Three Cast-iron Bell-end Fittings Having a Combined Weight of 19,150 Pounds.

Large Gate Valves and Pump Fittings

Representative of Modern Mammoth Construction

Our frontispiece shows one of four large gate valves recently shipped by a well-known firm of Bridgeport, Connecticut, to a Canadian Colliery at Union Bay, B. C., to be used in connection with a hydro-electric plant there.

The valves consisted of two 72-inch and two 50-inch standard iron body taper seat wedge gate valves with by-passes and spur gears.

While such large valves are most commonly supplied for low-pressure work, the 72-inch on this order will be used under a hydraulic working load of 125 pounds, and the 50-inch under a load of 165 pounds per square inch. They are massively constructed and have a large factor of safety, although built to retain as graceful lines as possible in such large castings.

The two mammoth 72-inch valves weigh 51,020 pounds and 49,080 pounds net each, respectively, averaging just about twenty-five tons apiece, this being about six tons heavier each than the low-pressure type. Of the two valves, the heavier, which was built to sustain a somewhat more severe strain than its companion, was tested to 240 pounds working pressure, and the other was tested to 175 pounds pressure by the customer's inspectors. Both 50-inch valves, which weighed 20,010

pounds each, were subjected to tests of 240 pounds.

As will be noticed by the illustration, the 72-inch valves are of a new type, having two bronze spindles, upon which the huge gates weighing $4\frac{1}{2}$ tons may be readily raised and lowered by the 42-inch hand wheel operating in connection with the gears. The gates are bronze faced and travel on bronze rollers upon bronze tracks in the valve body. This is also the method of operating the 50-inch valves, although they are equipped with single spindles and have steel rollers.

Other interesting dimensions of the 72-inch valves are: extreme height, $17\frac{1}{2}$ feet; face to face, 48 inches; diameter of flanges, 87 inches; size of by-pass, 10 inches. The 50-inch stand, $13\frac{1}{2}$ feet high; face to face, 38 inches; diameter of flanges, 62 inches; size of by-pass, 8 inches.

On all four valves, the by-passes are operated by long steel stems extending so that their hand wheels are even with the larger hand wheels and can be conveniently reached.

In shipping the valves across the continent, the 72-inch occupied a flat car apiece, while the two 50-inch went forward on another.

The illustrations on this page, reproduced by

courtesy of the editor of the *Valve World*, show three special discharge fittings for pumps, manufactured by the same firm for an irrigation company of Idaho.

The three cast-iron bell-end fittings have a combined weight of 19,150 pounds, the largest one weighing 10,850 pounds, the smallest one 4,100 pounds, and the third, 4,200 pounds.

The dimensions are, respectively: 5 feet with three 24-inch flanged outlets; 4 feet $4\frac{1}{2}$ inches with two 24-inch flanged outlets; and 3 feet 10 inches with two 18-inch flanged outlets.

The fittings connect at the bell-end to wood pipe and at the flanged ends to spiral steel pipe penstocks. The largest fittings will work under a static head of 159 feet, the next in size under a head of 89 feet, and the smallest under a head of 54 feet.

The work being done on this power and irrigation project is of the highest order, the object of the company and engineers being to make it one of the best and most efficient plants of the kind in the country. The nature of the country is wild and most uneven, and consequently some interesting and uncommon pipe, valve, and fittings installations mark the steady progress of the work.

Facts and Fancy About Ventilation—II*

Chemical Composition of the Air an Imperfect Criterion of Its Health Value

By Leonard Hill, M.B., F.R.S.

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Experimental evidence is strongly in favor of my argument that the chemical purity of the air is of no importance. Analyses show that the oxygen in the worst-ventilated school-room, chapel, or theater is never lessened by more than 1 per cent of an atmosphere; the ventilation through chink and cranny, chimney, door, and window, and the porous brick wall, suffices to prevent a greater diminution. So long as there is present a partial pressure of oxygen sufficient to change the hæmoglobin of the venous blood into oxyhæmoglobin there can arise no lack of oxygen.

At sea-level the pressure of oxygen in the pulmonary alveolar air is about 100 millimeters Hg. Exposed to only half this pressure the hæmoglobin is more than 80 per cent saturated with oxygen.

In noted health-resorts of the Swiss Mountains the barometer stands at such a height that the concentration of oxygen is far less than in the more ventilated room. On the high plateau of the Andes there are great cities: Potosi with a hundred thousand inhabitants is at 4,165 meters, and the partial pressure of oxygen there is about 13 per cent of an atmosphere in place of 71 per cent at sea-level; railways and mines have been worked up to altitudes of 14,000 to 15,000 feet. At Potosi girls dance

* Reproduced from *Nature*.

half the night, and treading display their skill in the ring. On the slopes of the Himalayas shepherds take their flocks to altitudes of 18,000 feet. No disturbance is felt by the inhabitants or those who reach these great altitudes slowly and by easy stages. The only disability to a normal man is diminished power for severe exertion, but a greater risk arises from want of oxygen to cases of heart disease, pneumonia, and in chloroform anæsthesia at these high altitudes. The newcomer who is carried by the railway in a few hours to the top of Pike's Peak or the Andes may suffer severely from mountain sickness, especially on exertion, and the cause of this is want of oxygen. Acclimatization is brought about in a few days' time. The pulmonary ventilation increases, the bronchial tubes dilate, the circulation becomes more rapid. The increased pulmonary ventilation lowers the partial pressure of carbon dioxide in the blood and pulmonary air, and this contributes to the maintenance of an adequate partial pressure of oxygen. Haldane and Douglas say that the percentage of red corpuscles and total quantity of the hæmoglobin increases, and maintain that the oxygen is actively secreted by the lung into the blood, but the CO method by which their determinations have been made has not met with unqualified acceptance. If waste products, which arise from oxygen want,

alter the combining power of hæmoglobin, this alteration may not persist in shed blood; for these products may disappear when the blood is exposed to air. Owing to the combining power of hæmoglobin the respiratory exchange and metabolism of an animal within wide limits are independent of the partial pressure of oxygen. On the other hand, the process of combustion is dependent not on the pressure, but on the percentage of oxygen. Thus the aeroplane pilot may become seized with altitude sickness from oxygen want, while his gas engine continues to carry him to loftier heights.

The partial pressure of oxygen in a mine at a depth of 3,000 feet is considerably higher than at sea level, and if the percentage is reduced to 17, while the firing of fire-damp and coal-dust is impossible, there need be in the alveolar air of the lungs no lower pressure of oxygen than at sea-level. Thus the simplest method of preventing explosions in coal mines is that proposed by J. Harger, viz., to ventilate them with air containing 17 per cent of oxygen.

There is little doubt that all the great mine explosions have been caused by the enforcement of a high degree of chemical purity of the air. In the old days when ventilation was bad there were no great dust explosions. Mr. W. H. Chambers, general manager of the Cadeby mine,

where the recent disastrous explosion occurred, with the authority of his great and long practical experience of fiery mines, told me that the spontaneous combustion of coal and the danger of explosion can be wholly met by adequate diminution in ventilation. The fires can be choked out while the miners can still breathe and work. The Coal Mine Regulation Act enforces that a place shall not be in a fit state for working or passing therein if the air contains either less than 19 per cent of oxygen, or more than $1\frac{1}{4}$ per cent of carbon dioxide. A mine liable to spontaneous combustion of coal may be exempted from this regulation by order of the Secretary of State.

The regulations impel the provision of such a ventilation current that the percentage of oxygen is sufficient for the spread of dust explosions along the intake airways, with the disastrous results so frequently recorded. If the mine were ventilated with air containing 17 per cent of oxygen in sufficient volume to keep the miners cool and fresh, not only would explosions be prevented, but the mines could be safely worked and illuminated with electricity, and miners' nystagmus prevented, for this is due to the dim light of the safety lamp. The problem possibly may be solved by purifying and cooling the return air, and mixing and circulating this with a sufficiency of fresh air.

Owing to the fact that the percentage of CO_2 is the usual test of ventilation and that only a very few parts per 10,000 in excess of fresh air are permitted by the English Factory Acts, it is generally supposed that CO_2 is a poison, and that any considerable excess has a deleterious effect on the human body. No supposition could be further from the truth.

The percentage of CO_2 in the worst ventilated room does not rise above 0.5 per cent, or at the outside 1 per cent. It is impossible that any excess of CO_2 should enter into our bodies when we breathe such air, for whatever the percentage of CO_2 in the atmosphere may be, that in the pulmonary air is kept constant at about 5 to 6 per cent of an atmosphere—by the action of the respiratory center. It is the concentration of CO_2 which rules the respiratory center, and to such purpose as to keep the concentration both in the lungs and in the blood uniform (Haldane); the only result from breathing air containing 0.5 to 1 per cent of CO_2 is an inappreciable increase in the ventilation of the lungs. The very same thing happens when we take gentle exercise and produce more CO_2 in our bodies.

By a series of observations made on rats confined in cages fitted with small, ill-ventilated sleeping-chambers, we have found that the temperature and humidity of the air—not the percentage of carbon dioxide or oxygen—determines whether the animals stay inside the sleeping-room or come outside. When the air is cold, they like to stay inside, even when the carbon dioxide rises to 4 or 5 per cent of an atmosphere. When the sleeping-chamber is made too hot and moist they come outside.

The sanitarian says it is necessary to keep the CO_2 below 0.01 per cent, so that the organic poisons may not collect to a harmful extent. The evil smell of crowded rooms is accepted as unequivocal evidence of the existence of such. He pays much attention to this and little or none to the heat and moisture of the air. The smell arises from the secretions of the skin, soiled clothes, etc. The smell is only sensed by and excites disgust in one who comes to it from the outside air. He who is inside and helps to make the "fogg" is both wholly unaware of, and unaffected by it. Flüge points out, with justice, that while we naturally avoid any smell that excites disgust and puts us off our appetite, yet the offensive quality of the smell does not prove its poisonous nature. For the smell of the trade or food of one man may be horrible and loathsome to another not used to such.

The sight of a slaughterer and the smell of dead meat may be loathly to the sensitive poet, but the slaughterer is none the less healthy. The clang and jar of an engineer's workshop may be unendurable to a highly-strung artist or author, but the artificers miss the stoppage of the noisy clatter. The stench of glue-works, fried-fish shops, soap and bone-manure works, middens, sewers, become as nothing to those engaged in such, and the lives of the workers are in no wise shortened by the stench they endure. The nose ceases to respond to the uniformity of the impulse, and the stench clearly does not betoken in any of these cases the existence of a chemical organic poison. On descending into a sewer, after the first ten minutes the nose ceases to smell the stench; the air therein is usually found to be far freer from bacteria than the air in a schoolroom or tenement.

If we turn to foodstuffs we recognize that the smell of alcohol and of Stilton or Camembert cheese is horrible to a child, while the smell of putrid fish—the meal of the Siberian native—excites no less disgust in an epicure, who welcomes the cheese. Among the hardiest and healthiest of men are the North Sea fishermen, who sleep in the cabins of trawlers reeking with fish and oil, and for the sake of warmth shut themselves up until the lamp may go out from want of oxygen. The stench of such surroundings may effectually put the sensitive,

untrained brain worker off his appetite, but the robust health of the fisherman proves that this effect is nervous in origin, and not due to a chemical organic poison in the air.

Ventilation cannot get rid of the source of a smell, while it may easily distribute the evil smell through a house. As Pettenkofer says, if there is a "dungheap in a room, it must be removed. It is no good trying to blow away the smell.

Flüge and his school bring convincing evidence to show that a stuffy atmosphere is stuffy owing to heat stagnation, and that the smell has nothing to do with the origin of the discomfort felt by those who endure it. The inhabitants of reeking hovels in the country do not suffer from chronic ill-health, unless want of nourishment, open-air exercise, or sleep come into play. Town workers who take no exercise in the fresh air are pale, anæmic, listless. Sheltered by houses they are far less exposed to winds, and live day and night in a warm, confined atmosphere.

In the modern battleship men are confined very largely to places artificially lit and ventilated by air driven in by fans through ventilating-shafts. The heat and moisture derived from the bodies of the men, from the engines, from cooking-ranges, etc., lead to a high degree of relative moisture, and thus all parts of the ironwork inside are coated with granulated cork to hold the condensed moisture and prevent dripping.

The air smells with the manifold smells of oil, cooking, human bodies, etc., and the fresh air driven in by fans through the metal conduits takes up the smell of these, and is spoken of by the officers with disparagement as "tinned" or "potted" air. This air is heated when required by being made to pass over radiators. Many of the officers' cabins and offices for clerks, typewriters, etc., in the center of a battleship, have no portholes, and are only lit and ventilated by artificial means. The steel nature of the structure prevents the diffusion of air which takes place so freely through the brick walls of a house. The men in their sleeping quarters are very closely confined, and as the openings of the air-conduits are placed in the roof between the hammocks, the men next to such openings receive a cold draught and are likely to shut the openings. To sleep in a warm moist "fogg" would not much matter if the men were actively engaged for many hours of the day on deck and there exposed to the open air and the rigors of sea and weather. In the modern warship most of the crew work for many hours under deck, and some of the men may scarcely come on deck for weeks or even months. Considering the conditions which pertain, it seems to be of the utmost importance that all the men in a battleship should be inspected at short intervals by the medical officers so that cases of tuberculosis may be weeded out in their incipency. The men of every rating should do deck drill for some part of every day. In the Norwegian navy every man, cooks and all, must do gymnastic drill on deck once a day. In the case of our navy, with voluntary service, the men should welcome this in their own interest.

I conclude, then, that all the efforts of the heating and ventilating engineer should be directed toward cooling the air in crowded places and cooling the bodies of the people by setting the air in motion by means of fans. In a crowded room the air confined between the bodies and clothes of the people is almost warmed up to body temperature and saturated with moisture, so that cooling of the body by radiation, convection and evaporation becomes reduced to a minimum. The strain on the heat-regulating mechanism tells on the heart. The pulse is accelerated, the blood is sent in increased volume to the skin, and circulates there in far greater volume, while less goes through the viscera and brain. As the surface temperature rises, the cutaneous vessels dilate, the veins become filled, the arteries may become small in volume, and the blood-pressure low, the heart is fatigued by the extra work thrown upon it. The influence of the heat stagnation is shown by the great acceleration of the pulse when work is done, and the slower rate at which the pulse returns to its former rate on resting.

The increased percentage of carbonic acid and diminution of oxygen which has been found to exist in badly ventilated churches, schools, theaters, barracks, is such that it can have no effect upon the incidence of respiratory disease and higher deathrate which statistical evidence has shown to exist among persons living in crowded and unventilated rooms. The conditions of temperature, moisture, and windless atmosphere in such places primarily diminish the heat loss, and secondarily the heat production, i. e., the activity of the occupants, together with total volume of air breathed, oxygen taken in and food eaten. The whole metabolism of the body is thus run at a lower plane, and the nervous system and tone of the body is unstimulated by the monotonous, warm, and motionless air. If hard work has to be done it is done under conditions of strain. The number of pathogenic organisms is increased in such places, and these two conditions run together—diminished immunity and increased mass influence of infecting bacteria.

We have very great inherent powers of withstanding exposure to cold. The bodily mechanisms become trained and set to maintain the body heat by habitual exposure to open-air life. The risk lies in overheating our dwellings and overclothing our bodies, so that the mechanisms engaged in resisting infection become enfeebled, and no longer able to meet the sudden transition from the warm atmosphere of our rooms to the chill outside air of winter.

As the prevention of spray (saliva) infection by ventilation is impossible in crowded places, it behooves us to maintain our immunity at a high level. We may seek to diminish the spray output of those infected with colds by teaching them to cough, sneeze, and talk with a handkerchief held in front of the mouth, or to stay at home until the acute stage is past.

In all these matters nurture is of the greatest importance, as well as nature. A man is born with physical and mental capacities small or great, with inherited characteristics, with more or less immunity to certain diseases, with a tendency to longevity of life or the opposite, but his comfort and happiness in life, the small or full development of his physical and mental capacities, his immunity and his longevity of life, are undoubtedly determined to a vast extent by nurture.

The essentials required of any good system of ventilating are then (1) movement, coolness, proper degree of relative moisture of the air; (2) reduction of the mass influence of pathogenic bacteria. The chemical purity of the air is of very minor importance, and will be adequately insured by attendance to the essentials.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject matter involved, or of the specialized, technical, or scientific knowledge required therefor.

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MUNN & Co.,
Patent Attorneys,
361 Broadway,
New York, N. Y.

Branch Office:
625 F Street, N. W.,
Washington, D. C.

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