficult and would require a great deal of ducting, inconvenient diffuser locations, and excessive tempering of ventilation air to reduce comfort problems. Recent work in Sweden, for example, showed that ventilation effectiveness in a centrally exhausted airtightened house was very poor, particularly in bedrooms, unless exhaust ducting was provided to each bedroom and a path to an air supply point kept open (16). The best ventilation effectiveness in a room is usually achieved when air is introduced either high or low and has to travel diagonally through the occupied zone before exiting. Local removal of air contaminants at their source is also critically important to ventilation effectiveness (15).

Diffuser arrangements which allow air to move laterally through a room without passing through the occupied zone are prone to "short circuiting" and are less effective. In most homes there are a limited number of air supply and exhaust points however, and outlets are not provided for each room. In this case the air path through the whole house becomes an important concern for ventilation effectiveness. The best ventilation effectiveness in this situation is achieved when air is introduced in one extreme region of the home and must find it's way through openings such as undercut doors all the way to the other extreme of the house before exiting. If exhaust points are located in rooms such as bathrooms and kitchens where contaminants are generated then overall ventilation effectiveness is enhanced. An example of this is an arrangement where air enters bedrooms and other category A rooms, passes under doors or through slots into corridors and travels across the house to kitchens and other category B rooms where it is exhausted. (See Appendix I, Sec.5.2.1)

Category A rooms (bedrooms, living rooms, etc.) are defined as general occupancy rooms with no special ventilation requirements. Category B rooms (bathrooms, kitchens, laundries, etc.) are defined as those rooms which require special exhaust provisions due to the moisture, cooking odors and other air contaminants generated there.

2.41 The occupied zone

The critical region for ventilation in a room is the zone extending from about 75 mm. (3 in.) above the floor to about 1800 mm. (6 ft.). Complete mixing of ventilation air is most important in this region both for comfort and ventilation effectiveness. Above and below this zone complete mixing is not essential. The region above this zone is usually where cooler air is introduced into the room allowing mixing with heated air before entering into the occupied zone. Comfort problems will arise due to cold drafts if untempered air is introduced into the room either in or below the occupied zone. For this reason systems using untempered air usually have high wall slots mounted near the ceiling which direct cool air across the ceiling where it enters the boundary layer adjacent to the ceiling and can mix with warm room air before entering the occupied zone.

2.42 Single room ventilation & Whole house vent. effectiveness. (See Figs. 9&10)

Undercut doors

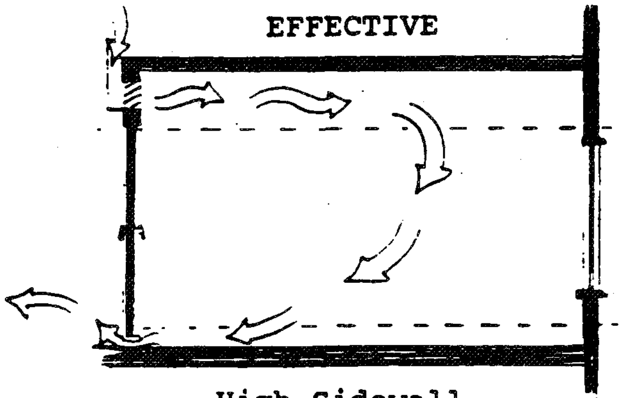
In most homes ventilation is not fully ducted and airflow from supply to exhaust points is interrupted by doors. Some means of allowing air to pass a closed door is necessary. Undercutting the door 12 mm. (1/2 in.) so that it is free of carpets or other obstructions is an accepted method, though wall grilles and slots are sometimes preferred. It is important to note that undercutting doors does not, in itself, improve ventilation effectiveness. The location of supply and exhaust points in the home must first be carefully planned to ensure an effective airpath. Even in tight well built housing random air leakage will be a factor in reducing whole house ventilation effectiveness because exhausts wil tend to draw outside air through nearby leakage sites rather than from the intended supply point elsewhere in the house (16).

2.43 The role of forced air heating in vent. distribution.

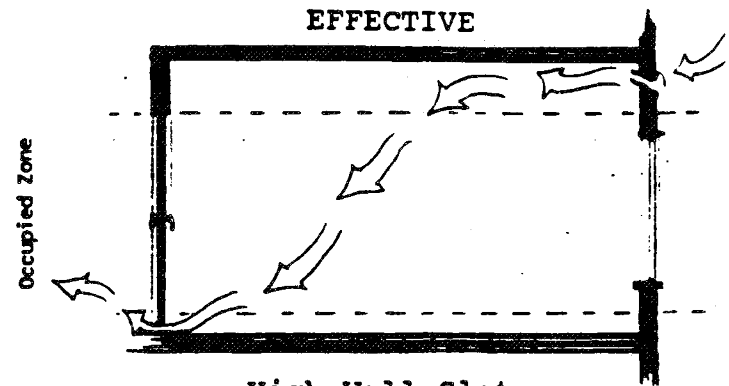
The main ventilation advantage of forced air heating systems is that the ducting and distribution can be used for both heating and ventilation. Forced air heating also mixes air from all rooms, potentially improving ventilation effectiveness by increasing the air change available to occupants in any room served by ducts. However the vent locations most suitable for heating are not necessarily best for room ventilation. For example the floor outlets usually placed below windows for effective heating may not provide comfortable or effective ventilation under some conditions. When the furnace burner is not operating, and an exhaust fan is depressurizing the house, cool outside air can enter the room through heat grilles, forming a pool of cold air near the floor. Ventilation air supplied through floor grilles may also travel across the floor and exit under the door without mixing adequately in the occupied zone. Two speed furnace blowers are necessary where forced air systems are used for ventilation, and will alleviate some of the distribution problems because they operate continuously at low speed when the burner is off.

ROOM VENTILATION EFFECTIVENESS FIG.9

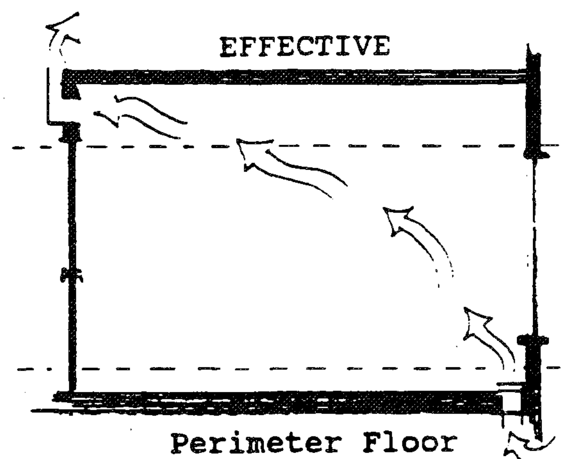
Effective room ventilation is dependent upon complete mixing in the occupied zone. Some airflow patterns tend to "short circuit" before full entering the occupied zone.



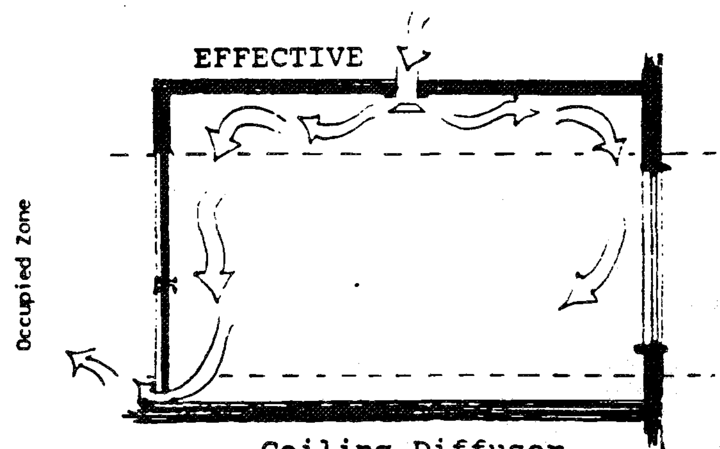
High Sidewall
Supply
Undercut Door
Exit



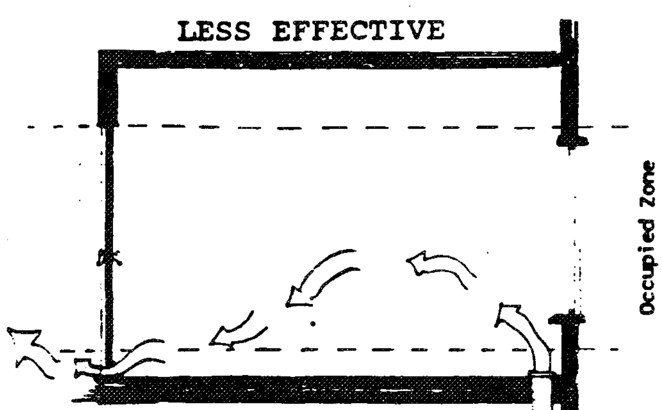
High Wall Slot
Supply
Undercut Door
Exit



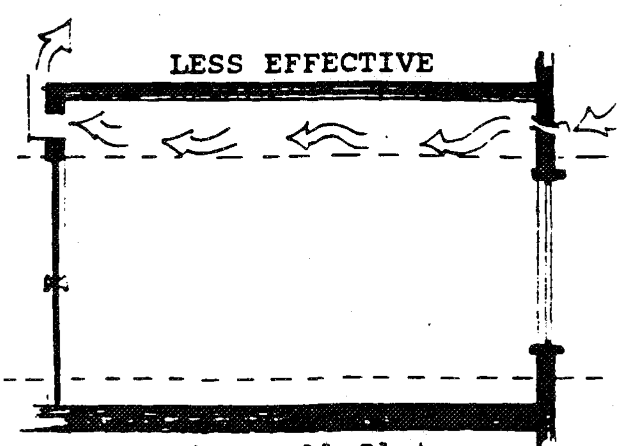
Perimeter Floor
Supply
High Sidewall
Exit



Ceiling Diffuser
Supply
Undercut Door
Exit



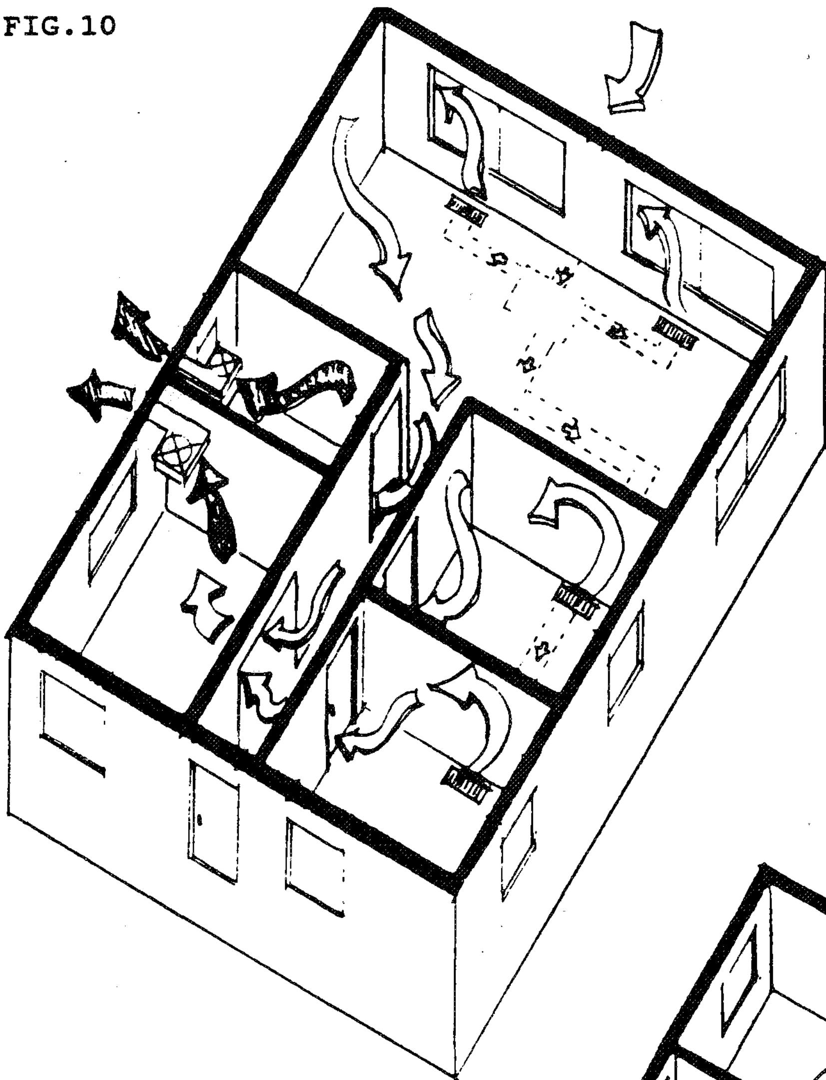
Perimeter Floor
Supply
Undercut Door
Exit



High Wall Slot
Supply
High Sidewall
Exit

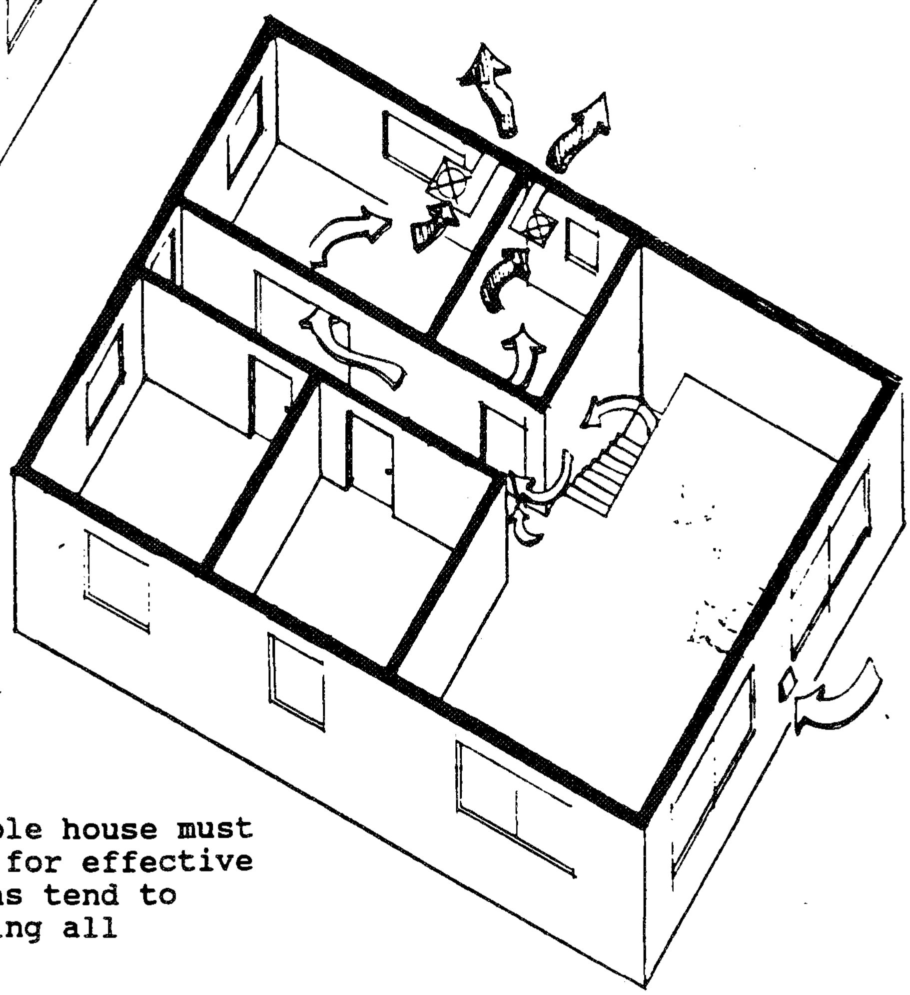
WHOLE HOUSE VENTILATION EFFECTIVENESS

FIG.10



EFFECTIVE

Supply Distributed to Bedrooms and Living Room. Exhaust Through Kitchen and Bathrooms.



LESS EFFECTIVE

Supply to Central Location. Exhaust Through Kitchen and Bathrooms.

The airpath through the whole house must include all occupied rooms for effective ventilation. Some air paths tend to short circuit before reaching all occupied rooms.

Spot ventilation and whole house ventilation:.
Two types of ventilation are needed in all housing. Spot ventilation is needed in kitchens, bathrooms and laundries for direct removal of excess moisture and odors. Spot ventilation is sometimes used in hobby areas or other special use areas also to control air contaminants from local sources. Whole house ventilation is necessary to ensure adequate ventilation for air quality throughout the entire house, particularly in areas such as bedrooms.

2.5 MAKE-UP AIR REQUIREMENTS AND DEPRESSURIZATION LIMITS.

Tight construction restricts the infiltration of outside air required to replace exhaust air. Furthermore large exhaust fans require make-up air to prevent excessive house depressurization. Because the leakage area of a house is not known unless a fan door test is done, and because the leakage may not be in the appropriate locations for fresh air delivery, air leakage is often disregarded as a factor when sizing make-up air for ventilation systems and providing for it's distribution. The proposed Canadian Standard F326 disregards air leakage for purposes of calculating ventilation rates and make-up air requirements. F326 also sets maximum depressurization at 10 Pa. for houses without naturally aspirated combustion appliances, or 5 Pa. for those with such appliances. System exhaust capacity for purposes of calculating make-up air requirements to prevent excessive depressurization are the sum of:

-The ventilation system exhaust capacity and
-The clothes dryer exhaust capacity or 75 L/s and
-The capacity of the two largest exhaust fans.

Proposed amendments to the B.C. code incorporate a table for sizing make-up air for automatically controlled ventilation systems based on maintaining 5 Pa. pressure decrease limits. The assumption in this code is that accidental leakage will provide make-up air for other exhaust devices. Proposed additions to the 1990 NBC include a table specifying required makeup air opening based on exhaust capacity for both houses with and without naturally aspirated combustion appliances (See Appendix I).

The sizing of make-up air should provide for the basic exhaust capacity of the house ventilation system as well as special requirements for supplying replacement air for large exhaust fans such as downdraft cooktops. In practice it is usually the large capacity exhaust units such as cooktop fans and open fireplaces which cause excess depressurization.

2.51 System pressure balancing

Systems using supply and exhaust such as most HRV devices are the most readily pressure balanced because both supply and exhaust can be regulated. Exhaust only systems operate under negative pressure which can vary dramatically with opening windows or other variables. Backdraft dampers are important in exhaust systems to prevent reversal during windy conditions and during operation of other exhaust devices. Manual or automatic dampers are necessary for flow regulation balancing, and automatic air control dampers are required in some installations for interlocking make-up air openings to fan or furnace operation.

2.52 ELA testing

To accurately size make-up air in order to prevent excessive house depressurization (generally accepted limits are 5 Pa. with natural draft chimneys and 10 to 20 Pa. with sealed or induced draft combustion appliances) the ELA (Equivalent Leakage Area) must be known or accurately estimated. In the R2000 Program leakage area compliance and the make-up air requirements for large capacity exhaust fans are calculated based on ELA fan door testing. However fan door testing to current CGSB Standards at this time requires relatively expensive equipment and a trained operator, and for these reasons is unlikely to be used by the building industry in general. In the future simpler devices such as a compact leakage area tester may become available.

2.53 Location

Ventilation make-up air intakes require isolation from ventilation system exhausts, ground, snow, chimneys, gas meters, oil tank vents, garages etc. The recommended clearance is 500 mm. (18 in.) above grade, or high enough to avoid snow blockage. The horizontal clearance recommended is 2 m. (6 ft.) from exhausts or other sources of contamination.

2.6 COMBUSTION AIR REQUIREMENTS

Combustion air requirements are specified in the gas code and are seperate from make-up air requirements, though the two are often confused. In cases where make-up air is inadequate, the combustion air supply to a naturally aspirated appliance will act as a "default" make-up air opening, a situation which can be hazardous if excessive depressurization and chimney backdrafting occurs. It is important to distinguish between make-up air and combustion air in system design, and it is probably wise to distinguish between the two in system installation. Some regulations suggest that an increased combustion air opening will be allowed as make-up air, potentially increasing the confusion. A code which requires that combustion air and make-up air be seperate <u>and labeled</u> would help to clear up confusion, and reduce the likelihood of tampering by homeowners. In B.C. gas furnaces are fitted with a combustion air opening which connects directly to the return plenum. A warm air supply near the burner then provides combustion air which has been diluted by mixing with room air. In the B.C. experience there has been no problem with condensation on heat exchangers.

Fireplaces:
Most fireplaces presently used in Canadian housing present problems with home ventilation design and, potentially, with indoor air quality. Problems with fireplaces are particularly severe in tight well built houses. Two particular problems are the "cold chimney effect" and poor isolation of the firebox from room air causing backdrafting and flue gas entry. Fireplace chimneys also act as powerful exhaust devices when operating and can contribute to excess depressurization and potential backdrafting of other combustion appliances in the house.

Fireplace chimneys rely on heat to maintain draft, but tend to be too cold to operate well during the start up and die out of the fire. The problem is most severe with masonry chimneys located outside the heated space which can easily backdraft when cold. Though new fireplaces are equipped with combustion air supplies and many are fitted with doors, they do not operate independently of room air as intended when the doors are closed due to the poor fit of door panels and frames.

The technology of fireplaces has advanced in the last decade but is still out of step with improvements in building technology in general. There is a serious need to improve standards for fireplaces and installations so that they will be more compatible with tighter new construction.

2.7 COST OF VENTILATION FAN OPERATION.

Fan operation alone typically costs $40 per year based on a 100 Watt fan motor (typical of a 50 L/s fan) operating continuously where electricity is $.05/kWh.

2.8 SYSTEM DESIGN

There are a number of factors which must be considered when designing a mechanical ventilation system for a home.

-Is the building envelope sufficently tight to allow controlled ventilation without undue drafts causing discomfort. No controlled ventilation system can function effectively if random building leakage is excessive.

-Are supply and exhaust locations designed to effectively distribute ventilation to all occupied rooms?

-Where naturally aspirated combustion appliances are used, will make-up air be required to prevent house depressurization due to exhaust fans?

-Is combustion air supplied reliably and directly to all combustion appliances?

-Is outside air being adequately tempered before entering the occupied zone?

-Are controls designed to respond to ventilation needs? Are they reliable, accessible and comprehensible?

-Is the ventilation equipment reliable, low noise, and accessible for servicing?

3.0 REGULATION

3.1 BUILDING CODES

Article A-9.33.3.1 of the NBC requires mechanical ventilation in new housing. The code Appendix states that "The tendency toward achieving higher levels of airtightness in housing and other concerns over energy conservation indicate that natural ventilation is not sufficient to ensure acceptable air quality during the winter heating season. The mechanical system required by this Article is, therefore, independent of natural sources including windows and air infiltration".
The Appendix however "does not require that a centralized ventilation system be provided with duct work leading to all parts of the dwelling unit. The requirement may be satisfied by means of exhaust fans located in kitchen and bathroom areas where a fresh air inlet is provided at a location remote from the exhaust outlet."

The recommended rate of ventilation that the system must be capable of delivering is one half air change per hour. System control is to be by means of automatic and manual switches.

3.2 PROBLEMS WITH RESIDENTIAL VENTILATION REQUIREMENTS

Technical problems:
The major technical problems with delivering adequate ventilation in new housing include:

- -Control of ventilation rate under varying weather conditions.
- -Control of comfort problems encountered when tempering is inadequate.
- -The effective distribution of ventilation.
- -The prevention of hazardous depressurization in houses with naturally aspirated combustion appliances.
- -The provision of reliable and quiet equipment that will not be defeated by users.

3.21 Acceptance problems

There are many problems with acceptance of new ventilation requirements, particularly among developers and builders. These problems include:

- -Limited understanding of the role of ventilation systems.
- -The cost burden and complexity of high performance ventilation systems.
- -The impact on building design of mechanical ventilation systems.
- -Concern that further reliance on mechanical ventilation systems is not appropriate for homes. Sceptics suggest that systems will be misused, intentionally defeated, or carelessly maintained.
- -The slow spread and acceptance of new technical information among many builders.
- -The difficulty with sizing exhaust equipment and make-up air.
- -The contention that the house will be over ventilated, especially if uncontrolled ventilation is not accounted for.

Many designers, developers and builders are hesitant to accept new requirements due to perceived cost burdens, and to the slow spread of technical information. Housing innovations which are perceived as adding cost and complexity can be expected to advance slowly in the mainstream marketplace, in spite of sound research and well proven new technology. Many builders, now responsible for meeting airtightness and ventilation requirements, have little experience with energy efficient construction where these techniques have been in use for some time, and have not been exposed to the rationales for air sealing and controlled ventilation. The code, to some, seems to be an incomprehensible nuisance that must be overcome rather than understood. At the same time there is a small core of people who have been trained in the R2000 program, or have other relevant experience, who are fully aware of the methods and purpose of the code.

Many designers and builders are not aware of the ducting requirements for ventilation systems, and proceed to design and build without considering this factor. Ventilation installers report that their job is often made more difficult by arbitrary decisions made at the building design stage or during construction. For example, in some cases the direction of floor joist runs is arbitrary and would not affect construction either way, but for ventilation ducting there is a major difference. The alignment of partitions for vertical runs is another example.

Some critics argue that passive ventilation has always worked in houses and that it can work today. There have been suggestions for thermal chimneys and other devices which would provide ventilation without mechanical equipment. Some builders also believe that air leakage in buildings should not be reduced and that the ventilation issue will be solved this way. Another common perception is that airsealing and therefore mechanical ventilation have been placed in the code for purposes of energy conservation and that R2000 policy has influenced the code. None of these assertions are well substantiated, but they are persuasive positions which influence many people. Because air quality and protection of building components from moisture damage are the primary purposes for the changes, it is important that public awareness of these issues be improved. It is likely that educating housing consumers as well as producers about new code requirement is necessary in order to further acceptance of designed ventilation by the industry.

3.22 Problems with application

The stated intent of the code is to require mechanical ventilation for maintaining acceptable air quality in housing. The purpose of maintaining air quality is to ensure the health and comfort of the occupants, and to prevent building damage due to poor moisture control. The means for achieving this are, however, not made clear in the 1985 NBC. A minimum interpretation of the requirement would require very little beyond what was already current practice in the building industry. A bathroom fan or fans of required capacity operated by a dehumidistat or switch, and a kitchen exhaust fan with manual controls would suffice. Where a forced air furnace is in use, a make-up air intake into the return duct would suffice as a tempered supply in many climates. A combustion air opening is already required for fuel burning appliances which, if increased in size, in some cases would suffice for make-up air also. Where it is perceived that climate permits and there is no forced air system, some sort of passive make-up air opening without tempering is thought by some to suffice. This "hole in the wall" approach is very doubtful, even in the mildest climate. In most locations, or where zone heating such as hot water systems are in use, further measures such as pre-heat devices for make-up air and some form of distributed exhaust system would be necessary to meet the intent of the code.

There is some doubt as to the effectiveness of such minimum responses to code requirements. Merely increasing the size of the bath fan and providing a passive make-up air opening, though it has been accepted by inspectors, is a doubtful solution. A system which exhausts only from the kitchen and bathrooms and has only one make-up air location which therefore is incapable of distributing air throughout the house may not provide effective air distribution. Even effective systems which are operated by manual controls which can be shut off may not be used often enough. Though such minimal systems may be code approved, there is reason to believe that a distributed ventilation system with pressure balancing, air tempering and both automatic and manual controls may be the only truly effective system for most new houses.

A major concern in air tightened houses with naturally aspirated combustion appliances is flue gas spillage. The potential negative pressurization of the house caused by the use of high capacity exhaust fans without make-up air provisions, or by the use of fireplaces without airtight doors is significant, and can cause spillage of combustion gases from chimneys. A survey of 131 early R-2000 homes which had combustion appliances showed that chimney backdrafting could be induced in 36 homes (27%) by a standard test with exhaust fans operating (17). The problem occured even though pressure balanced systems with adequately sized make-up air were in place. The reasons for backdrafting were that cold chimneys were unable to maintain a normal draft and HRV's operating in defrost mode in conjunction with other exhaust fans increased depressurization beyond anticipated levels. It appears that even with carefully balanced systems and make-up air sizing, backdrafting can occur. This led to the requirement in R2000 houses for sealed or induced draft combustion appliances. The means of specifying acceptable pressures for houses with various types of combustion appliances and measuring compliance with such a requirement are not yet in place, though they will be addressed in the CSA standard F326. In the mean time the more widespread use of sealed draft or induced draft appliances would obviate the need for such careful precautions.

3.23 Problems with provincial differences

The ventilation provisions in the National Building Code have not been adopted uniformly by all provinces. Ontario, for example, has adopted new air-tightness provisions without adopting the requirement for mechanical ventilation. In B.C. the code has been adopted but is in the process of revision due to difficulties in application. (See part 2.13)

3.24 The 1990 NBC

Due to concerns expressed about interpretation of Sec. 9.3 of the NBC a series of clarifications and additions have been proposed for this section in the 1990 code. (See Appendix I) The major differences in the 1990 code are:

-0.3 ACH will be accepted for continuously operating ventilation systems.

-Make-up air inlet sizes will be specified for various exhaust rates for houses with naturally aspirated combustion appliances, and for houses without them.

3.3 CSA STD. F326

The current code does not yet have a residential ventilation standard to support it. The proposed CSA Standard F326, Residential Ventilation Requirements, is currently being drafted, and will fill a number of gaps. It will "...define requirements for the design, installation, and compliance testing of ventilation systems for the provision of minimum controlled rates of ventilation ...". The standard includes clauses covering:

- -A minimum base flow rate for a house of 0.3 ACH.
- -Base flow rates for rooms based on room occupancy classification.
- -House pressure conditions for safe operation of combustion appliances.
- -References to good engineering practice as set out by other authorities for installation and design as well as venting and combustion air for fuel fired appliances.
- -Requirements for outside vented kitchen and bathroom exhaust.
- -Non-specific requirements for effective ventilation distribution.
- -Tempering and diffusion of ventilation air to prevent discomfort.
- -Minimum supply air temperature to fuel fired furnaces.
- -Insulation of cold ducting in conditioned space to prevent condensation.
- -Pressure increase limits during ventilation operation to reduce excess exfiltration.
- -Pressure decrease limits for various combustion venting configurations.
- -References to other standards governing equipment, ducts, etc.

The proposed standard does not directly address: system noise, maintenance access or presciptive requirements for make-up air and tempering.

3.31 Major areas of debate over ventilation codes

One of the most problematic areas in regulating residential ventilation requirements is the need for make-up air. However the means of determining when it is required and how it should be sized are not readily apparent in the 1985 NBC. This single factor has probably been the most controversial topic at any discussion of ventilation regulations, and is certainly one of the least understood issues among builders of conventional housing in the field. One house investigated during the course of interviews was built to the 1985 code airsealing requirements, contained a naturally aspirated gas boiler, and was fitted with over 450 L/s (900 cfm) of total exhaust capacity without any make-up air provisions. The only air inlet was the combustion air supply for the furnace. This house would be almost certain to experience backdrafting under some conditions, but the potential for this problem had not been anticipated by the architect, builder, inspector or heating and ventilation installer. Clearly one of the most pressing needs is for the standard to clarify depressurization limits, make-up air requirements and testing procedures.

Another area addressed in the standard is the need for tempering of incoming air, though no specific requirements are included. The commentary however cites industry recommendations that supply air should not be less than 17^{0}C if introduced at the floor and 13^{0}C if introduced at the ceiling unless diffusers are specially designed. This factor is also one which has raised a great deal of debate and is often misunderstood. Some maintain that in all but the most extreme climates air can be introduced at outdoor temperatures through a simple hole in the wall as long as it enters a laundry area or basement and can mix adequately with heated air before entering occupied space. However one of the common anecdotes heard during interviews is that homeowners, not understanding the purpose of a make-up supply, will plug the opening to prevent cold drafts or save energy. A similar problem occurs when make-up air and combustion air are provided through the same opening. Some homeowners, not understanding the purpose of the large duct spilling cold air into the basement will block it and restrict both combustion air and make-up air.

Though residential building codes and standards do not specifically address comfort issues, if tempering requirements are not included in the code it is possible that homes will be produced which meet code, and yet cannot be ventilated adequately during cold weather without discomfort. If this situation occurs, unsafe conditions are likely to occur as well as a good deal of dissatisfaction among housing consumers.

Prescriptive vs. compliance methods.
There has been so much confusion about ventilation requirements among designers, builders and inspectors, that it seems necessary to arrive at a clear and decisive code position that all can grasp. In order to do this, a clear and simple prescriptive code would probably be best. Simple tables determining ventilation requirements, make-up air requirements and other requirements based on occupancy, floor area and other simple variables are probably the best approach. This sort of evolution has taken place in other code areas where a great deal of information has eventually been condensed into tables. Though there is a danger of oversimplification and excessive safety margins, there will always be a compliance path open to anyone who wishes to prove a design by going through all of the calculations. The example calculations that have been done on the HRAI sample house as part of the documentation for F326 (18) illustrate the complexity of the compliance method, and clearly indicate that it will not be generally used or understood by most practicioners.

4.0 SYSTEM TYPES.

Independent vs. heating integrated systems.
There are two distinct types of ventilation system installations; those which use a forced air heating system for distribution of supply air (See Figs. 12-14) and those which do not (See Figs. 15-20). Systems using the heating ducts are less complex and significantly cheaper to install. Furthermore, relatively good effectiveness is usually assured because heat outlets and returns are likely to be well distributed throughout the house. One minor disadvantage is that comfort problems sometimes occur when the cool mixture of ventilation air and recirculated room air enters at floor level during low speed furnace fan operation. Ventilation systems which are independent of heating are clearly more difficult to design and install, though they can work as effectively as those using the heating ducts.

Heat recovery or not.
Though ventilation energy savings are an important reason for choosing a heat recovery ventilation system, this is often not the primary reason for the choice. The fact that most heat recovery systems also temper the incoming air is often the

more important reason because tempering outside air by other means can be difficult and costly.

Fan types

Most inexpensive fans are the axial "propellor" type. They are cheap to produce and quite efficient for low static pressure applications. Their major disadvantages are their rapidly decreasing volume delivery as static pressure rises, and their tendency towards higher noise levels. Many axial fans are also built with poor quality bearings because they are priced for the lower end of the market.

Centrifugal blowers are more capable of delivery at higher static pressures and are inherently quieter. They are generally priced above axial types, but are often more durably built. Another significant advantage of centrifugal blowers that some manufacturers have incorporated into their designs is that by reversing the motor rotation, air can be delivered in the same direction but at a reduced volume. This feature allows quiet "two speed" operation without speed controls or special motor windings.

Equipment ratings

Four important equipment ratings are: volume delivery at a given static pressure, duty rating, electrical acceptance, and noise rating. Though there are standards in Canada and the U.S. governing test procedures for all ratings, some of the test results (such as noise ratings) are supplied by the manufacturers or manufacturers associations and are not always reliable or applicable. Programs such as R2000 have consequently had to produce their own equipment acceptance criteria.

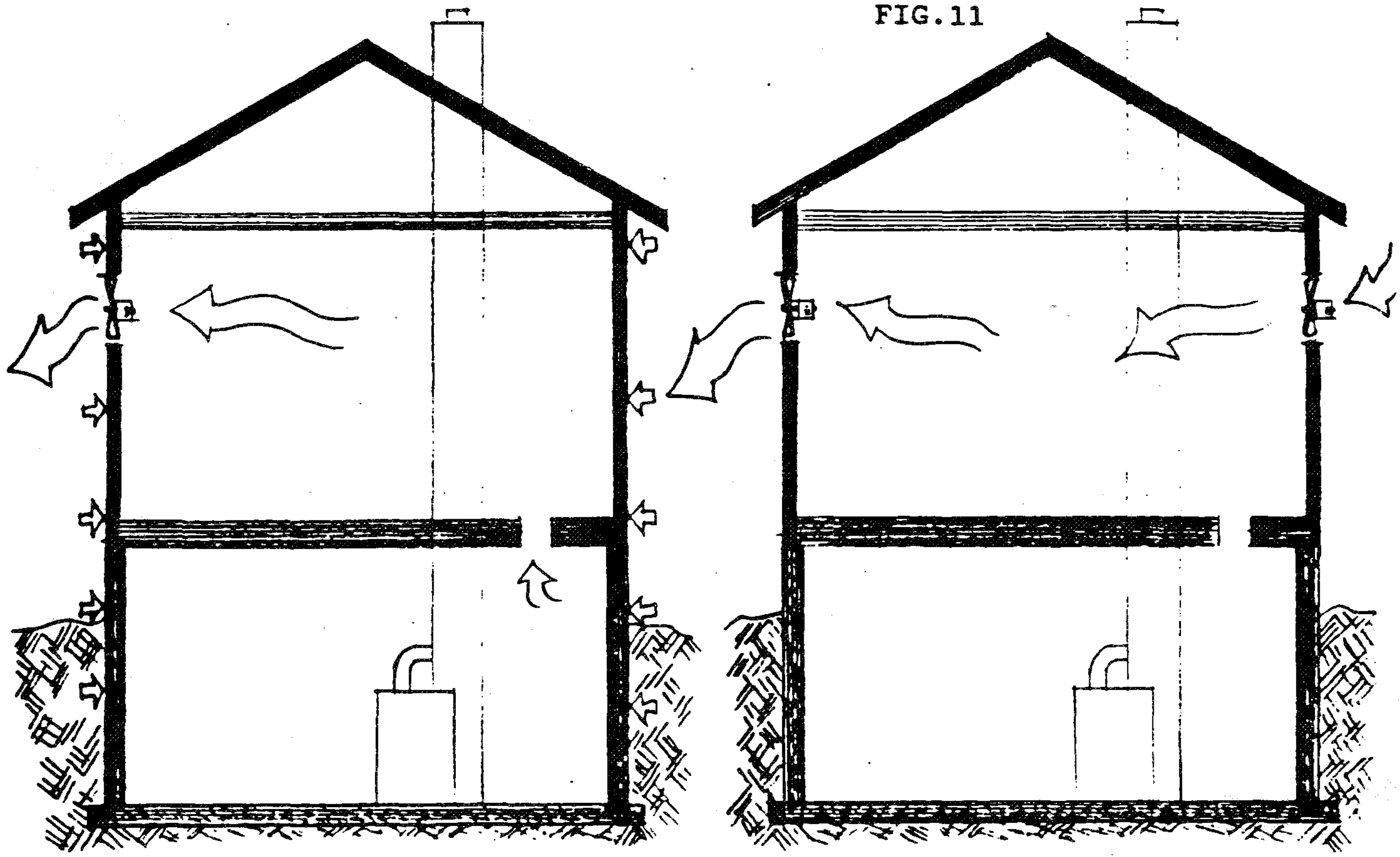
Some common complaints in the building industry and trades are:

-Volume rating is often listed at only one static pressure. Converting that information into an expected installed capacity is difficult.
-"Continuous" duty rating does not necessarily mean that equipment is mechanically suitable for continuous use. It is only an electrical safety rating.
-CSA or UL acceptance may apply to parts of a system but not to the entire system so that compliance and inspection approval can be difficult.
-Noise ratings are not specified in codes, are provided by manufacturers in differing and incompatible units,
and may not give a good indication of installed performance.

4.1 SYSTEM DIAGRAMS AND COMMENTARY

Figures 11-23 illustrate different approaches to residential ventilation. With each system type is a discussion of the relative merits and approximate costs.

FIG.11



EXHAUST ONLY (NEGATIVE PRESSURE) VENTILATION

ADVANTAGES

- simple method of whole house ventilation
- Low hardware and install. cost
- Spot ventilation capability

DISADVANTAGES

- Excess negative pressure hazards: chimney backventing, radon entry, infiltration.

SUPPLY AND EXHAUST (BALANCED) VENTILATION

ADVANTAGES

- Pressure balancing capability
- Air to air heat exchange capability.

DISADVANTAGES

- Greater cost and complexity.

FORCED AIR HEATING, LOCAL EXHAUST SYSTEM (Fig.12)

ADVANTAGES:

-Lower cost installation.
-Closest to familiar conventional ventilation.
-Automatic control possible by timer or de-humidistat.
-Two speed furnace can provide tempering in mild climates

DISADVANTAGES:

-Depressurization hazard potential (combustion appliance backventing, radon entry).
-Despite use of low noise fan systems tend to be noisier than others.
-No heat recovery.
-Not appropriate for very cold regions.

TYPICAL EQUIPMENT AND INSTALLATION CHARACTERISTICS:

Design: Exhaust fans in bathrooms and outside ducted range hood in kitchen. Centrally located bath fan (low noise unit) controlled by a de-humidistat located in central corridor or a clock timer.

Fan: Central bath fan rated at 25 to 40 L/s @ 50 Pa. (0.2" WG) and 2.5 Sones.

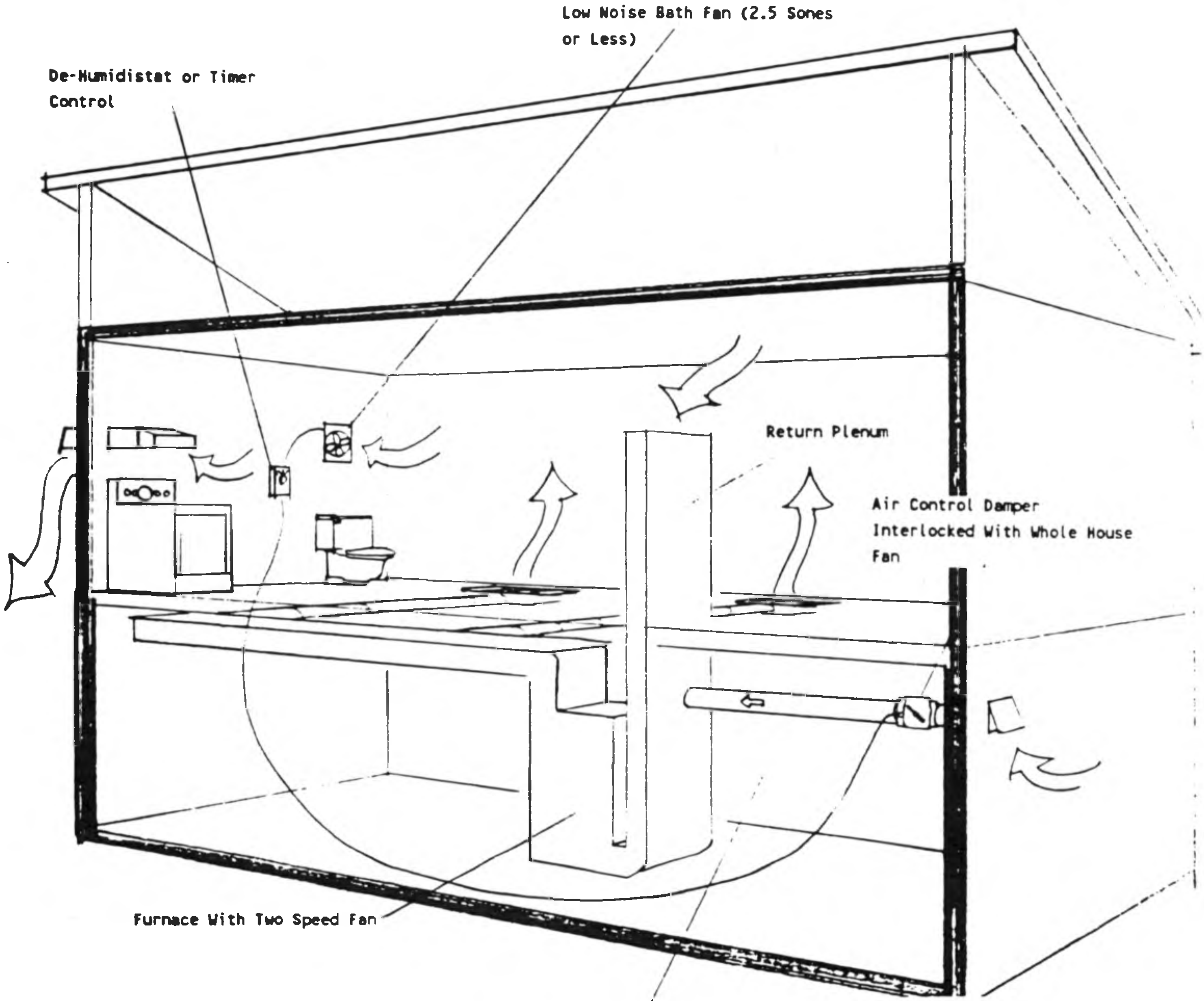
Controls: De-humidistat set between 40-60% RH. Clock timer set for 6-8 hrs. total morning and evening.

Tempering: Outside air drawn into the furnace return duct through a 100mm. (4") dia. duct. Air controlled by a electromechanical damper open only when the main exhaust fan operates. Pre-heat option required for very cold regions.

TYPICAL INSTALLED COSTS: $150 to $400 (CDN) over conventional system.

FORCED AIR HEATING, LOCAL EXHAUST SYSTEM

FIG.12



Duct Insulated and Wrapped With Exterior Vapor Barrier.

A low noise bath fan controlled by a de-humidistat and kitchen fan extract stale air from house. Outdoor air enters furnace return plenum.

FORCED AIR HEATING, CENTRAL EXHAUST SYSTEM (Fig.13)

ADVANTAGES:

-Can provide well distributed continuous basic ventilation.
-Lower cost than HRV systems.
-Package systems available.
-Very low noise due to remote fan and flex duct.
-In milder climates two speed furnace provides tempering.

DISADVANTAGES:

-Depressurization hazard potential (backventing, radon, increased infiltration).
-No heat recovery.
-Higher cost than "minimum whole house fan system"

TYPICAL EQUIPMENT AND INSTALLATION CHARACTERISTICS:

Design: Exhaust from kitchen, baths, and bedrooms. Supply through furnace ducting.

Fan: 30-70 L/s variable or multi-speed, usually attic mounted, operating continuously with intermittent high speed use.

Ducting: Flex duct, 100mm to 175mm. dia.

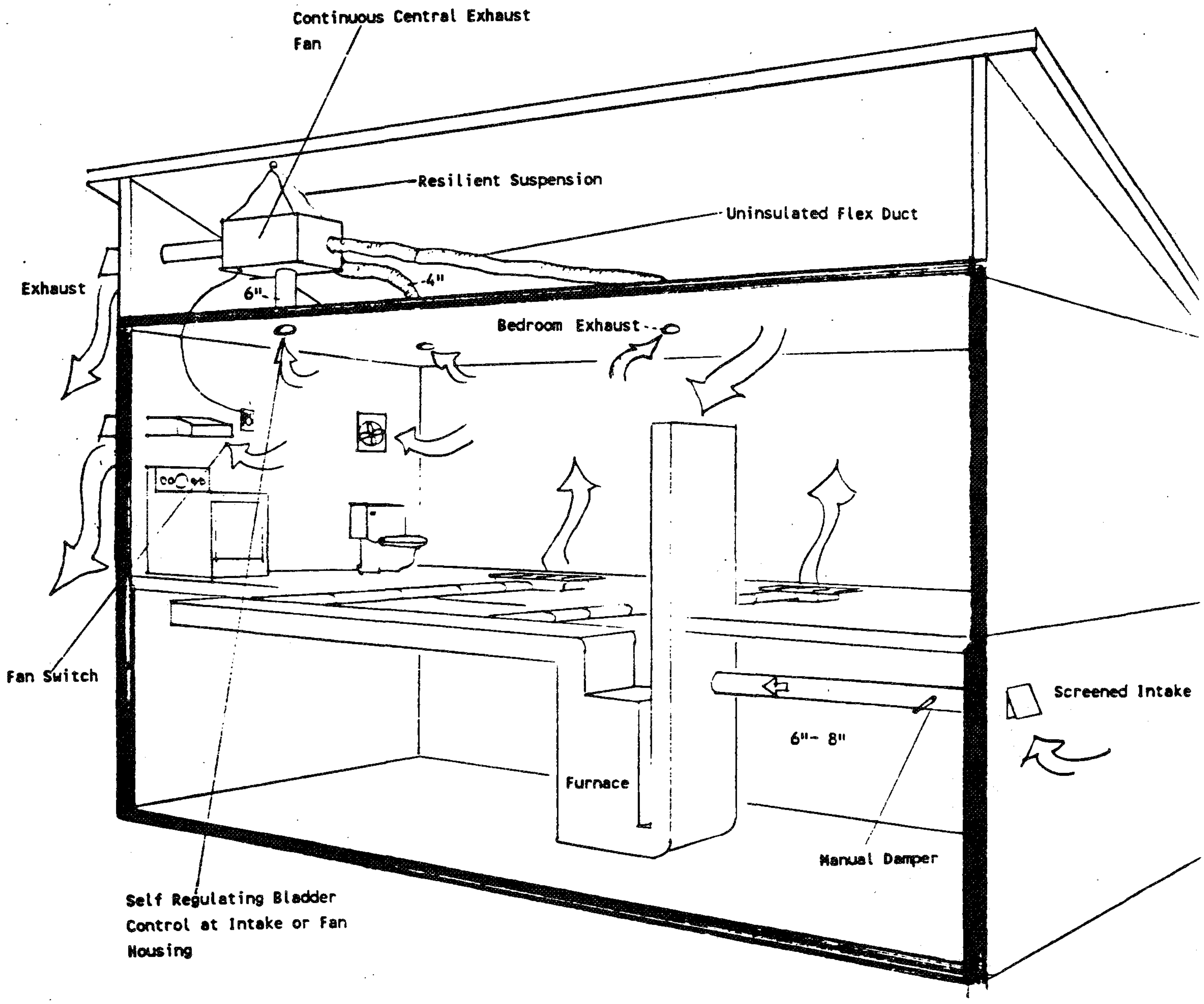
Controls: Usually clock timers, some use de-humidistat. Manual high speed switch. Control located in kitchen or central hall.

Tempering: Outside air mixes with furnace return air. Damper required to control airflow due to negative pressure in furnace return plenum. Pre-heat required in cold regions, hot water fin tube in intake preferred.

TYPICAL INSTALLED COSTS: $500-$650 (CDN)

FORCED AIR HEATING, CENTRAL EXHAUST SYSTEM

FIG.13



Continuous central exhaust fan extracts stale air from house. Outdoor air enters furnace return plenum. Timer or manual switch operates exhaust fan on high speed.

FORCED AIR HEATING, HEAT RECOVERY VENTILATOR (Fig.14)

ADVANTAGES:

- -Can provide a wide range of well distributed ventilation.
- -Reduces heating costs by heat recovery.
- -Can provide intermittent as well as continuous ventilation.
- -Tempers incoming outside air.
- -Provides pressure balanced ventilation which does not contribute to negative pressure.

DISADVANTAGES:

- -Relatively high cost compared to other options.
- -Air flows may not remain balanced during defrost or if filters and motors not maintained.

TYPICAL EQUIPMENT AND INSTALLATION CHARACTERISTICS:

Design: HRV unit located in conditioned space suspended with resilient straps, exhaust and intake are run to exterior and placed 2 M apart and 300 to 450 mm. above grade. Exhaust ducts are run from a central location, bathrooms, or bathrooms and kitchen. The duct supplying tempered fresh air from the HRV is connected to the furnace return plenum either indirectly or by a soft connection. A two speed furnace is required for best distribution and operation.

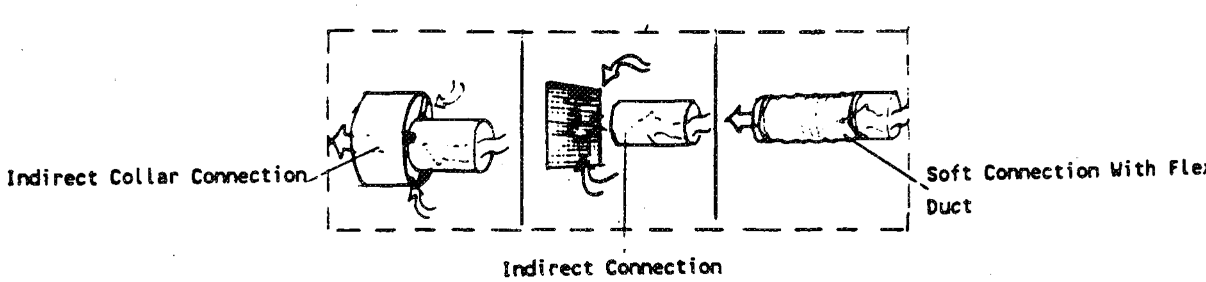
Capacity: Small unit- 25 to 60 L/s
Large unit- 45 to 115 L/s

Ducting: Pre-insulated flex duct between HRV and exterior. Flex duct or sheet metal duct for exhaust runs indoors. A short length of flex duct used at the HRV to isolate vibration.

Controls: De-humidistat centrally located or located in exhaust stream. On-off servicing switch for HRV.

Tempering: Outdoor air is tempered by heat recovered from exhaust air. Temperature rise of 50 - 78% of the temperature difference between indoors and outdoors possible. Additional tempering by mixing and furnace.

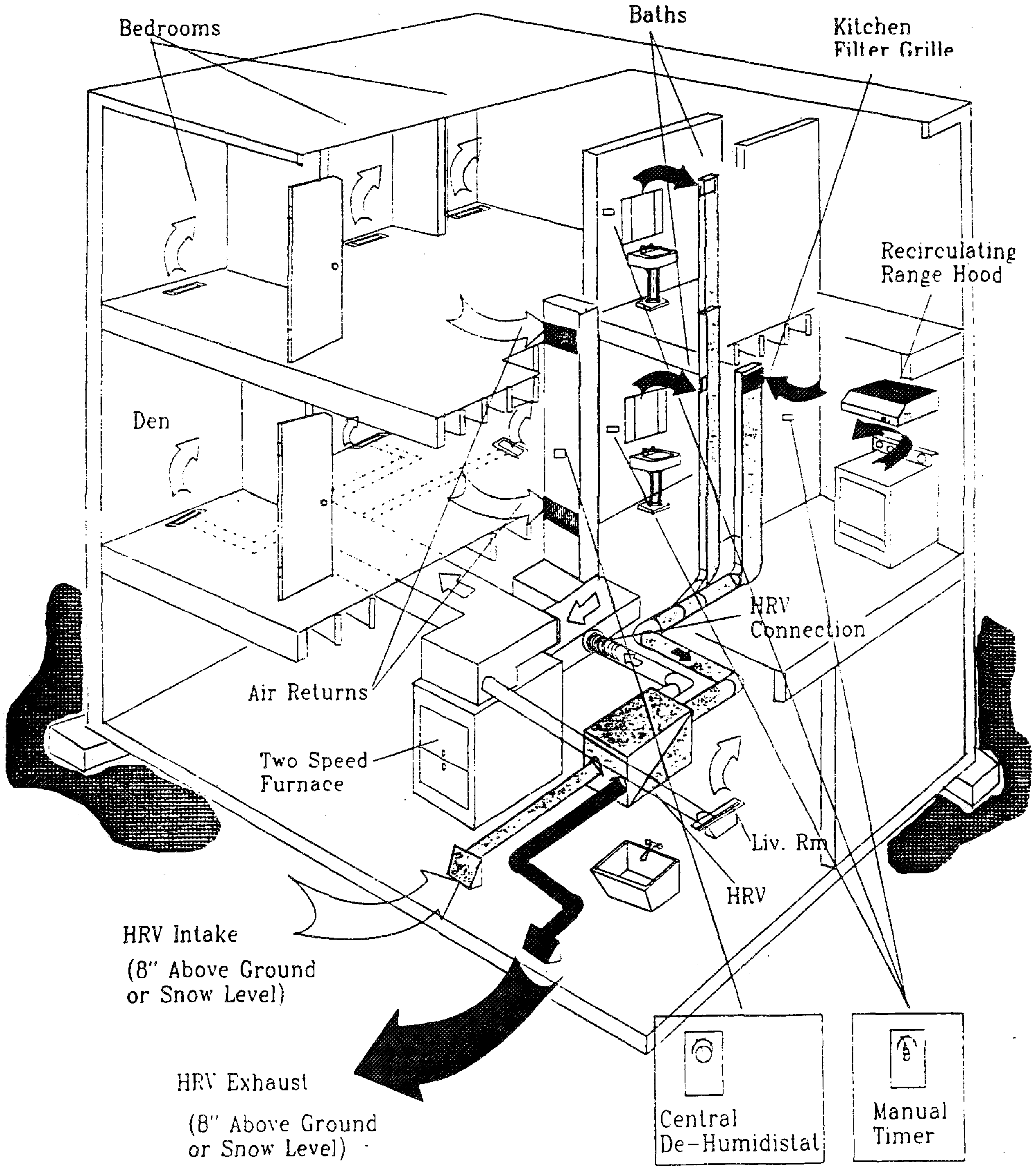
TYPICAL INSTALLED COSTS: $1000 to $1800 (CDN)



ALTERNATIVE FURNACE INTAKE METHODS

FIG.14

TWO STOREY BASEMENT SYSTEM
HRV SYSTEM WITH FORCED AIR HEAT



ZONE HEATING, LOCAL EXHAUST SYSTEM (Fig. 15)

ADVANTAGES:

-Lower cost installation.
-Closest to familiar conventional ventilation
-Automatic control possible by timer or de-humidistat.

DISADVANTAGES:

-Depressurization hazard potential (combustion appliance backventing, radon entry)
-Despite use of low noise fan, systems tend to be noisier than others.
-No heat recovery.
-Not appropriate for very cold regions.

TYPICAL EQUIPMENT AND INSTALLATION CHARACTERISTICS:

Design: Exhaust fans in bathrooms and outside ducted range hood in kitchen. Centrally located bath fan (low noise unit) controlled by a de-humidistat or clock timer located in central corridor.

Fan: Central bath fan rated at 25 to 40 L/s @ 50 Pa. and 2.5 Sones.

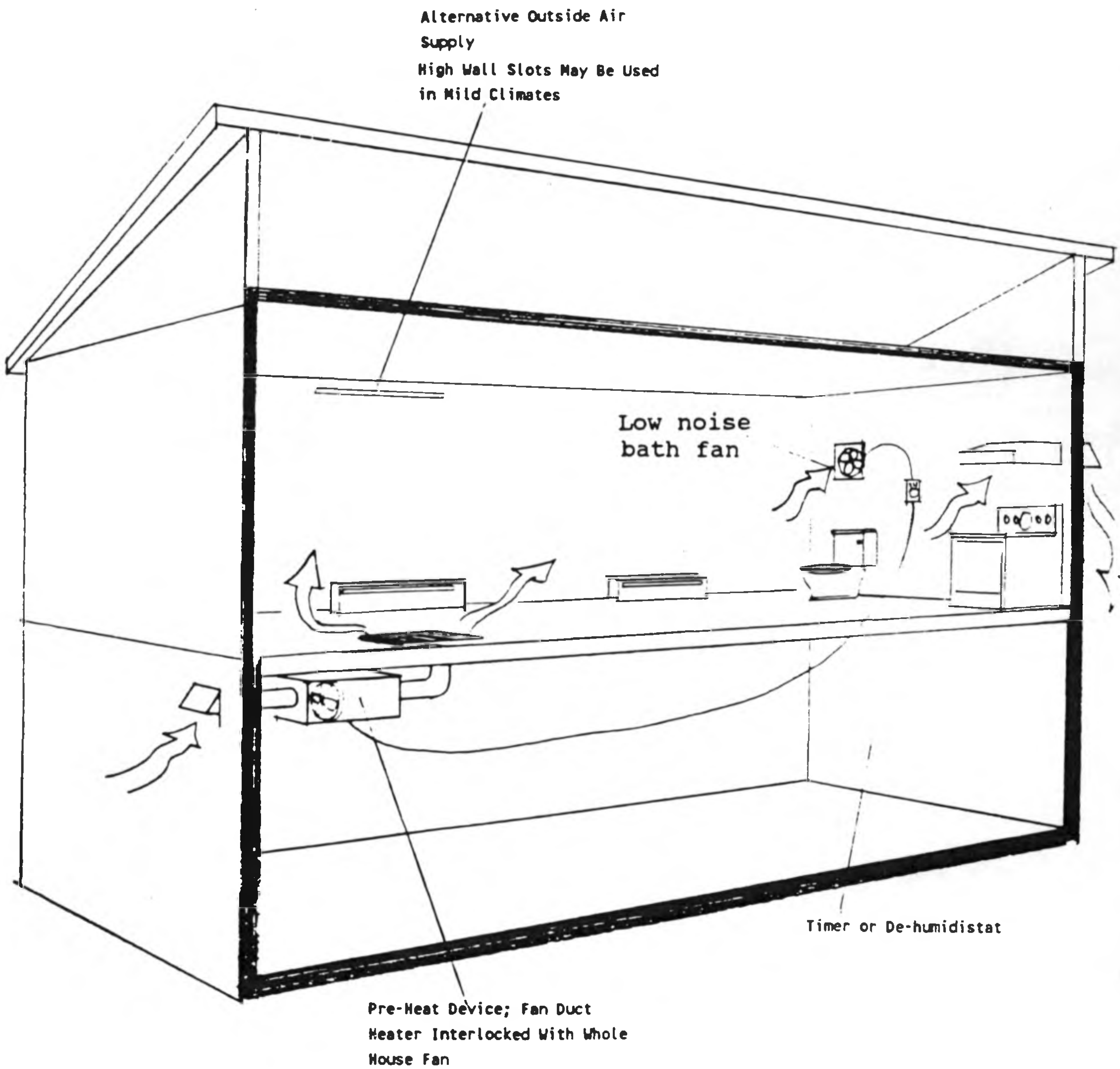
Controls: Clock timer set for 6-8 hrs total morning and evening, or centrally located de-humidistat set between 40 and 60% RH .

Tempering: Outside air drawn into the conditioned space through a 100mm. (4") dia. duct. Air controlled by an electromechanical damper open only when the main fan operates. Pre-heat option required for very cold regions.
Through wall port option: Outside air mixes with room air in the boundary layer near the ceiling before entering the occupied zone.

TYPICAL INSTALLED COSTS: $150 to $400 (CDN) over conventional system.

ZONE HEATING, LOCAL EXHAUST SYSTEM

FIG.15



Low noise bath fan controlled by a de-humidistat and kitchen fan extract stale air from house. Outdoor air enters through regulated high wall slots or other tempered intakes.

ZONE HEATING, CENTRAL EXHAUST SYSTEM (Fig. 16)

ADVANTAGES:

-Can provide well distributed continuous basic ventilation.
-Lower cost than HRV systems.
-Package systems available.
-Very low noise due to remote fan and flex duct.
-In milder climates two speed furnace provides tempering.

DISADVANTAGES:

-Depressurization hazard potential (backventing, radon, increased infiltration).
-No heat recovery.
-Higher cost than "minimum whole house fan system"
-Location and design of through wall diffusers is critical for tempering and comfort.
-Not appropriate for very cold regions.

TYPICAL EQUIPMENT AND INSTALLATION CHARACTERISTICS:

Design: Central exhaust fan located in attic, flexible ducting run to bathrooms, kitchen, and in some cases, bedrooms.

Fan: Single, two speed, and variable speed exhaust fans available. Capacity range 30 - 60 L/s. Fans are designed to operate continuously. Intermittent operation will lead to premature failure and condensation in ducts.

Ducting: 100mm to 150mm flex ducts only. Some mfgrs. provide automatic air flow regulators to balance ventilation among rooms served.

Air Supply Diffusers: Through wall port types:
-Fixed dimension inlets.
-Humidity actuated variable dimension.
-Closeable inlets.

In all cases ports must be located within 200 mm. of the ceiling.

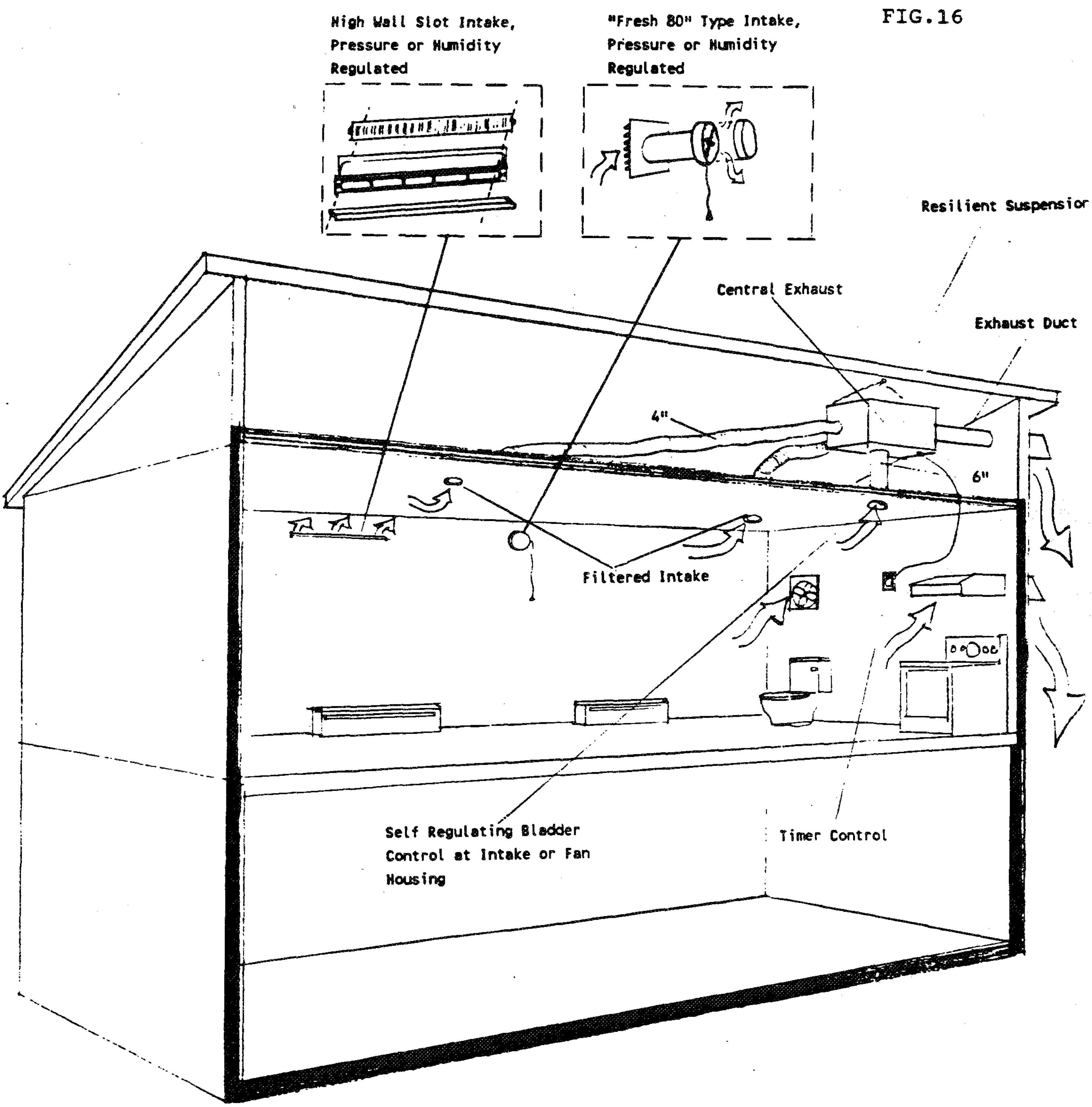
Controls: Clock timer or centrally located de-humidistat.

Tempering: Cold outside air mixes with room air in the boundary layer near the ceiling before entering the occupied zone.

TYPICAL INSTALLED COSTS: $600 to $900 (CDN).

ZONE HEATING, CENTRAL EXHAUST SYSTEM

FIG.16



Central exhaust, kitchen and bath fans (optional) extract stale air from house. Outdoor air enters through regulated high wall slots or other tempered intakes.

ZONE HEATING, HEAT RECOVERY VENTILATOR (Figs.17-20)

ADVANTAGES:

-Can provide a wide range of well distributed ventilation.
-Reduces heating costs by heat recovery.
-Can provide intermittent as well as continuous ventilation.
-Tempers incoming outside air.
-Provides pressure balanced ventilation which does not contribute to negative pressure.

DISADVANTAGES:

-Relatively high cost compared to other options.
-More ventilation ducting required.
-Air flows may not remain balanced during defrost or if filters and motors not maintained.

TYPICAL EQUIPMENT AND INSTALLATION CHARACTERISTICS:

Design: HRV unit located in conditioned space suspended with resilient straps, exhaust and intake are run to exterior and placed 2 M apart and 300 to 450 mm. above grade. Exhaust ducts are run from a central location, bathrooms, or bathrooms and kitchen. fresh tempered supply ducting from HRV typically runs to diffusers in all bedrooms and the main living area.

Capacity: Small unit- 25 to 60 L/s
Large unit- 45 to 115 L/s

Ducting: Pre-insulated flex duct between HRV and exterior. Flex duct or sheet metal duct for exhaust runs indoors. A short length of flex duct used at the HRV to isolate vibration from rigid duct.

Controls: De-humidistat centrally located or located in exhaust stream. On-off servicing switch for HRV.

Tempering: Outdoor air is tempered by heat recovered from exhaust air. Temperature rise of 50 - 78% of the temperature difference between indoors and outdoors possible.

TYPICAL INSTALLED COSTS: $1000 to $2600 (CDN).

ZONE HEATING, HRV SYSTEM

TWO STOREY CRAWLSPACE SYSTEM

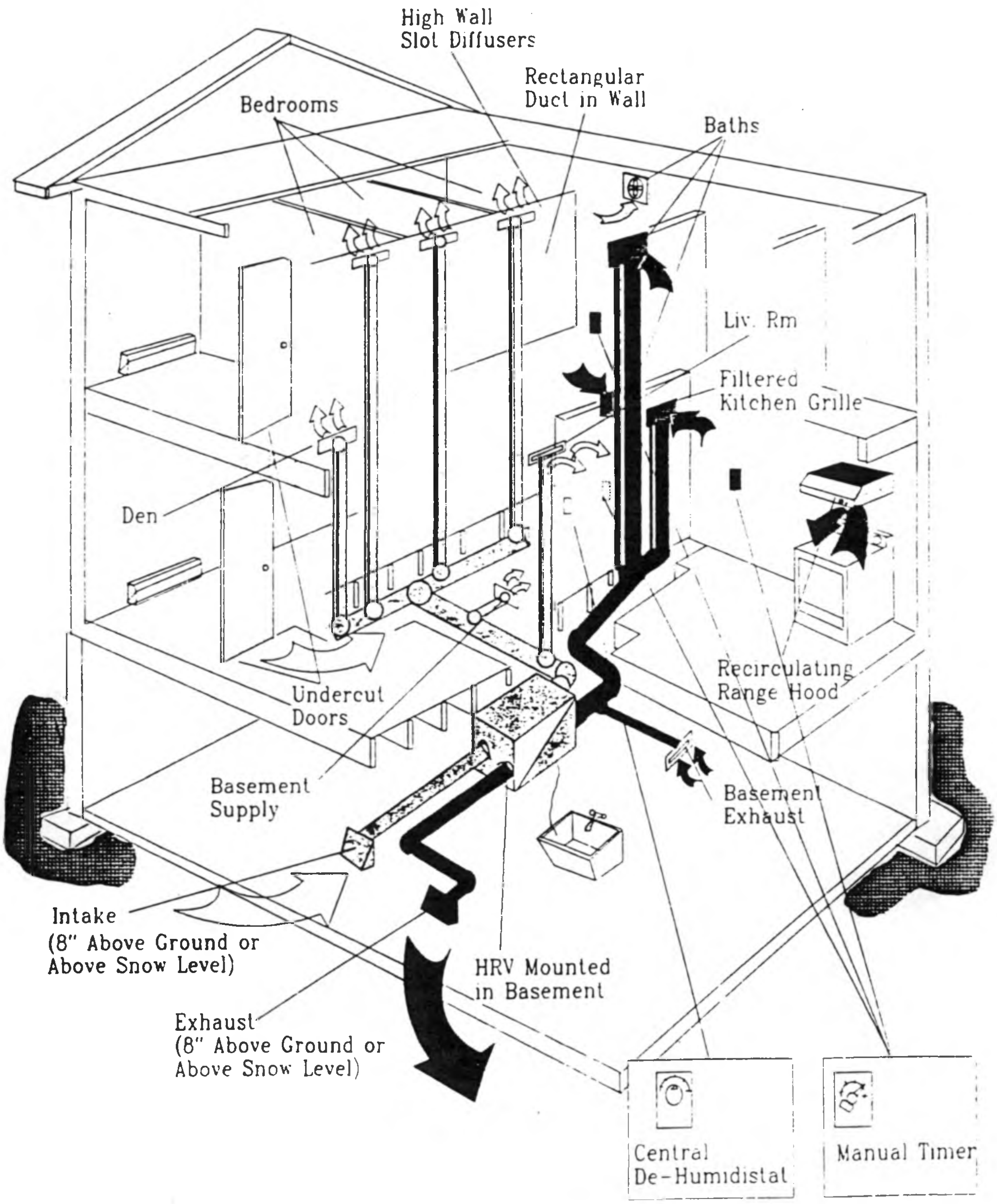


FIG.18

ZONE HEATING, HRV SYSTEM

SINGLE STOREY SLAB/CRAWL SPACE SYSTEM "A"

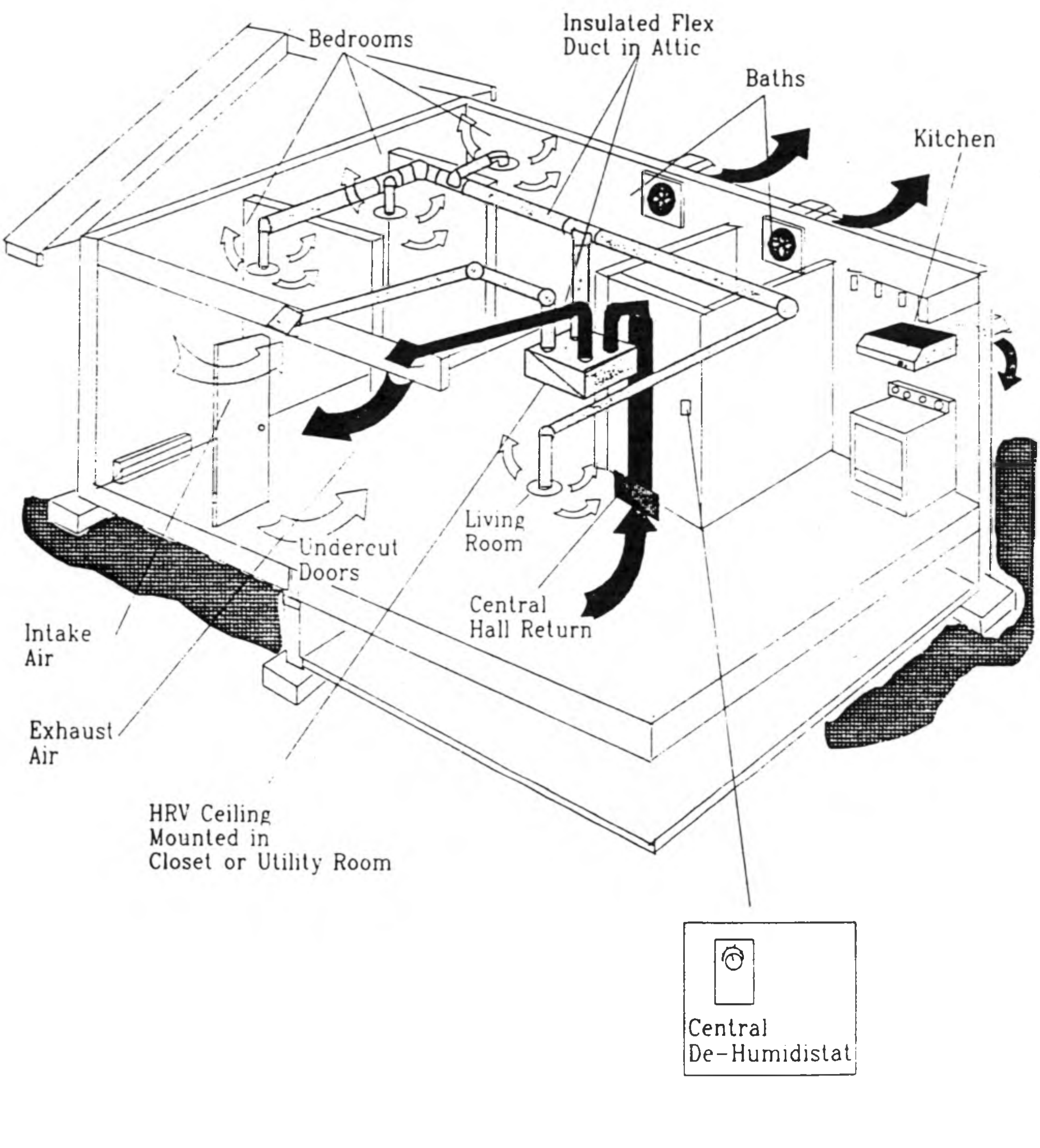


FIG.19

ZONE HEATING, HRV SYSTEM

SINGLE STOREY SLAB/CRAWLSPACE SYSTEM "B"

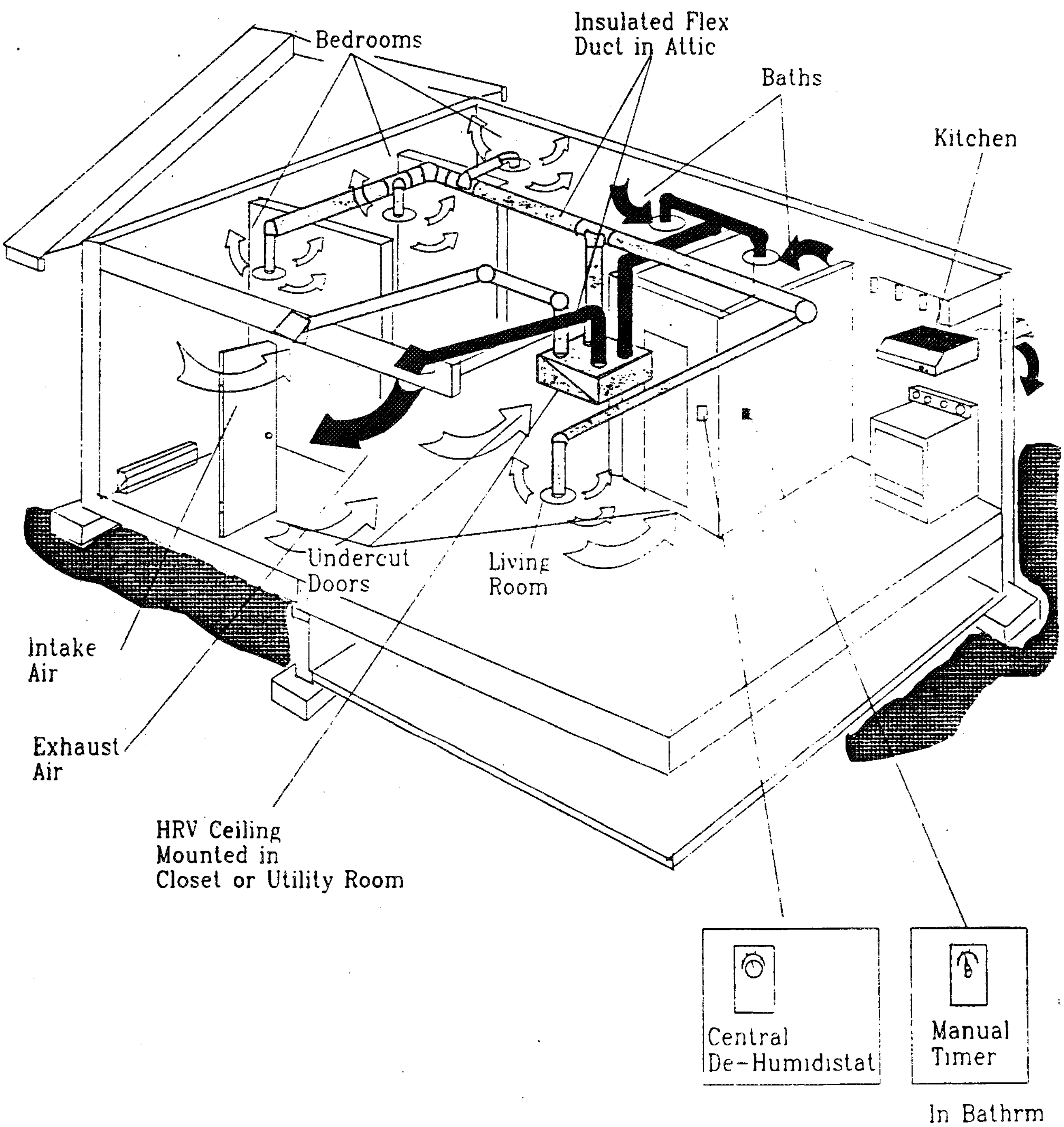
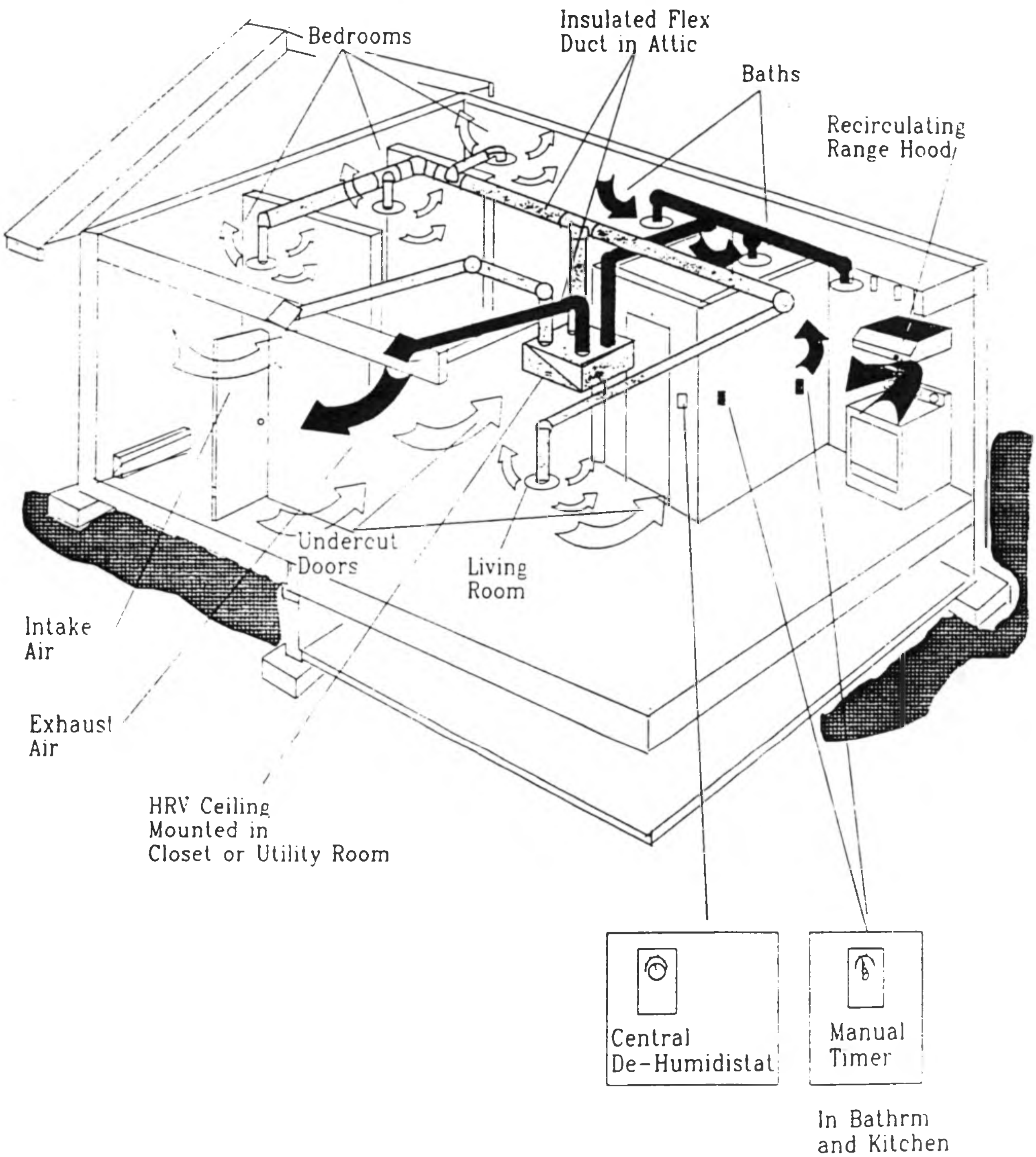


FIG.20

ZONE HEATING, HRV SYSTEM

SINGLE STOREY SLAB/CRAWLSPACE SYSTEM "C"



HUMIDITY REGULATED CENTRAL EXHAUST SYSTEM (Fig.21)

ADVANTAGES:

-Can provide well distributed continuous and intermittent ventilation.
-Ventilation rate responds to occupancy by sensing humidity level.
-Does not require occupant response for normal operation, though manual override is provided.
-Ventilation is variable room by room based on humidity.
-Less overventilation lowers heating costs.

DISADVANTAGES:

-Higher cost than other exhaust only options.
-More complex hardware than most exhaust systems.
-Depressurization hazard potential (backventing chimneys, radon entry).
-Not appropriate for very cold or very dry regions.

TYPICAL EQUIPMENT AND INSTALLATION CHARACTERISTICS:

Design: Centrally located constant pressure fan located in attic. Humidity regulated extractors connected to fan with sheet metal duct with all joints sealed.

Fan: Specially designed constant pressure fan. 100 L/s Max. capacity @100 Pa. constant pressure.

Ducting: Ducting required for extractors and fan exhaust only.

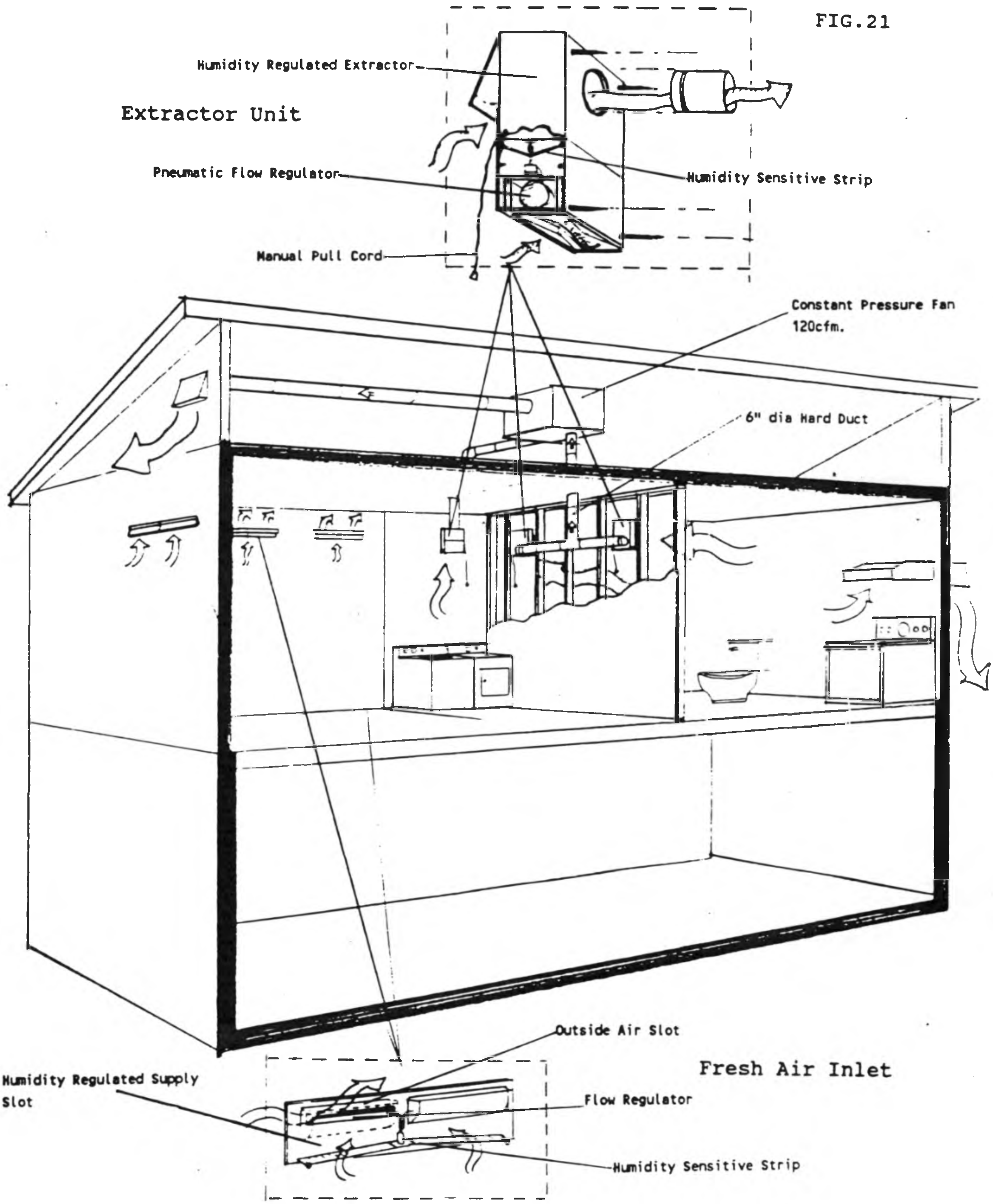
Controls: Fan operates constantly. Extractors controlled by humidity actuated pneumatic circuit. Intakes controlled by humidity regulated damper.

Tempering: Outside air mixes with room air in boundary layer near ceiling.

TYPICAL INSTALLED COSTS: Approx. $1200 (CDN)

HUMIDITY REGULATED CENTRAL EXHAUST SYSTEM

FIG.21



A constant pressure central exhaust fan extracts air from kitchen, bath, and laundry via extractors which open when indoor humidity is high. Extractors can be fully opened by a manual pull cord. Outside air enters through high wall slots in bedrooms via regulators which also open when indoor humidity is high.

EXHAUST AIR HEAT PUMP (Fig. 22)

ADVANTAGES:

-Highest thermal efficiency of any ventilation system.
-Supplies a large part of domestic hot water and some space heating.
-Can provide some cooling capacity for Summer.
-When dynamic wall construction is used for make-up air, incoming air is tempered and framing is dried continuously.
-Can provide continuous well distributed ventilation.
-Optional arrangement can provide subslab ventilation for radon reduction.

DISADVANTAGES:

-High capital cost.
-Potential depressurization hazard (chimney backventing, radon entry).
-Requires minimum level of internal and solar gains for effective operation.
-Most complex hardware of all exhaust systems.

TYPICAL EQUIPMENT AND INSTALLATION CHARACTERISTICS:

Design: Exhaust air is drawn from kitchen and bathrooms and ducted to heat pump evaporator coil. Heat is extracted and stale air discharged outside at approx 2^0 C. Condensor heats domestic hot water storage tank.
In cooling mode house air is recirculated over evaporator coil. Exhaust air is drawn continuously from the kitchen and bathrooms, passed over condensor and then discharged outside carrying excess heat away once hot water tank is heated.

Ducting: Exhaust ducting required from bathrooms and kitchens. Room air supply and return required for space cooling systems.

Controls: Dehumidistat or time of day timer.

Tempering: High wall slit diffuser or dynamic wall.

TYPICAL INSTALLED COSTS: $3400 (CDN) hardware and installation only (no tempering system)

EXHAUST HEAT PUMP SYSTEM WITH DYNAMIC WALL TEMPERING

FIG.22

The house is maintained under negative pressure by a central exhaust fan. Heat is extracted from the exhaust stream by a heat pump and delivered to domestic hot water storage. Outside air enters by infiltration through air permeable cladding and is tempered by mixing.

*Any Combustion Appliance Should be Sealed or Induced Draft.

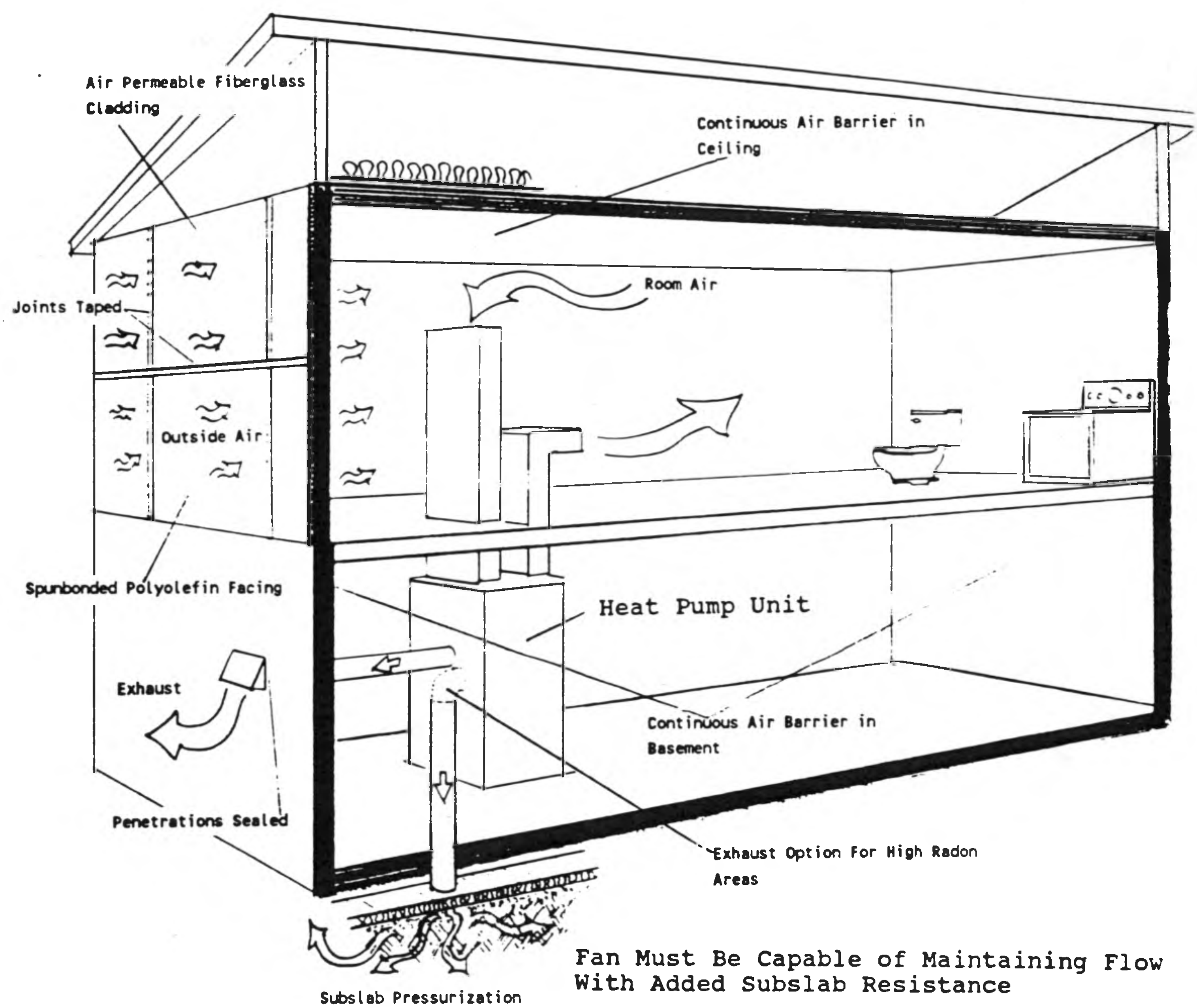
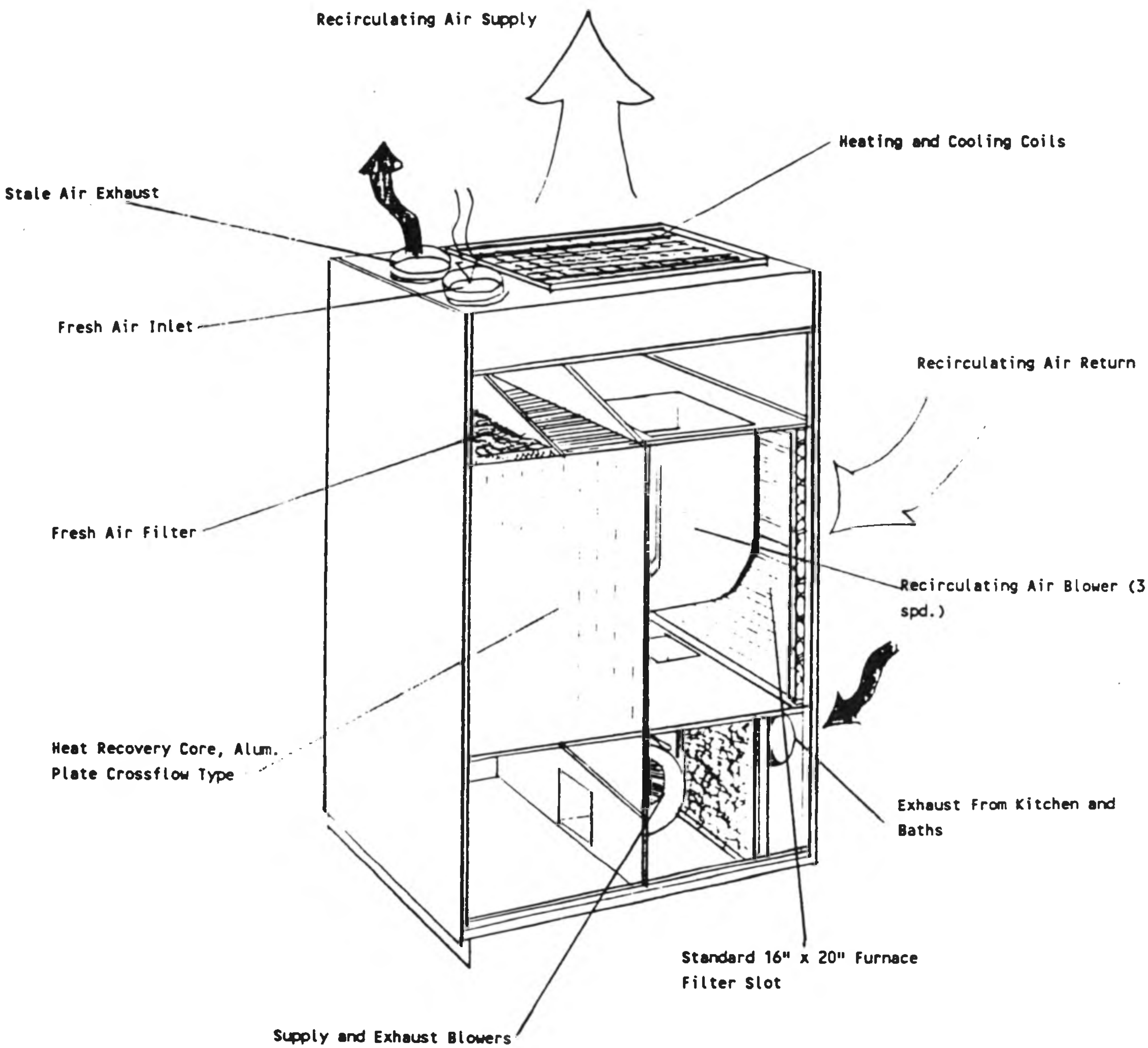


FIG.23

FURNACE/AIR-CONDITIONER/HRV UNIT



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4.11 System installed costs (19)

Typical system costs for new construction ($CDN)

Western Canada

-Central exhaust only system with forced air furnace. Make-up air into furnace with no extra pre-heat required. $500-650 installed, excepting flat roof houses and post and beam construction. Pre-heat adds to cost where design temp. <-10 C. (See Fig.13)

-Central exhaust only system without a forced air furnace. Supply via fixed through wall inlets, exhausts in kitchen and bathrooms. $600-900 installed. (See Fig. 16)

-Small balanced HRV system. Make-up air into forced air furnace, or minimally distributed to bathrooms and bedrooms if other heating systems are used. $1550-1800 installed depending on ducting requirements. Pre-heat adds to cost in very cold locations. (See Fig. 14)

-Full R2000 standard balanced HRV system with distribution of both supply and exhaust. $2000-2500 installed depending on type of heating system and ducting and control requirements. (See Fig. 17)

-European central exhaust system with humidity regulated extractors in Cat.B rooms and humidity regulated high wall slot inlets in Cat.A rooms. Approx. $1200 installed. (See Fig.21)

Eastern Canada

-Small HRV in a simple one storey house of approx 100 m^2, slab on grade construction. HRV ceiling mounted in a closet or utility room with insulated flex ducting in attic. Approx. $1000 installed. (Similar to Fig. 18)

-Large HRV in a multi-storey house with basement and without a forced air heating system. Basement mounted unit with full ducting similar to R2000 standards. Approx $2600 installed. (See Fig.17)

Western US

-Minimum HRV System, ceiling mounted, with supply to all bedrooms and one centrally located exhaust, seperate bath and kitchen fans. Approx. $850-1050 installed. Large dia. insulated flexible duct used in attic space. Compact heat wheel type HRV in common use. (See Fig. 18)

Eastern US

-Non-ducted HRV, through wall mounted. Minimum system for a small house. Approx. $650 installed.

-Central HRV system. Range depending on size of unit and ducting requirements- Approx. $1000-2000

4.2 CONTROLS

A range of types of both automatic and manual controls are in use for whole house ventilation systems. The most sucessful installations seem to be those which incorporate automatic humidity or time clock regulated controls with a simple manual override switch or timer. Most people are not familiar with the operation of ventilation controls in their homes other than simple bathroom and kitchen fans. Humidity regulated types are particularly misunderstood. For this reason the most foolproof automatic controls with the simplest and most accessible manual controls are probably the best combination. (See Appendix III)

4.21 Continuous vs. intermittent operation

In many central exhaust or HRV installations the preferred method of control is to operate the system continuously at low speed with intermittent high speed use as required. The switching from low to high speed is probably best managed by an automatic control with a manual override. A number of problems occur with continuous operation however:

-Most fan equipment is not designed for continuous operation and will deteriorate and become noisy after prolonged use.
-Constant equipment noise is a common cause of complaint.
-Overventilation can often occur in houses which are unoccupied for most of the day. Low RH in winter is a common complaint with overventilation.
-Continuous operation may create the perception of overventilation even where symptoms such as excessive dryness do not occur.

Intermittent operation has another set of problems:

-Intermittent operation of central exhaust fans can lead to condensation and equipment corrosion and to premature equipment failure.
-Underventilation can occur if fan off periods co-incide with periods of demand.

Most of these problems can be overcome by better hardware design, careful equipment selection and installation, and proper sizing and controls. The perception that continuous equipment operation is unnecessary is not so readily changed.

4.22 Variable speed fans

Most motor types commonly found in ventilation equipment will not operate properly and safely below approx. 50% of their designed speed, regardless of the type of speed control used. There are a few exceptions among the European built motors. Some HRV manufacturers simply wire two motors to run in series for half speed operation, a simple and reliable method. The result is that most ventilation systems are not capable of operating below approx. half of full capacity; a range which often does not allow enough flexibility for varying ventilation demand throughout the day, particularly with continuously operated systems. The use of time clocks or automatic flow regulators (such as the humidity controlled types) can alleviate this problem, but motors with a wider speed control range would be a major asset.

4.23 Timers and Time Clocks

Manual timers are in common use for manual control or override control of all types of equipment including HRV's, central exhausts and bathroom fans. A simple wall mounted crank type timer located in baths and laundries allows intermittent operation or intermittent high speed operation of exhaust systems on demand for up to one hour. This is a widely accepted and easily understood method of providing manual ventilation control. Time clocks operate on a time of day basis and are usually programmed to cycle ventilation equipment for extra air change during morning and evening peak demand periods. A common central exhaust fan installation uses a time clock to operate the fan intermittently for a total of 6 to 8 hours of operation each day. Time clocks are usually set by the installer and should not require any attention from the homeowner except for resetting after a power failure.

4.24 De-humidistats

De-humidistats are simple controls with contacts which close when humidity exceeds the value set by the control knob. They are now common in new housing under the 1985 NBC provisions for a controlled mechanical ventilation system, but are still widely misunderstood by consumers. The most common problem reported is that they are turned up (as a thermostat would be) when increased ventilation is demanded, when they should actually be turned down. Another problem is that if they are centrally located and not accompanied by manual override timers in bathrooms, kitchens and laundries, they are not sensitive enough to the periodic ventilation demands in those rooms.

Two recent innovations in the use of de-humidistats promise to alleviate these problems. Some manufacturers are now placing a de-humidistat inside their equipment so that it can sense the humidity in the exhaust stream. These units are less likely to be readjusted by the homeowner. Some control manufacturers are also changing the face of the control so that it no longer has RH values printed on it but simply indicates a "comfort zone" in the middle range. These innovations are likely to help reduce consumer confusion over the use of de-humidistats.

4.25 Condensate and frost control

Most heat recovery ventilators pass supply air and exhaust air through a core which collects condensate from the warm exhaust air. During cold weather the condensate will also freeze causing an ice blockage and can lead to equipment damage if it is not removed. All units which produce condensate must be installed with a connection to a building drain which is arranged so that it is unlikely to become obstructed. In the Canadian climate all installations should also be equipped with a defrost device.

There are two common defrost systems available. One uses a periodic bypass of warm room air through the core to melt ice buildup. During this defrost cycle intake air is temporarily interrupted. The other common system uses an electric heater to melt ice, either integral to the unit or as a seperate accessory.

4.3 ADVANCED SYSTEMS AND NEW DIRECTIONS (See Appendix IV)

A number of new products and trends are appearing in ventilation hardware and applications:

-Heat pump recovery of exhaust stream heat (See Fig.22 &23).

-Drawing outside air through permeable wall cladding using slight negative pressurization. The "Dynamic Wall" approach (See Fig. 6)

-Drawing heat from the earth using buried air intake tubes (See Fig.5).

-Humidity regulated extractors and supply slots (See Figs. 16&21)

-Automatic pressure balancing air regulators.

-An electric baseboard heater with an individual outside air supply (a European innovation).

-Individual room HRV's and wall through fresh air and exhaust units (Japanese and European innovations).

-CO_2 regulated ventilation (no affordable residential systems yet).

-Kitchen range hood HRV's with exhaust connections to bathrooms and laundry (a European innovation which probably doesn't meet Canadian fire codes).

-A packaged ventilation unit which automatically maintains enough make-up air to limit depressurization to 5 Pa.

-Improved motor designs which allow a wider range of speed control.

-Advanced packaged units incorporating heat recovery, humidity regulation, air filtration, pressure balancing and tempering.

5.0 HARDWARE SURVEY

Hardware available North American Mkt.

Table 1- Fans
Table 2-Central Exhaust Systems
Table 3-HRV's
Table 4-Accessories

CMHC VENTILATION SURVEY

TABLE 1

PRODUCT CATEGORY #1 FANS

CEILING AND WALL MOUNTED FANS

MANUFACTURER	MODEL	CAPACITY @ S.P. 25 Pa l/s	.1" WG CFM	NOISE SONE	COST APPROX RETAIL	REMARKS
Broan Ltd.	650 ceiling	24.5	49	3	$35	3" round discharge duct
1140 Tristar Dr.	660 ceiling	31	62	4	$45	"
Mississauga	675 ceiling	37.5	75	4.5	$50	"
Ont. L5T 1H9	684 ceiling	40	80	2.5	$105	4" round discharge duct
9416)676-1300	676 ceiling	55	110	4	$110	"
	678 ceiling	30	60	2.5	$100	4" duct and built in light
	360 lo sone	50	100	1.5	$190	Vertical or horizontal mount
	361 lo sone	80	160	3	$195	3-1/4"x10" duct
	362 lo sone	100	200	2	$230	
	363 lo sone	150	300	4.5	$250	
	365 in line	230	460	4.5	$400	7" diameter duct
	509 wall	85	170	5	$150	8" diameter duct
	508 wall	135	270	6	$190	10" diameter duct
	505 ceiling	90	180	4.5	$110	8" diameter duct
	504 ceiling	175	350	6.5	$160	10" diameter duct
	503 ceiling/wall	80	160	5	$130	8" diameter duct
	502 ceiling/wall	135	270	6	$180	10" diameter duct
Nutone Manufacturing	663LC ceiling	25	50	2.5		4" duct size
2 St. Lawrence Ave.	671C ceiling	40	80	3		4" duct size
Toronto, Ont. M8Z 5T8	672C ceiling	55	110	4		4" duct size
(416) 251-6587	693	30	60	4		3" duct size
	695	35	70	5		3" duct size
	696N	25	50	4		3" duct size
	8832C	40	80	3.5	$115	3" duct size
	8833C ceiling	40	80	3.5	$120	3" duct size
	8673C ceiling	50	100	3.5	$210	4" duct size
	8814C ceiling	55	110	4	$145	4" duct size
	QT80CA	40	80	1.5	$190	4" duct size
	QT110CA ceiling	55	110	2.5	$190	4" duct size
	QT200C ceiling	100	200	2	$260	3 1/4"x10" duct
	QT300C ceiling	150	300	4.5	$275	3 1/4"x10" duct
	851C	150	300	7.5	$180	3 1/4"x10" duct
	849C	130	260	5.5	$170	8" duct
	831C	90	180	5.5	$130	3 1/4"x10" duct
	822C	85	170	4	$110	8" duct
	821C	105	210	6.5	$120	7" duct
	817C	135	270	6	$180	10" duct
	807C wall	80	160	4.5	$150	8" duct
Penn Ventilator	Z6 Zephyr	47.5	95	1.3		Ceiling, wall or duct mount
	Z8 Zephyr	115	230	2.5		with adaptor
	Z10 Zephyr	207.5	415	4		
	Z101 Zepher	272	505	5.1		
Vent Axia	No. 6	67-100	133-200			3 speed reversible
	No. 7	96-150	192-300			window, roof or wall mount
	No. 8	150-250	300-500			auto damper available, rated
						for continuous use

TABLE 2

CMHC VENTILATION SURVEY

PRODUCT CATEGORY #2 CENTRAL EXHAUST SYSTEMS

MANUFACTURER	MODEL	CAPACITY CFM	@STATIC PRESSURE " W.G.	APPROVAL	COST APPROX	REMARKS
American Aldes	VMPK3	90-150			$420	
4539 Northgate Court	Central					
Sarasota Florida	Exhaust Fan					
34234	VMPK5	120-200			$465	
(813)351-3441	Central					
	Exhaust Fan					
Aston Industries	Astn Attic 2000	180	0.2		$200	
P.O. Box 220	Central					
St. Leonard d'Aston	Exhaust Fan					
Quebec, P.Q.						
JOC 1M0(819)399-2175						
(819)399-2175						
Conservation Energy	EX 200	150	0.25	CSA/UL	$200	
Systems (Van EE)	Central					
3310 Millar Rd.	Exhaust Fan					
Saskatoon, Sask						
S7K 7G9						
(306)242-3663						
Venmar Inc.	Econair	40-80				Recirculation feature, exhaust
1715 Haggerty		(exhaust)				humistat controlled
Drummondville, Que		150				
Canada J2C 5P7		(recirc)				
(819)477-6226	Air Exchange	40-80				Recirculation feature, exhaust
		(exhaust)				humistat controlled
		200-280				
		(recirc)				

HUMIDITY REGULATED CENTRAL EXHAUST

MANUFACTURER	MODEL	CAPACITY CFM	@STATIC PRESSURE " W.G.	APPROVAL	COST APPROX	REMARKS
Aereco	Central	120	1"			Proportional humidity actuated
Eneready Products	Exhaust Fan					passive exhaust fan intakes
5892 Bryant St.						and proportional humidity
Burnaby, B.C.						actuated through wall supplies
(604)433-5697						

MANUFACTURER	MODEL	CAPACITY @ S.P. 25 Pa l/s	.1" WG CFM	NOISE SONE	COST APPROX RETAIL	REMARKS
Xpelair	CX10	125	250		$165	
	WX6	95	190		$280	
	GXC6	95	190		$185	
	GXC9	158	317		$325	
	RXC6	91	183		$240	

DUCT MOUNTED FANS UNDER 500 CFM

MANUFACTURER	MODEL	CAPACITY @ S.P. CFM	"W.G.	NOISE SONE	COST APPROX RETAIL	REMARKS
American Aldes 4539 Northgate Court Sarasota Florida (813)351-3441	A4 Duct Fan	105	0.125	2.1		4" diameter duct
	A5 Duct Fan	143	0.125	2.1		5" diameter duct
	A6 Duct Fan	255	0.125	2.8		6" diameter duct
	A8-120 Duct Fan	375	0.125	3.2		8" diameter duct
	A8-150 Duct Fan	500	0.125	4.5		8" diameter duct
R.B. Kanalflakt Inc. 1121 Lewis Ave. Sarasota, Florida 33577 (813) 366-7505	K4XL	150	0.1		$142	Inline fan
	T1	60	0.1		$150	Inline fan
	T2	180	0.1		$160	Inline fan
	MV4	40	0.1		$170	Roof/pedestal
	GD8	140	0.1		$235	Roof/pedestal
	GD9	310	0.1		$300	Roof/pedestal
Conservation Energy Systems (Van EE) 3310 Millar Ave. Saskatoon Sask. S7K 7G9 (306)242-3663	A4 Duct Fan	105	0.125	2.1		4" diameter duct
	A5 Duct Fan	143	0.125	2.1		5" diameter duct
	A6 Duct Fan	255	0.125	2.8		6" diameter duct
	A8-120 Duct Fan	375	0.125	3.2		8" diameter duct
	A8-150 Duct Fan	500	0.125	4.5		8" diameter duct
Broan Ltd. 1140 Tristar Dr. Mississauga Ont. L5T 1H9 9416)676-1300	365	230	460	4.5	$400	

CMHC VENTILATION SURVEY

PRODUCT CATEGORY #3 HEAT RECOVERY VENTILATORS

MANUFACTURER	MODEL	CAPACITY CFM @ 0.3" WG	SENSIBLE EFFIC.	SOURCE	ACCEPTANCE	COST APPROX RETAIL	REMARKS
Air Changer Mktg.	DRA 150	104	74-82%	ORF	CSA, R2000	$1,018	Poly. plastic core,
1297 Industrial Rd.							2 spd., defrost by
Cambridge Ont.	DRA 275	371	"	"	"	$1,271	room air bypass.
N3H 4T8							
(519) 653-7129							
Air X Change	570	65	75-80%	Mfgr.	CSA	$462	Plastic wheel type,
401 V.F.W. Drive							variable speed,
Rockland, MA.02370	502	142	7% @0 C	ORF	CSA, R2000	$617	elec. pre-heat and
(617) 871-4816							dehumidification
							options.
American Aldes	VMPH 3/5	90-140	70%	Mfgr.		$1,203	P.V.C. plastic core,
4539 Northgate Ct.							self balancing and
Sarasota, FL. 34234	VMPH 4/8	130-180	"	"		$1,234	elec. defrost
(800) 255-7749							options.
Aston Ind.	Aston Atic	N/A	70%	Mfgr.	N/A		Alum. plate core
P.O. Box 220	Exchanger						only.
St. Leonard D'Aston	Core Only						
Quebec, P.Q. J0C 1M0							
(819) 399-2175							
Berner Intnl.	EM-250	153	71-77%	Mfgr.		$1,200	Alum. rotary core,
P.O. Box 5205							three speed, defrost
New Castle, PA.16105	EM-500	170-295	71-79%	"		$1,700	and dehumidification
(412) 658-3551							options.
Blackhawk Ind.							
607 Park St.	Blackhawk	250	65%	mfgr.			Concentric tube
Regina Sask. S4N 5N1							plastic core,
(306) 924-1551							variable speed.
Boss Aire	BX-75	80	80%	Mfgr.		$860	Alum plate core,
1321 Tyler St.	BX-125	125	"	"		$1,000	single speed.
Minneapolis, MN.	BX-150	184	"	"		$1,150	
55413	BX-250	279	"	"		$1,570	
(612) 781-0179	BX-350	377	"	"		$1,950	

TABLE 3

Can Ray Inc.							
255 Restigouche Rd.	2000 EXH	136	57-69%	ORF	CSA		Heat Pipe core,
Oromocto,N.B.E2Y 2M1							electric defrost
(506) 357-9811							available
Conservation Energy							
Systems (VAN EE)	Van EE 1000	125	59-60%	ORF	CSA, R2000	$600	Poly. plastic core,
3310 Millar Ave.							variable speed,
Sasktn. Sask.S7K 7G9	Van EE 2000	216	N/A		CSA, R2000	$700	defrost by room air
(306) 242-3663							bypass, double core
Enermatrix Inc.	EMX 10	96	50%	Mfgr.		$550	optional.
P.O. Box 466							Poly. plastic core,
Fargo, N.D. 58107	EMX 25	250	71-84%	"		$1,150	single spd.(mod 10)
(701) 232-3330							variable (mod25)
Ener-Quip Inc.	WV1 wndw mnt	77	N/A			N/A	bypass.
99 East Kansas St.	RHR 100	50	70%	Mfgr.		$900	Alum. plate core,
Hackensack, N.J.	RHR 200	100	"	"		$1,020	single spd., variabl
7601	RHR 400	200	"	"		$1,300	spd.(mod. 400)
(201) 487-1015							
Environment Air							
P.O. Box 459	NPR 135-5A	95	60-80%	"	CSA, R2000	$695	variable spd.,
Buctouche, N.B.	ENV K-5	80	"	"	" "	N/A	defrost by room air
EOA 1G0	ENV K-6	190	48-57%	ORF	"	$1,000	bypass, elec. defrost
(506) 743-8901	ENV K-8	290	60-80%	Mfgr.	"	N/A	option.
Fabrication Z Air							
(Des Champs DLI)	EZ Vent 175	75	75%	Mfgr.	ETL	$419	Alum. plate core,
690 Place Trans Can.	" " 210	135	"	"		$864	2 spd.(mod 210-240)
Longueuil PQ J4G 1P2	" " 220	215	73%	"		$940	defrost by room air
(514) 646-3514	" " 240	375	72%	"		$1,135	bypass.
Fan-X-Changer							
P.M. Wright Ltd.	WR 25 wheel	210	80%	Mfgr.		$600	Plastic capillary
1300 Jules-Poitras	type						wheel type,
Montreal PQ H4N 1X8							variable speed.
Lifebreath	Lifebreath 100	100	80%	Mfgr.	CSA	$700	Aluminum core, variable
Nutech Energy Systems	Lifebreath 200	185	58-60%	ORF	CSA, R-2000	$1,200	speed, room air defrost
124 Newbold Court	Lifebreath 300	220	75-79%	ORF	CSA, R-2000	$1,350	(optional), built in
London, Ontario							dehumidistat.
N6E 1Z7							
May Aire	MA 110	30	N/A			$650	Aluminum core,variable
Snappy ADP	MA 240	175	N/A			$750	speed
P.O. Box 1168							
Detroit Lakes, MN.							
56501							

Mountain Energy	MER 150	148	70%	MFGR			Heat pie core, aluminum
Research	MER 300	235	70%	MFGR			core stainless steel,
15800 West 6th Ave.							single speed, room air
Golden, CO							defrost.
80401							
(303)279-4971							
New Aire	HE 1800	N/A	70%	MFGR		$570	Coated paper core,
7009 Raywood Rd.	HE 2500	110	78%	MFGR		$700	single speed
Madison, WI	HE 4000	N/A	78%	MFGR		$950	
53713							
(6080221-4499							
Raydot Inc.	Mod 1 225	225	73-82%	MFGR	CSA	$1,150	Linear flat plate core
145 Jackson Ave.	Mod 2 145						10 feet long
Cokato, MN							
55321							
(612) 286-2103							
Safe Air	SAE 150	150	70%	MFGR		$780	Heat pipe core, single
QDT Ltd.	SAE 250	250	70%	MFGR		$920	speed, two speed option
1000 Singleton Blvd.							
Dallas TX							
75212							
(214) 714-1993							
Star Heat Exchanger	Nova	70	60%	MFGR	CSA	$540	Through wall unit, counter
8109-1772 Broadway							flow
Port Coquitlam, B.C.	165	165	80%	ORF	CSA R-2000	$840	Central HRV, plastic core
V3C 2N8	200	180	80%	ORF	CSA R-2000	$1,060	variable speed, self balancing
(604) 942-0525	300	240	80%	ORF	CSA R-2000	$1,300	control (optional), room air
							defrost.
Venmar Inc.	Heat Exchanger	40-110	65%	MFGR	CSA		Aluminum core, variable speed,
1715 Haggerty							preheat element, electronic
Drummondville, Que.							air filter, auto defrost
Canada J2C 5P7							
(819)477-6226							
	Apartment	50-80	65%	MFGR	CSA		Aluminum core, through wall
	Ventilator						mount, pre-heat element,
							electronic air filter
Xetex Inc.	BX-75	80	80%	Mfgr.		$860	Alum plate core,
3530 East 28th St.	BX-125	125	"	Mfgr.		$1,000	single speed.
Minneapolis, MN	BX-150	184	"	Mfgr.		$1,150	
55406	BX-250	279	"	Mfgr.		$1,570	
(612)724-3101	BX-350	377	"	Mfgr.		$1,950	
X Chang Air Corp	BDR 95	80	80%	Mfgr.	UL	$750	Plastic core, single speed
P.O. Box 1565							room air defrost
Fargo, ND	BDR 210	135	80%	Mfgr.	UL	$950	Plastic core, variable speed
58103	BDR 315	255	80%	Mfgr.	UL	$1,250	room air defrost
(701)237-04901							

RANGE HOOD HRV'S

MANUFACTURER	MODEL	CAPACITY CFM @ 0.3" WG	SENSIBLE EFFIC.	SOURCE	ACCEPTANCE	COST APPROX RETAIL	REMARKS
R.B. Kanalflakt	Metsovent K Range Hood	148	60-70%	MFGR		$800	Aluminum core 3 speed range hood, may not meet Canadian codes.

COMBINED FURNACE & AIR CONDITIONING HRV'S

MANUFACTURER	MODEL	CAPACITY CFM	SENSIBLE EFFIC.	SOURCE	ACCEPTANCE	COST APPROX RETAIL	REMARKS
Engineering Development Inc. Vent Aire 4850 Northporte Dr. Colorado Springs, CO 80907 (303) 599-9080	ECS-20 Horizontal Furnace & A/C	Ventilation 80-220cfm 600-1100 cfm	N/A		CSA	$1,100	Aluminum plate counter flow HRV, variable speed, room air defrost. Options electric defrost, electric heating, cooling coil. Electronic filter & auto balancing
	ECS-40	80-220cfm 600-1100 cfm Htg 60000 Btuh Clg 30000 Btuh	N/A		CSA	$1,650	Aluminum plate counter flow HRV, variable speed, room air defrost. Options electric defrost, electric heating, cooling coil. Electronic filter & auto balancing

HEAT PUMP HRV'S

MANUFACTURER	MODEL	CAPACITY CFM @ 3"wg	SENSIBLE EFFIC.	SOURCE	ACCEPTANCE	COST APPROX RETAIL	REMARKS
Dairy Equipment International	HPV 80 Ventilator & DHW	100-200cfm	N/A			$2,000	Exhaust only ventilator air to water heat pump, remote space heating possible through freon/fan coil unit
Fiberglass Canada	Habitaire 2800 Venilator and DHW system	150 cfm	N/A				Exhaust only ventilator Air to water heat pump Space heating and cooling capability

TABLE 4

CMHC VENTILATION SURVEY

PRODUCT CATEGORY #4 VENTILATION EQUIPMENT AND ACCESSORIES

DAMPERS

MANUFACTURER	MODEL	TYPE	CAPACITY	REMARKS
Conservation Energy Systems (Van EE) 3310 Millar Ave. Saskatoon, Sask S7K 7G9 (306) 242-3663	ACD Series	Electro mechanical air control damper	4" TO 12" diameter 24 & 120 volts	Used for interlocked make up air control and zone control
Hoyme Manufacturing 4331 41st St. Camrose, Alberta T4V 3V8 (403) 672-6553	MAC Series	Electro mechanical air control damper	4" to 9" diameter 24 volt	Vetrical or horizontal operation
	VAC Series	Electro mechanical air control damper	4" to 9" diameter 24 volt	Vetrical or horizontal operation
Industrial Comp. Designs 31264 La Baya Dr. Westlake Village CA 91362	ADV Series	Electro mechanical air control damper	Standard round & rectangular sizes	
Artis Metals P.O. Box 7489 Boise Idaho 83714 (800) 892-2277	RDWV Wall Vent	Reversable backdraft damper	4" TO 12" diameter	
Skuttle Route #1 Marietta, Ohio 45750 (614)373-9169	204-1	Make up air duct with pretempering and damper	4" diameter 30 cfm @ .1"	
	206-1	Make up air duct with pretempering and damper	6" diameter 42 cfm @ .1"	
	216	Self adjusting make-up air control	6" diameter 104 cfm @ .1"	

GRILLES & DIFFUSERS

MANUFACTURER	MODEL	TYPE	CAPACITY	REMARKS
Conservation Energy Systems (Van EE) 3310 Millar Ave. Saskatoon, Sask S7K 7G9 (306) 242-3663	EX Series	Exhaust grilles	4"to 8"	Adjustable opening white plastic
	SO Series	Supply grilles	4"to 8"	Adjustable opening white plastic
Eneready Products 5892 Bryant St. Burnaby, B.C. (604) 433-5697	VL1 Series Whisper grilles	Ceiling supply grilles	3" to 8" dia 12 to 105 cfm	Adjustable opening white plastic
	VL1 Series Whisper grilles	Wall supply grilles	3" to 5" dia 9 to 25 cfm	
	VLK Series Whisper grilles	Exhaust grilles ceiling or wall	4" to 8" dia 42 to 105 cfm	

WALL PORTS

MANUFACTURER/SUPPLIER	MODEL	TYPE	CAPACITY	REMARKS
Dairy Equipment Corporation International Inc. P.O. Box 8050 Madison, WI 53708	Fresh 80	Through wall inlet	Passive variable	Closable , filerand sound absorption options
	Fresh 99	Through wall inlet	Humidity controlled	Closable , filerand sound absorption options.
American Aldes 4539 Northgate Crt. Sarasota, Florida 33580 (813) 351-3441	11 536-539	Pressure regulated through wall inlet	10-20 cfm	Volume constant at any pressure, 10 or 20 cfm selectable
	11-517-526	Pressure regulated through window sash inlet	10-20 cfm	Volume constant at any pressure, 10 or 20 cfm selectable
	14-901-902	Humidity regulated through wall inlet	.78 in2 to 4.65 in2	Opening varies with humidity , 2 ranges selectable
	14-106-108	Humidity regulated through window sash inlet	.78 in2 to 4.65 in2	Opening varies with humidity , 2 ranges selectable
Aereco Eneready Products Ltd. 5892 Bryant St. Burnaby, B.C. V5X 1X6 (604)433-5697		Humidity regulated through wall inlet	.78 in2 to 4.65 in2	Opening varies with humidity , 2 ranges selectable
Venmar	Barometric Compensator	Pressure regulation through wall inlet	0-95 cfm	Opening varies with pressure

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16. Logdberg, A.& Adling, A. "Air Quality in Low Density Housing, A Study of Requirement Adapted Ventilation" EMR Canada, Unedited Translation.

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18. Wilson, A.G., "Ventilation System Design in Accordance With CSA F326, Sample House #1"

19. Informants: Jay Lewis, Soft Energy, Burnaby B.C.; David Hill, Eneready Products, Burnaby B.C.; Rick Olmstead, CES, Saskatoon Sask.; Bonneville Power Authority, Portland OR.; Bede Wellford, Air-X-Change Corp., Rockland MA.

20. Earth tube systems are being used by South Wall Builders, P.O. Box 8872, Missoula Montana 59807. They are also in experimental use in Sweden and have been used elsewhere in Europe.

APPENDIX I
N.B.C & B.C.B.C. 1990 proposed ventilation revisions

APPENDIX II
Radon control by ventilation

APPENDIX III
Control diagrams

APPENDIX IV
Selected hardware

APPENDIX V
Equipment Photos

GLOSSARY OF TERMS

APPENDIX I
N.B.C & B.C.B.C. 1990 proposed ventilation revisions

Proposed Change No. 9-171

Delete A-9.33.3.1. in Appendix A and substitute:

A-9.33.3. Mechanical Ventilation. For many years, houses were constructed without mechanical ventilation systems and relied on natural air leakage through the building envelope for winter ventilation. For the past 50 years or so, however, houses have become progressively more airtight through the introduction of new products such as plywood and waferboard, polyethylene film, improved caulking materials, tighter windows and doors, more efficient heating systems and generally improved construction methods. Following the energy crisis in the early 1970's, considerable emphasis was placed on reducing air leakage in order to conserve energy. Electric heating systems were encouraged and higher efficiency furnaces were developed which further reduced air change rates in buildings.

A significant portion of the air change rate in houses is due to air flow up the flue. Electric heating, however, eliminates the need for flues and high efficiency combustion furnaces greatly reduce the air flow up the flue through more efficient combustion and by restricting flue air leakage between firing periods. The increased use of such heating systems coincided with increased emphasis on sealing the building envelope to reduce air leakage, and initiated concern that the natural air change in dwelling units might be inadequate in some instances to provide a healthful environment. Condensation problems resulting from higher humidity levels were a secondary concern.

Exhaust fans were specified for electrically heated houses in the 1980 edition of the NBC to reduce the incidence of excessive humidity levels in these houses. However, with the continuing emphasis on reduced air leakage and the development of more efficient fuel burning systems, health concerns became paramount. These concerns led to the current requirements for mechanical ventilation in all dwelling units regardless of the type of heating systems used. The capacity of the system must allow at least one half air change per hour (ach) if the system is designed to operate intermittently or 0.3 ach if the system is designed to operate continuously.

The 0.5 ach value is believed to be fairly representative of the air leakage rate of typical houses with flues before special air tightening procedures were developed in response to the energy crisis. It also coincides with the value required in recent Swedish legislation.

The 0.3 ach value is the rate called for in the draft CSA Standard F326.1 and is about equal to the rate that would be achieved using the ventilation standard of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE Standard 62), which relates ventilation rate to occupant load. Because many ventilation systems designed to run essentially continuously must nevertheless be shut down for brief periods (e.g. the defrost cycle of a heat recovery ventilator), the rate is specified as the rate averaged over 24 hours. In other words, if the system must be periodically shut down, the air change rate when it is running must be proportionately higher in order to achieve the specified average rate.

Mechanical ventilation systems can be as simple as a ductless kitchen or bathroom fan exhausting air directly to the outdoors, or they may be as elaborate as a completely ducted system distributing a balanced supply of fresh air to each room. All are permitted provided the air change capacity requirements are met.

Simple Exhaust Systems

Where exhaust systems depend on natural air leakage through the building envelope to replace the exhaust air, the exhaust fans may have to operate against a substantial pressure difference if the building is relatively airtight. This can reduce the air flow through the fan significantly below its rated capacity. Also, the resulting negative pressure may cause spillage of combustion products from certain types of combustion heating appliances (including fireplaces) which rely on natural draft to drive their combustion venting systems and which include dilution openings (e.g. draft hoods, barometric dampers) which couple the venting system with the indoor air. To reduce this risk, tight buildings which incorporate such appliances must be provided with air intake openings to facilitate the inward flow of replacement air. The intake openings should be located a reasonable distance from the exhaust outlets to allow adequate mixing of the replacement air with the inside air and should be sized to prevent excessive negative pressure from being created by the exhaust fans . The following table provides suggested intake opening areas based on an allowable level of depressurization of 5 Pa.

Sum of Fan Capacities (L/s)	Size of Intake Openings Necessary to Avoid Excessive Depressurization in Dwellings With Spillage-susceptible Heating Equipment (m^2)
25	0.014
30	0.016
35	0.019
40	0.022
50	0.027
60	0.033
70	0.038
80	0.044
90	0.049
100	0.055
110	0.060
120	0.066
130	0.071
140	0.076
150	0.082

To minimize the effect of wind, the inlet should be shielded from the wind. Although Part 9 does not regulate where the intake openings should be located, it is preferable that they be in the least used areas, such as an unfinished basement, or be suitably baffled to prevent cold air being drawn through occupied areas before it is tempered or mixed with the inside air. Measures should be taken to prevent or accommodate the formation of condensation or frost.

Air intake openings are not required where it can be shown by test that spillage of combustion products is not likely to be a problem. Canada Mortgage and Housing Corporation has developed the "Venting System Test" which is suitable for this purpose.

Generally such intake openings are not required in dwellings which do not incorporate combustion heating systems of the type described above; e.g. induced draft furnaces are more resistant to pressure-induce spillage. However, even in dwellings which do not incorporate spillage-susceptible heating equipment, some control on the potential for high levels of depressurization created by the ventilation system is recommended since, as mentioned above, such high levels can impair the ability of the system to perform its function. Also, high levels of depressurization can result in contaminants being drawn into the dwelling from the envelope itself (e.g. formaldehyde from composite wood products) or from the soil (e.g. radon and other constituents of soil gas). Thus, in dwellings which have very low leakage areas (e.g. special low energy houses) and which incorporate exhaust-only ventilation systems, some amount of intake opening should be provided even if the heating system is not prone to spillage. The following table provides suggested intake opening areas based on an allowable level of depressurization of 20 Pa.

Sum of Fan Capacities (L/s)	Size of Intake Openings Necessary to Avoid Excessive Depressurization in Airtight Dwellings Without Spillage-susceptible Heating Equipment (m^2)
20	0.004
30	0.008
50	0.012
80	0.018
125	0.024
170	0.031

Such simple exhaust systems may be manually switched or designed to operate automatically such as by a signal from a humidistat. If such a system is operated in a manner which provides sufficient fresh air during the heating season to reduce humidity levels to the point where significant condensation on the inside glass of double glazed windows is eliminated, the ventilation rate should be at least comparable to that traditionally provided by air leakage in Canadian houses. This type of control is relatively economical to install and helps to reduce energy loss through excessive ventilation.

Indoor barbecue-type ranges incorporate an exhaust fan with a capacity so high that the operation of other exhaust equipment and appliances requiring combustion air may be affected. Where such ranges are installed it may be necessary to have a separate make-up air supply installed near the appliance. The capacity of these fans is so high (>150 L/s) that it is often impractical to provide a large enough intake air opening to avoid excessive depressurization. In such cases, one solution is to incorporate a make-up air fan with a capacity similar to that of the exhaust fan.

Outside Air Ducted to Furnaces

In some ventilation systems, fresh air is ducted to the return air side of the furnace, so that, when the furnace blower is operating, fresh air is drawn into the furnace plenum. This has the advantage of heating the fresh air before it reaches the living areas, thereby eliminating cold drafts.

Although such systems have been successfully used for many years to control surface condensation problems, they tend to pressurize the dwelling space, thus increasing air leakage into concealed roof and attic spaces and the risk of interstitial moisture problems. Such venting systems can also cool the furnace heat exchanger to the point where condensation may occur within the furnace. This can lead to corrosion problems unless the furnace is designed with adequate corrosion resistance. These problems can be avoided if the incoming air is mixed with return air and/or is tempered (e.g. with an electrical in-duct heating coil) before it comes in contact with the heat exchanger. A minimum temperature of 12°C is recommended by the heating industry.

Fully Ducted Mechanical Systems

Fully ducted mechanical ventilation systems have the advantage of providing better control of the ventilation rate and more effective distribution of the fresh air within the dwelling. Such systems can be relatively expensive; however this need not be the case in houses with forced warm air heating systems since the heating ducts can also be used for ventilation. These systems may also incorporate heat recovery equipment to reduce the energy loss due to ventilation.

Summer Ventilation

When windows are not openable, the mechanical ventilation system must provide fresh air on a year round basis. While one half air change per hour is adequate for health purposes, it may not be adequate in summer to keep the indoor temperatures from climbing to uncomfortable levels as a result of solar heating. Unless the dwelling unit is air-conditioned, therefore, the mechanical ventilation rate to individual rooms must be doubled to one air change per hour if the windows are not designed to provide summer ventilation.

Fan Sizes

The specified ventilation rates are additional to the natural infiltration that also occurs. The rates are based on the total volume enclosed within the building envelope.

Example: A 2-storey house with openable windows has 100 m^2 of finished floor area on each of the first and second storeys and in the basement. Exhaust fans are to be provided in each of 2 bathrooms and if necessary in the kitchen. The ceiling height is 2.4 m.

Find the fan capacity required for winter ventilation.

1. Finished volume of house = (100+100+100) x 2.4 = 720 m^3.

2. Required rate of ventilation = 720 x 0.5 = 360 m^3/h.

3. Required total fan capacity = (360 m^3/h x 1000 L/m^3)/3600 s/h = 100 L/s.

In this case, a 50 L/s (100 cfm) exhaust fan in each bathroom will provide adequate capacity, or a 100 L/s (200 cfm) kitchen exhaust fan can be used.

If the dwelling incorporates naturally-aspirating fuel-fired heating equipment, intake openings with a total area of at least 0.055 m^2 should be installed.

Information on acceptable levels of air quality in dwelling units and methods of design to control air quality can be found in the documents listed below. Designs which comply with these methods can be expected to meet or exceed the requirements in 9.33.2.

- Health and Welfare Canada, "Exposure Guidelines for Residential Indoor Air Quality"
- ASHRAE 62-81, "Ventilation for Acceptable Indoor Air Quality"
- Canadian Home Builders Association,"R-2000, Design and Installation Guidelines for Ventilation Systems"

- CSA-F326.1- "Requirements for Residential Ventilation" (In preparation)
- Institute for Research in Construction, Canadian Building Digest 245, "Mechanical Ventilation and Air Pressure in Houses"

REASON

To provide additional explanation of the requirements for mechanical ventilation in Subsection 9.33.3. This note will be renumbered as A-9.33.3.

Proposed Change No. 9-172

Delete Tables A-1 to A-11 and substitute:

BRITISH COLUMBIA BUILDING CODE 1985

FIRST REVISIONS

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Parliament Buildings
Victoria B.C. V8V 1X4
(604) 387-4010

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SUBSECTION 9.33.3. MECHANICAL VENTILATION

(See Appendix A.)

Mechanical ventilation requirements

9.33.3.1. Except as required in Article 9.33.3.2., *dwelling units* shall have a mechanical ventilation system capable of providing, during the heating season, at least 0.5 air change per hour or according to Table 9.33.3.A.

9.33.3.2. Mechanical ventilation systems in *dwelling units* designed in accordance to Part 6 to distribute ventilation air to or from all habitable rooms, but excluding such rooms as storage, foyer, laundry or mechanical rooms, shall be capable of providing, during the heating season, not less than 0.3 air change per hour or according to Table 9.33.3.A.

9.33.3.3. The rate of air change in Articles 9.33.3.1. and 9.33.3.2., and Table 9.33.3.A shall be based on the total interior volume of all *storeys* including the *basement* and heated crawl spaces, but excluding any attached or built-in garage.

Table 9.33.3.A.
Forming Part of Articles 9.33.3.1. and 9.33.3.2.

MINIMUM REQUIRED VENTILATION RATE			
Max. Total Interior Volume[1], m^3	Max. Total Floor Area[1] Based On Standard 2.44 m Ceiling Height, m^2	Minimum Ventilation Rate	
		0.5 Air Change per Hour, L/s	0.3 Air Change per Hour, L/s
122	50	17	10
146	60	20	12
171	70	24	14
195	80	27	16
220	90	31	18
244	100	34	20
366	150	51	31
488	200	68	41
610	250	85	51
732	300	102	61
975	400	137	82
1219	500	171	102
1463	600	205	123
Column 1	2	3	4

Notes to Table 9.33.3.A.:

(1) For rooms or spaces to be included or excluded see Article 9.33.3.3.

Rooms or spaces without natural ventilation

9.33.3.4. Where a habitable room or space in a *dwelling unit* is not provided with natural ventilation described in Article 9.33.1.5., mechanical ventilation shall be provided to that room or space that is capable of providing 0.5 air change per hour if the room or space is mechanically cooled in summer, and 1.0 air change per hour if it is not.
(See Appendix A.)

Automatic or continuous operation

9.33.3.5. A portion of the ventilation rate required by Articles 9.33.3.1. and 9.33.3.2. shall be controlled automatically by a centrally located dehumidistat, or be provided by a continuously operating fan during the heating season. This portion of ventilation rate shall conform to Table 9.33.3.B. (See Appendix A.)

Table 9.33.3.B.
Forming Part of 9.33.3.5.

MINIMUM REQUIRED VENTILATION RATE CONTROLLED AUTOMATICALLY OR PROVIDED CONTINUOUSLY			
Max. Total Interior Volume[1], m^3	Max. Total Floor Area[1] Based On Standard 2.44 m Ceiling Height, m^2	Minimum Ventilation Rate, Controlled Automatically, L/s	Minimum Ventilation Rate, Provided Continuously, L/s
244	100	20	10
366	150	30	15
488	200	40	20
732	300	40	30
975 and over	400 and over	40	40
Column 1	2	3	4

Notes to Table 9.33.3.A.:

(1) For rooms or spaces to be included or excluded see Article 9.33.3.3.

9.33.3.6. Except as provided for in Subsection 9.33.4. or as otherwise stated in this Subsection, mechanical ventilation shall conform to the requirements of Part 6.

Make-up Air **9.33.3.7.** Except as provided in Articles 9.33.3.8. and 9.33.3.14., mechanical ventilation systems for *dwelling units* shall include provision for introduction of fresh make-up air from the exterior for the ventilation rate controlled automatically or provided continuously as described in Article 9.33.3.5.

Make-up Air not required **9.33.3.8.** Make-up air as described in Articles 9.33.3.7. and 9.33.3.13. is not required, if the *dwelling unit* does not contain a naturally-aspirating fuel-fired heating *appliance*, or if all fuel-fired *appliances* are isolated from the *dwelling unit* atmosphere. *Acceptable appliances* include induced draft or sealed *furnaces*, gas fireplaces and hot water tanks, with combustion air directly from outside and with sealed *flues;* or fireplaces and *space heaters* that are equipped with tight-fitting, gasketed doors with all air supply requirements directly from the outside into the firebox.

Make-up Air tempered **9.33.3.9.** Make-up air shall be tempered as described in Articles 9.33.3.10. to 9.33.3.12.

9.33.3.10. For locations with winter design temperature not less than -10°C make-up air may be tempered by being supplied by ducting into secondary areas such as utility or storage rooms, by specially designed individual room or space through-wall diffusers, by methods described in Article 9.33.3.11., or by other *acceptable* methods.

9.33.3.11. For locations with winter design temperature less than -10° C make-up air may be tempered by being supplied through a forced air heating system as described in Article 9.33.3.12., by heating/fan unit, by heat recovery ventilator, or by other *acceptable* methods.

Make-up Air tempered by forced-air heating systems **9.33.3.12.** Make-up air tempered through forced-air heating systems shall be provided by a duct connected to the return-air *plenum*. The make-up air duct shall be at least 100 mm diam or an equivalent combined duct with the furnace air supply. The make up air duct shall be provided with a motorized damper that is interlocked with the exhaust fan controlled by the dehumidistat so that the exhaust fan only operates when the damper is in the open position. The dehumidistat shall also be interlocked with the furnace air circulating fan so that the furnace fan will operate when the exhaust fan is on and the damper is open.
(See Example (c) in A-9.33.3.)

Make-up air for other exhaust appliances

9.33.3.13. Except as described in Article 9.33.3.8., additional separate make-up air for the entire capacity shall be provided for other exhaust *appliances* installed in the *dwelling unit* with a rated exhaust capacity exceeding 0.5 air change per hour, or according to Table 9.33.3.A. Non-forced make-up air shall conform to Table 9.33.4.4. for the rates indicated, otherwise the make-up air shall be provided by a fan-forced unit of equivalent capacity interlocked with the exhaust appliance.

Combination forced air/ ventilation sytem

9.33.3.14. A naturally-aspirating forced air heating system serving a maximum total heated floor area of 460 m² is *acceptable* as providing the ventilation requirements, if the system is capable of providing at least 0.3 air changes per hour during its heating operation or has an air supply according to Table 9.33.3.C. The system shall have a ventilation rate controlled automatically or provided continuously by the furnace air circulating fan as required by Article 9.33.3.5., and have the required air supply according to Table 9.33.3.C., provided directly to the return-air *plenum*. (See Example (b) in A-9.33.3.)

Table 9.33.3.C.
Forming Part of 9.33.3.14.

MINIMUM AIR SUPPLY DUCT(1) DIAMETER FOR A COMBINATION FORCED AIR/VENTILATION SYSTEM		
Max. Total Interior Volume(2), m^3	Max.Total Floor Area(2) Based On Standard 2.44 m Ceiling Height, m^2	Minimum Air Supply Duct(1) Diameter, mm
536	220	100
805	330	125
1122	460	150
Column 1	2	3

Notes to Table 9.33.3.C.:

(1) The air supply duct has been sized for one duct to provide both for the air supply as required by the furnace installation code and for the ventilation air required by this Subsection.

(2) For rooms or spaces to be included or excluded see Article 9.33.3.3.

9.33.3.15. Special purpose air exhausting equipment such as central vacuum cleaning systems, downdraft cook tops and clothes dryers shall not be included in calculating the capacity of the ventilation system.

9.33.3.16. Systems designed to provide combustion and/or dilution air for fuel-burning *appliances* shall not be used to supply make-up air for the ventilation systems unless their capacity is sufficient to serve both functions simultaneously. An *acceptable* combination system includes a forced air heating system as described in Article 9.33.3.14.

Sound rating **9.33.3.17.** Wall and ceiling fans required by Article 9.33.3.5. to be controlled automatically or operate continuously, shall be rated by the manufacturer not to exceed a sound level of 60 dBA or 2.5 Sones.

Exhaust ducts **9.33.3.18.** *Exhaust ducts* shall discharge directly to the outdoors. Where the *exhaust duct* passes through or is adjacent to unheated space, the duct shall be insulated to prevent moisture condensation in the duct.

Access to ventilation equipment **9.33.3.19.** Ventilation equipment shall be accessible for inspection, maintenance, repair and cleaning. Except where the kitchen exhaust grille is located at least 1.2 m horizontally from the range, kitchen *exhaust ducts* shall be designed and installed so that the entire duct can be cleaned where the duct is not equipped with a filter at the intake end.

Air intake shield **9.33.3.20.** Outdoor air intake and exhaust outlets shall be shielded from weather and insects. Shielding from insects for ventilating equipment may be by an accessible filter at the equipment and by a 6 mm mesh screen at the intake or exhaust hood. Screening if used shall be of rust-proof material.

Duct requirements **9.33.3.21.** Ventilating ducts shall conform to the requirements of Part 6 for *supply ducts*, except *exhaust ducts* that serve only a bathroom or water-closet room may be of *combustible* material provided the duct is reasonably air tight and constructed of a material impervious to water.

Doors undercut **9.33.3.22.** Interior doors for dwelling units shall be undercut a minimum of 12 mm or the rooms shall be provided with a grille of an equivalent area.

• SUBSECTION 9.33.4. BASIC MECHANICAL VENTILATION SYSTEM
(See Appendix A and Example (a) in A-9.33.4.)

General

9.33.4.1. A basic mechanical ventilation system shall comply with the requirements in Article 9.33.3.1. and shall consist of one or more exhaust fans, without an air circulating ductwork system. The exhaust fans shall be located in some or all of the kitchens and bathrooms. The ventilation system shall conform to the appropriate requirements of Subsection 9.33.3., except the system need not conform to Part 6.

Exhaust fan

9.33.4.2. The exhaust fans required in Article 9.33.4.1. shall be rated for sound as required in Article 9.33.3.17. and controlled automatically by a dehumidistat as required in Article 9.33.3.5.

System capacity

9.33.4.3. The mechanical ventilation capacity of the exhaust fans in Article 9.33.4.1. shall be assumed as the total of the individual fans, rated by the manufacturer at a differential pressure of at least 50 Pa. The exhaust duct size shall conform to Table 9.33.4.A.

Table 9.33.4.A.
Forming Part of Article 9.33.4.3.

EXHAUST DUCT(1) SIZE FOR A BASIC VENTILATION SYSTEM IN SUBSECTION 9.33.4.

Maximum Exhaust Fan Ventilation Rate, L/s	Min. Exhaust Duct(1) Dia,	
	Smooth Duct	Flexible Duct
10	75	100
25	100	125
45	125	150
70	150	175
Column 1	2	3

Notes to Table 9.33.4.A.:

(1) The exhaust ducts shall not exceed 15 m in length or have more than two 90° elbows, otherwise the duct shall be increased to the next diameter size.

Make-up air

9.33.4.4. Make-up air shall be provided for the ventilation rate controlled automatically or provided continuously as described in Article 9.33.3.5. and shall conform with Articles 9.33.3.7. to 9.33.3.11. The non-forced air opening size for make-up air for a basic ventilation system as provided for in this Subsection shall conform to Table 9.33.4.B. Forced make-up air equipment shall be rated by the manufacturer to provide for the required air flow rate.

Table 9.33.4.B.
Forming Part of Article 9.33.4.B.

MAKE-UP AIR OPENING SIZE FOR A BASIC VENTILATION SYSTEM IN SUBSECTION 9.33.4.		
Maximum Ventilation Rate Controlled Automatically or Provided Continuously, L/s	Mimimum Make-up Air Duct	
	Vent Area, cm^2	Diam, mm
8	47	80
12	66	90
15	85	100
17	95	110
20	114	120
25	142	130
30	170	150
35	199	160
40	227	170
45	255	180
50	284	190
55	312	200
60	340	210
Column 1	2	3

Page	Reference	Revision
* 501	Appendix A	Delete all existing Appendix Notes to Subsection 9.33.3. and substitute the following:

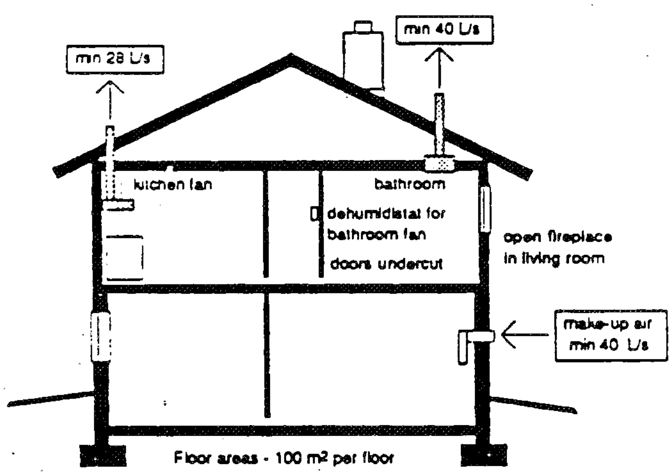
A-9.33.3. & A-9.33.4. Mechanical Ventilation. Subsection 9.33.3. contains the general requirements for mechanical ventilation systems for dwelling units. It also references Part 6 for the design of the ventilation systems, except for the "Basic Mechanical Ventilation System" described in Subsection 9.33.4. Part 6 in turn requires good engineering practice, such as found in ASHRAE handbooks and HRAI Digest for the design of ventilation systems.

Subsection 9.33.4. "Basic Mechanical Ventilation System", contains the specific requirements for the installation and verification of a simple ventilation system, utilizing exhaust fans and make-up air as required.

The following examples illustrate different ventilation systems and how the requirements can be satisfied depending on the heating system used. The house used in these examples has two storeys with 100 m^2 per floor and contains an open fireplace.

Example (a): shows the Basic Mechanical Ventilation System as described in Subsection 9.33.4., this can be used with any heating system. For this example the following would apply:

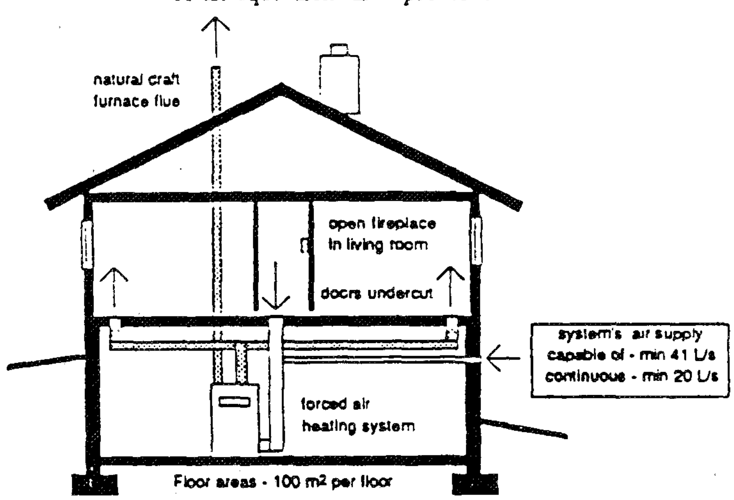
1. 9.33.4.1. - 0.5 air changes per hour or from Table 9.33.3.A. for 200 m^2 a minimum ventilation rate of 68 L/s is required, this is provided by kitchen and bathroom exhaust fans;
2. 9.33.4.2. - the bathroom fan to be rated for a maximum sound rating of 60 dBA (2.5 sones), be controlled by a dehumidistat and from Table 9.33.3.B. a minimum ventilation rate of 40 L/s is required;
3. 9.33.4.3. - fans to be rated at a minimum of 50 Pa, exhaust duct size according to Table 9.33.4.A.;
4. 9.33.4.4. - make-up air is required since there is an open fireplace; from Table 9.33.4.A. a 170 mm diameter duct is required for the 40 L/s bathroom fan and in this case it is provided to a storage room in the basement; and
5. 9.33.3.22. - doors to be undercut a minimum of 12 mm or a grille of an equivalent area provided.



(a) BASIC MECHANICAL VENTILATION SYSTEM - 0.5 A.C./H. WITH ANY HEATING SYSTEM

Example (b): shows a ventilation system utilizing a naturally-aspirating forced air heating system with a two-speed furnace fan as described in Article 9.33.3.14. A permitted alternate arrangement could utilize a dehumidistat which would control the furnace air circulating fan for the ventilation rate as required by Article 9.33.3.5. This is a combination heating/ventilating system where the furnace provides the heating as well as supplying the required house ventilation air. In this example, one air supply duct is provided to the return air plenum to provide both for the air supply as required by the furnace installation code and for the ventilation air required by Subsection 9.33.3. For this example the following would apply:

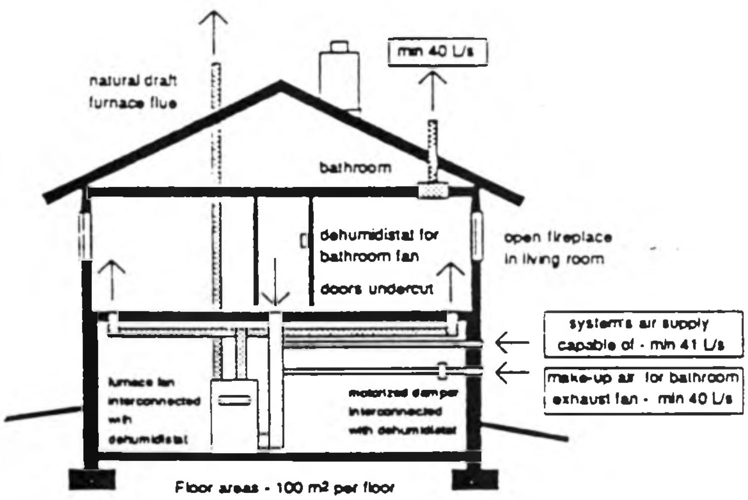
1. 9.33.3.14. - 0.3 air changes per hour or from Table 9.33.3.A. for 200 m^2 total heated floor area a minimum ventilation rate of 41 L/s is required;
2. 9.33.3.14. - minimum continuous ventilation rate of 20 L/s from Table 9.33.3.B. provided by the two-speed furnace fan;
3. 9.33.3.14. - the furnace and ventilation outdoor air supply provided by a 100 mm diameter duct directly to the return-air plenum from Table 9.33.3.C.;
4. 9.33.3.2. - the system design to Part 6, which also refers to ASHRAE handbooks and HRAI Digest for design of ventilation systems; and
5. 9.33.3.22. - doors to be undercut a minimum of 12 mm or a grille of an equivalent area provided.



(b) VENTILATION SYSTEM WITH A FUEL-FIRED FORCED AIR HEATING SYTEM - 0.3 A.C./H. AND CONTINUOUS VENTILATION

Example (c): shows a ventilation system utilizing a naturally-aspirating fuel-fired forced air heating system with a single speed furnace fan and a bathroom exhaust fan. In this example, an additional 100 mm make-up air duct with a motorized damper is provided to the return-air plenum for the make-up air required by the bathroom exhaust fan. This additional make-up air could also be provided by increasing the furnace air supply duct and installing a two-position motorized damper. For this example the following would apply:

1. 9.33.3.2. - 0.3 air changes per hour or from Table 9.33.3.A. for 200 m^2 total heated floor area a minimum ventilation rate of 41 L/s is required;
2. 9.33.3.5. - minimum ventilation rate controlled automatically of 40 L/s from Table 9.33.3.B., provided by bathroom exhaust fan;
3. 9.33.3.12. - make-up air is required since there is an open fireplace, this can be supplied through the forced air heating system by a separate 100 mm duct with a motorized interlocked damper as described in Article 9.33.3.12;
4. 9.33.3.2. - the system design to Part 6, which also refers to ASHRAE handbooks and HRAI Digest for design of ventilation systems; and
5. 9.33.3.22. - doors to be undercut a minimum of 12 mm or a grille of an equivalent area provided.



(c) VENTILATION SYSTEM WITH A FUEL-FIRED FORCED AIR HEATING SYTEM - 0.3 A.C./H. AND BATHROOM EXHAUST FAN

Page	Reference	Revision
* 501	Appendix A	Add new Note: **A-9.33.3.4. A mechanical ventilation system capable of operating on a year round basis is required for habitable rooms or spaces which do not have openable windows. The ventilation system for these rooms may be combined with the whole house ventilation system described in Articles 9.33.3.1. and 9.33.3.2. In most cases to comply with this requirement, an exhaust fan controlled by a switch or dehumidistat capable of providing 1 air change per hour (where summer cooling is not provided) based on the room or space volume would be required.**
* 501	Appendix A	Add new Note: **A-9.33.3.5. Automatic Control.** This Article requires that the fan(s) of a required ventilation rate be controlled automatically by a centrally located dehumidistat. In a typical example, where the bathroom exhaust fan(s) are controlled by this centrally located dehumidistat, the exhaust fan(s) should also be controlled by a switch or timer located in the bathroom. In all cases the centrally located dehumidistat would be the overriding switch. For the most effective use of the dehumidistat, it is recommended that the setting be between 40% to 60% relative humidity to maintain a healthy environment and to control any potential moisture problems.

Page	Reference	Revision
* 501	Appendix A	**A-9.33.3.7. Make-up air.** Make-up air is not required for the entire ventilation capacity only for the ventilation rate controlled automatically or provided continuously. However, in Article 9.33.3.13. additional separate make-up air is also required for any exhaust appliance with a capacity exceeding 0.5 air change per hour. This acknowledges the fact that although houses are being built tighter there is still enough air leakage through the envelope that can provide the additional air requirements of approximately 50L/s to 100L/s at 5 Pa, depending on the size of the house. This is based on a leakage rate or NLA of 1.08 cm^2/m^2 as established by a BETT/EMR survey of airtightness of housing across Canada. The 5 Pa depressurization has been established as the maximum permitted depressurization to prevent backdrafting of naturally-aspirating appliances.

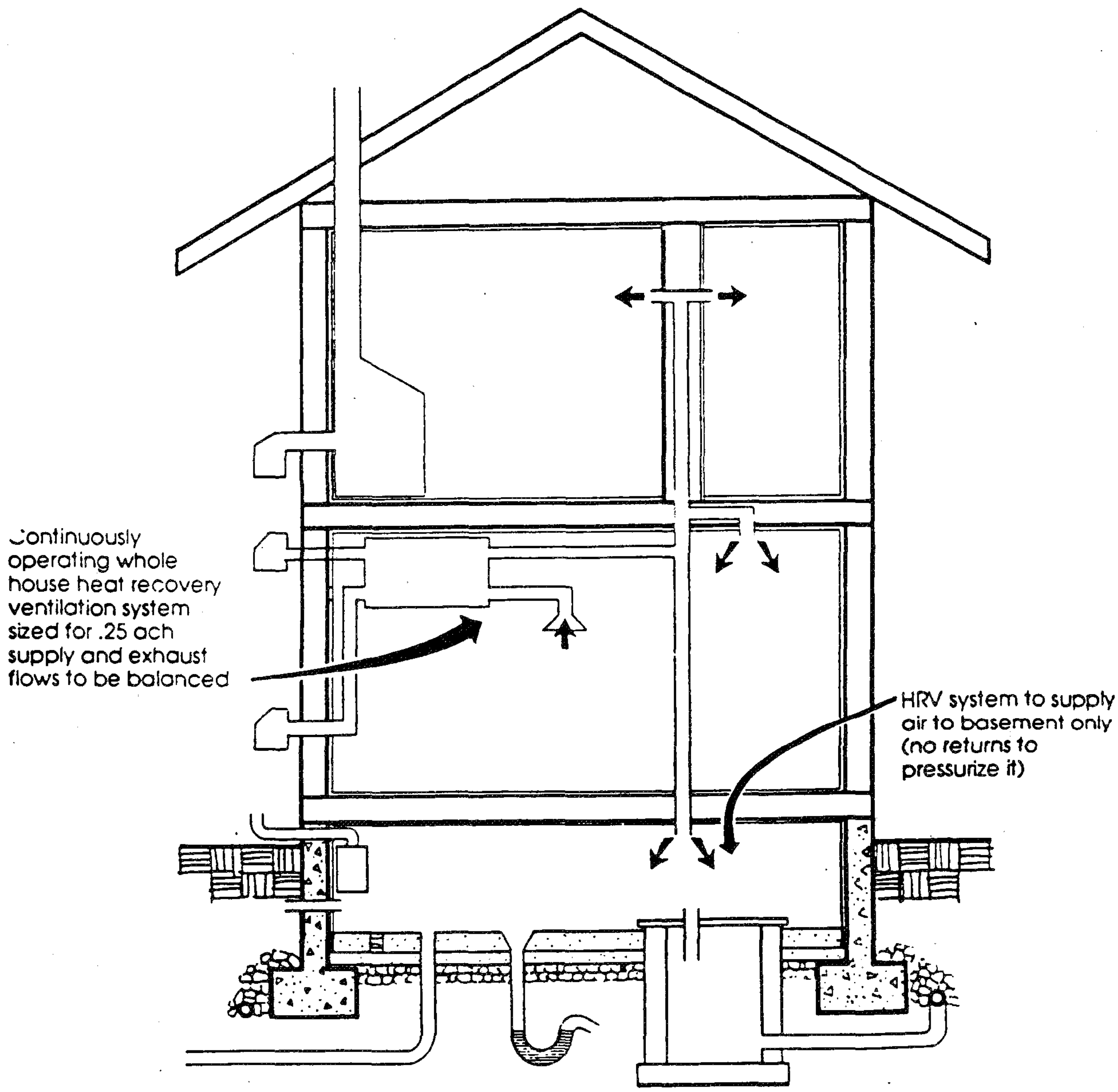
| - indicates N.R.C. errata (issued January 1988)
*- indicates B.C. errata

Note: N.R.C. issued revisions (or errata) do not automatically become part of the B.C. Building Code, they must be adopted by the Province.

APPENDIX II
Radon control by ventilation

Basement Foundation

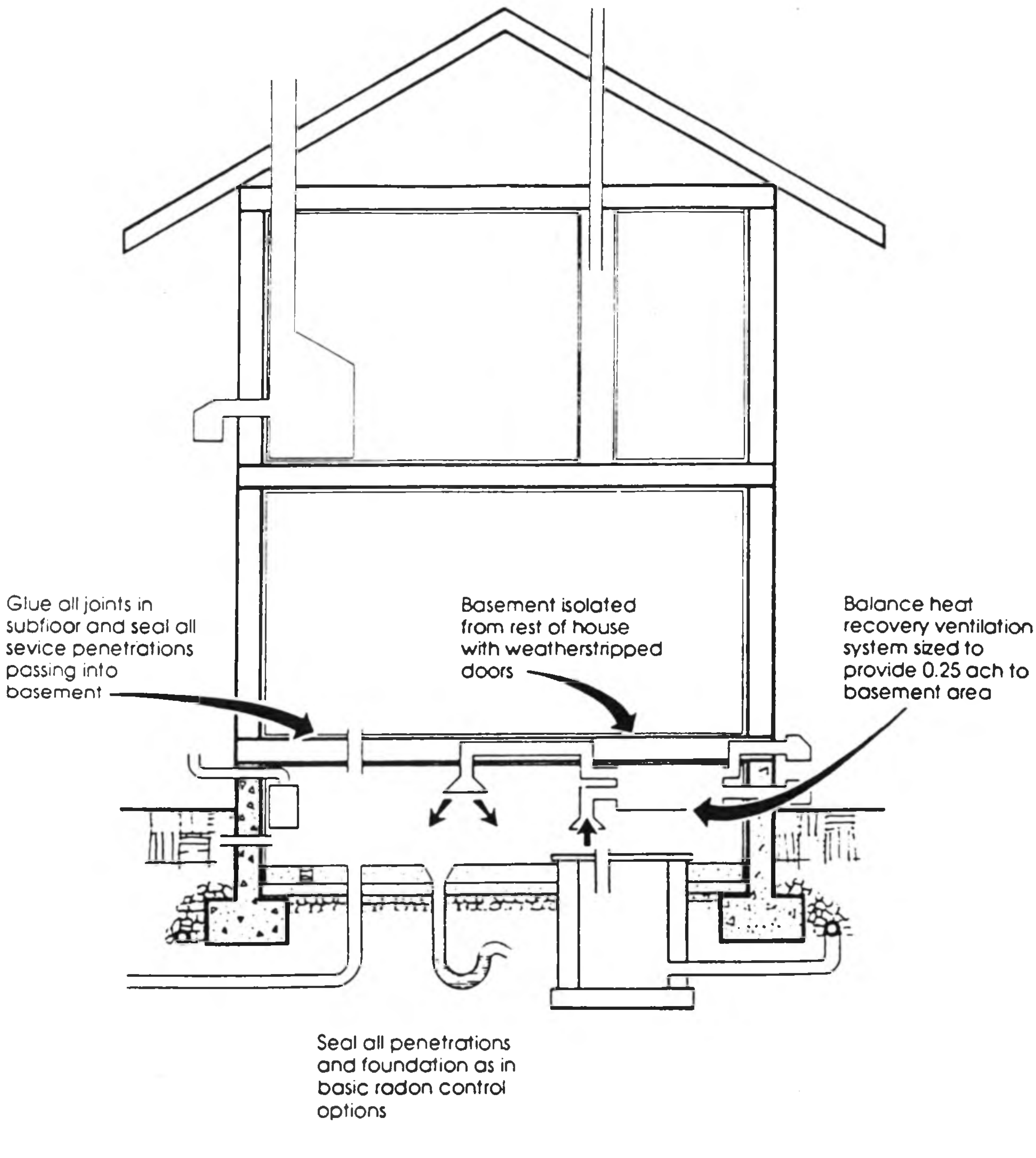
Radon Control by Wholehouse Continuous Ventilation



Seal all penetrations and foundation as in basic radon control option

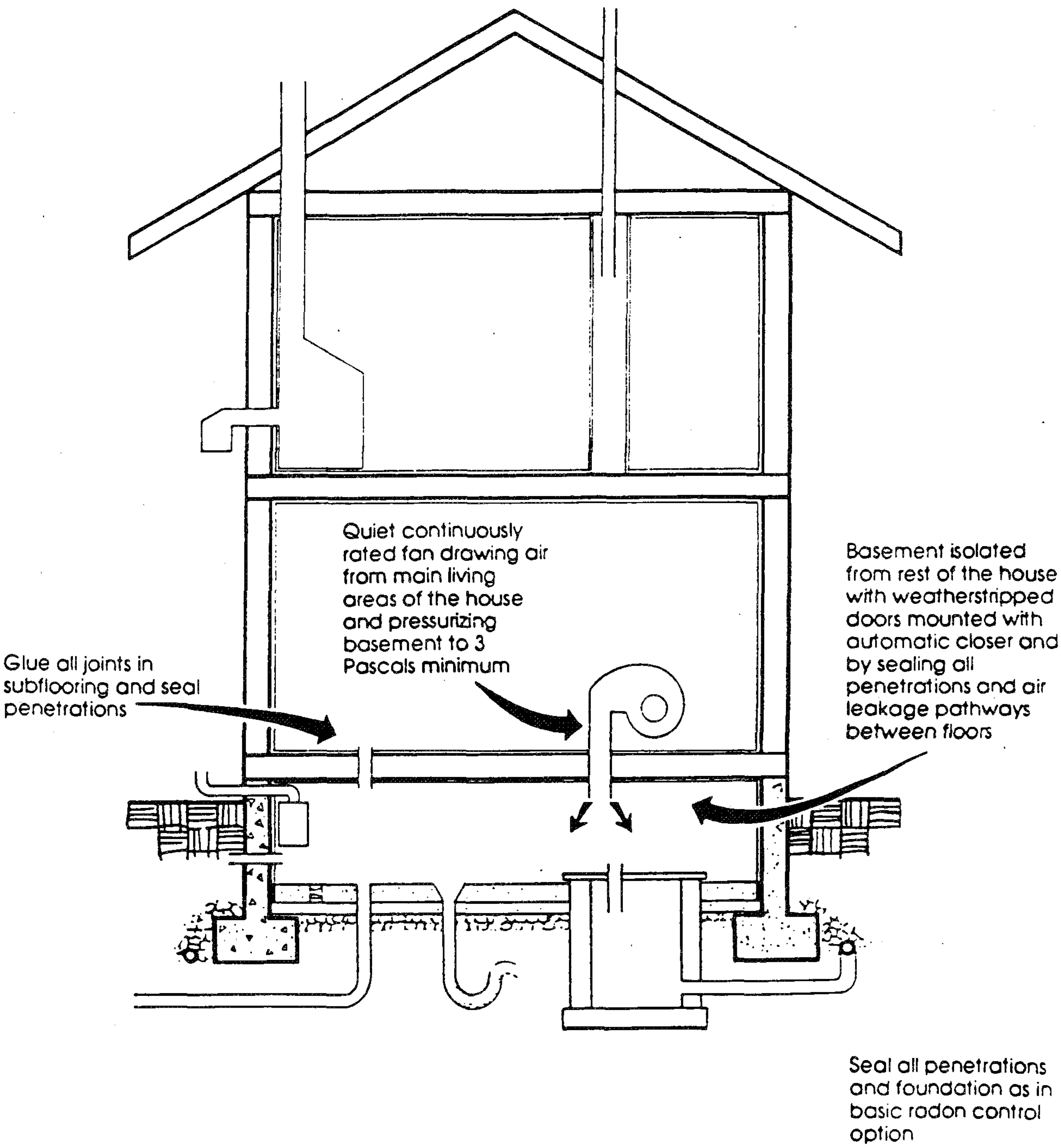
Basement Foundation

Radon Control by Basement only Ventilation



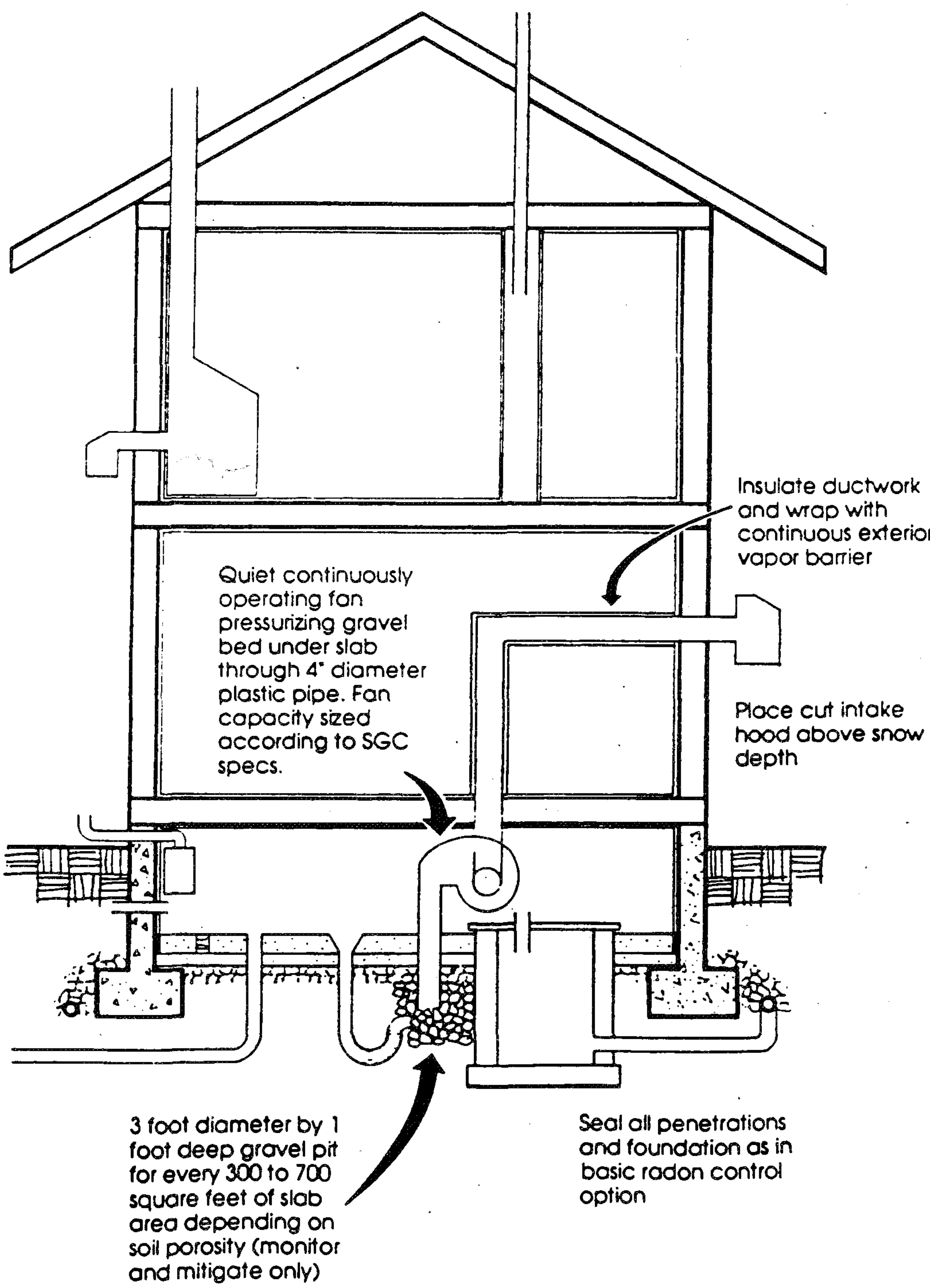
Basement Foundation

Radon Control by Basement Pressurization



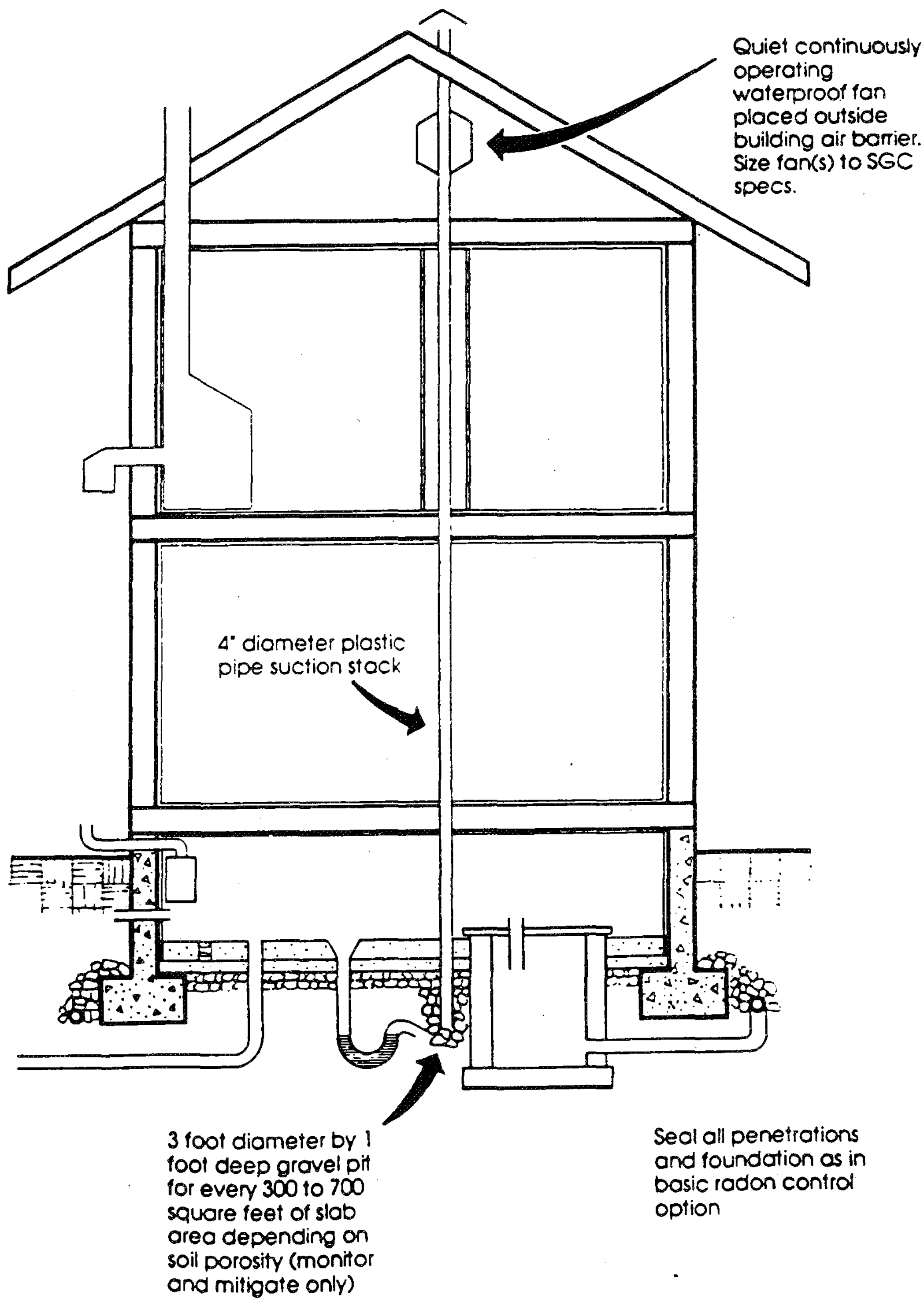
Basement Foundation

Radon Contol by
Subslab Pressurization



Basement Foundation

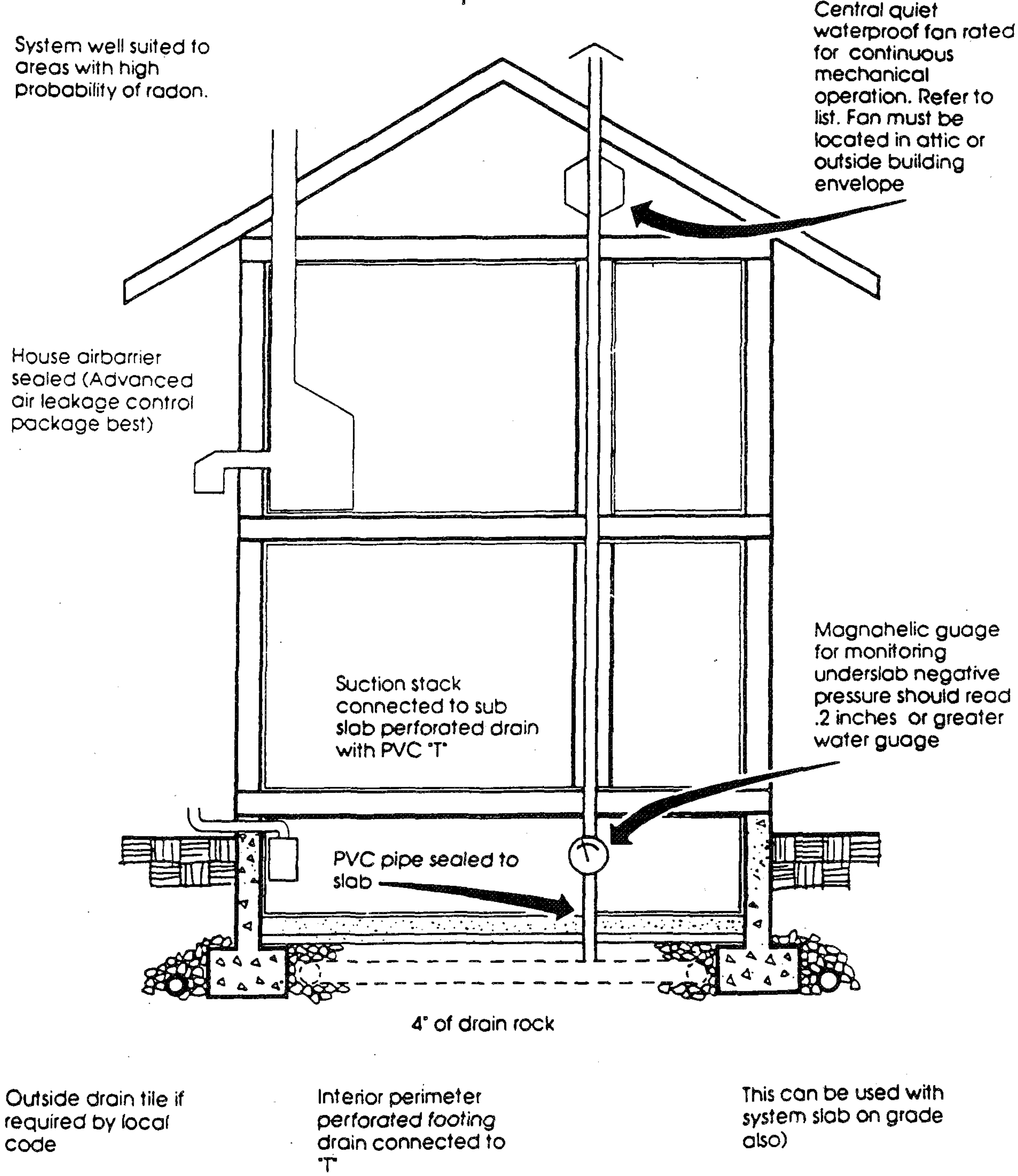
Radon Control by Subslab Depressurization



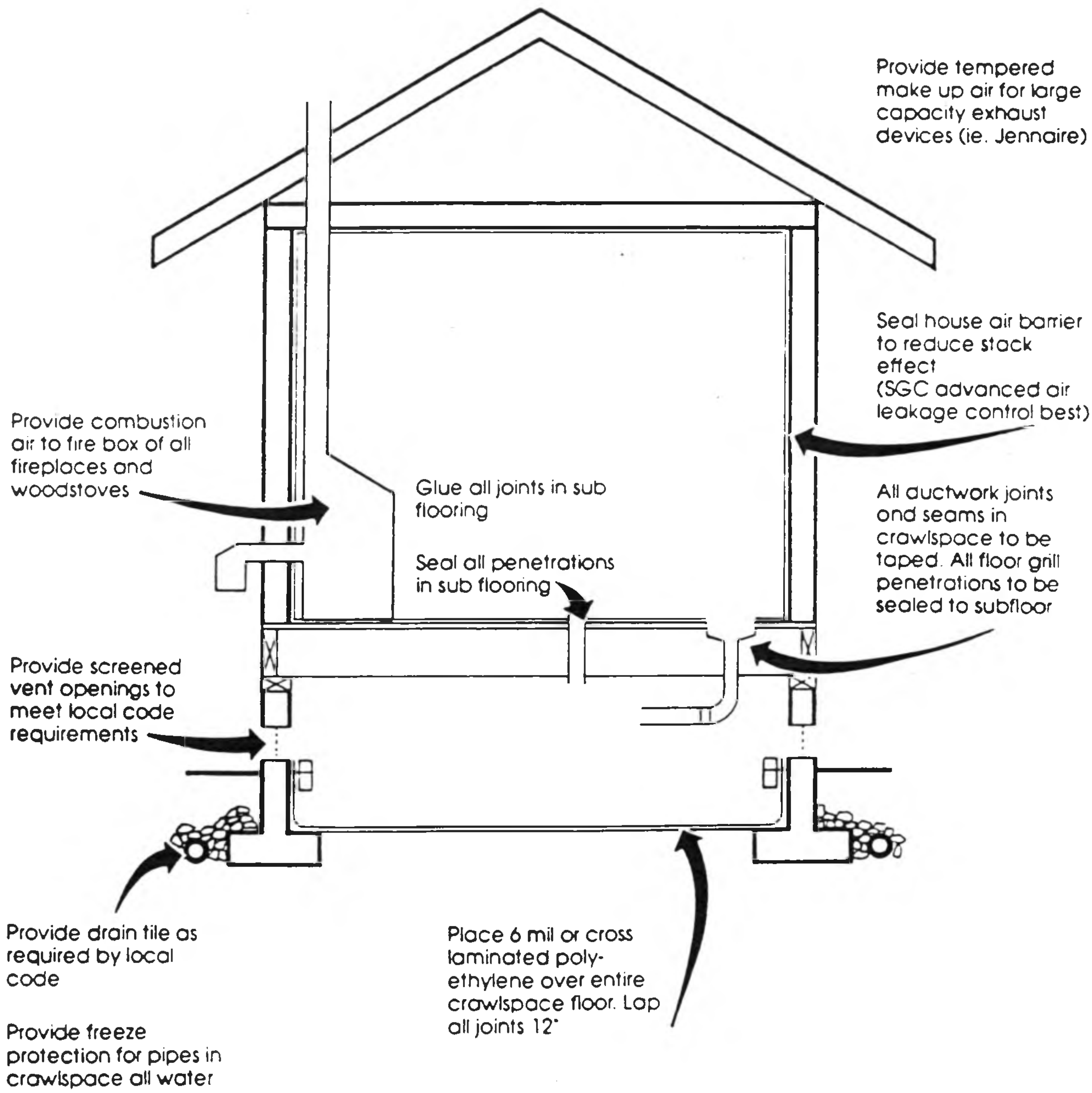
Basement Foundation

Radon Control by Subslab Depressurization

Option 2

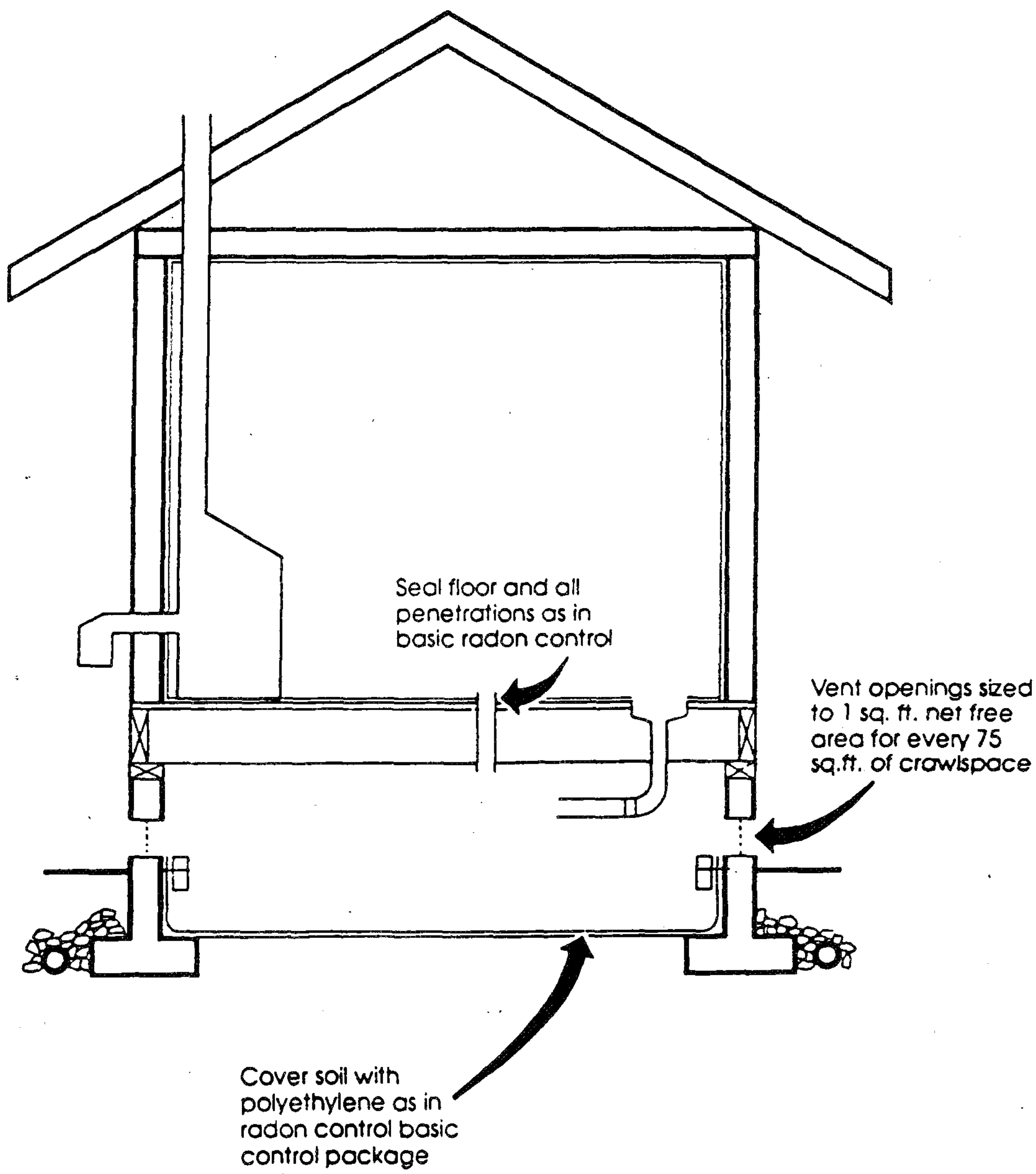


Crawlspace Foundation
Basic Radon Control



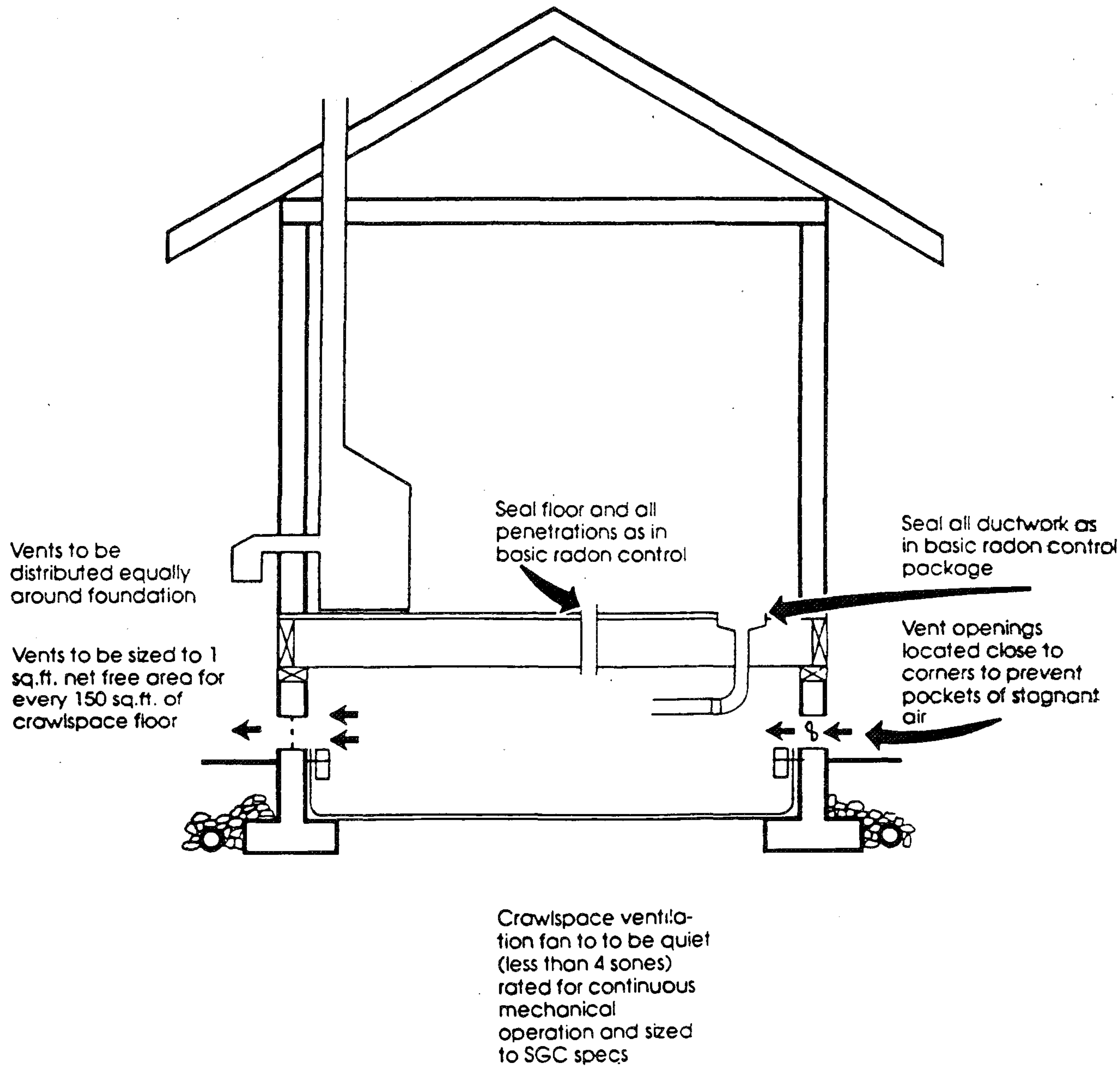
Crawlspace Foundation

Radon Control by Passive Crawlspace Ventilation



Crawlspace Foundation

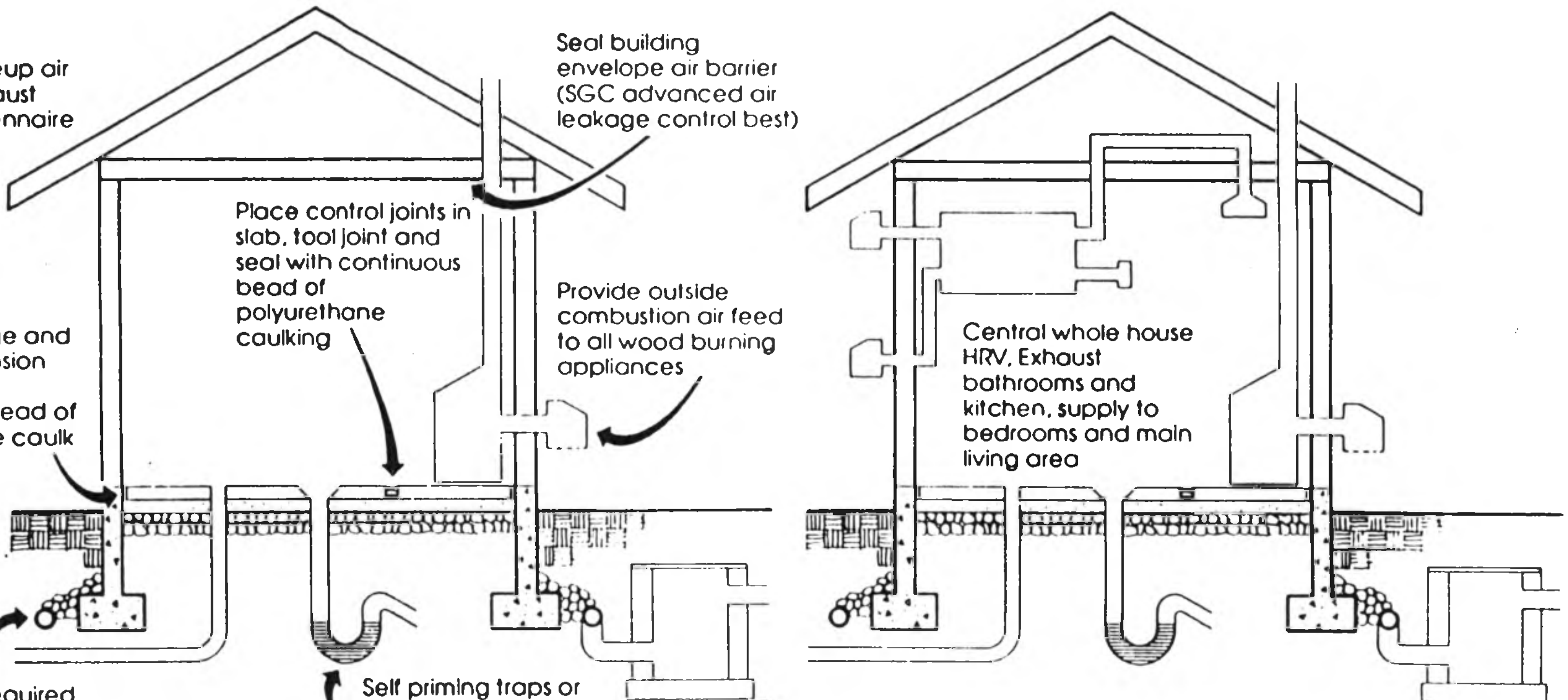
Radon Control by Active Ventilation



Slab on Grade

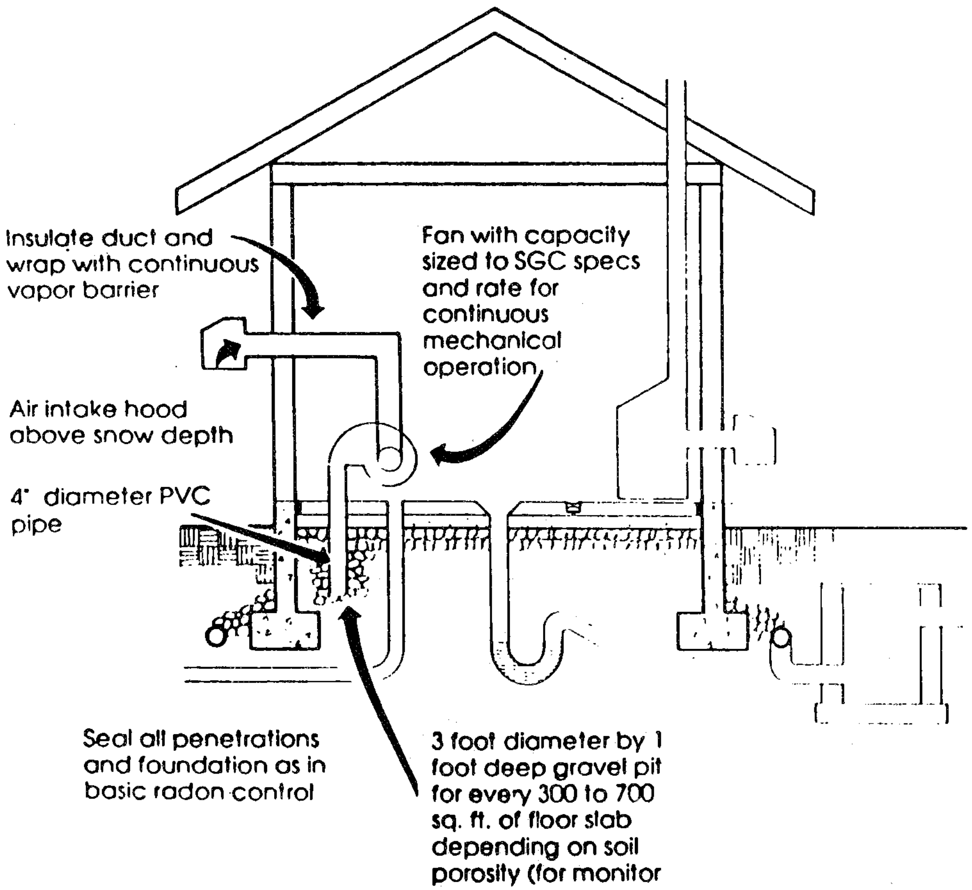
Basic Radon Control
Sealing Entry Points
and Reducing
Negative Pressure

Radon Control by
Balance Heat
Recovery Ventilation



Slab on Grade

Radon Control by Subslab Pressurization (High Porosity Soils)



Radon Control by Subslab Depressurization (Low Porosity Soils)

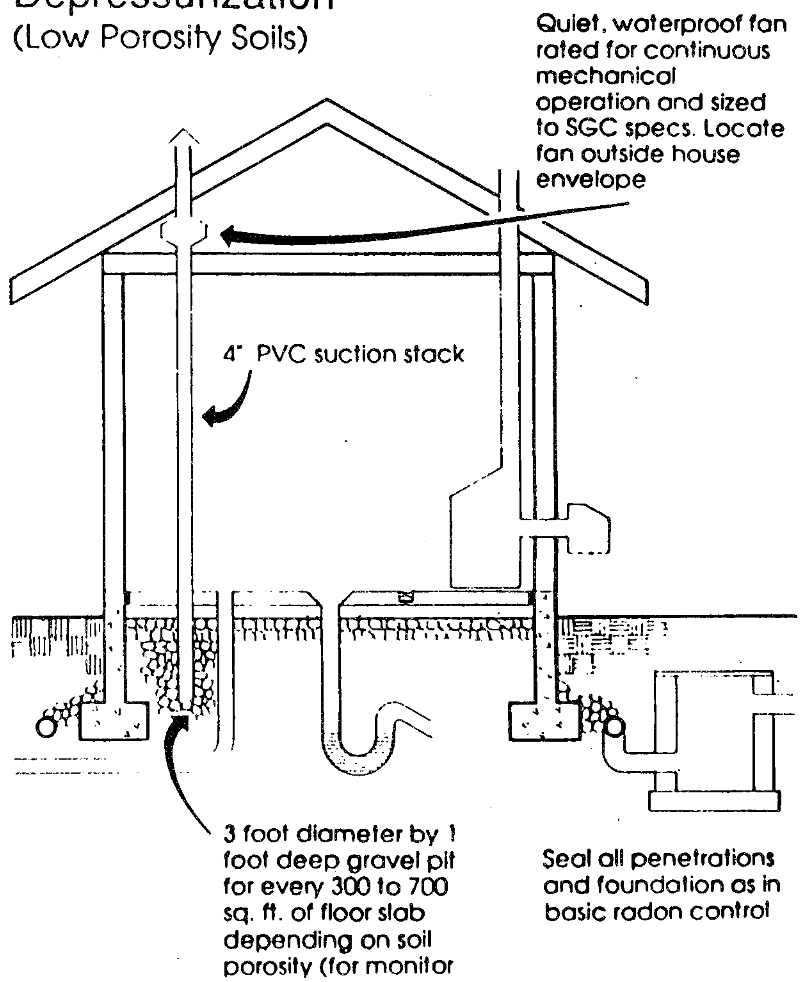


FIGURE 12.A

Non-HRV Option 1
Integrated Spot & Whole House System

CONTROL WIRING SCHEMATIC

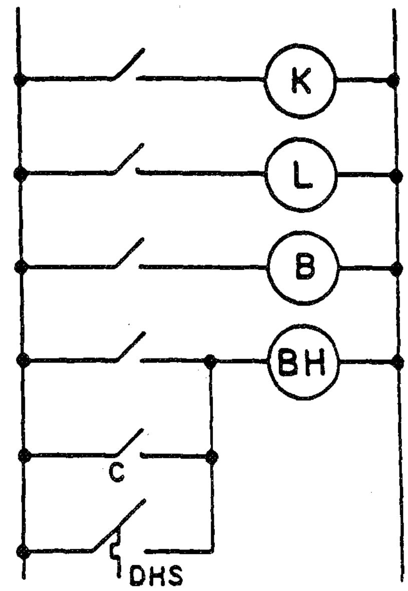
LEGEND

(symbol)	ON/OFF SWITCH
(symbol)	DEVICE ACTIVATED SWITCH
(symbol)	FAN MOTOR
(symbol)	RELAY/CONTACTOR
K	KITCHEN
L	LAUNDRY
B	BATH
BH	BATH/WHOLE HOUSE
FR	FAN RELAY
DHS	DEHUMIDISTAT
C	CENTRAL

OPTION: SUBSTITUTE TIME SWITCH FOR ON/OFF SWITCH

OPTION: SUBSTITUTE CLOCK TIMER FOR DEHUMIDISTAT

LINE VOLTAGE CONTROL OPTION



24 VOLT CONTROL OPTION

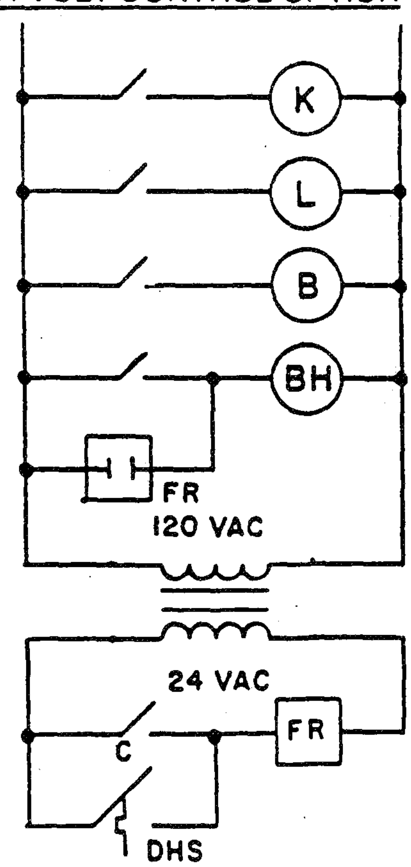
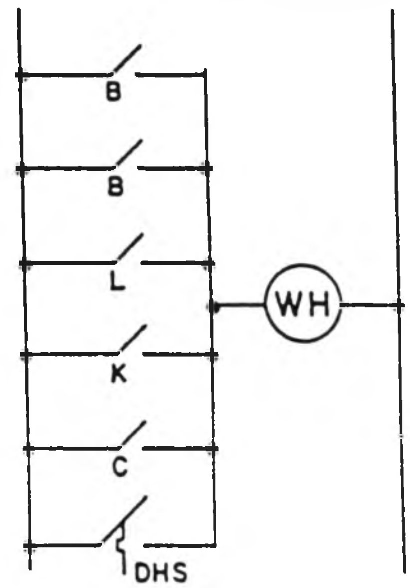


FIGURE 12.B

Non-HRV Option 2
Ducted Central Exhaust System

CONTROL WIRING SCHEMATIC

LINE VOLTAGE CONTROL OPTION

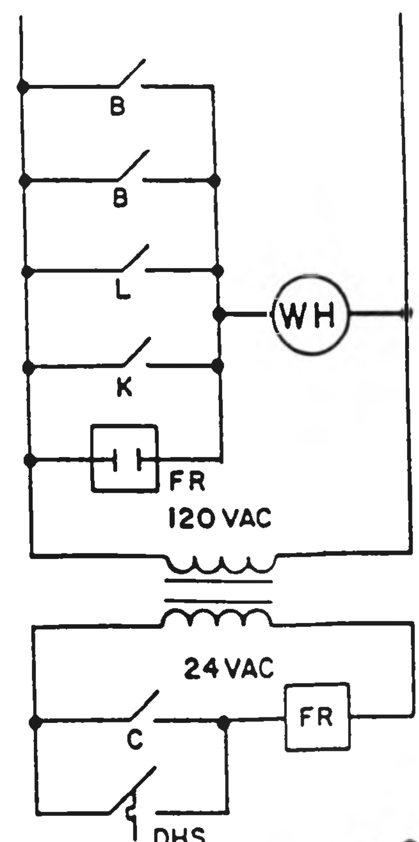


LEGEND

ON/OFF SWITCH
DEVICE ACTIVED SWITCH
FAN MOTOR
RELAY/CONTACTOR

WH	WHOLE HOUSE
B	BATH
L	LAUNDRY
K	KITCHEN
C	CENTRAL
DHS	DEHUMIDISTAT
FR	FAN RELAY

24 VOLT CONTROL OPTION



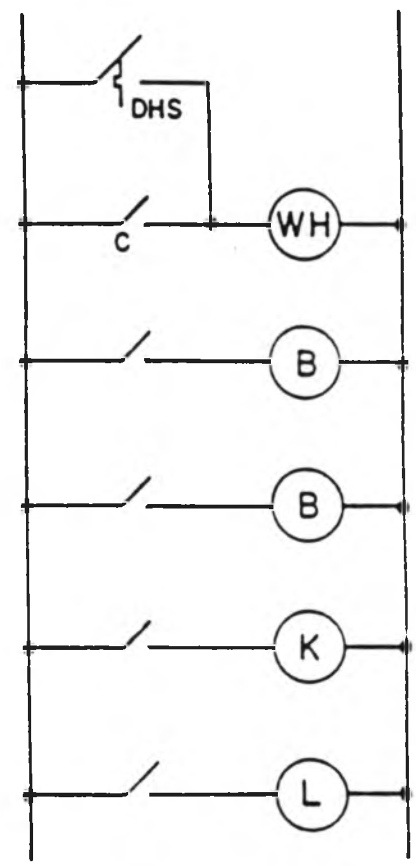
OPTION: SUBSTITUTE TIME SWITCH FOR ON/OFF SWITCH

OPTION: SUBSTITUTE CLOCK TIMER FOR DEHUMIDISTAT

FIGURE 12.C

Non-HRV Option 3
Discrete Spot/Whole House System

CONTROL WIRING SCHEMATIC



LEGEND

⁄	ON/OFF SWITCH
⁄	DEVICE ACTIVATED SWITCH
◯	FAN MOTOR
WH	WHOLE HOUSE
B	BATH
K	KITCHEN
L	LAUNDRY
C	CENTRAL
DHS	DEHUMIDISTAT

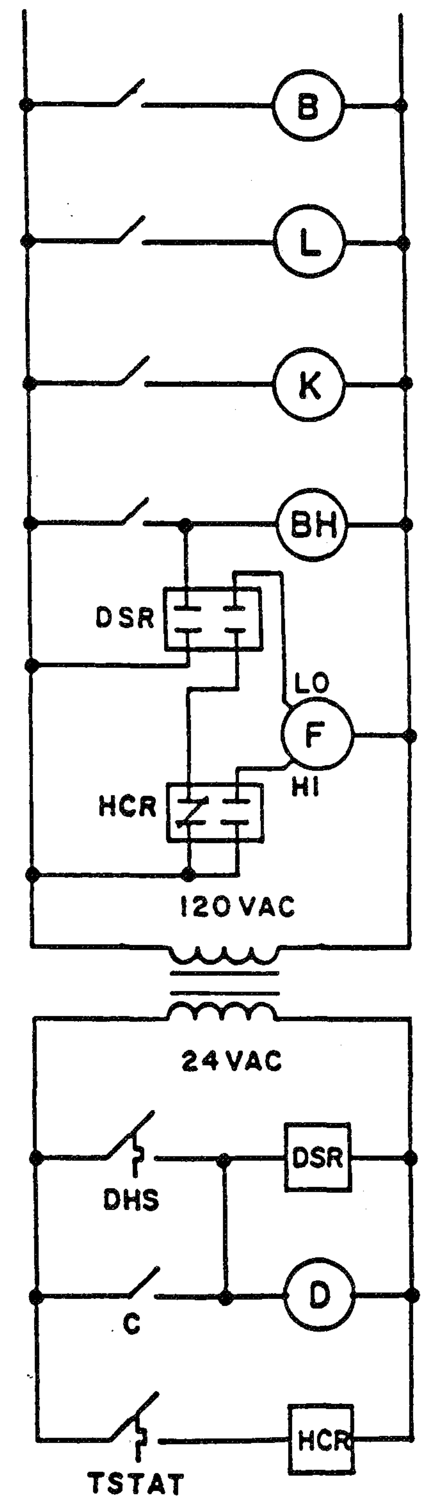
OPTION: SUBSTITUTE TIME SWITCH FOR ON/OFF SWITCH

OPTION: SUBSTITUTE CLOCK TIMER FOR DEHUMIDISTAT

FIGURE 12.D

Non-HRV Option 4
Whole House Ventilation Integrated W/Central Forced Air

CONTROL WIRING SCHEMATIC



LEGEND

ON/OFF SWITCH

DEVICE ACTIVATED SWITCH

FAN MOTOR

RELAY/CONTACTOR
NORMALLY OPEN
NORMALLY CLOSED

B	BATH
L	LAUNDRY
K	KITCHEN
BH	BATH/WHOLE HOUSE
F	FURNACE
DHS	DEHUMIDISTAT
C	CENTRAL
TSTAT	FURNACE THERMOSTAT
DSR	DEHUMIDISTAT RELAY
HCR	HEATING/COOLING RELAY
D	DUCT DAMPER

OPTION: SUBSTITUTE TIME SWITCH FOR ON/OFF SWITCH

OPTION: SUBSTITUTE CLOCK TIMER FOR DEHUMIDISTAT

Heat Recovery Ventilator

CONTROL WIRING SCHEMATIC

LEGEND

ON/OFF SWITCH

D.P.D.T.SWITCH CENTER OFF

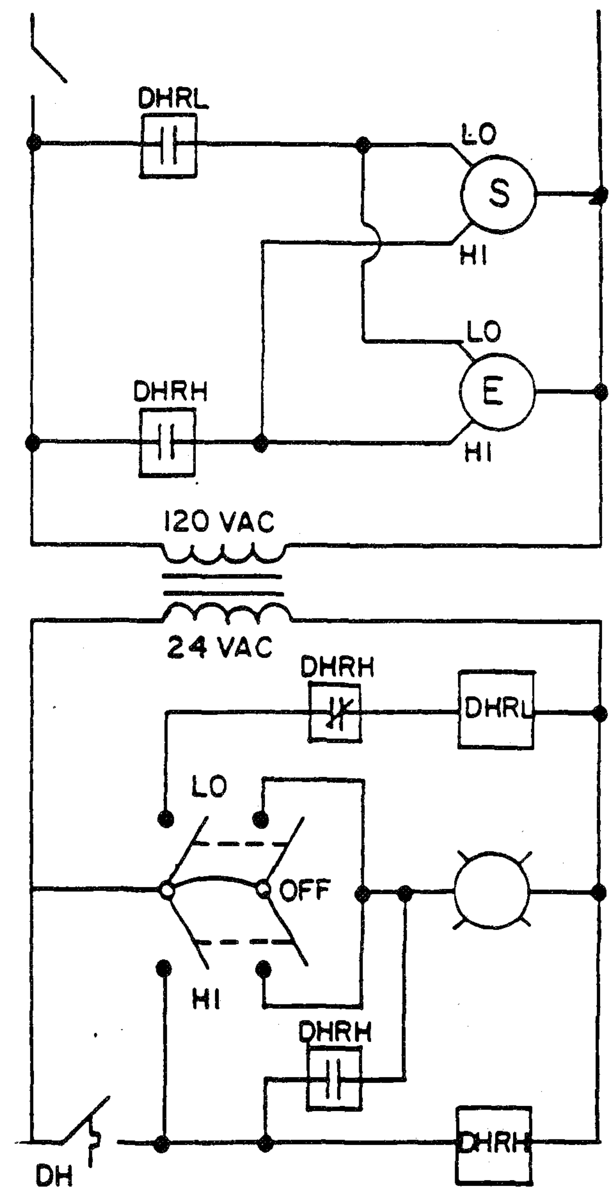
DEVICE ACTIVATED SWITCH

FAN MOTOR

RELAY/CONTACTOR
NORMALLY OPEN
NORMALLY CLOSED

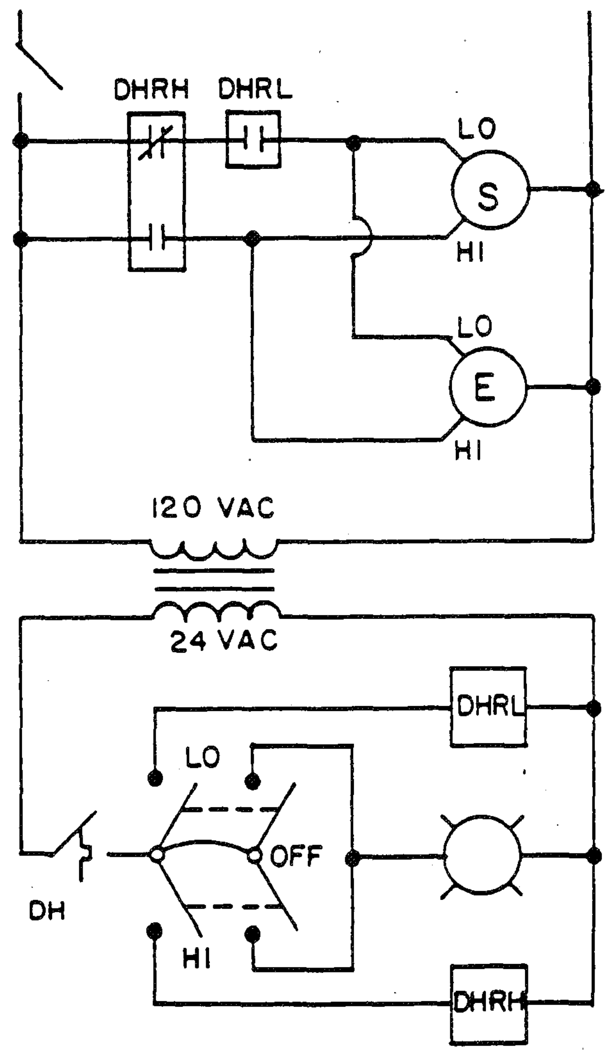
PILOT LIGHT

S	SUPPLY FAN
E	EXHAUST FAN
DH	DEHUMIDISTAT
DHRL	DEHUMIDISTAT RELAY (LOW)
DHRH	DEHUMIDISTAT RELAY (HIGH)



Heat Recovery Ventilator

CONTROL WIRING SCHEMATIC
VARIATION #1



LEGEND

- ON/OFF SWITCH
- D.P.D.T.SWITCH CENTER OFF
- DEVICE ACTIVATED SWITCH
- FAN MOTOR
- RELAY/CONTACTOR
  - NORMALLY OPEN
  - NORMALLY CLOSED
- PILOT LIGHT

S	SUPPLY FAN
E	EXHAUST FAN
DH	DEHUMIDISTAT
DHRL	DEHUMIDISTAT RELAY (LOW)
DHRH	DEHUMIDISTAT RELAY (HIGH)

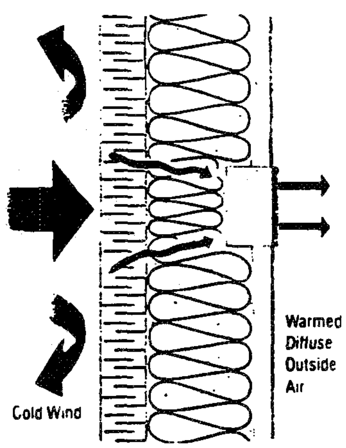
The FIBERGLAS Low Energy Housing System

You can use the Fiberglas System to build almost any home, no matter what design features or construction details you would like to incorporate. The superlative result will be a home that meets the R-2000* performance standard for energy efficiency. Your living environment will be warm and virtually draft free.

The Fiberglas System ensures that fresh, outside air is distributed throughout the house. Concealed condensation and collected moisture is greatly reduced because dry winter air is drawn inward through wall cavities, while damp indoor air is exhausted mechanically.

How the Fiberglas System Works

With the Fiberglas System, the house is approached as a complete package. The building envelope - foundation, exterior walls, windows, doors, and ceiling - works together with the HABITAIR* Energy Centre for heating and ventilation.



THE GLASCLAD WALL SYSTEM

*R-2000 [illegible] Mines and Resources Canada [illegible] R-2000 [illegible] builders [illegible] details.

There are five key elements which comprise the System:
- GLASCLAD* Wall System
- Upgraded insulation
- Improved windows
- HABITAIR central ventilation system with heat recovery

Working together, these features of the FIBERGLAS System provide clear benefits to both builders and new home purchasers, such as:
- Low cost space heating
- Low cost hot water
- Superior indoor air quality
- Draft-free
- Quiet
- Some cooling in summer
- Simple construction techniques
- Reduced condensation in walls

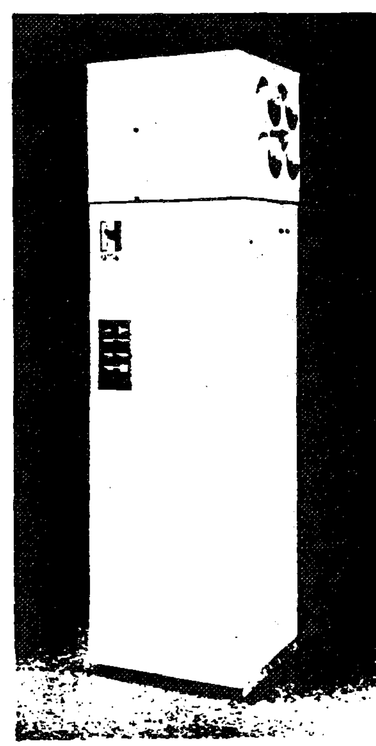
The key to the building envelope is the "GLASCLAD Wall System" - an innovative but simple way to assemble exterior walls that utilize GLASCLAD insulating sheathing. GLASCLAD has a spun-bonded polyolefin membrane (TYVEK*) as an exterior facing.

TYVEK is a wind barrier. Joints in the GLASCLAD are taped and TYVEK sheets are wrapped around typical air leakage points such as header areas. This continuous outer skin stops wind and drafts but allows the slow diffusion of air and moisture. So, as the diagram illustrates, fresh outdoor air, evenly distributed throughout the building envelope, moves slowly through the TYVEK into the wall cavity. The air is warmed as it weaves its way through the dense insulation and eventually enters the home through an electrical outlet or any other small opening. The vapour retarder is no longer required as an air barrier. And it only requires conventional installation with no special wall sealing details.

Fiberglas System homes operate under a slightly negative pressure, the traditional operating characteristic of house construction. The HABITAIR Energy Centre draws moist air continuously from the bathrooms, kitchen and laundry room, then pumps it outside.

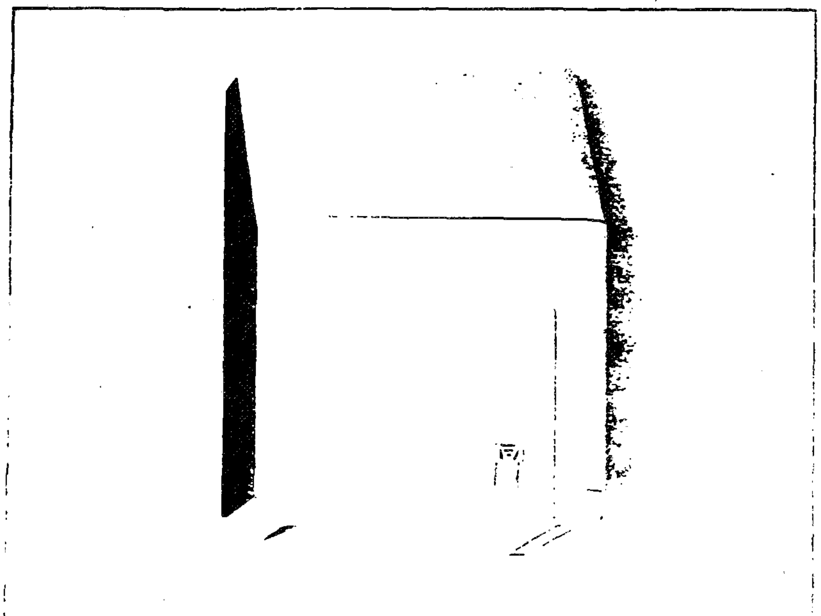
The HABITAIR Energy Centre recovers heat from the exhaust air. This recovered heat is used to provide domestic hot water. Once the hot water demand has been satisfied, the energy centre automatically contributes space heating to the home.

The Habitair Energy Centre*



Humidity-controlled extract unit

PATENTED



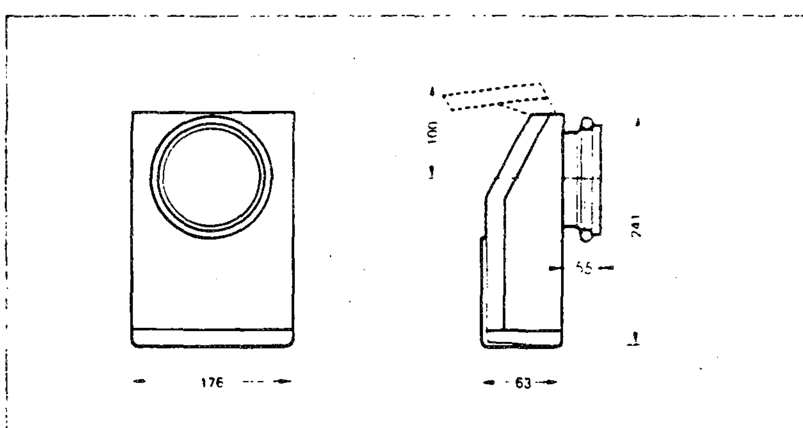
The humidity-controlled extract unit AERECO is the component of the humidity-controlled ventilation system, allowing to determine the average need of ventilation for the dwelling. It is installed in kitchen and bathroom.

It can only be used, in a new dwelling, in a complete humidity controlled ventilation system including a special fan and humidity-controlled air inlets.

I. DESCRIPTION

The humidity-controlled extract unit is composed of:

- a plastic front part (colour beige);
- a plastic base (colour brown);
- a connector on which a joint of foam is set;
- a membrane box (colour beige);
- a sensor composed of 8 nylon strips located on inox case detecting the humidity,
- 2 filters for protection;
- a venturi, amplifying the pressure difference;
- a membrane influenced by the venturi, adjusting the air flow;
- a shutter allowing to get an additional flow;
- a cord operating the opening of the shutter;
- a deflector with 4 positions reaching additional flows after 50 m³/h (30 cfm): 75 m³/h (44 cfm) – 90 m³/h (53 cfm) – 120 m³/h (71 cfm) and 135 m³/h (80 cfm);
- weight: 0,700 kg;
- 2 positions: ● and +



Dimensions mm

II. FUNCTIONING

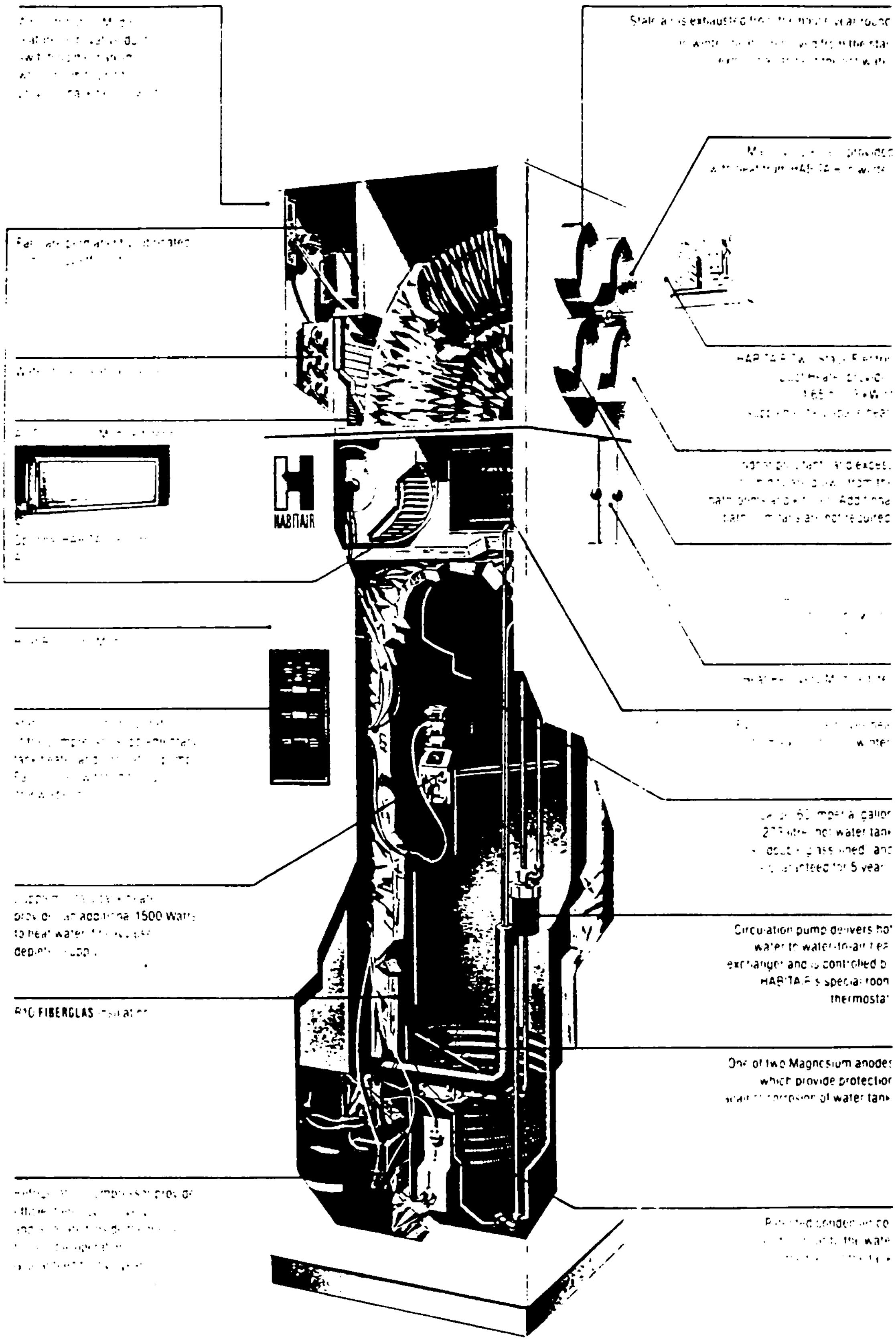
The humidity-controlled extract unit AERECO allows to change the air flow by inflating or deflating of a membrane as function of the relative humidity of the ambient air.

Example: a kitchen to ventilate with an ambient pressure of 0 pascal (0 in.wg).

The relative humidity of the ambient air influences the sensor which transforms and amplifies the reading of the humidity by moving a valve by-pass thanks to a return

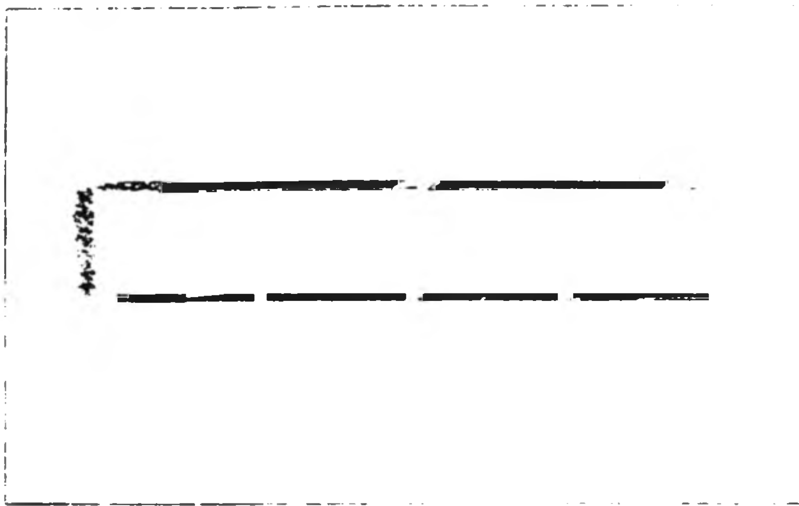
This valve changes the pressure difference in the tube leading to the membrane modifying the section of passage of the extracted air in the duct (where the pressure difference is 100 pascals) (0.40 ins wg.). In the meantime, a venturi is used to amplify the pressure difference. ▷

HABITAIR


HABITAIR
Circulation pump delivers hot
water to water-to-air hea
exchanger and is controlled b
HABITAIR's special room
thermostat
One of two Magnesium anodes
which provide protection
corrosion of water tank
R10 FIBERGLAS insulation
provides an additional 1500 Watts
to heat water
guaranteed for 5 years

Humidity-controlled air inlet

PATENTED



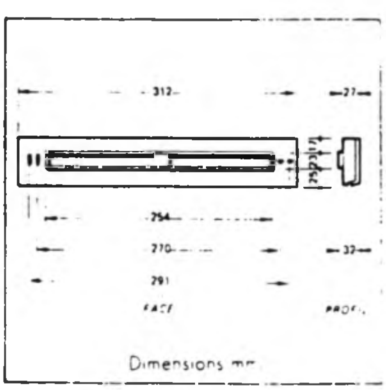
The humidity-controlled air inlet AERECO is the component of the humidity-controlled ventilation system allowing to distribute the incoming fresh air in each main room, according to their respective humidity.

It can only be used in a new dwelling, in a complete humidity-controlled system including a special fan and humidity-controlled extract units.

I. DESCRIPTION

The humidity-controlled air inlet is composed of:

- a humidity sensor composed of 8 nylon strips set in an inox case;
- a plastic front-part (colour beige);
- a plastic base (colour brown);
- a caulking-joint located on the back part of the base;
- an actuator;
- 2 shutters allowing to modify the opening section (from 5 cm² to 30 cm²);
- 2 positions: ● and +
- weight of the air inlet: 0,250 kg



II. FUNCTIONING

The functioning of the system is based on the physical reactions of a reader of humidity which is composed of a polyamid tissue stretching or shrinking as function of the humidity rate. The movements of the tissue are amplified and transmitted by a system of actuator to the movable shutter.

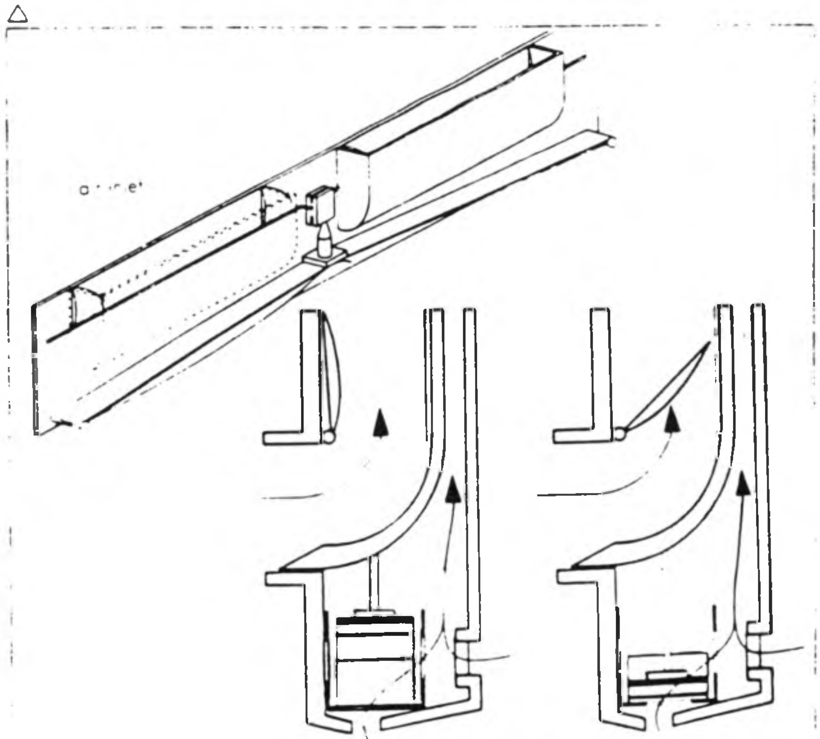
The humidity-controlled air inlet allows to change the opening section from 5 cm² till 30 cm² according to the humidity rate of the room where it is. The opening section is: ●

- 5 cm² for 40 % humidity;
- 30 cm² for 75 % humidity.

With the position signed +, the opening section is:

- 5 cm² for 25 % humidity;
- 30 cm² for 60 % humidity. ▷

△



VMP K

MULTI-POINT MECHANICAL VENTILATION EXHAUST SYSTEM

INSTALLATION OPERATION MAINTENANCE US 775

A multi-point mechanical exhaust system, the VMP-K assures constant, efficient and silent ventilation for the home by

- bringing fresh outside air into the bedrooms, living room and dining room,
- extracting the stale, polluted air from the kitchen, bathrooms, powder rooms, laundry and storage rooms through air grilles and the corresponding ducting system to a fan unit, which in turn exhausts to the exterior

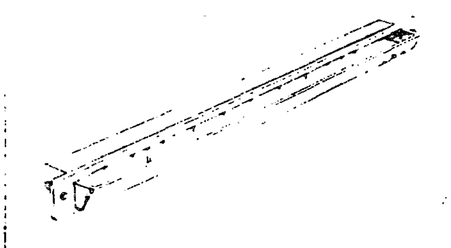
The installer should have, beforehand, taken notice of the VMP-K's characteristics indicated in our descriptive literature

FRESH AIR SOURCE

While the use of the specially designed ALDES air inlets, in conjuction with the VMP-K, is not absolutely necessary, they are strongly advised, and especially in the case of superinsulated or airtight homes. These air inlets assure a source of fresh air from the outside. Because these inlets are self-balancing, they let enter only the amount of air strictly necessary in function with the fan, assuring a healthy air change rate. A damper blade inside the inlet grille makes this possible. In this way, constant ventilation is achieved in the most economical manner

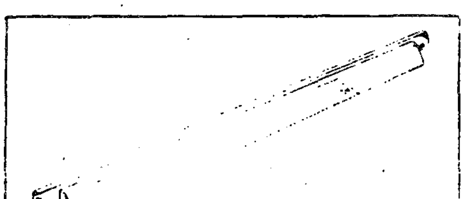
If air inlets are not installed, the cracking of windows and natural infiltration will in most cases provide the necessary fresh air intake

A window installation is shown below. Consult ALDES for other models



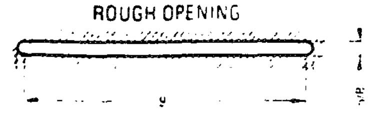
SELF-BALANCING AIR INLET GRILLE FOR FACADE

1

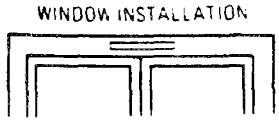


EXTERIOR COVER PLATE

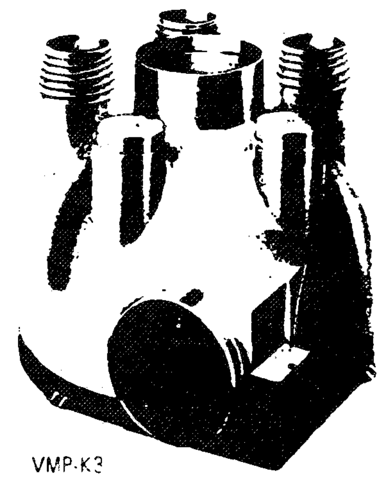
ROUGH OPENING



WINDOW INSTALLATION



FAN UNIT



VMP-K3

The fan unit should be placed, when possible, close to the kitchen grille

In any case, the fan unit should never be placed over a bedroom, dining room, or living room in order to eliminate any chance of noise or vibrations being transmitted to these room

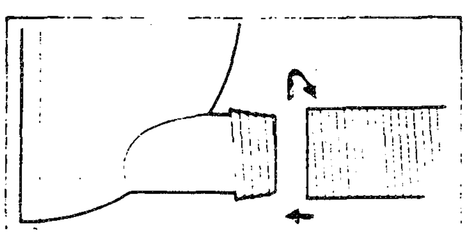
If the VMP-K is to be installed in the habitable part of the house, care should be taken to assure the necessary acoustical insulation. See Descriptive literature for noise data

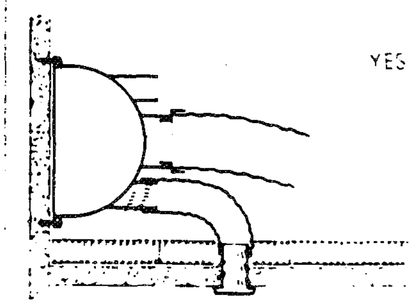
The fan unit may be installed as shown in figure n° 4

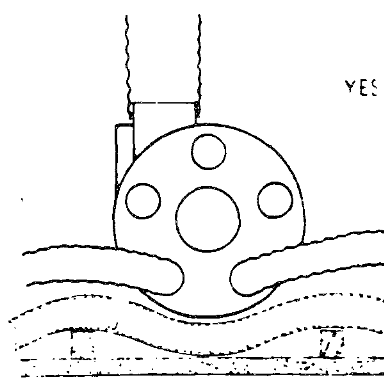
- in the attic by mounting on the rafters or wall,
- in the basement or mechanical room against a vertical surface

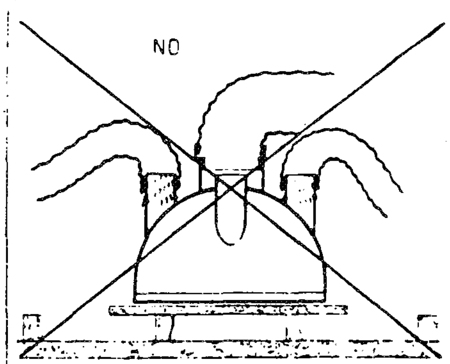
Caution : because of the risk of condensation accumulating in the bottom of the fan unit, and eventually damaging the motor, the VMP-K can not be installed with its base horizontally placed on the floor.

The 3" duct connectors for the bathrooms and powder rooms on the fan unit have threads. The flexible ducting may be easily screwed on by a 360° clockwise turn









4

FRESH AIR SUPPLY
With Connection to Forced Air Systems for Exhaust Ventilation

DESCRIPTION
8 U.S. 998

AMERICAN ALDES offers the solution to the problem of supplying fresh makeup air to replace air exhausted by a mechanical ventilation system from the home, without uncomfortable drafts, and without risk of excessive supply air. The ALDES solution is a Fresh Air Makeup Kit, which incorporates the **Constant Airflow Regulator** (CAR) as the key element. The use of the CAR permits fresh air to be distributed throughout the house without risk of positively pressurizing it, thus avoiding the forcing of moisture-laden air into wall cavities. *This device is ideal for homes equipped with a continuous-duty exhaust fan and a forced air heating system.*

The CAR may be used to control the ventilation supply air to the return side of the furnace, where it is then distributed to the house through the supply ductwork. It may be desirable to run the furnace fan continuously, or at a lower speed for ventilation, or to cycle the fan periodically to distribute fresh air. This is advisable especially in the fall and spring seasons, when there is little demand for heating or cooling. Best results are obtained with the furnace fan running on low speed for ventilation, switching to high speed for heating. Contact your local electrician for the necessary relay installation.

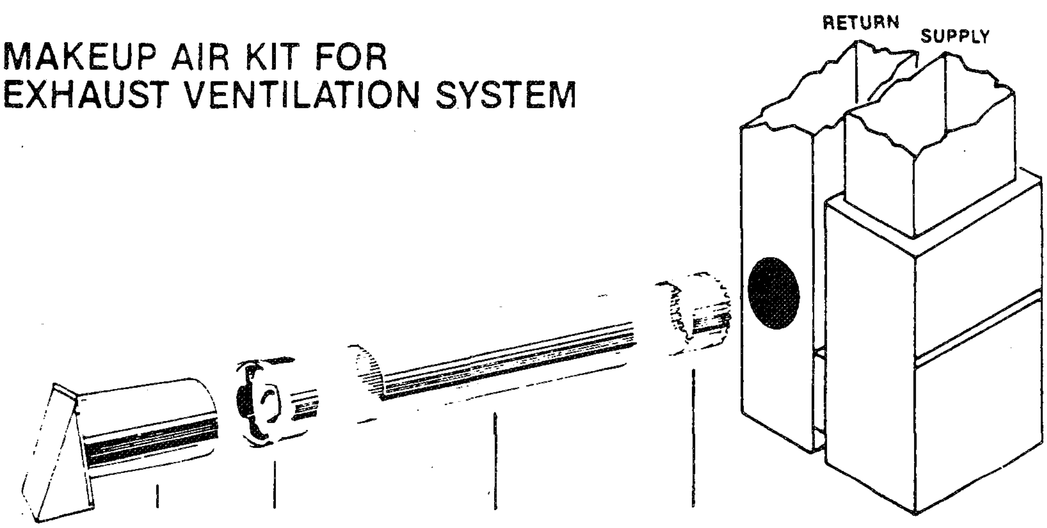
It is necessary to connect the fresh air duct to the return plenum as close as possible to the furnace fan, to assure there is sufficient pressure available to operate the CAR properly. The CAR must be sized to provide the low speed exhaust rate (plus the combustion air requirement for naturally vented furnaces if not separately furnished). It requires between 0.2 and 1.0 inches w.g. to provide its rated airflow. If 0.2 in. w.g. is not available in the return plenum, using one of the larger sizes will provide the proper airflow. If in doubt contact American ALDES for assistance.

Insulated duct is recommended to avoid condensation on the cold duct.

The illustration below shows the contents of the Makeup air kit used in conjunction with an exhaust system, such as the ALDES VMPK (not shown).

The same kit may be utilized in conjunction with a heat exchanger added to the system to recover heat from the exhaust air stream. The CAR controls the fresh airflow allowing a direct connection from a conventional heat recovery ventilator to the return side of a furnace. This procedure is not recommended without a CAR. The CAR permits this connection, by regulating the supply airflow, protecting against excessive cold air when the furnace fan cycles on. Without such regulation, the excessive supply air will result in freezing the heat exchanger, and pressurizing the house.

MAKEUP AIR KIT FOR EXHAUST VENTILATION SYSTEM



PART NUMBER	MODEL	DIAMETER	TABLE OF RATED AIRFLOWS					
65XXX*	MAK-5	5"	15	29	44	59	77	94
66XXX	MAK-6	6"	77	100	124	147		
68XXX	MAK-8	8"	118	147	177	206	235	

*XXX Designates the rated airflow. Example: Part Number 66124 designates a kit with 6" diameter fresh air intake, takeoff collar, and CAR, rated at 124 CFM.

OPTIONAL: *Insulated ductwork, in 25 foot lengths may be ordered from American ALDES.*

AMERICAN ALDES VENTILATION CORPORATION
Northgate Center Industrial Park
4539 Northgate Court • Sarasota, Fl ... 34234-4864
Phone (813) 351-3441
Telex 75653?

CAVC CONSTANT AIR VOLUME CONTROLLER

DESCRIPTION INSTALLATION

Balancing forced air systems have always been a major problem in the heating, air condition ing and ventilation field. Yet, correctly ba lancing a system is absolutely necessary today, for it offers the comfort, the silence and the energy savings which make all the difference between the satisfactory and unsatisfactory installation.

The unsatisfactory forced air system is almost always the result of the same error. To gain space and reduce costs, ducting is down-sized. As a result, the pressure drop within the sys tem is relatively high and difficult to calculate. This means that each grille or register must be individually controlled and or adjusted when installed, or when modifications are made in the system. However, the result is often less than satisfactory, and always remains subject to a certain number of factors, such as stack effect. And of course, such installations may be tampered with by the occupants, ren dering inefficient the entire system.

Many attempts have been made to find a prac tical solution to this problem. Such a solution must assure a constant airflow at grilles and registers independently of the operating pressure. Diverse servo and automatic control systems are currently used, but have the disadvantage of needing comparatively high pressure to operate efficiently. The conse quence is increased power consumption and high noise levels.

ALDES offers a new and relatively simple so lution, for the first time, to this problem: the CONSTANT AIR VOLUME CONTROLLER.

This device is self-balancing and assures a cons tant airflow at air grilles and registers. Among the advantages of the CAVC are that it:

- assures a perfect balance between the supply and return airflows. Energy loss due to air change can be perfectly controlled and kept to a minimum. A forced air system may thus be calculated with precision, permitting a very efficient installation ;
- assures a constant airflow rate at very low pressure levels, permitting all the advantages of low pressure systems, i.e., reduction of motor size, less power consumption, lower noise levels and energy wasted by leaks at ducting joints ;
- allows a certain choise of operating pressure which means a greater flexibility in system design. The CAVC operates efficiently within a pressure range of 0.2" to 1" w.g. ;
- facilitates engineering : the CAVC compen sates for minor errors made when calcula ting a system ;
- compensates automatically, to a certain degree, the pressure drop due to stack ef fect, dust clogging of fan or ducting, etc. ;
- with factory pre-set airflow rates, and be cause it is self-balancing, the CAVC elimi nates on-site balancing. Consequently, the installation can be done rapidly and without specially trained and costly labor ;
- by comparison to constant air volume devices actually installed, the CAVC is inex pensive.

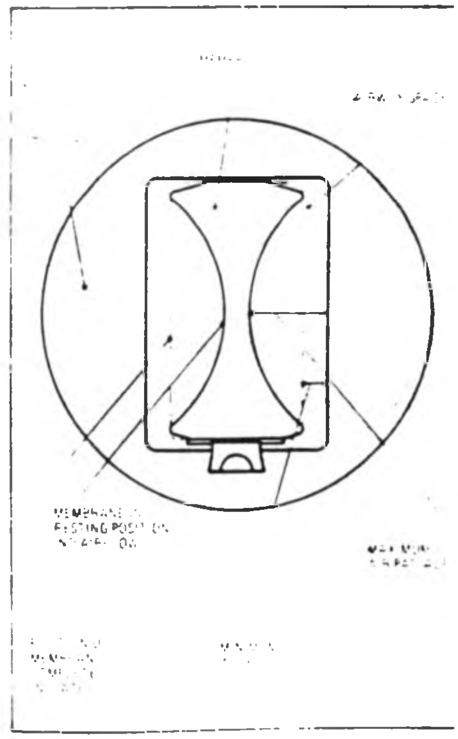
DESCRIPTION

The CAVC is composed of:

- an active part : 1 or 2 silicone membranes depending on the model ;
- an inert part : the housing.

The membrane is made of stabilized silicone. In its resting position, i.e. when there is no air flow, the membrane element lets by a max imum amount of air. However, under the effect of a pressure difference between the 2 sides of the CAVC, the membrane automatically in flates to adjust the airway cross-section in order to compensate for the pressure dif ference, and maintains, in this way, a cons tant airflow.

The housing, in the center of which is the air passage, serves as the support for the mem brane. It is either made of autoextinguishing plastic or aluminum, and is designed for round ducting (see table for diameters).



SBO SELF-BALANCING EXHAUST OUTLETS

DESCRIPTION

Very sensitive to pressure changes and automatically adjusting to provide a constant air flow rate, the ALDES SBO is the most recent and advanced solution for balancing forced air systems. It is intended for most applications in connection with such installations in apartment buildings, condominiums, houses, hotels, hospitals, etc.

It was designed keeping in mind the needs of architects and contractors as well as those of the installer and occupant.

The results speak for themselves:

- a product which meets most forced air system requirements,
- a complete product line,
- easily installed,
- very resistant, light weight and attractive appearence,
- no on site adjusting necessary,
- very low noise level,
- diminished noise [illegible] through ducts,
- may result in energy saving.

The ALDES Self-Balancing Outlet product line consists of 3 types:

1. «Constant» SBO
   - for round duct: 1 or 2 membranes
   - for rectangular duct: 1 or 2 membranes
2. «Variable» SBO
   - for round duct: 2 membranes
   - for rectangular duct: 2 membranes
   - Both have a flap for closing one of the membranes
3. «Closable» SBO
   - for round duct: 1 membrane with flap for closing outlet

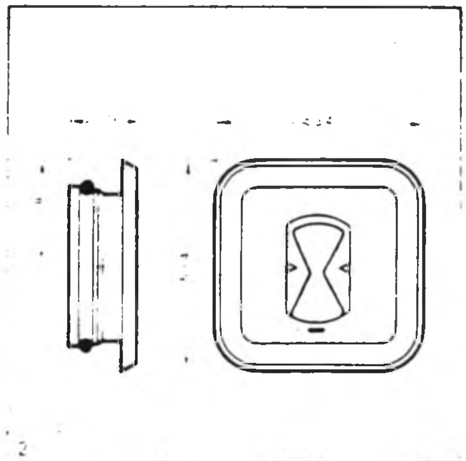
1. CONSTANT

The Self-Balancing «Constant» [illegible] air outlet is designed for use where only one preset airflow rate is desired.

FOR ROUND DUCT

Description

- auto-extinguishing plastic (ABS) [illegible] face,
- for 5" dia. duct model, a roll-in rubber washer for a snug airtight duct fit,
- for 4" dia. duct model, a clip-in and screw system with a foam rubber joint for an airtight fit between wall and outlet,
- a central snap-in element in which is placed the self-balancing silicone membrane
- weight: 5.3 oz (150 gr)



The «Constant» SBO comes preset for [illegible] airflow rate for 4" and 5" round duct:

10, 20, 30, 35 and 45 cfm

The «Constant» SBO is also available in a double version (2 membranes) same presentation as the SBO «Variable» for round duct shown in figure 6 but without the flap. For more important installations. It may be installed vertically or horizontally.

Available for 3 airflow rates for 5" round duct:

50, 70 and 90 cfm

Weight: 14 oz (400 gr)

FOR RECTANGULAR DUCT

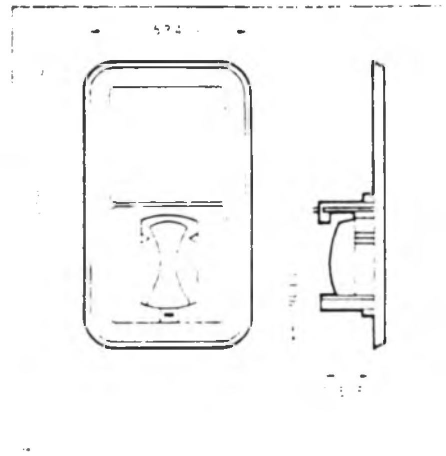
Description

- auto-extinguishing plastic (ABS) housing,
- one or two snap in elements, in which are placed the self-balancing silicone membranes,
- one or no cover plate (see figure n° 3)
- a foam rubber joint for a perfect airtight fit between the SBO and partition,
- an expanding claw and screw system for fixing SBO in ducting,
- weight: 6.5 oz (185 gr)

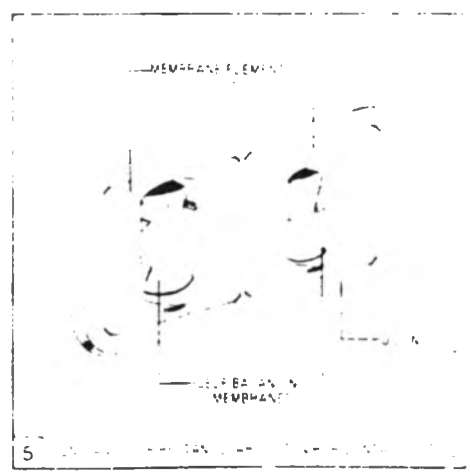
The «Constant» SBO for rectangular duct may be installed horizontally or vertically and will fit on ducting up to and including 5" x 9".

Available for 10 airflow rates:

10*, 20*, 30*, 35*, 45*, 50, 60, 70, 80, 90 cfm

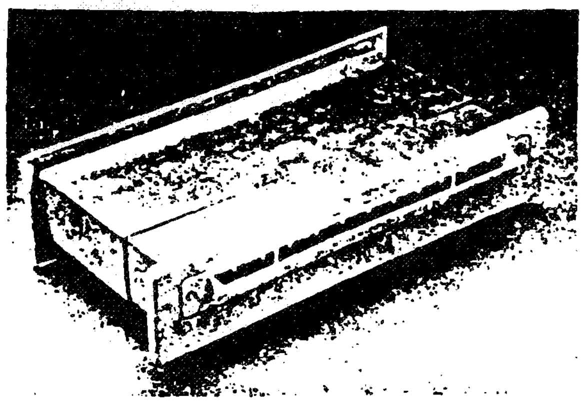


Those marked with an asterisk are furnished with only one membrane element. The emplacement for the other element has a snap-in cover plate in its place. If for aesthetic reasons it is desirable to have both membrane element openings filled, it is [illegible] the 20, 30, 35 and 45 cfm models. For example, a 20 cfm model may be constituted with two 10 cfm membrane elements.



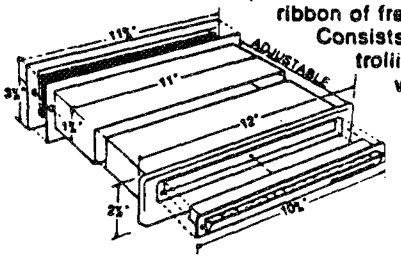
FRESH AIR INLETS
For Make-Up Air In Mechanical Ventilation Systems

DESCRIPTION
7 US 999



Self-Regulating Through-Wall Inlet

For installation in exterior walls. Designed to be used with ALDES ventilatior systems. Controlling element is a plastic self-balancing damper that automatically adjusts free opening to provide a regulated 10 cfm or 20 cfm fresh air intake independent of wind pressure. Interior fixture deflects thin ribbon of fresh air towards ceiling.



Consists of white interior face plate with controlling element, adjustable galvanized sleeve with filter, and white exterior weather grille with mesh.

P/N 11 536	4½" to 8" sleeve	10 cfr
P/N 11 537	8" to 15" sleeve	10 cfn
P/N 11 538	4½" to 8" sleeve	20 cfr
P/N 11 539	8" to 15" sleeve	20 cfr

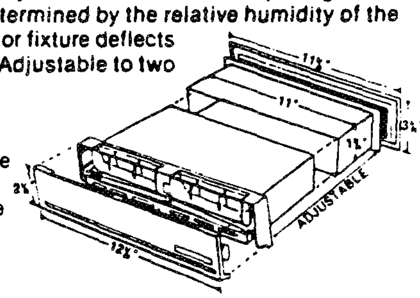
Humidity Controlled Through-Wall Inlet

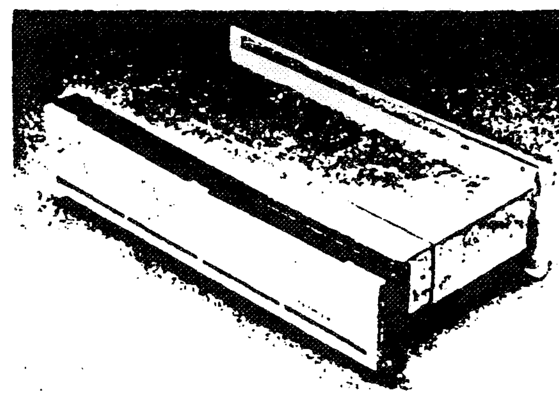
For installation in exterior walls. Designed to be used with ALDES ventilation systems. Controlling element is a humidity sensitive device. Free opening varies from 0.78 sq. in. to 4.65 sq. in. and is determined by the relative humidity of the room in which the inlet is installed. Interior fixture deflects thin ribbon of fresh air towards ceiling. Adjustable to two relative humidity operating ranges:

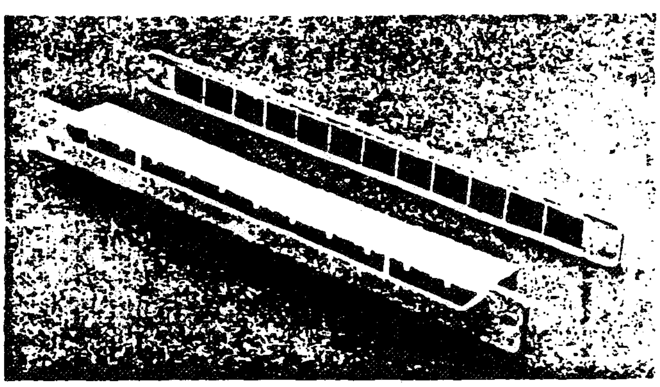
25% RH to 60% RH
40% RH to 75% RH

Consists of beige interior face plate with controlling element, adjustable galvanized sleeve with filter, and white exterior weather grille with mesh.

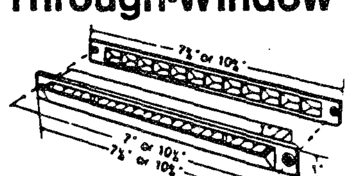
P/N 14 901	4½" to 8" sleeve
P/N 14 902	8" to 15" sleeve





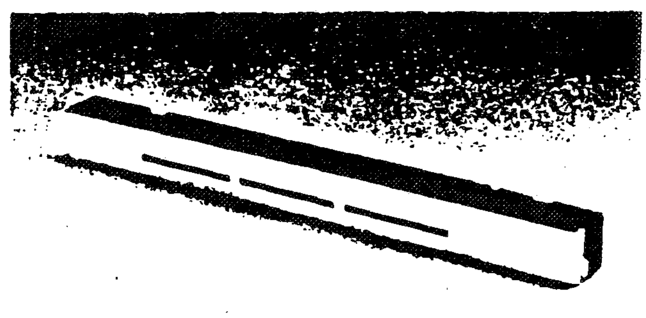


Self-Regulating Through-Window Sash Inlet

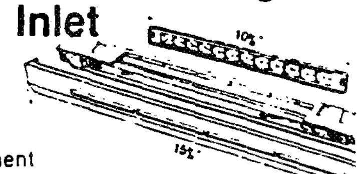


For installation in window sashes. Designed to be used with ALDES ventilation systems. Controlling element is a plastic self-balancing damper that automatically adjusts free opening to provide a regulated fresh air intake independent of wind pressure. Interior fixture deflects thin ribbon of fresh air towards ceiling. 10 cfm and 20 cfm models available in white or brown. Consists of white or brown face plate with controlling element and matching white or brown exterior weather grille.

P/N 11 517	10 cfm, white	6¼" x ⅝" x ⅞" rough opening
P/N 11 525	10 cfm, brown	6¼" x ⅝" x ⅞" rough opening
P/N 11 518	20 cfm, white	9¼" x ⅝" x 1" rough opening
P/N 11 526	20 cfm, brown	9¼" x ⅝" x 1" rough opening



Humidity Controlled Through-Window Sash Inlet



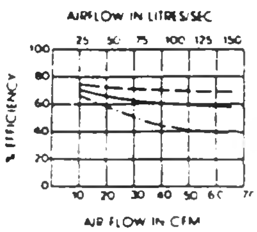
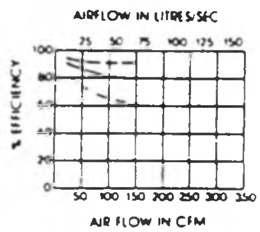
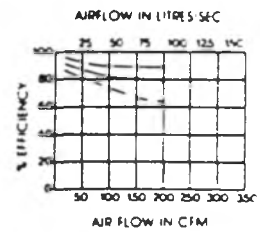
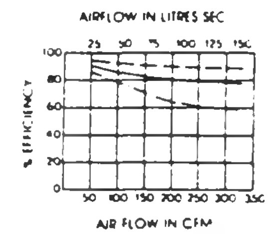
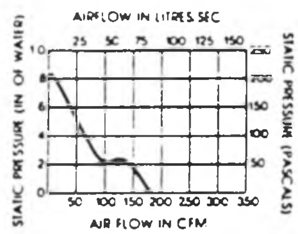
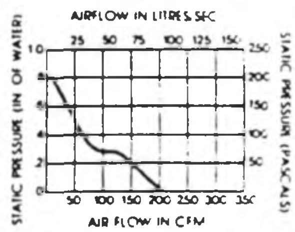
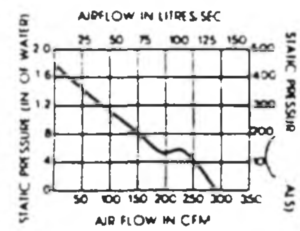
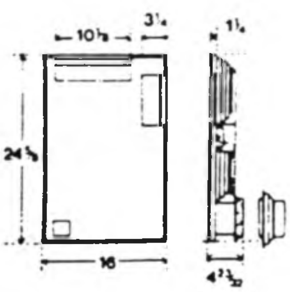
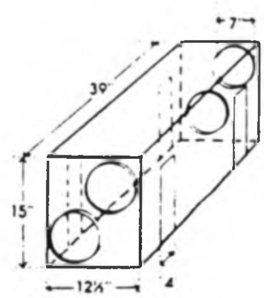
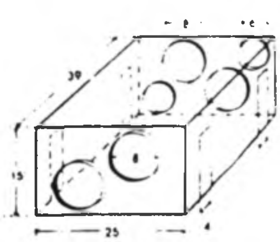
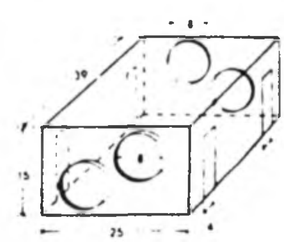
For installation in window sashes. Designed to be used with ALDES ventilation systems. Controlling element is a humidity sensitive device. Free opening varies from 0.78 sq. in. to 4.65 sq. in. and is determined by the relative humidity of the room in which the is installed. Interior fixture deflects thin ribbon of fresh air tow ceiling. Adjustable to two relative humidity operating range:

25% RH to 60% RH
40% RH to 75% RH

Consists of beige or brown face plate with controlling elem and white exterior weather grille.

P/N 14 106	beige interior face plate	9⅝" x ¾" rough oper
P/N 14 108	brown interior face plate	9⅝" x ¾" rough oper

TECHNICAL SPECIFICATIONS

	NOVA	165	200	300
.ze	24¾"x15 7/8"x7½"	12½"x44"x15"	25"x44"x15"	25"x44"x15"
Weight	12 lbs.	22 lbs.	40 lbs.	44 lbs
Flow Capacity	0-70 c.f.m.	0-165 c.f.m.	0-200 c.f.m.	0-280 c.f.m.
Core	Plate Type - counterflow	Plate Type - counterflow	Plate Type - counterflow	Plate Type - counterflow
Case	A.B.S.	A.B.S.	A.B.S.	A.B.S.
Fan Motors	Computer Type - axial Sleeve Bearing	Computer Type - axial Sealed Ball Bearing	Computer Type - axial Sealed Ball Bearing	Computer Type - axial Sealed Ball Bearing
Power Consumption	34W - .4 Amps	66W .62 Amps	66W - .62 Amps	132W 1.2 Amps
Filter Size	12"x4"x1"	12"x12"x2"	24"x12"x2"	24"x12"x2"
Collar Size	N/A	7"	6 & 8"	8"
Efficiency Curve -----30°C/-22°F ——— 0°C 32°F -.-.- 10°C 50°F				
Flow Chart	N/A			
Technical				
LIMITED WARRANTY (For details contact your Star representative)	1 year	5 years	5 years	5 years

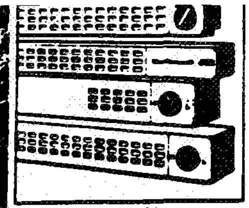
CSA APPROVED

DEALER STAMP:

Price

STAR HEAT EXCHANGERS

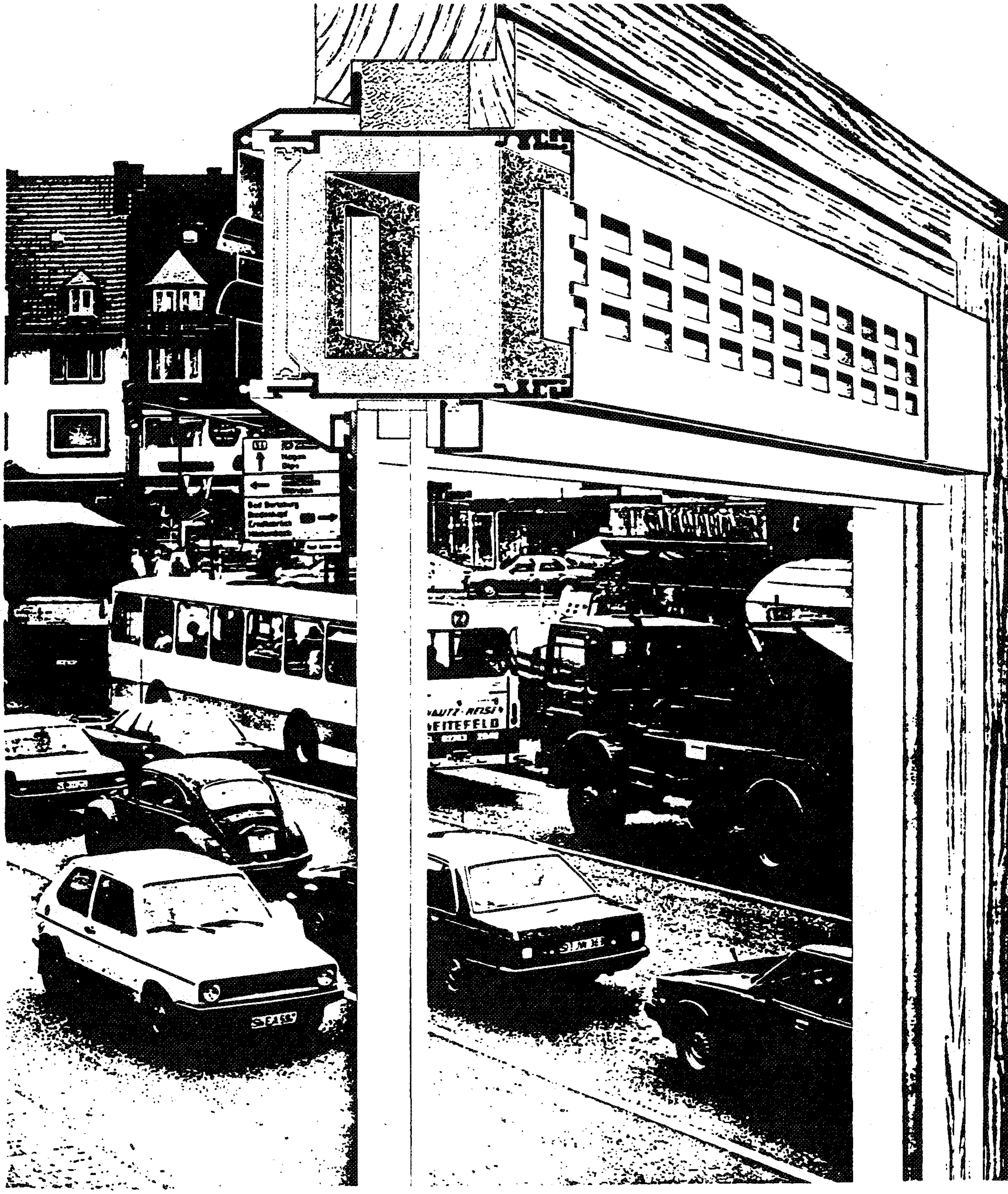
The Star Heat Exchanger Corp.
B109 - 1772 Broadway Street



Ausführung W

SIEGE Schalldämmlüfter für den Glasfalzeinba

SOUND ABSORBING AIR INLET



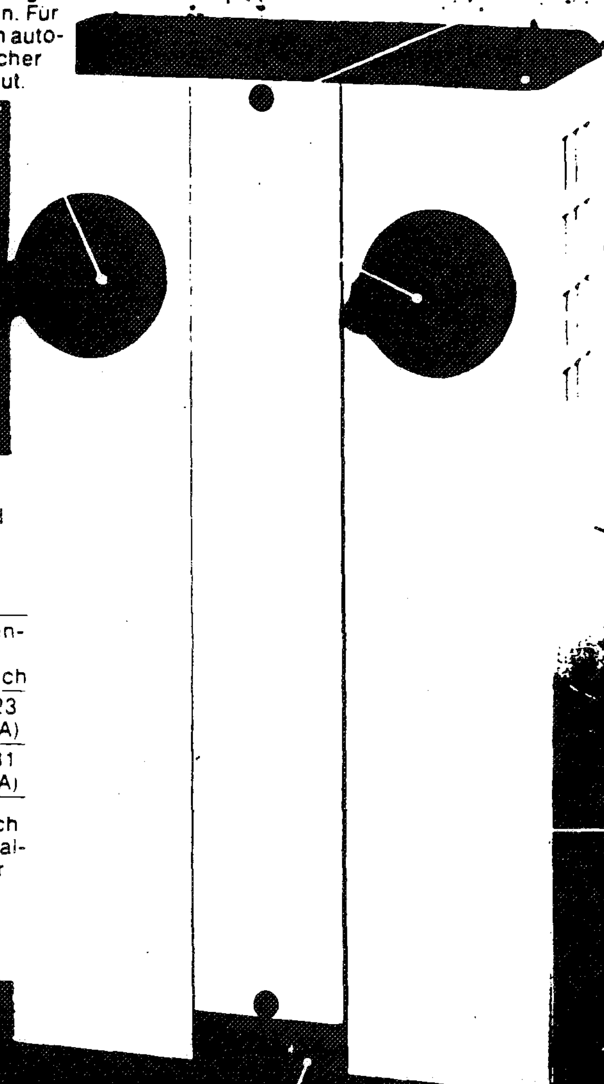
SIEGENIA

kein Fenster ohne

SINGLE ROOM WALL THROUGH VENTILATOR

Öffnen und Schließen der Lüftungsklappen – wahlweise nach links und/oder rechts – werden durch zwei praktische Drehknöpfe geregelt.
Das Gerät kann, selbst wenn es bei geschlossenen Lüftungsöffnungen in Betrieb ist, nicht überhitzen. Für die absolute Sicherheit ist ein automatisch arbeitender thermischer Überlastungsschutz eingebaut.

Durch Senkrechtstellen der beiden Verschlüsse, zum Beispiel mit einem Geldstück, kann die Gehäuseoberseite abgenommen und das Gerät problemlos innen gereinigt werden (vorher Netzstecker ziehen).



Für zugfreies Lüften sorgen die schräg zur Wand angeordneten beidseitigen Lüftungsklappen. Ein sanfter Frischluft-Strom wird gleichmäßig von der Wand in den Raum abgegeben.

Der Siegenia AEROPAC® ist leistungsstark, außerordentlich sparsam im Stromverbrauch und arbeitet fast lautlos. Hohe Schalldämmung verhindert das Eindringen von Außenlärm.

	Luftleistung	Stromverbrauch	Eigengeräusch
Typ 1	30 m^3/h	2 Watt/h	20-23 dB (A)
Typ 2 (2stufig)	30 oder 50 m^3/h	8 Watt/h	20-31 dB (A)

Schalldämmwerte, bestätigt durch Prüfzeugnis der Amtlichen Materialprüfanstalt für das Bauwesen der Technischen Universität Braunschweig:
geöffnet: Dn, w = 49-52 dB,
geschlossen: Dn, w = 57 dB

Mit modernem Design, harmonischer Farbgebung und kompakten Abmessungen (Breite 220, Hohe 400, Tiefe 100 mm) paßt der Siegenia AEROPAC® in jeden Raum.

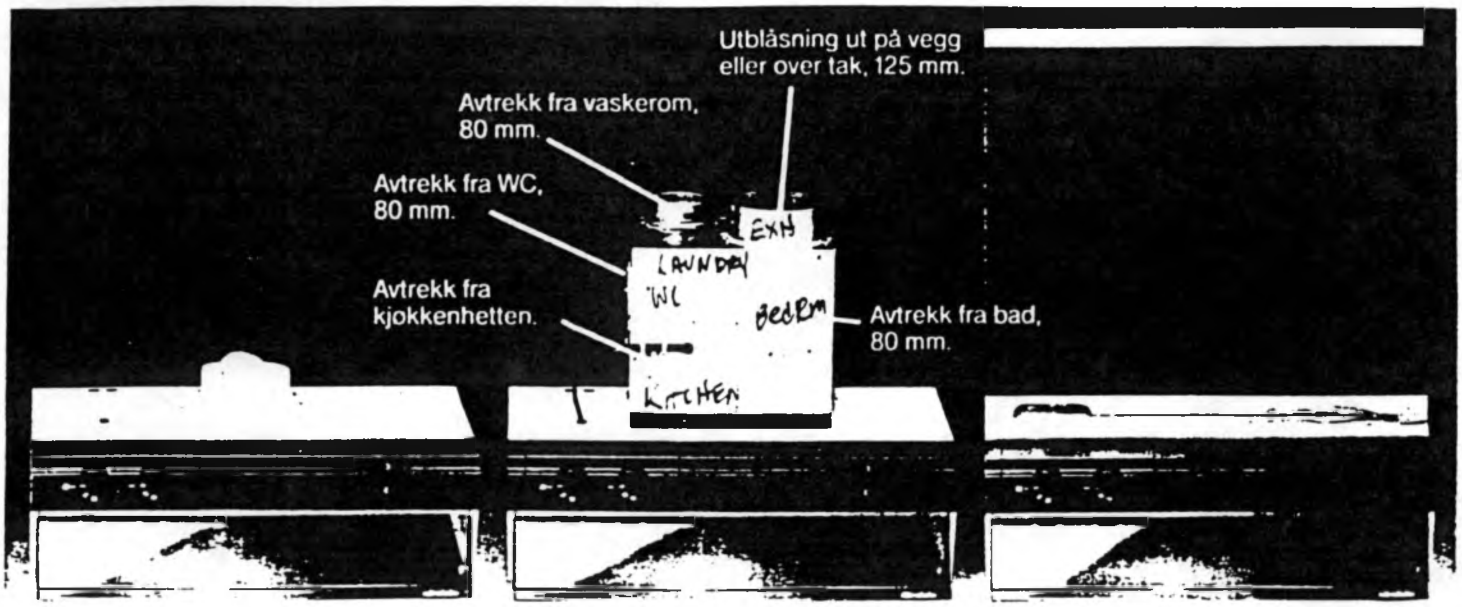
Es gibt den Siegenia AEROPAC® mit ein oder zwei Leistungsstufen, je nach Raumgröße und Lüftungsbedarf.
Typ 1 für energiesparende Dauerlüftung.
Typ 2 mit der zusätzlichen Möglichkeit der schnellen Luftumwälzung.
Der rote Schalter leuchtet beim Einschalten auf. Bei der 2stufigen Ausführung liegt daneben ein weiterer Schalter zur Wahl der Luftmenge.

Der Siegenia AEROPAC® wird serienmäßig mit einem 1,5 m langen Netzanschlußkabel mit Schukostecker geliefert.
Elektrischer Anschluß:
220 V~/50 Hz/2-8W

RANGE HOOD MOUNTED CENTRAL EXHAUST

INDOLA NYE LYDSVAKE AVTREKKS-SYSTEM.

Indola "alt-i-ett" avtrekks-system for småhus, hybler, rehabilitering og leiligheter.



Indola Combi-Vent system.

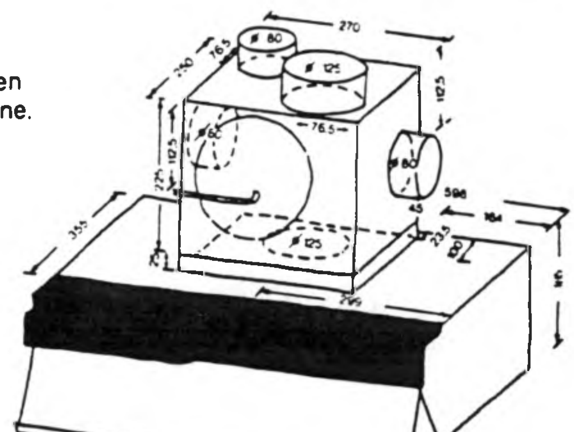
Hele det mekaniske avtrekksanlegget monteres enkelt på kjøkkenet der det ikke er plass på loftet til viften.
Den idéelle løsning for kjøkken i underetasjen i småhus, i boligblokker og til rehabiliterings-boliger. Alle typer leiligheter vil nå kunne få et skikkelig system som ikke bare ventilerer kjøkkenet, men også bad, vaskerom og wc.
Systemet kan enkelt monteres av alle – uten bruk av håndverkere.
Indola kjøkkenhette, type AK-700 monteres over komfyren i passende høyde, viften CVE-50 plasseres rett over avtrekksåpningen i toppen av avtrekkshetten. Det er hull for dette under viften. Ønsker en avtrekk fra flere rom i leiligheten, kan kanaler trekkes fra disse frem til viften. Det er avsatt plass i viften til tre kanaler i tillegg i dimensjon 80 mm.
Fra viften legges en kanal i dimensjon 125 mm opp og over tak, eller ut på vegg der hvor dette er tillatt. Hele systemet styres fra bryter på hetten.
Som kanaler anbefaler vi uisolerte Flexal.

Kjøkkenhetten

AK-700 kan også benyttes som ren kjøkkenhette uten bruk av stussene. De får den mest stillegående og effektive kjøkkenhette som kan leveres.

- Stillegående.
- Kraftig.
- Effektiv.
- Rimelig.
- Enkel montering.

1. Min. ventilasjon, 70 ^{3}/t.
2. Normal drift, 150^3/t.
3. Forsert ventilasjon, 260^3/t.



Frisk luft i huset.

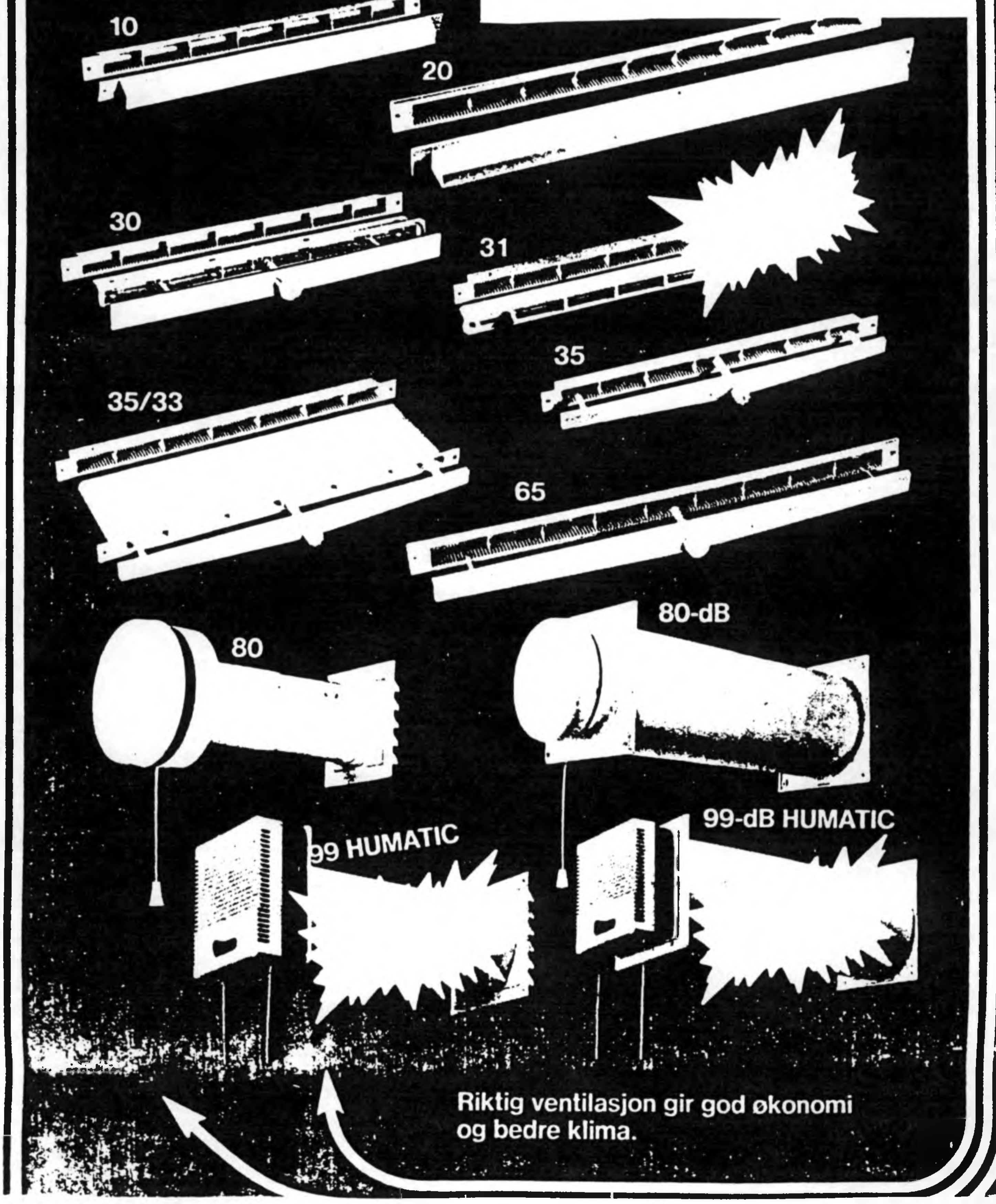
Hvis ikke brukt, dårlig luft kommer ut av huset fra vaskerom, bad, toaletter og kjøkken, nytter det ikke å tilføre luft i leiligheten ved å åpne vinduet. Riktig avtrekk er viktig for å få til et bedre klima i boligen.
Dårlig ventilasjon fører også til skader på boligen, fuktproblemer og lukt. Allergiske sykdommer kan være forårsaket av dårlig luft. Med Indola Combi-Vent avtrekkssystem vil De for all tid ha løst problemet med lukt og fuktighet i Deres bolig.
Systemet er så lydsvakt at det kan gå døgnet rundt, og alle kjenner fordelene med å ha et stillegående avtrekkssystem. Den største fordelen ligger selvfølgelig i at all dårlig luft forsvinner før det får anledning til å spre seg rundt i huset.
Kondensproblemer vil De for all tid være kvitt.

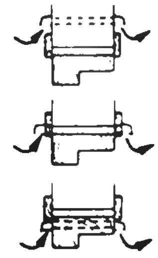
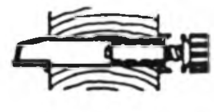
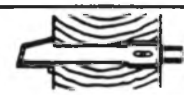
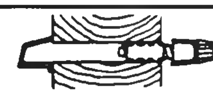
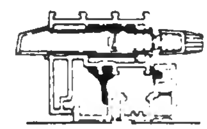
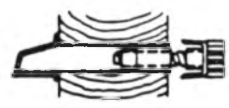
Importor for Norge:

LVK-Senteret A/S Tvetenveien 158, 0671 Tveita, Oslo 6. Tlf.: (02) 27 35 01.

Fresh®

AIR INLETS
- FIXED THROUGH WALL
- HUMIDITY REGULATED
- SOUND ~~ABSORBING~~



TYPE – Mål i mm	HULLSTØRRELSE	MONTERING/FARGER	Luftgjennomgang – areal ca. romkapasitet
FRESH 10 Gjennomstrømningsventil 21 363 23 FRESH 10 består av 2 rister	SPALTE 12 330 HULL 20 st Ø 12	A B C 	Areal: Spalte 35 cm² Hull 23 cm² Kap: Spalte 30 m² Hull 20 m²
FRESH 20 Gjennomstrømningsventil 30 500 30 FRESH 20 består av 2 rister	SPALTE 18 454 HULL 23 st Ø 16	**Farger: hvit, brun, sort**	Areal: Spalte 75 cm² Hull 45 cm² Kap: Spalte 60 m² Hull 40 m²
FRESH 30 Spalteventil 21 Utvendig 363 23 25 Innvendig 338	SPALTE 16 330	 **Farger: hvit, brun, sort**	Areal: Spalte 30 cm² Kap: Spalte 25 m²
FRESH 31 Spalteventil 21 Utvendig 363 23 15 Innvendig 370 22	Planforsterket ventil SPALTE 10 330	 **Farger: hvit, brun, sort, antikkhvit, sv. rød, grønn umbra**	Areal: Spalte 30 cm² Kap: Spalte 25 m²
FRESH 35 Spalteventil 21 Utvendig 363 23 16 Innvendig 345	A. Industri 12 330 B. Gjør det selv 23 st Ø 12	 **Farger: hvit, brun, sort, antikkhvit, sv. rød, grønn umbra**	Areal: Spalte 35 cm² Hull 23 cm² Kap: Spalte 30 m² Hull 20 m²
FRESH 35/33 Spalteventil 21 Utvendig 363 23 18 Innvendig 363 95	Beregnet til montering i hull-kammerprofiler som aluminiums- og PVC-vinduer. SPALTE 15 336	 **Farger: hvit, brun, sort**	Areal: Spalte 33 cm² Kap: Spalte 25 m²
FRESH 65 Spalteventil 30 Utvendig 505 22 Innvendig 470	A. Industri 16 454 B. Gjør det selv 22 st Ø 16 1 st Ø 12	 **Farger: hvit, brun, sort**	Areal: Spalte 65 cm² Hull 45 cm² Kap: Spalte 60 m² Hull 40 m²
FRESH 80 Veggventil 55 100 - 360 (standard) Ø 138 * 115	min 82 Forlengerrør Type / Lengde / Max. veggtykk. 80 - 370 / 370 / 460 80 - 750 / 750 / 840	**Farger:** **Innvendig: hvit, brun** **Utvendig: hvit, brun, sort, grå, gul, rød**	Dimensjonert til rom opp til 25 m². I større rom anvendes flere ventiler.
FRESH 80-dB Veggventil 60 200 - 400 (standard) * 165	**FRESH 80-dB** har en lydreduksjon på ca 40 dB ved normale veggtykkelser min 180 Lyddempere til veggtykkelse over 400 mm leveres etter oppgave.	**Farger:** **Innvendig: hvit, brun** **Utvendig: hvit, brun, sort, grå, gul, rød**	
FRESH 99 Veggventil 60 80 - 360 (standard) * 140	min 100 Til veggtykkelser over 360 mm leveres forlengerrør i 150 mm moduler	**Farger:** **Innvendig: hvit, brun** **Utvendig: hvit, brun, sort, grå, gul, rød**	**FRESH 99 HUMATIC** med fuktstyrt automatikk.
FRESH 99-dB Veggventil 65 200 - 400 (standard) * 165	**FRESH 99-dB** har en lydreduksjon på ca 35 dB ved normale veggtykkelser min 150 Lyddempere til veggtykkelser over 400 mm leveres etter oppgave.	**Farger:** **Innvendig: hvit, brun** **Utvendig: hvit, brun, sort, grå, gul, rød**	Dimensjonert til rom opp til 35 m². I større rom anvendes flere ventiler.

Produsent: Fresh Danmark A/S
Blokken 29, 3460 Birkerød
Tlf.: (02) 81 00 98

Rett til konstruksjonsendringer forbeholdes.
FRESH-produktene er patent- og mønsterbeskyttet.

Importør:

Schreiner Fleischer Sinsen AS
Storoveien 12, v/Sinsenkrysset
0487 Oslo 4, tlf. (02) 15 23 85

Forhandler:

ELECTRIC HEATER WITH FRESH AIR INLET.

GLAMOX friskluftovn gir både rimelig oppvarming og trekkfri ventilasjon.

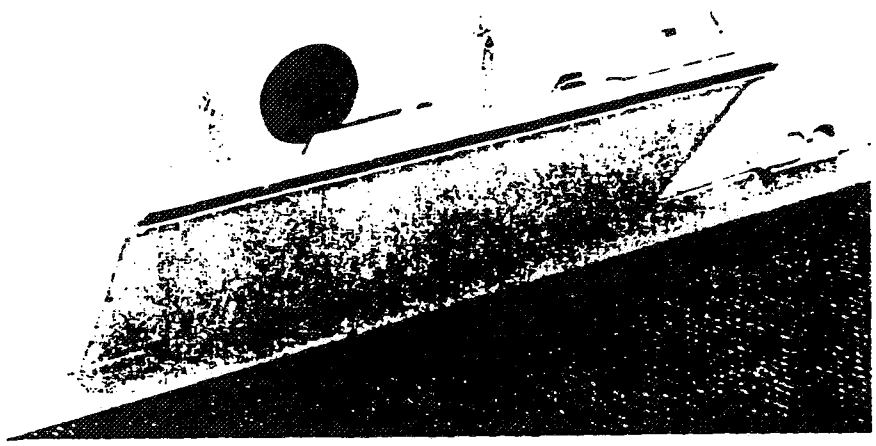
Glamox friskluftovn er en forbedring av tradisjonelle oppvarmingsmetoder.
Problemet er velkjent:
Moderne hus er særdeles tette, slik byggforskriftene forlanger. Men når du fyrer må du også lufte av og til, for å få friskluft inn i huset.
Systemet som stort sett benyttes, med spalter i vinduene er langt fra noen perfekt løsning: De er for små og skaper trekk, eller stenges og gir ingen ventilasjon i det hele tatt.
Også pipe, dører og andre utettheter skaper trekk fordi friskluften kommer inn på en ukontrollert måte.
Resultatet er ujevn ventilasjon, usunt inneklima, varmetap og dårlig fyringsøkonomi.

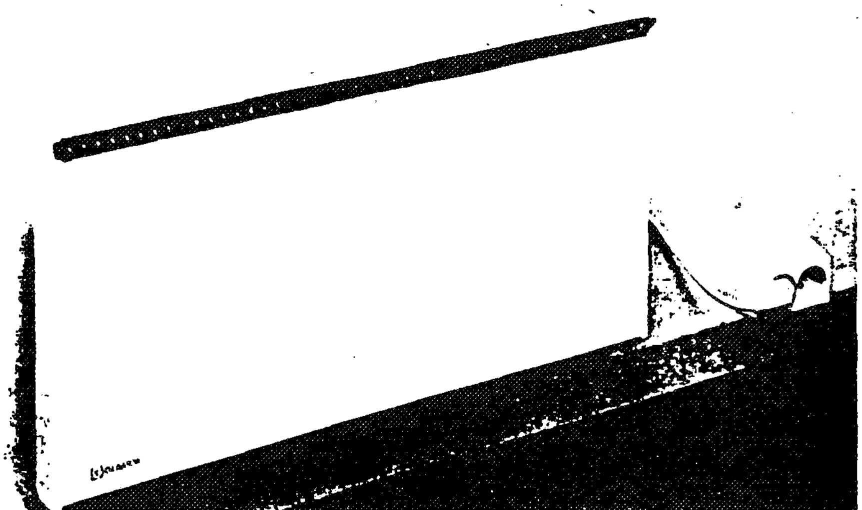
Glamox-prinsippet er en genistrek i all sin enkelhet.
Friskluftovnen er koblet til en trekkfri ventilasjonskanal gjennom veggen, utført i kraftig plast.
Ved hjelp av termostaten forvandles friskluften – som er filtrert for støv, partikler o.l. – til ønsket temperatur før den passerer inn i huset.

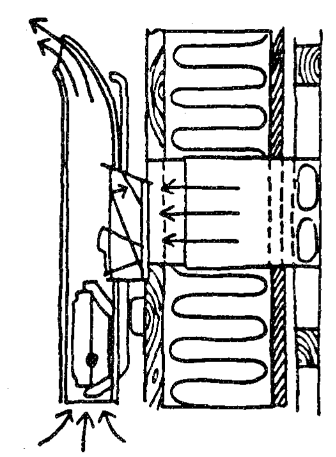
Montering og tilkobling.
En monteringsramme festes til veggen, hvoretter ovnen kan settes på plass uten bruk av verktøy.
En hurtigkobling forbinder styringsmodulen på ovnen og koblingsboksen på monteringsrammen.
Som ekstrautstyr leveres gardinbøyle som hindrer at gardiner kommer i berøring med ovnen.

Funksjoner.
- Av/på bryter.
- Elektronisk termostat. Reguleringsnøyaktighet ± 0,3°C.
- Rød lampe viser når ovnen er på
- Leveres i 600, 800, 1000 og 1200 W

Utførelse og materialer.
Varmeelement i rustfri utførelse med lamell-varmefordeler. Styringsmodul og koblingsboks i støpt plast.
Monteringsramme i aluzink.
Ovnen er en stålplate, elektrolytisk galvanisert og overflatebehandlet med varmebestandig ovnsherdet polyesanpulver.
I luftspalten er et beskyttelsesgitter av aluminiumsbelagt stålplate, og endestykkene er i støpt plast.







– Et varme- og ventilasjonssystem like enkelt som effektivt!

LVK-Senteret A/S Tvetenvn. 158, 0671 Oslo 6. Tlf. (02) 27 35 01. Telefax (02) 26 24 02

Forhandler:

A SELECTION OF CONTINUOUS VENTILATION SYSTEMS TAILORED TO YOUR NEEDS.

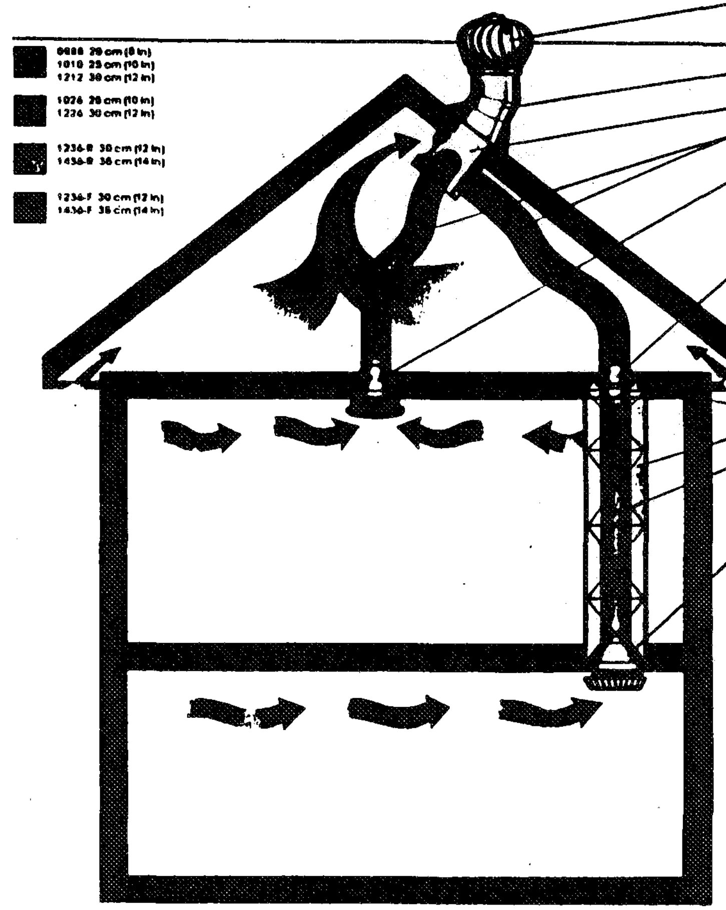
THE "ENERGY MONEY SAVER"

An entirely automatic ventilation system that doesn't consume any energy because it is powered by the wind.

- Automatically controls humidity in all living spaces.
- Controls the humidity level and heat of the attic.
- Ensures aeration of the house.
- Can be easily installed, or installed for you at low cost.
- Quiet.
- Eligible for insulation subsidy programs.
- Carries a lifetime guarantee.

The "ENERGY MONEY SAVER" ventilation system ensures control of humidity in all rooms of the house, from the basement to the attic. The "ENERGY MONEY SAVER" stands up to all weather conditions (rain, snow or high winds can neither penetrate nor affect its operation). It works on a gravitational principle to ensure that humid air is expelled outdoors whenever necessary. Since humid air is lighter than dry air, it rises to the ceiling of the house, where it exerts pressure to escape. This pressure, combined with the turbine's suction, is enough to expel the humid air outside. On the other hand, when there is no accumulation of humidity, the turbine's weak level of suction is only enough to expel a minute quantity of air. In such case, the turbine works to ventilate the attic. The same thing happens in the case of high winds, thanks to Venmar's patented chimney calibration. The "ENERGY MONEY SAVER" is thus entirely automatic, which saves energy. Tests* ordered by the Canadian government prove it: The "ENERGY MONEY SAVER" does not increase heating costs." In fact, it can result in heating savings of up to 8%.

*Study carried out (1992) by an independent firm of consulting engineers



SELECTION CHART

Surface of main floor	Number of levels including attic	
	2 lev.	3 lev.
120 m² (1 200 sq.ft.) and less per level	1026	1236
120 m² (1 200 sq.ft.) and more per level	1226	1436
160 m² (1 600 sq.ft.) and more per level	VBT-14	
ATTIC only		
90 m² (900 sq ft.) and less	0888	
90 m² - 120 m² (900 sq.ft - 1 200 sq.ft)	1010	
120 m² (1 200 sq.ft) and more	1212	

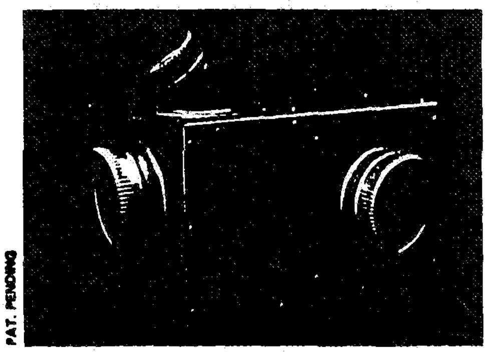
VENMAR

THE ECONAIR 25®

The ECONAIR 25: a motorized system of continuous ventilation controlled by humidistat.

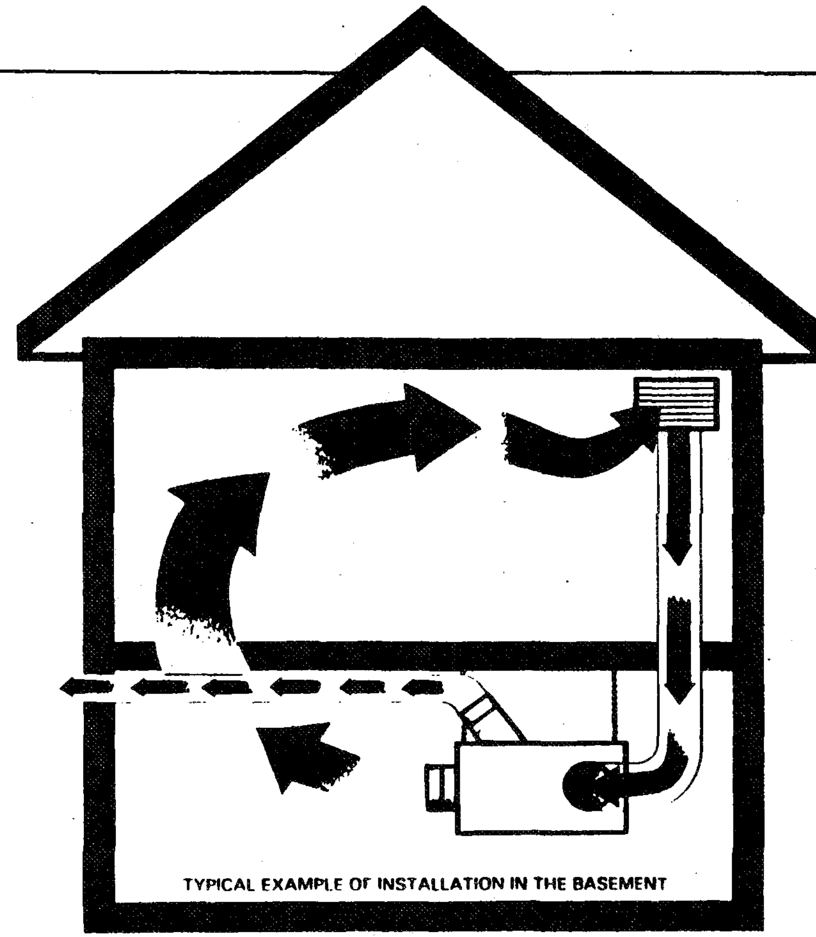
- Ensures ventilation throughout all living spaces.
- Keeps humidity constantly uniform throughout the house.
- Automatically controls the humidity level which you have selected on the humidistat.
- Equipped with an air-expulsion device which is adjustable in accordance with the size of your house.
- Uses a minimum of energy ($5/year).
- Suitable for bungalows having up to 120 m² (1200 ft²) of floor space.
- Can be installed in the basement or attic.
- Covered by a one-year guarantee.

The ECONAIR 25 ensures a slow and continuous circulation of air all over the house, in order to *maintain a uniform level of humidity* throughout. The ECONAIR 25 expels humid air outside slowly and only when necessary. It thus maintains a constant level of humidity — the one selected on the humidistat. The ECONAIR 25 can be easily installed in the attic or the basement. Finally, it is equipped with an air-expulsion device which is adjustable in accordance with the size of your house.



PAT. PENDING

Dimensions	46 cm x 32 cm x 32 cm (18 in x 12½ in x 12½ in)
Air inlet.	15 cm (6 in)
Air outlet:	15 cm (6 in)
Adjustable Humid-Air Outlet:	10 cm (4 in)
Flow rate	240 m³/h (7 200 ft³/h) at 14.6 Pa (0.3 in of water) 318 m³/h (9 600 ft³/h)
Adjustable rate of humidity outflow	Maximum 156 m³/h (4 600 ft³/h)
	Minimum 78 m³/h (2 400 ft³/h)
Motor power:	1.9 kgm/s (1/40 HP) — 1 Amp
Electric feed:	115 V at 60 Hz
Operating cost:	5 $ a year



TYPICAL EXAMPLE OF INSTALLATION IN THE BASEMENT

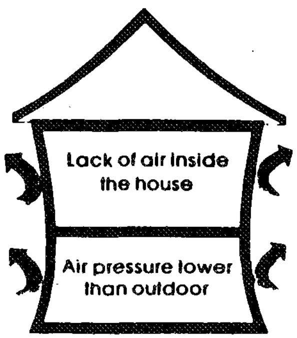
A QUESTION OF BALANCE

New and reinsulated houses prevent the natural exchange of indoor and outdoor air. When you consume air inside the house — for example, with heating devices, ventilation systems or by breathing — the airtightness of the house often prevents fresh outdoor air from coming in to replace the consumed air. Result: it creates a lack of air in the house and the indoor pressure becomes lower than the outdoor pressure.

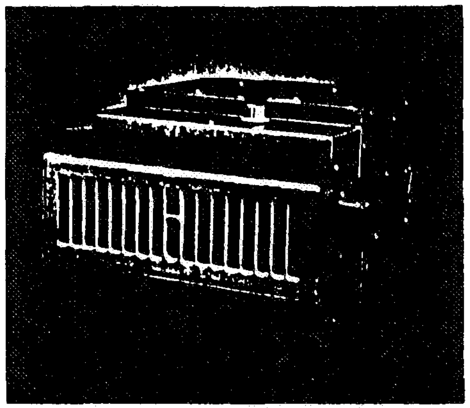
SYMPTOMS OF NEGATIVE PRESSURE

Negative pressure can be recognized by the following symptoms:

- Cold air comes down the chimney.
- It's difficult to light your stove or fireplace.
- You have condensation on your windows in spite of having a ventilation system.



THE SOLUTION... VENMAR'S BAROMETRIC COMPENSATOR



IT AUTOMATICALLY AND CONTINUOUSLY BALANCES THE INTERIOR PRESSURE OF YOUR HOUSE WITH THE EXTERIOR PRESSURE.

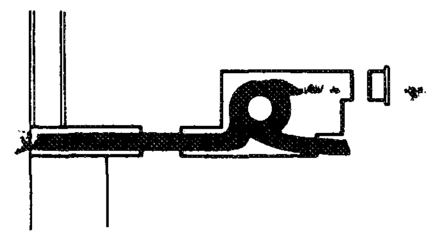
Its role:

— When air is consumed inside the house, the Venmar barometric compensator automatically and simultaneously allows an equivalent amount of air to enter the house. For greater comfort, an element pre-heats the incoming cool air to avoid chilling the house.

Its advantages:

— This regulated increase of fresh air guarantees:*

- improved performance of your heating units;
- maximum efficiency of your ventilation systems;
- a supply of healthy, well-oxygenated air.

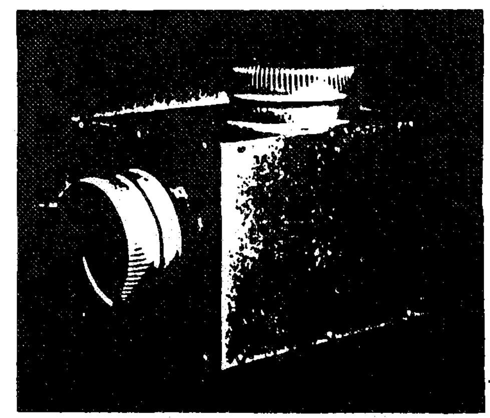


THE BAROMETRIC COMPENSATOR BY VENMAR... HEALTHY AIR, GREATER COMFORT AND MAXIMUM PERFORMANCE BY YOUR HEATING AND VENTILATION EQUIPMENT.

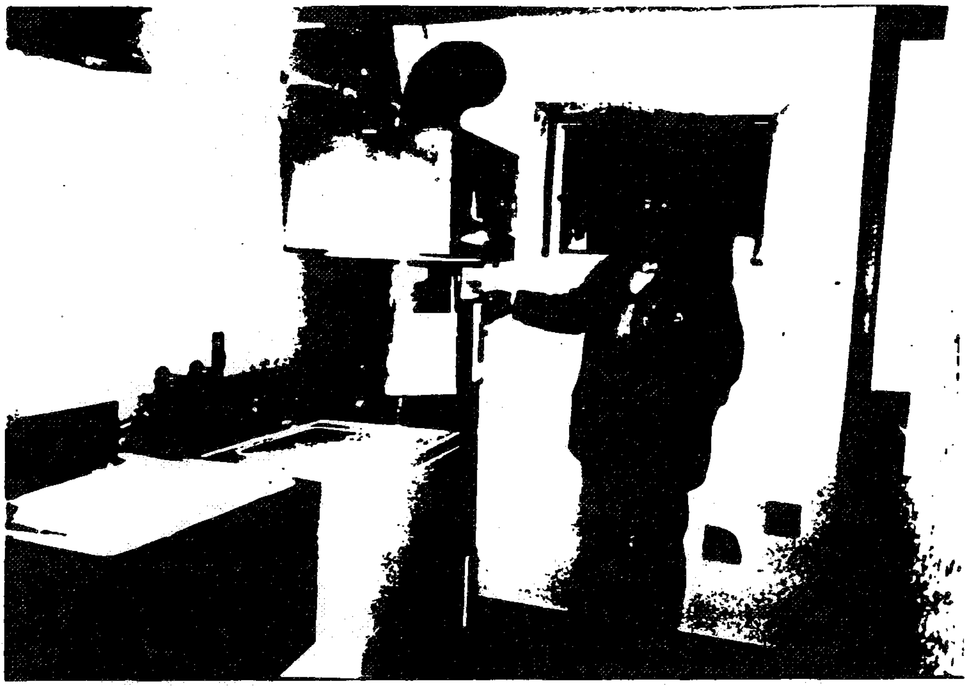
*To find out whether the barometric compensator can solve efficiently your problems operate all the equipment that consumes air at the same time (heating, ventilation, fireplace) and then open one window 60 cm (24 in.) wide 1.8 cm (¾ in.). If all the negative pressure symptoms disappear, the barometric compensator would solve your problem, persistence of symptoms would indicate that it lacks the capacity to meet your home's needs.

UNIVENT™ A VENTILATION MODULE FOR THE ATTIC

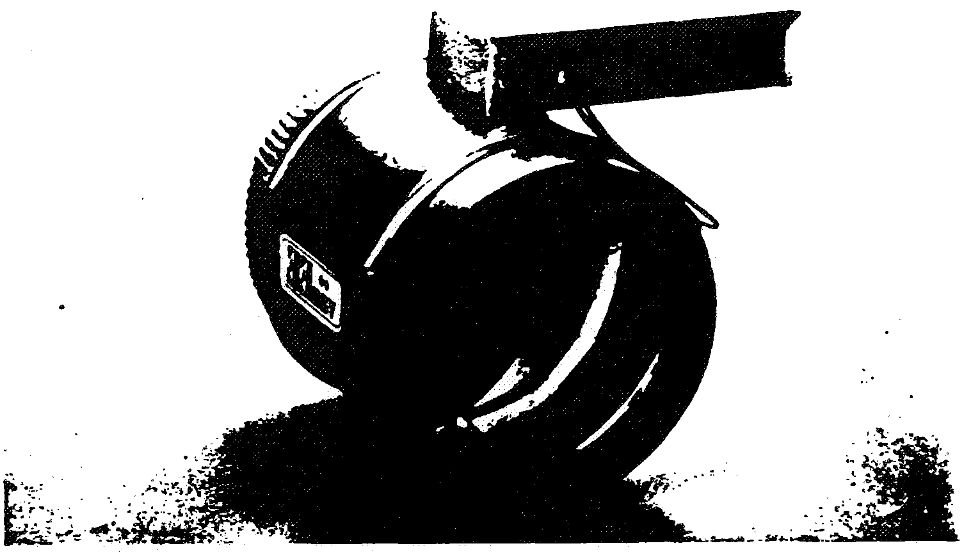
Venmar offers a module specially designed to ensure ventilation of the attic. Installed in just a few minutes, UNIVENT ensures a change of air in the attic. It eliminates humidity, prevents structural rotting and preserves the effectiveness of insulating materials.
On very hot days, the temperature of the attic can sometimes rise as high as 70°C (160°F). UNIVENT lowers this temperature, thus preventing the premature deterioration of asphalt shingles and the peeling of paint.
Another advantage: the effect of radiation is diminished as a result, decreasing the indoor temperature by approximately 6°C (10°F).



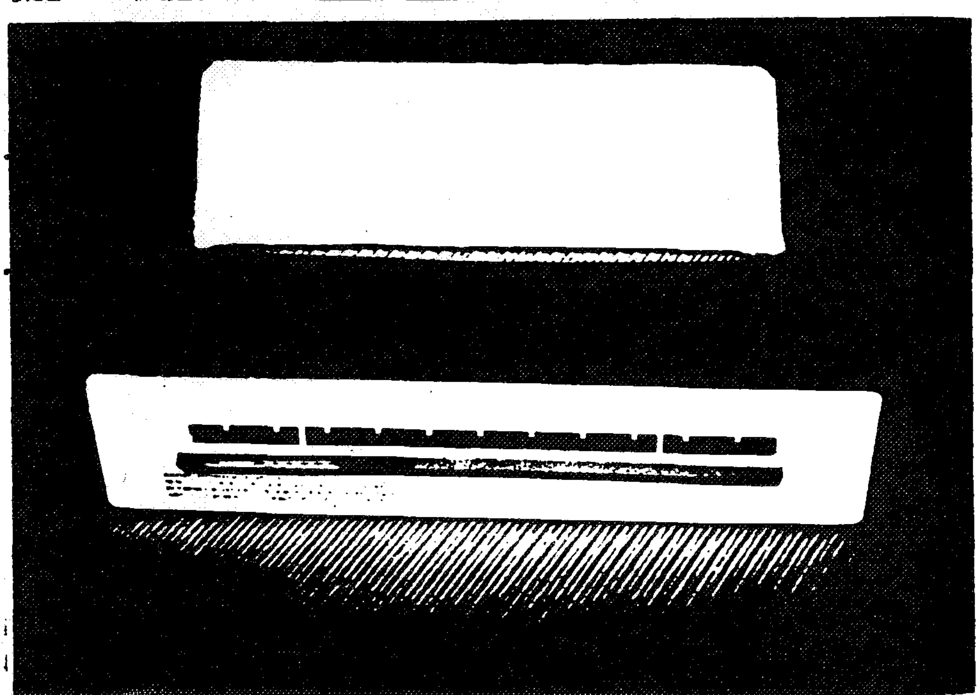
APPENDIX V
Equipment Photos



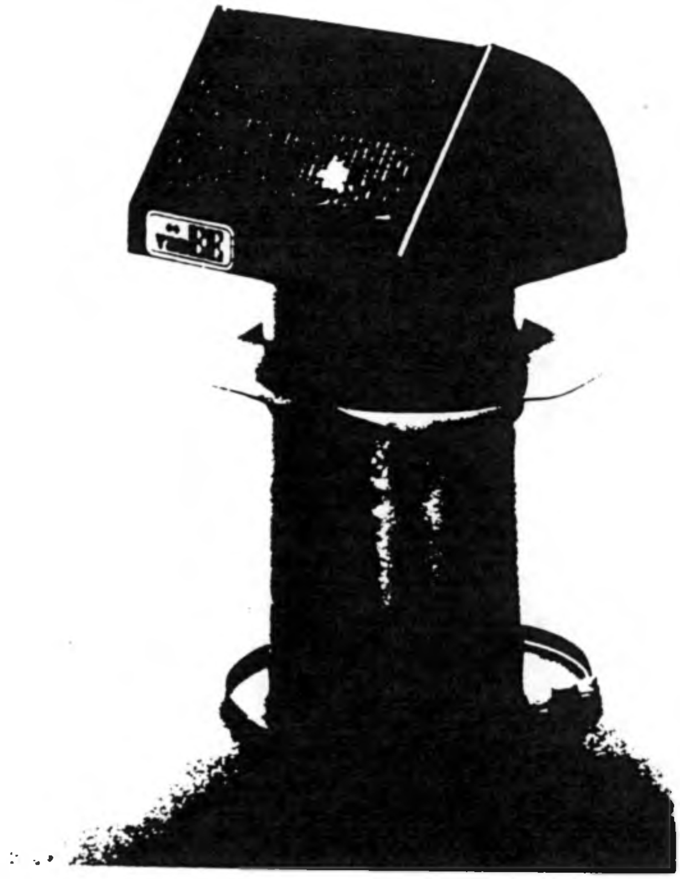
1. Derry Eqpt. Corp.(DEC) Therma Vent exhaust air heat pump/domestic hot wate supply.



2. VanEE ACD low voltage air control damper used for controlling outside air supply to ducted exhaust only systems.

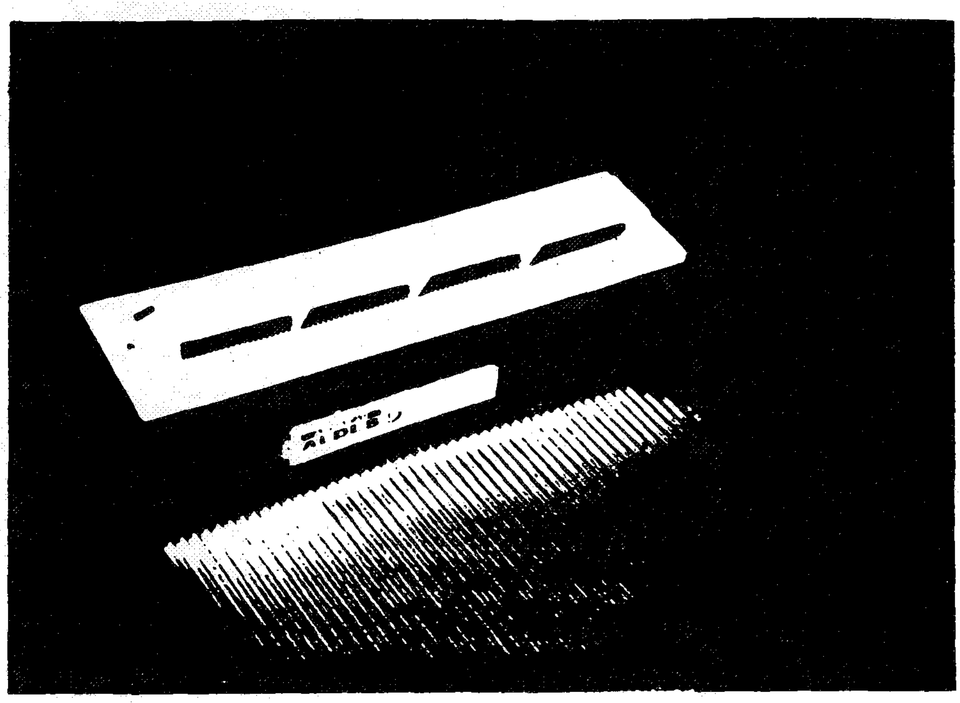


3. Aldes through wall air inlet with filter.



4. Screened HRV intake hood with gasket for sealing to house air barrier.

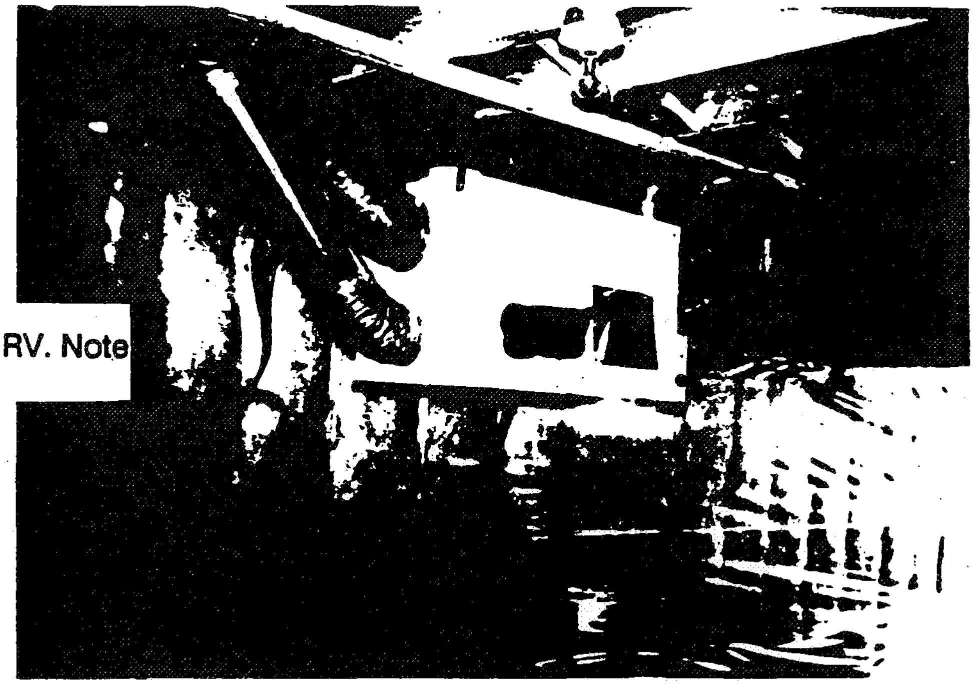
5. Aldes VMPK3 central exhaust unit with three 75 mm. connectors and one 150 mm. connector. Crank timer shown at right.



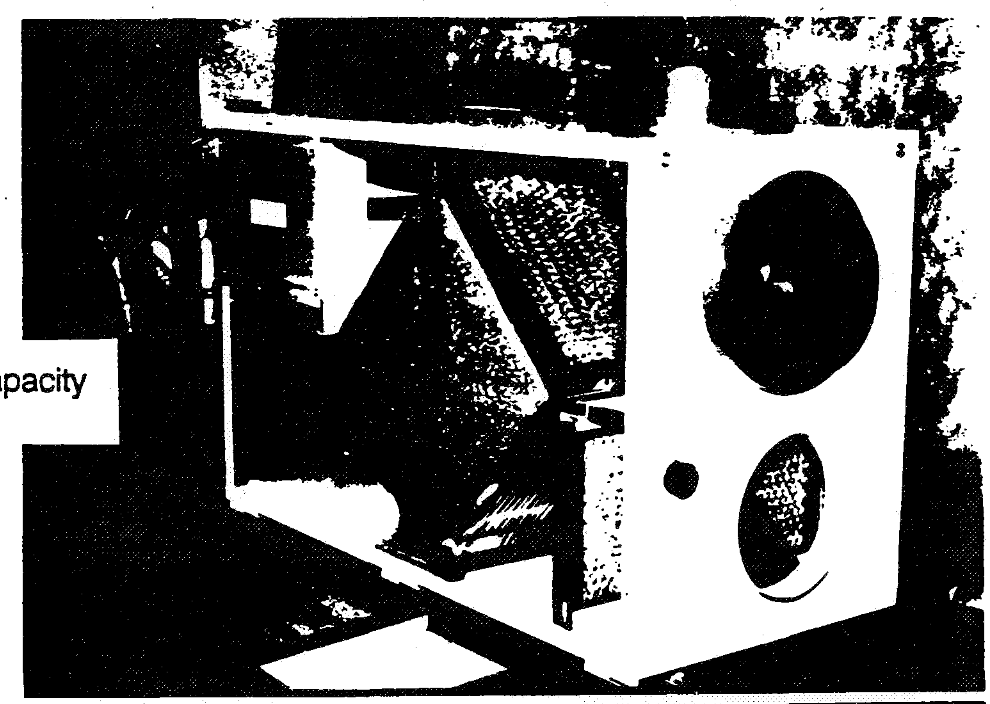
6. Aldes hood for through wall air inlet

7. Vibration isolation straps for hangin HRV's.

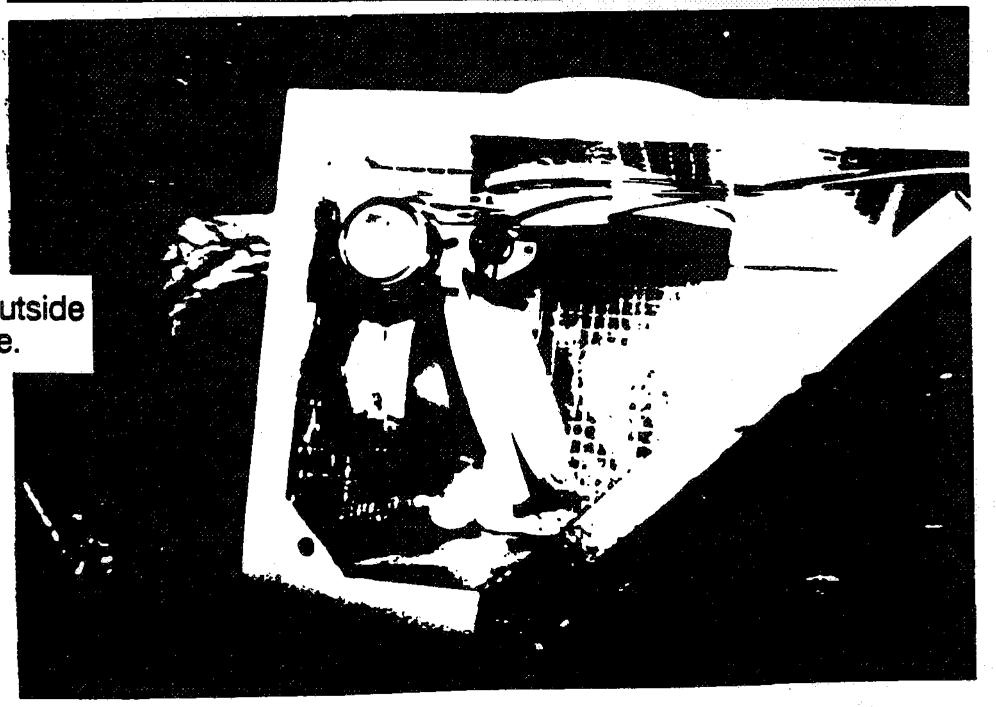
8. HRV hung from floor. Note insulated duct and exterior vapor barrier to preve condensation.



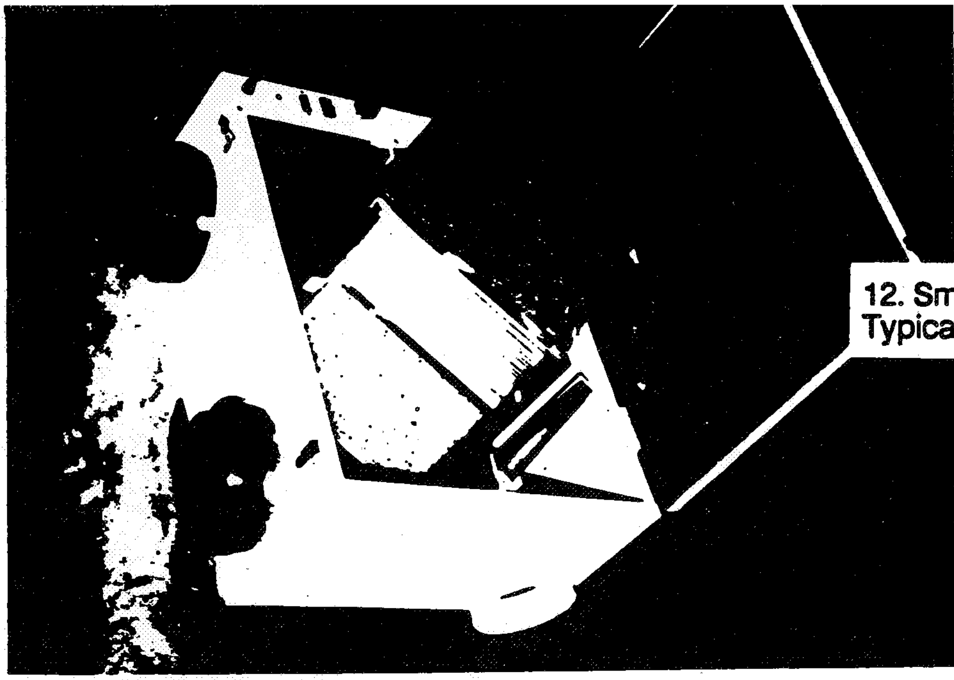
9. Typical well installed plate type HRV. Note flex duct coupling to metal duct.



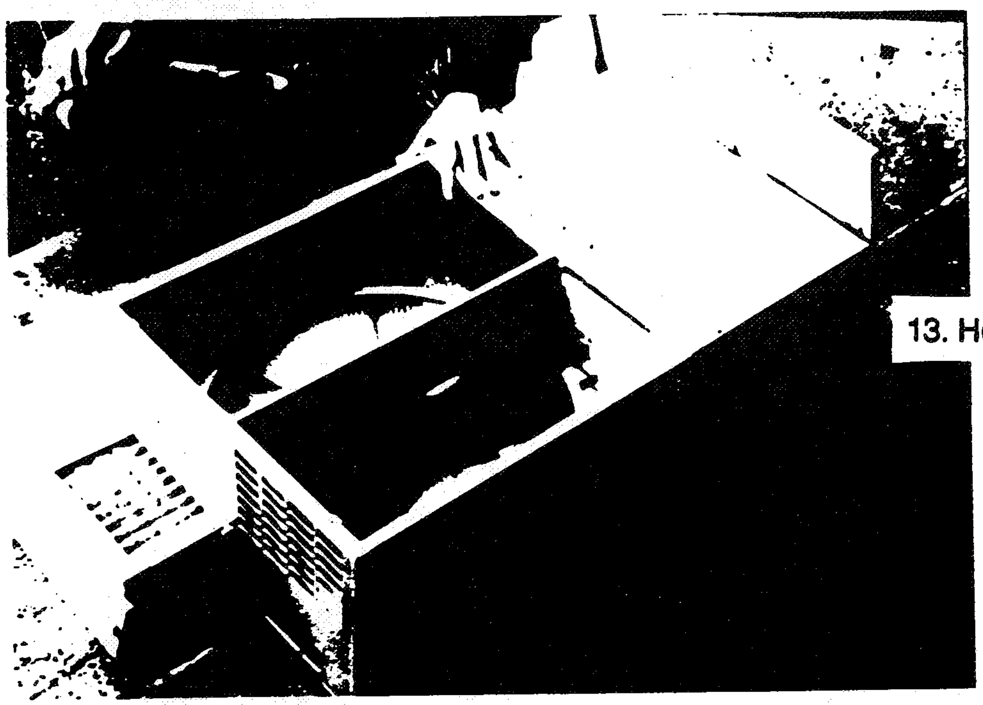
10. Large plate type HRV. Typical capacity 40-100 L/s.



11. Motorized damper used to close outside air supply during room air defrost cycle.

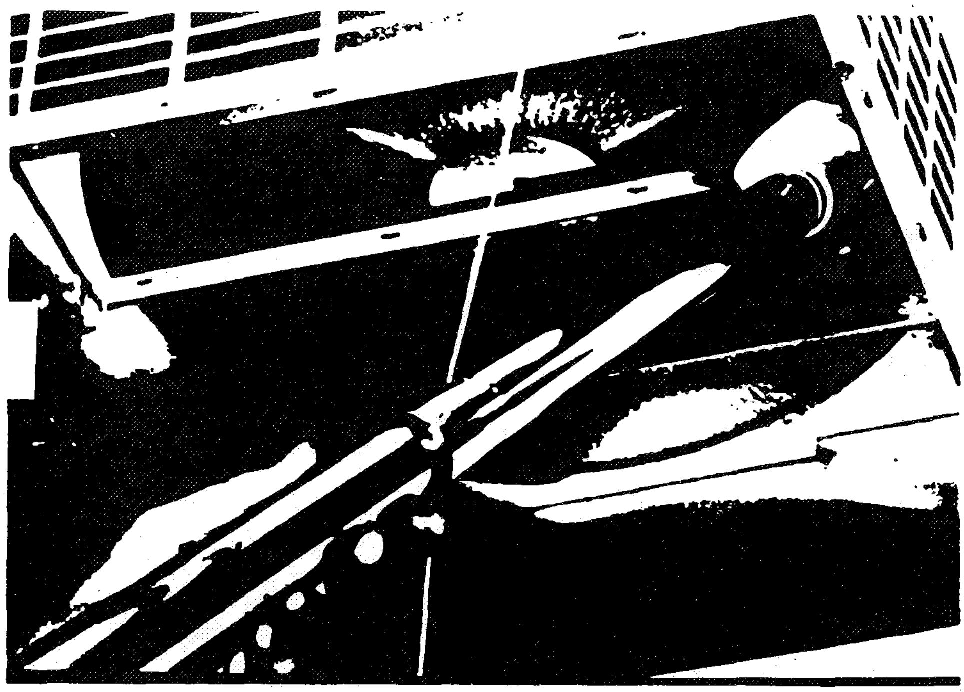


12. Smaller plate type HRV with alum. core. Typical capacity 30 -60 L/s.

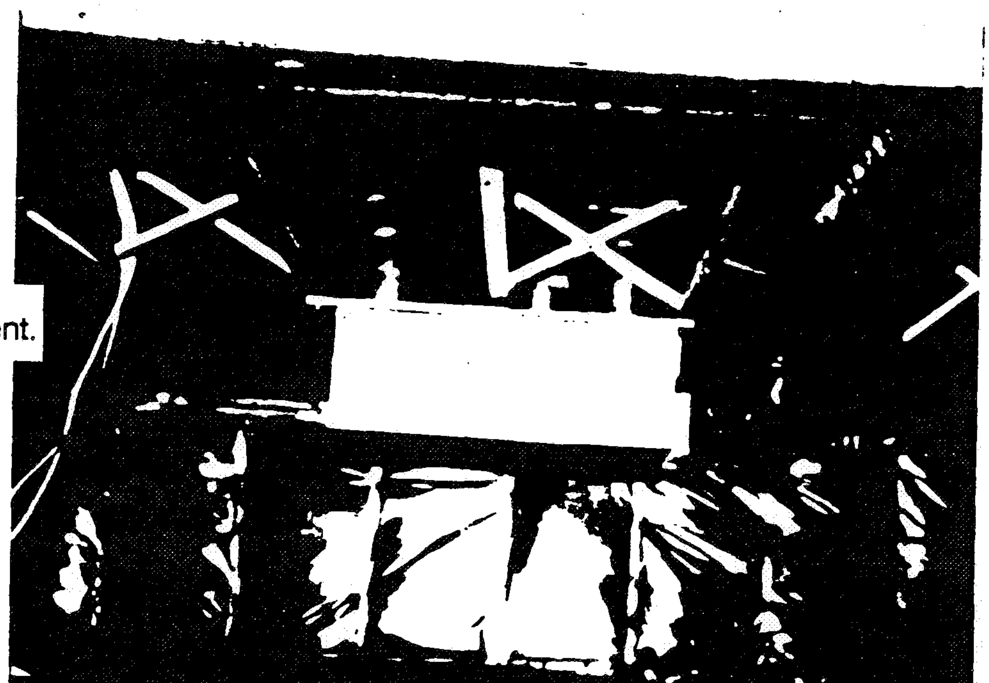


13. Heat wheel rotary core HRV.

14. Rotary core made of spiral wound plastic strip.



15. HRV core must be accessible for cleaning and service.

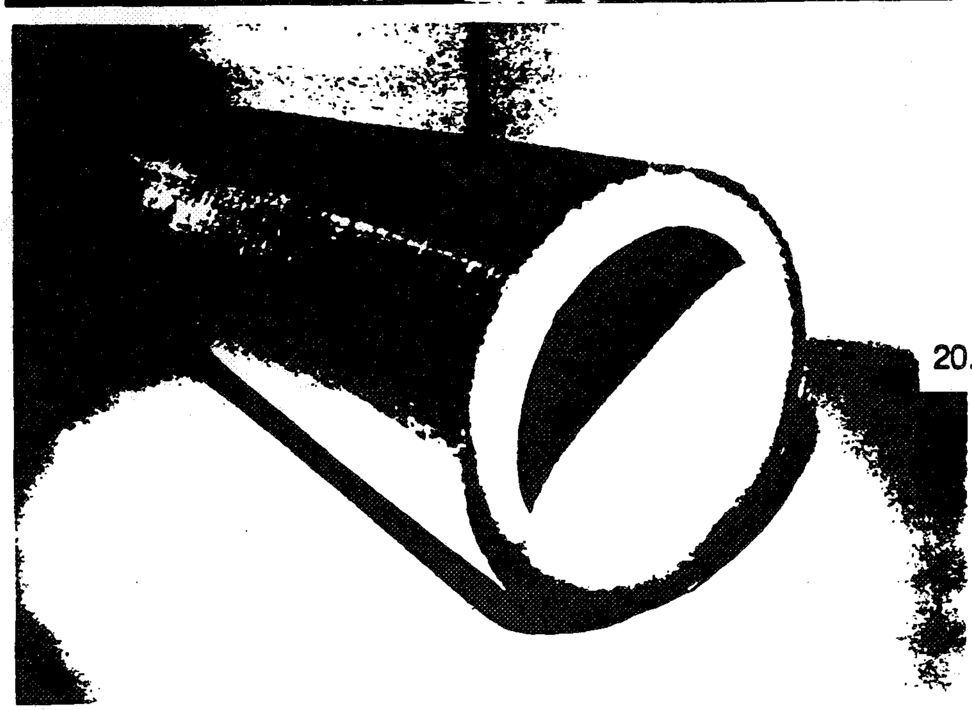


16. Rotary HRV installed in basement.

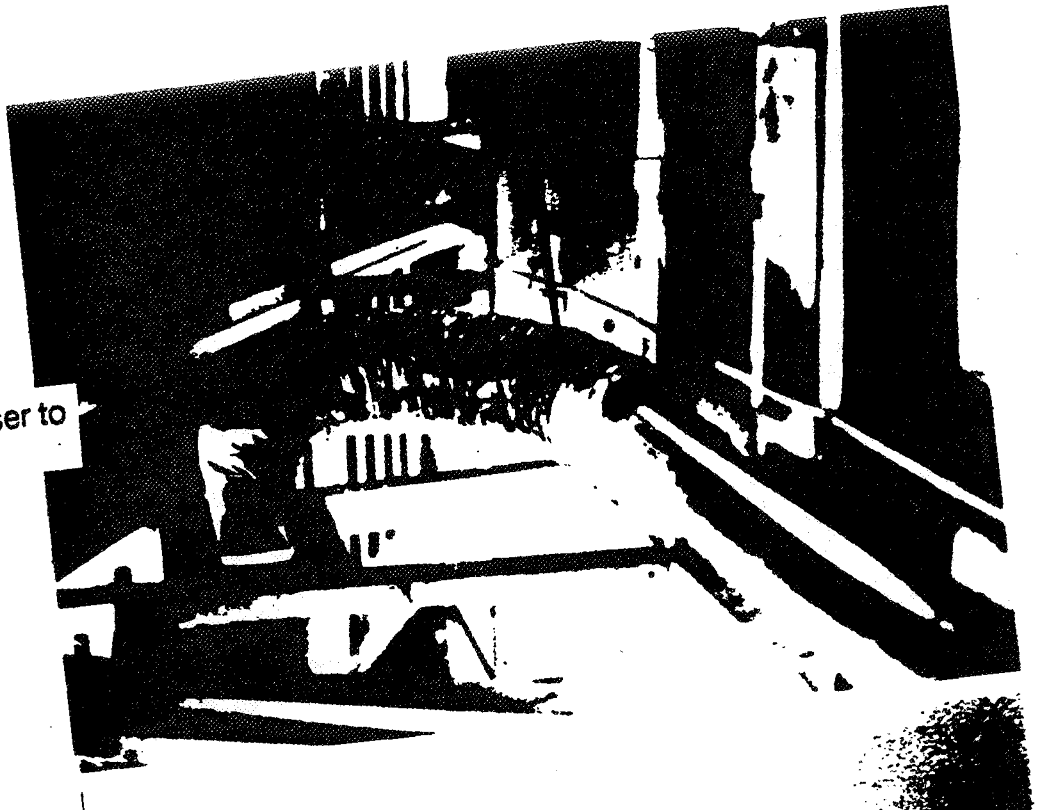
17. Rotary HRV installed in hall closet. Exhaust return is only via the grille on the unit.

18. HRV filters must be readily accessible for changing. Medium efficiency pleated filters have proven effective if changed every 3 mos.

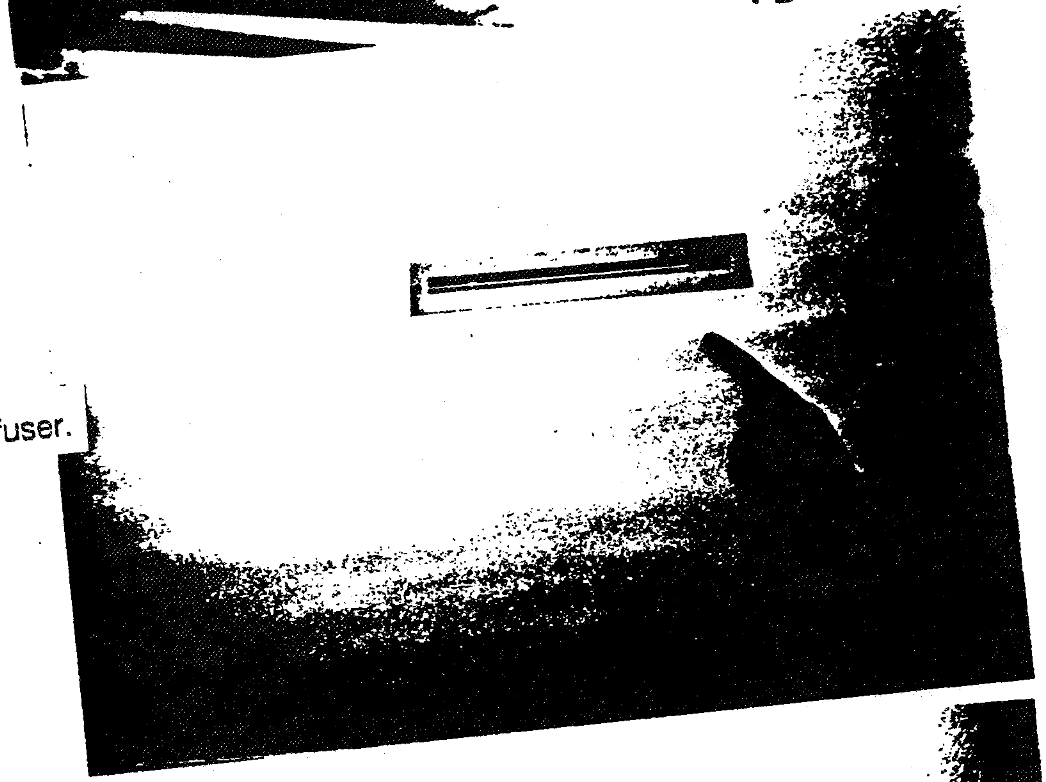
19. Typical insulated flex duct installed in attic.



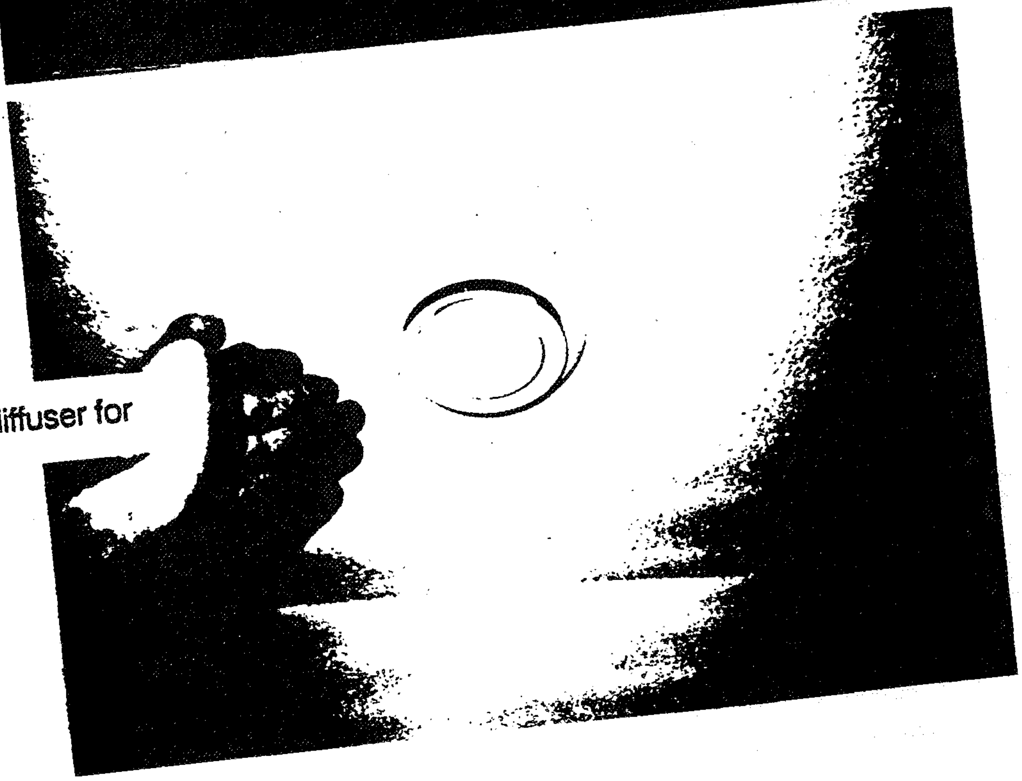
20. Fiberglass lined "muffler" duct.



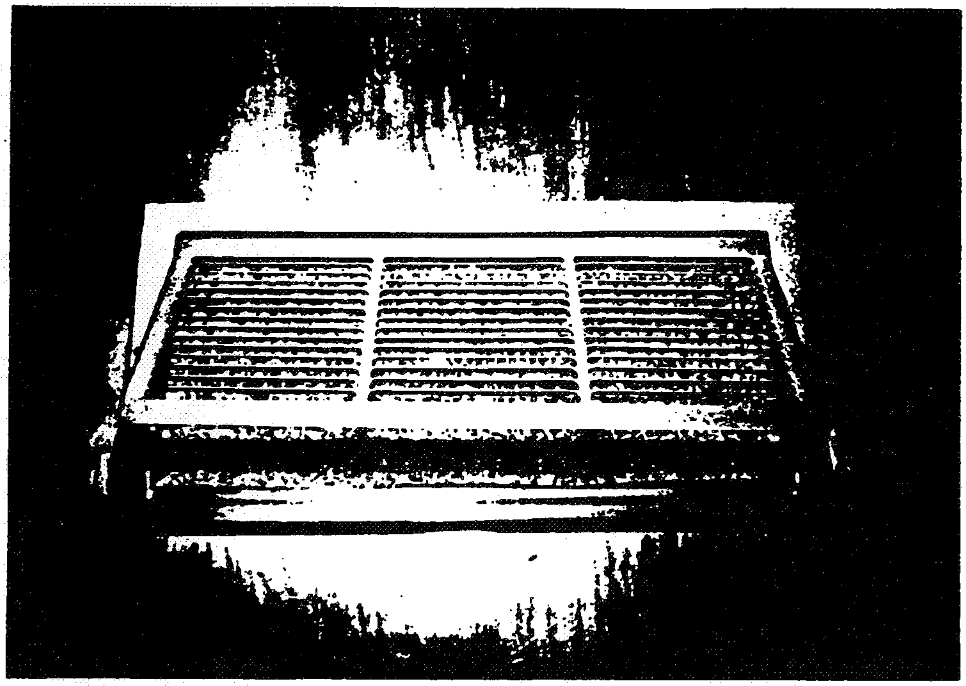
21. Flex duct used at supply diffuser to reduce fan noise transmission.



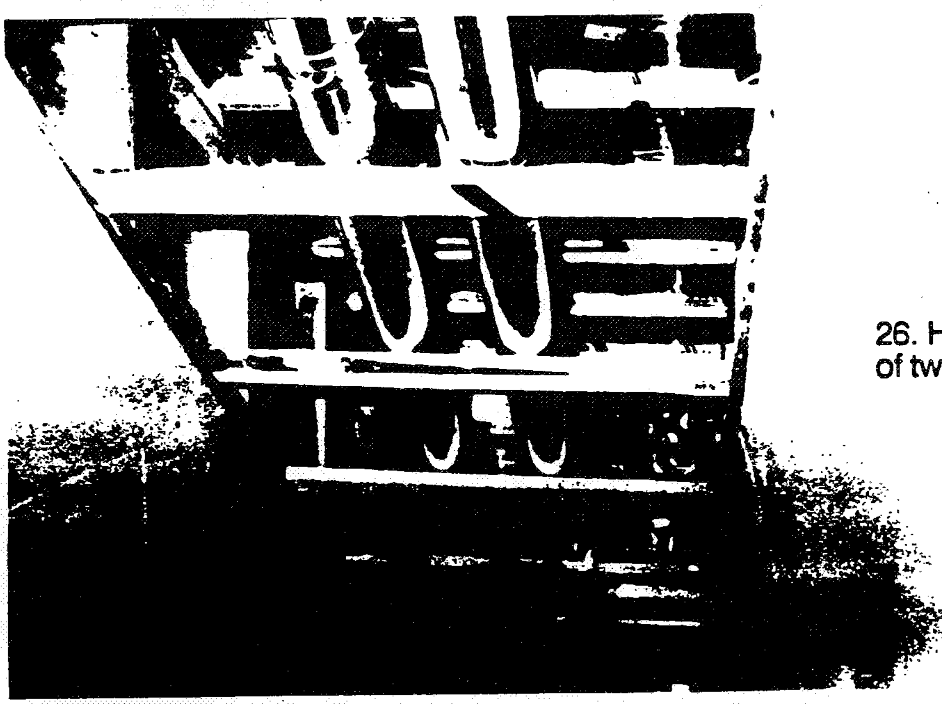
22. High sidewall slot air inlet diffuser.



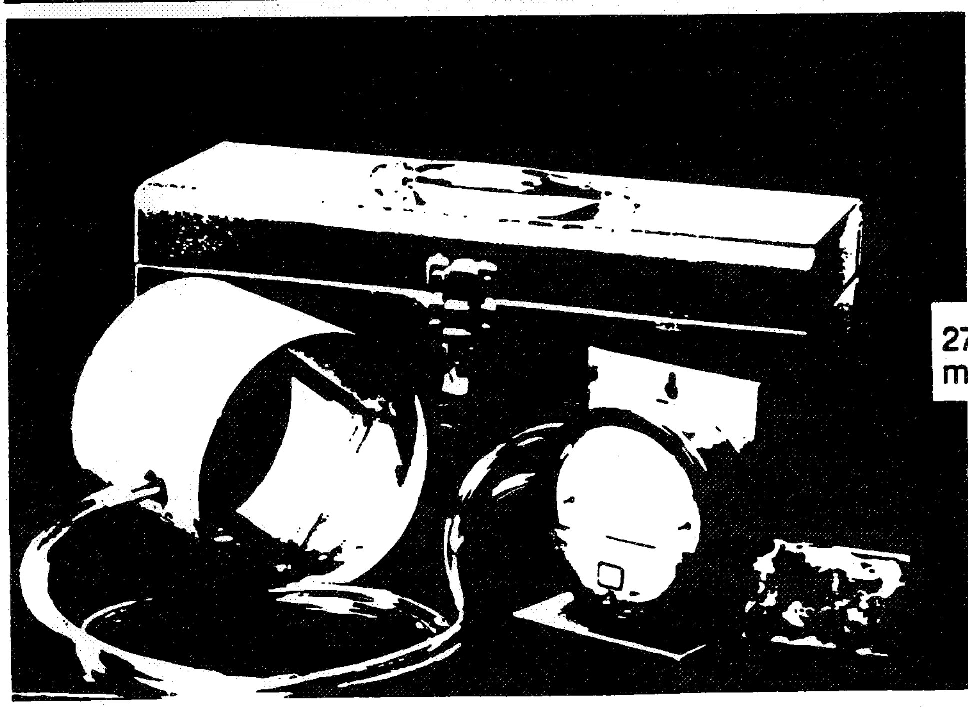
23. Adjustable supply air ceiling diffuser for HRV's.



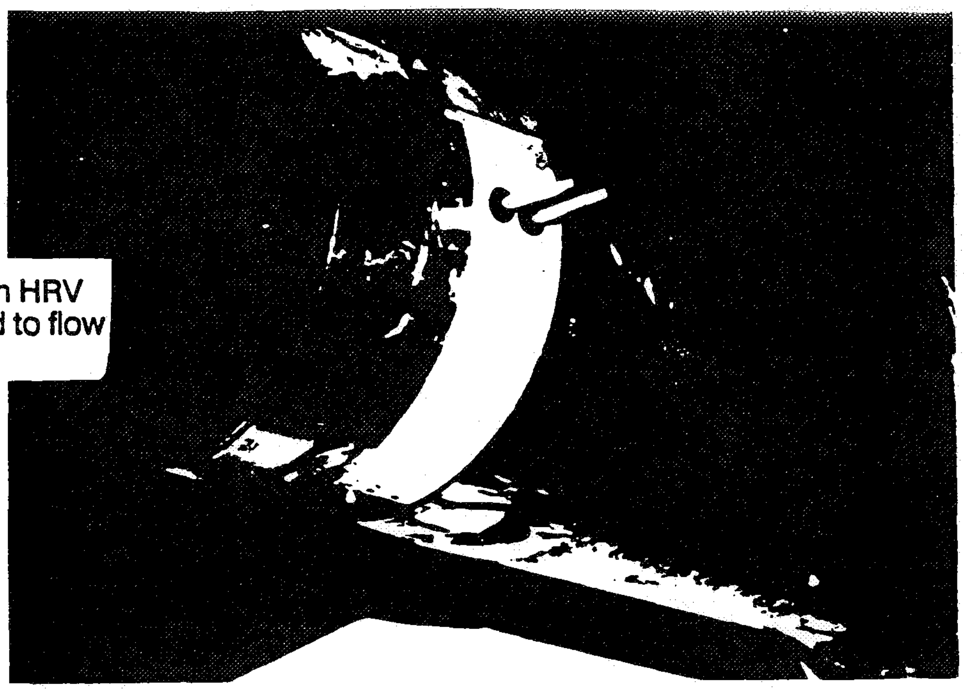
25. HRV kitchen exhaust grille with removeable grease filter.



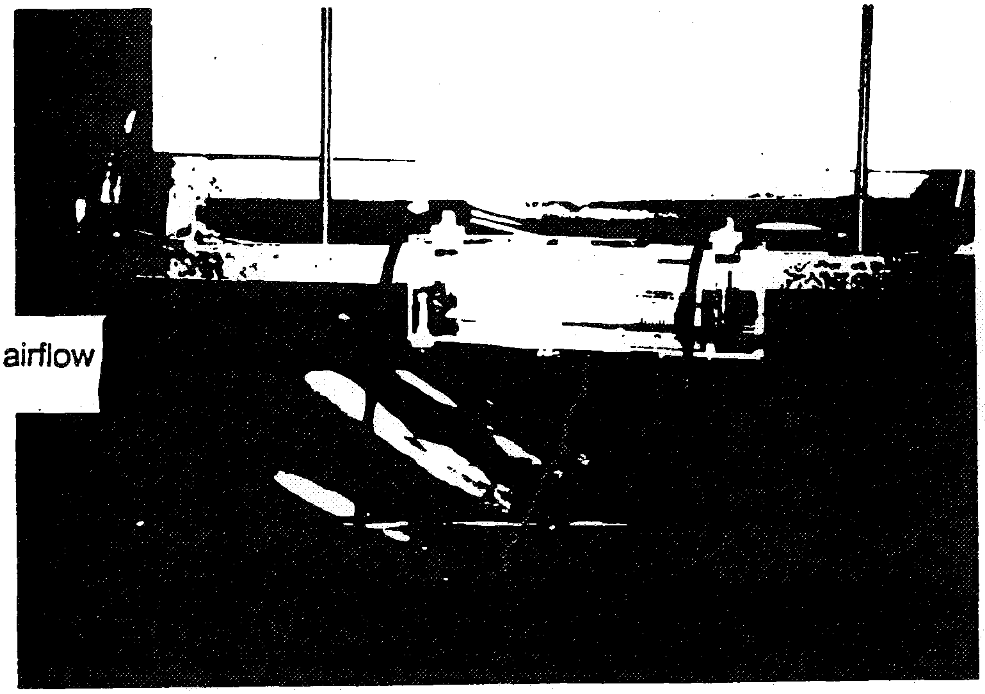
26. HRV duct work in dropped ceiling typic of two storey construction.



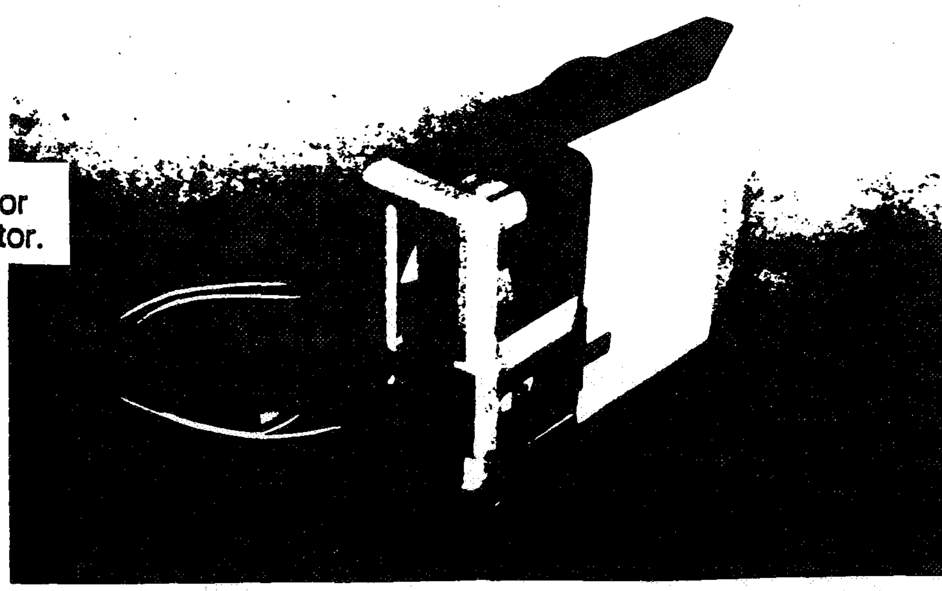
27. HRV flow balancing kit including measuring station and pressure gaug



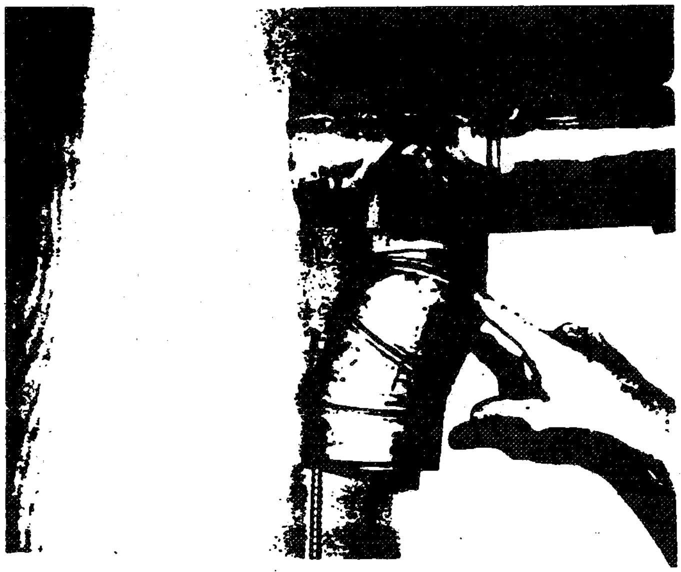
28. Flow measuring station in use on HRV duct. Pressure reading is converted to flow rate using conversion tables.



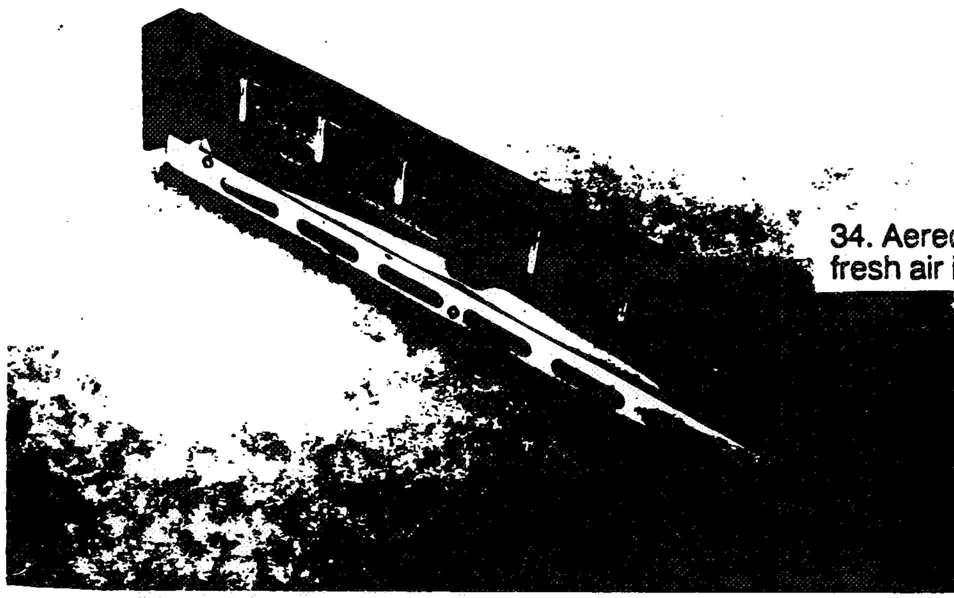
29. Block manometer also used for airflow measurement.



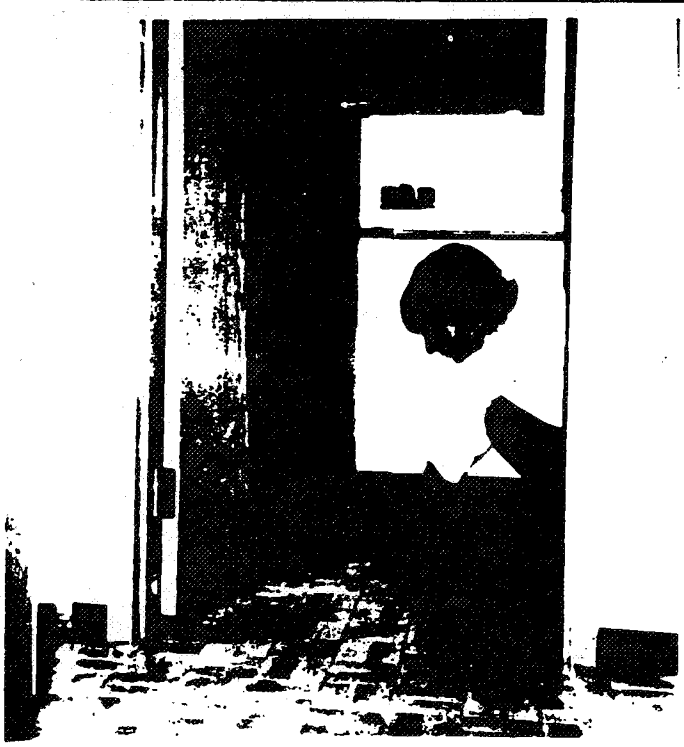
30. Aereco humidity regulated extractor showing intake and pneumatic restrictor.



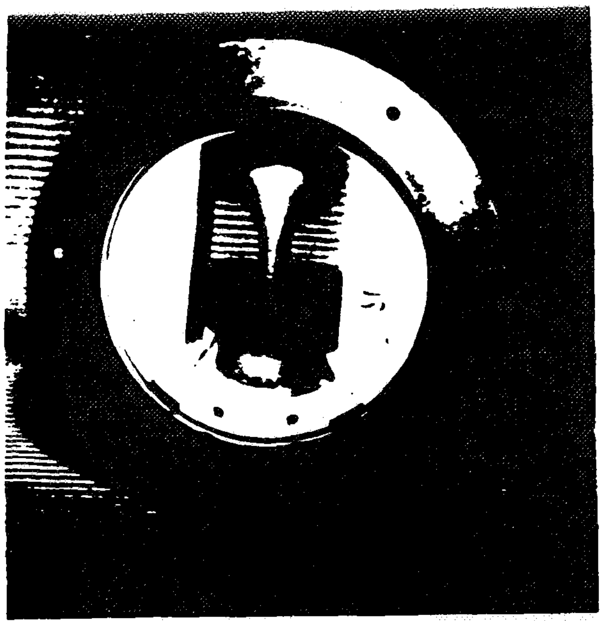
32. Metal duct for connecting Aereco extractors to central fan. Joints must be sealed.



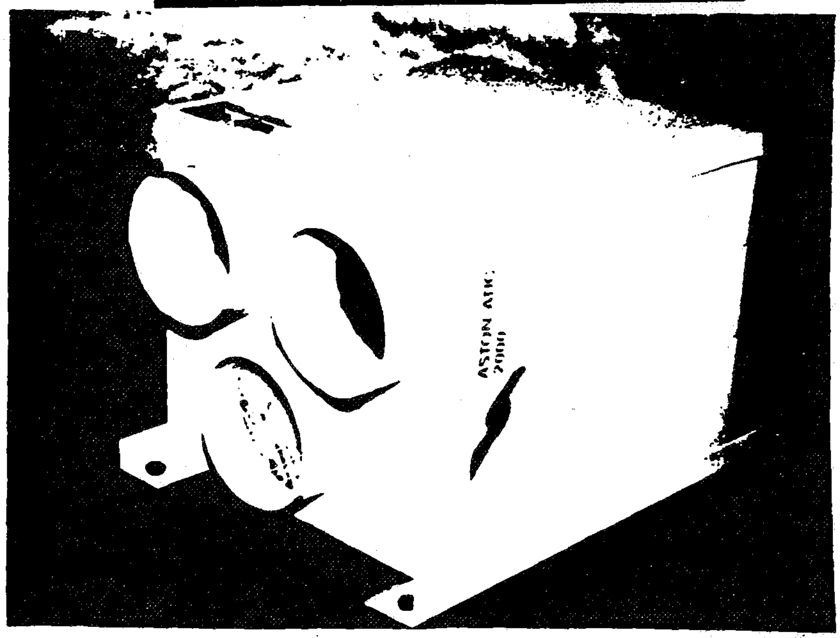
34. Aereco humidity actuated through wall fresh air inlet.



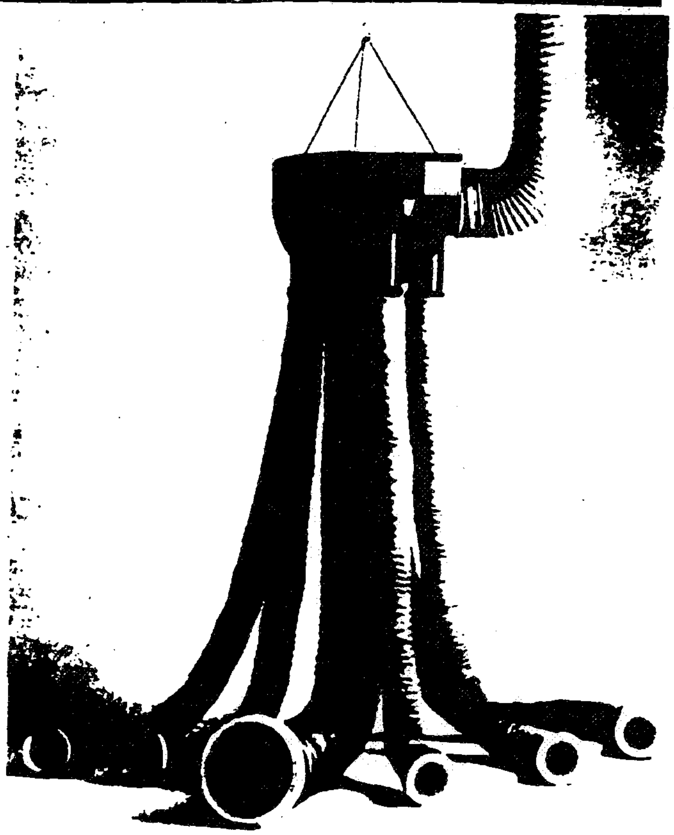
35. Undercutting of bathroom and bedroom doors is essential to ventilation system operation.



37. Aldes CAR automatic air flow regulator. Limits flow to 10 L/s



39. Aston central exhaust unit.



40. Aldes VMPKS central exhaust unit with resilient mounting and flex duct.

GLOSSARY OF TERMS

ACH- "Air changes per hour". The number of times each hour that the entire volume of air contained in a dwelling is replaced by outdoor air.

Air Exchange- The movement of air into and out of a building by all means including infiltration, exfiltration, natural ventilation, and mechanical ventilation.

Air Flow Regulation- The adjustment of air volume delivery by means of fan controls and duct dampers.

Air to Air Heat Exchanger- An element in which heat is transferred between two separated airstreams.

ASHRAE- The American Society of Heating, Refrigerating and Air-Conditioning Engineers. A professional body responsible for setting voluntary standards in the industry.

Back-draft- The spillage of combustion gases from a chimney into room air due to pressure imbalances.

Bq/m^3- Becquerels per cubic meter, a unit used in Europe and Canada to measure radioactive decay rate. Equal to 0.03 pCi/L.

BPA- The Bonneville Power Authority, a utility company in the Northwest U.S. heavily involved in energy conservation and indoor air quality programs.

Category A room- Those occupied rooms such as bedrooms, living rooms etc. which have general ventilation requirements.

Category B room- Those rooms such as kitchens, bathrooms etc. which have special ventilation needs.

cfm- "Cubic feet per minute". An imperial unit of air flow measurement equal to approx. 0.5 l/s in metric units.

Combustion Air- Air that is supplied specifically for the burning of a fuel.

DbA- Decibels, A scale. A logarithmic measure of sound intensity used for rating fans and equipment.

De-humidistat- A control device incorporating a switch which operates a fan or other device when humidity rises above a preset level.

Equivalent Leakage Area (ELA)- The total leakage area (cm^2) of a theoretical perfectly tight envelope which would produce the equivalent measured air leakage rate of a building.

Exhaust Air- Air removed from a dwelling and discharged outside.

Heat Recover Ventilator (HRV)- A factory assembled unit incorporating a heat exchanger or heat extractor and a means to circulate ventilation air.

HRAI- The Heating, Refrigerating and Air-Conditioning Institute. A trade association representing the HVAC manufacturing and contracting industries.

HVI- The Home Ventilation Institute.

Induced Draft Unit- A fuel burning appliance in which a fan forces combustion air through the firebox and enhances chimney draft.

L/s- "Liters per second". A metric unit of air flow measurement equal to approx. 2 cfm in imperial units.

Local Exhaust- The extraction of air contaminants at their source, such as kitchen and bathroom exhausts.

Make-up Air- Outdoor air which is provided to replace air exhausted by fans and exfiltration.

Mechanical Ventilation- Forced air exchange driven by fans.

Natural Ventilation- Air exchange by means of intentional openings in a building.

Naturally Aspirated- A combustion appliance which has no fan to assist exhausting of combustion gases but relies entirely on natural air movement in a chimney.

Occupied Zone- The region within a habitable room between 75 mm and 1800 mm above the floor, and more than 300 mm from the walls or fixed air-conditioning equipment.

Outgas/Offgas- The release of air contaminants during aging and chemical degradation of materials.

Pascal (Pa.)- A metric unit of air pressure equal to 0.004" Water Column in Imperial units.

pCi/L- Pico curie per liter. A unit used in North America to measure radon concentration. Equal to 37 B/m^3.

PPM- Parts per million.

Pressure Balancing- The adjustment of make-up and exhaust air flow rates in order to regulate the difference between indoor and outdoor air pressure during fan operation.

Radon Daughter- Radioactive decay products of radon gas, some of which produce hazardous alpha radiation.

Recirculation Air- Air removed from the space to be reused as supply air.

Return Air- Air removed from the space to be recirculated or exhausted.

Sealed Combustion Unit- A fuel burning appliance in which the combustion is completely isolated from the ambient air. These units are equipped with totally enclosed combustion air supplies, fireboxes, and chimney connections.

Sone- A linear scale used for measuring sound intensity of fans and equipment.

Spot Ventilation- Local ventilation, usually exhaust only, intended to remove air contaminants from a localized source such as a hobby area or cooking appliance.

Supply Air- Air delivered to the space for ventilation, heating or cooling.

Tempering- The heating of ventilation air before it's introduction into the occupied space. Tempering is often necessary in order to prevent comfort problems.

Ventilation Air- That portion of supply air used for ventilation that has not previously circulated through the dwelling.

Ventilation Effectiveness- The efficiency with which general ventilation air mixes with air in the occupied zone and contaminants are removed.