

was carried by 25 votes to 7. The original resolution was therefore not put.

Mr. EASTRICK adds in a subsequent communication that the main object of moving his resolution has been secured. The cane and beet sugar sections have joined hands in public, and as these representatives are the leaders they have practically solved the most difficult problem to be faced—that is, to secure combined action and a uniform platform.

Manchester Section.

Meeting held at the Grand Hotel, on Friday, March 5th, 1915.

MR. JULIUS HÜBNER IN THE CHAIR.

CHEMICAL EXAMINATION OF GHEE.

BY KAPIBRAM H. VAKIL.

Indian ghee is a form of clarified butter obtained from cow's milk or from buffalo's milk. Ghee from the latter source is generally and extensively used in India, but it has only been examined twice. Lewkowitsch, in his chapter on butter fat, has given two observations on buffalo fat by Pizzi and Petkow. Similar work has been done by F. Strohmer and W. Fleischmann, but these observations refer mainly to Egyptian and Bulgarian buffalos. In 1910 Bolton and Revis contributed a paper to the Analyst (Vol. 35, pp. 343—345; see this J., 1910, 1070); three samples were examined, but it is not stated whether they were made from cow's or buffalo's milk. A. Kesava Menon (this J., 1910, 1428) gives the results of analyses of cow and buffalo ghee, but it seems that only one sample of each was examined.

A summary of the results of these authors is appended:—

Author.	Sample.	Butyro- refracto- meter 40° C.	Saponif. value.	Reichert- Meissl value.	Acid value.
Bolton and Revis ..	1	41.4	228.8	30.58	—
	2	41.4	228.7	30.42	—
	3	41.5	229.1	31.50	—
Menon ...	Cow	40.6	218.25	25.70	1.49
	Buffalo	44.5	206.8	18.24	2.00

The author has examined a number of samples obtained from different ghee-producing districts. The following table represents the analytical results of ten typical samples:—

	Butyro- refracto- meter at 40° C.	Saponifi- cation value.	Reichert- Meissl value.	Acid value.
(1) Bombay A.	44.0	232.2	23.08	1.67
(2) " B.	44.2	229.8	23.43	2.24
(3) " C.	—	226.1	21.87	1.68
(4) " D.	44.3	231.0	23.10	1.67
(5) Porbunder A. ..	45.0	230.0	23.76	1.68
(6) " B.	44.8	218.0	20.46	2.37
(7) Surat A.	43.5	227.2	25.30	1.71
(8) " B.	44.0	231.0	24.53	1.49
(9) Bulsar A.	45.0	224.0	22.11	3.63
(10) " B.	—	220.0	21.78	2.89
Average	44.35	226.9	23.05	2.14

Sample (4) was specially prepared for analysis. The acid values are not oleic acid values.

From these figures it will be seen that the principal difference is in the Reichert-Meissl values, the highest recorded being that of Bolton and Revis, viz., 30.80, and the lowest, 18.24, by Menon. This abnormally low figure was explained in the discussion of Menon's paper, by Bolton, who suggested that the sample was heated until quite free from water and might have been over-cooked, whereas the manufacturer, whose object was to obtain the minimum loss, would heat it just sufficiently to drive out the water and thus often under-cooked it.

There is no doubt that the samples from the manufacturers are under-cooked, but it was surprising that it should make such a difference in the Reichert-Meissl values. The results obtained by the author are within fairly narrow limits, the highest being 25.51 and the lowest 20.46. This may indicate that the commercial samples are uniformly cooked.

Menon's paper also shows an abnormally low figure for saponification value, viz., 206.8.

The acid values, obtained by the author, if converted into oleic acid values, will be found to be very low. This is quite natural, as the samples examined were all fresh. The high values obtained by the previous authors are due to their samples being old.

Nottingham Section.

Meeting held at University College, Nottingham, on Wednesday, February 24th, 1915.

MR. JOHN WHITE IN THE CHAIR.

GRINDING AND CRUSHING MACHINERY.

BY M. A. CROSBIE.

Presumably the first method used to powder material was to lay it upon one piece of rock and hit it with another, possibly choosing a hollowed out stone for the bottom, to prevent losing the material. This method remains to-day in the pestle and mortar of the pharmacist.

Another method adopted by prehistoric man, and still in daily use, is that of rubbing the material between two flat stones. This remains in its original form in the more primitive parts of the world as the quern, where two flat discs of stone are used, the upper of which (having a central hole through which corn is fed) is twisted with a semi-rotary motion with a stick handle. It is in every-day use in India and Africa, where one native squats working the stones, while another drops in the corn grain by grain, and it is this type referred to in the Biblical phrase, "two women grinding at a mill." Its more modern equivalent is the horizontal mill, and this was until recently the only mill used for preparing flour.

Another method consists of crushing the material by rolling a cylindrical stone over it, as exemplified by the edge runner, where the stones roll over a flat bed, and the rolls, where two rollers run together crushing the material between them.

Of course metal has often been substituted for stone, but these three methods remained the only means at our disposal, until the introduction some forty years ago of the "percussive" grinder or "disintegrator." Here the material to be powdered comes in contact with rapidly revolving arms or beaters, and is ground by reason of its

inertia. The underlying principle of all these methods consists of stressing the material by applying either a compressive or a shearing strain, or a combination of the two.

Proceeding now to describe each method more fully, noting the different varieties of each type, there is first the *pestle and mortar*, the hand variety of which is familiar to all, whilst for little jobs just too big for hand the mechanical mortar is employed, where the pestle is rotated by machine, being loaded with weights to suit the material, and sometimes given a spiral path in the mortar. Or the pestle may have a rotary path and the mortar a reciprocating motion.

The stamp mill is another variety of this type; here the pestle is lifted by machinery and dropped by gravity, by means of a revolving arm engaging with a flange on the stamp rod, this arm giving a twist to the stamp rod as well as lifting it.

The *stonebreaker* really belongs to this class. Here a crank or eccentric rocks a chilled iron or manganese steel plate, crushing the material between it and a stationary plate, which latter can be adjusted to give any desired opening at the bottom through which the crushed material drops.

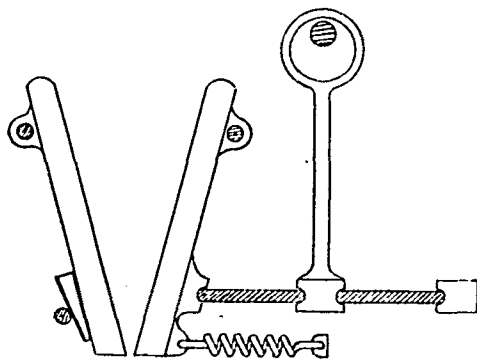


FIG. 1.
Stonebreaker.

Fig. 1 shows a simple type which, however, suffers from the defect that some materials tend to slip up again rather than receive the full nip, but this defect can be overcome by compounding the motion or altering the fulcrum position.

Gyratory crusher. Another type of rock breaker, more rapid than the "stonebreaker," but yielding a less regular product, is the gyratory crusher, again an adaptation of the pestle and mortar, where the pestle has a motion akin to that of an expiring pegtop, inside a fluted mortar open at the bottom to allow the exit of the crushed material.

The second method, that of grinding between two flat surfaces, exists as the quern, already mentioned, and the *horizontal or flat stone mill*, which consists of two stone discs, one of which (usually the upper) revolves, while the stock to be ground is fed through a central hole in the upper stone. These stones vary from soft Derbyshire grit stone to the hardest French or German buhr (a quartz). These latter are built up of wedge-shaped pieces cemented together, with iron binding hoops shrunk on, and a backing of cement and small stones to give extra weight. These stones are dressed by cutting groves or "furrows," the shape of which varies considerably with different classes of work. Specimens of dress are shown in Fig. 2, and a sectional elevation of a mill in Fig. 3. Both top and bottom stones are dressed alike while lying side by side, so that when the top stone is inverted and in position the furrows lay across one another, and when running give a scissor-like

action to the "land" or grinding surfaces between these furrows. The furrows have a steep back, but run off to a feather edge in the direction of

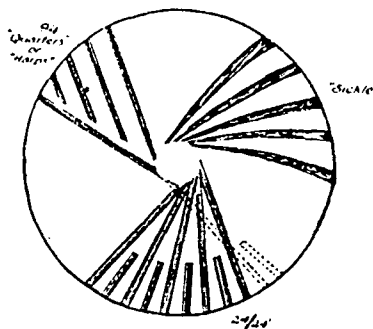


FIG. 2.
Specimens of Horizontal Millstone Dress.

travel, up which the stock rolls; it is then swept forwards by the running stone, gets nipped between top and bottom land, falls into the next furrow, and so on, all the time working outwards by centrifugal action, pursuing a spiral course until it reaches the edge, where it is swept round to an opening, and so leaves the mill. The safety of a

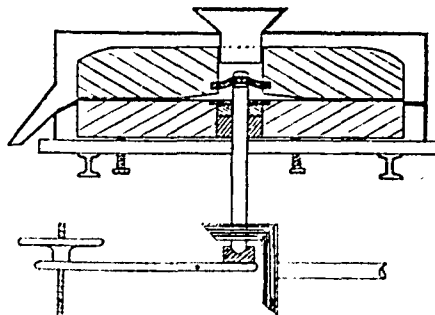


FIG. 3.
Horizontal Mill.

built-up stone depends entirely upon the shrunk-on rings, and if these, by attrition or rusting, become weak, they must be replaced, and also care must be exercised to prevent these mills racing, about 120 revs. per minute being the normal speed of 4 ft. or 4 ft. 6 in. diameter stones. Care must also be exercised to prevent these mills running empty, for besides damaging the faces, wearing away the dress, they might set fire to the material lying round the outside, which is a grave risk in a flour or rice mill, as here the spouts from the mills are connected to a stove room filled with cereal dust and air, a highly explosive mixture. A flame started by sparks from a mill running empty travelling up the spout and firing such a mixture, has wrecked many a mill.

Variations of this mill are legion. The grinding surfaces are sometimes made of an emery or other hard composition. Fluted chilled iron plates are often used, and are sometimes made conical instead of flat, fitting one within the other. The domestic pepper mill is a minute specimen of this type. Such composition or iron mills are more often turned on their side, so that an outside bearing can be easily fitted. A diminutive specimen of this type is the coffee mill used in provision shops. These lead up to another variety of iron

mills, having annular teeth instead of tangential grooves, but these are best considered when dealing with disintegrators.

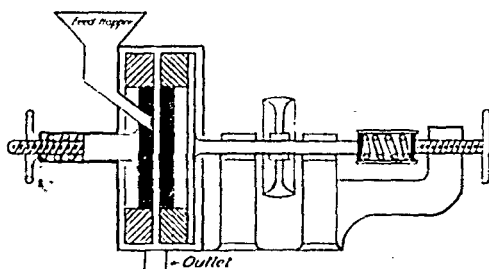


FIG. 4.
Combined "Stone" and Iron Vertical Mill.

"Edge runners" or "chasers." Here two stone discs roll round on a flat bed as shown in Figure 5. The stones used in this country are usually grey Aberdeen granite, varying from a few cwt. up to three tons or more apiece, very occasionally even six tons each. It will be noticed that while both the outer and inner edges of the runner must of necessity travel at the same rate, yet for each

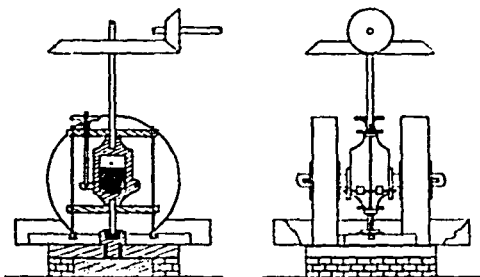


FIG. 5.
Edge Runner—Side and Cross Sectional Elevations.

revolution round the bed they have covered different length paths on the bedstone, so that runners and bed are not in simple rolling contact, a twisting motion being set up, and the nearer the stones are to the centre the greater is the difference

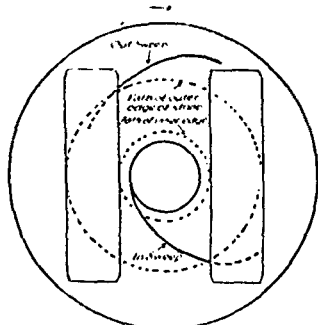


FIG. 6
Plan of Edge Runner—Showing Insweep and Outsweep position and path of stones.

between the two paths; consequently the twisting action is increased, and with it the efficiency of the mill. For rough work, such as mortar mixing, iron is substituted for granite, and it is then the pan which revolves, and the mill is usually under-driven.

Two scrapers or "sweeps" are fitted, one to carry the material under the stones and the other (which can be raised or lowered at will) to throw the material out when sufficiently ground. Provision is often made for lifting the cross shaft and so relieving part of the weight of the stones off a material which would otherwise clog, whilst occasionally the stones are tapered, making the circumference of the stone equal or proportional to its path, thus eliminating the twist and leaving only the rolling motion; this is, however, unusual and only used for special work. These mills are used for a variety of articles, *e.g.*, drugs, chemicals, minerals; even such substances as lead or aluminium can be ground to a fine powder in a mill with 5 ft. 6 in. or 6 ft. diameter stones weighing about two and a half tons apiece. They are also used in many trades for crushing and kneading, such as cider apple pulping, clay kneading for pottery and brick making, mortar mixing, etc. For paint and ointment mixing these mills are apt.

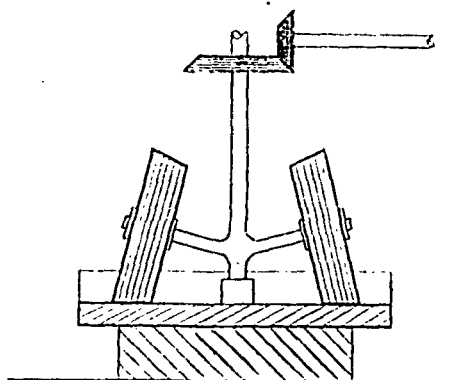


FIG. 7.
Special Edge Runner giving Rolling Contact only.

to skid, pushing the material in front of the stones instead of rolling over it, so a bevel wheel is sometimes made fast to the toe-pot or vertical shaft bearing housing, meshing with bevel wheels fastened to the sides of the runners, so that the stones cannot rotate without revolving. The author has seen one of these mills used for grinding and levigating earth colours, such as rouge, where an impalpable powder was required. The mill was entirely submerged in a tank of water, a steady stream of which, admitted at the bottom, caused a continual overflow carrying away to a settling tank those particles light enough to float. Fire risk with these mills is practically non-existent. The stones are usually secured on the cross shaft by cotters strong enough to withstand the end thrust at their normal speed of 14 to 19 r.p.m., but it is as well to make sure that they will stand the increased strain due to accidental racing.

"Rolls" are used where one "bite" is sufficient, as in linseed crushing, where prolonged pressure would start the oil, making a greasy mass. They consist of two chilled iron or porcelain rollers, sometimes of equal size, sometimes one large and one small, either plain or, if there is any difficulty in getting a grip on the material, fluted or spiked; whilst for crushing material such as sugar cane they often resemble spur gears, but are very wide compared with their diameter. Sometimes the rollers are compounded, being four or five high, the material passing between the first and second rolls, back again between second and third, again between third and fourth, and so on; this method is adopted for paint rolling and also for seed crushing before pressing for oil. Another method of adding to the efficiency of rolls is to supplement their

purely crushing action by reciprocating one or both of the rollers laterally, or by passing the material between a single roll and a shaped block, which is

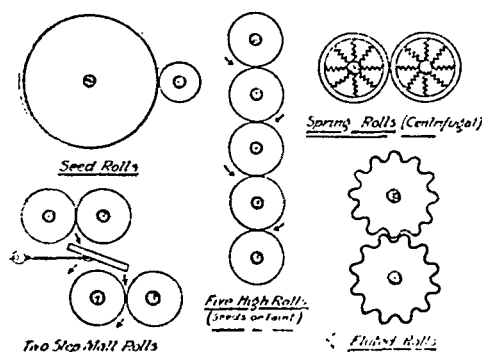


FIG. 8.
Rolls of various types.

continually moved backwards and forwards across the face of the roll. This gives the required combination of compression and shear necessary for fine grinding.

Occasionally it happens that to crush a seed so that every particle is fine enough for use entails the softer part being too finely crushed; this occurs with malt for brewing, and in this case the grain is given a preliminary nip through one pair of rolls, falling on to a sieve which separates the fine, while the coarse passes over the end of the sieve and through another pair of rolls, giving a much harder nip, crushing the rest sufficiently. With rollers running at equal speeds the material is only subjected to a squeeze or nip which tends to flatten out a soft material rather than reduce its size, so differential rolls are used, where one roller revolves faster than the other, imparting a rubbing as well as a flattening action. Again, these rollers may be either plain or grooved, and it is these fluted differential rolls that have of recent years displaced the horizontal for flour grinding. The horizontal mill grinds all the constituents of the wheat berry together, but the consensus of opinion is that the husks and germ are best removed, so that after cleaning (a process involving sifting and winnowing to remove stray seeds, stones, chaff, etc., knocking about to break up lumps of dirt, soaking in water to wash and

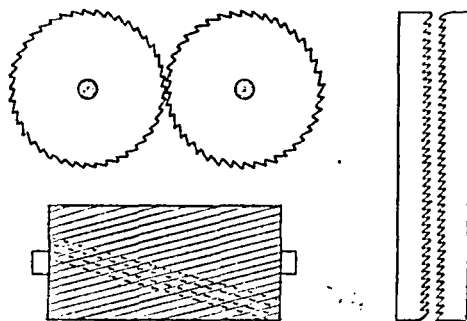


FIG. 9.
Fluted Differential Rolls.

toughen the husk, brushing with rotary brushes to help remove the dirt, drying, and passing over a magnet to remove any stray iron), the wheat is subjected to treatment designed to liberate the

flour from the husk and germ, at the same time keeping the cells unbroken as far as possible. This is achieved by the use of fluted differential rolls of the type shown in Fig. 9, where the size of fluting is exaggerated for the sake of clearness. These grooves are cut at an angle of about 15° , as shown, and give a scissor-like cut, and are so shaped as to leave a series of teeth (from 8 to 40 per inch, according to conditions) on the face of the rolls, with one straight and one sloping edge like saw teeth. Both rolls of a pair are cut to the same hand, so that when in position the teeth are face to face, both rollers running inwards and so in opposite directions. Now if the roll with teeth facing forwards is the fast roll, it overtakes the sharp faces of the teeth on the slow roll, and the teeth pass face to face, setting up a sharp cutting action accentuated by the guillotine or scissor action, due to the grooves being cut spirally and lying at an angle of 30° to each other. If it is the roll with the teeth set backwards that is the fast one, it overtakes the teeth on the slow roll from their back, and the teeth thus pass back to bark, setting up a rubbing or squeezing action.

This can be clearly seen in the figure, where two saw blades have been substituted for the rollers. Both these actions are made use of, the latter method being adopted in the first "break," where the wheat is subjected to a light nip, sufficient only to burst it open, and liberate the "crease dirt" being, as its name implies, dirt contained in the fold or crease in the skin which cannot be removed by any preliminary cleaning. To prevent the large grains being unduly broken, or the small grains not being sufficiently crushed, this first break or reduction is performed in two machines, the wheat being graded and the larger grains passing through one pair of rolls set wider apart than the pair through which the smaller grains are passed. Grooved differential rolls must never touch or the teeth would be spoilt; they are carefully set to the requirements of the stock passing through. In the first break the teeth are parallel to the axes of the rolls, so that there is no scissor action. The stock from these two pairs of rolls is passed to a "scalper" or sieve to remove this crease dirt, and the coarse crushed wheat is passed on to the second break, where the first-mentioned method is used, which lightly detaches flour and germ from the husk. From here it goes to another scalper and the coarse particles pass on to the third break where the process is repeated, and so on through a fourth (and perhaps a fifth) break, by which time the husk has been entirely separated from the flour and germ. This process is sometimes completed in four breaks, and sometimes extended to six. The method adopted to separate the germ clearly shows the difference between differential and equal speeded rolls. The "chop" or fine crushed stock sifted out after the second and subsequent breaks is sifted collectively or separately, according to requirements, into "semolina" and "middlings," and the various products are separately run through equal speeded smooth rolls, which, while reducing the starchy matter to a uniform product, flattens out and increases the size of the soft, oily germ, which is then sifted out and the flour finished off by a final grinding between smooth faced differential rolls.

The sifting or "purifying" is a complicated process involving both sifting and aspirating, but no grinding principles.

Centrifugal rolls. Here the rolls consist of metal sleeves, or tyres, held in position on their shafts by radial springs, instead of being solid. A large lump passing through attempts to displace the shell, and should the combined effect of spring and centrifugal force be sufficient the lump is crushed (a stray hammer head which would wreck a jaw crusher would

pass through without damage). Obviously the faster these rolls are run (within safe limits) the more powerful they become, yet there is no need for them to be run faster than is required just to crush the material, hence the speed should be adjusted to suit each job to obtain their highest efficiency.

The next type of roll to consider is entirely different in construction but may also be called the centrifugal roll. Here a pair, or sometimes four, rollers working in slotted arms fastened to

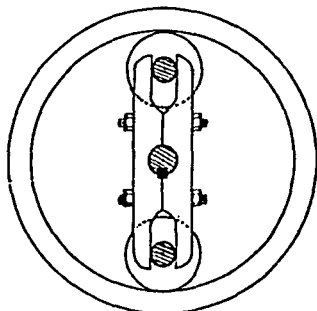


FIG. 10.
Centrifugal Rolls.

a shaft, are rotated inside a stationary ring against which they roll, being held out by centrifugal action. Steel rollers are used weighing about 60 lb. apiece, travelling at about 300 r.p.m. inside a steel ring 2 ft. internal diameter. One variety has a vertical spindle, being fed from above while the powder leaves at the bottom, while another has a horizontal shaft as shown in Fig. 10, and in this case the powder is exhausted from the mill by a fan the speed of which is varied according to the material and fineness of powder required, while steel balls are used in some types instead of

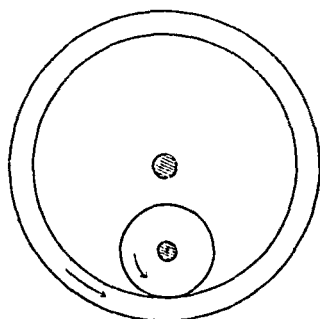


FIG. 11.
Self-Contained Rolls.

rollers. A connecting link between this type and those already considered is to be found in a mill consisting of a small solid roll revolving inside a larger hollow roll which also revolves (see Fig. 11). This type has recently been revived and patented, with the important improvement of having the axes of the rolls set "on the cross."

This mill also forms a connecting link with another type of mill, namely the *ball mill* (see Fig. 12), where a cylindrical iron drum containing a number of loose rollers, balls, or sea-shore pebbles, revolves on trunnion bearings, the grinding being done between the surfaces of the rollers or balls as they move one on the other, or on the inner surface of the container as this latter is revolved. The type generally adopted consists

of an outer shell of boiler plate fitted with a renewable porcelain or quartz lining (to prevent iron taint) and about half filled with pebbles and the

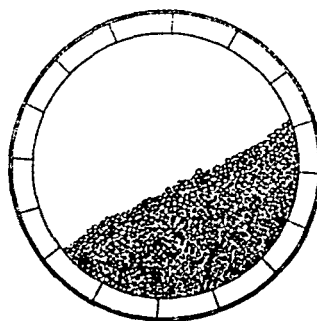


FIG. 12.
Ball Mill.

interstice filled with crushed material; a dust-tight manhole cover is fitted and the drum set revolving for anything from a day to a week, when the stones rolling over and over on the stock grind it to powder. At first sight this does not seem a very business-like method, but in practice it works extremely well; it is dustless and requires little attention, and many materials can be ground sufficiently fine to dispense with sifting, except through a coarse grid to separate the powder from the stones. Such mills are in great favour with chemical manufacturers on the Continent, whilst for grinding the ingredients for high-class porcelain they are invaluable, being equally suitable for both wet and dry grinding and, being porcelain-lined and using porcelain balls, no possible taint can accrue. Another variation of this principle is the *tube mill* (Fig. 13), which is

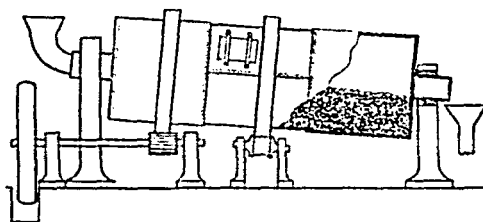


FIG. 13.
Tube Mill—partly in section.

simply a ball mill of extreme width or length, slightly inclined and fitted with hollow trunnions through the higher of which the material is fed, and by the time the stock has worked its way to the lower end and out through the trunnion it is sufficiently ground, the rate of feed determining the fineness of the product. Such mills from 20 to 30 ft. long and from 5 to 6 ft. in diameter, containing four to five tons of pebbles, have superseded all others for cement grinding, the banks of the Thames round Northfleet being littered with old horizontal stones thrown out within the last few years to make room for tube mills. The pebbles used must be hard without being too brittle, and Belgian sea-shore pebbles are the most suitable, even being exported to America. They do not wear appreciably unless they break, when they are quickly reduced to powder which is of no consequence in cement; in fact as pebbles are considerably cheaper than cement replacements cost nothing (this, by the way, also occurs with barley ground for cattle feed in very soft-stoned horizontal mills).

Another type of ball mill, the *continuous feed and discharge ball mill*, is very similar to that first considered, except that the grinding drum is unlined and perforated and enclosed within another drum which acts as a sieve, the material being fed through a hollow trunnion; in this type the inner surface of the drum is not cylindrical but built up in a series of steps as shown in Fig. 14. The

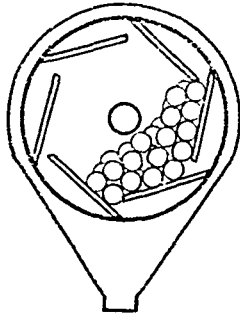


FIG. 14.
Continuous Feed Ball Mill.

action is akin to rolling the material and a number of steel balls down an interminable staircase, each tread of which is perforated, letting the fine particles through on to a sieve underneath, the finest passing through and away, whilst the larger particles are returned to the bulk a few steps lower down. The construction makes the use of steel imperative, but the actual wear is so slight as to render the iron taint negligible.

There are one or two types which form connecting links between the disintegrator and the horizontal mill. In *bar or cage disintegrators* both discs revolve, but in opposite directions, thus doubling the effective velocity without increasing the speed. The discs have a number of bars projecting from their faces, forming a number of concentric rings alternately attached to one disc or the other, as shown in Fig. 15. The material

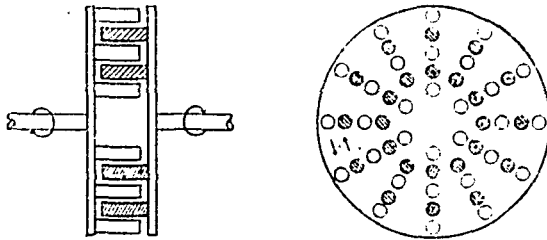


FIG. 15.
Bar or "Cage" Mill.

is fed into the centre through a hole in one of the discs, and in passing outwards is struck by the bars and knocked first in one direction and then the other, being struck by perhaps eight sets of bars before it leaves the mill. The action can best be likened to a series of squirrel cages one within the other and rotating in alternate directions; hence the name, cage mills. A mill has been designed for rock crushing in which the material was to be its own grinding medium; it consisted of two funnel-shaped discs running mouth to mouth in opposite directions, the idea being that the material (broken down in a stone-breaker) on being fed into the mill would fill up these funnels which would then act as millstones (see fig. 16).

Eccentric disc mills. Here one disc is smaller than the other, and has a central hole through

which the feed reaches the mill. This disc is driven, carrying round with it the lower disc, setting up a shearing action, while pressure can be regulated by raising or lowering the bottom

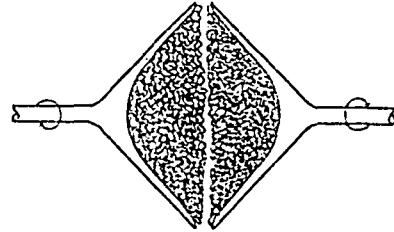


FIG. 16.
Auto-Grinder.

disc. Sometimes the top disc is convex, and the lower one concave. The *end runner mill*, which belongs to this class, is somewhat similar to, but much more efficient than the mechanical mortar (see fig. 17).

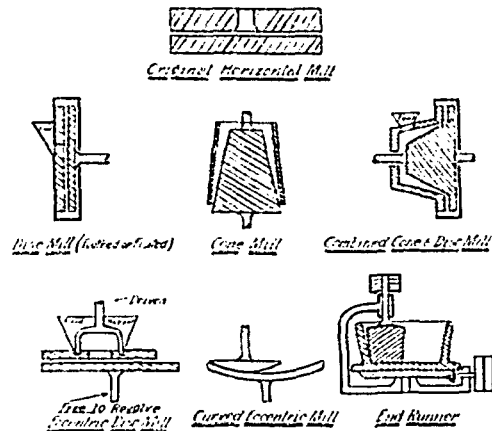


FIG. 17.

The now obsolete "*pulveriser*" had two shafts in line revolving in opposite directions, on the inner extremities of which were fitted bosses carrying arms, at the ends of which were hand plates set at an angle as shown in fig. 18,

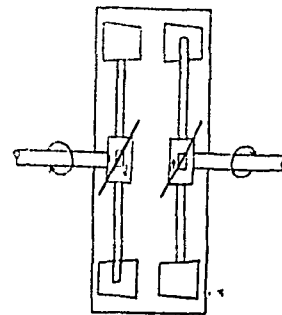


FIG. 18.
"Hand Plate" Pulverizer.

so that a particle struck by one hand would be deflected into the path of a hand travelling in the opposite direction and smashed, these smaller pieces being in turn flung back at the other set of plates and further reduced, and so on until the

particles were small enough to be carried out of the mill in a current of air. First of all the hand plates were abandoned as useless, and later one set of arms was omitted as unnecessary, it being found that the arms themselves did the grinding. This simplified construction constitutes the present day *disintegrator* as shown in fig. 19. The boss is

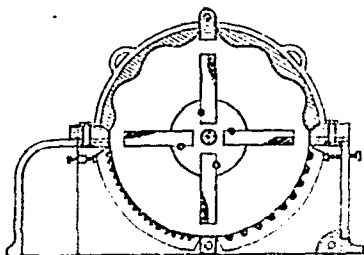


FIG. 19.
Disintegrator.

supported by a bearing on each side instead of being overhung, as was necessary where two sets of beaters were employed, and these beaters are made of Lowmoor iron with a facing of hard steel welded on to resist wear, and fit into mortices in the boss, being secured by cotters. The fluted top is made of chilled iron and by its shape deflects the material back into the beater path, and the sides are made of the same material and also fluted for the same purpose. The powder escapes between the bars shown, which are of steel held in cast-iron frames, the gaps between the bars varying from 1 in. down to $\frac{1}{2}$ in. according to the fineness of powder required. The mill runs at a high speed, depending on its size, all sizes having the same peripheral speed, about 3 miles a minute, and at this speed acts as a powerful fan, thus preventing blow-back through the feed intake, and the air leaving the mill through the grids or screens carries the powder with it, thus rendering a settling chamber necessary.

These mills are highly efficient and will deal with most classes of material, but unless properly erected can constitute a grave fire risk, and should be well isolated from main buildings. As an instance the disastrous explosion and fire at Liverpool in 1911 started from the breaking of a driving belt of a disintegrator when grinding linseed cake. The belt in its recoil struck and burst the dust-settling chamber, liberating the air containing fine particles of linseed cake which became ignited, the explosion wrecking and firing the factory. At least two big fires have been caused by grinding resin in these mills.

Owing to the rigidity of all the parts, this type of mill suffers considerably in the event of stray metal of any size entering accidentally, and a mill designed to obviate this has the beaters hinged and constructed without grids; the beaters stand straight out by centrifugal action in the ordinary course of grinding, but hinge back when a large mass of metal is encountered. Such a mill is useful in crushing articles such as horse hoofs, where an occasional horse-shoe is encountered which would wreck an ordinary machine, or in grinding house refuse, as is done by some municipal bodies; this consists in the main of tea-leaves, fish skins, ashes, etc., but an occasional flat iron or dumb-bell has to be reckoned with. One section of the casing is hinged and held in place by an easily opened catch, and upon the attendant hearing the noise caused by such a stray article he at once opens the catch with a long pole, standing well aside and out of the way of the ejected material. I once saw a piece of metal, which had

originally been a bolt, leave such a mill almost white hot, and become imbedded in a wall fifteen feet away.

Multiplex disintegrators, of which there are many varieties, have several sets of beaters mounted upon one shaft, becoming progressively larger from feed end to delivery end, the idea being that the preliminary crushing is done by the small set of beaters, and the final fine grinding by the last set, whilst occasionally a wing fan is mounted on the shaft beyond the last set of beaters to draw the powder through (see fig. 20). As a class these

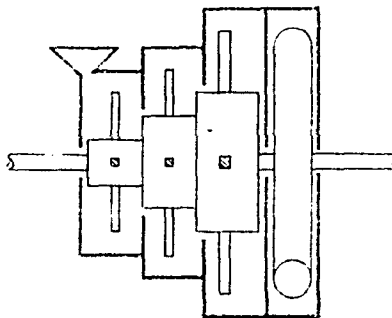


FIG. 20.
Multiplex Disintegrator.

mills are successfully used on soft materials such as sugar, although it is questionable if they are more efficient than the single type even on such articles, but they are out of the question for the general run of work, for if one set of beaters is running at the right speed the rest must of necessity be wrong, and as considerations of safety limit the speed it is the largest which is correctly speeded and consequently the others are all running too slowly and working inefficiently, and the material only partly crushed is speeded up by one set before passing to the next, thus reducing its effectual speed. Experience shows that the larger the piece which can be fed into the mill with safety the finer the resultant powder, which is only to be expected from a consideration of the underlying principle. For instance, large pieces of liquorice root fed into an ordinary disintegrator can be ground to a fine powder, whereas crushed root would only be reduced to fine splinters, while the large pieces if fed into a Multiplex would either wreck it or hopelessly clog it.

DISCUSSION.

The CHAIRMAN asked what was meant by two stones or rollers being cut to the same hand. How many grindings did it require to convert wheat into white flour? Was wheat ever ground so as to produce a particular offal (sharps)?

Mr. J. T. WOOD asked what mill was used in grinding aniline colours? Was a variety of mills used or only one?

Mr. CROSBIE: A variety.

Mr. WOOD said he knew that ball mills were used because sometimes steel balls were found in the colours.

Mr. ANDREW SMITH asked if the author could suggest any way by which the flat stones could be superseded. Earth colours and oxide of iron must be ground wet: could the author suggest a mill that would do it?

Dr. CAVEN said he had always understood that metals such as lead and aluminium could be powdered better if they were heated till they were brittle. He understood Mr. Crosbie to say that they were ground cold.

Mr. CROSBIE, in reply, said the meaning of the phrase "cut to the same hand" was that both

top and bottom stones were dressed exactly alike as they laid side by side: when the top stone was turned over the furrows would be in opposite directions, so that when it was twisted round there was a scissor-like action between the stones. The "land" was the ground between the furrows. The mill with the interminable staircase was a Krupp mill. "Sharps" was a mixture of flour and fine bran thrown out because it could not be separated. About 10% of very fine sharps was produced in milling. Aniline colours were usually ground in ball mills if there were sufficient colour to justify it: in case of one or two cwt. only, it was ground in an edge-runner mill. He suggested to Mr. Smith that rock emery or composition stones might be used instead of continental quartz or English mill stones, and grinding dry, or wet ball mills. Flat stones were often used for grinding basic slag. In reply to Dr. Caven, there was no cause to heat lead or aluminium in any way. He had ground compo pipe, lead foil, and so on without any treatment. The aluminium ingots were roughly broken up into ounce or half-ounce pieces and could be ground into particles of 1/20,000 sq. inch. The temperature in the mill was never high, though it might rise locally to 40° C.

Meeting held at University College, Nottingham, on January 27th and February 24th, 1915.

MR. J. T. WOOD IN THE CHAIR.

DISCUSSION ON THE EFFECT OF THE EUROPEAN WAR ON THE CHEMICAL INDUSTRY OF GREAT BRITAIN.

The CHAIRMAN, having referred to the Government scheme for the manufacture of dyestuffs, and enumerated some of the objections to the scheme,

Mr. J. H. DUNFORD, in describing the effect of the war on bone works, said they were considerably hampered by a number of imported raw materials, such as bones and pyrites for sulphuric acid making, being put on the prohibited list by practically all European countries. Moreover in certain articles manufactured from raw materials supplied by the bone industry, they had to accept half the usual price from the English manufacturers, as this class of work was mainly in the hands of the French and Germans. British fertilizer works had been badly hit by the lack of potash mainly supplied by German mines. On the other hand, opportunities offered themselves of stimulating the production in this country of cheap potato spirit and beetroot sugar. Given a low-priced spirit and freedom from restrictions, the English manufacturers could compete in many lines with his foreign rivals. One of the cheapest raw materials for the production of this spirit was potatoes. Poor sandy land in cold and damp localities would do very well for raising those kinds of potatoes suitable for distilling. Such potatoes needed little manuring and did not prove exhausting to the soil. Ordinary potatoes contained about 15% of starch, whereas one of the varieties—the Blue Giant—suitable for distilling contained up to 25%. The growth of sugar beet was of the greatest importance to this country, and we ourselves could very easily supply the greater part of our sugar requirements. In Holland the area under beet had been nearly doubled in 10 years because it paid, and with practically identical conditions there was no reason why it should not pay England to do likewise. The Dutch grew 170,000 acres of mangolds

but they found that the deeper rooting beet with its greater penetration of the subsoil and also because of its great crop of leaves, which were either ploughed in or eaten by stock, was a steady improver of the land.

In the Netherlands, the rural population was only about one-half that of London and yet they had twenty-seven beet sugar factories—three of the largest belonged to the farmers themselves. We could not at present expect the Government to take it up directly, but the Development Commission might profitably turn its attention to the most promising opening yet offered.

Germany produced in 1913 11,607,510 metric tons of crude potash salts of which she exported about 50%. The United Kingdom consumed in 1913 about 100,000 tons. In the past farmers had bought the bulk of their potash in the form of kainit which had a high chlorine content. It was estimated that in Scotland in 1913 25,000 tons of kainit was sold as against only 500 tons of high grade potash salts. Chlorine exerted a disastrous influence on the physical constitution of the soil and on vegetation. Calcium chloride was formed, and being very soluble in water, was lost in the drainage. Chlorinated manures robbed soil of its lime. It had been estimated by Mercker that a given weight of kainit caused the soil to lose an equal weight of lime, and that therefore as much quick lime as kainit should be applied to the soil to balance the loss. The comparative cheapness of kainit before the war was thus illusory. In marshy or wet lands simultaneous application of lime was necessary, as potash salts were rapidly robbed of their acid, so that in absence of lime chlorine formed free hydrochloric acid which was most injurious to plant life. Lime was also a corrective of the secondary effects of crude potash salts to prevent nitrification in the soil. Lawes and Gilbert proved that potash salts could be replaced with good results by other salts.

Lime and gypsum released potash from soils containing hydrated silicates of alumina and potash. Free or quick lime acted as a liberator of potash in all but the lightest of sandy soils. In the Caucasus there were 24 factories producing potash from the stems of sunflowers. In 1907 14,500 tons was produced. Other sources of potash were suint from wool-washing, farmyard manure, various cake meals, fresh guano, Peruvian guano, and mother liquors from the preparation of salt from sea water. Beet sugar residues contained ½% potassium calculated on weight of roots. The spent wash was neutralised by chalk and decanted, evaporated and calcined: the crude ash left contained about 50% potassium salts. Weeds, prunings, hedge clippings, brush wood, bracken, leaves and vegetable refuse contained up to 15% potash. Thistles contained ½%; chrysanthemums 2½%, and absinthe stems or fumitory 7 to 8% potash, and active steps were now being taken towards the commercial production of potash. Two hundred tons of bracken ash were being used for the first test. A ton of fresh weed should yield 20 to 30 lb. of potash—enough to manure from ¼ to ½ an acre of potatoes. Canada exported potash fertilizer in the form of wood ashes.

According to the U.S. Agricultural Dept. the Searles dried-up lake in California contained about six million tons of potassium chloride. Seaweed was used in the Channel Islands, south-west of England, and parts of Scotland, very extensively as a manure. According to Hendrick, seaweed and superphosphate gave even better yields than dung and superphosphate. It decomposed in the soil more readily than dung and had the advantage of containing no injurious seeds of weeds or spores of disease organisms such as finger and toe, etc. It should either be calcined for its ash or mixed with dung in a concrete pit. According to a report of