General Report on British Acetones
Toronto Limited
July 14, 1917

Edward Metcalfe Shaw
Engineer-in-Chief

SECTION 1.—GENERAL INTRODUCTION.

GENERAL—In the spring of 1916, the Imperial Munitions Board entered into certain arrangements with the General Distilleries, Limited, and Messrs. Gooderham & Worts, both of Toronto, Canada, under which the British Acetones, Toronto, Ltd., was formed for the purpose of converting the General Distilleries into a factory for the manufacture of Acetone; certain parts of the Gooderham and Worts Distillery being also placed at the disposal of the Company. Operations were begun in May, 1916, Colonel Gooderham accepting the position as manager of the new Acetone Factory with Capt. Gooderham as Assistant Manager. Mr. E. Metcalfe Shaw accepted a position as expert in connection with the various methods and processes. Mr. J. W. Hayward, Construction Engineer, Mr. Allison Legg and Mr. H. B. Speakmann, Research and Bacteriological Chemists, were sent out by the Imperial authorities to take charge of the respective departments.

PROCESS—The process to be adopted was that in use at the time at the Royal Naval Cordite Factory at Poole, involving the use of Dr. Weizmann's culture, but the information available regarding the process was admittedly very incomplete. Accompanying this (see Appendix to this section) is a copy of a memorandum by Mr. Arthur E. Hadley, the only information available before the arrival of the experts from England, and the only written matter received on the subject.

The process is simple provided certain fundamental conditions are not violated and the culture under favourable conditions, works rapidly, but is unable to combat even small numbers of foreign germs. Thoroughly sterile liquor or starch solution produced from either crushed maize or malted barley wort is inoculated with the culture and the resulting fermentation continues for from 18 to 48 hours, with a reasonable certainty of completion between 24 and 30 hours, depending on various conditions after which the beer is distilled and fractionated or rectified in the usual way. The yield based on previous work elsewhere was stated to be about 8% of acetone and 19% of butyl alcohol (both on a dry corn basis).

OUTPUT—Originally the plant at Toronto was expected to have a maximum output of 250 tons of Acetone per year. This maximum has, however, through hard work, careful management, good engineering, chemical and bacteriological practice and painstaking attention to details, been steadily increased to a rate at present of 1,000 tons per year. This rate, however, is being constantly increased through improved methods and apparatus, and increased skill in operation, and it is expected the final rate will considerably exceed the present output.

In view of the difficulty experienced here and elsewhere in getting steady good results by this process the successful working of this plant makes it desirable that this report should be as exhaustive as possible, not only as regards the arrangements which are working well, but as to many details which have been eliminated as faulty or dangerous.

WORT *vs.* MASH—The first point considered was whether wort produced by malting on the one hand, or mash on the other was to be used for fermentation. The decision in favor of the latter was influenced mainly by the greater yield from mash, the increased cost of malting and largely by the experience of Colonel Gooderham in dealing with problems involved in operating with large quantities of mash and beer, containing high percentages of undissolved matter. It was evident that the mash system would reduce cost whilst the difficulties involved in handling the mash and beer, in the beer still could be safely dealt with under Colonel Gooderham's guidance.

There were many points to be considered before arriving at a decision in the matter. The most important factors favoring the use of the clear wort are the percentage of solids retained as cattle food and an easier liquid to handle, especially when cooling, while against these are the greater cost of barley and the cost of malting. In connection with the mash, the disadvantages to be overcome are the difficulty of cooling and maintaining sterility, the complete destruction of the solids from a cattle food point of view, and the difficulty of disposing of the enormous quantities of slop. On the other hand, the use of mash possesses the advantages of giving excellent results and better yield than the wort.

The record at present made, during a continuous run of 3 months still proceeding of 460 fermenters of 25,000 gals. capacity equal to a total of 11,500,000 gals. without the loss of any maize and a high yield of from 8.5 to 8.8% shows that though difficult the system can be safely and regularly worked.

Having decided on the mash as against the wort system an inspection of the plant, placed at the disposal of the Imperial Munitions Board showed that ample facilities existed for corn and coal storage, steam production, corn grinding and mashing. It remained to re-arrange, re-construct and add to the appliances available or deemed necessary for carrying on the whole of the process from the mash stage to the shipped product.

CONDITIONS—In doing this the following conditions had to be fulfilled:

(1) Complete sterilization of mash.

(2) As complete solution of starch as reasonably possible.

(3) Absolute sterility of all pipes, valves and vessels in use.

The methods adopted at the outset to secure the fulfilment of these conditions have been found satisfactory in principle. From time to time improved means of carrying the methods into effect have been devised until it would appear that for a partially continuous plant such as this developed into, the existing arrangements as now being perfected are capable of only such improvements as would be possible in putting up an entirely new installation.

PRINCIPLES UNDERLYING METHODS ADOPTED.

In the beginning practically the only information available on which to base the construction and operation of an acetone factory working on this system, was that gathered from the operation of the comparatively small acetone plant at the Royal Naval Cordite Factory at Poole, England. This information was first received in the memorandum from Mr. Arthur E. Hadley and later directly from the Research and Bacteriological Chemists and Construction Engineer sent out by the Imperial authorities, and who had the benefit of having actually worked at Poole.

In the Toronto plant, however, there were principles underlying the methods adopted to carry out the various processes which differed from those used at Poole, these constitute one of the factors to which the Toronto Plant largely owes its success.

MASH PREPARATION—The first change in principle from the methods adopted at Poole, was the abandonment of the, in some respects preferable and more easily handled system of using malted barley or oats to produce wort for that of using a mash of crushed maize. As will be observed from the section of the report dealing with the original plant, there were in the Gooderham & Worts Dis- tillry, a completely equipped mill and mashing arrangement in- cluding 4 wooden mashing tubs, formerly employed in the produc- tion of the whiskey from malt, rye, oats and corn. This equipment was used for the grinding of the maize to meal of a fineness which has been successively varied from that which would pass through a 36 screen down to that passing through an 18 mesh, and the sub- sequent mashing or mixing of the meal with water, in the mash tubs at the temperature of 120° F.

This necessitated combining the preparation of the mash in the whiskey plant of the Gooderham & Worts Co. with the subsequent fermentation in the plant of the General Distilling Co. originally producing industrial alcohol from molasses.

DIGESTERS—A convenient and valuable device adopted was an arrangement for heating and partial-cooking the above mash on its way to the cookers proper by means of steam jets, near the deliv- ery and of the mash pipe which thus formed a "Digester"—see special section describing this. This proved efficient and a satis- factory innovation taking care of a part of the cooking and deliver- ing the mash at the working temperature into the cooker, thus materially reducing the load on the cooker, and rendering the mash immediately sterile.

SEPARATE COOKERS—Another departure in principle of an im- portant character was the cooking of the mash in steel tanks en- tirely separate from the tanks in which the fermenting part of the process is being carried on. The mash passes from the digest- ers into the cookers, of which there are four. These are cylindrical steel 8,000 gal. tanks, in which the cooking is done under a pres- sure of 15 lbs. of steam for an outside period of 2 hrs. thoroughly preparing the mash for bug food and rendering it absolutely sterile.

COOLING—Continuous cooling is an important element in the process as carried on at Toronto. The cooling is done as the mash is pumped from the cookers to the fermenters in specially built coolers of the coil type, which are fully described in a separate sec- tion of the report. There are two coolers both designed on the same principle in so far as the mash circuit is concerned, but of different construction as regards the water circuit. These coolers have done well and are efficient, as regards space occupied, rapidity of cooling and self-cleaning properties, and working together deal with about 10,000 galls. of mash per hour, with cooling water ... at 40° F.

POSITIVE SYSTEM—A principle to which much of the success of the Toronto plant is due is that of securing continued sterility in the plant by maintaining so far as possible, a positive steam pres- sure at all times throughout the entire system (except in the fer- menters, which under rigid precautions are compelled to have at definite times an internal pressure slightly below that of the atmo- sphere), and also in addition the frequent steaming of the units and lines under high pressure. The general system is thus a positive one by means of which the pressure is always from the inside outward effectually preventing the entrance of foreign germs. In the case of the fermenters this positive pressure cannot be continuously maintained because of the cooling which causes a partial vacuum. A system of sterilised air supply under pres- sure to overcome this objectionable lowering of pressure was con- sidered but abandoned because of serious objections to its use. The inflow of air occurs now through sterile cotton wool.

This positive system will be found illustrated and described in various sections of the report.

FERMENTER PROTECTION—The problem of safeguarding the large fermenting tanks made of thin steel sheeting which are fully described in the section of the report dealing with the exist- ing plant was a difficult one. It was finally solved by discarding commercial types of vacuum, and safety valves, and installing a specially designed and constructed style of vacuum valve (see sec- tion on the Existing Plant which was sensitive and safe as regards sterility; together with a new and efficient safety device. (See section on the Existing Plant and also the section on the Gas Dis- charge). This latter consists of a water seal arrangement using antiseptic water thus ensuring absolute sterility. The device acts as a safety valve, a gas discharge measuring device and when gas is discharging at a maximum rate affords a free outlet to the at- mosphere. It has proved eminently satisfactory, as with its intro- duction the long run of successful fermentations began.

The abandonment of gauge glasses on the fermenters was an- other radical but necessary step because of the nature of the medium in the tanks. The glasses proved quite unreliable due to choking and were therefore abolished. At the present time the trycocks only are used to determine the approximate contents of the fermenter (within 200 to 300 gals.) The contents are primarily dependent on the quantity in each mash tub. Five of the latter are divided equally among four cookers and four cookers are used to fill a fermenter. A tank is known to be empty when the pump emptying it commences racing.

EDWARD METCALFE SHAW.

Appendix—Communication from Arthur E. Hadley.

ACETONE—WEIZMANN PROCESS.

As this process is new and has not been tried on a large scale for any length of time, I am unable to send exact details of what alterations will be required at the Distillery. You will realize that lacking detailed drawings of the fermenting vats, etc., and not knowing whether the Distillery produces its Alcohol from grain or molasses, it is rather difficult to say exactly what should be done to make it suitable for producing Acetone. Perhaps the best way will be to give a general account of the Weizmann process as it is at present at work in the Royal Naval Cordite Factory at Poole, and you will then be able to judge the local alterations that are necessary to the General Distillery Company's plant at Toronto.

The process is simple provided absolute sterility is obtained before the liquor is inoculated. The culture works rapidly under favorable conditions, but fails if foreign germs are present even in small quantities.

The liquor to be inoculated may be produced from crushed maize or from malted barley wort. If crushed maize is used, the spent grain or draff must be left in the liquor until fermentation is completed; clear wort is preferable as the spent grain after fermentation gives rise to difficulties in handling it and cleaning the fermenting tanks.

If wort is used, the clear liquor should be run off as a mixture composed of about 1 part grain to 15 parts water by weight, the grain being about 86-90% crushed maize to 14-15% malted barley. It has been suggested that a mixture of malted barley and malted oats would be better on account of cost, but this has not been tried. The wort prepared in this way has to be run into the fermenting vat and well sterilised. The sterilisation is complete after the liquor has been brought to a temperature of 90° C. for two hours. After sterilising, the liquor must be cooled to about 37° C. and then inoculated. The inoculant is about 3% of the liquor to be in-

oculated in the fermenting tank. If crushed maize only is used, the fermenting vat can be filled about two-thirds full with water and the crushed maize added. The liquor has then to be raised to boiling point and boiled for about 6 hours to fully extract all starch. Of course, the liquor will also be sterilised at the same time; it has then to be cooled to about 37° C. and the inoculant added as before. It is important that no contamination should take place, and it is, therefore, necessary to admit only sterilised air into the tank after the liquor has been sterilised. Air must, of course, be admitted when the liquor is cooled, and the steam occupying the upper portion of the tank begins to condense.

You will see that to enable the liquor to be sterilised and cooled in the fermenter, it is necessary to have each fermenter fitted with heating and cooling coils through which steam or cold water can be passed. At Poole a tank of 16,000 gallon capacity (containing a charge of 12,000 gallons) had an iron coil fitted inside the pipe being 4 inches internal diameter and 382 ft. long. A larger portion of heating and cooling surface would have been better as it was found that too much time was taken up in heating and cooling the liquor.

After the liquor has been inoculated and fermentation has commenced, the liquor must be kept at about 37° C. and if all goes well the fermentation keeps at about this temperature without any artificial assistance.

After fermentation is complete, which takes from 24-48 hours, depending on the virility of the germs and the temperature at which the tank is kept, the liquor contained ½% Acetone, 1% Butyl Alcohol and 98½% water.

The gases given off during fermentation are hydrogen and carbon dioxide. To prevent the entrance of unsterilised air at manhole joints, etc., it is advisable to allow the gases to escape through a relief valve which may be set at say 1 lb. per square inch above atmosphere.

Dr. Weizmann finds by experiment that 1 kilogramme of sugar or starch gives off 150 litres of hydrogen and 150 litres of CO_2.

The best distillation has not yet been evolved, but the latest trials at Poole are encouraging, and it seems established that practically all the Acetone and Butyl Alcohol are given off by evaporating 10% of the fermented liquor. As the boiling points of Acetone and Butyl Alcohol are far apart, the fractionation should not be difficult. The Acetone, however, contains traces of aldehydes, and it may be advisable to mix a small quantity of sulphuric acid or bisulphuric acid with the liquor before distillation.

The fermenting tanks we have at Poole and for experimental purposes are made of iron which has no injurious effect on the liquor and no undue corrosion has occurred on the iron.

Yours faithfully,

ARTHUR E. HADLEY.

SECTION 2—PRODUCTION OF ACETONE.

THE PRODUCTION OF ACETONE BY THE USE OF THE WEIZMANN CULTURE.

GENERAL—Dr. Weizmann's culture is one which operates in connection with enzymes on starch, producing chiefly butyl alcohol and acetone. During this process hydrogen carbonic acid and slight traces of other gases are liberated. The bacilli seem to work best at temperatures of about 100 degrees Fahrenheit. They are extremely delicate organisms, and are destroyed by the ordinary bacilli present in water and air to such an extent that it is absolutely imperative that even in the smallest numbers such bacilli should be kept away.

In the early days of the work at the Toronto plant, and even to a small extent now, irregularities occurred, resulting in the time of the fermentation varying between rather wide limits 28 to 48 hours, with occasional complete spoiling of a 25,000 gall. charge of mash through contamination.

The bacteriological and chemistry experts have had great difficulty in deciding as to how far this irregularity was due to some inherent property of the culture, contaminatory influences acting during the period when the inoculent was being produced, or to other unknown causes, which might ultimately be found to depend on mechanical defects in the plant. The experience gained through a year's operation of this plant has led to a better understanding of the subject and one by one various defects, causing failures and irregularities have been discovered. These defects, such as leaking seed tank flanges, leaking valves with resultant contamination in the pipe lines when rectified have resulted in much more uniform and regular working.

STAGES OF PROCESS—There are four stages in the process.:

The first is that of producing sterile thoroughly cooked mash;

The second the production of the seed;

The third of obtaining the fermentation;

The fourth, of separating the acetone and butyl alcohol from beer.

These operations are dealt with more or less fully in other sections of this report; the one great principle adopted was that of obtaining as far as possible a positive continuous system.

INOCULENT AND SEED—It is of importance that the growth of the inoculent during the early stages should be in a series of small vessels of increasing size, thus reducing the time during which the big vessel would be occupied, and the loss should the original culture be contaminated. Present practice is to inoculate a 5 gallon steam jacketted pail charging this when properly developed into a 100 gal. inoculating vessel, then dividing this latter between three charges of 500 galls. of mash in 600 gallon seed tanks, from which the final quantity considered necessary is introduced into the large 31,000 gal. fermentors. At present a battery of six 5 gal. and six 100 gall. culture vessels is being installed. Thus there will now be two stages in the laboratory followed by the four in the plant proper.

It is obvious that a risk, however small, is incurred every time the growing volume of inoculant is moved from one vessel to another, and this must be true in the laboratory, where the inoculant is poured from one vessel to another, as well as in the factory, where the first portion is poured from the 5 gallon can, into the 100 gal. inoculator or from the flask into the 5 gal. culture vessel and subsequently passes through pipe systems with many cocks and valves and joints. Even under the present system of working there are an objectionable number of places throughout the whole plant where leakages are possible, although the number has been greatly reduced, and it is the constant endeavor of the whole staff to eliminate those remaining as soon as discovered, or possible without interfering with the normal operation of the plant.

CONTINUITY—Dealing with the question of continuity, the applications of this method, which have been possible up to the present are in digesting, cooking and cooling the mash. These are fully described under separate headings. The combined effect of these is that a safe rapid and easily operated continuous system is at work from the mash tubs to the fermenters.

POSITIVE SYSTEM—With regard to the question of the positive system, this takes the form of maintaining throughout the system from the inlet to the cookers to the discharge from the fermenters (with the exception of certain intervals in the fermenters themselves) a pressure in excess of that of the atmosphere, so that whatever leakage of liquid or gas occurs is outwards sterilised gas or liquid flowing from the system, whilst no ingress of unsterilised gas, air or liquid can occur. One danger only remains which is the possibility of bugs growing back into the system through a leak filled with mash, which is overcome by the application of the same positive principle in the form of the "steam lock." See section of report on pipe lines.

The failures through contamination have occurred from various causes.

SUCCESSFUL RESULTS—Every effort has been and is still being made by applying the positive system, to obtain absolute security. The results of the last three months working shows that a remarkable degree of safety has been obtained, the plant now has been running to July 20th, during which time 516 fermenters have been distilled continuously from April 4th without one failure.

EDWARD METCALFE SHAW.

SECTION 3—ENGINEERING DIFFICULTIES.

ENGINEERING DIFFICULTIES.

The difficulties of an engineering nature that have been encountered in the work at Toronto, have arisen from three fundamental causes, the first being the inherent difficulties of the process, the second the natural difficulties attending the manufacturing of an explosive product, and the third due to the adapting of an existing plant to new requirements and methods.

DIFFICULTIES OF PROCESS—Amongst the difficulties to be dealt with, due to the nature of the process itself, were the maintenance of sterility, handling of the large quantities of thick mash, rapid cooling of this mash, and exact control of the quantities of mash put into or taken out of the tanks.

The sterility was largely maintained by using the so-called positive system. The applications of this principle up to the present has not been thorough due to the difficulties encountered through the adoption of a lot of the plant and piping not quite suitable for the purpose. These latter, referred to later, were mainly due to leaking valves and fittings, awkward piping arrangements and structurally weak tanks.

The handling of the thick mash in such large quantities has been satisfactorily taken care of under the guidance of Col. A. E. Gooderham whose extensive experience in dealing with such problems proved invaluable.

The rapid cooling of the thick mash by some 150 degrees Fahrenheit was a difficulty solved by the invention of a new type of coil cooler of great efficiency and small bulk, with absolutely sealed joints which prevented by its construction, any possible choking of the tubes with the mash.

Because of the nature of the mash, the problem of indicating the level in the different tanks is a difficult one. Gauge glasses proved useless as ordinarily employed, but might prove more successful if provision were made for blowing them out with either steam or water, as is now done on some of the smaller vessels here. At present, trycocks are largely depended on to show the level.

DIFFICULTIES DUE TO EXPLOSIVE NATURE OF PRODUCT—The fact that the product is explosive, and that hydrogen gas is generated in large quantities during the fermentation necessitated extreme care as to its safe discharge from the building. The question of the disposition of this gas occupied a considerable amount of attention, attempts to utilize its heating or power value, were finally disposed of by discharging the gas directly to the outer air.

DIFFICULTIES DUE TO USING AN EXISTING PLANT—Coming to the consideration of the difficulties due to the adopting of an existing plant to the requirements of a new, although somewhat similar, process.

In the first place the tanks were of large size, and built to withstand practically no pressure beyond that due to being filled with liquid so that when strengthened as much as possible the allowable working pressures were extremely low. A higher allowable working pressure would have greatly speeded up the cooking, reduced the time occupied in sterilising both cookers and fermenters and greatly assisted in emptying. The fact that the tank bottoms were all flat, while not only rendering the tank weak from the standpoint of withstanding internal or external pressure, was a great hindrance in emptying the tanks rapidly. This time of emptying is now greatly in excess of what it would be in vessels of similar size with conical or hemispherical bottoms. Those difficulties have been partially overcome in the new tanks by sloping the bottoms as much as possible without interfering with existing piping arrangements, and by rivetting the bottom to I beams.

Another prolific cause of trouble was in the valves and fittings. The valves which were in the plant, were in bad shape and required overhauling and both the old ones and the new ones, either gate or globe, were extremely difficult to maintain tight when dealing with mash. In such a process it is not only a question of tightness in the ordinary way, but tightness from a bacteriological point of view. The positive system has been the saving element here, whether the steam is applied to a whole line, to a short section between two valves or to a valve alone. In the former a whole line or header is kept under steam pressure, high or low; in the second an opening is "double valved", that is two valves placed a few feet apart in the same line with a steam connection between them forming a "steam lock", and in the third a steam jet is played on the valve disc. All of these have proved excellent in preventing contaminations but depend to a large extent on the exercising of the utmost care by the staff in working the plant.

The use in the old plant of cast iron fittings was another serious difficulty due to danger of fracture and the bad threads. This is being overcome as rapidly as possible by the substitution of malleable fittings. For extra special work, genuine wrought iron pipe is used because of the better threads.

The labor problem was a serious one from the beginning. An attempt was made to utilize the existing workmen of the two distilleries as far as possible, but proved rather unsatisfactory, because of the new methods employed. Pipe fitters were a cause of much worry because of their failure to understand the importance of tight joints and valves. The operating staff required to be trained on the job to secure good results.

It will be understood that it has been difficult to get the requisite engineering staff, both with regard to superintendents, draughtsmen and workmen. Recently the staff has been greatly strengthened by the appointment of a mechanical superintendent, and as a result the work in hand is being much more rapidly and efficiently carried out.

EDWARD METCALFE SHAW.

SECTION 4—ECONOMIC CONSIDERATIONS.

ECONOMICS.

Accompanying this are 4 sheets of curves and graphs, a sheet giving the capacities in order of every separate part of the plant and another giving a summary of the monthly expenditures and manufactured acetone and Butyl alcohol passed into stock or shipped.

The curves and graphs show at a glance not only the capacities of the separate parts of the plant, but the rate at which money has been spent and earned.

No account is taken of the value of the plant and premises placed at the disposal of the British Acetones Toronto but from an examination of the Municipal assessment figures and the property itself but it may be safely taken that this represents a sum of $1,750,000. The salaries of the four experts are not included.

Outside these items every expense has been taken into account. It is satisfactory to note that the expenditure and earning curves are rapidly approaching and allowing for the increased inclination of the expenditure curve after this date when the corn paid for is just used up and the new corn will have to be paid for it appears that in the course of the next (1 to 2) months the curves will meet and all capital expenditures to date would be paid off.

With the expenditure now being incurred for additions to plant and with the increased rate of production the curves will jump up, but though this will delay the date at which the lines will intersect indicating the paying off of all capital expenditure the cost per lb. of product will be reduced considerably below the present figure.

The enlargement of the plant will not entail any appreciable increase in the cost of labour and with the economies now being effected there will be a considerable decrease in the cost of coal per lb. of product.

It will be noticed that the consumption and production curves jump considerably owing to the corn and coal purchases being added at the date of payment. In future reports which will be forwarded monthly the curves will be of a more regular form, the purchases of corn and coal going on to a stock curve and the manufacturing being debited as the stock is used up.

The coal to corn curves show a large relative saving in coal during the last few months. This is partly due to the warmer weather but more on account of the efforts made to save steam.

With the completion in about 10 weeks of the additions now being made to the plant, bringing it up to a maximum output of 12 fermenters daily the reasonable limit of expansion on these premises will have been reached. At the same time the arrangements for steam and coal economy will be practically perfected.

When this plant has reached this stage it will be a well balanced, and economical installation producing Butyl Alcohol and Acetone with certainty at a cost which could not be appreciably reduced except through reduction in the cost of raw material.

EDWARD METCALFE SHAW.

QUANTITY PER HOUR.

Size.	Required for 12 Fermenters per day.	Available.	No. of Fermentations per day possible.	Remarks.
1. Grain Storage, 1,000,000 bu.				
2. Coal Storage, 6,000 tons.				
3. Boilers, Gen. Dist., 1,200 H.P. G. & W., 1,200 H.P.	2,400 H.P.	2,400 H.P.	12	
4. Milling, 4,000 bu. day	2,000 lbs.	10,000 lbs.	13	
5. Sifting, 4,000 bu. day	2,000 lbs.	6,000 to 10,000 lbs.	8-13	Depends on dryness of corn.
6. Mashing, 4 tubs	2,000 lbs.	12,000 lbs.	16	At 1¼ hrs. ea.
7. Pumping, new 14 x 10¼ x 10	12,500 gals.	25,000 gals.	24	Estimated.
old 4 ins. cent.	12,500 gals.	20,000 gals.	15	Test
8. Digesting	12,500 gals.	12,500 gals.	12	Designed from data.
9. Cooking, 4 tanks	12,500 gals.	8,000 gals.	8	Depends on pump.
continuous	12,500 gals.	12,500 gals.	12	Or more.
10. Pumping, 8 x 6 x 12	12,500 gals.	12,500 gals.	12	Estimated.
11. Cooling, No. 1 x No. 2	12,500 gals.	12,500 gals.	12	Clean and winter (30)
No. 1 x No. 2	12,500 gals.	7,200 gals.	7	scaled & summer (50).
No. 2 x No. 3	12,500 gals.	14,600 gals.	14	Estimated summer conditions.
12. Culture Vessels, 3-5 gal.			7	Trial
6-5 gal.			12	Estimated.
13. Inoculating Vessels, 3-100 gal.			7	Trial
6-100 gal.			12	Estimated.

QUANTITY PER HOUR

Size.	Required for 12 Fermenters per day.	Available.	No. of Fermentations per day possible.	Remarks.
14. Seed Tanks, 9-600 gal.			7	Trial.
16-600 gal.			12	Estimated.
15. Fermenting, 16-30,000 gal.	12,500 gals.		10	38 hr. period.
22-30,000 gal.	12,500 gals.		14	38 hr. period.
16. Beer Pumping, 7 x 5 x 12	12,500 gals.	7,200 gals.	7	Existing Pump.
7 x 5 x 12 and 10 x 4 x 12	12,500 gals.	20,000 gals.	20	Plus new pump.
two 10 x 4 x 12	12,500 gals.	25,000 gals.	24	Two new pumps.
17. Foaming Tanks, 3-50,000 gal.			12	
18. Beer Pumping, 10 x 5 x 12	12,500 gals.	12,500 gals.	12	
19. Beer Stills, 2,500 gals.	12,500 gals.	12,000 gals.	12	Maximum.
20. 1st Rectification, 2-13,000 gal.	375 gals.	425 gals.	14	Estimated.
21. 2nd Rectification, 14,000 lb. Barbet			12	Designed by Badger.
22. Butyl Salting	230 gals.	600 gals.	30	Actual trial.
23. Butyl, Rectifying, 2-7,000 gal. G. & W.	165 gals.	200 gals.	14	Trial.
24. Acetone Storage, 2-1,000 gal.		Ample		New tanks.
25. Butyl Storage, Crude, 1,250,000 gals.				
Salted, 2-18,000 gal		Ample		Salting plant tanks.
Rectified, 16-2,100 gal.				G. & W. Spirit tanks.
26. Acetone Shipping, 5 drums 1 hr.			42	Trial.
27. Butyl Shipping, 5 drum 1 hr.			19	Estimated.

NOTE—(a) The above is based on a 24 hr. day.

(b) Cooking and fermenting capacities depend largely on pumping rates, filling and emptying. The fermenting, in the above modified methods of working are assumed and no time allowed for cleaning tanks.

SECTION 3—ORIGINAL PLANT.

ORIGINAL PLANT.

General Description of the Portion of the Plant of the Gooderham & Worts Company and of the Plant of the General Distillery Company used by the British Acetones, Toronto, Limited, as they existed prior to May, 1916.

The firm of Gooderham & Worts, Limited, Toronto, established in 1832, carry on a general whiskey distilling business, manufacturing various grades of Canadian whiskey from grain. The plant is in operation from October 15th, to June 15th, of each year, manufacturing in the eight months 2,000,000 gallons of spirit, from corn, rye, malt and oats. The numerous buildings making up this plant were built at various times, dating from the original windmill plant of 1832 to the present.

The more recently incorporated General Distillery Company manufactures industrial, non-potable alcohol by distillation from molasses. This plant was erected in 1902, and is of modern construction throughout. The plant deals with about 100 tons of molasses a day, from which 10,000 proof gallons of industrial alcohol result per day. The plant operates during the summer, the length of time varying from six weeks upward, depending on the amount of molasses on hand. In 1912, during which the plant was in operation for ten weeks, 8,500 tons of molasses were used, giving an output of 840,000 proof gallons of spirit. This was the greatest period of operation of any year.

The plants of both distilleries are situated at the foot of Trinity Street, on the north shore of Toronto Bay, at a point where the Don River at present empties into it.

As will be seen from the accompanying plan (see drawing 62), the plant covers a considerable area, extending from the bay on the south to the Canadian Pacific Railway tracks on the north, and from Cherry Street on the east to Parliament Street on the west. The property is cut by the main line of the Grand Trunk Railway from Montreal and by Mill Street running east and west, and by Trinity Street running north and south.

There are numerous buildings of various types of construction, making up the complete plant of both companies, of which the majority belong to the Gooderham & Worts Company.

GOODERHAM & WORTS BUILDINGS—There are four of the G-
erham & Worts buildings made use of by the British Acetones
the granary, coal shed, the main building and boiler house.
these, the two former are located at the water's edge south of
Grand Trunk Railway, and the latter two and other buildin
both distilleries lie north of the railway. There are ample
facilities on the Grand Trunk Railway, and the raw materials
brought in by rail, as there are no docks or marine unlo
equipment.

Since the above was written the following additional buildi
have been wholly or in part taken over and used: Rectifying H
containing three rectifiers, No. 2 Tank House with 16-9,100
tanks, Malt House, Fermenting Cellar and Barrel Store House

COAL SHED—The coal shed is of corrugated iron and timber
struction, and is situated on the bay shore at the west side
Trinity Street. The coal comes in by rail, is shovelled from
cars on the siding into horse-drawn carts, and hauled up a
into the shed and dumped from elevated runways in the shed
piles on the ground below. The coal piles are ventilated with
usual gas pipes. From these piles the coal is loaded into ca
again by hand, and carted to the various boiler rooms as requir

The storage capacity of the shed is about 6,000 tons, and
addition coal may be stored in outside piles between the shed
the tracks.

Normally the coal used is slack, but the recent coal shortag
Toronto has necessitated the use at present, of a mixture of
and lump. There is at this time (May 1st, 1917) about 3,700
of the latter in storage.

GRANARY—The granary or grain elevator is also of corru
iron and timber construction, and is situated on the bay front,
of the coal shed. The railroad cars may be run on to a si
under the building, and the grain is then elevated to a horizo
conveyer, running the length of the building. The conveyer
charges the grain into the various bins, from which it is drawn
at the bottom into specially constructed one horse grain carts,
hauled to the mill. The grain is unloaded directly at the mill un
the storage bins there are full, in which case the surplus is taken
at the elevator. There is at the granary a storage capacity of

eight hundred thousand to one million bushels, and at this time (May 1st, 1917) there are about five thousand bushels in store there.

MAIN BUILDING—MILL—The mill is located in the south-east corner of the substantially constructed masonry and timber main building, built in 1859, on the west side of Trinity Street, just north of the tracks. It contains a power house, mill, mashing equipment, distilling apparatus, various tanks, and the slop drying presses and ovens. The siding from the Grand Trunk railway runs along the south wall.

GRINDING—The grain may be received at the mill either directly from cars on the railroad siding or from carts bringing the grain from the granary, and elevated, passing through a hopper weigh scale to the storage bins in the mill, having a capacity of 18,000 bushels. This is sufficient to maintain a continuous running of the mill night and day for a week.

From the bins the grain passes to the stones, of which there are eight run, five generally in use, with three under repair, as operated now. The meal from the stones is sifted in four gyrating sieves and scalpers, the fine meal goes directly to the meal storage hopper, and the coarse is passed through chilled steel rolls, of which there are ten sets, with only two or three in use.

A single sifter handles the meal from the rolls, separating the bran, which is sacked and sold, and the meal, which passes into the meal hopper. The sifters are equipped with No. 36 mesh wire screens. (A No. 24 mesh wire screen is used in the sifters for acetone work).

The capacity of the mill is from 150 to 170 bushels of corn per hour, depending on the condition of the corn. At present (May, 1917) it is damp, and only 150 bushels per hour is being ground. This capacity is limited by the sifters, which cannot handle as much as the stones are capable of dealing with.

From the meal storage hopper the meal drops into a hopper weigh scale, mounted on a car on rails, in which the charge for the mash tubs is weighed out (3,600 pounds per mash), and the car is run along and emptied into either of four mash tubs.

MASHING—The mash tubs are located in the main building, west of the milling section on the second floor. They are of wooden construction, fifteen feet in diameter by six feet deep, and are fitted with paddles, steam injecting pipes and a series of copper cooling coils. The paddles are driven from below through bevel gears and horizontal shafting, located on the "stone floor" or machinery floor. For mashing for acetone cold city water (3,900 gallons or 39 inches depth) is run into the tubs, and the whole heated by the steam jets blown directly into the mixture through perforated pipes. The bulk is increased to 4,750 gallons during the mashing.

After mashing for whiskey distillation the mash is run from the mash tubs through 6" copper pipes to the fermenting room, where it passes into open wooden troughs, leading to the various wooden fermenters. For acetone work 5" wrought iron pipe was coupled on to the original copper mash pipes close to the tubs, and carried the mash to a steam engine driven reciprocating pump (gear drive). The latter was found unsatisfactory, and was in turn replaced by a steam engine belt driven four-inch single stage centrifugal pump, discharging through a four-inch wrought iron pipe leading to the General Distilleries Building.

Both the engine and pump were supplied and installed by the British Acetones.

The changes mentioned here constitute the only alterations made in the plant of the Gooderham & Worts distillery.

The centrifugal pump requires about thirty-five minutes to empty a mash tub, 200 gallons of water being allowed for washing down the tub.

On the machinery floor in the main building are also other pumps, which are not in use by the British Acetones, and a steam air compressor and receiver, supplying air for the construction work, rivetters, etc., and also where required for the plant operation. The remainder of the main building, excepting the power plant, is occupied by the beer still, tanks, scales, with a slop filter and drying apparatus necessary in the distillation of whiskey, and the preparation of the waste solids for cattle food.

POWER PLANT—In the north-east corner of the main building is the power plant, fitted with four 100 h.p. John Abell return tubular boilers, with Jones automatic stokers, which ordinarily supply steam for the various operations in the manufacture of whiskey, and a 500 h.p. 28 in. by 60 in. single cylinder horizontal steam engine, with Brown valve gear, which drives through an intricate system of gearing, spur and bevel, both the mill and the mash tubs. This engine is located between the mill and the mash tubs, on the same floor as the latter. The boilers are not now in use.

BOILER HOUSE—Steam is at present supplied through a ten-inch main from another Gooderham & Worts boiler room, located east of Trinity Street, on the south side of Mill Street. There are here, eight 100 h.p. return tubular boilers, working under 60 lbs. pressure, and fitted with Jones underfeed stokers. These boilers, of which five are normally in use, also supply the steam to the shop engine and the Gooderham & Worts bottling department.

GENERAL DISTILLERY COMPANY PLANT—This plant is of comparatively recent construction, and is located as shown on the plan, comprising briefly the distillery building proper, filter room, boiler room, store house, and three large outside storage tanks.

The buildings lie between Mill Street and the Grand Trunk railway tracks, and extend from the west limit of the Gooderham & Worts property to Parliament Street.

The buildings, with the exception of the store house, are of rather light steel frame brick construction. The distillery proper is five storeys (72 ft.) high, the fermenting portion two storeys (30 and 36 ft.) and the filter and boiler rooms one storey (20 ft.) high only. These buildings are all adjacent to each other, forming one continuous building. The store house is a separate one storey structure of brick and timber construction, with concrete floor.

MOLASSES—Both beet and cane sugar molasses is used, and is received in railroad tank cars, which are run on the siding at the south side of the store room, (75 ft. by 80 ft.), and emptied by means of a 8 x 10 x 12 in. steam pump in the south-west corner of the store room. The pump is so connected that molasses may be pumped through four-inch pipe into either of the outside storage tanks, from one outside storage tank to another, or into the two mixing tanks. The pump may also be used to return molasses to tank cars on the siding from any of the tanks. These outside tanks are of steel, roofed, and of the following sizes:

The north tank is 48 ft. in diameter 35 feet high, capacity 400,000 gallons.

The west tank is 40 feet in diameter, 30 feet high, capacity 225,000 gallons.

The east tank is 95 feet in diameter, 30 feet high, capacity 1,250,000 gallons.

The west tank is also used for slop storage, and the two varieties of molasses are kept in separate tanks.

The second molasses pump (8 x 10 x 12 in.) in the north-west corner of the store room draws the molasses from the largest outside tank through a five-inch line, and discharges it into either of two inside molasses boiling or mixing tanks of steel, 16 ft. in diameter, 15 ft. high, and 18,000 gallons capacity, located at the west end of the store room. A third brass pump (6 x 5 x 8 in.), between the latter tanks, takes the hot mixture of molasses and acid from the mixing tanks, and pumps it through a battery of three vertical molasses coolers, located outside the north wall of this building over to a second molasses mixing tank in the south-west corner of the distillery proper. In the latter tank the molasses mixture is diluted and run by gravity into molasses pits or sunken tanks in the distillery. The molasses piping is mostly four-inch wrought iron.

DISTILLERY BUILDING—The main building of the General Distilleries is 146 ft. 7 in. by 123 ft. 8 in., and is divided into two principal parts, there being no dividing wall between the parts on the ground floor. The north part of this building, known as the fermenting room, is 146 ft. 7 in. by 77 ft. 2 in.. two storeys high and has a wooden operating platform throughout, about 20 feet above the ground, except at the west end. Along the north wall stands a row of six and at the east end a parallel row of three steel fermenters, 18 ft. diameter by 20 ft. high, capacity 31,780 gallons. These are mounted on brick piers, and extend through the platform. In the centre of the west end of the platform a row of four steel yeast tanks, 12 ft. by 12 ft., 7,500 gallons capacity, standing on timber frames, extend through the platform. These are arranged parallel to the fermenters. South of these yeast tanks, on the platform, are four 635 gallon copper second yeast tubs, and five 128 gallon copper first yeast tubs in a row. Along the west wall at the north are two sunken steel molasses storage tanks or "pits," 15 ft. by 10 ft. by 7 ft., with a capacity of about 7,000 gallons, and a 6 x 4 x 6 steam pump for elevating the molasses into the nine fermenters. The building is fully equipped with the necessary steam, slop, beer, air and water (bay and city) pipe system.

The south 30 feet of the north portion of the building is occupied by three copper high wines tanks, 14 ft. diameter by 14 ft. high, with 13,400 gallons capacity; located south of the yeast tanks an elevated 1,400 gallon steel fusel oil tank; and at the east a battery of two elevated spirit receivers and a weigh tank, in a screened-off Government weigh room. Each of these tanks has a 9,600 gallons capacity, and is 14 ft. in diameter by 10 ft. high. There is a 6 x 8 x 12 in. steam wine pump for handling the spirit from these tanks. At the west and south of the previously mentioned molasses pits stand two wooden slop neutralization tubs 14 ft. diameter and 14 ft. high, 13,400 gallon capacity, with a 6 x 8 x 12 in. steam slop pump between them. These tubs receive slop from the still and the pump elevates it to the evaporator supply tank.

On the west wall behind these tubs is the tail box for the rectifying battery. East of the Government weigh room is the superintendent's office.

On the ground floor of the south five storey section of the distillery, which is 83 ft. 10 in. by 46 ft. 6 in. (see drawing 59), at the east wall, are two 13,400 gallon copper spirit tanks, with a 6 x 8 x 12 in. steam spirit pump between, and in the north-east corner a second 6 x 8 x 12 in. pump for the scale tanks. At the south wall about the middle and opposite the doorway stand two 14 ft. diameter by 14 ft. high rectifiers, taking a 13,000 gallon charge. North of the rectifiers is the gear driven (steam engine) 6 in. by 12 in. duplex pump, supplying the still, a 10 x 12 x 12 in. air compressor, and two 12 x 14 x 18 in. 1,000 gallon per minute duplex steam pumps, drawing water from the bay through 12 in. intakes, and discharging into a reservoir on the roof through two 8 in. mains.

Standing on special steel columns in the south-west corner is a "double-effet" evaporator for dealing with the slop from the beer still, working on exhaust steam, supplied through a 10 in. inlet, provision also being made for live steam supply if necessary through a 2½ in. line.

Under the evaporators at the south wall is placed a 12 x 10 x 20 in. steam slop pump, which handles the slop from the evaporators discharging it through a five-inch main to the west outside tank. At the west wall is a 16 x 20 x 36 in. dry vacuum pump for the evaporators, and in the corner is the seal well for the evaporator condenser above. Beneath the north evaporator is a small drip receiver (cast iron), and an 8 x 8 x 10 steam drip pump, also for the evaporators. The steam and exhaust piping from the boiler room comes through the west wall at about the north limit of this section.

The 6 ft. diameter by 42 ft. long beer still, capable of handling 4,000 gallons of beer per hour in alcohol distillation, fitted with calandria, stands in the north-east corner of the building, and extends from the second floor through to about three feet above the fifth floor. Its 30 in. diameter by 13 ft. long beer heater (600 gallons) stands just south of it on the fifth floor, extending through the roof, and south of the heater is the 60 in. by 24 ft. long condenser (3,000 gallons), extending from the third floor to the fifth floor. The tail box for this condenser is located on the third floor, which is the operating floor. North of the two rectifiers and connected to them through a 16 in. and a 6 in. pipe, and in about the centre of the building, are two 60 in. spirit columns (1,438 gallons), 37 ft. long, running from the second to just below the fifth floor, which connect through 14 in. headers with two goose tanks (11 ft. 6 in. x 11 ft. x 9 ft. 7,200 gallons, steel), on the fifth floor at the middle of the south wall. Between the goose tanks and spirit columns, and connected to the former through a 12 in. pipe, are two cooling columns, 42 in. diameter by 24 ft. long, (4,400 gallons) which extend from the fifth floor down to the third, where the tail boxes are located. A four-inch copper pipe from the fusel oil traps under the fifth floor leads to the fusel oil cooler, 22 in. diameter by 14 ft. long, with its tail box also on the third. The cooler extends from the third to midway between the fourth and fifth floors.

On the second floor of the north wall is a 100 cubic foot steel compressed air receiver, and west of the latter a 881 gallon open steel evaporator supply tank. In the south-west corner of the third floor is the evaporator condenser, connected to the latter through an 18 in. pipe. At the south wall on the operating floor is an open steel yeast tank, 1,000 gallon capacity, and in the south-east corner is a second 12 ft. diameter by 10 ft. high, 7,100 gallon copper weighing tank in a Government weigh room. The operating floor communicates over the roof of the intervening portion with the north or fermenting part of the distillery.

A large light and ventilation well extends from the evapor-

ators through to the roof at the west side of the building. Over this well at roof level is a 14 ft. diameter by 5½ ft., 5,300 gallon steel water reservoir, covered by a pent house on the roof, and supplied with bay water by the previously mentioned duplex pumps below. This supplies water for cooling purposes in condensers, cooling columns, and, if necessary, for fire protection.

At the east side of the rectifying section and south of the fermenting room (Government weigh room) is small two-storey 46 ft. 6 in. by 32 ft. 6 in. building, forming part of the distillery proper, containing drafting office, vaults, laboratory and storerooms.

Boiler House—The boiler house of the General Distilleries, Limited, is 117 ft. 1 in. by 77 ft. 2 in., and contains a battery of two 250 h.p. and four 175 h.p. Babcock and Wilcox boilers, equipped with Jones automatic stokers, and capable of supplying steam at 110 pounds pressure, through a 10 in. main to the distillery proper. The exhaust returns are brought to a steel hot water drum of about 1,000 gallons capacity at the east end of the boiler room, where the feed water, either city or bay water, controlled by float, is heated. The boiler feed pumps south of the drum are two Northey duplex outside packed pumps 9 in. by 5 in. by 10 in. For draft purposes there are two high speed steam engine driven pressure fans located at the west end of the room. The flue gases are carried off in a 4 ft. diameter by 125 ft. steel stack at the west of the boiler house.

At the rear of the boilers, at the north side, is a large potash riping pit, and in front of the boilers is ample storage space for coal, which is delivered in horse-drawn coal carts through three large doors to the piles, and shovelled from the piles into the stoker hoppers by hand.

In the north-east corner of the boiler room is a bricked-off yeast storage room, and an 800 gallon steel yeast boiler. At the east wall between the latter and the hot water drum is an elevated 8 ft. x 8 ft. 2,500 gallon steel slop tank, designed to be used to supply a special slop burner or potash furnace in the two large end boilers from which the potash goes to the potash riping pits at the rear of the boilers.

Filter Room—The filter room 123 ft. 8 in. by 29 ft. 7 in., occupies the space between the distillery proper and the boiler house, and is a one-storey structure. At the north wall are two 14 ft. diameter by 14 ft. high 13,400 gallon light copper spirit diluting tanks. Just south of these is a battery of three high pressure steam rectifying pumps, 5½ in. by 2¼ in. by 7 in., and next these a 496 gallon steel wash water tank for filter washing purposes. The body of the filter room is occupied by a rectifying battery of 32 heavy cast-iron charcoal filters. A light hand-power travelling crane runs north and south over the filters. At the south of the filter room and separated from it by a brick wall is a second molasses mixing tank (previously mentioned), of steel, rectangular, 19½ ft. by 15 ft. by 10 ft., 18,000 gallons, arranged with baffles, where the molasses from the store room is diluted and then run by gravity into the molasses "pits."

WATER SUPPLY—There are two sources of water supply: the municipal system, which supplies pure water at about 80 pounds pressure per square inch, and the company's private supply, which draws impure water directly from the bay. The General Distilleries boiler house is arranged so that the supply may be taken either from the city or from the bay.

The two 12 x 14 x 18 in. duplex steam pumps on the ground floor of the distillery, which supply the tank on the roof, draw their supply from the bay, and are capable of handling 1,000 gallons per minute at a pressure of 100 pounds per square inch. These are ordinarily used to supply cooling water for different purposes but are also connected to the fire protection system.

The Gooderham & Worts Company have a special fire protection pump house, situated at the west side of Trinity Street, just north of the tracks. This pump house is equipped with two 85 h.p. hand fired Babcock and Wilcox boilers, and two duplex Northey 1,000 gallon per minute pumps, capable of maintaining a pressure of 100 pounds per square inch.

Steam is always up in one of these boilers, and the other has the fire all ready laid, is cleaned, and full of water, and the flue gases from the one under steam pass around the drum of the one not in use, keeping the water warm.

LIGHTING—The lighting is electric, by incandescent lights operating on 110 v. or 220 v. alternating current at 25 cycles, supplied by the Toronto Electric Light Company. The wiring is partly open, partly in conduit. There is besides 550 v. current available

for power purposes where required.

MISCELLANEOUS—SHOPS—The Gooderham & Worts Company maintain well-equipped steamfitters', carpenter and coppersmiths' shops, which are used jointly by the Gooderham & Worts and General Distilleries Companies.

LABORATORIES—There are two well-equipped laboratories on the premises. One is the bacteriological laboratory, located over the Gooderham & Worts offices, and the other is a chemical laboratory, located in the General Distilleries building.

These are more fully described in the reports of Mr. Speakman and Mr. Legg respectively.

OFFICES—The office work of the General Distilleries is handled in the offices of Gooderham & Worts. There is a small drafting room in the same building with the laboratory, the remaining rooms being used as store rooms only.

STAFF—The Gooderham & Worts Company and the General Distilleries Company maintain jointly a staff of about ten steamfitters and helpers, about six carpenters and helpers, and a coppersmith. The operating staff of the Gooderham & Worts mill numbered about nine men, and there were four men required to look after the mashing, with two still men, two rectifying men, a foreman and a relief man. The General Distilleries Company use two operating engineers in charge of the engines, pumps and boilers, together with about ten firemen and six men as attendants in the fermenting room and rectifying department.

TRANSPORTATION—The transportation of raw material about the plant and throughout the city for both the Gooderham & Worts Company and the General Distilling Company is taken care of by the transport department of the Gooderham & Worts Co. The department is under the direction of a foreman who has charge of 8 carters, 8 horses, 8 coal carts, 6 grain trucks, 3 single lorries, 2 double lorries, 2 barrel waggons, an ice waggon, a watering cart, a lumber waggon and a 3 ton motor truck. The latter is used almost entirely for outside work. The transport department is at the disposal of the British Acetones as required.

The coal carts are the usual single horse back dumping two wheel carts with a capacity of rather more than a ton. The grain carts or trucks are also single horse two wheel with a special low hung body carrying a maximum of 50 bushels of grain.

EDWARD METCALFE SHAW.

SECTION 6.

EXISTING PLANT.

APP. 1—INOCULATING ARRANGEMENTS.
" 2—DISTILLATION AND RECTIFICATION.
"" 3—BRAN DISPOSAL.

PRESENT PLANT.

Description of the Plant of the British Acetones Toronto, Li ited as reconstructed from that of the General Distilling Compa with a note on the few alterations made in the Plant of the Good ham & Worts Company, Limited.

It should be understood that the plant, even after one yea construction work, is still in a state of evolution. Knowledge the operation and requirements in such a new process and plan being constantly acquired and results in the plant being consta in a floating state: *i.e.*, improvements, additions and excisions being continually made as soon as possible and convenient wit interfering with the operation of the plant and the manufactur as large an output as possible of acetone.

Major alterations on vital parts of the plant and equipment generally carried out on Sundays when the mashing and cook processes are out of operation, while minor changes and additi on parts not affecting vital parts are done throughout the w This description, then, will describe the conditions of the plant f a mechanical point of view as it exists at the time of writing report—May 15th, 1917.

GOODERHAM & WORTS BUILDINGS.

Raw Materials, Handling, Milling and Mashing Sectio British Acetones, Toronto, Ltd.

Coal Shed and Granary—No structural changes have made in either of these buildings, and they are operated ju they were in the old days by the Gooderham and Worts Comp The granary is used only to a very limited extent.

Main Building—Milling—The mill has undergone no structural alterations nor changes in equipment, with the exception of the replacing of the No. 36 wire screens in the sieves by No. 24 wire screens for the acetone meal. The mill is operated in practically the same manner, but at a slower rate due to the dampness of the maize being dealt with at this time.

Mashing—The mash tubs have received only such minor repairs as were required to keep them in good operating condition. For instance, the valve controlling the water was in rather bad condition and has been repaired. The steam jets are used for mashing (supplied at present with 60 lb. steam from the Gooderham and Worts boiler house) and the copper cooling coils are not required or used. The original 6 in. copper mash pipes formerly used have been flange jointed to 5 in. wrought iron pipe (with cast iron fittings), leading through a by-pass system of piping either to a 6 x 12 reciprocating pump, driven through spur gearing from an 8 x 22 steam engine (Brown valve gear), or a 4 in. single stage centrifugal pump, belt driven at 680 r.p.m., by a Leonard 8 x 10 high speed steam engine (220 r.p.m.) The latter is now used exclusively, and is provided with a 3 in. relief bypass.

The pump handles about 170 gals. a minute at present, and operates under 24 lbs. discharge pressure. It is so situated that there is always a static head of about 10 ft. on the suction.

Mash Lines (Mash Tubs to Cookers)—The mash is discharged from the centrifugal pump through a 4 in. swing check valve, into a 4 in. mash line leading to the distillery. This line is exceedingly crooked, due to structural difficulties, and its relocation and construction is now under consideration. The line is approximately 400 ft. long, and in that distance there are ten right angled bends and ten 45 degree elbows. It is asbestos lagged, and is mostly under cover in the different buildings, but about 100 ft. of it is in the open air. The line is heated up before pumping through the mash with steam from the digester nozzles and afterwards is washed out by pumping about 200 gallons of wash water through.

GENERAL DISTILLERIES BUILDING.

Fermentation Section—British Acetones, Toronto, Limited.

Mash Line (Mash Tubs to Cookers)—Digestors—About 50 ft. from the first cooker in the mash line from the tubs, and just inside the south distillery wall there are inserted eighteen ½ in. steam jets, placed 18 in. apart on the average, along one side of the pipe and coupled up by a 2 in. pipe with steam supply at the centre, each half being under gate valve control. The nipples forming the nozzles are bevelled off at 60 degrees against the mash flow, permitting of better steam injection. The 2 in. pipe connecting up the jets of this "digester" is supplied from a 3 in. steam main, in which the steam is controlled by a 3 in. gate valve located on the operating platform some fifty feet away from the nozzles and operated by an attendant, whose duty it is to keep the temperature constant by regulating the steam injected through the nozzles.

It is proposed to place the control valve as close to the digester as possible in the new line, (which is all prepared and awaits only a favorable opportunity to be installed) as the present construction is subject to serious defects from a temperature control viewpoint.

Just past the nozzles on a 4 x 4 x 3 tee is placed a 3 in. pop safety valve set to blow at 40 lbs., and inserted in the tee immediately before reaching the first cooker is the bulb of a recording thermometer, the dial of which is opposite the digester steam control valve. Between the safety valve and the thermometer connection is a pressure gauge connection (fitted with a drain) leading to a pressure gauge placed above the thermometer dial. The mash line runs along the south side of the row of cookers, and 4 in. branches lead from tees in it through 4 in. swing check valves and 4 in. gate valves, controlled from the upper platform, into the cookers, about 3 ft. from their bottoms. The flanges for these connections were already on the cookers.

Between cookers 2 and 3 a 4 in. slip expansion joint is placed and at the end in the branch leading to No. 4 cooker is a 3 in. drain line with a 3 in. gate valve in it, leading to the floor gutter.

COOKERS—The cookers consist of four 12 x 12 steel yeast tanks standing on 10 ft. timber stands. These tanks are of 5-16 in. steel plate with single riveted lap joints, and originally carried only a light flat cover. When taken over new domed 5-16 in. plate covers (19 in. dome) were riveted on them, fitted with 14 x 21 in. manholes and special central gland; a special 3 in. cast iron flange for the safety valve; a standard 2 in. flange for relief valves; and tapped for the pressure gauge.

The bottoms, which are flat, were strengthened by being riveted to six beams built up of two 12 in. channels at 20½ lbs., which

were placed on the timber stands, and fitted with vertical plates and angles at the ends riveted to the tank sides. The tanks were subjected to a static test of 22½ lbs. by the government inspector. A special electric cast steel bowl outlet casting (see drawing 3) is riveted in the centre of the bottom, having an upper diameter of 10¾ in. and a lower diameter of 4 in. and carrying a journal for a vertical pin. This casting is fitted with ½ in. steam jet, to guard against contamination by playing on the gate of a 4 in. gate valve, flange-jointed to the casting below. The jet is on a 22 lbs. steam system, controlled by a Locke regulator.

The manhole gaskets are of asbestos 1¼ x ½ standard stock. The central gland (see drawing No. 1) on the tank roof is designed to take a 3 in. rotating pipe, and is bolted by studs on a lead levelling gasket to an electric cast steel stud ring, riveted to the roof. The 3 in. pipe, machined on the outside to 3 7-16 diameter, passes through this gland and is fitted with 3 x 3 x 2 x 2 in. cast iron cross below, in the bottom opening of which is screwed a bronze plug with a 1¼ in. pin which rotates in the journal of the bowl casting at the bottom (see drawing 4). Fitted in the two openings of the cross are two 4 ft. lengths of 1 in. pipe, which are used as steam jet stirrers, the steam discharging directly from the end and thoroughly mixing the mash.

There is also another cone type stirrer bolted on each central pipe, but it does not act to any extent under the present system of operation. These stirrers are described in another section of the report.

The steam is supplied to the 3½ in. central pipe from the 1½ in. steam line on the 22 lb. steam system through a special gland connection; (see drawing 5). The central pipe carries a 16 in. cast iron worm wheel, originally used for motor driving purposes, mounted on it between the tank gland and the upper gland. This wheel now has a long handle fastened to it, which is used to rotate the central pipe and steam jets through 180 degrees at intervals by hand.

Each cooker is fitted with a 3 in. spring loaded safety valve, set at 15 lbs., the vertical exhaust pipe from which is fitted with a drain to prevent liquid from settling back on the valve.

From the 2 in. flange a bent nipple leads to a cast iron tee, on opposite branches of which are mounted a 2 in. brass swing check valve, acting as a vacuum valve; and a 2 in. gate valve, with vertical pipe leading to the atmosphere, which is also fitted with a drain. There is also a 30 lbs. 6 in. dial pressure gauge mounted on the tank roof. The cookers are fitted with ¾ x 18 in. gauge glasses, one at the top, which is above the platform, and the other at the bottom. The latter is tapped into the bottom of the tank, and comes away from a ¾ in. cross, the downward opening of which acts as a blow-off, controlled by a ¾ in. gate valve. This gauge has proved useless owing to choking with the thick mash at the tank bottom. There are three ½ in. try cocks; one 2 ft. and one 3 ft. from the top, and the other at the bottom, which are used to check the water gauge readings.

The tanks are asbestos lagged, the roof lagging being protected by sheet metal cover.

MASH LINE (COOKER TO COOLER—HOT)—This mash line (see drawings 63 and 71) is of a 4 in. wrought iron pipe and leads from the bottom of the cookers (bowl casting) to the cooler pump. The line from each tank runs from the outlet casting through a 4 in. flange gate valve and two flange elbows (to act as an offset), and then north through a length of pipe a 4 x 4 x 2½ tee, and a 4 in. globe valve located just beyond the edge of the tank, into the main mash line. These two valves are controlled by extension handles from a runway between the fermenters and the cookers. In one of the two elbows a ½ in. high pressure steam pipe is tapped, which keeps the pipe between the two valves always under high pressure steam, affording an efficient steam lock against contamination.

From each of the tees just mentioned a connection runs into a 2½ in. line for filling the culture vessels (seed tanks). This small line at the dead end beyond cooker No. 4 is fitted with a 2 in. diameter drain and a 2 in. blow-off valve to blow at 20 lbs. and at the west end turns south and then vertical leading to the seed tanks where the sterilising steam supply is located.

The mash line to the cooler has at the east end beyond No. 1 cooker a 1 in. high pressure steam sterilising inlet. At the west end just beyond the connection from No. 1 cooker the line turns and passes south under No. 1 cooker, then drops vertically to a 4" Y, and through the side outlet of the latter to the cooler pump. The through outlet of the Y (vertically downward) leads into a short length of pipe, capped and fitted with a 2" drain gate valve, forming a pocket which is expected to catch any nails, pieces of wire, etc., which may come through with the mash. From the

side outlet the 4" line passes to a gate valve and thence into the side outlet of a second Y at the suction of the cooler pump. The through opening of the latter Y is connected through a 4" gate valve and pipe line to what was originally the fusel oil tank (1,400 gal. steel) now placed at the west wall south of fermenter No. 14.

STERILE WATER RESERVOIR—The tank acts as a sterile water reservoir (90-100° C) and is used to supply water to flush out the cooler pump, cooler coils and fermenter mash line after pumping through the mash. It is supplied with sterile water from two traps in the 2" beer still calandria exhausts. The traps discharge into a 3" line leading to the feed water drum in the boiler room. From a 3 x 3 x 4 tee in the latter line the condensate runs under gravity through a 4" line to the above tank.

To insure sterility there is a ½" steam pipe tapped into the tank through which live steam from the main steam line is being continually discharged into the tank. In addition there is a 1½" exhaust line from the main exhaust header running to the tank supplying it with exhaust steam.

The cooler pump is a new 8 x 6 x 12 Fairbanks duplex steam pump and is located on the ground floor south of No. 1 cooker. The piping between it and the coolers is arranged with valves and cross connections as shown in drawing 84 to enable the mash to be discharged into either No. 1 or No. 2 cooler or both simultaneously. Both the new No. 2 cooler and the old No. 1 are now used acting in parallel. The mash piping is laid out to give the least resistance by using long radius elbows, Y's and offsets wherever possible, as shown.

COOLERS—The coolers are described in detail under a separate heading, and will not be touched on here (see drawings 6, 7, 12, 30, 30A, 35 and 41).

(COOLER WATER CIRCUITS)—The cooling water lines, see drawing 84, are supplied from the municipal system and are arranged so that either cooler or both together may be supplied. In No. 1 cooler there is a single water circuit while in No. 2 cooler there are two water circuits, one acting in units 1 and 2, and the other in 3 and 4. The water discharged from all three circuits is brought together in a single header from which it may be directed to various destinations. From the west end of the header a 4" line passes from a 4" T, under fermenter 15 and along the west wall to a 8 x 8 x 10 simplex pump (formerly evaporator drip pump) located south of fermenter 14 and under the north evaporator. This pump draws the water from the coolers thereby reducing the back pressure on them and delivers the hot water at about 110° F. and 10 lbs. pressure through a 4" line to the mash tub reservoir in the main building. Water from this reservoir besides supplying the mash tub is used for all other possible purposes in the building. The other branch of the previously mention T leads through a 4" by-pass around the latter pump into the mash tub supply line and from this by-pass a 2" pipe leads to the feed water tank in the boiler room. All boiler feed in the General Distilleries boiler house is supplied from this line. The boiler feed is thus primarily heated in the coolers and afterwards in the feed water heater in the boiler room.

From a 4" T in the east end of the water header a 4" line passes to an 8 x 10 x 12 simplex pump (formerly molasses pump) which discharges the warm water through a long 4" line across Trinity St. to the Gooderham and Worts boiler house supplying all the water required there for boiler feed purposes. The surplus water in excess of that required for all these various purposes escapes through the other outlet of the above T and a 4" line to the sewer. Thus all the water used throughout the plant with the exception of some for minor purposes, passes first through the coolers.

The water and mash lines as shown in drawing 84 are all provided with suitable thermometer pockets and guage connections for getting accurate information on the cooler operations. There are also steam sterilising connections and drains for keeping the different sections of the system sterile. The cooler piping both mash and water is, as is evident from the drawing No. 84, rather confused and complicated. The reason for this lies in the fact that the plant has been constantly developing, necessitating additional equipment and alterations in piping. In addition the process is a new one and the coolers themselves new so that their behaviour was unknown and provision had to be made for all possible eventualities, such as choking of coils, scaling, etc. Further the endeavour has been to make the system a thoroughly interchangeable one. The very necessary provisions for sterilising added considerably to the complexity.

MASH LINE (COOLER TO FERMENTERS—COOLED)—The mash outlets from both coolers, see drawing 84, come together in a 4" over the east end of No. 2 cooler and pass thence south through

4 x 4 x 2 T (inoculant entrance), through a long radius elbow and vertically downward into the top opening of a 4" cross set vertically in the main mash line. The lower opening of this cross carries a 3" gate valve for emergency drain purposes, but which is ordinarily plugged as an additional safeguard. On either side of the cross are gate valves in the mash line for directing the mash either east or west in the mash line as required. A ½" high pressure steam inlet is tapped into the side of the cross for sterilising or steam locking.

The 2" inoculating line from the seed tanks passes through a 2" cross set vertically, with a 2" gate valve placed immediately next it, directly into the top of the 4 x 4 x 2" T in the mash line from the coolers. The upper opening of the 2" cross carries a 2" blow off valve set for 15 lbs., and the lower opening acts as a drain fitted with a 2" gate valve. The inoculating line is sterilised from a steam connection at the seed tank end of it.

The mash line (see drawings 65, 71 and 77) proper forms a rectangular closed circuit from which the fermenters are supplied through 4" branches, with two dead end branches to supply fermenters 14 and 16. The branches enter the fermenters 5' from their bottoms, the flanges for these connections existing on the original tanks. The flow of mash into each fermenter is controlled by a 4" gate valve placed next the tank and operated through a long spindle from the upper platform.

There are three types of branches from the mash line to the fermenters. The first is of the type shown in drawing 84 in the connection to fermenter No. 13. It is employed on the most recently installed fermenters, 10, 11, 12 and 13 and consists of a copper expansion U bend extending from a T in the mash line to the valve at the fermenter. Brazed into this bend is a ½" steam nozzle so placed and shaped that a high pressure jet of steam is directed on the valve disc when closed to ensure sterility. The second type is that shown in the drawing for fermenter No. 15, and is applied to fermenters 1, 2, 3, 14, 15 and 16, it differs only in the curvature of the bend which is much less than in the first type. The third is employed on fermenters 4 to 9 and is the same as the last except that the connections are taken off in pairs from 4" crosses placed in the mash line.

The mash line itself is provided with two copper expansion bends, one between fermenters 2 and 3 and the other between 4 and 5. Th line is also divided into three sections by gate valves placed one between fermenters 3 and 4 and the other between fermenters 7 and 10. On either side of the former valve is a 1[illegible] steam sterilising inlet which enables either half of the mash line to be sterilised or used independently of the other. In the mash line beyond fermenters 6 and 7 is connected the sterile air inlet shown in drawing 77. This device carries a 1¼" steam inlet [illegible] a 1¼" drain T, a compound pressure-vacuum gauge and a 4" air inlet "C" which is provided with a gate valve and wire screen covered with a sterile cotton wool filter. It provides an inlet for sterile air should a vacuum ever occur in the mash line due to condensation of the steam.

At the two previously mentioned dead ends at fermenters 1[illegible] and 16 the steam seal arrangement shown on drawing 77 is used. This arrangement is as follows: In the mash line beyond the connection to the fermenter is placed a 4" T carrying a 2" blow off valve set for 10 lbs., next this is a pair of 4" gate valves with a T between them in which is a ½" steam connection and a 1¼" gate valved drain. This provides a steam lock and beyond this final [illegible] valve is a 4" line to the sewer.

SEED TANKS (CULTURE VESSELS)—There is a battery of nine culture vessels in a row on the operating platform south of the four cookers. These tanks are of copper 4 ft. 6 in. in diameter by 6 ft. 6 in. over all high, with dished bottom and a slightly domed flanged cover, having a 635 gal. capacity. Of these tanks four originally existed as second stage yeast tubs, and five new ones, of a slightly improved type have been added by the British Acetones replacing five original smaller yeast tubs. Very few alterations were found necessary, however, in the existing tubs, which are of the usual type of culture vessel. The most important change made being the strengthening of the cover flange joints. The general arrangement of the tanks and the various fittings on the new tanks are shown in drawing No. 66. The actual tanks differ in a few minor details from this drawing.

The vessels are of copper and are provided with various fittings. The cover carries an 11 x 16 double arched manhole at the right hand side, a 1¼ in. spring safety valve, at the left a ¾ in. gas connection at the right in front of the manhole from which the pressure gauge connection comes off (in the old tanks a 30-lb. pressure gauge is used, in the new a 15-lb. pressure—vacuum gauge), at the back a 2½ in. air valve (globe) with filter flange (this is on the

five new tanks only), and at the left back and front two 1¼ in. spring vacuum valves. In the four old tanks there are no automatic vacuum valves. Their place is taken by a vertical 1½ in. branch from the inoculating line entering the front just below the top, which is fitted with a globe valve and acts as both vacuum valve and air valve. This latter construction made it necessary to use the air line as the inoculating line, as otherwise the inoculant escaped through the air valve. In the centre of the cover is a gland through which a 1½ in. stirring shaft passes.

On the side of the tank at the left are two 30 to 240 degree F. thermometers, placed 6 in. and 48 in. from the bottom; while at the right are three ½ in. sampling taps at 12, 30 and 48 in. above the bottom.

The inoculating line (green) from the small inoculating vessels passes from the east to the west in front of the tanks, and branches run from it through 1½ in. gate valves into the front of the tanks 9 in. from the top. This line at the west end is fitted with a drain and safety valve. A 2 in. filling line from the cookers (refer back) comes up through the platform beside the west vessel and leads east in front of the tanks, branches running through gate valves into the tanks 24 in. from the bottom.

From the centre of the bottom of each vessel a 2 in. fermenter inoculating line, fitted with 1¼ in. side drain, runs into the three way cock in the main 2 in. inoculating line, which passes along the front of the tanks just above the floor and down through the platform at the west tank where it is fitted with a gate valve, drain and safety valve into the fermenter mash line at the previously mentioned cross.

There are 1¼" steam sterilising connections (22 lbs. system) at the east end of both inoculating and filling lines. (The connection in the former sterilises the mash line to the fermenters also.)

There are two 1 in. steam inlets into jets in the bottoms of the new tanks, and a single inlet in the side of the old ones, supplied from the Locke regulator 22 lb. system, through an overhead 1½ in. header. Each vessel is equipped just beneath the cover flange with a copper water cooling ring, supplied through a ¾ in. pipe, and all tanks are set on timber blocks in a large sheet metal tray which catches the drips, cooling water, etc., and carries them through a galvanised drain to the sewer.

The ¾ in. gas outlets are arranged with globe valves, and stop cocks, so that the gas may be discharged either through an ordinary gas meter (of which there are three, one for each battery of three tanks) or into the atmosphere through the wall. The lines to the meters pass through water cooled pipes to cool the gas and there is a steam connection on the air lines also.

The stirrers are of the propeller type in the new tanks, and of a special cone type in the old ones, and are mounted on $1\frac{1}{2}$ in. shafts, carrying 9 in. pulleys, driven through a quarter turn belt from 9 in. pulleys on the countershaft mounted on the wall. These latter pulleys are driven through a lever controlled jaw clutch, and the shaft rotates at about 75 r.p.m., driven from a $7\frac{1}{2}$ h.p. motor through a system of countershafting.

The stirrers of the old tanks are driven one-half as fast as those in the new.

There is in process of installation a set of galvanized iron ventilating caps over each air valve.

INOCULATING VESSELS—A small laboratory has been erected over fermenters 8 and 9, and is fitted with a battery of three 100 gallon inoculating vessels, and a small 100 gal. mashing kettle (see drawing 66). These vessels are hung on cast iron frames, and are equipped with stirrers (propeller type) driven from the main countershafting. The covers are fitted with a gland for 1 in. shaft, $1\frac{1}{2}$ in. air valve, a 60 to 260 degree F. thermometer, a pressure vacuum gauge, and 4 in. filling or charging hole with screw cover. The vessels have a steam jacket around the hemispherical bottoms, supplied with steam (22 lb. system) through a $\frac{3}{4}$ in. pipe. The jacket may also be supplied through 1 in. bottom connection with water for cooling purposes. This latter connection is further arranged to drain either to the sewer or through a check valve to a steam trap. The jacket has a $\frac{1}{2}$ in. air outlet cock at the top over the steam inlet and at the top opposite the steam inlet pipe a $\frac{3}{4}$" water overflow line. The vessels are equipped with a gauge glass and sampling tap, and empty through a 2 in. inoculating line running to the large seed tanks, each branch being fitted with a gate valve, 1 in. drain and connection for the gauge glass (see drawing 38). This latter inoculating line has a $\frac{1}{2}$" steam sterilising connection at the east end.

MASHING KETTLE—The mashing kettle is open at the top, 40 in. in diameter and 30 in. deep, with a hemispherical bottom. It is also

equipped with a steam jacket ($1\frac{1}{2}$ in. 22 lb. steam and $\frac{3}{4}$ in. drain to trap line) and two sets of special mixing paddles, running in opposite directions, and scrapers driven through bevel gearing from the counter shafting. There is a $\frac{3}{4}$" water inlet at the top. The mash passes from the bottom through a 2 in. line to a header branching into the three inoculating vessels at the sides through gate valves and fitted at the east end with a steam sterilising connection. At the east end of this inoculation laboratory is a small office and testing room.

FERMENTERS—The fermenters, 16 in number, are of three types, viz.: those constructed from the original fermenters Nos. 2-9; new fermenters installed in the fall of 1916, Nos. 14-16, together with a rebuilt No. 1; and new fermenters built in the spring of 1917, Nos. 10-13. These are more fully described under a separate heading.

ORIGINAL TYPE—The original fermenters were of 5-16 in. plate, 18 ft. in diameter by 20 ft. high, with a slightly dished bottom (about 6 in.) and no cover. The tanks had single riveted lap joints, and simply rested on brick piers giving great difficulty under slight vacuums due to the drawing up of the bottoms. In the centre of the bottom was a 4 in. outlet, originally controlled by a plug valve with a long handle reaching to the top of the tank, but now leading to the front of the fermenter through a nipple and elbow where the valves are located.

A new conical roof of $\frac{1}{4}$ and 5-16 in. plate, with an 18 in. rise, is now on the tanks. This roof is fitted with a 6 in. flange at the apex; a 12 x 16 manhole; two special 3 in. flanges side by side for the safety valves; a flange for the 4 in. air valves; and a 6 in. flange for a vacuum valve. The cover is also tapped for a 1 in. thermometer gland, and a $1\frac{1}{4}$ in. steam supply.

On the side, 4 ft. 6 in. from the bottom at the front, there already was riveted a 4 in. flange, which was used for the mash line entrance. There are three holes tapped for $\frac{1}{2}$ in. pipe arranged down the side for the sampling cocks, one two feet from the top, one midway between top and bottom, and the third 1 ft. from bottom, and a second $1\frac{1}{4}$ in. steam inlet tapped in 1 ft. from the bottom. At the front, just below the top is tapped in a $\frac{1}{2}$ in. manometer connection. These improved old tanks were subjected to a static test of $1\frac{1}{2}$ lbs. per sq. inch.

FERMENTERS 14, 15, 16 AND REBUILT NO. 1—The new fermenters No. 14, 15 and 16 and reconstructed No. 1 differ from the old ones in that they are built of 1/4 in. plate and are 17 ft. in diameter, and 22 ft. 4 in. high at the back, 22 ft. 8 in. at the front, while No. 1 as reconstructed has a diameter of 18 ft. and a height of 20 ft. 2 in. and 20 ft. 8 in. at the back and front respectively. The seams are single riveted lap joints with 1/2 in. cold driven rivets. The roof is strengthened with ten 3½ x 3½ x 5-16 in. angle rafters and the bottoms are flat with a 4 in. slope toward the front. The tank bottoms are riveted to six 12 in. I beams at 31½ lbs., running with the slope, which are in turn set on concrete pedestals. The fittings are the same as just described for the old fermenters, and the locations are shown on drawings Nos. 18-36 appended. The water gauge holes shown on these have since been plugged. The 4 in. beer outlet flange at the bottom instead of being at the centre is at the front of the bottom, 8 in. from the side. Also the upper central flange at the top of the cone is 4 in. instead of 6 in., on tanks 14, 15 and 16. These tanks were tested at 3 lbs. static pressure.

FERMENTERS 10-13—Tanks Nos. 10-13 are of the same size and type as the new ones just described. There are, however, two points of difference, the first the beer outlet at the bottom, which is in the form of a special cone elbow casting, with a 16 in. diameter where riveted to the tank, and a 4 in. flange outlet at right angles to the floor; and the second in the placing of a second 12 in. 16 in. manhole in the side 1 ft. from the bottom. A static test pressure of 3 lbs. was imposed on these.

MANHOLES—The manholes used are of the usual type with two arches; a special 1/2 in. square rubber core gasket was used to overcome the unavoidable inequalities in the faces of the cover and ring; 1½ x 1/4 plain asbestos gaskets having proved unsatisfactory.

VACUUM VALVES—The vacuum valves are of special design and construction, which will be evident from drawing No. 67, and are set to draw at about 4 in. of water. They are of brass with an inner diameter of 4½ inches, fitted with an air filter funnel (with detachable screen), and screwed into a 6 in. flange riveted to the tank roof near the side. The valves are sensitive, readily accessible for cleaning, proof against contamination and have been found

extremely satisfactory, both from a mechanical and from a bacteriological point of view, eliminating all danger of damaging the tanks or of contamination through drawing in outside air. Commercial vacuum valves proved decidedly unsatisfactory, working on such narrow limits and also due to the difficulty of making the valve bacteriologically tight.

AIR VALVES—The air valves are standard 4 in. gate valves, connected through a 4 in. close nipple with the tank flange, and are fitted above with an air wool filter funnel of galvanised iron.

SAFETY VALVES—The safety valve flanges are not now in use, as the two 3 in. pop safety valves previously employed have been replaced by the device described in the following paragraph.

FERMENTER SAFETY DEVICE—In the central 6 in. or 4 in. flange at the top of the cone is screwed or attached through a nipple and flange a special cast iron cross, having hinged flanges at top and back for cleaning purposes and a front flange set at an angle giving the 4 in. pipe bolted to it an upward slope of 1 ft. in 10 ft. The upper flange permits of the thorough cleaning of the tank flange, and the cross itself; and the back one allows a swab to be run through the 4 in. pipe for cleaning it.

The 4 in. pipe is screwed into the 4 in. brass flange on the special fermenter safety device. This device is now being installed on all the fermenters, and has proved decidedly satisfactory to date, there being no failures on record for any tank on which it has been used. (The one on tank No. 7 has now been in continuous use for two months.)

The device is constructed of No. 20 gauge galvanized iron, and as will be seen from drawing No. 60, is simply an adjustable water seal using antiseptic water. The device relieves at 10 in. water pressure. By adjusting the gate and the outer can the device measures the gas generated by its flow through a 1½ in. circular orifice, and by again adjusting the gate the flow of the gas is obtained through the equivalent of a 4 in. pipe. (For detailed description of the device see section on "Gas System.")

When foaming the outer can is removed completely and the foam discharges directly into the large funnel below. The device is cheap, safe, easily manipulated, readily understood by unskilled operators, and eminently satisfactory from a bacteriological or mechanical point of view. It is the result of a long series of experiments on this subject, and has eliminated an enormous amount of trouble and waste of mash.

THERMOMETERS—There are two methods of registering the temperature of the tanks. The first by means of a continuous recording thermometer, sample charts of which accompany this report. These thermometers are manufactured by the Taylor Instrument Company, read from 60 to 220 degrees Fahrenheit, and are of the well known type by means of which a mercury pressure is obtained through a long pipe of very small bore, with a wire in the mercury space. This long capillary tube passes through a special gland (1 in. pipe thread), tapped into the tank roof at a radius of 4 ft. 3 in. from the centre, and suspends the thermometer bulb at a depth of ten feet from the top. This arrangement gives a fairly accurate average record of the temperature changes in the fermenter.

These records are useful but at the same time temperature records may be taken by means of the bib cocks situated near the top level of the fermenting liquor, half way down the tank, and at the bottom, the liquid withdrawn being tested by ordinary thermometers. Temperatures are taken at intervals of samples drawn from the lowest tap and show a variation of from 2 to 3 degrees higher or lower than the recording thermometer. This results from the fact that the samples are taken from near the side of the tank where radiation, proximity of other hot fermenters, etc., seriously affect the temperature of the sample. The temperature variation from top to bottom of tank as shown by samples taken at the different taps, is extremely small.

MANOMETER—The manometer connection is arranged as follows:

A short ½ in. nipple is tapped into the tank and carries a brass lever handled stop cock into which a second nipple is screwed carrying a ½ in. cast iron cross set vertically. The lower outlet of the cross carries another nipple and a second lever handled stop cock. The opening opposite that leading to the tank is plugged and the fourth opening, that at the top, has a length of ½ in. pipe about 12 in. long screwed into it, carrying a tee (or elbow), of which the upper opening is plugged, and the side outlet has screwed into it a plug into which a short ¼ in. copper tube is threaded. The rub-

ber tubing is slipped over this copper tubing, and connects to the manometer which is quite close to the end of the copper tube.

This arrangement was found advisable because of the difficulty encountered through the connections choking with mash. The construction as described allows the connections to be readily swabbed or blown out when possible, without contamination.

The manometer is simply a ¼ in. glass U tube, with legs about 15 in. long and 3 in. apart, filled with coloured water, with a scale marked on cross section paper, reading to one-tenths of an inch. Both the thermometer and the manometer are mounted on a 12 x 1½ in. pine board, set vertically next the tank at the front on the operating platform, the boards of all the tanks being arranged in parallel rows. The thermometer is placed above the manometer about 5 ft. above the floor, and above the thermometer is the slide or holder for the operating tickets of each tank, while below the manometer is the hook on which is hung the file carrying the operating record of the fermenter.

STEAM CONNECTIONS—The two 1¼ in. steam inlets (high pressure), previously mentioned are for different purposes, the upper one in the tank roof at the side passing through and into a tee in which each branch has a nipple screwed into it and a 45 degree elbow set to throw horizontal jets of steam across the tank top to break up the foam. The action has not been found very satisfactory in this respect. The lower inlet passes to the centre of the tank, and into the back of a side outlet cross (a five way fitting), the other four outlets carrying 1 in. pipes reaching nearly to the walls of the tank and drilled with 1-32 in. holes 1 in. apart. The holes are inclined at an angle of 45 degrees to the horizontal, and giving a swirling action tending to move the heavy sludge collecting at the bottom when emptying the tank toward the centre. This action has been found effective. The lower steam inlet is also used for steaming when sterilising a fermenter. Both lines are controlled from the operating floor.

SAMPLING TAPS—The try cocks or sampling taps are simply ½ in. lever handle plug taps, screwed directly into the side of the tanks, and are used for taking test samples of the mash.

Originally the tanks were fitted with continuous ½ in. gauge glasses reaching from the bottom to the top. The bottom connection was tapped into the tank bottom and for this reason and because of difficulty of effectively washing out, the glasses rapidly chocked and were unreliable and they were therefore abandoned and the try cocks used when necessary.

COOLING RING—For cooling purposes in preventing incipient foaming there are now available two cooling rings of 1 in. copper pipe drilled with 1/8 in. holes 2½ in. apart, and supplied through 1½ in. hose from the water mains. This ring is placed around the centre flange of the roof and directs streams of water over the roof and sides of the tanks. These are to be permanently installed on all the fermenters as they have been found fairly effective in preventing foaming if applied in time.

PROTECTIVE COATING—The tanks are painted on the outside with red lead, and the question of a protective coating for the interior has received considerable attention, but no definite conclusions in this regard have been arrived at up to the present.

BEER LINE (FERMENTER TO PUMP)—The beer line from the fermenter bottom, either the centre or the front, is fitted with a 4 in. gate valve which is just outside the edge of the fermenter. Beyond the valve is a close nipple and cast iron Y, with the branch pointing in the direction of flow to the beer pump. The through opening of the Y is fitted with a close nipple, and a second 4 in. gate valve, which is used for running off sour beer when a fermenter goes "bad," The branch of the Y carries a length of 4 in. pipe in which is placed a third 4 in. gate valve, this branch being sufficiently long so that the main beer line into which it connects through another Y clears the run off valve with a fair margin.

Into the Y next the fermenter is tapped a ½ in. steam pipe leading from a header supplied from the Locke regulator steam system (14 lbs.) which keeps the pipe in between the three valves always under steam and effectively seals a fermenter against contamination working in from the beer line or the outside air. This arrangement which has been placed on all the new fermenters and is in course of application to the older ones is shown on drawing No. 63, as well as a previous arrangement which it has replaced.

The 4 in. beer line runs by way of several branch lines shown diagrammatically on drawing No. 81 from the different fermenter groups to the suction of a 6 x 4 x 10 inch steam duplex beer pump located just south of cooker No. 4. These groups are as follows:—

Group 1—Fermenters 14, 15, 16, 1, 2 and 3 (with 16 on a dead end); Group 2—Fermenters 4, 5 and 6; Group 3—Fermenters 7, 8, 9, 10, 11, and group 4—fermenters 12 and 13. At present No. 7, 8 and 9 are in the 4, 5 and 6 group 2, but are being altered at the present time to the above grouping. Each group passes through a 4 in. gate valve into the two suctions of the beer pump the two groups 1 and 2 into the north suction and groups 3 and 4 into the south. In the latter just before the pump is reached there is a 4" drain. The lines are about 12 in. above the concrete floor, and use is made of Y's and long radius fittings wherever possible to assist the flow of beer. The ends of groups 3 and 4, at the east wall, and group 1 at fermenter 14 are provided with 2" city water connections for washing out and there is a 2" drain at the dead end at fermenter 16 and at the end of No. 13. No provision is made for steaming the beer line as a whole.

PIPE LINES—The pipes in this and other buildings of the distillery, except those carrying spirit, were all wrought iron, and cast iron fittings were exclusively used in the old distillery days, even on the steam lines, and the practice was continued to the present time with the British Acetones; the reason given for the use of cast iron fittings formerly being the fact that they are more readily taken down than wrought iron (a few taps with a 2 lb. hammer generally sufficing to remove the most obstinate cast iron fitting). At present malleable fittings are being substituted on all steam lines, and to a large extent the other lines, as rapidly as possible.

The pipe lines are all painted distinctive colours, and the steam lines and water lines are asbestos lagged. The slop and beer lines are painted red, water lines white, steam, both live and exhaust, black, inoculant green, air and gas yellow and spirit, either iron or copper, blue. The majority of the lines are 4 in. in diameter.

RUNWAY—The fermenter section of the building has been fitted with a timber runway midway between the floor and the operating platform, extending the length of the building between the north row of fermenters and the cookers, and also north of the new fermenters Nos. 10-13 and a small one between Nos. 14 and 15. This is used in manipulating the valves of the cookers, getting samples from the fermenters, etc. The upper platform has also been extended around all the new fermenters and several new flights of stairs built to render the plant more convenient of operation.

FLOORS—The fermenting section of the building had a concrete floor arranged with a system of gutters in the concrete leading to drains to the sewers. These gutters are roughly situated below the beer lines, as they now exist, and afford a convenient means of getting rid of sour beer, drippings from pipe drains, etc. The floor is frequently washed down with hose. Small movable plank platforms or walks are now being put down for the convenience and comfort of the operators and the question has been considered of placing a runway over all the beer lines.

Signals and Communication—There is a complete system of gong and light signals between the mash floor and mash pump in the main building and the operating floor of the fermenting section by means of which the pumping of the mash is controlled. The fermenting floor is also provided with a telephone for communication with the laboratory (bacteriological) or the city system and there are speaking tube communications where required.

DISTILLATION AND RECTIFICATION SECTION OF THE BRITISH ACETONES, TORONTO, LIMITED.

See Drawing 59A.

Beer Line (Pump to Beer Still)—The beer line from the 6 x 4 x 10 duplex beer pump south of No. 4 cooker passes upward at an angle through the operating platform and south over No. 1 fermenter through the north wall of the distillery five-storey portion of the building, passing just west of the beer still, and then runs vertically upward through the third and fourth floors and discharges over the side of the 7,100 gallon copper beer still service tank (formerly a scale tank) located on the third floor. The line has as easy a run as possible, right angle bends being replaced by 45 degree elbows wherever possible, and at the bottom it is fitted with a 2 in. bypass to the suction. The line just before discharging into the tank is fitted with a 1½ in. riser extending to just below the roof.

From the service tank a 6 x 12 duplex pump, gear driven from a 6 x 10 single cylinder steam engine, draws the beer through a 4 in. suction line, discharging it at a rate subject to close regulation by means of this type of drive, through a 3 in. line to the bottom of the beer heater just below the fifth floor. The pump is fitted with a 2 in. blow-off bypass, and the line to the heater with

a 2 in. drain. The suction line to the still pump has besides a 4 in. gate valve a 4 x 4 x 2 tee into which runs a 2 in. city water main for washing down.

This arrangement of two pumps has improved the operation and increased the rate of working considerably over the results obtained by the old arrangement, which used the single gear driven pump on the ground floor. The arrangement has proved advantageous also when foaming occurs through being able to pump some of the beer out of the fermenter into the service tank.

Beer Heater—The beer heater is of copper 36 in. in diameter by 15 feet long on the cylindrical part, fitted with sixty-six 2½ in. tubes 14 ft. long, the upper tube header being about 9 in. from the top, and the lower 3 in. from the bottom flange. The top is slightly domed, and is fitted with two 2 in. swing check valves on a tee, acting as vacuum valves.

The bottom of the heater is conical, about 30 in. deep, and the beer passes into the bottom of the cone up through the tubes, and the heated beer flows out at the north side, 6 in. from the top flange, through a 5 in. copper pipe into the beer still, entering the latter just below the top flange at the east side.

The vapour coming from the still through a 9 in. copper pipe enters the heater 9 in. below the hot beer outlet, and leaves the heater from the opposite or south side through a 9 in. pipe, 24 in. above the bottom flange, and passes directly into the condenser. There is a 3 in. copper syphon return for the condensed vapours from the heater back into the first plate of the still.

Beer Still—The beer still is 6 ft. in diameter, and 41 ft. long, with a capacity of 6,000 gallons per hour on acetone work. The still contains 19 plates, the first located 5 ft. 9 in. from the upper flange, and spaced about 18 in. apart, the lowest one being 8 ft. from the bottom. It is built of 6 flange jointed 54" sections each containing 3 plates, and a 7' 4" top and bottom section. Each plate carries 69 boiling caps or mushrooms of 1½" diameter and one 8½" downpipe or overflow.

In the upper part of the still is a heating coil of 5 in. pipe, through which the beer from the heater passes, surrounded by the hot vapour. This 5 in. line leaves the still about 3 ft. below its entrance, and re-enters at the second plate down. There is a 4" vacuum valve on the top and between the second and third plates from the top on the side. The lower 6 ft. of the still is occupied by a calandria containing 404-2 x 42 in. tubes, the steam surrounding them entering through a 3 in. pipe (controlled by a globe valve from the operating floor) which divides into 4-1½ in. branches and enters the calandria at the top at four points of the circumference. There are two 2 in. exhaust outlets at the bottom, running to two steam traps. In addition, there are two auxiliary steam inlets, one a 5 ft. coil of perforated 1½ in. pipe at the bottom below the calandria, and the other a straight piece of 1½ in. pipe above the calandria. Both of these are now used in operating the still.

The calandria is equipped with two 2 in. blow-off valves, set for 12 lbs., a 1 x 18 in. water gauge, and a pressure gauge located on the third floor. The 6 in. slop outlet is arranged with a syphon so that the calandria is always covered, and a float controlled valve which maintains the level at the proper point. From the syphon the slop is carried by a 5 in. W. I. pipe line direct to the sewer.

The still proper has a 3 in. drain, and is fitted with 12 x 20 manholes between each plate, at the top and at the bottom. The pressure on the still itself at the operating floor (between the second and third plate above the calandria) is registered on a water column device on this floor, which proves very sensitive and accurate, more so than a dial gauge. There is generally 2 lbs. pressure at this point on the still.

Beer Condenser—The beer condenser is of copper 60 in. in diameter by 24 ft. long, standing on wooden base on the third floor. The vapours come from the beer still and heater through a 9 in. copper pipe, and enter the tube header (containing a spray plate), which is 42 in. in diameter and is fitted with 148-1½ in. x 20 ft. 0in. long tubes, spaced 3" centre to centre. The condenser is cooled with bay water through a 3 in. pipe from the reservoir (there is also a 2 in. auxiliary cooling line and 2 in. drain at the bottom) and overflows through a 4 in. W.I. pipe. It is provided with a 4 in. vacuum valve on the upper tube header.

The spirit leaves the condenser through a 3 in. copper pipe passing to the tail box, from which it passes through a three way cock, the side outlet of which is plugged into a 3 in. copper line, which is flange jointed to a 2 in. W.I. pipe line below the floor, and leads to the top of a 14,300 gallon copper tank AB, formerly one of the three wine tanks. From tank AB the spirit is drawn through a short 4 in. copper pipe into a 6 x 8 x 12 simplex steam spirit

pump, and is discharged through a 4 in. copper line to the kettle of rectifier No. 1. This pump is arranged with a suction from a second spirit tank A1, also, which is immediately south of AB. There is, however, only one discharge, as the charge for rectifier No. 1 is made up of spirit drawn from both tanks. The discharge line passes through a 4 in. gate valve into a 6 in. returns line from the spirit column to the kettle just above the latter.

Rectifying Kettle—The rectifying kettle, taking a 13,000 gallon charge, is of copper, 14 ft. in diameter by 14 ft. high. It is equipped with a steam heating coil of 2 in. copper tube, having 4 coils around the side just above the bottom and the remainder consisting of a spiral (17 coils), lying on the bottom of the kettle. This coil is supplied through a 2½ in. steam pipe at its outer circumference, the exhaust coming from the inner coil through a 2 in. pipe and passing to a trap or drain.

The steam valve located where the line passes into the kettle is controlled from the operating floor through a long handle, and the pressure on the boiler side of the valve, usually 90-95 lbs. is indicated on a gauge at the third floor between the two coolers.

The vapours from the kettle pass through a 16 in. copper pipe from a 4 ft. dome on top of the kettle to the spirit column entering the latter 27 in. from its base, and turning down to within a few inches of the bottom inside.

The rectifier is equipped with a 3 in. weighted safety valve, set at 5 lbs., a 4 in. spring loaded vacuum valve, drawing at a very slight vacuum, and a ½ in. gauge glass extending the full depth of the kettle. The 6 in. returns leaving the spirit column below the vapour line entering, runs into the kettle at the top near the side, and passes down inside to within 6 in. of the bottom. The kettles have a slightly dished bottom, leading to a 4 in. copper drain, and are mounted on brick piers about 24 in. above the floor. There is a 12 x 16 manhole in the side near the bottom.

Rectifier Spirit Column—This is of copper, 60 in. in diameter by 37 feet high, and stands on the second floor, reaching to just below the fifth. It contains 24 plates, 15 in. apart, each fitted with three 6 in. overflows or down pipes and seven 7 in. capped vapour pipes or bonnets. The first plate is about 3 ft. from the bottom, and the top one 2 ft. from the top. Under the first plate is a 12 x 16 manhole. There are 1 in. copper draining bypasses around each plate, and a ½ in. sampling tap for each. The column is composed of ten 31½ in. sections flanged together, with a 5 ft. bottom section and a 4 ft. 6 in. top.

The pressure gauge on the operating floor indicates the pressure in the 16 in. header between the kettle and the column, and usually indicates 3 lbs. There is a 3 in. copper line running from what was formerly the fusel oil trap in the 6 in. copper returns line from the goose to the spirit column, which enters the column through 3 in. iron body gate valves between the ninth and tenth and between the nineteenth and twentieth plates from the bottom. This was expected to speed up the action of the rectifier, but proved disappointing in practice and is not now used. It was applied to No. 1 column only.

From the slightly domed top a 14 in. copper vapour pipe passes through the fifth floor and south near the roof to the goose. The 6 in. copper returns line from the bottom of the goose, containing the fusel oil trap, enters the top of the column near the side. There is a 4 in. vacuum valve also on the domed top of the column.

GOOSE TANKS—The rectangular goose tanks are of steel plate, 12 ft. 6 in. by 11 ft. by 8 ft. 6 in., 7,283 gals. capacity, placed with their bottoms 12 in. below the fifth floor, and are re-inforced with angles and tie rods. The vapour from the spirit column enters the middle of the top of a 14 in. header, 5 ft. 3 in. long, from which seven 6 in. outlets open downward, connecting to seven parallel sets of 4¾ in. pipe loops, consisting of 6 complete loops, each 6 ft. long, vertically, and ending in a 14 in. by 9 ft. 9 in. header at the east end. The seven loops enter the south half of this header at the bottom, and from the north half six similar sets lead parallel to the former sets to a third short 12 in. by 4 ft. 6 in. header, with its axis in line with the first.

The vapour passes out from the north end of the latter header down through a 12 in. copper pipe into the spirit cooler. Each set of loops drains into a header at the bottom, which in turn leads into a connecting header, passing out through a flange in the tank side, a 6 in. copper returns line and what were formerly fusel oil traps into the spirit column.

A 2 in. city water line for washing down or filling up the column runs into this returns line just outside the tank (see note re this later).

The goose tanks are filled with bay water for cooling which

enters from the water reservoir through a 4 in. pipe in which is a gate valve controlled through a long spindle from the operating floor. The water is distributed in the tanks from the inlet pipe through five long 2 in. perforated pipes between the different loops. There is a 6 in. overflow 6 in. from the top, and a 3 in. drain in the bottom. A ¾ in. W.I. water sampling pipe from the goose tank taken from a 2 in. flange in the side near the bottom, passes down the south wall of the building to a tap at the third floor, which discharges into a sampling pail fitted with an overflow. The pail is used to obtain the temperature of the water in the goose tank.

Formerly the 2 in. flange connection from which the sampling line is taken connected through a 2 in. plug cock directly into the 6 in. returns line, into which the city water is now supplied. Bay water from the goose tank was then used to wash and fill the column.

SPIRIT COOLERS—The spirit coolers stand on wooden bases on the operating floor, and are of copper 42 in. in diameter and 24 ft. long. They are made up of 60 in. sections. The 12 in. inlet pipe from the goose enters a 29 in. diameter tube header (situated about 2 ft. below the open top), from which 151-1 1-8 tubes 20' 0" long lead to the lower header. The upper header is fitted with a spray plate and 4 in. vacuum valve. The spirit leaves through a 3 in. copper pipe leading to the tail box.

Bay water is the cooling agent, and is supplied through a 2 in. pipe, 6 in. from the base (from which a 2 in. drain also leads), and overflows through a 4 in. W.I. pipe, 6 in. from the top. There is a 12 x 16 manhole in the side at the bottom.

From the tail box the spirit is directed into a 4 in. header, from which three 2 in. outlets lead through stop cocks to the different pipes and tanks.

The first runnings pass through the north outlet into a 2 in. copper pipe leading to the 14,300 gal. spirit tank A1, located beside the tank AB. The second runnings flow through the south outlet into a three way cock, and out of the side opening of the latter into a second 2 in. three way cock, passing out through the outlet of the latter into a 2 in. W.I. pipe leading to the returns line to the kettle of rectifier No. 2.

The next runnings are directed into A1, and are followed by runnings (butyl) which pass out through the outlet of the first three way cock through a 2 in. W.I. line to the reservoir B1, formerly a 13,400 gal. wine tank.

The "last runnings" come out through the south outlet and the side outlet of the second three way cock into a 2 in. iron line known as LR. and flow to a small 881 gal. tank on the second floor, formerly the evaporator supply tank. The middle outlet from the header leads through a 1½ in. "tails" line (copper) to the two spirit diluting tanks, 13,400 gallon capacity, in the filter room, the tails being directed to the west tank. A branch of this line also runs to the top of BI, but is not used. The tails line is used for emergencies, bad stuff, etc.

RECTIFIER No. 2—The second rectifier, spirit column, goose and cooler are identical with the first, but the charge is made up of the spirit R2 from rectifier No. 1, soda and water, and the runnings from the tail box of rectifier No. 2 pass into the header as in No. 1, from which in turn it passes through the three plugged stop cocks and 1½ in. pipe to three possible destinations.

The first runnings pass through the north outlet and a 1½ in. copper pipe into the previously mentioned line to tank AI. The second runnings (acetone) pass out of the south outlet through a short 1½ in. W.I. pipe to a battery of gauging vessels on the third floor. After the acetone there is another run of AI, and the last runnings, the "oils", pass through the 1½ in. copper pipe previously mentioned to the east tank of the two in the filter room.

SODA TANK—The former 1,000 gallon yeast tank on the third floor is now used as a soda mixing tank, and is supplied with city water through a ¾ in. line and tap. The soda from this tank passes through a 1 in. W.I. pipe line to the tops of the kettles of the two rectifiers, and also through ½ in. pipes to plates 2, 4 and 6 (from the base) of spirit column No. 2, entering through the sampling tap holes.

SPIRIT TANKS—The location of the three former wine tanks has been altered. Two of them viz.: AB and AI, are now side by side between fermenters 13 and 14, and just east of the main stairs leading to the platform. The third, BI, stands practically due north of rectifier No. 2, between two brick pier carrying the north wall of the building, and south of and midway between fermenters 12 and 13.

The two 13,400 gallon spirit tanks formerly located at the east

wall (now B2 and A3) east of the rectifiers have not been moved, except that the south one, A3, used now as an acetone storage tank, has been raised some 3 feet to provide sufficient head to cause flow to the shipping room.

From a point 2 ft. from the top of B1 a 2 in. W.I. line leads into B2 about 30 in. from the bottom, and from B2 a 4 in. W.I. line leads to the 12 x 10 x 20 steam pump under the evaporators (formerly slop pump) from which a 4 in. overhead pipe carries the butyl to the north 400,000 gal. outside storage tank.

Another connection may be substituted for the one just described on B2, the drain from the tank passing to a 6 x 8 x 12 spirit pump between the two east tanks, which discharges through a 2 in. W.I. line back to rectifier No. 1 through the safety valve opening.

The bottom layer of B1 is drawn off through a 4 in. W.I. pipe by the one-time scale tank spirit pump (6 x 8 x 12) beneath the beer still, and discharged through a 3 in. copper line up to the beer still service tank.

GAUGING VESSELS—These vessels, four in number, located on the operating floor, are of galvanized iron, 100 gals. in capacity, 4 ft. in diameter with a 15 in. cylindrical part, a 6 in. conical bottom, terminating in a 1½ in. pipe flange. The lids are fitted with a 9 in. diameter sampling opening with a hinged cover. They are shown in drawing No. 22, attached herewith, together with their connections.

These vessels are used to hold the runnings from rectifier No. 2, while the sample is being tested, after which it may be directed back to A1 for re-rectification or to the acetone storage, as determined by the test. The inter-connections are 1½ in. genuine W.I. pipe. The supply from the tail box of No. 2 rectifier enters the tops of the vessels through globe valves and leaves at the bottom; the left-hand branch of the drain controlled by globe valve being the return line to A1, and the right-hand controlled by lever handled plug stop cock the acetone line which passes down the south wall of the building. The vessels are placed so that the handles of the lower valves are just above the floor, all the underpiping being below the floor level. The vessels are numbered 1-4 from south to north and the samples are taken from them by means of a copper dipper.

ACETONE LINE—The acetone line from the gauging vessels coming down the south wall of the building branches just below the second floor, one branch running horizontally and fitted with a valve, controlled from the operating floor, into the raised tank A3 in the south-east corner of the building. The other branch passes down through a globe valve about 6 ft. above the ground floor, and into a tee in a line from the bottom of the raised tank, there being a valve in the latter line at the tank. A single line passes from the tee through the wall and along the south side of the building on the ground for about 75 ft. to a small concrete drip box, where it turns down and run southwest for 25 ft. underground through a 3 in. protecting pipe to about 3 ft. from the north-east corner of the store room building (now used as a shipping room), and under the south-east corner of a new elevated acetone storage house. The protecting pipe has a slope back to the concrete box and serves to indicate any leaks in the acetone line.

ACETONE STORAGE HOUSE—Just outside the wall of the shipping room is a tee in the acetone line, one branch running west and then vertically upwards through the concrete floor to the acetone storage house near the roof, where it again divides, one branch with gate valve control going over the edge and through a 3 in. flange into each of two 3,000 gallon 9 ft. diameter by 7 ft. 4 in. average height, No. 12 gauge galvanized iron tanks.

The tanks are covered, the covers having a 12 x 16 in. manhole, and a flat sloping bottom (4 in. slope) draining to the front, where a 2 in. drain flange is riveted. The tanks are placed in a small steel and galvanized iron elevated structure, shown in drawing No. 20. The tanks now used are larger than those indicated on the drawing, which were recently replaced by the larger ones in order to secure storage for a carload of acetone with a sufficient margin for eventualities.

The structure has a sloping, reinforced concrete floor, and was erected by the British Acetones. The 2 in. drain lines provided with 2 in. gate valves pass through the concrete floor and come together below, a single line passing into the shipping room.

SHIPPING EQUIPMENT—The store room of the General Distilleries is used as a shipping room for the British Acetones. The 1½ in. line from A3 and 2 in. line from the elevated storage tanks run along the east wall to the centre, where they turn outward at right angles and terminate in downward directed pipes fitted with plug cocks over the platform of a 1,200 lb. platform scale, on which

the drum is rolled for filling. A short length of pipe is inserted in the bunghole of the drum, and is then screwed on the end of the plug cock nipples for filling. Midway between the north wall and the scales is placed a drum washing tank, which is shown on drawing No. 21, from which the dimensions may be obtained. There are two rotateable wash nozzles which may be supplied with either steam or water.

The drum is rolled up a skid on the north end over the trough, and a nozzle inserted in the bunghole. After washing it is rolled down the skid at the south end rinsed out with acetone and up another directly to the 42 in. by 42 in. platform of the scale, where it is filled. From the 2 in. acetone line previously mentioned, a branch runs to a flange in the side of the trough, by which means any acetone of poor quality may be run into the trough and drawn by a small pump (2½ x 2 x 4) in the north-east corner through a 1½ in. pipe from the drain of the trough, and discharged through a ¾ in. pipe enlarging to 1¼ in. back to rectifier No. 2. The drum washings are redistilled in this rectifier. The 1½ in. acetone supply line also has a branch for the same purpose, which instead of entering the flange provided on the trough comes into the pump suction direct through a tee. Besides the drain line from the trough to the pump there is a second 1½ in. drain running directly to the sewer.

North of the scales on the wall are the stencil racks and the scale testing weights, while south of them is the desk, sample cupboards and storage shelves. A 9 ft. by 9 ft. door in the middle of the south wall opens directly on the railroad siding, and in this door was erected a 5 x 10 ft. timber loading platform, at a slightly greater height than the floor of the railroad cars.

The filled drums are hoisted to this platform by means of a fixed radius (9 ft.) steel jib crane, equipped with a 1 ton Morris electric hoisting block, installed by the British Acetones; and the drums are then rolled on a skid to the car.

Empty drums received from the cars are simply rolled down a skid from the hoisting platform to the floor of the shipping room, which is about 3 ft. below the yard level.

The remainder of this building, with the exception of that occupied by the original molasses mixing tanks and pumps, and the butyl salting plant in the north-west corner, is used for drum storage purposes, there being kept here generally about 100 empty cleaned and uncleaned drums. There may in addition occasionally be 15 to 20 filled drums here left over from a previous shipment.

The acetone is shipped in carloads, with 42 drums to a carload generally. The drums are standard pressed steel 28 x 42 in. acetone drum, with a 2 in. pipe tap plug. The drums have a tare weight of about 170 lbs., and are now shipped with 700 lbs. of acetone in them. The plugs are screwed home with a heavy 24 in. T plug wrench.

The rate of filling with this equipment is six drums an hour, and a car can be loaded in about one hour with a gang of nine men.

Outside Storage Tanks—Of the three original outside storage (molasses) tanks, the west 250,000 gal. one has been broken up and sold and the north 400,000 gal. tank, now holding butyl has been sold and is about to be broken up. The south 1,250,000 gal. tank will be retained. It is at the present time unused but will likely be used for butyl storage or slop settling in the future.

Power Plant and Steam Supply—The boiler house of the General Distilling Company supplies the steam required for all the operations with the exception of the milling and mashing.

The equipment consists of a battery of six Babcock and Wilcox boilers arranged in pairs, the two end ones being 250 h.p. and the four middle ones 175 h.p. The boilers are equipped with Jones Underfeed stockers, hoppers hand filled, 3½ in. spring loaded safety valves, set for 125 lbs., and carry normally 120 lbs. of steam. The higher power boilers have two drums, the others one only. The steam comes off through a 6 in. valve and pipe into the top of a steam header which increases from 6 in. diameter over the west boiler to 10 in. where it passes through to the distillery. At the west end a 4 in. valve controls a line leading to the shipping room and butyl plant, with a 2 in. branch parallelling the main header running to the east end and supply the boiler feed pumps. A 2 in. line from the safety valve connection on the second boiler from the west end is connected into the latter line also. At the east end just past the last boiler is a 10 in. gate valve from which the 10 in. steam main leads through the east wall, through the shop (formerly filter room) and into the distillery proper.

The boiler feed pumps, are two 9 x 5 x 10 outside packed duplex pumps, which draw the feed through 4 in. pipes from a 6 x 6 hot water drum, (there is a 2 in. city water connection into the west

pump section) and discharge it through a 4 in. pipe either through a 1,200 h.p. Alberger exhaust steam feed water heater, or directly to either of two 4 in. feed water lines, equipped with swing check valves, to the boilers. The discharge lines from the heater are provided with a large air chamber. Up to the present there has been only one feed line passing in front of the boilers supplying them from the 2 in. branch. This was extremely bad, as with a break down in the line at the east end all the boilers west of the break were put out of commission. There is now, however, a practically completely installed second 4 in. line parallelling the first, and linked up with it at the west end. The first will be broken between each pair of boilers, and 4 in. valves inserted, effectively safeguarding the boilers against feed line breakages.

The hot water drum is so connected that the water may be supplied to it through a 2 in. float valve from either a special separate city supply, the ordinary distillery city supply, the bay water system or a hot water line from the mash coolers, all through 2 in. pipe. A 3 in. and four 2 in. exhaust steam lines from various traps, that formerly entered the drum direct, causing difficulties when the traps were out of order through steam surging in, are now connected with tees and branches collecting in an overhead 4 in. header, leading the steam either into the main 8 in. exhaust header to the heater, or if sufficient exhaust is already available directly to the air.

The exhausts from the different pumps and engines in the distillery have recently been collected into a single 8 in. exhaust header, and returned to the Alberger heater from which the condensate passes through a 2 in. pipe to the hot well.

The flue gasses from the boilers pass off through a 6 ft. 6 in. square iron breeching to the 4 x 125 ft. steel stack, set on a concrete base, outside the west end of the boiler room. A continuous flue gas recorder and a flue gas thermometer have been inserted in the smoke flue just beyond the last boiler.

There are two pressure fans for forced draft, one motor driven (30 h.p.) by a belt at 750 r.p.m., with a 5 ft. x 24 in. impeller which is generally used, although not continuously, merely to keep the pressure up under heavy loads. This also drives the stoker feed mechanism. The other fan has a 4 ft. x 21 in. impeller, and is belt driven from a high speed steam engine.

STEAM PIPING SYSTEM—The main steam header enters the distillery through the west wall, where a recording and indicating pressure gauge is tapped in just as it passes through the wall, and beyond it is a tee from which a 6 in. branch passes vertically through a valve and again divides, another 6 in. branch going south to supply the evaporators and pumps in the south-west corner, and a 4 in. branch going north to supply the fermenting section.
ward and divides into two 6 in. valve controlled branches, one supplying the rectifying kettles and beer still, and the other the two

From the first tee, the second or through 8 in. line runs east main water pumps, various small pumps, besides the Locke regulator controlling a 2 in. 15 lb. heating line for the girls' mess room and offices. The 4 in. fermenting section steam supply divides into two 4 in. lines, one of the latter further dividing into a 3 in. under control of an attendant supplying the mash line digester nozzles, and another 3 in. feeding the cooler pump, beer pump and fermenter mash line valve jets. The other 4 in. branch itself divides into a 3" branch and two smaller branches as follows: a 2 in. Locke regulator 22 lb. line for the cookers, inoculating vessels and sterilisation of lines and a 2 in. line for fermenters 10-13. The 3 inch branch supplies a 2" fermenter header over the remainder of the fermenters which loops up with the 2 in. over fermenters 10-13 at the east end and also supplies a 1½ in. high pressure sterilising line under the runway. The latter supplies the steam for the jets on the valves in the mash line to the fermenters. There is a 2 in. cross-connection to supply the fermenting section with steam from the line feeding the office Locke regulator, and also from a 2 in. line from the Gooderham & Worts boiler house. The latter line is further connected up to supply the Locke regulator on the office heating system.

At present five of the six boilers in the General Distilling boiler house are always in use, but the boilers have been found to be in bad shape, and are now being thoroughly cleaned. It is expected that three boilers will in future do the work now being done by the five, so that five will be able, in addition, to supply all the steam necessary for milling and mashing, thus eliminating the Gooderham & Worts boiler house now used.

In the latter there are eight 100 h.p. return tubular boilers, of which six are now in use, supplying steam for mashing and milling, the Gooderham & Worts fitters' and carpenter shops and bottling

department.

WATER SUPPLY SYSTEM—There are four main sources of water supply for the British Acetones.

The first is a 4 in. line from the municipal system entering the building at the north wall between fermenters 1 and 16, which divides into a 4 in. branch which runs around fermenter 16 and branches, a 4 in. branch running east under the runway to supply the coolers the floor hosing system and the beer line washing connection and a 3 in. branch running east and vertically to supply the fermenting floor and from which a 2 in. header runs east above the cookers and fermenters besides a branch over the seed tanks both of which supply the cooling rings of the different tanks. A 3 in. branch from the original supply passes under the platform and through the west wall into the filter room, where lines run to the spirit diluting tanks, the wash water tank, the molasses mixing tank south of the filter room, the shipping room and from which two 2 in. branches pass into the boiler room, one to the yeast kettle and the other to the feed water drum.

The second source is also the municipal system, and is a 2 in. line for boiler feed purposes only, coming in through the boiler house wall and a separate meter to the feed mater system direct.

The third is a bay water supply which is drawn by two 12 x 14 x 18 in. duplex steam pumps in the distillery through 12 in. suction pipes from a well at the bay front, and discharged through two 8 in. lines to the reservoir on the roof. The pumps handle 1,000 gals. per minute at 100 lbs. per square inch. From the 5,300 gal. bay water reservoir on the roof, which is fitted with a 10 in. overflow, a series of lines are taken. The first is a 4 in. line which reduces to 3 in., and supplies the beer still condenser; the second a 6 in. which divides into a 5 in. to the goose tanks and a 3 in. to the rectifier cooling columns; the third a 4 in. to the evaporator condenser; and the fourth a 6 in. which divides into two 4 in. branches, one running north toward the fermenter section, which is now broken, and the other west to the evaporators. A 10 in. overflow from the main reservoir runs into an 8 in. drain pipe passing down the south wall of the building, into which various other drains are run. There is a second 6 in. drain at the east wall connecting other drain lines.

The fourth water supply system is a fire protection service. On this system there is a 4 in. line, reducing as it passes upward, running up the south wall of the five-storey section of the building, fitted with hose connections at each floor and at the roof. From the first of these connections a length of hose is already laid north of the fermenting section. This was deemed advisable rather than a fixed iron pipe line, due to its flexibility in case of an explosion. On the fire system there are also a number of hydrants in the yard at convenient points.

Electric System—The electrical power is supplied by the Toronto Electric Light Company, and is 550 v. 25 cycle three phase alternating current. It is stepped down in the different transformers to 220-110 v. as required. The electric wiring, both power and light, has all been put in conduit, with the switches, switchboards and fuse boards placed in small outside galvanized iron switch houses. There is one of the latter outside the main distillery door, receiving current from a transformer on the wall above, through which the lines to the distillery section are controlled.

There is a second house on the roof of the fermenting section at the west end. It receives current from the previously mentioned transformer, and contains the controls for the fermenting section lines and the motor for the seed tank drives. The shipping room switches, light and motor for butyl plant, are in a galvanized iron box outside the shipping room door. The transformer for the boiler house is on the south wall outside, with a switchboard just inside the west door. The fan motor runs directly on 550 v. The shop motor, fuse box and switches are just inside the new doorway. The yard is now lighted with high power lamps equipped with reflectors, and the offices, drafting rooms and laboratories are brilliantly lighted with special semi-indirect fixtures. The motors used are all of the induction type, with special oil bath non-sparking starting boxes.

Compressed Air System—The compressed air is supplied from the compressor on the stone floor of the Gooderham & Worts main building. A 2 in. overhead line runs to the distillery, from which various connections are taken off to supply the air drills and riveters used on construction work.

Shops—The shops of the Gooderham & Worts Company were until the present time, used exclusively for doing the work required by the British Acetones. This resulted in much loss of time owing

to the distance away and the frequent travelling back and forth. Recently, however, the filters were removed from the filter room and the room fitted up as a steamfitters' shop. The door into the distillery was bricked up, and a new doorway at the south end opening into the yard put in, the walls cleaned and the lighting improved. The north half is equipped as a stockroom, with various racks, drawers and a counter dividing it from the south half. In the south half are placed the different benches, with machines and vices, a 4 in. pipe cutting and threading machine, a small drill press, and two-wheel emery grinder, and acetylene welding outfit. The power is supplied from a 7½ h.p. motor, and there is a small portable forge outside in the yard. At the south wall opposite the door is the pipe rack.

The carpenter and coppersmith shops of the Gooderham & Worts Company are still used, as the time lost due to their distance away is not great, the trips back and forth not being so frequent in this work.

Girls' Quarters—The south-east corner of the fermenting section of the distillery, formerly used as a superintendent's office, is now fitted up as the girls' quarters, comprising girls' messroom, toilet, etc.

Superintendent's Office—There has just been built a small separate superintendent's and time office, located in the yard at its narrowest point before reaching the General Distillery property. This building is equipped with an office for the superintendent, timekeeper and stock clerk. There is also provided an entrance for the workmen fitted with a time clock. There will also be installed here a watchman to prevent the entrance of anyone to the plant without the proper authority, and also to relieve the men of matches or other dangerous materials. The watchman is now located in the only entrance to the distillery building proper, other than the girls' entrance, which is through the girls' quarters, and prevents the carrying in of matches, etc., there.

Offices—The two-storey section of the distillery building in the south-east corner has been remodelled and fitted up as the offices of the British Acetones. The lower floor contains the business office and distilling laboratory, and on the upper floor is the drafting office and the office of the general manager, which is also used as the board room.

STAFF —LABOUR STAFF—The construction staff at present employed has recently been considerably improved through the acquiring of a competent and experienced superintendent, who has been able to put his entire time and attention on the actual construction work, resulting in much smoother working and better and faster work. The mechanical superintendent has charge of the construction work, and has under him the steamfitting force, consisting of a foreman and eight steamfitters and helpers; the carpenter force, also under a foreman, consisting of about three skilled carpenters and three men for the rougher work, who also handle the concrete work; and the coppersmith force, comprising the smith and his helper. There is also an unskilled force under a foreman of about nine men, who handle the cleaning of the acetone drums, the heavy hoisting work, the cleaning of the different parts of the plant, and the loading of the railroad cars.

OPERATING STAFF—The operating staff consists of the boiler room section, composed of three shifts of three firemen each; the operating engineer force, of three shifts of three men each; the milling staff, of one shift of six men; and two mash floor attendants.

The fermenting section is also worked in three shifts in charge of the fermenting foreman, who has under him four girl operators. The distilling section is also in three shifts, composed of two girl attendants under the direction of an experienced still man. The drum filling is taken care of as required by an experienced man from the Gooderham & Worts Company.

ENGINEERING TECHNICAL STAFF—This department is under the direction of Mr. E. M. Shaw, of the Imperial Munitions Board, and consists of three draftsmen.

BUSINESS STAFF—The business staff consists of a skilled stenographer and assistant, under the supervision of an accountant from the Gooderham & Worts Offices.

EDWARD METCALFE SHAW.

APPENDIX I—INOCULATING ARRANGEMENTS.

To reduce the possibilities of contamination that are always present when inoculant is transferred from one vessel to another, the 5 gallon pails now in use to transfer the inoculant from the

laboratory to the 100 gal. inoculating vessels described previously are being replaced by three small 5 gal. culture vessels.

CULTURE VESSELS—These culture vessels are similar to the inoculating vessels previously described. They are of copper, with hemispherical steam jacketed bottoms and flanged covers. Each cover besides the gland for the 7/8" central shaft, is fitted with a 1/4" gauge connection, a 1/2" gas outlet, and two 1" pipe openings, one for the thermometer and one for the filling gate valve. The gland for the shaft, as are the glands on the other inoculators, is fitted with a funnel device for carrying antiseptic sealing fluid. In the side of the vessel is a 3/8" sampling cock and the jackets are provided with two 1/2" connections, one near the top, being for the steam inlet, and water outlet, and that near the bottom for water inlet and steam exhaust. There is also a 1/8" pet cock in the jacket. The vessel outlet is 1" and runs into a 1" cross through the lower opening of which the inoculant passes, and thence through a Y into the inoculating line to the 100 gal. inoculating tanks. One side opening of the cross is for a steam sterilising connection and the other for a drain for contaminated mash to the sewer.

The vessels are equipped with a hand operated stirring gear consisting of a copper blade or scraper, conforming to the vessel's shape, to keep the interior of the vessel clean, and of two radial blades set at an angle to beat down the "head."

The culture from the laboratory will be emptied from the flask into one of these 5 gal. culture vessels, from which it will be run into a 100 gal. inoculating vessel and in turn from this 25 gal. lots will be run into the 600 gal. seed tanks (containing 500 gals. of mash) and each of the seed tanks will be used to charge one fermenter of 25,000 gals. of mash.

There will be thus now four stages in the plant, instead of three, which will all be carried out in closed vessels and pipes.

NEW LOCATION—At the present time there is also a proposition under consideration to remove the whole inoculation department over to the third floor of the distillery proper, at the west end increasing the number of seed tanks to 16 or more and the inoculators and culture vessels proportionately in order to increase the output of acetone. In this case a 2,000 gall. cooker fed from the mash line will be added. This department would then be in charge of a separate foreman. A bacteriological laboratory is also proposed to be placed on the floor above.

FORCED INOCULATION—Another important change in the inoculating arrangements recently installed and now successfully at work, is the installing of a small 2" rotary belt driven pump with a capacity of some 2,500 gals. an hour at the proper speed, but now operated so that it empties a seed tank in 20 minutes or at a rate of 25 gals. per minute. It is located at the east end of the battery of 600 gal. seed tanks, since the seed tank emptying line or fermenter inoculating line has been altered so that it now runs from west to east and drops vertically from the east end to the mash line. The pump is completely submerged in a tank of antiseptic liquid and is belt driven from the main seed tank drive. It draws the inoculant from the seed tanks and discharges it under pressure through 2" line into the top of a T placed in the mash line from the coolers (see drawing 84). There is also a 2" by-pass around the pump. The inoculating line just before the T is reached is provided with a 2" blow off valve and a 2" drain on the branches of a 2" cross and between the cross and T is a 2" gate valve. This arrangement renders the inoculating of the large fermenters more positive without introducing any further danger of contamination. The low pressure steam now admitted through a 1" pipe at the west end of the inoculating line beyond No. 9 seed tank thus sterilises the whole line through to the gate valve just mentioned and blows off through the blow off valve.

HEAD MIXER—Another scheme being worked on here and about to be installed as an experiment in one seed tank is an arrangement of blades and baffles, for carrying the head down into the liquor and thoroughly mixing the two. In the seed tank are riveted two vertical copper baffles 12" wide extending across the tank, one just above the propeller and the other about 9" above the first. Between the two baffles and above the top baffle fixed to the rotating shaft are two paddles 8" wide, set at an angle to beat down the head. The baffles are provided to prevent the whole mass of liquor rotating as a whole and the paddles and propellor are to beat down and draw down the head and liquor, mixing the two and insuring that the whole of the inoculant gets to the inoculating pump suction. Fuller details and results will be available after trial.

EDWARD METCALFE SHAW.

APPENDIX 2—DISTILLING AND RECTIFICATION.

In order to increase the output of the plant, the capacity of the stills and rectifiers has had to be increased. The question has been considered carefully and a course of action decided upon. The contracts have been let and work on them is now proceeding. It is expected the alterations and additions will be completed in about three weeks or a month. The changes are as follows:

DISTILLING—The capacity of the original 6 ft. dia. beer still on acetone work is from 6,000 to 7,000 gals. per hour. The still is of copper built up of a 6-54" sections, each containing 3 plates, a 7'-4" top section containing one plate and two 5" spiral beer heating coils and a 6'-6½" lower section containing calandria, etc. Three of the middle sections of this still are to be removed and used in the construction of a second still. The top section and that next it containing the beer entrance are to be lowered, the vapour and beer pipes lengthened and the remaining equipment of the old still left as at present.

NEW BEER STILL—The new second still will be constructed of the three sections of the old still, together with a new bottom and top. The new bottom will be comparatively shallow and contain a 5" perforated copper steam soil with a brass fitting for connection to a 3" steam line and be fitted with a brass washout plug, and an automatic valve with copper bend and float for controlling the slop outlet. The section is also equipped with gauge glass and pressure gauge. No calandria is being fitted in the new still because of the difficulty of obtaining the necessary tubing and the comparatively small saving effected by using the calandria as compared with using live steam direct. If desired, a calandria can be added later.

The top of the new still will be 7'-10" high and contain two plates, one new and the other an old one moved from the top of the old section immediately below the present top section. This is done in order to provide room for the beer line entrance between the 2nd and 3rd plates down which necessitates the increasing of the spacing of these plates from 18 to 24 inches. The top section will be fitted with a flanged cover in order to be able to put in the spiral beer heating coils at a later date if found necessary.

NEW BEER HEATER—The large molasses cooler (formerly a steam condenser), see section on Original Plant, is to be used as a beer heater for the new still. This cooler is contained in a ¼" boiler plate shell 42" diameter by 20' 3" long and contains 63-2" outside dia. x 18' long 18 gauge copper tubes fitted into cast iron headers by means of glands. This cooler is being thoroughly overhauled, cleaned, and the necessary new openings put in it.

This "heater" will be connected to the new still with 10" pipe and to the condenser with an 8" pipe; the beer line between heater and still is of 5" copper tubing.

The present beer condenser is to be used for both stills by making slight alterations. The vapour head is to be removed, the present 10" opening closed, a division plate inserted between the centre of the tube plate and the inside of the top of the dome and an 8" opening provided in each compartment. An 8" vapour line from each still and heater will pass through an 8" gate valve into each of these two 8" openings. The existing arrangement of the tail box will be retained.

RECTIFICATION—In the rectification section the present two rectifiers taking charges of 13,000 gals, as described previously in the section on the Existing Plant, and now used, one for preliminary and the other for secondary rectification, are to be both used in future for preliminary rectification, which will necessitate only slight alterations in the piping.

NEW CONTINUOUS ACETONE STILL—For the secondary rectification a new Modified Barbet Continuous Still is being built by the E. B. Badger & Sons Co. of Boston, Mass., capable of dealing with 14,000 lbs. of acetone per 24 hours. The elevations and plans showing the general arrangement accompany this report. Briefly, the arrangement of the still is as follows:

The acetone to be purified or rectified is elevated through a 3" supply pipe to a 3' x 3' constant level reservoir just below the roof. The level in this tank is controlled by a float acting through a chain on a Mason Regulating Valve on the feed pump. From the reservoir a 1½" line drops vertically to the operating floor, where a control valve is located, and then rises and enters the bottom of a 13" heater on the top floor. From the top of the heater a 2" line drops to the top of a 54" Exhausting Column which is supplied with steam at the bottom through a 2" pipe from a 2" Mason Regulating

Valve controlled by a 16" Steam Regulator on the operating floor. The steam regulator is actuated by the pressure at the base of the rectifying column through a 2" pipe. The slop from the bottom of the exhausting column escapes through a 4" slop seal and 4" pipe to the sewer. A ¾" line from the bottom of the column runs through a Vapour Separator to a Slop Cooler and Tester on the Operating floor. A ¾" line runs from between the 12th and 13th plates of the exhausting column through a Pressure Bottle at the third floor into the top of the rectifying column, while a second line 1¼" dia. starting from the same level runs to the steam regulator. These latter lines are for regulating purposes.

The vapour from the exhausting column passes up through a 5" pipe and into the base of a 36" Rectifying column standing on the third floor. There is a 2½" returns line from the latter column to the top of the exhausting column. The vapours from the rectifying column pass through a 5" pipe to the top of the 13" heater, from the bottom of the heater to the top of a 21⅝" Dephlegmator and from the bottom of the latter through a 4" pipe to the top of a 16" Condenser. The latter three units are side by side on the top floor. Three returns lines, 2½", 2" and 1½", run from the heater, dephlegmator and condenser respectively into the 2½" line and into the top of the rectifying column.

From the top of the rectifying column a 1½" line loops down to the third floor where a control valve is located, and thence into the top of a 36" Auxiliary Rectifying Column standing on the fourth floor, from the bottom of which a 1½" line drops to the top of a 13" cooler on the operating floor and passes from the bottom of the latter vertically and through a flow meter and valve to the south one of two Testers or Tail Boxes. The vapours from the top of the Auxiliary Column pass through a branching 4" pipe to either the top or below the first plate of the rectifying column.

The liquor from the bottom of the condenser passes through a regulating bottle and thence either through a returns line to the rectifying column or through a 1¼" pipe and flow meter and valve to the north Tester on the operating floor.

BUILDING REINFORCEMENT—The new beer still and the new beer heater are being placed in the same position as regards elevation as the old still and the old heater. They are being placed west of the present units in the second panel of the building from the east wall. The new continuous Barbet Still is being placed at the north wall in the third panel from the east wall, and therefore just west of the new beer still. To carry these additional weights the building is being strengthened by means of steel columns and beam reinforcements extending from the top floor right through to concrete footings, so that the old steel work carries practically no additional load.

EDWARD METCALFE SHAW.

APPENDIX 3.—BRAN DISPOSAL.

The bran as it drops from the scalpers is now picked up at the ground floor level by the suction of a 35" Sheldon Suction Fan and discharged through a long 12" galvanized iron pipe, vertically and over the court and intervening buildings to an 82" Cyclone Separator on the roof of the Gooderham and Worts malt house. This latter building is now not in use.

From the separator the bran drops vertically and is deflected by valves into either of three chutes which carry it to either of three wooden hoppers placed in the fourth floor of the malt house.

The bran is drawn from these hoppers, sacked and sold to farmers and others for cattle food.

EDWARD METCALFE SHAW.

SECTION 7—IMPORTANT DETAILS.

SECTION 7(a)—COOKER STIRRING.

COOKER STIRRING.

STERILISERS—At the beginning in the reconstruction of the yeast tanks to form cookers, it was considered necessary from experience gained in England to sterilise the inside surface of the tanks, and to this end the steam steriliser shown in drawing No. 4 was devised. The device consisted of two bent 2 inch pipes, screwed into the $3\frac{1}{2}$" cross on the bottom of the central rotating $3\frac{1}{2}$" wrought iron pipe. Each pipe was bent to rotate within 1 inch of the bottom and side of the tank and had a slit sawed in it which was afterwards brought together. The slit under the steam pressure (14 lb. Locke Regulator System) inside the pipe opened up slightly allowing a sheet of steam to play on all the tank surface reached by the mash, during the rotation of the central pipe.

STIRRERS—The stirring of the mash was also deemed advisable, during the cooking period and was done by means of the cone stirrer (see drawing 9) consisting of the frustrum of a cone 26 in. deep 36 in. diameter top and 66 ins. diameter bottom, built up as shown in order to permit of its passage through the manhole. The stirrer was assembled inside the cooker and mounted on the central pipe, 20 in. from the tank bottom. Similar smaller stirrers were used in the four original large seed tanks and are still in use, running at about 40 r.p.m.

DRIVE—The drive employed was electric, from two $7\frac{1}{2}$ h.p. induction motors, one to each pair of cookers, hung on the wall, controlled by oil starting boxes, and driving through 3 in. Balata belting and countershafts, a shaft rotating in bearings carried on a special pedestal on each cooker roof, carrying a pulley (driven from fast and loose pulley above) and a mild steel $1\frac{1}{2}$ C.P. single thread worm meshing with a 14.32 P.D. 30 tooth cast iron worm wheel set screwed to the central rotating pipe. The latter rotated at 20 r.p.m.

DIFFICULTIES—This arrangement was used for some time but due to the great inertia of the wide spreading parts and the mash resistance the starting and operating torque was excessive, lubrication exceedingly difficult and wear on belt and worm wheel exceedingly rapid, resulting in the teeth of the latter wearing practically through.

PRESENT STIRRERS—In the meantime as a result of further experience gained in the actual operation of the plant and of additional experiments it was found that the sterilising of the inside surface of the cookers was unnecessary and that results sufficiently good as far as cooking and stirring were concerned were obtained by simply blowing directly into the mash steam from the 14 lb. system, through the ends of 4 ft. lengths of 1 in. pipe, carried by the central 3" rotatable steam pipe rotated occasionally by hand. As a result the other arrangement was abandoned in favor of the latter simple hand operated arrangement.

One of the motors is now used for the seed tank and culture vessel stirring and the other for the steamfitters' shop drive.

EDWARD METCALFE SHAW.

SECTION 7 (b)

NEW MASH LINE AND CONTINUOUS COOKING.

APP. 1—EXPERIMENTS ON RAPID STERILISATION AND STARCH SOLUTION.

NEW MASH LINE AND CONTINUOUS COOKING.

A complete new arrangement of the portion of the plant between the mash tubs and the cooler is now under construction (see drawing No. 83). This includes relocation, re-arrangement, redesign and reconstruction of practically all the units between, including pump, mash line, digesters and cookers.

The location of the present mash line was subject to grave defects, not the least of which lay in the fact that it was exceedingly tortuous, containing some 10 right-angled bends and 10-45 degree elbows in its 400 ft. of length. The centrifugal pump was also deemed insufficient in capacity to handle the mash required for the proposed increased output.

Mash Pump and Control—The new line commences in a 5" cross placed in the 5" mash tub emptying main (the other two branches of the cross leading to the centrifugal pump and a previously used steam engine driven plunger pump respectively) from which a 5" suction line passes under the tubs to a 14 x 10¼ x 10 duplex steam pump, that was already in place on the stone or machinery floor of the main building. This pump was employed in the Distillery days for pumping bay water.

The pump is fitted with a Mason standard pump pressure control on the steam, and a 4" blow-off by-pass on the water end between the discharge and suction discharges into a vertical 5" line passing up through the mash operating floor to the floor above. The pump which is directly below the mash tubs is to be controlled from the mash operating floor, thus eliminating one intermediate control element between mashing and cooking. It will be noted that the mash line has been increased in size from 4 to 5 inches.

Digesters—On the second floor the mash line leads to two horizontal U's of 5" pipe, placed on the floor. These U's have straight legs 12 ft. long, except the first leg of the first U, which is 21 ft. These U's form the heat receiving part of the Digester, the long leg containing two sets of ½" digester nozzles, the first consisting of

6 nozzles and the second of 5, while the remaining legs of the U's each contain a set of 5 nozzles.

These steam nozzles are of ½" pipe bent to point downstream and bored out to ⅜" diameter at the tip. They are welded into the 5" pipe at intervals of 20", alternately on the off centre. The one off centre is so shaped that the steam jet imparts a swirling motion to the mash, while the one on the centre blows directly down the centre of the pipe.

The jets are supplied through 3 separate 1½" steam lines with the three control valves located at the centre of the mash operating floor.

The mash line proceeding from the digester passes through 2 elbows into the mash line proper leading to the cookers. In the second elbow are tapped connections for a dial thermometer and pressure gauge which are located near the ceiling of the operating floor, together with a second pressure gauge indicating the steam pressure in the line supplying the nozzles. There is also a thermometer pocket in the mash line for the insertion of an ordinary thermometer for checking up the dial thermometer.

The mash foreman is thus in full control of the mashing, pumping and digesting arrangements, simplifying the operation of this part of the plant, besides making the control more positive. Another important reason for placing the Digester at the mashing end of the line was in order to use the long length of pipe efficiently lagged to form part of the digester.

The system provides that whilst the steam pressure on the digester will be from 50-60 lbs. the pressure in the mash line will fall to say 45 lbs. at the cooker end. At the rate of 12 fermenters a day (25,000 gals. each) or 200 gal. a minute of mash the velocity in the 5" pipe will be 230 ft./min. The new line from the digester to the cookers is about 400 ft. long, so that this arrangement gives the mash about 1½ minutes of cooking under a pressure which is gradually falling to the cooker end to 45 lbs. with a temperature of 292 deg. F. By this means the mash is not only treated at a high temperature, but is churned up and thoroughly agitated. This action is expected to do a considerable amount of the cooking, and from experimental results obtained will probably complete the sterilisation, even though the ground corn used may as a result of this digesting arrangement be considerably coarser, thus increasing the milling capacity at the same time as mash quantities are increased.

MASH LINE—The mash line part of the digester passes through the 180 deg. bend fitted with the gauge connections, and thence north over the court, over the roof of the barrel store-house and enters the east wall of the fermenter house, just below the roof, and over fermenter No. 7. The line then passes west over fermenters 7, 8 and 9 to what is now No. 4 cooker, but which will be No. 1 in the new arrangement. All pipes are efficiently lagged, and the bends between digester and cooker are of bent pipe. There is a uniform fall totalling 3'-6" from the digester nozzles to the cookers, so that the line drains to the cookers. The new line thus passes by entirely different route from that of the old line, is much less tortuous and is altogether more efficiently designed and constructed.

CONTINUOUS COOKING—For continuous cooking the present cookers are being used with only minor alterations or more properly additions (see drawing 80). These additions are such as not to render the cookers useless for operating as at present on the batch system, and as the old mash line is to be left in place there will be the present arrangement to fall back on in case any defect in the system is discovered.

At the end of the 5 inch mash line is placed a pressure gauge and recording thermometer for the fermenter foreman's use in keeping account of the condition of the mash coming over. The 5 in. line runs into a special 4" angle valve through which the mash passes and vertically downward through a 4" pipe, through the roof of cooker No. 1 (formerly No. 4) 1½ ft. from the side and out through a special spraying nozzle 10'-6" from the bottom, or at the level of the mash, distributing the incoming mash fairly uniformly over the top surface of the mash in the vicinity of the spraying nozzle. The location of the outlet at the bottom on the opposite side, together with the fact that the access of heat, except at half-hour intervals when for one minute the steam stirrer is operated, is only with the incoming mash at the top, prevents the mash short circuiting directly from the inlet to the outlet at the bottom without remaining its full time in the cooker.

EXPLODING VALVE—The exploding valve shown in drawing No. 79 is of special design and construction, combining an exploding valve and relief valve in one. The whole of the above arrangements are based on the results of experiments carried out here. (See appendix to this section of report). It was found that after a

period of cooking under steam pressure and then suddenly exploding down to a lower pressure the large lumps of maize and even the starch cells were largely broken up and the mash rendered absolutely sterile. The period of cooking is provided in the mash line and the exploding valve takes care of the explosion of the mash.

In the experiments none of the friction and agitation occurred as is proposed in the system being described. It is therefore expected that the cooking will be carried to a further stage than in the experiments.

Some tests were made subsequently on the existing installation of digesters, mash line and cookers at various times, and showed conclusively that using steam to bring up the steam pressure in the pipe to 14 lbs. by means of the 18 nozzles of the digester, and with only 50 feet between the last nozzle and the cooker the mash entering the cooker was always sterile.

This led to the conclusion that 1½ minutes of digesting at 45 lbs. with the agitation and turmoil consequent on its rapid motion through the long mash line would be quite sufficient to render the mash sterile and quite likely also to do a considerable amount of mashing and cooking. It is therefore conceivable that the cooking period in the cookers proper may be reduced to such an extent that three or even two cookers will suffice for the increased quantities which will be dealt with in the future.

In starting operations in the digester line it is necessary to safeguard the line against water hammer action, the special valve takes care of this also.

As will be seen, the valve is a 4" angle valve, the disk of which is pressed against its removable seat by three means, a spring, a hydraulic piston and a dead weight. The spring is "floating" and when a surge comes along the line the pressure rises to a pressure above that from which the exploding is usually done and therefore compresses the spring, which due to the suddenness of the action and the small passage leading to the water piston, may be considered as having its outer end fixed. This allows the valve to open and relieve the pressure. For ordinary working a pressure of water is maintained in the cylinder on the outer end of the valve spindle equal to 22 lbs. due to the head of water in the distillery reservoir at the roof. This pressure on the 4" piston is sufficient to allow such a valve opening as will maintain a pressure of 40 lbs. in the mash line, with a cooker pressure in No. 1 of 15 lbs. whilst allowing the valve to discharge an amount of mash continuously through it equal to that delivered by the pump. In order to allow of varying the mash line pressure from 10 to 15 lbs. the dead weight device is provided. The latter by varying the dead weight which acts through levers as shown provides the variable factor.

CONTINUOUS COOKERS—The mash entering the first cooker from the exploding valve is sprayed over the surface of the mash by the distributing nozzle, the velocity of the liquid being acquired by the explosion, and the vertical drop. Between each pair of cookers about one foot from their tops is an 8" pipe connection, fitted with an 8" gate valve in each. In No. 1 and 2 cookers an iron plate shield extends from within 6" of the cooker bottom to close to the roof in front of the 8" opening, so that the mash passing through this 8" pipe from No. 1 to No. 2 and from No. 2 to No. 3 cooker comes from the bottom of the cooker in each case. At the outlet end of these 8" pipes in No. 2 and No. 3 cookers is arranged a deflector constructed of welded plate, so designed that the mash is deflected to right and left in the cooker.

The mash entering each cooker is thus fairly uniformly distributed and the outlet is as far as possible from the inlet, thus preventing short circuiting of the mash.

Any settlement of sludge is prevented by stirring with the existing rotatable steam jet arrangements which are to be retained and worked in sequence, No. 3 cooker first, then No. 2 and No. 1. The reason for this is that any possible short circuiting that may result from the stirring is limited to the effect in one cooker only, thus preventing any mash passing through without at least 66 per cent. of the full period of cooking. This action may result in slight occasional and partial undercooking to the extent only of one per cent., but cannot jeopardise the safety through non-sterilisation.

No. 3 cooker is to be the final cooker, and in this cooker the mash level is to be maintained at 9 ft. above the bottom instead of 10' 6" as in Nos. 1 and 2. The mash outflow from this cooker is through a 5" pipe which passes through the tank bottom at the opposite side to the mash entrance and extends surrounded by a second 10" pipe which reaches from within 6" of the bottom to close to the roof. This arrangement of outflow is for the purpose of preventing the pump lowering the mash level below the 9' level

whilst at the same time drawing the mash from the bottom of the cooker.

The steam from the first three cookers passes from No. 3 into No. 4 tank, through the 8" connecting pipe fitted with an adjustable back pressure valve for maintaining the pressure at any desired value in the No. 3 cooker. This pipe is also provided in No. 3 cooker with an elbow and short nipple in order to draw the steam from as high a point as possible, besides eliminating the possibility of mash splashing over. No. 4 cooker is to be used as a low pressure exhaust steam reservoir.

The mash level in No. 3 cooker is automatically controlled by means of a Fisher Tank Control. The float of this device is of heavy copper and large size and operates through a lever and spindle extending through a gland in the tank side. On the outer end of the spindle is a second lever, one end of which operates through a chain or rod, a pump regulating valve in the cooler pump steam line, and the other end of the lever carries a compensating weight. The cooler pump thus draws the mash from the final cooker at the same rate that the mash pump, under the mash tubs, pumps it into the first cooker through the exploding valve.

EXHAUST STEAM RESERVOIR—From tank No. 4 which is to be used as an exhaust steam reservoir at 5 lbs. pressure a 9" steam line will be run to the two beer stills (one under construction). This line will be connected through a 4" pressure reducing valve to the live steam, so that should the pressure in the line drop below 5 lbs. live steam will be admitted. In addition, provision will be made for admitting exhaust steam from the pumps to the 9" line. A T will be inserted in the exhaust main leading to the feed water heater and on the heater side of the T a gate valve. From the T an 8" line will run to the 9" line and will be fitted just before reaching the latter with a back pressure valve to maintain the pressure on the line at 5 lbs., and this back pressure valve will be by-passed to permit the flow of exhaust steam from the pumps into the 9" line from the exhaust main.

The low pressure steam will be admitted to each still above the mash level and below the first plate. The quantity admitted will be under direct control of the still attendants, and should the beer in the bottom of the still at any time contain butyl it will still be possible to admit live steam through the existing steam coil arrangement and boil it out.

To heat the boiler feed water it is proposed to force the water from the coolers through the tubes of the two evaporators (formerly used for slop evaporation), and pass the slop from the stills around the tubes. These evaporators are such that the feed water will be 6 min. in the ⅝" bore brass tubes in each one thus securing a good heat transfer and high temperature of feed water. The boiler feed pump drawing from the evaporators will have a static head of some 10 ft. of water on the suction side.

COOKING OPERATIONS (STARTING)—The action of the system is as follows: In commencing operations the mash foreman turns on some of the steam jets of the Digester and the steam gradually works along the mash line, warming it up, and finally building up a pressure forcing open the exploding valve and passing through the first and second cookers to the third. The steam builds up in the three cookers a pressure dependent on the adjustment of the exploding valve which at the beginning may be set to explode to a lower pressure than when operating normally. The valve between No. 3 cooker and the exhaust steam reservoir is a back pressure valve set to maintain the same, or slightly smaller, pressure as the exploding valve, say 12 lbs. The system is thus completely warmed through and on the mash foreman getting the signal from the fermenter foreman to send over the mash he starts the mash pump and the mash enters a hot system. The mash foreman then regulates his steam jets to get the right temperature of the mash at the Digester end, and it is his business to see that this does not vary.

By the time the mash reaches the cooker end of the mash line thoroughly digested and sterile, the fermenter foreman can tell from the recording thermometer and pressure gauge its condition, and instructs the mash foreman if any variation is required. The mash explodes through the valve from its pressure of say 45 lbs. down to 12 lbs. in No. 1 cooker, the initial pressure being determined by the adjustment of the exploding valve and maintained in the cookers by the back pressure valve between cooker No. 3 and the exhaust reservoir.

Cooker No. 1 gradually fills up until the 10'-6" level is reached, when the mash flows over into No. 2 cooker, filling it in turn. All the cookers were originally under 12 lbs. pressure, but the mash passing over will probably restrict the passage so that a slight drop in pressure will occur, which will necessitate an increase of say 1 lb. in pressure in cooker No. 1, and because of the adjustment of the exploding valve a corresponding slight increase in pressure in the mash line. The steam passing through the 8" connecting pipe assists the mash over, and together with the deflectors thoroughly agitates the mash. No. 2 having been filled to a 10'-6" level, the mash and steam escape through the 8" pipe into cooker No. 3, and again there is a slight drop in pressure caused, and a consequent rise of pressure in cookers 2 and 1 and the mash line. The pressure in cooker No. 3 is finally 12 lbs. (governed by the regulating valve between No. 3 and the reservoir), in No. 2 say 13 lbs., in No. 1 14 lbs., and probably in the mash line 47 lbs. From No. 3 cooker the mash is drawn by the cooler pump at the same rate that it enters the system (through the float control), and discharged to the cooler. The lower the pressure in No. 3 cooker, the less will be the cooling that the cooler will have to do per gallon of mash.

When commencing mashing and cooking operations on Monday the stills will probably be stopped and therefore no low pressure steam will be required. The steam from the cookers will then escape through the back pressure valve into the exhaust steam reservoir and build up a pressure there and in the 9" line of say 5 lbs., which is maintained by a back pressure valve in the 8" pipe leading from the 9" line to the existing 8" exhaust main to the feed water heater in the boiler room. The pump exhausts, when the stills are not working, pass directly to the feed water heater, while the reducing valve governing the admission of live steam to the low pressure line from the reservoir to the stills simply maintains a pressure of 5 lbs. in the line and the reservoir. The steam liberated from the explosion and cooking thus escapes from the 12 lbs. pressure in No. 3 cooker to a 5 lb. pressure in the reservoir, and thence through the 9" line and 8" back pressure valve to the exhaust main to the feed water heater.

COOKING OPERATIONS (NORMAL)—The ordinary normal operation of the continuous cooking system is of a similar nature to that just described for commencing operations. The mash explodes into No. 1 cooker, passes over into No. 2 and then into No. 3, and so to the cooler pump. The time during which the mash would theoretically, assuming no short circuiting, be in the three cookers would be, assuming a rate of 200 gals. a minute, and the capacity of the tanks 700 gals. per foot of depth, 105 minutes or 1¾ hours for the three cookers in series, an average of 35 minutes per cooker.

About 36 hours after cooking begins, when the stills commence operating, the valve will be closed in the exhaust main cutting off the exhaust feed water heater, and at the same time the by-pass around the back pressure valve maintaining the pressure of 5 lbs. in the 9" line and exhaust reservoir will be opened, allowing the exhaust to pass into this line and reservoir instead to the heater. This exhaust, plus the cooker exhaust, aided when necessary by live steam admitted through the 4" reducing valve, will maintain a pressure of 5 lbs. in the reservoir and 9" line and supply the stills with the greater part of the steam they require. It has been calculated that the steam liberated from the cookers alone will be sufficient to operate one still. When the exhaust steam is cut off from the feed water heater the feed water will be heated by the slop coming from the beer stills, as both the slop and feed water will be passed through the evaporators.

COOKING OPERATIONS (FINISHING)—At the end of a run when the mash stops coming over the cooler pump will cease drawing because of the lowering of the level, and the present outlet line will then be used to empty first No. 3, then No. 2 and No. 1, as at present in the ordinary batch system. Whilst doing this in order to secure proper cooking the present 15 lbs. steam system can be turned on, thus cooking as ordinarily.

This arrangement incidentally enables a difficulty at present existing to be overcome. Owing to the flat bottoms of the cookers it is difficult and slow work to empty them. In the new arrangement as soon as No. 3 fails to keep the pump full No. 2 is opened. There is no objection to some mash from No. 2 flowing into No. 3, as will certainly occur. When the drainage of No. 2 and No. 3 runs short, No. 1 is opened, and so at the end it will be found that the pump and cooler will have been kept at full normal speed of working, and the final drawings of three cookers will keep the supply of cooked mash up till they are quite empty.

The stills will be in operation for some time after cooking has ceased, and to supply them with steam the pump exhausts will discharge into the 9" line and reservoir, and any steam lacking will be made up through the 4" reducing valve from the live steam main.

When the stills stop running the valve in the exhaust main will be opened, permitting the exhaust to pass to the feed water heater, and the by-pass around the back pressure valve in the line between

the exhaust main and 9" low pressure line will be closed, preventing the exhaust passing into the reservoir and low pressure line.

EDWARD METCALFE SHAW.

APPENDIX TO SECTION OF REPORT ON NEW MASH LINE AND CONTINUOUS COOKERS.

EXPERIMENTS ON RAPID STERILISATION AND STARCH SOLUTION.

There were two series of experiments carried out at Toronto on the subject of rapid sterilisation and starch solution; in the first the whole maize was treated, and in the second the ground maize, freed from bran.

FIRST SERIES—OBJECT—The first set of experiments were made for the double purpose of eliminating the grinding and securing the rapid sterilisation of the starch solution.

APPARATUS—The apparatus used was of a very simple type. A piece of two-inch pipe, twelve inches long, was fixed in connection with a steam system carrying 120 pounds pressure. The pipe was fixed vertically, with a tee at the bottom end, carrying in a horizontal direction a half-inch steam connection, and vertically a one-and-a-half inch cock fixed into the tee. A steam vent was provided at the top.

TESTS—This tube could be charged with whole maize, some fifty or sixty grains being used in these experiments. The grains were treated direct by means of the steam only, and also with a small quantity of water added. They were subjected to the full heating effect of the steam which flowed out through them, with an escape at the top of the tube, for periods ranging from one to three minutes, the amount of escaping steam being just sufficient to ensure the full temperature in the tube corresponding with the steam pressure. Steam pressures from fifty to ninety-five pounds were used.

RESULTS—It was found that with ninety-five pounds steam pressure and a three-minute period of treatment the grains were slightly discoloured. The experiments were made from these extreme high limits down to fifty pounds pressure with one minute treatment.

The idea was to cause water at the full temperature to penetrate every part of the grain. When the period of treatment determined upon had elapsed, the steam supply and vent were both closed, and the stopcock was struck open by a rapid blow, so as to give as nearly as possible an instantaneous release of pressure. The sudden release of pressure causing perhaps ten per cent. of the water in the grain to turn into steam, blew the grain to pieces.

This effect was perfectly obtained at the higher pressures, and very imperfectly obtained under the lowest conditions of pressure and time.

It was found, however, that the pressure of eighty pounds of steam, with a two-minute period of treatment, gave the best all-round results. The solid and liquid matter was collected inside a tin can sixteen inches in diameter and three feet deep, when the explosion was caused to drive tangentially against the inside of the can near the top. The non-gaseous particles were found to consist of four groups: the husk, complete except for being split; the germ, complete but soft; a considerable amount of starch in solution; and the remainder in an extremely fine form, showing under the microscope perhaps thirty to forty per cent. of complete starch cells.

No tests were made of sterility in this series, as the main object had been accomplished, viz.: to prove the possibility of very rapidly reducing whole maize grains to a state in which the starch and proteins would be separated from the husk in a condition ready for cooking. Sterility if not complete at this stage would certainly be rapidly completed under any form of cooking which would put the whole of the starch in solution.

SECOND SERIES—OBJECT—The second series of tests was for the purpose of determining the least time necessary to secure sterility and solution of the starch through treating ground maize with high steam pressures for short periods and then exploding. The apparatus used in these experiments is shown on drawing No. 40.

APPARATUS—Referring to this drawing, both the vertical and the sloping vessels were ordinary hot water boilers, capable of working at 100 lbs. gauge pressure, such as are used in connection with house hot water systems. The vertical vessel was charged with 10 gallons of mash from the mash tun, steam was admitted at the bottom through a pipe which gave a swirl, and at the same

time a small amount of steam was allowed to escape from the top of the vessel. By this means the mash was heated up to temperatures corresponding to the pressures which are shown in an accompanying table, which gives the results of one typical set of the series.

TESTS—This treatment was carried on under varying conditions of pressure and time, at the end of which the cock connecting the vertical and sloping vessels was quickly opened, and the contents of the vertical vessel were exploded by pressures ranging from fifty to eighty-five pounds into the sloping vessel, whence steam was allowed to escape at pressures varying from ten to twenty-five pounds.

This gave definite temperature and explosive difference between the two vessels.

RESULTS—The following are the results of one of the tests made on October 26th, 1916, in brief form:

Test.	Intial Press.	Time at Initial Press.	Exploded to Pressure.	Incubated for.	Result.
1	50	5 min.	10	24 hrs.	sterile.
2	97	"	13	"	"
3	80	"	25	"	"
4	75	"	15	"	"
5	65	"	15	"	"
6	55	"	15	"	"
7	50	"	10	"	"

It will be seen from the table that in all cases a twenty-four hour laboratory test indicated sterility.

Several samples of this exploded mash were inoculated, but the results of the fermentation indicated imperfect starch solution.

The question as to the reduction in the size of the particles has received much consideration. It is considered by the bacteriologists that the difficulty in obtaining complete sterility is increased when spores exist in the middle of the larger particles, and under some conditions may even be protected by a water-resisting layer, so that the destructive effect of the temperature combined with the presence of water is not so readily obtained; and, further, under the circumstances such spores are not subject to desirable disintegrating effects through movement.

These considerations have led to efforts being made, as in the new mash digesting line, to soften and break up all the larger particles, so that as far as possible sterilisation and cooking can be perfectly performed continuously under the most favourable conditions.

EDWARD METCALFE SHAW.

SECTION VII (c).
RAPID COOLING SYSTEM.

RAPID COOLING SYSTEM.

Refer to drawing 6, 7, 8, 12, 30, 30A, 35, 41 and 84, also various photographs.

DESIGNED CONDITIONS—The coolers in use at Toronto have been designed to meet the special conditions of this work.

(1) Absolute tightness of joints and connections.
(2) Self-cleansing.
(3) Rapid continuous cooling.
(4) High efficiency of the cooling surface.
(5) Economy of water.

The first and more compact cooler was perfectly satisfactory so far as the mash conditions were concerned but required water to the extent of 5 to 6 times the quantity of mash cooled.

The second was equally satisfactory on the mash side and reduced the water required when worked for extreme economy to 1/5 of that required by the first cooler and by more than 50% as at present worked. This was of further value because of the higher temperature of the water, resulting in a considerable fuel economy. On a separate page the working results of both coolers are tabulated.

OPERATION—The first cooler was able to deal with the full quantity of maize for which it was designed, viz.: 5,000 gallons per hour, reducing the temperature from 240 degrees to 96 to 100 degrees, as required.

The heat transmission was unsatisfactory on account of the circulating water not interfering sufficiently with the hot film of water on the outside of the pipe.

From an inspection of the drawings and also of the photographs

accompanying this, it may appear strange, because it looks as if the turmoil created in the water would be such as to bring about a very rapid exchange of heat between the copper pipe and the water.

RESULTS—From the records attached it will be seen that the rise in temperature of the water when the cooler was working at a rate of about 6,250 gallons (4 hours per fermenter) per hour, was only 26 degrees, leaving a temperature difference of 60 degrees between the cooled mash and the cold water, while at the same time there was a temperature difference of 174 degrees between the temperatures of the heated water and the hot mash.

GENERAL NOTES ON THE WORKING OF THE NO. 1 COOLER—It was not known whether the nature of the mash was such that from time to time one or other of the tubes of 7/8 bore, 1 inch outside diameter, by 120 feet long, would become choked, and therefore an elaborate arrangement of cocks was attached, see drawing 12, so that any one tube could be separately cut out of the circuit and cleaned under high pressure.

The results obtained during the eight months of actual working, however, show that there is no such danger. The high pressure at which the liquid is forced through the pipe, aided probably by a certain jolting of the pressure, keeps the pipes reasonably clear during a run. At intervals of 9 to 12 hours the pipes are scoured out with clean sterile hot water a 15 minute operation; otherwise no cleaning is necessary.

It is noticed, however, that when the cooler is first put into action is has a slightly greater efficiency than it has when 25,000 gallons have been passed through. This is undoubtedly due to some slight deposit on the surface which ceases to increase beyond a certain point.

CLEANING—Another method of cleaning the inside of the pipe, is by closing the outlet, keeping the water round the pipe, and turning high steam pressure into the mash supply pipe. This leads to a condensation of steam throughout the whole pipe, loosening the deposit after which the pipes are blown through and the process is repeated, with a final blowing out before starting again to cool.

It has been found unnecessary to do anything more in order to keep the inside of the pipes in good working condition.

COOLING WATER—The water used for cooling has been city water, the analysis of which is as given at the end of this section. This analysis was made by the Toronto Department of Public Health about one year ago—summer of 1916.

This water is obtained from Lake Ontario, and is drawn from the lake at a distance of 3,200 ft. from the shore of Toronto Island at a depth of 79 feet. It is filtered and treated by chlorine for any possible bacteriological contamination. The temperature at which this water reaches the distillery ranges from 35 degrees in winter to 58° F. in summer.

SCALING—Once since the cooler was started the cover was taken off for the purpose of observing any encrustation effects on the outside of the pipes, and it was found that a slight deposit, some 1/20 of an inch in thickness, was apparent on the first set of convolutions out of the eight comprising the length of the cooler. Beyond this no deposit was found. It will be noticed that no deposit was occurring at the point of the highest temperatures.

Under the conditions under which the cooler was fixed, considerable inconvenience was found in watching and controlling the rise and flow of the temperatures, so that the man in charge was kept quite busy the whole time. This can be improved.

COOLING SURFACE—It will be noted that there are six copper pipes, the total cooling surface in contact with the hot mash being 6 x 24=144 square feet, the heat transmission amounting to a total of 9,375,000 B.T.U.s per 144 sq. ft. or 65,100 per sq. ft. and divided by the average temperature difference of 125=511 B.T.U.'s per square foot per hour per degree temperature difference Fahrenheit.

This compares with the normal transmission of 250 BTU's per square foot per hour per degree temperature difference as obtained in standard evaporators, where heat transmission is much more easily obtained.

GENERAL NOTES ON MAKING OF NO. 2 COOLER—This cooler was designed not only to deal with a larger quantity of mash per hour, but to ensure a higher efficiency per square foot of surface.

It will be noticed that cooler No. 1 required five to six times as much water as the quantity of mash to be cooled, as against 1.2 to 3 times required by the new cooler, according to the working conditions.

Plans of this cooler are attached, and it will be seen that while

the conditions under which the mash flows through the pipe are the same as in cooler No. 1. An effective means of compelling scouring action on the outside of the pipe has been provided, the action being now similar to what occurs with mash inside the pipes. And, in addition to this, it will be seen that the sloping baffles cast in the water passageway not merely cause a continual cross-flow of the water over the pipe, but at the same time cause the whole body of water to circulate at right angles to the direction of its general movement in the water passageway.

This cooler is constructed in four sections, in such a way that any one section can be opened by taking off the cover, while the copper pipe connections are made on the same plan as those in connection with Diesel engines, affording an absolute security and tightness.

The coils can be readily moved, and by taking off the outside copper connectors any section of pipe which may get choked can be dealt with independently. The small rectangular passage, planed lengthwise, at the top and bottom of the water passage allows of drainage of the box on the one hand, and of the scouring out of the air on the other.

It will be noticed from the photographs that the four thermometers with steam and water and mash controls are now all at one end, and can be observed and manipulated without the operator moving.

This cooler was designed at a time when it was thought that it might be necessary at intervals of, say a few months to open up the boxes for the purpose of cleaning the outsides of the copper pipes, or of removing these pipes; but it would appear from the continued use of No. 1 cooler that such a contingency is remote, and in building another cooler of the same general size and capacity it seems quite safe to dispense with the four covers, bolting the boxes together in pairs, with double jointing and wrought iron plate between.

By this means a much more compact arrangement could be obtained at reduced cost, while the objection to the height of the cooler, which is now excessive, would be removed.

DETAILED DESCRIPTION OF NO. 1 COOLER—The first cooler built in the spring of 1916 consists essentially of a series of copper coils, contained in a cast iron box. The mash is forced through the coils from one end of the box to the other, while the water passes around the outside of the coils in the reverse direction.

The coils, (see photographs and drawings), are of copper tubing, 1" outside diameter 7/8" bore No. 16 gauge. There are six separate coil circuits in parallel each made up of eight unit coils in series. Each unit coil consists of a length of 15 ft. of tubing coiled to form 5½ figure 8 coils one above the other. Each loop of the eight was formed by bending around a 4" diameter former so that the outer diameter of the coil was finally 6¼" and the overall length of the two loops 12" while the depth of the 5½ coils between planes perpendicular to their axis was 12½". The beginning of each coil is at the top at one end to which is braced a special brazing metal coil connection, see drawing 7, which brings the coil through the lid, while the end of the unit coil is at the bottom and opposite end and is brazed to the corresponding end of the next unit coil. The other end of the second unit coil is at the top and is brazed to the corresponding end of the third coil and so on until the 8 unit coils are brazed together in series, the eighth coil passing through the lid with a coil connection as at the beginning. Each coil thus contains 120 feet of tube and the six parallel sets 720 feet. The area or surface in contact with the water is 31.4 sq. ft. per set and a total of 188.4 sq. ft.

The six parallel sets of 8 coils in series are placed together side by side and mesh together, sliding into one another sideways so that the overall width of the six coils is 24". (It was found that three unit coils could be compressed into a volume 12 x 12" x 13" deep.)

Lengths of ¼, ⅜ and ½" galvanized wrought iron pipe as shown in the photograph were placed in the free spaces between the coil convolutions for the purpose of reducing the free water flow in such a manner as to more efficiently wipe the hot film off the pipes. To prevent short circuiting of the water through the comparatively free passage down each side of the box, cast iron baffles, see drawing 8, representing one-half a coil were slipped into the cast iron box and the lid bolted on.

The cast iron box (see drawing No. 6) is of ⅝" average thickness 100" x 24" x 12½" inside and provided with strengthening ribs as shown. The overall outside dimensions are 9' 4" x 29¼ x 17¾". The water inlet and outlet are 5" in diameter, bell mouthed and fitted with thermometer pockets. The 5" size was provided but found unnecessary, 4" pipe now conveying the water to and from the box under the city pressure. The

cast iron box has a ribbed lid through which the coil connections project and are locked tight with lock nuts and washers.

The six coil connections at each end are connected up with the complicated system of piping shown in drawing 12 to a 4" header placed above the lid of each end. This arrangement was provided in order to make it possible to cut out any coil at will (as it was thought possible that coils might choke up with the thick mash) and blow steam, air, acid or alkali through to clear it out. This has been found unnecessary under actual operating conditions and there are now simply copper tubes between header and coil connections.

Detailed Description of No. 2 Cooler—The second cooler was built in the fall of 1916 and is of somewhat similar construction as regards the coils, but differs considerably in the water circuit arrangements. It is composed of four separate units connected together so that the mash passes in series through all four while the water divides into two circuits each passing through two boxes in series. The four units are arranged one above the other vertically.

The coils are of the same size tubing as in No. 1 cooler, namely 1" outside 7/8" bore and No. 16 gauge copper. The shape of the coil was altered to make construction simpler, while still obtaining the same results, so far as the mash flow inside the pipe is concerned. Each coil (see photographs and drawings 30 and 30A) is a flat wriggle, formed by bending the tube with a special device to a 2½" radius loop first one way and then the other. Each coil consists of two 15 ft. lengths brazed together after bending and forms 28 loops of a total length of 30 ft. There are eight of these 30 ft. coils in each box, ¼" clearance between two adjacent coils and passage walls. Each box, therefore, contains 240 ft. of tubing, a total surface of 62.8 sq. ft. In the four boxes or the complete cooler there are 960 ft. of tubing with a surface of 251.2 sq. feet.

The coils lie in 1½" x 10" deep passages, cast in the boxes and are coupled through the ends of the box by Diesel joints either to the coils in another box or to the mash inlet or discharge. These joints are of steel, the flat steel ring being pressed by the nut on to the flange formed on the copper tube securing tightness by concentrating the pressure forcing the copper against the steel.

The boxes are of cast iron 9'-11" overall long by 14 7/16" the inside dimensions being approximately 9' 6" x 10⅛" x 10". The coil passages are cast with baffles on the sides, sloping in different directions on either side of the passage their function being to drive the water backwards and forwards across the passage, wiping the hot film off the tube surface, and also to circulate the water in a direction at right angles to this chief movement and thus to thoroughly mix hot and cold streams of water. The lids or covers are on the side of the box in order that the coils might if necessary, be easily removed should they choke up. It will be noted that the box is extremely strong structurally, allowing a heavy internal water pressure. The boxes are coupled by alternate feet and water passages at alternating ends, thus also providing for the flow of water from box to box. As arranged now the hot mash coming through a 4" pipe enters a cast iron connection (drawing No. 35) from which 8 copper tubes lead through Diesel joints and connect to the 5 Diesel joints at the west end of the bottom box. From the east end of this box copper tubes lead from the Diesel joints to the joints on the corresponding tubes at the east end of the second box. There are similar tube connections between boxes 2 and 3 at the west end and between 3 and 4 at the east, and from the west end the mash passes through a second cast iron coil connection to the 4" pipe (see drawing 84).

The water enters the top box at the west end through a special elbow and the oval opening on top of the box and flows in the reverse direction to the mash flow, around the outside of the tubes in the cast passage to the east end where it passes downward through the oval outlet into the second box. The oval outlets are provided with a baffle to throw the water away from the passage and prevent short circuiting. The water passes through the second box and out through a standard 4" flange opening at the back of the box at the west end. The oval opening between box 2 and 3 at the west end has been blocked by a plate.

The water for the second pair of boxes enters the third box down through a flanged opening at the back and passes through boxes 3 and 4 as in the former two and leaves the bottom box at the west end through the oval outlet and a special elbow pedestal casting to the 4" pipe (see drawing 84).

COMPARISON OF AVERAGE RUNNING CONDITIONS OF OLD AND NEW TYPES OF COOLERS AT THE BRITISH ACETONES, TORONTO, LIMITED.

	New Cooler.	Old Cooler.
Temperature of Inlet Mash	246°F.	243
Temperature of Outlet Mash	98.5°F.	99
Fall in Temperature of Mash	147.5°F.	144
Temperature of Inlet Cooling Water	41.2°F.	43.6
Temperature of Outlet Cooling Water	113.4°F. 81.5F	67
Rise in Temperature of Water	72.8°F.	23.6
Quantity of Mash, gals. per hr.	9,090.9 gals.	5,200 gals.
Quantity of Water, gals. per hr.	11,410 gals.@113.4°F.	
	12,870 gals.@ 81.5°F.	
	24,280 gals. Total	31,750 gals.
Gals. of water per gal. of mash	2.671	6.11 gals.

APPENDIX 1.—CHEMICAL ANALYSIS OF LAKE ONTARIO WATER.

Appearance			Cloudy
Odor	Cold		Nil
	Hot		Nil
Reaction to Litmus	Cold		Nil
	Hot		Alkaline
Chlorides			9.0
Nitrogen as free Ammonia			.004
Nitrogen as Albuminoid			.05
Oxygen Consumed			.51
Total Solids			120.0
Solids in Solution			108.
Suspended Solids			12.
Loss on Ignition (Total Solids)			60.
Loss on Ignition			55.
Alkalinity (Lacmoid) Bicarbonates		103	
Carbonates		2........	105.
Alkalinity (Phenolphthalein)			1.
Permanent Hardness			32.5
Total Hardness			132.5
Iron (colorimetric)			.1
Siliceous Matter			3.84
Iron Oxides, Albumins and Phosphates			.17
Lime (CaO)			43.4
Magnesia (MgO)			12.2
Sulphates (SO4)			10.5
Free Carbon Dioxide			1.

Numerical results expressed in parts per million.

EDWARD METCALFE SHAW.

SECTION 7 (d)—FERMENTATION TANKS.

FERMENTATION TANKS, WITH NOTES ON FOAMING AND METHOD OF INCREASING YIELD.

Defects of Fermenters—These tanks were formerly used for the fermentation of molasses, and the dimensions are given in another portion of the report (Refer to Existing Plant). The old pipe arrangements for the introduction of new liquor and for the drawing off of the beer are generally speaking retained. Very serious trouble in working the plant is experienced, owing to the difficulty in clearing the flat bottom of the tanks of the head which settles down at the end of the fermentation, and up to the present the very slow and unsatisfacory method of partially removing this has been by the condensation of steam inside the tank, together with swirling steam jets.

It will be seen at once that these tanks are extremely difficult to manipulate, especially in view of the fact that the bottoms of the original tanks rest simply on brickwork, and that an internal pressure of under half-a-pound to the square inch is sufficient to float the top and sides of the shell, so that at anything above this pressure the bottom of the tank bellies and the sides and top of the tank rise.

They are even more difficult to handle when the pressure inside is less than that of the atmosphere, and as it has been deemed necessary to steam the tanks between each fermentation, it is only by the exercise of the greatest possible care that accidents can be avoided. Prior to the provision a few months back of the special vacuum relief valves (see drawing 67) on two or three occasions the bottoms of tanks were lifted and the pipe connections broken.

The operation of steaming out the tanks with pressures below half-a-pound to the square inch means a long period of sterilisation.

The total capacity of the tanks up to the top of the sides is 31,800 gallons, and the volume of mash dealt with is 25,000 gallons. This headroom is not sufficient when a brisk foaming takes place, and there has been up to the present a loss when this occurs although it has been customary immediately to put on the beer pump, which empties the tank at the rate of about 8,000 gallons an hour. This evil will probably be entirely removed under the system now being introduced (see Separate Finishing and Foaming Tubs).

Additional Fermenters—In the new fermenters (see drawings 18 and 36) it will be observed that the tanks still have comparatively level bottoms, but strengthened by being riveted to I beams, although there would be great advantage in having conical bottoms with a sufficient slope to make drainage easy of the heavy matter in the beer to the outlet. It was, however, impossible to do this without interfering seriously with the general arrangement of the existing fermenting tanks, cookers, piping, etc. It would further have involved alterations to the building owing to the head-room not being sufficient.

The arrangement of the fermenting tanks in relation to the mash tuns, cookers, pumps and beer still is anything but satisfactory, the system of piping being complex and the resistance of the flow of the mash and the beer being unnecessarily great.

The mash and beer lines are four inches in diameter. While this was quite satisfactory for the operations in molasses fermentation, with only nine tanks it is rather small for moving the mash and beer at the present output from 16 fermenters, especially when the pressure is small, such as at the end of the fermenting process when the fermenter is nearly empty.

Every care has been taken to rearrange from time to time as experience has shown to be best the relations and methods of operating the different valves, but it has been found impossible to get anything that is reasonably fool-proof or even safe, unless constant supervision and thought and care are exercised in adjusting the valves for the mash, beer and steam circuits. This is particularly the case in connection with the sterilisation of the mash lines, where it has been found necessary to arrange the flow of the mash, the steam circuit, drain-pipes and safety-valves in such a manner as to make it possible to clear the mash out of the pipes, thoroughly sterilise every connection, provide for safety in case of the mash pump being started without a discharge into a fermenter being provided, etc.

In connection with the beer line, contamination was unquestionably caused on more than one occasion owing to the beer not being thoroughly cleared out of the pipes, which are not treated for sterilisation, and the final discharge valve being closed. Under these conditions considerable gas pressure, giving an unpleasant odour, generated in the pipe system, and leakages with contaminating bugs took place back into the fermenters. The valves, which are of the gate type, have been found very difficult to keep tight, owing to heating and cooling action, and further owing to mash preventing the valve gates from being driven thoroughly home. The double valve system, with steam connections between, described already in the section on the Existing Plant, has therefore been installed on the beer line, so that when the valves are not being used the steam will keep the space between the valves sterilised and any leakage which takes place will be of sterilised matter.

Another difficulty has been in connection with the steaming of the fermenters, causing high temperature in the building, both by radiation and conduction. It is not convenient to lag these tanks since under certain conditions it is desired to cool the outside of the tanks with water. After considering various propositions it has been decided that the best means of protecting the staff operating the system from excessive heat would be by building up from the working platforms partitions following the curvature of the tank and four inches away from it to a height of four feet, and bringing cold air conduits from outside the building to the level of the platform, and at the same time putting ventilators in the higher part of the roof. The working platform would thus be protected as far as possible from radiated heat, and will also be kept cool by the flow of cold air, which will be to a large extent trapped until it is drawn up by the hot air rising between the partition and the tank towards the discharge in the roof.

Any attempt to keep the building cool simply by discharging large quantities of air from the top would defeat itself, since the heating capacity of the tanks is so great that little would result in the way of cooling, and at the same time a great amount of heat would unnecessarily be discharged from the building.

FOAMING.

POSSIBLE EXPLANATION OF PHENOMENON—The phenomenon of foaming is not understood. There is no known reason for the action of the fermenting mass, although it may reasonably be assumed that it is due partly to the sudden release of occluded gases in conjunction with a certain phase of the fermentation which sometimes occurs, the liquor assuming the colloidal state, and thus opposing the release of the gas.

Under such conditions it is probable that the gas generated in minute volumes at an infinite number of points is not able to collect in a large enough volume to rise until a certain stage has been

reached. At this stage the surface tension of the liquid on the outside of the minute volumes of gas, having been sufficient to hold the gas at a pressure above that due to internal pressure, is upset and the imprisoned gas expands freely, collecting into larger bubbles. When this occurs at one point it instigates similar action throughout the whole of the mass. Under such conditions the volume of the liquor will increase, tending finally to fill the whole tank, from which it is finally discharged at considerable pressure.

This explanation seems more probable than that there should be any sudden increase in the actual generation of gas, although in view of the obscurity attached to the action of the enzymes it is possible that there may be increased rate of starch decomposition occurring.

METHODS OF ELIMINATING OR COUNTERACTING—Various methods have been suggested, and some have been tried, for dealing with this trouble. Amongst them are the following:

CIRCULATING THE BEER—A pipe system four inches in diameter has been arranged in connection with a centrifugal pump capable of discharging fifteen to twenty thousand gallons per hour, and liquid has been drawn from the bottom of the tank and discharged at the top of the tank above the level of the free surface of the liquid.

The idea was that such a circulation might do two things, viz.: mix up the head which at about this time collects on the top of the liquor, and also give a discharge of the gas, which would then be freed from the liquid. This was tried, but without good results.

STEAM INJECTED INTO THE BEER—Another system is in use (refer back) having four 1 inch diameter steam pipes, radiating from the centre, at the bottom of the tank, perforated with holes (at an angle to the tank bottom), through which discharge of steam gives a circulation of the mass of the liquid. This does not give good results in prevention of foaming, but was useful in stirring up the semi-solid liquid when the tank is nearly empty, thus assisting emptying.

STEAM JETS INTO THE "HEAD"—Another means was to discharge steam at high pressure slightly above the top level of the liquid, or still higher, near the top of the tank (refer back). It has been found that this is partially successful, as in passing through the "head" or mass of foam it evidently causes the liberation of a considerable amount of gas.

WATER COOLING—The use of water cooling rings described previously have also proved partially effective if applied in time in arresting the foaming.

STEAM JETS AND WATER COOLING—A combination of the steam jets and cooling ring is now used when indications point to a case of foaming in order to gain time to put the beer pump into operation. The steam jets blow the foam against the cold surface of the tank, partially checking the foaming and gaining valuable time to enable the beer pump to start drawing beer from the fermenter, thus lowering the level and giving more room for the foam.

THE USE OF OILS, ETC.—Experiments have been made for the purpose of determining whether the use of oils, acetone or ether would have the effect of liberating the gas from the top surface of the fermenting mass. Any of these is found to be good in connection with what is termed frothing, *i.e.*, formation of large gas bubbles, which sometimes occurs at an early stage of the fermentation; but the results are not good when tried on the real foam, which is characterized by the presence of as much as fifty per cent of the volume of the liquid in very minute gas bubbles.

The following method has been devised and is now in course of application to the fermenters for the prevention of foaming, and also to increase the yield of acetone from the fermenters.

SEPARATE FINISHING AND FOAMING TUBS—The yield of acetone has been found to be over ninety-five per cent at from eighty to eighty-five per cent of the time occupied until the yield ceases. Further, there is reason to believe that the condition of the fermenting liquor is such that no foreign bugs can successfully compete with the B. Y. bacillus at this stage, hence it becomes possible systematically to withdraw the fermenting liquor from the fermenting tank at a point before complete yield of acetone is obtained, and at about the time when foaming would occur, in order to increase the duty of the tanks and prevent loss by foaming. This plan is now about to be put into operation.

The arrangement which is now being installed for this purpose (July 16th) is as follows:

The 4" line connecting the two east and west beer lines (see drawing 81, from which the beer pump suction is taken off has been replaced by a 6" cross header connecting into the east and west beer lines through 4 x 4 x 6 tees with a 4" valve on each side. From about the middle of this 6" cross header a 6" branch leads from a 6" tee to a 6 x 4 x 6 tee. On the 4" branch of the latter tee the suction of the existing 7 x 5 x 12 beer pump, 8,000 gals. per hour at 80 strokes per minute, is connected, and on the 6" branch a new 10 x 6 x 12 duplex steam pump will be connected, capable of handling 11,700 gals. per hour at 75 strokes per minute.

Both the new pump and the existing pump will discharge through a 5" pipe which will rise vertically to below the operating platform and thence south under the floor and over the court to the fermenting cellar of the Gooderham & Worts Co., where it will discharge into either of three 50,000 gal. tubs. The line is kept as clear as possible by using long radius fittings.

These fermenting tubs are of wood, with copper bottoms, and are 25 ft. in diameter, 16 ft. high, with a capacity of 49,395 gals. They were formerly used for whiskey fermentation. The three tuns to be used have been roofed with a conical sheet iron cover (24" rise), culminating in an 18 inch ventilator and fitted with a 15 x 20 manhole. They are thus provided with means for discharging the hydrogen gas outside the building and are kept reasonably clear of air, but otherwise have no protection against contamination.

The beer and foam from these tubs is drawn off through two suctions, one drawing beer from the bottom and the other with a special float controlled arrangement drawing at the same time some of the head floating on the beer.

By this means both foam and beer are drawn off simultaneously and thoroughly mixed during the subsequent pumping, so that the beer still receives a homogeneous liquor.

A new 10 x 6 x 12 duplex steam pump, placed at the north wall of the building containing the tuns, draws beer and foam from the two suctions through a 5" pipe, and discharges it through a 4" line over to the two beer stills (one in course of construction). This pump is fitted with an automatic relief by-pass and an automatic pressure control, so that it always maintains a pressure sufficient to deliver the beer to the top of the stills. Under the new arrangement the beer still service pump and tank on the third floor will be dispensed with. Each branch of the beer line leading to either still will be fitted with a valve at the operating floor which the attendant will regulate to suit the still operation, and the automatic control on the pump will regulate the pump operation to suit.

This system then with its two beer pumps of large combined capacity permits of the rapid emptying of any fermenter on the first indication of incipient foaming, and the discharging of the beer across into the large tuns where there is ample capacity to allow for foaming without loss. Even if more than one fermenter starts foaming at the same time the arrangement of the beer line and large cross header permits of the emptying of the tanks at an equal or greater rate to that at which the foam rises.

The suction arrangement in the tuns as previously stated thoroughly mixes the foam and beer into a homogeneous liquor, which is delivered continuously and at a constant rate, under easy and direct control of the still attendant, to the beer still. The still may thus be operated more efficiently because of the continuity through not having to wait for a fermenter, and also because of the homogeneous beer dealt with, foam itself having a bad effect on the still operation.

It is expected that this system will increase the possible yield and duty of the fermenter tanks appreciably, since not only will they be emptied more rapidly but it is hoped that they will now only be in operation during the period when contamination is a source of danger, and that is during approximately eighty per cent of the whole period of fermentation. This latter advantage will only be obtained if the disturbance of the fermenting liquor is found not to interfere with the bugs completing the fermentation. It will probably be put in operation when at least 95 per cent of the total yield of acetone has been obtained.

EDWARD METCALFE SHAW.

SECTION VII (e)—GAS DISCHARGE FROM FERMENTERS

GAS DISCHARGE FROM THE FERMENTERS.

QUANTITY, RATE AND COMPOSITION—The total amount of gas discharged from a fermenter of 25,000 gallons, is approximately 90,000 cubic feet=5 c.f. per lb. of maize. The maximum rate of

discharge is about six to eight thousand cubic feet per hour.

The approximate analysis of the gas and vapour discharged is, carbonic acid gas, 50%, hydrogen 50%, with small quantities of acetone, water vapour and hydrogen sulphide and possibly traces of ammonia.

The carbonic acid gas is below 50% at the beginning of the fermentation, increases to 50% about the middle and becomes greater than 50% towards the end, but the average percentage during the whole fermentation is 50.

UTILISATION OF THE GAS—Considerable attention has been given to the possibility of utilising these gases, particularly with reference to the hydrogen and acetone.

GASES AS A FUEL—One suggestion was to burn the gases, using the heat to save coal. Without considering the cost of an installation for this purpose, the heat available would save the consumption of 1.25 tons of coal per fermenter. At $6.00 per ton for coal this equals .22 cents per pound of total weight of Acetone and Butyl Alcohol obtained per fermenter.

One grave objection, however, to the burning of the gases is the danger involved through enclosing the gases in pipes, and of having explosions either in connection with the conduits or with the gases when they were consumed, and it does not appear wise to run a serious risk to the plant and incur considerable expense to reduce the cost of the product by .22 cents on say 22 cents or only one per cent.

ACETONE RECOVERY—Another suggestion was to recover the acetone and plans were prepared and parts of the plant purchased for doing this by means of compressing the gases and cooling them under conditions where probably seventy-five per cent of the acetone could be recovered.

GAS COLLECTION—This plan for dealing with the gas was as follows: The gas was brought from the top of the fermenter through an elbow and short length of 4" pipe, in which was placed a T carrying a 3" weighted safety valve, to the front where it passed through a second elbow, a gate valve and into one end of a gas measuring box, as shown in drawing 26-24" diameter and 4 feet long and fitted with dividing plate with an 1½" orifice in it.

The original 8 tanks were bolted together, the final 4 welded. A manometer was connected across the orifice plate, measuring the drop in pressure and thus giving a measure of the gas discharged. In some respects this answered well, but there was constant leakage, and it was found impossible to prevent a tank when foaming from filling up these vessels with fermented liquor.

The 4" discharge pipes from the drum were collected in an 8" W. I. header leading to what is now No. 9 fermenter, which was fitted up as a gas receiver. The gas receiver carried a battery of three 3 in. safety valves and from it the gas was drawn through a 4" and a 5" line to the compressing and extraction plant.

PROPOSED COMPRESSION PLANT NO. 1—The first compressing plant was laid out and partially erected to recover from the gas any acetone contained by freezing it out. Thus the 4" line mentioned above led to a gas drum from which the existing 12 x 12 compressor north of the rectifiers and an 11 x 11 x 12 Westinghouse compressor draw and discharged into a compressed gas header.

Through the 5" line gas passed to two belt driven Rand Air Compressors, one an 6" x 8"—54 cu. ft. per minute, and the other a 10" x 8"—179 cu. ft. per minute which discharged the compressed gas at 60 lbs. gauge into the compressed gas header. These compressors were belt driven at 250 r.p.m. by two steam engines, acting as air engines.

From the header the gas passed through two 100 h.p. exhaust feed water heaters used as coolers, one employing water and the other cold gas as the cooling agent and through a steam separator to pick out the acetone and into the steam engines used as air engines one a 12 x 16 and the other 8 x 10" high speed. The exhaust (expanded cold gas) from these engines passed through a second separator to pick out any further condensed acetone and through one cooler (feed water heater) and out to the atmosphere.

PROPOSED COMPRESSION PLANT NO. 2—As a result of further consideration and experience together with the installation of 3 new fermenters, the design of the plant was altered.

In the 4" line leading to the gas boxes from the fermenters, between the gate valve and the box a 4" gate controlled side outlet for air was fitted. No. 9 fermenter was refitted as a fermenter and a gasometer designed using one of the scale tanks as a gasometer, fitted with a new bell. This gasometer took the surplus

from the gas header and the main 8" header passed along to the redesigned gas plant. This header fed the two Rand Compressors and the Westinghouse placed together. The large engine was retained as the gas expansion engine and the high speed engine was used as a steam engine. One of the "feed water heater" coolers was retained, the other being replaced by a cooler made up of pipes.

The construction of this plant was stopped because of an explosion which occurred on Nov. 10, 1916, at 11 a.m., which showed the danger to the whole plant if the gases were retained in the building, a faulty connection in the electric light circuit having caused the explosion.

PROPOSED COMPRESSION PLANT NO. 3—It was deemed advisable therefore, to place the compressing and acetone recovery plant elsewhere than just south of cookers 3 and 4, where it was being erected. Consequently the design of another plant and building was started. The building was to be erected on another part of the property and the plant fitted up with gas engines working on the cold fermenter gas from which the acetone had been extracted as in the other plant. The use of gas engines was impossible in the fermenting room due to risks of explosion. Due to further difficulties the whole scheme of acetone recovery from the gas was abandoned and the following system of piping laid out and its construction proceeded with.

GAS DISPOSAL ARRANGEMENT NO. 1—The arrangement then applied was as follows (see drawing 63): From the upper central flange of the fermenter the gas passed through a short 4" nipple, elbow and a second nipple, through a 4 in. gate valve to the side outlet of a 4" tee. From the upper outlet of the tee a 4" gas pipe led through the roof and was fitted at the top with flange carrying an 1½" orifice plate which was arranged so that it could be entirely removed when the gas discharge became high. The gas discharged directly into the air. The lower outlet of the T was fitted with a drain so that no contaminating liquid could fall back on the gate valve disc. In addition a steam jet was arranged through the T discharging on the disc of the valve. This jet was always in operation when the valve was closed but introduced a serious possibility of contaminating through negligent operators.

FROTHING SYSTEM—In conjunction with the above a frothing system was laid out and partially installed. On the side of each fermenter 12" from the top a 3" flange was riveted to which a 3" gate valve was bolted. From the latter a 3" line passed down through the floor and through the branch of a Y into a 3" frothing header. This header received the froth from each fermenter and carried it to two of the scale tanks from which it was to be drawn by the beer pump and sent to the still. The line was fitted with water flushing connections and all the bends were through Y's and 45° elbows to give as free a run as possible. It was, however, finally considered inadvisable to try and control or make use of the foam and the scheme was abandoned retaining only the gas outlet arrangement at the top which permitted the foam, by removing the orifice plate, to discharge on the roof.

This arrangement of gas discharge was continued in use for about two months and was finally displaced by the system now being followed of discharging the gas by means of the most direct route to the outside of the building.

PRESENT GAS DISPOSAL SYSTEM—The arrangements adopted for this purpose are indicated on drawing No. 60, which shows a device which has been found to be entirely satisfactory in practice and a perfectly safe means of discharging gas. This provides an accurate and safe means of regulating the gas and steam pressure and of the steam discharge when sterilising the tanks, at the same time giving effective safety against collapse through a vacuum forming in the tanks, certainly preventing any serious damage should every other precaution fail. The first of these was installed in No. 7 fermenter about March 24, 1917.

This device consists principally of a cast iron cross and a galvanized iron box. The cross is a special casting arranged to either screw into the 6" flange of the original fermenter or to bolt to the flange and close nipple screwed into the 4" flange of the new fermenters (the latter construction was used in order to keep a full 4" diameter outlet). The front flange of the cross is set at an angle so that the gas pipe bolted to it has an upward slant of 1 in 10, in order that any liquid carried out in the gas may drain back into the fermenter. The other two openings of the cross are cleaning openings, provided with hinged bolted flanges, the upper one for cleaning the cross itself and the fermenter top in the immediate neighborhood of the outlet, and the back one to permit of the swabbing out of the gas pipe with a long swab.

FERMENTER SAFETY DEVICE—The device proper is in the form of a 6" square galvanized iron box about 46" long becoming circular at the top where it is flange jointed (millboard gasket) to the 6" exhaust galvanized iron pipe and with an open bottom. There is a dividing plate arranged as shown which is shaped to eliminate all pockets and crevices around the flange for the gas pipe, which might possibly afford a hiding place for bugs or make cleaning difficult. The dividing plate has cut in it a rectangular orifice with a notched upper edge permitting the easier discharge of gas and eliminating the sudden release of a large quantity that would occur under a flat edge with the consequent surging. This orifice is equivalent in area to a 4" pipe, and the lower edge of the dividing plate is also notched. There is a gate controlled by a lever which may be slipped in front of the orifice in the dividing plate which carries an 1½ in. circular orifice. The operating lever of this gate is bent as indicated and moves in a closed sector (with thumb screw fastener) to catch any drip and keep the handle dry. Around the box a few inches below the water level is riveted a perforated ring to dampen out surges and prevent liquid slopping over.

This box is arranged inside a 10" x 30" can into which the antiseptic water is poured from a pail or other container, through the larger lip, and overflows through the hooded overflow which prevents the liquid level exceeding the proper value. The can is also provided with a second lip and bailing handle for emptying and with a pair of roller handles. This can is suspended on sash cord carried over pulleys on the pipe frame and counterbalanced by a cast weight. There are movable brackets on which the can is hung at different levels and the frame work is arranged with horizontal arms on which the can may be rolled out of the way.

A large funnel underneath catches the overflow or froth and carries it through a 6" pipe to the drains in the flow below.

ACTION OF DEVICE—The action is as follows:

Steaming, Cooling and Filling a Fermenter—The can is at its upper level and the gate open, the device then acts as a safety valve relieving at 10" of water through a 4" pipe.

Fermenting—1st stage. The can is at the lower level and the gate closed, giving free gas discharge through an 1½" orifice the pressure on which is measured by the manometer on the fermenter.

Fermenting—2nd state. The can as in 1st state gate open, giving free discharge of the greater volume of gas now generated through a 4" pipe. The gate is opened after the pressure on the manometer shows 5 or 6 inches on the 1½" orifice.

Foaming—The can is further lowered until just sealing the end of the square box and the foam overflows the can and drips into the funnel. After foaming the can is cleaned out and replaced.

EDWARD METCALFE SHAW.

SECTION VIII.—AUXILIARIES.

SECTION VIII. (a).

BUTYL SALTING PLANT.
APP. 1—ALTERATIONS.
APP. 2—BUTYL RECTIFICATION.

BUTYL SALTING PLANT AND SALT RECOVERY SYSTEM.

The Butyl Salting Plant at Toronto, is a dual continuous system, composed of two distinct units; the salting plant proper, and an auxiliary salt recovery plant, either of which may be operated independently of the other, and both of which operate continuously, differing therein from plants operating on the batch system.

The plant was designed to operate under the following conditions:

The crude butyl as it comes from the rectifier at Toronto, is run into a tank B, where an aqueous layer of about one-third the depth settles out. This aqueous layer contains approximately 8% butyl, and is pumped back and redistilled. The butyl overflows from B into a second similar tank B2. The butyl passing into B2 from B is about 75% dry, but this may possibly run down to as low as 70%. A pump draws the butyl from B2 and discharges it into either a large outside storage tank, from which it is drawn as required for salting, or directly into the salting plant reservoir. The salting plant was designed to deal with butyl 30% wet. From each fermenter of 25,000 gallons, are obtained 400 gallons of wet butyl, and at a rate of 6 fermenters a day, there would be 2,400 gallons of butyl to be salted per day, or 100 gallons per hour. Allowing for a possible doubling of this rate or 12 fermenters per

day, and still further, a margin for other contingencies, the plant was designed to handle 240 gallons of wet butyl per hour.

Tests at Toronto have shown that after one minute of vigorous steady shaking, in a graduated cylinder, and three minutes of settling, the depth of liquid being 10 inches, the resulting butyl is 92% dry. In 240 gallons of wet butyl, 70% dry, there are 72 gallons of water, of which say 55 gallons will be salted out to bring the butyl up to 93% dryness. It is expected that the average will be 93% dryness. This water will take up about one-third its weight of salt when saturated, or 183 lbs. (26% of brine by weight is salt at saturation), which will increase the bulk about 15% or say 8¼ gallons. Therefore on this basis, there will be 55x8¼—63¼ gallons of saturated salt water separated out per hour. The total quantity of butyl, water and salt water to be dealt with by the plant is thus 248¼ gallons per hour. In the drum, the time allowed for salting was set at five minutes, and the total quantity of liquid being 248¼ gallons per hour, the salting drum was required to hold 5/60 x 247 say 20½ gallons of the mixture. As the drum would normally be about one-third full, the total capacity was fixed at 70 gallons. The drum speed was provisionally set at 60 r.p.m. until experimentation allows a proper speed to be determined.

The salt water rejected in the plant specified, would be 63¼ gallons per hour, which must be handled by the evaporator or salt recovery plant. Steam is supplied the evaporator at 100 lbs. per sq. inch, gauge (338°), the inlet temperature of the solution being set at 210°, an inlet temperature difference of 128°, 45% or 58° of which is the rise in temperature of the salt solution. The latent heat of solution, where steam is discharged is 960, so that the quantity evaporated will be 58/960 or 6% of its volume. The evaporator thus must handle 100/6 x 63¼ or 1,050 gallons per hour of solution, in order to recover the 183 lbs. absorbed per hour in salting. From data established at Glasgow where .622 sq. ft. of surface with a steam pressure which gave 40° rise of temperature, 140 gallons per hour were pumped through the tube, hence with a higher steam pressure giving 58° rise of temperature, 203 gallons per hour can be put through, and thus to do the work required in this case '622x1050/203=3.21 sq. ft. are necessary. This area is given by 4 tubes 5/16" bore 11' 6" long and to afford an ample margin 6 tubes were put in the evaporator giving an area 5.75 sq. ft.

DESCRIPTION OF SALTING PLANT.

See Drawing No. 56.

The crude butyl as it comes from the rectifier is run into a tank B1, (13,400 gallons capacity, formerly used for wine storage) on the ground floor of the distillery, and allowed to settle, the drier butyl running over through a 2" overflow, located about one foot from the tank top, into a second similar tank, B2, (previously a spirit storage tank) from which it is drawn by a reciprocating steam pump (wine pump formerly) and discharged into a large outside storage reservoir B3 (400,000 gallons, formerly molasses tank), or directly into the inside wet butyl storage tank R, (2,500 gallons capacity, formerly slop tank) of the salting plant. From the outside tank the wet butyl may be drawn by a large reciprocating steam pump P1, at one time used for molasses, and raised into the small reservoir R, previously mentioned. From the latter the wet butyl runs under the influence of gravity through a 2" pipe, in which is a 2" float controlled balanced valve, into the hopper H of the salting drum, washing in the salt added at this point, either by shovelling or from the salt recovery system to be described later. The salt and butyl pass from the hopper into the salting drum through a hollow journal.

The salting drum, (see drawing 47), is belt driven from a counter-shaft driven from a small 5 h.p. vertical steam engine (see note in appendix). The drum rotates at about 60 r.p.m. in specially designed pillow blocks, and requires little power to operate. The interior of the drum is divided by disks into seven chambers, and there are four paddles or blades extending throughout the whole length of the drum. Communication between the chambers is by means of a 6" diameter hole in each disk, or through a rectangular slot.

The operation of the drum is as follows:

The mixture of wet butyl and salt, passes from the hopper into the first chamber, and as the drum rotates the blades successively pick up the salt and let it slide off into the wet butyl, stirring the mixture thoroughly. Once during each revolution, a deflector opposite the rectangular slot cuts off a portion of the salt and guides it into the next chamber. The drum axis being horizontal, and the inlet opening 4" in diameter, while the holes in the disks are 6", the liquid flows from chamber to chamber through the 6" hole

and also through the rectangular slots when below the axis. In this way the salt and butyl pass on from chamber to chamber, being constantly agitated by the paddles, and the water in the mixture dissolving salt until, upon reaching the last chamber, when the drum is being properly operated, the water is thoroughly saturated with salt, and comparatively little undissolved salt is present. The rate of flow of the liquid through the drum, and the quantity of salt are under easy and direct control, the latter depending on the former. The mixture of 93% dry butyl and saturated salt solution, flows out through the 5" diameter outlet in the other hollow journal.

From the salting drum, the mixture flows into and through an observation chute O.C. in a broad shallow stream. In the chute the mixture may be momentarily arrested from time to time by means of a small flap gate, and examined through the glass windows to see that just a slight amount of crystal salt is coming through insuring thorough saturation of the water. In this way the amount of salt admitted to the drum, may be properly regulated to suit the rate of flow of butyl, so that the water is saturated and very little excess salt passes over.

The observation chute ends in a passage way leading into a settling tank T, (see drawing 49). This passage way is so designed that the mixture of dry butyl and saturated salt solution in passing into the tank, imparts to the whole body of liquid in the tank, a rotary motion. The object of the rotary motion is to obtain a low velocity and more time for the thorough or complete settling out of the suspended salt. The passage way is further so designed as to be readily accessible through the hinged observation window, for cleaning out accumulations of salt. A large proportion of the salt carried out of the drum in suspension, drops to the bottom of the settling tank and the liquid remaining (dry butyl and saturated salt solution) flows out through the elevated overflow. The salt that settled out drops to the cone shaped bottom of the tank, and is drawn off occasionally through the salt valve V, (see drawing 48) into flat pans or pails and returned to the hopper H. This is the only manual handling of the salt in the plant, except at starting.

The liquid proceeds from the overflow of the settling tank into the pump reservoir R2 (see drawing 54), where the rotary motion and elevated overflow are made use of to effect the complete separation of any remaining suspended salt. In this tank is arranged a float which controls the stop cock in the butyl supply line above, allowing the wet butyl to flow in only as fast as the pump draws the salted mixture from the tank.

The small rotary belt driven pump, (see appendix), draws the butyl saturated salt solution mixture from the reservoir R2, and discharges it into the main dry butyl storage reservoir R3 (formerly molasses storage tank) where the separation of the dry butyl and salt solution immediately takes place, the former rising to the top, and the latter settling to the bottom. The depth of salt solution at the bottom of R3, to effect a proper separation, need not be more than one foot, possibly less. The separation is so definite that even with small depths there is no danger of any butyl passing out of the drain. There may of course, be any quantity of salt solution kept in R3, but the greater the amount of salt solution stored, the less storage capacity is available for dry butyl, whilst with a small quantity of salt solution, the pressure of the butyl above it, will feed the evaporating system.

The dry butyl may be drawn off from the tank R3 through either of three 2" connections located at three different levels in the tank. To the south of R3 is a duplicate tank, in the same building. This will be used for dry butyl storage purposes and connections are arranged between the two tanks so that butyl may be run from either of the three 2" cocks in R3 into the second tank.

This constitutes the Butyl Salting Plant and it may be operated entirely independently of the second part of the plant about to be described.

SALT RECOVERY SYSTEM.

The saturated salt solution settles out in the dry butyl storage reservoir, on the bottom, and runs out under the influence of the static head in the reservoir (due to dry butyl and salt solution) through the original 4" drain connections and into a new 1½" supply line leading to the float chamber F.C. (See drawing 54.) (Evidently the head of salt solution and dry butyl in R3, must be greater than in the float chamber for flow to take place.) The 1½" supply line is provided with water connections for washing out possible accumulations of salt, which are not however expected. Normally 63¼ gallons per hour of saturated salt solution will be handled containing 183 lbs. of salt.

The salt solution is admitted to the float chamber through a 1½" ball float valve, in order to maintain a constant level of liquid in the chamber and to prevent flooding. The float chamber and exploding chamber, are really one vessel, as the two are in direct communication through a 2" opening protected by a baffle. The solution passes through this opening into the exploding chamber (where the liquid has a rotary motion for reasons given later) and out through the elevated overflow and a 1¼" return line, to the suction of a second small rotary pump E3, (see appendix), which discharges into the evaporator E. (drawing 46), through a ¾" pipe. This pump must handle about 1,050 gallons per hour.

In the evaporator the salt solution is pumped from a header into six copper coils (entering at 210°) through which it flows under pressure, while the coils are surrounded by live steam under a pressure of about 100 pds., flowing in the opposite direction through the passages in which the coils are laid. The solution is thus heated under pressure to a temperature of 268° and passes out through the second header and returns through a ¾" delivery line to the exploding chamber. The evaporator is provided with water connections for washing out the coils together with air vent and drain for condensate.

The hot salt solution is maintained at the required pressure in the tubes by a needle throttle valve (drawing 54). On entering the exploding chamber, 6% of the water is evaporated, and the depositing in fine crystals, of about 6% of the salt in solution results. The needle valve is so placed that the jet issuing from it gives to the liquid in the exploding chamber, a rotary motion, which together with the elevated central overflow, gives the salt opportunity and time to settle. There are two overflows provided, one of which will cause the needle valve to discharge freely, the other submerged. It is not known at present, which arrangement will give the better results in the way of crystals of suitable size. The salt settles to the cone bottom of the tank, and is fed as required through the salt valve V2, into the hopper H and salting drum. The evaporated steam escapes up the exhaust pipe which is provided with a moisture drain to prevent any condensed steam dripping back into the exploding chamber.

The salt solution coming in through the float valve just compensates for the water evaporated and keeps the quantity of liquid in the system constant.

Generally speaking, this plant is designed to utilise as fully as possible, the advantages of continuous methods. The liquids and salt are reduced in quantity at each stage, to the smallest amount consistent with certainty of action, and the two advantages of small quantities under treatment and small size of apparatus are obtained.

The plant is capable of easy control by one attendant.

At the rate of 6 fermenters a day, 2,400 gallons of wet butyl must be dealt with each day, and 240 gallons uses 183 lbs. of salt, so that 1,830 lbs. of salt can be recovered daily instead of being thrown away. At present prices of $11.50 a ton for crushed rock salt, or $13.50 for clean salt crystals, the salt used represents say $12.00 a day with only 6 fermenters. At a wage of say $4.00 for 10 hours and coal used 15 cwt. at $4.00 a ton, a total of $7.00 the saving of salt will easily pay for working of the plant.

Much of the plant we shall use was already on the premises when the buildings and equipment were taken over by us.

EDWARD METCALFE SHAW.

APPENDIX TO BUYTL SALTING PLANT REPORT.

There have been found, as a result of actually operating the plant, several changes necessary in the construction of the plant. In the first place, the steam engine drive proved unsuitable and was replaced by a 3 horsepower induction motor, 750 r.p.m., driving through a countershaft to the drum direct. This drive has proved entirely satisfactory.

It has also been found necessary to place on the inlet end of the salt drum a gland as shown in drawing 69 to prevent leakage.

The small rotary pumps originally arranged for were deemed unsuitable, finally, and replaced by a 3 x 2 x 4 duplex steam pump to handle the butyl-salt solution and a 6 x 4 x 6 duplex steam pump to handle the salt solution in the evaporating part of the plant. Small galvanized iron pans 18" diameter x 6" deep, were made to slip under the settling tank to receive the salt.

The salt was found to stick in the cone bottoms of the settling tank and exploding chamber and the agitators shown in drawing 70 were installed that in the former hand operated and in the latter driven by belt from the drum. Those have been found fairly satisfactory.

With regard to the operation of the plant as shown after some time in actual use. The salting portion of the plant is imminently satisfactory having handled 600 gals. of wet butyl per hour and salting to 92 to 93% dryness. This part of the plant proved itself easy of manipulation, lent itself readily to accurate observation of the results, quality of butyl, etc., and close regulation of salt supply by means of the observation chute. The settling tank was effective in the removal of undissolved salt. The results obtained by the evaporation portion of the plant were disappointing. The heater proved most efficient and satisfactory, but the great difficulty arose through the escape of considerable salt up the exhaust with the steam and through the caking of the salt in extremely hard formations all over the interior of the vessel and its fittings. As a result the original vessel was heightened with the same results and with even a 7' 6" diameter by 6' tank and the needle valve at either side or top of roof the results were poor. Finally the latter tank was used with a large copper steam coil, simply boiling the brine but again the salt froze on the tubes in an extremely hard crust, rendering the coils useless.

Having in mind then, the comparative cheapness of the salt used ($11.00 to $13.00 per ton) in comparison with the value of the butyl dealt with, the extremely difficult nature of the problem and the pressure of other more important work, it has been resolved to abandon for the time being the salt recovery system and use only the salting plant itself.

EDWARD METCALFE SHAW.

APPENDIX 2—BUTYL ALCOHOL RECTIFICATION.

Recently instructions were received to increase the dryness of the butyl alcohol beyond that obtained by simply salting and the butyl alcohol at Toronto is therefore now put through the following system of rectification:

STORAGE AND SETTLING TANK SYSTEM—The crude butyl from No. 1 rectifier passes to a 13,400 gal. copper spirit tank B1, in which an acqueous layer settles out at the bottom and the drier butyl overflows through a 2" pipe about one foot from the tank top into a second similar tank B2 entering the latter 30" from the bottom. From B2 the butyl is drawn by a

12 x 10 x 20 simplex steam pump(formerly slop pump) and discharged through existing 4" piping to the large 1,250,000 gal. outside storage tank, west of the shipping room. From this large reservoir the wet butyl is pumped by an 8 x 10 x 12 simplex steam pump (formerly molasses pump) through a 4" line (partly existing) into a 7' 6" diameter x 6' high galvanized iron tank—1,500 gal. tank (built for acetone storage but replaced by larger). From a point 2 ft. from the bottom of this tank, to allow of any further settling out of water at the bottom, a 1" line passes to the hopper of the salting drum.

Salting Plant—The butyl is salted in the salting drum, salt being fed in by hand and the butyl, brine mixture passes to the settling tank, where the solid salt settles out, overflows into the pump reservoir and is pumped by a 3 x 2 x 4 duplex steam pump through a 1" line into the north one of two 18,000 gal. steel tanks in the shipping room, entering the latter midway between top and bottom. In this large tank the butyl and salt solution separate and the dry butyl overflows through the top one of three 2" overflows into the south 18,000 gal. tank. From this latter tank a 6 x 4 x 6 duplex steam pump (formerly used on the salt recovery system) draws the dry butyl through a 2" line and discharges into a line made up of various sizes of pipe, most of which was in place in the old plant, across the intervening buildings and Trinity Street to the Gooderham & Worts Still House and into either of two 11,000 gal. copper still supply tanks. From these latter a 3" copper line runs to either of three Gooderham and Worts stills No. 1, 7,000 gal. No. 2, 7,000 gal. or No. 3 4,000 gal.

Rectification Section—The butyl rectification is carried out entirely in Gooderham and Worts equipment. From the kettle of No. 2 still, which is now used for butyl rectification, the vapors pass through a 16" pipe to the column (8 sections and 23 plates) and thence through a 14" pipe to the goose. From the goose a 9" pipe leads to either of two condensers and from the condensers the liquor passes to the tail box.

The runnings from the tail box are directed through either of two 2" lines to the centre of Gooderham and Worts No. 2 Tank House, containing sixteen 9,100 gal. copper tanks or to either of two 3,600 gal. copper tanks (formerly alcohol), south of No. 1 Still. From the ends of the 2" lines in the centre of No. 2 tank

house, lines of hose are employed to carry the runnings to any one of the sixteen tanks. The last runnings are directed into the two 3,600 gal. tanks from which a 2" line drops to 6 x 4 x 6 duplex pump which discharges vertically to the long line by which the butyl is brought over from the salting plant. This same line is thus used for both delivering the butyl to the rectifying section and for returning the last runnings. The above pump may also be used to empty the rectifying kettle should a bad charge at any time require to be removed.

Returns—The last runnings are thus pumped back to the salting plant where it is discharged into the top of what was formerly the 2,500 gal. steel salting plant supply tank. This tank is arranged similarly to the 1,500 gal. galvanized iron tank so that there is provision for aqueous layer to settle out. A 1" line leads from a point 2 ft. above the bottom to the salting drum hopper, where the upper layer of the returns is salted. The lower layer that settles out in this tank is returned by a belt and gear driven single plunger pump (3" x 7") through a 1¼" line to the bottom of the 13,400 gal. tank B1, and the lower layer in the latter tank is removed at intervals by a 6 x 8 x 12 pump (formerly spirit pump) and returned through a 3" line for re-rectification.

The butyl will be run into the drums directly from the tanks in the Gooderham & Worts No. 2 Tank House, probably using the existing alcohol racking off arrangements.

The butyl obtained by this system is 99½% dry while the best obtained at Toronto by simply salting was 92-93%.

Edward Metcalfe Shaw.

SECTION VIII. (b)
CONTINUOUS FERMENTATION SYSTEM.

EXPERIMENTAL PLANT FOR TESTING CONTINUOUS FERMENTATION.

An experimental continuous plant for fermentation with the Weizmann bug has been under construction since the fall of 1916. Pressure of other work has held back the completion though most of the work is done. It is designed to ferment about 700 galls. per 24 hours.

The necessity for such a method of working has largely disappeared since the present plant has run for three months without contamination spoiling a single fermenter, but the completion of the work seems advisable because success would mean reduced cost of construction, working expenses and increased safety as regards yield and accidents.

Some work had already been done in connection with continuous cooking when this plant was first started and from the experiments made it appears certain that the time required for sterilising the mash and for getting the starch in solution can be cut down materially. Continuous cooking is now being applied on a large scale to the Toronto Plant—see section of report on New Mash Line and Continuous Cooking.

DIFFICULTIES OF ORDINARY FERMENTATION—Considerable difficult is met with on account of the uncertain nature of the fermentation as carried out under the existing system—the rate of fermentation and the frequent frothing and foaming of the fermenting liquor. This has not merely affected the periods, but has also caused trouble from the sudden increase in volume for periods of as long as two hours, during which there is frequently some loss of the fermenting liquor from the tank.

POSSIBLE ADVANTAGES OF CONTINUITY—It is believed that continuity through a series of fermenting vessels, arranged to allow for a continuous flow from one end of the system to the other, may result in more uniform conditions of fermentation, while the effect of an increase in volume at a certain stage, though likely to be always happening in the same vessel, would result, should the increased volume be abnormal, merely in bringing about for a short period a more rapid discharge of the completely fermented beer from the end vessel.

CONTINUOUS INOCULATION—The system of fermentation provides for the possible continuous reinoculation of the system, so that should the system act as perfectly as is possible the spores originally introduced into the inoculating system will supply from the seed stage a continuous amount of fresh inoculant.

In this connection, and in view of the uncertainty which at present prevails as to the variations in the vigour and efficiency of the bugs, provision is made by means of which a number of pipes

of a suitable length are fed from the end of the seed circuit by means of small pumps immersed in antiseptic fluid, so that the length of time which any of the seed takes to pass to the end of the inoculating circuit varies, say, from two up to twenty days.

By having at least two separate circuits for each period the inoculant introduced into the beginning of the seed stage will, it is thought, provide from the assortment of spores, having, perhaps, widely different properties, a uniform inoculant. Such a system, of course, at least provides for absolute sterility.

It may be stated here that it has not been made clear up to the present to what extent the continuous system may dispense with the introduction of fresh inoculant. Obviously, having once charged the system there will always be B.Y. bugs in the first tank.

OBSERVATION AND TESTING FACILITIES—The system of continuous cooking provides a constant quantity of mash, which is regulated as to flow for the main fermenting system and for the seed system. There is considerable uncertainty as to what really happens at the different stages of the fermentation, and therefore the twelve tanks in the series are provided, with long glass windows, which will generally be kept covered, with a suitably placed window on the opposite side of the tank so that a powerful light can be thrown over nearly one-half the depth of the fermenting liquor, allowing observation to be taken of the conditions of fermentation.

Among other arrangements provided are those for distributing the seeded mash in the first tank in a thin stream, so as to ensure uniformity as far as possible.

Another provision made allows of the introduction into any tank of fresh inoculant, or of experimentally testing the effect of introducing other forms of food for the bacteria, or chemicals such as alkalies or antiseptics.

In view of the possibilities arising in connection with foaming on the surface of the liquid, or of the collection of solid matter at the bottom of the tanks, a system is provided by means of which some of the gas drawn off from the system can be forced at high pressure through suitably placed perforated tubes in the bottom of each vessel.

CONTROL—The general system of flow is controlled by the difference of pressure in the first and last vessels, which may amount to as much as two pounds to the square inch. The whole of the gas flows from one end to the other of the system, and is discharged from the last tank. It can, if desired, be drawn off at one or more intermediate points.

Absolute precautions are taken to prevent contamination in the system, and for this purpose any cocks or testing tubes are immersed in pots of antiseptic liquid.

The whole system is designed in such a manner that should it prove successful the existing plant of the British Acetones can be reconstructed to work on this system, and this work can be done at small cost and without putting more than two fermenting tanks out of the total number out of commission at any one time.

Apparently the point most in doubt is whether such a system can be worked continuously without adverse influences arising in the series of vessels. Naturally, until the system has been tried and in view of the present state of knowledge, it is impossible to say; but it can at least be said that there is no known cause which will operate adversely.

Full details and results of the working of the plant will be sent on as soon as the plant has been completed and fully tried out.

EDWARD METCALFE SHAW.

SECTION VIII (c)—IDEAL PLANT.

IDEAL PLANT

FOR PRODUCING BUTYL ALCOHOL, ACETONE AND METHYL ETHYL KETONE, FROM CORN BY THE WEIZMANN PROCESS.

GENERAL—It will be evident from the accompanying sections of the Report on the British Acetones, Toronto, Limited, that there have been difficulties to cope with, many of which have arisen from the fact that an existing plant was being adapted to new uses. These difficulties could be avoided or eliminated in the design and construction of an entirely new plant. It was with this in mind that the plant shown in drawing 64 attached was designed embodying as far as possible and compatible with other essential conditions all the principles, arrangements and details of construction shown by 12 months' work on the Toronto Plant to be necessary for convenience, safety and efficiency in such a factory. This plan, together with the accompanying description, is therefore put on record more to define experience up to date than as a perfect arrangement.

The plant is based on the use of material and equipment now in use at Toronto, re-arranged with such modifications as have been shown to be advisable.

OUTPUT—The plant based on the use of sixteen 30,000 gal. fermenting tanks (although additional ones are under consideration) which, under the improved conditions of this ideal plant, would be capable of fermenting 10 fermenters a day or 250,000 gals. of mash, resulting in 5 tons of acetone per day and 10 tons of butyl, or if converted, in approximately 9 tons of methyl ethyl ketone, that is a total of 14 tons per day of solvent.

LOCATION—In the design a location on a waterfront is assumed, together with railroad facilities enabling the raw materials, corn and coal to be brought in either by rail or boat and the delivery of the solvent also in either way. The plant is laid out then on a rectangular plot of ground roughly 5½ acres, divided into practically equal halves by the railroad right of way and with a berth for vessels in the middle of one side.

RAW MATERIALS—HANDLING CORN—On one side of the berth for the vessels is the corn elevator with a capacity as at Toronto of 1,000,000 to 1,250,000 bushels. This elevator would be arranged with unloading equipment both marine and rail and provided with amply conveying equipment for handling the grain, transferring from one bin to another, and delivering to the mill across the railroad tracks. Ample grain handling facilities have been shown to be very necessary at Toronto in order to dry the grain by transferring from one bin to another, eliminating dampness, which renders grinding slow and screening difficult. The Toronto Plant is without such equipment, and is under a serious handicap in this respect as the grain can only be turned by hand.

COAL—On the other side of the berth is the coal storage which in the case of Toronto, must be ample to eliminate shut downs as occurred last winter through a shortage of coal and uncertain railroad deliveries. To overcome danger from spontaneous combustion from the large quantities stored, under water storage might be resorted to, in concrete pits with coal handling equipment for marine or rail unloading and delivery to storage, and from storage to boiler house by overhead conveyor across the railroad tracks.

FIRE PROTECTION—At the end of the slip is located the fire service pump house complete with boilers and pumps, drawing directly from the slip and capable of discharging 2,000 gals. of water per minute at 100 lbs. pressure.

The buildings on the land side of the railroad track are arranged in the form of rectangle with the distillery and storage building in the centre. Between the various buildings are ample passage-ways provided with light tracks and turn tables and cars for the transporting of heavy materials.

MILL—The corn is delivered from the elevator to the mill by the overhead conveyor. The mill approximately 50' x 50' is located as shown and has a capacity of 4,000 bushels a day and is equipped with eight run of steel rolls and other necessary equipment, capable of handling this quantity.

MASHING—Next the mill, in the same building, is the mashing section also 50' x 50'. The mashing equipment consists of four mash tuns properly equipped and with a capacity of 16,000 gals. per hour. Over the tubs are the meal storage hoppers and weighing gear fed by conveyor from the mill and feeding the tuns through chutes under gravity.

POWER—The mill and mashing equipment is driven from the engine room (30 x 50) next the mashing room. Here is located the main steam engine driving the countershaft which extends through mashing room and mill. Here also is the mash pump and digesters with controls and gauges extending through the wall to the mash room.

DIGESTING AND COOKING—The mash is drawn from the mash tuns by the mash pump capable of dealing with some 200 gals. a minute and forced through the digesters and 5" mash line across the passage to the fermentation building (100 x 125), through the exploding valve into the first of three 8,000 gal. steel cookers. In the mash line the mash is digested under 50 lbs. of steam and in the cookers probably cooked on the continuous principle under about 15 lbs. pressure or less. The fourth tank shown is an exhaust steam reservoir as at Toronto. The cookers are designed for higher pressures than at Toronto and built with cone bottoms (45° slope) so that the arrangement of the piping would be slightly different.

COOLER—A cooler pump under float control from the final cooker and with a capacity of 200 gals. per minute, forces the mash through the cooler of the same type as at Toronto but larger and with slight improvements which are being embodied in No. 3 cooler here which is now being built. The cooler in the ideal plant is capable of cooling 200 gals./min. 150° F. The cooler water is used everywhere possible throughout the plant, for mashing, boiler feed, etc.

FERMENTER—From the cooler the mash is delivered through 5" mash pipes properly protected on the positive system from contamination and arranged with long radius bends 45° elbows and Y's to offer least resistance to the fermenters entering the latter at the centre of the bottom. The fermenters are sixteen in number arranged as shown. They are built to withstand pressures of 5 lbs., have conical bottoms and are equipped with the devices and equipment that has proved satisfactory here, including vacuum valve safety device, thermometer, etc. The inlet and outlet is a single opening at the bottom of the conical bottom and is 6" in diameter. The fermenters are arranged in four groups with the piping as shown, the filling and emptying lines being one above the other, the former 5" and latter 6" and the valves properly safeguarded with steam locks, etc., against contamination.

BEER LINES AND PUMP—The 6" beer line from each group of fermenters passes by the most direct route and with easy bends to either one or two pumps with a capacity of 20,000-25,000 gals. an hour which discharge the fermenting beer before completion of fermentation to the Finishing Tanks.

INOCULATION—The inoculation equipment is arranged on the floors above the continuous cookers and consist of six 5 gal. culture vessels, six 100 gal. inoculating vessels on the top floor and sixteen 600 gal. seed tanks arranged on the intermediate floor. The feed from one to another is by gravity. Besides this equipment is a laboratory on the top floor for the staff in charge of the seeding vessels. The inoculant from the seed tanks is forced into the mash line under pressure by a rotary pump (2,000 gals. hr.). The seed tanks are of steel or copper with conical bottoms, capable of withstanding internal pressure of 15 lbs.

FOAMING AND FINISHING—The fermenting liquor from the fermenters is pumped at a high rate through the 6" line across the central passageway of the plant to four 40,000 gal. foaming and finishing tanks on the ground floor at one end of the distilling and rectification building. Here the fermentation is completed and the beer and foam drawn off simultaneously by a 200 gal./min. beer pump and discharged vertically to the distillation section.

DISTILLATION—In the distillation section the beer first passes from the beer pump to the two 6,000-7,000 gal. an hour beer stills. The stills with their heaters and condensers are on the floors above these tanks and operate on exhaust steam from the central exhaust steam reservoir. The runnings from the still tail box pass through the wall to the storage tank building where it is stored in a 15,000 gal. copper tank. The slop from the stills passes through a line to the heat recovery unit in the boiler room (evaporator) where it is used to heat the feed water.

RECTIFICATION (PRELIMINARY)—The preliminary rectification is taken care of by two kettle rectifiers each taking a 15,000 gal. charge. The charge for these rectifiers is drawn from two tanks in the tank house and pumped into the kettles by a simplex steam pump. The rectifiers are complete with columns, goose dephlegmator and coolers and the runnings are directed to the proper tanks (15,000 gal.) provided in the tank house.

ACETONE RECTIFICATION—(SECONDARY)—The secondary rectification of the acetone is carried out in a continuous Barbet Acetone Still capable of dealing with 14,000 lbs. per day of finished acetone. This still is shown in the rectifying room. The finished acetone from this still is directed to the storage tanks in the tank house with a capacity of 8,000 gals. (glass lined) giving ample margin over a car load.

BUTYL SALTING AND RECTIFICATION—The butyl alcohol from the first rectification after settling out the aqueous layer in the tank house (15,000 gal. tanks) is pumped to the salting plant on the ground floor of the rectifying building. From the salting plant feed tank (2,000 gal.) the upper layer passes to the salting drum and thence to the first of a pair of settling tanks and overflows from the first into the second; from the second the salted butyl is pumped to the third of the battery of three rectifiers from which

it passes 99½% dry to the dry butyl storage tank or tanks in the tank house.

METHYL ETHYL KETONE—Provision is also made for a methyl ethyl ketone plant as shown. This plant, capable of dealing with all the butyl from an acetone factory of this capacity, could, from work done here on the design of such a ketone plant, be housed in a building 50 x 50 or the size indicated. Here the butyl would pass through the various stages and rectifications and finally pass to the tank house methyl ethyl ketone. Should a sulphuric acid recovery plant be necessary on the usual tower system a separate building will be required.

SHIPPING—The shipping room is shown on the drawing of ample size for drum washing and racking off purposes and conveniently located with respect to tank house and railroad. The shipping room is connected by pipe lines with the different acetone, butyl and ketone tanks and is provided with drum washing tank, platform scales, drum handling and loading equipment.

RECEIVING—The empty drums and construction material is received from the railroad cars in the receiving room next the shipping room. The drums are then passed through the doorway directly to the shipping room as required.

BOILER ROOM—The boiler room occupies one whole side of the rectangle and contains 2,400 h.p. of boilers. The coal is delivered by conveyor from the storage and dropped into hoppers which feed through chutes and mechanical stokers. Flue gas is carried off in a brick stack and fans are provided for forced draft.

PIPE LINES—The pipe lines are all provided where necessary with ample sterilising connections, drains and also with sterilised water washing connections. They are of larger size than in the Toronto plant and fitted with malleable fittings.

LABORATORIES—The laboratories are located as shown, the bacteriological as near as possible to the fermenting section, with a small branch laboratory next the inoculating room, and the distilling laboratory next the rectification building.

SHOPS—The steamfitters' and carpenters' shops and mess room are in a separate block of buildings, conveniently located with regard to practically the whole plant.

OFFICES—The business offices, engineering offices and girls quarters are as shown in a convenient and handy location. The girls rooms being over the offices and communicate by bridges with the fermenting floor and rectifying rooms.

EDWARD METCALFE SHAW.

DRAWINGS.

No.	Title.
1.	Stuffing Box for Cookers.
3.	Step Bearing and Outlet for Cookers.
4.	Sterilisers for Cookers.
5.	Steam Connection for Cookers.
6.	Cooler.
7.	Coil Connection for Cooler.
8.	Baffles for Cooler.
9.	Stirrer for Cooler.
12.	Header and Piping for Cooler.
18.	Fermenters.
20.	Acetone Storage House.
21.	Drum Washing Tank.
22.	Gauging Vessels.
26.	Gas Measuring Box.
30.	Cooler.
30A	Cooler Details.
35.	Mash Inlet for Cooler.
36.	Reconstruction of Fermenter No. 1.
38.	Piping to Inoculators.
40.	High Press. Cooker.
41.	Piping to No. 1 Cooler.
46.	Evaporator.
47.	Salt Drum.
48.	Salt Valve.
49.	Settling Tank.
51.	Salt Drum Pillow Blocks.
54.	Exploding Chamber.
55.	Salt Drum Hopper.
56.	Butyl Salting Plant.
59A	Rectifying.
60.	Safety Device for Fermenters.
61.	Distillation System.
62.	Block Plan of Property.
63.	Fermentation System.
64.	Ideal Plant.
66.	Culture Vessels.
67.	Fermenter Vacuum Valve.
69.	Salt Drum Stuffing Box.
70.	Agitators.
71.	Mash and Inoculating Lines.
77.	Details of Mash Line.
79.	Exploding Valve—Continuous Cooker.
81.	Beer Line.
83.	Plan of New Mash Line.
84.	Cooler Piping.
85.	Continuous Cookers.
86.	Continuous Cooker Details.
7979.	Elevation—Continuous Acetone Still.
7980.	Plans—Continuous Acetone Still.
1.	Characteristic Curves of No. 1 Cooler.

CURVES.

1. Consumption and Production Curves.
2. Expenditure and Revenue Curves.
3. Capacity of Plant Graph.
4. Graph of Process.

TABLE.

1. Production Data.