

gravel bed is extended upward so as to come about 2 in. above the parting lines of the tile. Underdrains are sometimes omitted where this type is used, any water which seeps into the conduit being allowed to flow down the bottom of the conduit to the nearest manhole. Drains are laid from the floor of each manhole to some point of free discharge. The pipes are supported on roller frames and these, according to the type of conduit used, are either supported by the conduit itself or have their lower parts set in concrete thus supporting the pipes independent of the conduit.

**Sectional Insulation Type (Bituminized Fibre Conduit).**—Each pipe is individually insulated and encased in a bituminized fibre conduit. The insulating material is 85 per cent carbonate of magnesia sectional pipe covering, applied in the usual manner as on overhead pipes, except that bands are omitted. After every fifth section of magnesia covering there is applied a short, hollow section of very hard asbestos material in the bottom portion of which rests a grooved-iron plate carrying ball-bearings upon which the pipe rides when expanding or contracting. This short expansion section is of the same outside diameter as the adjacent 85 per cent magnesia covering. Over the pipe covering and expansion device there are placed two layers of bituminized fibre conduit with all joints staggered and the surface of each conduit finished with liquid cement. Conduits are placed on a bed of crushed rock or gravel, approximately 6 in. deep, and this is extended upward to about the center line of the conduit when trench is backfilled. Underdrains leading to points of free discharge are placed in the gravel or crushed rock beds.

**Wooden Conduit.**—Each pipe is enclosed in a tin-lined wooden casing. Sufficient space is allowed between the pipe and the casing to provide for the insertion of pipe guides or rollers which rest on the bottom of the casing. The casings are bedded in gravel or broken stone and one or more tile underdrains are laid beneath them.

## PART II

### CHAPTER XIV

## VENTILATION

By PERRY WEST, Member

**V**ENTILATION is the science which has to do with the maintenance of such indoor air conditions as are most conducive to proper health and comfort. Practical ventilation results may mean anything from the very best to the very poorest in quality and from the maximum to nothing in quantity. Ventilation perfection is, however, a very definite thing which may be defined as follows:

That atmospheric condition in every part of indoor space occupied by human beings which is continually maintained with a proper amount of oxygen; free from dust, bacteria, objectionable odors, poisonous and other objectionable substances; with suitable air movements and at the temperature and humidity quality shown within the zone of human comfort as defined by the joint research work of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, the United States Bureau of Mines and the United States Bureau of Public Health.

Taking this as the highest aim of ventilation and calling it 100 per cent the other extreme of 0 per cent of ventilation may be defined as follows:

That atmospheric condition in any part of indoor space occupied by human beings where one or more of the above enumerated factors is or are maintained so as to separately or collectively inflict death or permanent injury upon human beings.

Between these two extremes are the wide range of conditions met with in practice.

Good ventilation may be defined as follows:

That percentage of perfection of the above factors which is warranted by the requirements of human health, comfort and efficiency on the one hand and expense and labor to produce these conditions (wherever they do not naturally exist) on the other.

The science of ventilation began its existence with, and is still growing out of, the fact that wherever human beings assemble within an enclosed space the atmosphere within this space will become vitiated, unless proper provisions are made to prevent it. It is the difficulty of determining and applying these proper provisions of prevention that has kept physiologist and ventilating engineers busy for so many years endeavoring to produce anything like satisfactory results.

The commonly accepted usage of the term *vitiated atmosphere* has for a long time continued to designate conditions which cause unpleasant, uncomfortable or unhealthful physiological reactions, but our interpretations of the true causes and meanings of these reactions have undergone many vital changes with the progress of the art and our growth in its knowledge.