Ramifications of the Oil Industry

(Part II.) The Plant

BY THOMAS ANDREWS

TO those of you who have followed the first part of this paper it will come as no surprise to hear that there is practically no type of machine without representation in the oil world. It is not, however, my intention to catalogue the various machines that are used in the trade but rather to give some insight into the uses of the plant found in these works.

The oil industry in normal times is one of those industries that, once started, must be kept going, often without intermission, all year. Therefore we find in this trade some of the finest machinery that can be bought, and it is generally admitted that it is false economy to use any other. In the larger works it is usual to duplicate machinery that might, by its failure, bring whole sections of the works to a standstill.

The Power Station

The modern, up-to-date, oil mill and works generally has its own power station. There are no hard and fast rules regarding the type of prime mover that should be used and, in fact, we often see many types running side by side. I can give you a personal note on this matter to show you the extremes which can be met in actual operation. In a large works we had the following series of prime movers—there being a reason in each case why one was preferred to the other—the hydrogen production plant was run by gas engines working on the gas from a mond producer; the refineries and hardening equipment were electrically driven from power supplied by Diesel and Semi-Diesel engines; the extraction plant was run by a horizontal steam engine and the main power station contained turbo-generating sets feeding by electric current many processes scattered over a wide area. This instance shows that the power supply on a large works may take the power engineer through the whole gamut of prime movers.

Exhaust Steam Important

Exhaust heat is one point that needs careful thought when considering the type of prime mover to be installed. The old works using non-condensing engines exhausting to the atmosphere did give us, when properly used, a fairly continuous supply of low pressure steam. As outlined in the first part of this paper there is a large amount of vacuum evaporation done in an oil works and low pressure "waste" steam has great value. With the rise of condensing engines and the use of internal combustion engines this source of supply was lost, but recently another source has arisen. I refer to the use of "waste heat" boilers in conjunction with internal combustion engines. The hot products of combustion often leave the engine at temperatures up to 400° C when the engine is working at full load (the natural state of the load in oil works) and the heat discharged in the exhaust averages approximately 40 per cent of the calorific value of the fuel supplied. This 40 per cent can be used largely in the modern "waste heat" boiler to give low pressure steam, and, as the load is continuous over large periods, such installations deserve close attention from the designers.

Types of Conveyors

The first process machinery that has to be considered comprises that which is used to get the raw material into the mill. The seed and other oleaginous material comes either by land or water and the unloading is generally accomplished mechanically. In the case of material brought by railway trucks a good procedure is to tip the contents into a pit from which it can be trimmed into elevators for transmission to a higher level. Handling by cranes and winches in bags and baskets is a slow, dusty business and absorbs far too much labor, although we do find conditions where it is the only feasible method. For small seeds the pneumatic or suction method has distinct advantages. It is, however, rather costly in power, and unless the bends are kept free from obstructions and the resistances in the suction pipe kept low the rubbing and bruising effect is likely to damage the seed—a point that is material when the seed has to be stored. However, the fact that flexible suction pipes make channelling and trimming unnecessary, gives a big advantage to this method as compared with the elevator.

For moving the material about on the level we have a choice between band conveyors and spiral or worm conveyors. For large and lumpy material such as copra, and for long distance travels the band conveyor is ideal. For short distances, and for moving material that is not damaged by friction the spiral conveyor is more adaptable. For material that is to be processed immediately and for material in the course of treatment there is no objection to the spiral conveyor, but where seed is to be stored for some time, then it is necessary to take into account the bruising action of such a conveyor.

Conveyors of all kinds play a big part in the economical running of an oil works. They place seed inside buildings, only as a preliminary. When the material gets inside the building it generally falls into an automatic weighing machine from which it is transferred by a band conveyor to a magnetic separator; it falls from this to the screens, the screened material falls into a pit from which it is removed by an elevator and is carried by band or worm conveyor to the silo; drops from the silo to the machines which remove the outer coverings, is carried from these in two parts—the husks to the boilers and the meats to the grinding machines—on conveyors; after rolling, the meats are elevated and distributed by hoppers to the kettles in the case of pressing, but taken on elevators and conveyors in the case of expelling and extracting; from these the extracted meal is taken on conveyors to the driers, the dried meal is taken on conveyors to the nutters and cubers, and lastly the finished nuts and cubes are fed to the bagging hoppers by conveyors. Surely a most important part of the running is effected by conveyors.

Decorticating Machines

The machinery used for removing the outer coverings differs with every class of nut and seed, and its efficiency is largely in the hands of the operatives, but in every case the mechanical efficiency is determined by that part of the machine which separates the various portions. It is of no use to find that the shell or covering is detached from the oleaginous material unless at the same time efficient separation takes place. Each of the machines which do this part of the work can be divided into two portions, that which detaches the covering and that which separates the two. We have all, at some time or another, broken the shell of a Brazil nut and, unless there has been a clean breakage, experienced some difficulty in removing the bits of shell from the nut and the bits of nut from the shell. If, therefore, we can visualize the quantity of shell that would, in this extreme case, go forward with the kernel to the detriment of the cake and the amount of kernel that would be wasted with the shell, we can get some idea of the importance of the separation at this stage. The perfect machine would be the one which would give 100 per cent whole kernels and 100 per cent covering as two distinct parcels. Such perfection, however, is never attained. The condition of the seed plays a very important part in the separation. A "green" nut, i.e., one freshly picked, is generally found with the kernel fast adhering to the outer covering. As the seed or nut dries, the kernel shrinks inside the shell and the seed or nut falls out when the covering is broken. This being so, it is obvious that the condition must play an important part in the complete separation.

Rolling and Grinding

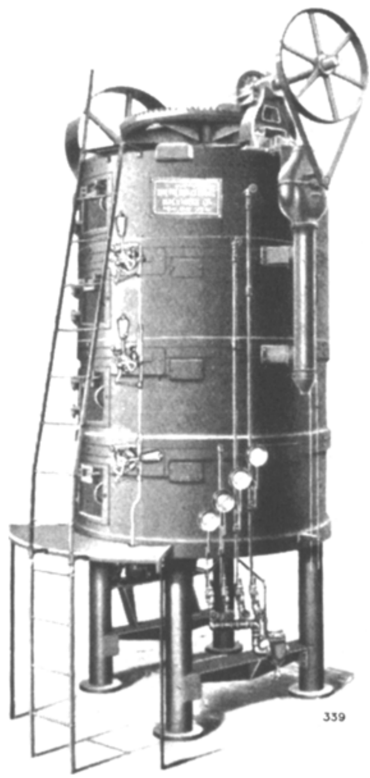
The next operation is that of rolling and grinding. Rolling of oilseeds is not undertaken solely with the object of bringing the material into as fine a division as possible, but with the object of freeing the oil from the tissue or sac in which it is contained. Therefore, it follows that not only must a grinding action take place but a tearing action must accompany it. In the old fashioned edge stones the action is one of perfection. The action of a parallel edge stone running round a fixed centre is, theoretically, impossible. Consider for one moment the inner and the outer faces of a parallel edge stone that is revolving round a fixed centre point and we find that the inner face is rolling round the circumference of a circle smaller than the outer face, the difference in the radii of the circles being equal to the width across the face of the stone. Therefore, since all parts of a rotating body equidistant from its centre of rotation must have a uniform velocity, and since these have not, they must fall to pieces.

Edge Stone Action

Actually, in practical work we find that there is a certain amount of slip on the inner faces (shown by the tendency for all parallel stones to wear conical) that is very valuable, as it exercises the necessary tearing action on the material underneath it. The use of edge stones for the preliminary crushing of the seed has largely fallen into disuse, owing to their comparatively small output, and their place has been taken by rolls. The rolls are generally mounted five high, one above the other, the seed being fed from alternate sides as it falls from between any pair. To obtain the necessary tearing action the rolls are run at different speeds so that in any pair through which the seed is passing the one is pulling it through faster than the other. The effect is improved by cutting flutes or spiral rifles on the circumference of the rolls, these flutes being of different pitch on adjacent rolls. Where large nuts are to be treated, it is usual to pass them through serrated, or hedgehog rollers to reduce the size of the pieces previous to rolling. The mechanism of the rolls is simple, the more interesting features being those which give a constant feed to the machine and the arrangements for maintaining the right pressure. The troubles which arise are due to uneven wear on the rolls due to the central portion doing more work than the extreme ends of the rolls and the pounding on the bearings due to the uneven opening and closing of the rolls according to the variations in the coarseness of the feed. Plain bearings are usually found on these machines, and it is doubtful whether there is any advantage in the roller bearing, due to the difficulty of maintaining the housings and rollers free from aggregation of dust.

Having obtained the requisite rolling, the seed is tempered in kettles to give the maximum yield of oil and to convert some of the starch into a colloidal condition to obtain a firmer cake. The kettle is a jacketed vessel fitted with agitators and possessing some method for damping the seed. This damping is usually done by injecting low pressure steam into the kettle while agitating. The kettles are of cast iron or mild steel plate, there being very little to choose from between the types. The kettling of the seed is purely mechanical and the plant calls for little comment. In those cases where the seed is to be crushed by hydraulic pressure, it is practically always tempered, but there is a growing tendency among the users of the worm expeller not to temper the meals. Those seeds containing gluco-cyanides should always be tempered, as heat releases the hydrocyanic acid radicle.

Where the meal is to be treated in hydraulic presses, it is next passed into a moulding machine where a known and constant volume of meal is pressed sufficiently to give the right size and shape cake to allow rapid and even filling of the hydraulic press. The moulding machine is essentially a ram or pis-



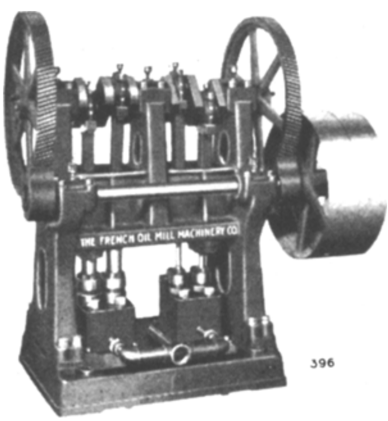
*Steam cooking kettle**

ton worked by hydraulic or steam power acting on a table free to rise and fall, a headplate being fitted to take the pressure. The rapid return of the table is arranged for, either by making the table sufficiently massive or by allowing the pressure to pass to the top of the piston at the end of the compression stroke. In the "Marseilles" system the moulding presses are

**Illustrations, courtesy French Oil Mill Machinery Co.*

often made large enough to take a whole batch of meal for one pressing and to mould many cakes at one operation. I do not think this method as good as the single cake moulding, for it is easy to get parallel faces on the moulded cake in the case of the single press but extremely difficult to get parallel faces where a large number are moulded together, due to the "give" of the material. Cakes which taper in thickness cause endless trouble in pressing and often do damage to the press, owing to the setting up of uneven strains.

The hydraulic press is an adaptation of the "Bramah" press. A small plunger, pumping a certain amount of a non-compressible fluid into a receptacle containing another plunger, will pass on its energy to the second plunger and, subject to certain losses, the energy in foot pounds will be the same at the sec-



Power hydraulic pump

ond ram as the first. As the rise in the second ram will be inversely as the square of the diameters, the total pressure under it will be directly proportional to the squares of the diameters of the two rams. Thus by making our ram diameter many times the size of the pump diameter we are able to obtain large pressures at the presses. Pumps capable of exerting pressures up to 7,000 lbs. per square inch are in use for seed crushing. This pressure is not as a rule used for the initial filling of the press nor for "taking up the slack," much lower pressures being used at first, and in some cases an intermediate pressure is used for the greater part of the time, the higher pressure being used only at the end of the time.

The pressure may be applied directly from the pump to the press. In this case there is a slight pulsation in the rise of the press due to the oscillating motion of the pump. In the other case the pressure from the pump is used to lift a load in a hydraulic accumulator which smooths out the pulsations before the load is applied to the press. Which is the better method is doubtful in oil pressing. Each method has its adherents who strongly maintain the advantages of their own particular method. Those who favor the accumulator method state that in the other method the oil is alternately squeezed out and sucked in after a certain point has been reached in the expression, and the other side states that the pulsation does give a larger yield of oil. The analysis of the cake and parings, however, does not show any marked difference, and so the matter can well be left to individual choice. In the case of long and continuous pressing at full load, such as we have in high titre stearine and wax pressing, I believe the accumulator has distinct advantages. The pumps and presses, provided no undue strains and stresses are set up, give very little trouble other than in the matter of the packing of the rams and plungers. Specially prepared leather packings are used to make a tight joint between the plunger and the pump barrel and between the ram and the cylinder. The life of a leather is an unknown quantity, but it is generally reasonably long when there is no scoring of the plunger or ram respectively. In the case of the cylinder and the ram the leather is inserted in a slot in the cylinder. Owing to the difficulty of fitting the leather, the slot is made deeper than the leather, the slack being made good with wooden packings. Water is seldom used in the system owing to its scoring action, but in its place a good, non-congealing oil of low viscosity is used.

Hydraulic accumulators

The expeller, which has more recently been adopted for removing the oil, is a powerful adaptation of the old "sausage mill." A worm conveyor—working in a perforated cage—carries the meal against a cone obstruction. The cone is so set that the space surrounding it and the cage is insufficient to pass the meal as fast as the worm can bring it along. By this means pressure is generated and continues to mount up until a state of equilibrium is reached. At this point the meal at the given pressure can pass through the orifice. By inserting or withdrawing the cone varying pressures may be obtained. Above a certain pressure the oil will be forced out of the meal and will find its way out through the minute perforations of the cage. This oil is collected and drained away to the crude oil tanks. The expellers are belt driven and once they are set for any particular meal should be continuous in their working. They suffer from the usual defects, inherent in all machines where pressures are derived from worms, namely high friction followed by wear and heat generation.

That part of the seed which is to receive treatment by extraction is loaded direct from the rolls into enclosed tanks for treatment by the solvent. In all the plant that we have considered up to this point the action of the apparatus has been mechanical, but extraction involves another factor in that we have to add something to the meal to do the work—the plant being simply an accessory. The process depends on the oil being soluble in certain reagents which have no effect on the solid portion of the meal. The types of this plant are legion, but, in principle, they are the same. The principle is a very old one, and in the salt industry was in use for generations. In that industry water was pumped into saline earths and was recovered as brine solutions. These solutions were evaporated and the salt was left in the evaporator. The analogy is not quite perfect because the reagents used in oil extraction are valuable and have to be recovered for further use, whereas the water used to dissolve out the salt was permitted to go to waste.

Units of Plant

The plant consists of a vessel in which the solvent can be brought into intimate contact with the oily material, a still in which the solvent can be boiled off, a condenser where the vapors can be condensed, a separator in which entrained water can be removed, and a store tank for the solvent. There are other refinements which have to be incorporated to prevent the loss of solvent and one of these is the washing or absorption chamber where the solvent can be recovered from the air driven out of the various vessels. This air is naturally saturated with the solvent vapors, the quantity varying with the outlet temperature of the air. The solvents most commonly employed in this country are petroleum spirit, the fractions of which boil between 90° C and 110° C (sold as extractor spirit), and tri-chlorethylene—a non-inflammable solvent boiling at 88° C. The extractor is a closed vessel of cylindrical shape with dish ends and may be mounted either horizontally or vertically. It is provided with agitating gear and contains some form of straining arrangement which will retain the solid material while allowing the oily solvent to pass through quite freely. Some method of introducing live steam into the vessel is also incorporated. The extractors are usually of mild steel boiler plate and there is nothing peculiar in their construction. Great care is necessary in the selection of the right kind of jointing and the right type of cocks and fittings, as the solvent is capable of dissolving quite a large proportion of the fillers used in making packings and penetrates the most minute orifices. Since many of the joints are subjected to the action of solvent, solvent vapor, oils, water and steam, we have added reason for the careful selection of the jointing.

The still may be either tubular or coil heated and may work under vacuum or not. It is a tall cylindrical vessel and may be either of cast iron or of mild steel. When it is heated by tubes these are of steel in steel plates. The plant is dependent on the still for its efficient operation, as it is here that the greater part of the solvent is distilled off and unless the still is kept efficient a fall off of efficiency may be expected all round. The chief enemy of the still is the fine solid matter that pulls through with the oily solvent. This soon coats the tubes and the coils, making it very essential that these should be periodically cleaned. The condenser is the most important item in the whole assembly. It is generally of the tubular type of surface condenser and in the better quality extraction plants is fitted with brass tubes and brass end plates, the outer casing being of cast iron. From the point of view of solvent loss, the success or failure of a solvent plant is bound up with the vapor velocity and with the cooling surface of the condenser. Provided the plant is free from leaks, a low vapor velocity combined with a generous cooling surface supplied with ample cold water will keep the losses of solvent within reasonable limits. The mixture of oil and solvent in the still does not readily part with the last trace of solvent, and it is usual to distill this off with the aid of saturated steam. In small installations this steam is generally admitted to the oil in the still, but as this means that from a solvent recovery point of view the still is practically inoperative, it is not adopted on large installations. As soon as the solvent recovered from the batch of oil in the still falls below a reasonable percentage of the normal, the contents are blown across to an independent tank where the oil is freed from the last traces of solvent, the still, meanwhile, being freed for its more important duty of recovering solvent.

It is not usual, in England, to grind those cakes which can be fed to cattle, it being left to the farmer to break them as they are fed to the cattle. In the case of those cakes which are to be used as fertilizer, they are ground. The commonest form of grinder for this work is the disintegrator consisting, in its elements, of a series of fixed or hinged bars revolving at high velocity within a grid cage. The cake is fed into a hopper and passes into the body of the machine where it is beaten fast and furiously by the beaters until it is fine enough to pass through the bottom grid. The chief mechanical trouble is due to the wear of the the grids and care should be taken to see that in the type of disintegrator installed these are easily renewable. Those consisting of triangular sections run in with white metal and capable of being removed in short lengths are largely favored. The material being fed to these machines should be carefully looked over, as they are rather prone to strike sparks and sparks in the presence of fine combustible dust make as happy a combination as a flame in a powder magazine. Some meal is ground to be used in the manufacture of nuts and cubes for cattle feeding. The nuts are made by feeding the meal—either in a cooked condition or with some external binding medium such as molasses—through a pair of rolls each having half a die of the required shape cut into its circumference at numerous points. The cubes are made by the pressure exerted by a worm forcing the meal through a die, which in the presence of a binding medium causes the meal to extrude as a bar having the same cross section as the die. A revolving knife running against the face of the dieplate cuts the bar into the required length.

In the roll type of nutter there is little to give trouble provided that the two rolls are in alignment, but troubles due to wear and heat have to be guarded against in the worm type. The heat can be dissipated by jacketing the worm barrel so as to allow a current of cold water to surround it. The wear of the parts incidental to this type of machine calls for constant adjustment and finally for replacement of the worn parts.

(To be continued)

To Reopen Linseed Oil Plant

Articles of incorporation have been filed with the secretary of New York state for the resumption of business at the linseed oil plant of Kelloggs and Miller in Amsterdam, N. Y. The plant was closed some time ago because of the death of George Kellogg. The articles of incorporation were executed by Lauren Kellogg, the surviving member of the old firm, J. Arthur Brannock, C. Lauren Archer, W. Fenton Myers, and Edgar C. Bisbee, all of Philadelphia. The original business was established in 1824 by the grandfather of Lauren Kellogg, at Amsterdam, N. Y., and the mill was operated continuously from that time until the date of the shutdown.

Referee Applicants

The following applications for Referee Chemist certification have been filed with J. C. P. Helm, secretary-treasurer of the American Oil Chemists' Society: H. M. Shilstone (second publication).

The American tung oil industry in Florida is maintaining a steady rate of growth.