was heated to perform the drying, whilst the gases from the furnace passed away through a smoke-stack without coming into contact with the malt. In both styles of furnace, which might be constructed for coke or coal, was situated in the basement or ground floor, and was equipped with air flues, which again were fitted with ventilators or louvre-work. The hot gas and air flues both terminated in a chamber from 6ft. to 8ft. high, and the full width and length of the building, which the heat accumulated either in the form of direct furnace gas, mixed with air, or pure air which had been heated by the series of pipes before mentioned, or by a "calorifere." The shape of the building was, as a rule, a perfect square. This building was divided into one or more chambers, one above the other, by perforated floors. These floors were made of perforated sheet-iron, or wire gauze, or perforated tiles. The tiles and perforated iron floors had an air space of from 10 to 20 per cent. of the entire floor space, and the wire gauze floor offered an air space of from 30 to 40 per cent., all depending upon what pattern of gauze was used. The chambers so formed were from 7ft. to 12ft. high. In America, most of the kilns contained three or four chambers, whilst in England many single kilns were still in use. The whole building was covered with a conically-shaped roof, from which a vapour shaft lead the moisture and smoke into the open air, and which was covered with a hood to prevent rain and snow from falling into the kiln. Many mechanical devices had been invented, and some were freely used for the handling of the malt on the kiln floor, such as turning it, and also for dropping it from one kiln to a lower one; for this purpose the dumping floors (an Americon invention) were used. These floors consisted of iron frames, which extended through the full length of the kiln, and were about 12 inches wide, and on which the wire gauze was fastened. If a kiln was 40ft. wide, then 40 of these frames were necessary to form the floor. From each end of the frame extended an iron rod, which formed an axle on which the frames could be brought into a horizontal or vertical position. At one end these rods extended right through the wall, and a number of them were connected together with lever-work, so that in one act, and without entering the kiln, a part of the malt on one kiln floor could be dumped into the lower one by bringing the frames into a vertical position. Particular attention was paid to having a good draught through the kiln, to enable the drying of the malt to take place at a low temperature, and to facilitate this exhaust fans were employed, which were generally fixed in the vapour shaft of the roof. Pale malts were produced by drying at a temperature of a little over 100deg. F., and when the same was air dry, or in other words contained from 10-15 per cent. moisture, the temperature was raised to 180-120deg. F. For dark malt this end temperature sometimes reached 230deg. F., and the firing up commenced when the amount of moisture contained in the grain ranged between 22 and 25 per cent. As more time had been taken up with the description of the malthouse and kiln than was intended, he would now endeavour to be as brief as possible with the description of the brewery proper. The first stages of brewing commenced in the mill and brew-house. Both were, as a rule, in the same building, and very often divided off by an air-tight wall, to prevent the dust from the former entering the latter. Before the malt was crushed it was freed from all foreign matter and dust by a method similar to that used in the malt-house. The crushing was performed by a roller-mill. In some cases two mills were used, where the smaller grains were previously separated from the larger, and were crushed separately in the two mills, or double mill, the rollers being set accordingly. This prevents the smaller kernels being missed, which would mean a loss. Modern mills were fitted with powerful magnets immediately above the rollers, which arrested any pieces of iron or steel, which might be mixed in the malt, from coming between the rollers, and not only injuring them but also causing explosion and fire by striking sparks. A further safeguard was often attached, which consisted of a diaphragm hanging on a spindle, and this, again, on a lever which passed out through the wall of the mill, and to the end of which a weight was fixed. When the space below the rollers was empty, this diaphragm closed the outlet. When the crushing began, and this space filled with crushing malt, and the weight of the malt becomes equivalent to that of the iron weight on the end of the lever, the diaphragm valve began to open, allowing enough malt to escape so that a little space was always left for the fresh malt to fall into. This spaec was, however, limited to the utmost, to allow as little air-space as possible. As oxygen was necessary to produce an explosion in flour, the danger was much reduced by this arrangement. A third safeguard was to have a short spout, about 12 inches in diameter, leading from the space immediately below the rollers into the open. The outer end of this spout was covered with a piece of flannel, which prevented the flour from escaping, but which would be torn asunder by the pressure of an explosion, or burned by its fire, thus prevneting the destruction of the mill housing. If the miller was in attendance, and stopped the flow of the malt quickly, the burning malt would be prevented from being elevated into the hopper, the diaphragm valve preventing that. The Americans had introduced a very ingenious weighing arrangement, which measured and registered the pounds or bushels of malt passing into the mill automatically, and which could be set to a certain quantity, so that when this was reached the action of the weighing machine stopped, and allowed no more malt to pass.

On the top floor of the gravitation system brew-house the water-tanks, in which the water for the brewing was boiled, and the crushed malt-hopper, were located. On the floor below the mash tun or tub; this was built of iron, steel, or wood; in America and Germany sheet-iron and steel were used, and in England wood and cast-iron, which was made in sections and bolted together. The latter was a very heavy and clumsy contrivance; the sheet-iron structure was far preferable. All these mash-tuns were fitted with a perforated false bottom, which was made in sections, each section overlapping the other where they met. In America and Germany a lighter and more easily handled false bottom made of sheet copper was in vogue, whereas in England this was generally made of cast-brass, gun-metal, or iron, the sections of which must be made smaller on account of their weight, and thus entail more labour and time. These perforations were either small round holes or slots, and in each case they widened out conically towards the lower side of the bottom. The false bottom was placed so that it stood 1 to 2 inches above the real bottom. The real bottom was tapped at several places equally divided, and from these openings copper pipes lead to the periphery of the tun, where they either joined and terminated in one large tap or in as many smaller taps as there were pipes. For many reasons the latter arrangement, although a little more costly at first, was preferable. In a wooden tub with a false bottom and a battery of pipes beneath they had a mashtun as it was used before hand or steam driven, labour-saving machinery was introduced into breweries. The mash of those days was performed by putting the whole or part of the mashing water into the tun and letting the malt run slowly into it, keeping the whole constantly stirred with pieces of wood shaped something like an oar, or with mash forks.

The brewery of to-day that could lay any claim to modern and rational equipment had fitted to its mash tun an external and an internal mash machine. The external when driven with steam power was a cylinder about 12 inches diameter and 3 to 4 feet long, through which ran a shaft on to which were fastened paddles an done turn of a disc worm. The shaft was driven by a pulley. The malt or "grist," together with the water, entered this external mash machine from the top at one end and left it thoroughly mixed at the other, where it fell into the mash tun. There were other external mash machines which worked without steam power, on the principle of gravitation and friction, but these were not so commonly used.

The internal mash machine, or rake, as it was manufactured in England, consisted of a vertical shaft driven from a spur-wheel and placed in the centre of the mash tun. About two feet from the bottom there was a horizontal shaft which was driven by a bevel-wheel on the vertical shaft. On this shaft, paddles or shovels were fixed which, while the horizontal shaft travelled around the vertical shaft, also turned around its own centre, and the paddles thereby performed the mixing or "mashing" of the "goods" (malt and water). The horizontal shaft was nearly as long as the radius of the tun and rests, and was guided on the far end by spur-teeth fastened to the wall of the tun. This piece of machinery travelled around in the tun from 3 to 15 times a minute.

The mash rakes used in Germany and America were much stronger in construction, and differed from the English machine inasmuch as they had two horizontal shafts and were geared to a higher speed—from 15 to 30 revolutions—and, as two horizontal shafts were used, these machines accomplished about four times the mixing that the former did. The construction also differed in that in the latter the ends of the shafts are not supported by teeth around the walls of the tun, which entailed much labour in cleaning, and had also a tendency to increase friction. The ends of the shafts in these cases were supported by two strong cast-iron arms, which extended from the vertical shaft through nearly the diameter of the tun, about 2½ feet above the bevel-wheels. As a rule these rakes were driven from below the tun, the vertical shaft extending through the bottom, to which a stuffing-box was fitted to prevent the liquid from escaping. The great advantage, apart from any mechanical view, was that the oil which was used for lubrication could not drop into the mash. It was needless to say that all bearings of the rake were kept lubricated by the water of the mash.

A disadvantage which was experienced in connection with the rakes was that as the horizontal shafts with these paddles remained in the "goods," the grains, or the skins of the grains, through which the "wort," or malt extract, should percolate, formed channels along the paddles, in this way allowing the escape of the sparging water, which was administered from above by a sprinkling apparatus, without draining through the grains, thereby leaving large quantities of extract matter in them, always causing material loss. This drawback had been overcome by an American invention. Around the lower part of the vertical shaft a hydraulic jacket was formed, and a small hydraulic hand-pump was placed next to the mash tun, and was connected from the bottom through the stuffing-box to the jacket; and when this pump was set in motion the mash rake was bodily lifted out of the "goods," by the vertical shaft. This movement was guided by a feather, which ran upward on the shaft, and thus also kept the movable parts of the rake in the same position always relatively to the shaft. Two more valuable advantages were offered by this arrangement. Many brewers, when the first wort has run off and when sparging, preferred to break up the filter-bed formed by the skins of the malt, and allow it to re-form, in this way loosening it and making good any defects in the way of channels and so on; this was done with the rake. If the rake was buried in the "goods" from which all liquid was withdrawn, to start it meant that it had to stand a heavy strain until the filter-bed was loosened and sufficient water had flowed in. With a rake which could be raised out of the "goods" on completion of the mash it was different. The rake was set in motion, and then the water in the hydraulic jacket was allowed to escape slowly, so that the rake also sank, but gradually, into the "goods"—an inch, or the smallest fraction of an inch, at every revolution. What this meant by way of minimising any strain on the machine and driving gear was at once apparent. A further reform consisted in the rake being fitted with a scraper, which was situated about half-inch above the false bottom, and fastened on to the rake; the whole of the refuse grains could be removed from the tun though a 14-inch opening in its bottom, which was located in the half of its radius. Formerly this work was done by manual labour, which was performed at a temperature of about 160deg. F.

The main features of a mash tun and its equipment must be to facilitate the objects of the mash in the highest possible degree. During this process the starch of the malt was converted by the enzyme diastase into the different malt sugars; some of these were fermentable and others were not. Collectively, these were called the malt extract, but also contained other matter, as, for instance, nitrogenous substances. The ratio in which these matters stood to one another was known as the chemical composition of the "wort." The chemical composition of a wort was in a very large degree dependent on the temperature employed, and the time the temperature was allowed to prevail. It was, of course, of the utmost importance that the brewer should be able to control them absolutely, which was only possible when the temperature throughout the mash tun could be kept even, which again was only possible when the rakes were sufficiently strong and rapid in their motion to equalise any differences without delay. These differences were bound to occur where hot mash water was run into a mash somewhat of the consistency of porridge. So much for the qualitative results to be obtained from a mash tun. But these went hand-in-hand with the quantitative results, and were dependent on the mechanical equipment of the tun. Malt contained theoretically 68 to 75 per cent. of extract matter, but the practical yield often was no more than 55 and 50 per cent. with an inferior milling and mashing plant; whereas 64 to 70 per cent. might be looked upon as a good result. What had been said with regard to mash tun equipment was of equal moment to the infusion, decoction, or semi-decoction methods of mashing.

In America and on the Continent, two-armed internal mash machines, or rakes, were universally used; and in England, the one-armed rake was now rapidly finding its way into the breweries. In Australasia, however, in the greater number of breweries they were still conspicuous by their absence. This might be accounted for to a large extent by the fact that there was no engineering firm in this country which made the requirements of breweries a special study, and thus most of the machinery had to be imported, which was a drawback in more ways than one. Brewing in this country was, so to speak, still in its infancy, and if this industry had assistance from engineers who made its wants and needs their business, there was hardly a question but what the Australasian brewing industry would work out and form its own methods the same as America did, and in this way overcome many a difficulty our climate put in the way. With approaching Federation, a firm of engineers, making a study of brewing engineering, should find profit for themselves, at the same time rendering a great service to the brewing industry.

With the addition of a lift, the English or Colonial brew-house contains hardly any more machinery, excepting some pieces of apparatus such as the surface cooler and refrigerator (the former being dispensed with in many countries on account of the danger it carried with it regarding infection from the atmospheric air), hop-back, hop press, and other minor utensils. Where raw grain was used, a gelatinising apparatus found its place in the brew-house. A modern brew-house was constructed and equipped so that manual labour was reduced to a minimum, the whole of the work, excepting cleaning only, being done by steam power.

Some of the American breweries had also replaced shafting and the gearing belonging to it by electric transmission. A large dynamo in the engine-room supplied motors, situated in the various departments, with the requisite power. Quite outside of the economic aspect this arrangement considerably promoted cleanliness, so essential in brewing.

The equipment of the ale cellar was, as a rule, very simple, containing the vessels for fermentation and travelling casks only. There were several systems of fermentation in use for top fermentation, and they were known under the following names:—Cleansing, Skimming, and Burton Union systems. All three found strong advocates. The arrangements of these three systems were also very simple in a mechanical sense, and viewed from the present standpoint of science, left much room for improvement. The Continental, and especially the American breweries, had made much progress in this respect. Not only labour and beer saving machinery and apparatus were to be found throughout the brewery and cellars, but pace had also been kept with modern science. The brewer had been taught that the ordinary cleanliness which was applied and carried out with water, brush, and elbow grease was by no means sufficient, and that sterility in "everything" with which the beer or wort came in contact were what was needed. To accomplish this was far from being a simple matter when they came to deal with huge receptacles such as were empolyed in breweries. Mechanical science, however, came to the assistance of the brewer and accomplished things which only twenty years ago were deemed impossible. The inner walls of wooden tanks had for a great number of years been covered with resin, and also shellac, in America and on the Continent, whereas in England the beer always still came in direct contact with the porous raw wood, excepting where other material such as slate was used. But this covering had found a competitor in glass. In America huge steel tanks were being built; these were lined with a glass enamel. What this improvement meant with regard to cleanliness was self-evident and needed no comment.

Science had further showed us that fermentation was carried on by minute cells (yeast cells) belonging to the plant life; in fact, that each cell, in size about 6 to 8in long and 3 to 6in. in diameter, was a fully constituted plant of a low order. The brewer, for this reason, was in a sense an agriculturist, and as such his main aim must be to create all those conditions which were best suited to the life and welfare of his plants so as to induce them to do their best work for him. These conditions were too well known to need ventilation. One of these conditions was complied with by storing ice during the winter in huge ice-houses built over underground cellars; but these had been again replaced by the chemical refrigerating machines, which he refrained from describing, as he understood that papers had been read by members of the Association whom he knew to be experts on this subject, and an endeavour on his part to say anything more would take up time uselessly. All he wished to draw attention to was a new insulating material, viz., tea-tree bark, which was chemically made fire and corrosion proof, and 1½ inches in thickness, had stood the test against 3 air spaces of 1 inch each (these spaces had been created by four thicknesses of 1 inch timber and 12 layers of B. and P. paper) successfully. This was an Australian invention. He insulated a lager beer cellar with this material in New Zealand last year, and it had given entire satisfaction.

Since it was known that the ordinary brewers' yeast was composed of a mixture of cells of different species, some of them favourable to beer fermentation, others just the reverse, a good cell was singled out and was