lever system opens the inlet valve against a spring. The nut *M* on the inlet-valve stem tends to carry the gas-valve down with the inlet valve by compressing the spring *K*. The gas-valve disk *G* carries an upward cylindrical extension *H* which terminates in a vacuum piston *P* and incloses the spring *K*. A protected opening *O* allows air to pass in and out of the space below the piston *P*, and a check valve *N* prevents the entrance of air above the piston, but allows the escape of any that may be there. A "bleeder" valve *J*, controlled by the governor, allows more or less air to enter the vacuum cylinder and vary the upward pull of the piston *P*. When the spring *K* is compressed by the downward movement of the inlet valve, it presses the gas valve open more or less, according to the amount of air admitted by the valve *J* and the resulting degree of vacuum that a given downward movement of the piston *P* can form above it.

As all of the American gears excepting that of the Bethlehem Steel Company's engine have been fully described in *Power*, there is no need to discuss any but the Bethlehem gear in this article. Fig. 9 is a sectional elevation of the mixing-valve cage and shows also the inlet and mixing valves and the immediate operating mechanism. In this gear the ported cylinder attached to the inlet-valve stem which was first used in this country on the Westinghouse engine has been applied, but the ports are cut diagonally. This makes it possible for the governor to control both the area of the port openings and the length of time that they are open, without using trips or cutoffs. The sleeve *S* is twisted about the vertical axis by the governor rod, and the relative angular positions of

the same amounts of gas and air. When the load lightens, the governor shifts the sleeve *S* around so that at each stroke the ports in the sleeve and those in the plunger overlap less and less, until at very light loads they register only during the latter part

FIG. 9.—BETHLEHEM MIXING AND INLET VALVE AND CAGE

of the stroke. As the ports are very wide and slant at a considerable angle, the governor has a very long "selective" range, the total movement in an 800-horsepower engine being about 3 inches on the surface of

FIG. 7.—VALVE MECHANISM OF THE COCKERILL ENGINE

its ports and those in the mixing-valve plunger are thereby varied. The mixing-valve plunger is attached to the upper end of the inlet-valve stem and moves up and down with invariable stroke, under the pressure of the cam *C* and the usual seating spring, which is not shown here. At full load the ports in the housing sleeve register completely with those in the plunger, and since the total time that they connect is one-half of that for continuously registering ports, the area of the ports must be twice as great to pass

the sleeve and 7 inches at the pin on the outer end of the arm.

This gear is the latest one that has been developed in American practice, and both this and the Westinghouse gears constitute an advance over English gears up to the present time in that they provide a variable cutoff without the use of any complicated trip arrangements or multiplicity of levers, links, cams, etc.

The Sterilization of Milk

By DR. M. SEIFFERT.

THE unsanitary and economically defective method of transporting milk in cans and pouring it repeatedly before it reaches the vessel of the consumer is still in general use. In this way the milk is exposed to contamination of many kinds, and the visible impurities which it collects are not the least dangerous ones. The employment of cans for the transportation and sale of milk is also open to the objection that, even when no fraud is intentionally practiced by the dealer, one customer may receive milk which contains much more than the normal proportion of cream, while another receives what is virtually skim milk. Unfortunately, however, the bottles and the method of sealing them which are now in use possess serious defects. The so-called patent bottles, which are closed by a porcelain stopper and a rubber ring, are condemned by the bacteriologist because they cannot be cleaned and freed of bacteria so perfectly as to make them fit containers for a liquid so prone to decomposition as milk. The bottles covered with paper caps are objectionable because the caps and the mouths

of the bottles are handled in transport and therefore necessarily become conveyors of germs. Furthermore, it is not practicable to make or to apply the caps by absolutely aseptic processes.

The new "uvio" method of bottling milk uses a seal which satisfies every requirement of bacteriological science and allows a perfectly aseptic handling of the milk. This seal is a disk of tinfoil which is coated on its lower side with a germ-free stiffening material and which comes to the bottling room in a germ-free package. The bottles are sterilized before being filled and are sealed by an automatic machine, neither the seal nor the mouth of the bottle coming into contact with a human hand during the operation.

Another obstacle to the increased use of milk in large cities is the uncertainty whether the milk comes from healthy or from diseased cows. The old remedy for this state of things consisted in boiling the milk and thereby seriously impairing both its flavor and its nutritive value. The necessity of boiling all milk in order to escape the danger of swallowing disease germs has caused a great many persons to abstain from milk altogether. Those persons who prefer bottled milk in its natural condition to boiled milk are certainly far more numerous than those to whom the taste of boiled milk is not disagreeable. It is equally certain that raw milk is more effective than boiled milk in promoting the growth and increasing the blood supply of infants, whose food consists entirely of milk.

In the manufacture of butter and cheese, also, sterilization of the milk by some method other than boiling is not only desirable, but sometimes absolutely necessary. Although many butter makers pasteurize the milk, it is well known that the process injures the flavor and quality of the butter. The heating of milk used for cheese making, although it is enjoined by the new (German) cattle plague law, cannot always be employed, because it seriously affects the formation of the curd.

In the feeding of calves and pigs, also, experience has proved that better results are obtained from raw than from boiled milk, and the feeding value of such waste products as curds and whey would be greatly increased if they could be used in the raw state, without danger of infection with tuberculosis or intestinal disease.

For these reasons the "uvio" process, which destroys disease germs but spares the acidifying organisms in milk, has been developed. The process is based upon the power of violet and ultra-violet rays to paralyze the growth of vegetable organisms. The bactericidal efficiency of these rays is now universally recognized. By the "uvio" process the germs of disease, chiefly tubercle bacilli and pus-forming bacteria, which the milk of a cow may contain, even before the veterinary inspector can detect the disease and remove the animal from the herd, are killed without altering the natural state of the raw milk.

In the industries dependent on fermentation, also, the "uvio" process will soon find important applications, as yeast and mold fungi are likewise destroyed, though less rapidly than bacteria, by ultra-violet rays.

The success which has been attained in purifying water with ozone has naturally led to attempts to sterilize milk by means of the same agent. The experiments soon proved, however, that the conditions in the two cases are entirely different. In water, the destruction of organic matter is desirable, but in milk this must be avoided, if the milk is to remain fit for use as food. The quantities, both of organic matter and of bacteria, which the two liquids contain, also differ widely. Even the results obtained in ozoning water, however, appear to indicate that milk cannot be perfectly sterilized by direct action of an electric current, because the ozone generated by the current passes through the liquid in large bubbles, making unfit for use those portions of the milk which it touches and exerting no germicidal action on the rest of the milk. In order to sterilize milk completely without injuring it, the ozone must pass rapidly through it and come into contact with every particle.

For this purpose Dr. Emil Wiener has made experiments with atomizers producing sprays of exceeding fineness, in which the diameters of the drops range from 12 to 20 millionths of an inch. As these drops are little larger than bacteria, any bacteria which they contain are fully exposed to the action of ozone coming into contact with the drops, and are instantly killed even by greatly diluted ozone. The ozone is then quickly removed from the milk by the same apparatus by which it is applied. In this apparatus the milk is atomized by a jet of compressed air, mixed with ozone. The milk falls to the bottom of a glass vessel, from which the ozonized air escapes by an orifice above the level of the liquid. Before the milk is drawn off it is thoroughly aerated by a current of compressed air which has been filtered through glass wool, calcium chloride and soda lime. In this way Dr. Wiener succeeded in freeing milk completely from disease germs and toxins and improving its "keeping" qualities, without affecting its taste, odor, or chemical composition.—Umschau.

FIG. 8.—CROSSLEY REGULATING MECHANISM FOR LARGE ENGINES