those which pertain to the hot water heating apparatus for mild weather. Such a system in order to be successful would be operated when the weather was cold at atmospheric pressure or slightly above, in which case the temperature of the steam might vary from 212 deg. to 220 deg. Fah. With a milder temperature pressures lower than atmospheric could be had provided the atmospheric pressure were nearly removed from the system, in which case we might have a boiling temperature and steam corresponding to the pressure which would vary from 150 deg. upward. In the Paul, in the Webster, and in the Johnson system the vacuum is produced by an independent air pump which removes mechanically all the air from the system. In the Morgan system and several similar ones the air is removed through a mercury trap by applying pressure for a short time to the entire system, arrangements being used which prevent the air from entering after it has once been driven out.

The first three systems referred to are evidently positive in their methods of operation and have proved to be eminently practicable and satisfactory in the heating of large buildings where power is available for removing the air. The Paul and also the Webster system is eminently suited for the use of exhaust steam since each provides practical means of circulating exhaust steam without the addition of back pressure on the engine. The use of exhaust steam for heating very frequently permits the saving of large quantities of coal, for the reason that exhaust steam which would otherwise be wasted may frequently be made to answer every requirement for heating, without the necessity of burning additional coal.

Large buildings which are constructed for office, dwelling or factory use usually contain steam plant for elevators or other power purposes. The exhaust steam from such a plant may frequently be sufficient for warming the building during the cold months and should if possible be utilized for that purpose. The Paul or the Webster systems can be installed without the expense of pipes of extra large size and in this way present an opportunity for great improvement in economy of fuel and in obtaining satisfactory results at much less cost than the older processes.

The vacuum systems without the use of power devices for removing the entrained air require excellent workmanship, but if properly installed are very satisfactory and will produce excellent results.

## IMPROVED HOT WATER SYSTEMS.

Some attempts have been made to improve the heat carrying capacity of hot water by adding some substance which would decidedly raise the temperature of the boiling point. While such substances are known, the cost at the present time is too much to preclude any extensive commercial use. If we could raise the temperature of the boiling point of hot water without increasing the pressure, smaller radiators could be used and the objections to that system which now exist would be entirely removed.

Among the chemicals which are found well fitted for use in a hot water heating system, the chloride of calcium is perhaps the most prominent. Its expense would, however, prevent its extensive use. Common salt (chloride of sodium) is entirely unfitted for such a purpose for the reason that it rusts any iron material with which it comes in contact.

Hot water has also proved to be an admirable medium for use in connection with exhaust steam heating ; for such uses the hot water is circulated by a pump and is warmed by passing through a metallic heater so arranged that the exhaust steam comes in contact with the outer surface of a series of tubes and the water to be heated comes in contact with the inner surface. This system has been applied by Evans & Almirall of New York to the heating of large establishments and small towns and has proved admirably adapted for such purposes.

High temperature can be obtained in hot water heating systems by omitting any expansion tank and closing off any connection with the external air; such a system being known as a high pressure system. Such

systems have been frequently installed but they are exceedingly dangerous, for the reason that the pressure increases as the temperature is raised, with the result that unless appliances for protecting the apparatus be installed and maintained in perfect order, a pressure sufficient to cause an explosion is likely to be produced. I cannot too strongly argue against the use of a pressure system of hot water heating for the reason that I think it is too dangerous to be seriously considered as a possible means of heating. Happily, I believe that this system has been pretty nearly abandoned both in Canada and in the United States, although I have recently heard that a system of hot water heating has been employed in Canada in which valves were used in the return pipes and located in such a manner that they could be closed during the operation of the heating system and in fact were so closed, the effect being to produce an over pressure and a serious explosion. This calls attention to the need in all hot water heating plants of constructing a circulating system so that it cannot possibly be obstructed either by accident or otherwise.

## HEATING WITH HOT AIR.

Heating by hot air circulation or from a furnace which is located so that the air entering the building will pass over a heated surface and thence flow to the various rooms to be warmed, is well adapted for small buildings and gives in many cases excellent satisfaction. A system of furnace heating is not well adapted for carrying air long distances horizontally tor the reason that the motive force which induces circulation is extremely small and liable to be overcome by adverse winds. Systems of furnace heating are trequently illy designed and poorly erected and as a result this method of heating has gone into considerable disrepute. In many cases extremely small furnaces have been used and in order to obtain sufficient heat, the heating surfaces have been kept extremely hot, thus overheating a limited amount of small ait; this comes from an attempt to make small volume of air heated to an extremely high temperature do the work which should be done by a large volume heated to a moderately low temperature. A hot air furnace with ample heating surface in proportion to grate and installed with well proportioned hot air flues and with exhaust flues leading from each room into the attic can be made an extremely satisfactory and desirable method of warming a 10 or 12roomed house. The turnace should be installed as closely as possible to the windward side of the house so as to utilize as far as possible the natural air circulation to aid in the distribution of heat; it will generally be found much more satisfactory to co-operate with natural forces than to oppose them.

## CONCLUSION.

In conclusion I would say that I have in this short address intended to call attention only to desirable and undesirable features in several of the most prominent systems of heating and ventilation. I have carefully avoided the discussion of detailed methods of design and the methods of proportioning the various parts of a heating and ventilating system for the reason that such methods are fully and exhaustively treated in well known text books on the subject and moreover could hardly be considered in the limited time at our command. I have myself endeavored to discuss the various questions of such design in a book on the subject of Heating and Ventilation, which I believe is accessible to all the members of your Association.

I am much pleased at the interest taken in this important branch of building construction by the members of your Association as I am thoroughly convinced that comfortable and healthy buildings are of equal importance with noble and artistic ones. There is no reason, however, why buildings should not possess all of these attributes and I am pleased to learn that the members of your Society have done so much towards solving the questions relating to the construction of both sanitary and beautiful structures. The architects of Ontario already occupy an honored position in the reputation of the world because of the artistic, noble and useful structures which they have produced; let us