there is greater resistance to the flow of water through the finer sand than through the coarse, consequently the liberation of air bubbles from the water occurs in the zone of least resistence, viz., in the coarse sand. These air bubbles rising upwards are intercepted by the finer sand, cause air-locking and retardation to flow of water.

In the most recent types of mechanical filters the strainers are arranged in tiers so fitted to the channels which carry off the filtered water as to afford passages for escaping air into conduits connected with external pipe carried up to the top of the filter and turned downwards with their exits underneath the surface of the water in the filter; by this means air-locking is prevented, and accumulated air allowed to escape.

The system of mechanical filtration is so arranged that the least possible positive head is imposed on the gelatinous film of filtering material formed on the sand bed and the maximum amount of negative head made available, thereby maintaining the normal efficiency of the film.

After 12, 16 or 24 hours, depending upon the character of the water under treatment, the filter is washed by a reverse current of pure water pumped through it at a head of about twenty feet; this pressure lifts the whole sand bed without carrying over into the waste channel any of the sand, but removing all matters of less density, and while the reverse current is flowing, the sand is thoroughly washed by mechanical agitators. The volume of filtered water used for washing usually averages 3 per cent. of the volume filtered.

After leaving the filters, which, in conjunction with the sedimentation tanks, eliminate the whole of the suspended matter, and effect 95 to 98 per cent. reduction in bacteria, there may still remain a small percentage of bacteria in the filtered water.

An alleged objection to the use of mechanical filters is sometimes raised, viz., that after washing there must be a period of imperfect filtration as the gelatinous film formed partially by chemical means and partially by the slimy matter intercepted takes a long time to form, meanwhile water passing through the sand is liable to carry with it any pathogenic germs which may be in the water.

This objection has had some foundation, for in some American cities, where mechanical filtration has been adopted and where insufficient attention has been given to the preparation of the coagulant and to its proper distribution over the filter, bacteria have been found in the effluent.

This objection is easily overcome and loss of time avoided by the use of an auxiliary chemical feed tank containing solution which quickly forms a gelatinous film over the surface of the sand, while the rewash water is flowing downwards through the filter.

The rewash water is a small percentage of wash water, which, after the upward current has been stopped, the agitators brought to rest, and the sand begins to pack, is the water which finally flows through the filter after washing and which for a few minutes runs to the waste water drain.

The flocculent precipitate formed by the solutions used during this period of rewashing forms a film with great rapidity, and as soon as the rewash valve is closed this film is in its normal condition for delivering pure water.

After filtration the next process to completely purify water is that of sterilization, which can now be practically accomplished by the use of ozone.

Ozone is formed in the atmosphere from oxygen, which the air contains, during the slow oxidation of moist organic matter under the influence of solar light, and also on the passage of lightning through the air.

For industrial purposes, ozone is used in the shape of atmospheric air, which has been partially ozonized by having been passed through a space traversed by silent electrical discharges.

The hourly production of ozone in an apparatus of given size depends upon the tension of the current. Professor Chasey, of Lyons, found that with the ozonizer he experimented upon, no ozone appeared under 9,000 volts; from this point, the production increased irregularly up to 13.000 volts, and then became proportional to the square of the difference in potential; at 41,000 volts the apparatus produced 9.9 times as much ozone as at 13,000.

The temperature of the air, heated by electrification, should be kept at a proper level. Dr. Rideal says that the yield increases with air that is up to 24 degrees C., then declines; other authors, working with oxygen, found that larger quantities of ozone were obtained below than above freezing point.

Prof. Chasey has established that it is uneconomical to try to increase the ozone concentration in ozonized air. To obtain a concentration of 7 per cent., ninety times as much energy was wanted as for a concentration of ½ per cent., so that to produce a given weight of ozone, it is cheaper to enrich feebly a greater volume of air than to enrich considerably a smaller volume of air.

As, in the presence of moisture and powerful bases, ozone has a tendency to oxidize the nitrogen of the air into nitric acid, it is advisable to dessicate the air before electrification begins or to make the ozonizers from unoxidizable materials.

Ozonizers are spaces traversed by silent electrical discharges, through which space passes the air current to be ozonized.

To prevent the silent discharges from turning into sparks, either a dielectric, such as glass, is interposed between the two poles, or the bare metallic electrodes are provided, at the entrance of the current, with regulating devices in the shape of resistances which keep the voltage within the boundary at which the formation of sparks commences, or in that of electrical condensers which limit the intensity of the current.

To ensure the efficiency of the ozone, time and intimacy of contact between the ozonized air and the water are required; intimacy of contact, to ensure the ready absorption of the but slightly soluble ozone, and time for the double process of physical dissolution of the ozone in the water and chemical action of the dissolved and free ozone on the organic matter and the micro-organisms.

The ozonizers are horizontal. There are usually two in the series, each consisting of three groups of three elements.

Each element is made of a horizontal brass half-cylindrical trough, fitted with a plate glass cover and a cast iron water jacket. The trough is earthed and makes one of the poles.

Across the trough, at regular distances, brass half discs with serrated circular edges of platinum about 60 millimeters less diameter than the trough are suspended from the glass lid by means of screws which receive the high tension current from the liquid resistances fitted to each half disc. The resistances are vertical glass tubes sealed at the bottom, in each of which is secured a platinum wire projecting on both sides of the glass. The tubes are filled with a solution of glycerine through which the current is transmitted by a platinum wire dipping in the top of it.

The resistances perform the part of regulators preventing the tension of the portion of currents allowed to each semi-circular pole, to rise above the limit at which sparks or voltaic arc are produced.

Silent discharges are produced between the sharp points of the semi-circular poles and the inner surface of the troughs. The troughs are closed at each end and fitted with an air inlet at one end and an air outlet at the other. The current of air circulating between both ends, passes through the succession of half annular discharges which transform part of its oxygen into ozone.

After its passages through each discharge, the air, which becomes heated, is partially cooled down by the surface of the trough. This cooling is completed by means of surface condensers placed between the units of each line of ozonizers.

The ozonizers are placed in a dark room for better observation of the blue-violet color of the rays, which indicate when the apparatus is working in good condition, or otherwise.

In many cases the cost of ozonization combined with rapid filtration is more economical than that of bacteriologically less efficient slow filtration. But even should the reverse be the case, it may occur that even from the standpoint of social economy, the more expensive but safer process deserves the preference.

The practical irregularities to which filtration has been subject appear from a study of the death-rate of typhoid fever in large cities, now generally admitted as an index of quality of water supply.

Fuertes has arranged the statistical data about the typhoid death rate in various localities supplied with different kinds of waters. The typhoid death-rates per 100,000 people, per annum,