The Government Laboratory.

By John Mills.

Illustrated with Photographs specially taken by George Newnes, Limited.

ON the north side of that chief artery of London—the Strand—immediately behind the new Bankruptcy section of the Law Courts, and approached by Clement's Inn Passage, there is a rather extensive building of red brick which possesses, externally, no architectural features of a character likely to arrest the attention of the passing pedestrian. An officer in blue, who acts as guardian of the place behind the swinging doors at the entrance, affords a somewhat uncertain clue, perhaps, to the fact that the structure is a department of the Public Service. If you can manage to get past this sentry you find yourself in a lofty corridor with tessellated floor extending almost the full length of the building, but still nothing to be seen except doors right and left, and flights of stairs at each end, in both cases leading into the basement below and to the floors above. At uncertain intervals, however, you may hear the dull slam of doors in the distance, followed by the sound of active feet on the unyielding pavement, or one of the doors near you may open any time when unexpected and thus afford a glimpse of what is going on within—a man, perchance, decanting a liquid or washing a precipitate, or maybe with his cheeks distended operating the blow-pipe. It is the Government Laboratory.

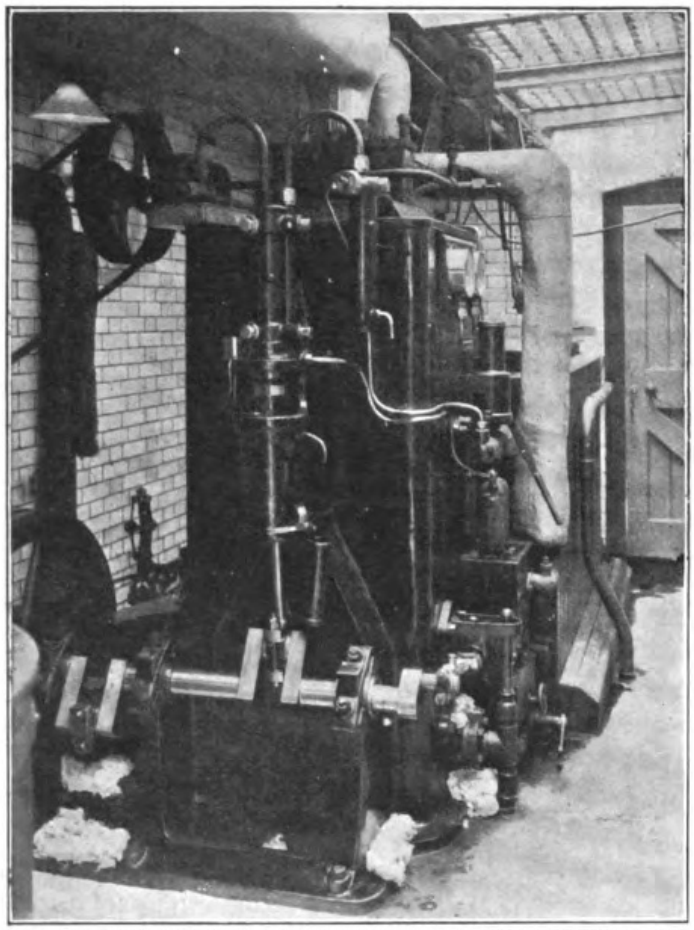
THE COLD STORE-ROOM, CONTAINING BOTTLES OF ARSENICAL BEER, ETC., READY FOR ANALYSIS.

A highly trained staff of chemists is here constantly kept busy in every imaginable form of chemical manipulation. Pass along the corridor and peep into the rooms on either side: it is laboratory after laboratory all the way round, except, of course, the private rooms of the principal and his deputy. Descending the stairs into the basement, there again one enters a long corridor, immediately under the first, with laboratories on one side and store-rooms on the other. Ascending to the first floor, the visitor finds the corridor here abruptly terminated, or rather closed, by large swing doors with glass panels, through which thirty or so young chemists can be seen engaged in analytical work: this is the main laboratory, a large, well-lighted room about 50ft. square, and covered in with a lofty lantern roof; entered from the corridor, outside the glass doors at each end of this principal room, are more laboratories, and stairs lead upwards to yet another floor, where chemists, secluded in specialized departments, exercise their scientific skill in the interests of the State.

The building is, as nearly as human skill can make it, fireproof. The interior walls of all the laboratories and corridors are lined with highly-glazed white bricks, with a dado of similar bricks of blue, yellow, and reddish-brown colour, finished by a row with scroll pattern. The floors, except in the corridors and a few other places, are of pitch-pine parquetry.

Its arterial and venous systems are thoroughly differentiated—the water used in operations in the laboratory being delivered through separate channels to the drains, while the aqueous liquid used as water-jackets for the distillations is lifted by a force-pump into cisterns above the building, to be used over and over again. Water at a constant tem-

perature a few degrees above the freezing-point is supplied all the year round for condensing purposes in distilling operations. The refrigerating apparatus employed is in the basement, but outside the main building. Liquid carbonic acid is evaporated to cool brine, which in turn reduces the temperature of the tank containing water. This refrigerator is also used in making ice to supply the needs of the establishment and for maintaining a low temperature in a specially constructed refrigerating chamber adjoining the main laboratory containing "work to be done"—samples of beer, worts, and other perishable articles which would suffer by exposure to changes in the temperature of the outside atmosphere.



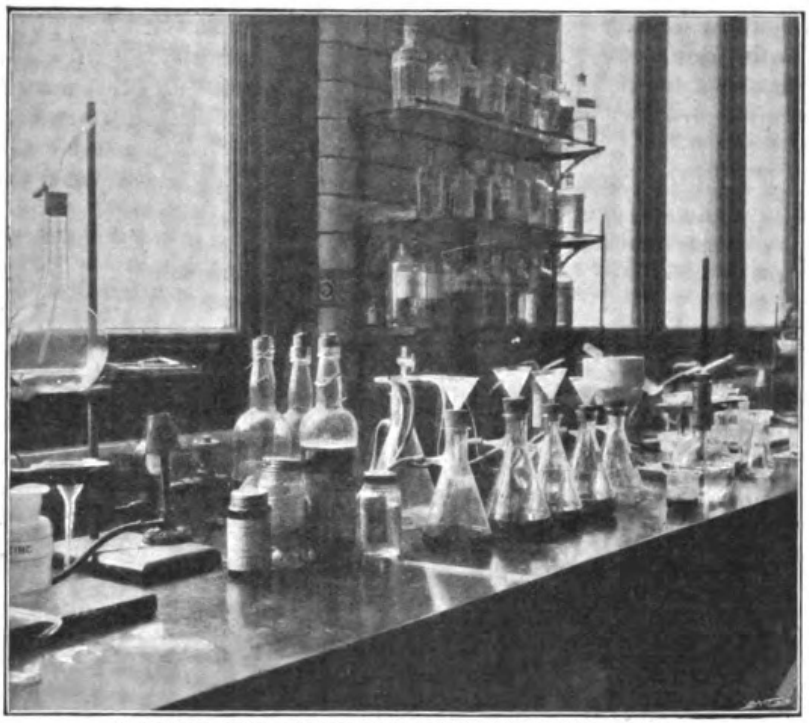
THE REFRIGERATOR FOR COOLING WATER THROUGHOUT THE BUILDING.

Although the Government Laboratory is at the present time an imposing institution and the most perfect of its kind, the day of small things is not long past. Some fifty years ago the late George Phillips began the work in one or two small rooms at Arundel Street, Strand, when the Excise Department intrusted him with the duty of detecting adulteration in tobacco. Soon other branches of the Excise recognised the value of chemistry as an auxiliary, and Mr. Phillips found it expedient to devise methods for determining the original gravities of beer and other fermented liquors.

More convenient premises were found for this branch of the public service in 1859 at Somerset House, right at the top of the west end of the building. Very early in the history of the laboratory other Government departments began to seek the aid of Mr. Phillips, the Stores Department of the India Office being one of the first, with its frequent dispatches of large quantities of all kinds of supplies for the use of the railways, telegraphs, and other public works in India, as well as much food and medical stores for the troops. To assist in controlling the quality of these articles it was arranged that samples from all tenders and supplies sent in by contractors should be systematically examined by the Inland Revenue chemical staff.

From a couple of rooms at Somerset House the laboratories gradually extended till more than twenty rooms were occupied, and the number of samples analyzed increased from 9,055 in 1867 to 39,224 in 1887, and in 1897 the enormous aggregate of 64,664. Professor Thorpe, soon after his appointment as principal chemist, came to the conclusion that new laboratories in a building specially constructed for the purpose would be much more satisfactory than any further extension of the old premises. The Treasury agreed to his proposals, and the present Government Laboratory, opened in 1897, was constructed in accordance with his designs, and embodies all the recent improvements and appliances calculated to facilitate every branch of analytical chemistry.

The recent epidemic of arsenical poisoning attributed to beer caused a thrilling sensation throughout the country. At the time I visited the Government Laboratory this grave subject was under the consideration of one section of the department, and many samples of the condemned or suspected beverage were under examination. I was permitted to look at the arsenic extracted from beer which had been submitted to the most searching chemical analysis. There the poisonous element was in the form of sulphide, a bright yellow powder, pleasing

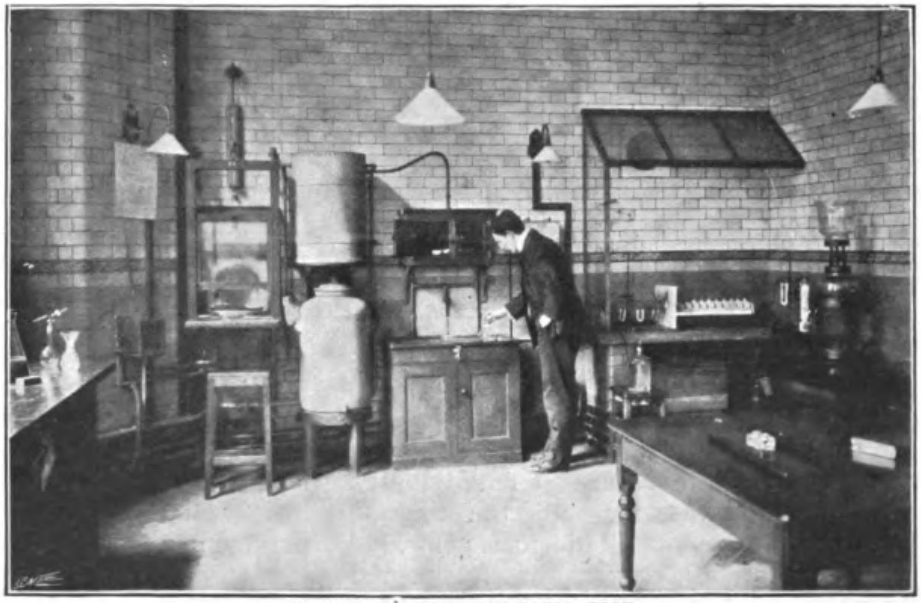


ARSENICAL BEER AND SUGAR SAMPLES UNDER EXAMINATION.

to the eye and very much in evidence, but how terrible a scourge is sufficiently attested by the published figures. I also saw the naked arsenic itself in the form of a black, lustrous mirror which had been deposited inside a glass tube in the process known as Marsh's test ; by means of this test the most minute traces of arsenic can be detected.

In 1899 many letters appeared in the *Times* on yew-tree poisoning—a question of considerable importance to the agricultural community, as, until we have ascertained the exact nature of the poison, we are not likely to find the remedy. Although the poisonous principle contained in the yew is at present unknown, there are numerous cases on record of death resulting not only in cattle, but human beings, from eating the leaves and berries of this tree. Gilbert White, in his antiquities of Selborne, says: "The twigs and leaves of yew, though eaten in small quantity, are certain death—and that in a few minutes — to horses and cows." A singular fact bearing on this subject is related on the authority of old Scottish history "that the northern part of Ireland was so much infested by yew trees that a great emigration of Irish took place in consequence, who, with their families and cattle, went over to Scotland, these yew trees everywhere destroying their cattle in Ireland."

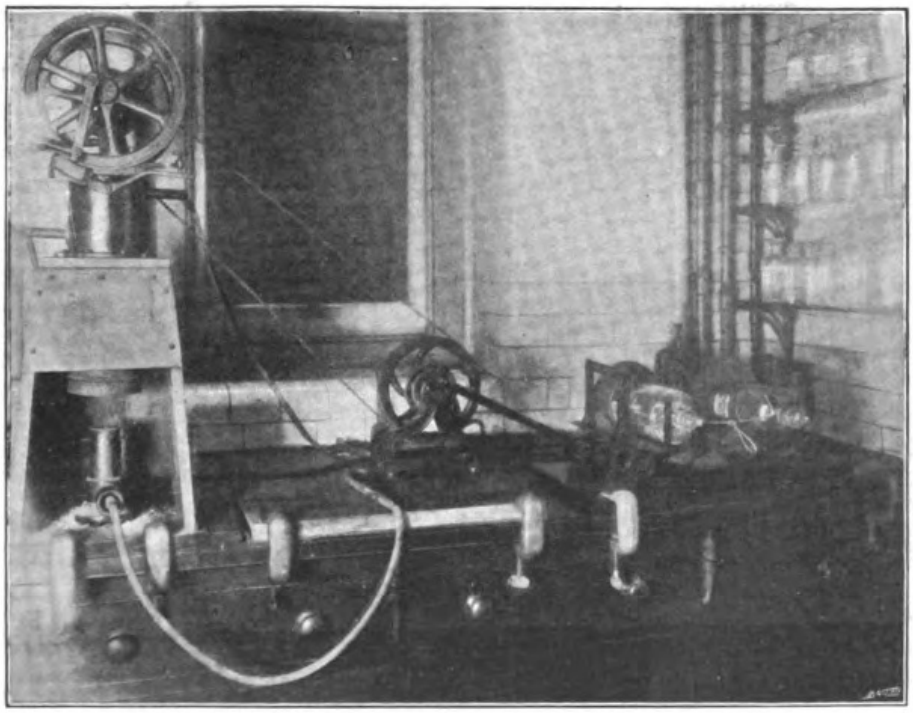
The ancients held that wine kept in yew vessels was poisonous, and it is a curious fact that the tree is avoided by insects. Many recent cases of yew-tree poisoning have been brought to light, general absence of knowledge by medical practitioners on the subject commented on, and the question raised whether this phase of poisoning is not one on which, to a great extent, ascertained scientific "facts" so called are at fault. I had forgotten all about these interesting letters until my visit to the Government Laboratory resurrected the whole affair. Though dead to the public these many months the yew-tree question has found a domicile in the Research Department of this institution, and the poisonous principle is under careful investigation by the chief chemist.



DR. THORPE'S RESEARCH LABORATORY.

Some years since a great agitation was set on foot about lead-poisoning in the Potteries, and in 1893 the Home Office clearly established the fact that lead-poisoning prevailed extensively. Professor Thorpe, the Government chemist, was engaged in a Royal Commission, and instituted experiments in the Government Laboratory to ascertain how far the danger may be diminished by substituting for the "white lead" ordinarily used some less soluble compound of lead. By far the greater portion of the domestic and sanitary ware and china, glazed bricks, wall and hearth tiles, door-knobs, finger-plates, fittings for electric-light installations, and countless other articles are glazed with materials containing compounds of lead.

The potters are now required by the Home Secretary to abandon the use of raw lead. The "fritts" used are examined as regards their solubility at the Government Laboratory. Our illustration shows the apparatus used by Professor Thorpe in ascertaining the amount of lead extracted from "fritts" and "glazes" by means of dilute acids, comparable as regards their action with that of the gastric juice and the animal solvents.



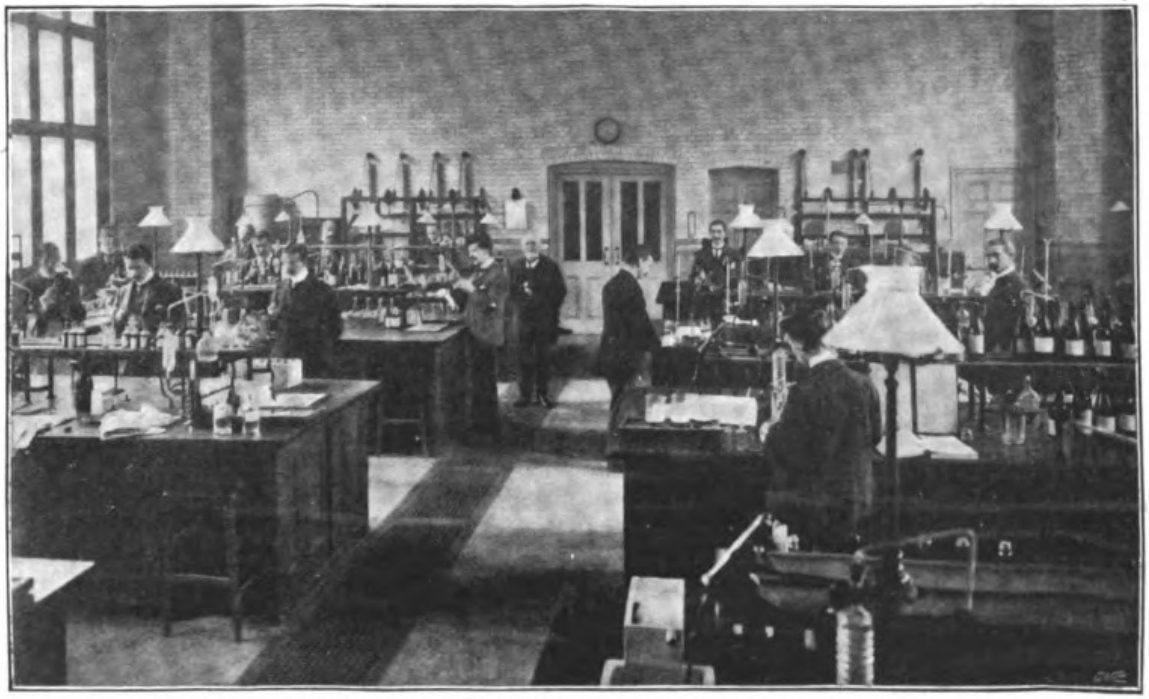
MOTOR ROCKER USED IN EXTRACTING LEAD FROM FRITTS AND GLAZES.

Last year the India Office referred to the Government chemist the subject of the use of artificial or synthesized indigo as compared with the natural product, the growth and preparation of which is so important an Indian industry. This arose out of a public discussion in the Press about the way in which the indigo industry in Bengal was threatened in consequence of the manufacture of indigo artificially in Germany. When we consider that this industry is worth about £4,000,000 annually to the Indian planters, and the Germans are on the way to slay the ancient industry by making indigo in the chemical laboratory, it will be seen that the stake to be played for is a heavy one.

In this way the principal chemist of the Government Laboratory is called upon from time to time to confront any analytical problem which may arise for the benefit of the whole or a part of His Majesty's subjects. He has to steer this dry-land ship, manned by a crew of a hundred hands or so, and, like the captain of a battleship, must depend on his own resources in every emergency. If an entirely new problem arises he may have to play the part of engineer, architect, and chemist, all rolled into one—construct his own apparatus, invent mechanical auxiliaries, and sketch out plans of attack and defence, for chemical work—especially in the unexplored region—is not by any means free from danger.

The scope of the Government Laboratory has widened from year to year until at the present day nearly all Departments seek the assistance of the principal chemist in controlling their contract supplies—the Admiralty, Board of Agriculture, Board of Trade, Colonial Office, Commissioners of Works (London and Dublin), Home Office, India Office, Local Government Board, Post Office, Stationery Office, Trinity House, and the War Office may be instanced. The regular work of the institution may be roughly divided into four distinct departments: (1) the main laboratory, wholly reserved for the analysis of alcoholic products—beer, wines, tinctures, rum, brandy, etc.; (2) the

tobacco-rooms, fitted with appliances for the examination of manufactured and the so-called "offal" tobacco, for the determination of fraudulent or improper admixtures; (3) the Board of Agriculture Department, where all cases of disputed analyses of fertilizers, etc., are referred here, and on which the decision of the principal chemist is final; (4) the Crown contracts laboratories, in which all manner of substances may from time to time be examined, from the gilt buttons and gold lace on the uniforms of our naval and military grandees to the steel rails of a railway.



THE MAIN LABORATORY: TESTING ALCOHOLIC DRINKS, BOTANIC BEERS, TINCTURES, ETC.

The main laboratory presents a scene of extreme activity, and one is almost bewildered by the variety of operations in which the many chemists are engaged. There is a profuse distribution of bottles of all kinds of alcoholic drinks, tinctures, etc., on the top shelves of the benches—the work set out for the day. The operation of kicking out the carbonic acid from beer is performed by a sort of electric screw revolved rapidly in the liquid. An abundance of froth rises to the surface, and, as the bubbles break, carbonic acid escapes. A measured quantity of the beer is then weighed for the purpose of determining its specific gravity, and it is then transferred to a still, by which means the alcohol, under the influence of heat, distils over into a receiver. In this way a distillate is obtained richer in alcohol than the original beer, and the distillate, when weighed in the balance, indicates a different specific gravity, which enables the chemist to compute the percentage of alcohol in the sample of beer under examination.

The number of analyses and examinations made in the Excise branch last year amounted to 68,287. Seven thousand five hundred and two samples of wort in various stages of fermentation had been examined to check the declaration of gravity made by the brewer. Two thousand three hundred and eighty-six samples of finished beer, taken from 1,223 publicans, were analyzed, and 319, or 13 per cent., of the samples were found to have been diluted with water or otherwise adulterated. The practice of diluting beer by publicans is almost entirely confined to London! Beer of a heavy brew has always been regarded as the typical drink of all Englishmen. John Bull is looked upon by foreigners as a man of little polish, few manners, and much beer and beef. Large numbers of persons confine themselves mainly to alcoholic liquors, and others imagine that their physical salvation lies in their taking no hot drinks, while another school of faddists tell us that the food we eat contains all the moisture that the body requires, and that liquids are a source of weakness.

Originally the Government Laboratory was established for the purpose of assisting the authorities in collecting and protecting the revenue derived from excisable and dutiable

GOVERNMENT CONTRACTS LABORATORY—GENERAL VIEW.

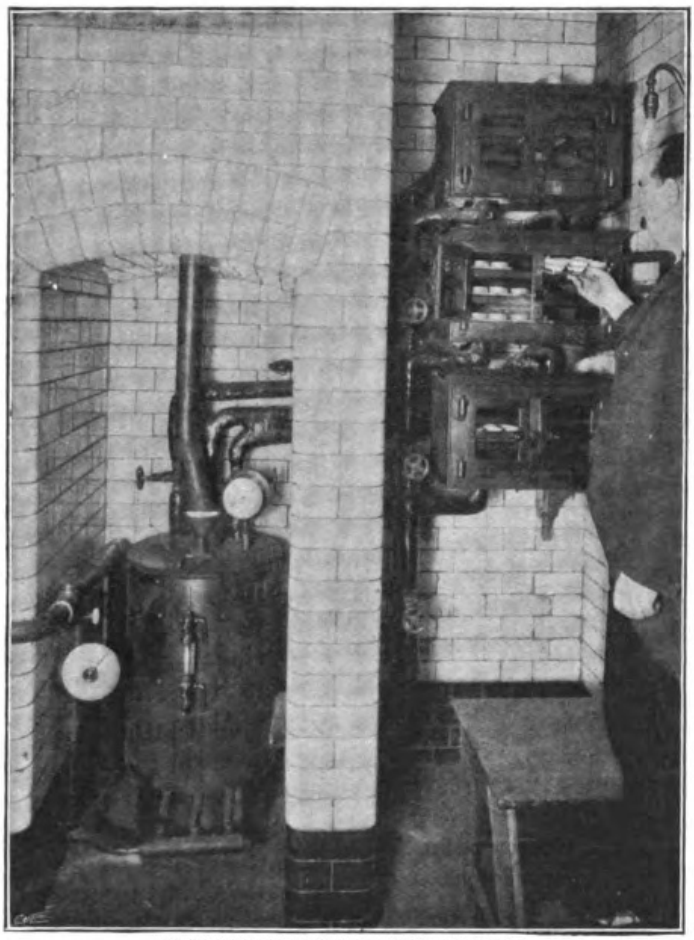
articles. How effectively this has been realized is clearly seen in the results which attended the change in the method of testing imported spirits in 1881. Previous to that date the practice was to assess the duty solely by means of the hydrometer, a method which fails to indicate the true percentage of spirits in most cases when colouring or sweetening matter is present; by substituting the method of testing by distillation a saving of about £180,000 was effected in the Customs' revenue.

As long as spirits are in bond they are duty free, but on being taken out a heavy duty becomes leviable. A certain quantity of the spirits becomes absorbed in the wood of the casks, and this amount is practically duty free. It has been found, however, that traders know a process by means of which they can extract the spirit from the wood. By soaking in water two or three gallons in some instances may be obtained from a large cask. This process of extracting spirits from casks is known as "grogging." In the year ended 31st March, 1900, legal proceedings were taken against seven persons for the unlawful exercise of this gentle art of grogging.

About a thousand samples of herb, ginger, and botanic beers were analyzed last year to ascertain if the proof spirit present was within the legal limit of 2 per cent. One-fourth exceeded the limit; nineteen samples contained 4 per cent., and the highest reached as much as 7·6 per cent.! While, however, the interests of the people at large are jealously guarded by our official chemists, the small vendor sometimes finds himself in an unenviable position; indeed, it is an easy matter for a salesman realizing a profit of three or four pounds a year on an article to find himself called upon to pay a fine of three times that amount for an offence which, in some cases, can hardly be regarded as premeditated.

The tobacco laboratory is provided with special drying ovens for expelling water from the fragrant weed, and so, by the diminution in weight, estimating the moisture contained in it. The drying ovens, three in number, are placed on the wall one above the other, and steam for heating them is generated in a special boiler standing close by. For carbonizing the tobacco and so ascertaining the solid matter in it a special furnace is employed. The flame can be regulated so as to play uniformly over the under surface of the platinum dishes containing the tobacco, which are supported on a light wrought-iron nickel-plated grid. The furnace is capable of holding forty dishes at one time and so treating as many samples simultaneously. The incineration of the samples is completed in three muffle-furnaces, of special design, heated by gas. Ninety-five samples of tobacco taken from manufacturers and dealers were analyzed last year for adulteration generally, and twenty of them were found to be adulterated with liquorice or glycerine. All the adulterated samples were apparently either smuggled cake cavendish or cut tobacco which bore no label to show it had paid the proper rate of duty.

Under the old moisture limit there were allowed thirty-five parts water and sixty-five parts tobacco, but under the new regulations



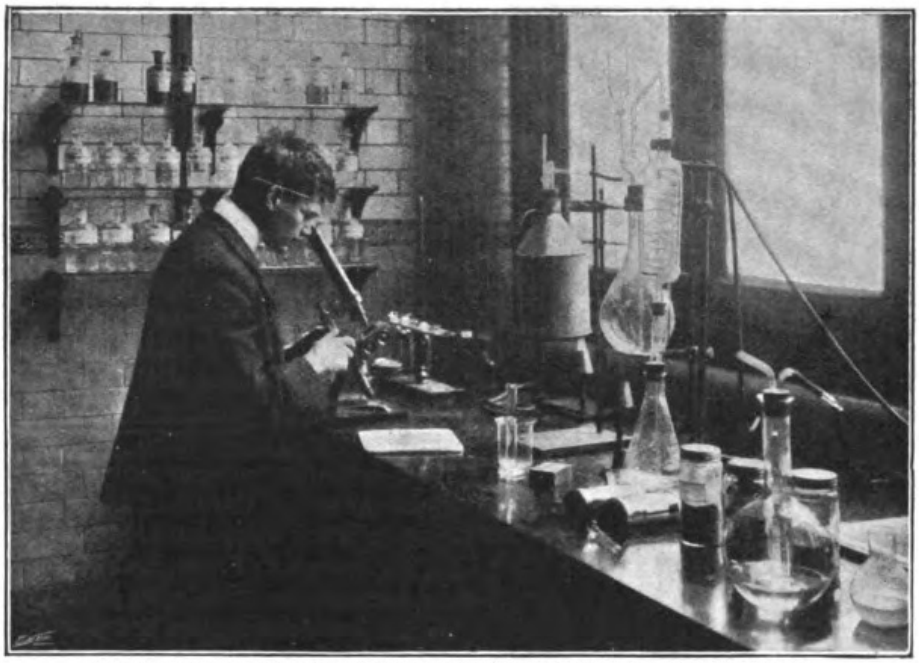
EXTRACTING MOISTURE FROM TOBACCO.

only thirty parts of moisture are allowed to seventy parts of tobacco. The 30 per cent. includes the natural moisture of the leaf, which varies from 13 to 17 per cent., and, as it is difficult to manufacture tobacco so that the manufactured article shall contain in every part of a pound exactly thirty parts of water, manufacturers allow a margin varying from 2 to 3 per cent. in working. Tobacco now sold contains more real tobacco and less water than formerly. There is probably no country in the world where the smoker obtains such pure tobacco as in Great Britain, because of the strictness of the Excise laws.

In the analysis of foodstuffs the object aimed at is protection against fraud in, for example, the sale of margarine under the name of butter. Margarine may be a wholesome and palatable form of food for those who can only afford to pay a moderate price and who are not given to inquire too curiously whether they are consuming animal fats ingeniously manipulated or the products of legitimate dairy produce. The ordinary farmer makes real butter, and he has to confront the competition of the manufacturer of what looks like butter, and is sold as such, though it is quite a different thing —an artificial product which may deceive the eye and even the taste. The colouring of margarine is not done to affect the taste, but to impart to it the appearance of butter.

The number of samples examined in connection with the Board of Agriculture during the last year was 1,745. One thousand three hundred and ninety-three samples of imported butter were examined. A large number of butters contained boric preservative, and were artificially coloured. As usual, it was found that the use of boric acid is most prevalent in France, Belgium, and Australia, and is very common also in Holland. The most frequent colouring-matter is annatto, but the use of coal-tar yellow appears to be on the increase, and is especially prevalent in Holland, the United States, and Australia. One hundred and thirty-two samples of imported margarine were analyzed. The bulk

FURNACE FOR INCINERATING TOBACCO.

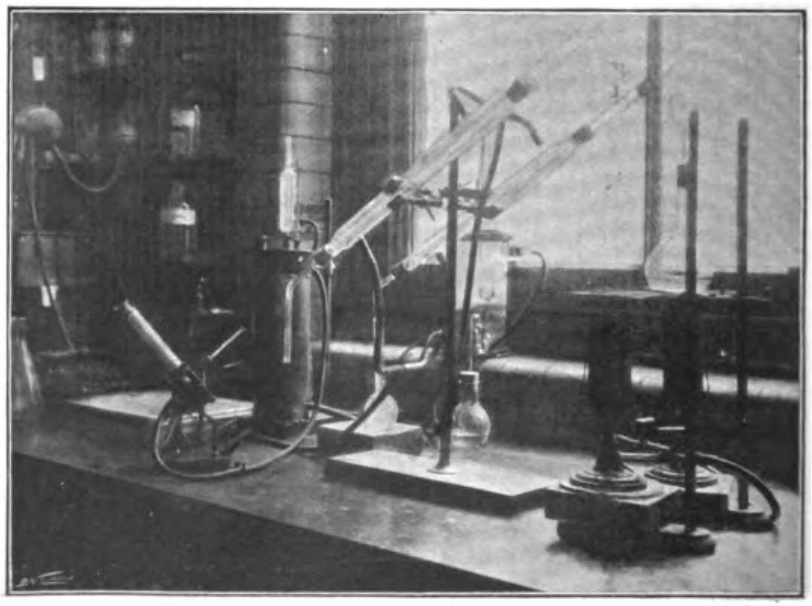


CROWN CONTRACTS LABORATORY—SOLDIERS' RATIONS UNDER THE MICROSCOPE.

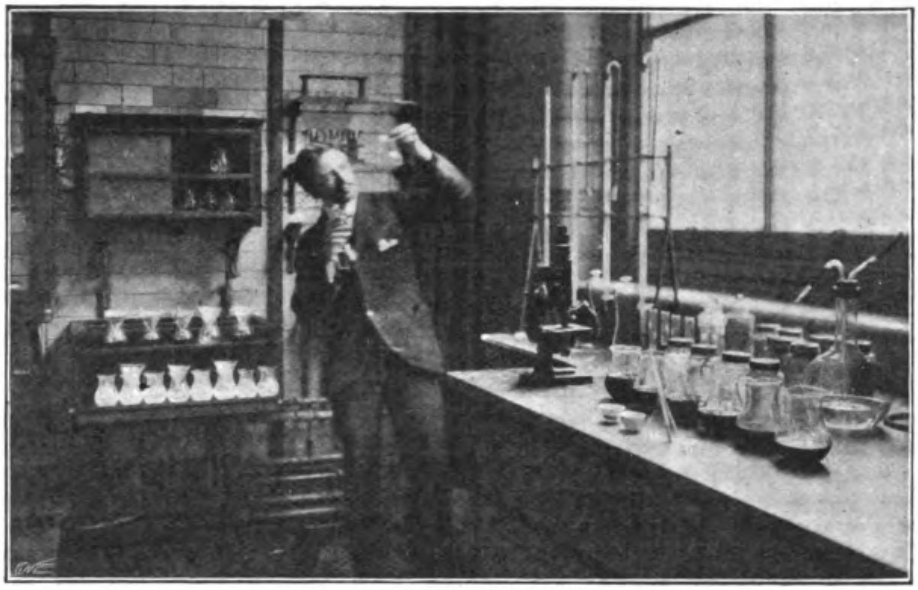
of the margarine imported comes from Holland, and it is usually made with cotton-seed oil, contains boric preservative, and is artificially coloured with a coal-tar yellow. Analyses of milk under the Food and Drugs Act most frequently indicate dilution with water, fat, and in rare cases the somewhat novel double charge of dilution with water and addition of starch.

How can the analyst detect foreign matter in, say, butter? One method is by means of a specially constructed microscope. The pure article, when melted and a ray of light passed through it, has a definite refractive angle for a given temperature, and when foreign matter is present the refractive angle varies according to the nature of the substance added. Hence, a sample of butter is put in the instrument and melted by hot water from a conical vessel introduced into a jacket in the microscope by means of indiarubber tubing. The temperature is then registered by a thermometer, and the angle of refraction is read off on a graduated scale in the field of view. The proportion of butter fat may be deduced by distillation of the "volatile acids." Then there are specimens of butter, margarine, and so on kept in the laboratory of known composition. So that any sample submitted for analysis may thus be confronted by several independent witnesses, so to speak, as to the purity or otherwise of the subject under examination.

Public attention has often been called to the dangers that may arise from the careless use of the more volatile descriptions of petroleum, commonly known as petroleum spirit. Not only is the vapour therefrom, which is given off at ordinary temperatures, capable of being easily ignited, but it also forms, when mixed with air, an explosive atmosphere. It is therefore necessary, in dealing with and handling the spirit, to take strict precautions by the employment of thoroughly sound and properly-closed vessels, and by avoiding the use of naked lights in dangerous proximity to prevent leakage of the spirit and the contact of any form of artificial light with the highly inflammable vapour which it is always



BUTTER-TESTING APPARATUS, FOR DISTILLING THE VOLATILE ACIDS AND MEASURING THE ANGLE OF REFRACTION.

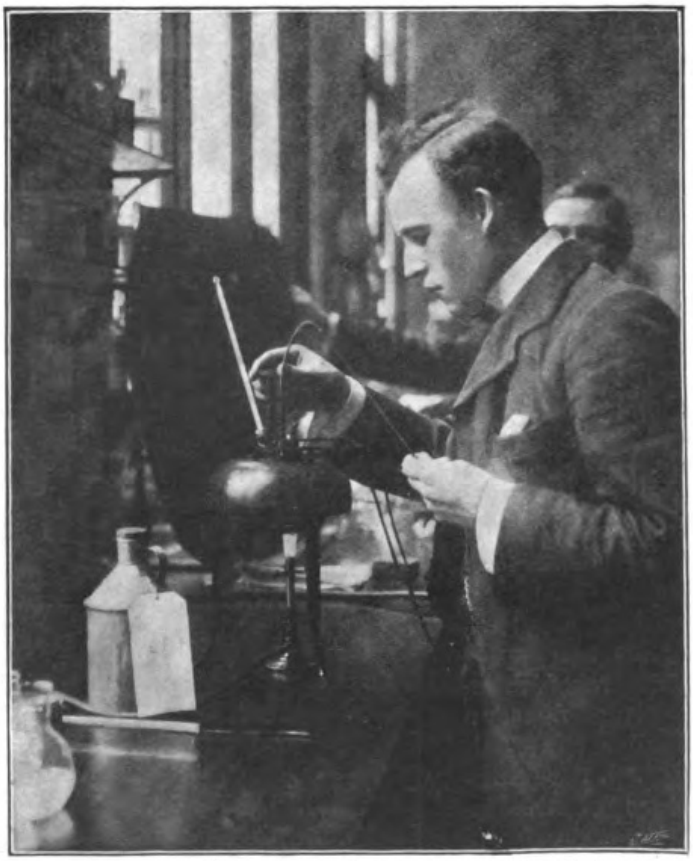


TESTING BUTTER AND CHEESE.

evolving. The oil allowed to be burnt in England must not "flash"—that is, give off inflammable vapour in a *closed* vessel—at a temperature below 100deg. Fahr. It was not until 1859 that the use of petroleum for illuminating purposes commenced to be general. Prior to the introduction of these oils only animal and vegetable oils (excepting oil of turpentine, which was employed to some extent under the trade name "camphine") had been used; they possessed many of the qualities of tallow, and were capable of being burned with a small wick and with free exposure to the air.

The petroleum oils, however, are of an entirely different nature, containing much more carbon and hydrogen than do the animal and vegetable oils, and are far more volatile and inflammable. They must be supplied in a regulated quantity to the flame and with a proper amount of air, or a smoky and objectionable lamp results. The enormous number of lamps which are now in use, and the necessity for fixing an arbitrary limit for the volatility and inflammability of the oil which may be used in them, and the conditions under which the oil may be stored, conveyed, and sold have given rise to much legislation.

Legislation in this and other countries is mainly based on what is known as the "flashing" point, which means the temperature at which the oil gives off an inflammable vapour. This is, of course, lower than is shown by the fire test, *i.e.*, the temperature at which the oil itself will take fire. The Acts of 1862 and 1868 in the United Kingdom included under the term "petroleum" such oil as gave off an inflammable vapour at less than 100deg. Fahr. by what is known as the open test—that is, when warmed in a vessel exposed to the air; but as this test was found to give varying results in different hands it was replaced in the Act of 1879 by the closed cup, or Abel tester, in which the oil is warmed in a closed vessel and is only exposed to the air at the moment that the testing flame is applied. The recent Petroleum Committee appointed by Parlia-



TAKING THE "FLASH-POINT" OF OIL FOR LIGHTHOUSES.

ment decided that 100deg. Fahr. "Abel close-test" is the safe medium. Here in the Government Laboratory all kinds of oil are tested, from those which "flash" at about 70deg. Fahr. up to 200deg. Fahr. Our illustration represents one of the Government chemists testing the "flash" point of a sample of lighthouse oil.

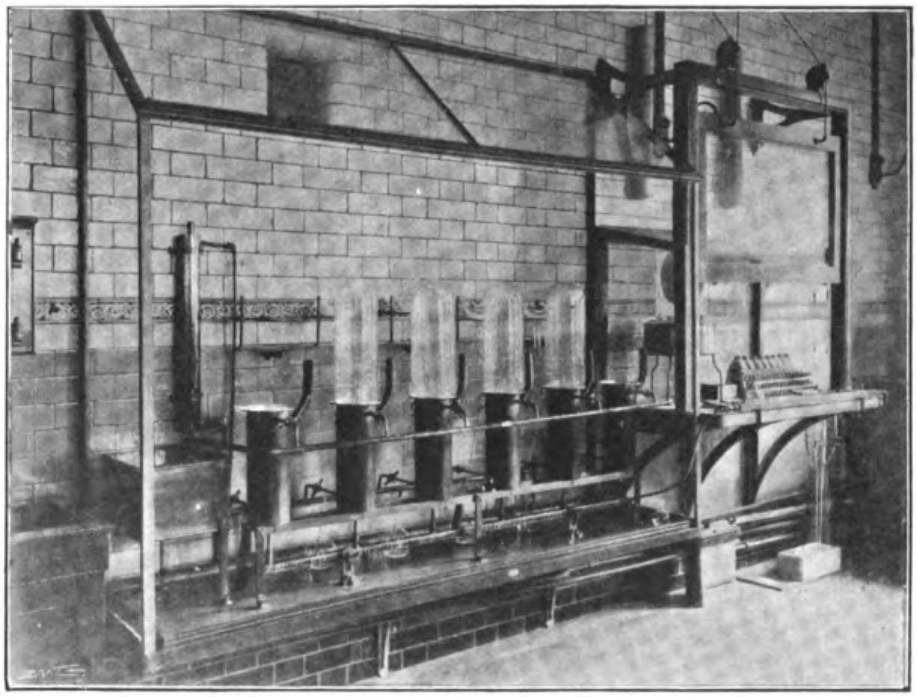
A specimen of steel may be under examination for sulphur, and if more than a regulation amount is found the steel is condemned as unfit for a particular purpose. The steel, as filings, is dissolved in acid by which means the sulphur in it is set free, and this free sulphur is converted into lead sulphate by a roundabout process, a definite compound in which the proportion of sulphur is known. And so the sulphur which before existed in the steel in an unknown proportion is now united with lead in such a ratio as admits of computing its proportion in the original sample of steel.

All tea imported as merchandise into and landed at any port in Great Britain or Ireland is subject to examination by persons appointed by the Commissioners of Customs. Samples of such tea, selected at the discretion of the inspectors, are sent to the Government Laboratory for chemical and microscopical analysis. In the Customs Department during the last year 226 samples of tea, representing 3,322 packages, were found to contain exhausted leaves or to be mixed with sand or other substances, and were refused admission for home consumption. Of these packages 2,274 were exported and 1,048 destroyed. It is estimated that the Anglo-Saxons are by far the biggest tea-drinkers in the whole world, and that in this way we contribute largely to the prosperity of the four countries which are the chief sources of supply — British India, Ceylon, China, and Japan. This most interesting return shows that, although the attractions of the innocuous cup are winning fresh adherents in the United States, all Europe treats tea with disdain. In Russia, Germany, and France the amount used by each person every year is less than 1lb. a head, the consumption in the last country being infinitesimally small. The figures of the consumption per head for the past three years for the English people at home are as follows: 1897, 5·81lb.; 1898, 5·86lb.; 1899, 5·98lb. Fourteen per cent. of the tea imported comes from foreign countries and 86 per cent. from British possessions. The production of coffee, like that of tea, is largely increasing—has, in fact, doubled in the last ten years. But the Anglo-Saxon race are not responsible for this growth. Coffee, in fact, holds the same place in England that tea does in Germany.

Here also large numbers of hydrometers are received from outports and examined. After verification they may be issued to officers throughout the kingdom. Other instruments, such as slides, calipers, rules, rods, measuring vessels, and so on, required by the service for gauging, sampling, and testing, are calibrated and tested before leaving the Government Laboratory.

On the death of Sir Edward Frankland in August, 1899, the Government chemist was requested by the Local Government Board to undertake the analyses of the London water supplies, and there is now a special room in the laboratory fitted up for this purpose. Water is, of course, such a powerful solvent that it is almost impossible to obtain

TESTING HYDROMETERS.



SPECIAL APPARATUS FOR TESTING LONDON WATER.

it in a state of perfect purity. The nearer you ascend to the source of a river the freer it becomes from contaminations, but there are still held in solution many substances, as, for example, those dissolved out of the surface soil and strata with which the water in its course comes into contact. When we consider that London requires something like a hundred million gallons of water each day for drinking, domestic, trade, and other purposes, and that the modes of contamination are legion, it becomes apparent that the waters supplied to the Metropolis need a physician. The possibilities which might follow in the wake of neglect on this point are terrible to contemplate. Diagnosis and prescription are constantly required to detect and eliminate such foreign matters as may jeopardize the public health.

The calamity which overtook the inhabitants of Maidstone in 1897 is an instance of what may happen if vigilance in these matters is relaxed. This town enjoyed the reputation of being a healthy locality with a low death-rate and an enviable freedom from typhoid fever—circumstances which, when the first cases of the epidemic became known, pointed to some specific and serious sanitary defect, and no time was lost in endeavouring to trace the source of the mischief. All the world knows that a more striking instance of guilt has never before been brought home to a particular water supply.

In the course of the year 1899 it was decided that all passenger ships should be required to carry a filter capable of delivering water free from micro-organisms. There were many sources of water-supply formerly within the City of London in the form of superficial springs. These have been sought after on account of their coolness and sparkling condition. Any praise given to sources of this kind generally illustrates the fallacy of popular judgment on such subjects, and shows how easily those qualities of coolness and freshness, which are absent from stored waters, impose on the palate, and induce a preference to be given to waters which are relatively most objectionable.

Water sources within the immediate vicinity of graveyards derive products of animal decomposition from the soil. Not very long ago a celebrated pump within the City of London—that adjoining St. Bride's Churchyard—was abandoned on account of such impregnations. Or, perhaps, I should say that it was not *abandoned*, for till almost the last moment the neighbours adhered to it with fondness; but the parochial authorities, alarmed by the proximity of cholera, caused its handle to be locked.

Chemical laboratories, of course, bear a close resemblance to each other, but there are reasons why the one at Clement's Inn Passage should be, to some extent, familiar to all. It is a factor, however small or indirect, in our daily lives; it is unique of its kind, and includes in its construction all the best features of existing laboratories, ignoring their defects.

A process of evolution has wrought in recent years a change in chemical laboratories comparable with the elevation of the human race from the barbarous to the civilized condition, and for this happy result at Clement's Inn Passage we are indebted to the wide experience and sound judgment of Dr. Thorpe, the principal chemist.