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THE CENTENARY OF CASEIN

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If cellulose nitrate in the form of Parkesine was in 1862 the first semi-synthetic plastics material then casein came second, almost 40 years later. Nobody remembers the names of runners-up, and so it is with casein which has always been the poor relation of the plastics industry. Few people in the general population have heard of casein and even fewer recognise it, despite the fact that most older people would have handled it almost every day in the form of buttons, fountain pens, propelling pencils, knitting needles, knife handles, and dressing table and manicure sets.

Parkesine had been introduced as a new kind of material but did not gain acceptance. After improvements to the manufacturing process, cellulose nitrate plastics were re-introduced in the United States as Celluloid and in Britain as Xylonite. They imitated expensive materials such as ivory and tortoiseshell, and also fine linen for collars and cuffs. From the start, casein was introduced in imitation of less exotic material - horn and semi-precious stone. The trade association was known as the Artificial Horn Manufacturers Association and not until 1938 did it become the Casein Plastics Association. In the 1920s and 1930s there was a twice monthly magazine called The Artificial Horn Gazette.

It is reported that casein, the protein in milk, was used by the ancient Egyptians of the eighteenth dynasty as a medium for fixing pigments (on a recent visit to historic iron mines in the Forest of Dean I noticed that on sale were packets of ochre pigments, still mined there, and packets of casein for those who want to use the old recipes).

It must long have been noticed how hard some cheeses became when left to dry out, but as far as I am aware there are no recorded attempts to use casein as the basis of a material until the late nineteenth century. Those first attempts were probably thwarted by dimensional stability problems and biological deterioration, but the discovery of the hardening effect of formaldehyde (formalin) on casein was the breakthrough which led to casein plastics. There is a story, probably untrue, that a cat, left in a laboratory overnight, upset a bottle of formalin into its milk saucer, but most likely the discovery was linked to attempts to stop deterioration, since formalin was used to preserve biological specimens.

Krische, head of a large firm of printers in Hanover, Germany was looking to waterproof paper in an attempt to replace the slate and chalk used in schools with a washable white board. He collaborated with Adolf Spitteler, a chemist in Bavaria, and a patent for plastic compositions was taken out in Germany on 15 July 1899. The patents were taken up by firms in Germany (Vereinigten Gummivarenfabriken at its factory in Harburg) and in France by Pellerin & Orosdi (Compagnie Française de la Galalithe at Levallois Perret). The product was introduced under the trade name Galalith and was first exhibited at the Paris Universal Exhibition of 1900. So this year we can celebrate the centenary of casein plastics. A lot of development work was still required to produce a stable material, and the two companies merged in 1904 to form the International Galalith Gesellschaft Hoff & Co. (often referred to at Erinoid as "The Hoff "), witha new factory in Harburg. They held the rights to the, so called, dry process for manufacturing casein plastics from rennet casein.

The history of the development of casein in the UK is no less interesting. In 1909 a Russian student, Victor Schutze, from Riga, patented a process for the manufacture of a solid plastics material from milk curds: this became known as the wet process. The patent was finally granted in 1911 and a company, Syrolit, was formed to exploit it. Manufacture began in a disused cloth mill, Lightpill Mill, in Stroud, Gloucestershire. Syrolit had a share capital of £60 000. The patent shows that the wet process is long and costly (milk contains only about 3% of casein) and with the possibility of much scrap material - as proved to be the case so that the capital was soon whittled away and by 1913 the company was bankrupt. The main source of supply for skimmed milk was the Condensed Milk Company of Ireland which, probably as a salvage operation in its own interest, was on the point of taking over what remained and starting a new company in Ireland to manufacture casein under the trade name Erinoid. One of the founders of Syrolit was U. A. Cleeve. He realised that for the company to succeed the manufacturing method would have to be changed to the dry process, an idea he may have got from E Petersen of Hamburg when he met him at the 1912 Paris Exhibition.

Petersen had had a varied career which had taken him across the USA, returning to Germany as a manager at Galalith. To improve his position there he would have to wait for "dead men's shoes", so he was open to offers and in the spring of 1914 was appointed works manager of Erinoid. He concluded that the new company should stay at Lightpill because of its road, rail and water transport facilities and because he thought that the workers at Stroud would be more stable than an Irish workforce. He was to re-equip the factory to make five tons of casein per week using the dry process financed by a levy of two shillings per £1 share which raised £6000. He succeeded for less, luckily before the outbreak of World War I.

Petersen, being German, was an enemy alien and he and his family were confined to a flat converted for them on the top floor of Lightpill Mill until the end of the war. Production of casein began in October 1914 with a labour force of less than 20. As the war had stopped supplies of Galalith, Erinoid had a ready market and button manufacturers from Birmingham waited on the doorstep to take away the first consignments. Initially only rod was manufactured and as buttons were generally trepanned from sheet material the button manufacturers had to adapt their methods and this may explain the boom in barrel buttons at that time. Erinoid exhibited at the first British Industries Fair in 1915. It was here that Queen Mary first became acquainted with casein and was so impressed that she ordered several articles for personal wear (where are they now?).

An intermediate, semi-dry process was worked for a while at premises in Croydon, making Neolyte. This process started with dry casein which was then boiled in water and worked as a dough. This overcame some of the difficulties associated with the wet process, i.e. working with large quantities of liquid and problems with freshness. This business was run by Robert Dodd until the mid-1920s when he joined Erinoid taking some of his experienced workforce with him - he later became works manager, technical director and managing director of Erinoid.

In the United States the first successful casein plastics material was produced about 1919 under the name Aladdinite. In 1924 Karolith was produced followed by Kyloid and Inda, and a subsidiary of Erinoid was also established to manufacture Erinoid over there. Casein did not achieve the same success in the US as it did in Europe - probably because the manufacturing process did not lend itself to the more mechanised American scene. Also, many European applications were denied because of the different climatic conditions and greater competition from cast phenolic resins. Starting in about 1928, many US casein manufacturing plants joined forces with button manufacturers to make casein directly into buttons. These included button manufacturer George Morrell who took over Kyloid, and Aladdinite which joined the Button Corporation of America. In 1931, American Machine & Foundry Company (who made Inda) Karolith Corporation, Erinoid Company of America, and

Pan Plastics Corporation merged their casein interests to form the American Plastics Corporation to produce casein under the name Ameroid.

The first Russian factory for artificial horn was started up in July 1928 in Mnewniki, near Moscow with an initial capacity of 700kg per day.

The 'dry process'

The 'dry process' for making casein plastics starts with granulated rennet casein. This is precipitated from skimmed milk using rennet - an enzyme found in the stomach of calves. (A similar enzyme exists widely in the vegetable kingdom, and an extract from thistles, called thistle rennet, was tried but it is not known whether this produced a casein suitable for plastics). Casein granules come from the dairy in sacks - before the Second World War most of it from France - and is then ground at the factory to pass a 40-mesh sieve. A grinder made in Germany around 1890 which started life as a flour grinder continued working until the factory stopped making casein in 1980 when it was given to the Science Museum.

After grinding, the casein powder is moistened with water containing any necessary colourants and mixed in Artofex dough mixers. All water is absorbed by the casein which swells but appears quite dry - although it will bind together if squeezed in the hand. This mix is then fed into the hopper of an extruder which converts it into a continuous rod or strip which is still quite flexible but stiffens somewhat on cooling. Four Greenwood & Batley twin machines were delivered in 1914 and apparently caused quite a stir in Stroud. The rod for knitting pins was produced on such machines, and the twin extruder feeding a single nozzle was also used to producing various multicolour effects. In latter years, a small "piggy back" extruder was added to manufacture more complicated colour configurations.

Next comes the moulding of sheet material. Extruded sections, or chopped pieces are put into simple picture-frame moulds. The manner in which the material is placed determines the colour configuration of the moulded sheet.

The moulds are loaded into multi-daylight presses, usually steam heated and loaded to 50 tons pressure. On removal from the moulds, the sheets are still soft and rubbery but about half an hour after removal are sufficiently stiff to be placed in racks ready for the next stage in the process: immersion in formalin tanks (Formalization). The immersion time depends on thickness and temperature (taking much longer in winter) - up to six months or more for a 25mm thick sheet. if rods are required, e.g. for pen barrels or knitting needles, pressing into sheets is of course not necessary. However, some colour configurations can only be obtained in sheet, and these were often 'pinched' into rods using another mould which left each rod joined to its neighbour with a thin 'flash' of material.

Before about 1930, buttons were trepanned from sheet material by the manufacturers. The development of suitable machines then allowed button blanks to be punched from unformalized sheet and, later, unformalized rod was also sliced into button blanks. This also had the advantage that button blanks, being smaller, required less time in the formalin tanks. Larger button blanks were formalized in perforated zinc boxes and small blanks were put into linen bags to be formalized, making them easier to handle. During formalization, the material hardens so that it becomes more resistant to water and other solvents and is no longer thermoplastic. Soaking in formalin inevitably causes some distortion (this is why very few casein plastics mouldings are found). Sheet material requires flattening in presses. Thematerial still contains excess water at this stage which must be removed. Rods and buttons are placed in rotary driers while sheet is conditioned in stock rooms. Rods such as knitting needle material are ground to size and button blanks sorted by thickness before dispatch.

Casein is produced by unique batch processes. Every batch was slightly different and each factory produced its own range of colour configurations, so that it is sometimes possible to identify the manufacturer. For example the striped pencil made for the Coronation in 1953 can be identified as of Lactoid, made by BX Plastics, Erinoid's chief rival. Other designs for the pen trade, including propelling pencils, are seen to be in Erinoid casein. Imitation horn was always a popular effect, while black-and-white sheets in Lactoid, were machined into rods for the pen trade. This kind of colour configuration, made by surface-dyeing white pieces before moulding into sheet, is much liked by pen collectors and known as 'cracked ice'. Plain colours are more difficult to identify. Examples of pencils and other items made from casein plastics illustrate this article.

Wartime difficulties

With the German occupation of France in 1940, all supplies of rennet casein stopped and new sources were needed if button manufacture was to continue. The UK government urged the Casein Plastics Association to seek an alternative supply. (They had obviously learned the lesson of Napoleon's defeat by the Russians, when soldiers were hampered as their tin buttons crumbled in the intense cold, coats flapped open and one hand was needed to keep trousers up!).

EO Weeks was the man for this task and chose to get supplies from Argentina which had been making casein but not of a grade suitable for plastics manufacture. Weeks had joined Erinoid in 1919 and was later sent to France to set up and manage the Erinoid factory at Montendre. He must have had, or acquired, considerable knowledge of the manufacture Of rennet casein from milk, possibly from dairies around there. He embarked on the Highland Patriot for the Argentine, where his preliminary survey showed how immense was the country and how difficult the task of producing any sort of rennet casein. There was no suitable plant available and it seemed that separating stations, which generally consisted of a tin shed with a tea kettle and a few rusty appliances were incapable of being adapted.

He nevertheless succeeded in attaining his target of 1000 tons per annum, although the quality left a lot to be desired. Weeks, who was appointed an officer of the Legion d'Honneur by the French Government for his work, after the war reopened the Erinoid factory in France for a while but later set about teaching rennet casein manufacture to dairies in New Zealand and Australia. He wrote before he left: "There can be no doubt that casein is the king of materials for buttons. No other material can approach it for beauty, for polish, or for its silky, satisfying touch. A sufficient and cheap supply of a standard high grade casein will solve many of the plastic makers difficulties. He will be able to offer his customers a regular, easily worked material at a falling price on a market that is sure to rise for all other materials used for buttons. It is with these hopes that the writer sets off for the Antipodes."

About this time the fashion was for pastel colours and the base colour of casein needed improving. After much development work at Erinoid, assisted by Weeks' experience, a method for improving the purity of raw rennet casein was patented. This was taken up by the New Zealand dairies and resulted in a casein of much improved colour and clarity. By 1954,

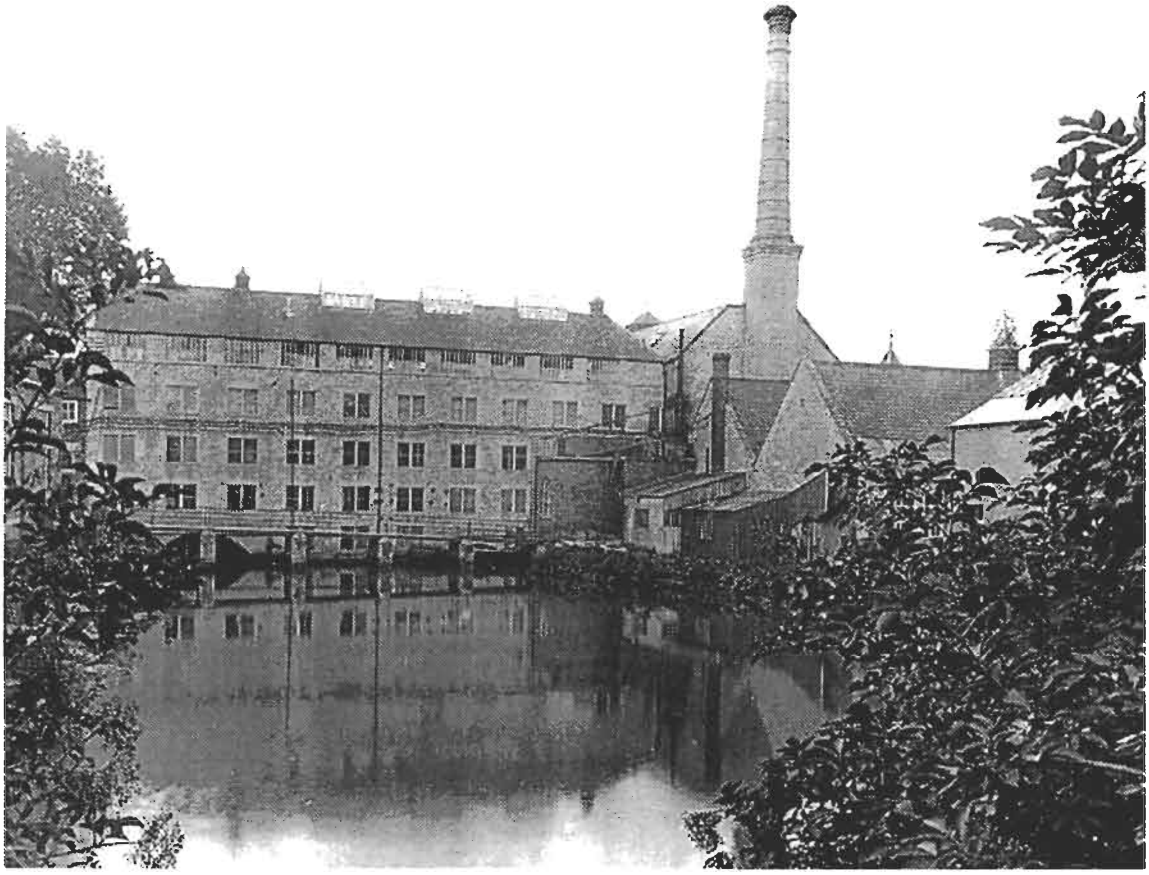
New Zealand was the major supplier of rennet casein to Erinoid and batches were usually identified by the name of the ship which had carried them to the UK.
In 1953, Weeks wrote: "A typical New Zealand dairy dealing with 30 000 gallons of milk a day, that is to say 30 vats of 1000 gallons each would be provided with two milk scales; storage vats for from 1000-2000 gallons of whole milk; preheaters capable of dealing with up to 5000 gallons per hour; five separators of 1 000 gallons per hour capacity; and from 25 to 30 vats of 1000 gallons. From the moment the word "Go" is given the milk comes pouring in from each farm in cans holding about 20 gallons; these are poured into the scales as fast as the men at the reception can handle them. As soon as a lot is weighed, the scale pan is emptied into the receiving tanks by a four-inch valve cock, so they soon start filling up. The preheater starts taking the milk and the separators start one by one as the milk is available. From ten minutes to a quarter of an hour after the start everything is going full blast. From then onwards the method of filling the curdling vats is the only relief the casein maker can use to regulate his work. Once the first tank is rennetted he must go on - he may gain a small respite by filling two or three tanks at once instead of pouring all the 5000 gallons into one tank, which gives him a tank about every ten minutes, but then he is only storing up trouble for later on as he will have two tanks to handle together. He cannot slow down the arrival of the milk as his storage tank will soon become full, and if he stops the reception of the milk he is saluted with every kind of horn and klaxon that has ever been invented. If all goes well he ha, to keep about twice as nippy as one of Lyons' ladies, and if anything goes wrong he has to make almost superhuman efforts to catch up, and the work is almost sure to be scamped. If he should lose his head, a vat or two is completely ruined and that means working it away bit by bit which means bad casein for a month or so as he dare not lose three or four hundred pounds of his output."

The Final Years

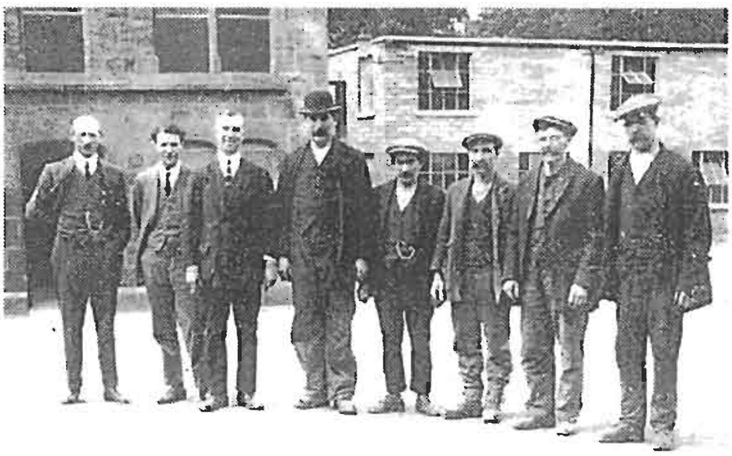
Erinoid was taken over by O & M Kleeman in 1957 which, although expanding the company, largely adopted plans already formulated by the previous board. Thermoplastics extrusion was very much expanded and at one time it was boasted that the extrusion shop was the largest in Europe. Casein production plodded on with its traditional markets having continued largely unchanged throughout its history. Although, over the years, many attempts had been made at modernising production methods, particularly the formalization process, nothing better could be found. In the end this proved its downfall although it was still a profitable business when it finally closed about 1980. Although Erinoid, which had been in the hands of British Petroleum since October 1965, was being run down, there were negotiations in hand for the sale of the casein business. However, forthcoming regulations for the Control of Substances Hazardous to Health would have meant substantial investment to eliminate the open formalin tanks and deal with effluent, etc. There was a dwindling market that did not justify the expenditure. *Lactoid* at BX Plastics had already closed as had the other minor British casein firms.

Although casein has always taken a back seat, the plastics industry owes a lot to its pioneering efforts. In particular, it was very easy to colour and also took a surface dye easily (it is, after all, a protein not dissimilar to wool). It could be dyed to match fabrics for buttons, something which people handled every day and accustomed them to accept plastics other than as an imitation of this or that.

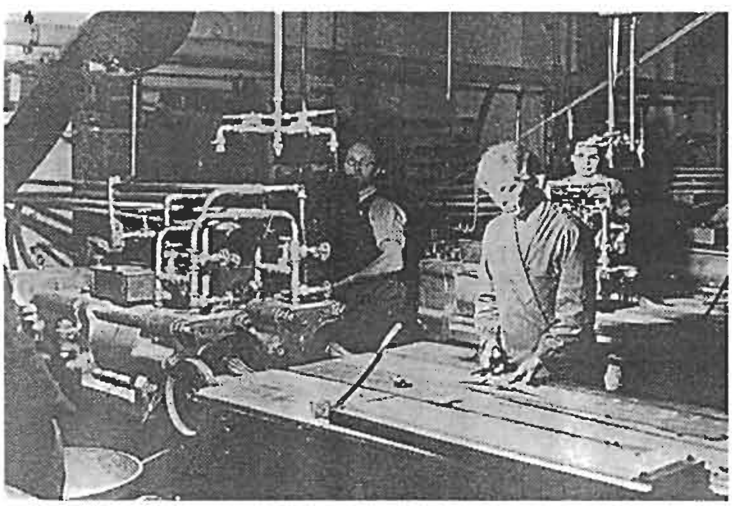
Casein is still produced for buttons in some countries with large dairy interests, for example Masterton Buttons in New Zealand.



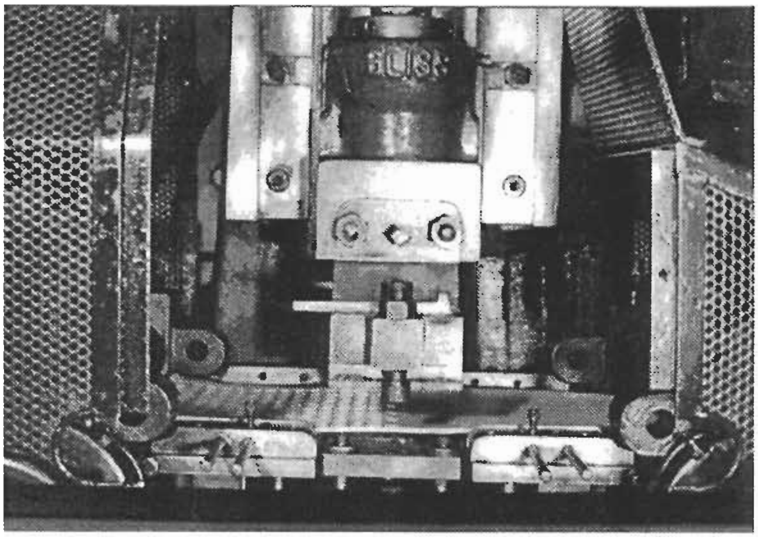
▲ Fig. 1 Lightpill Mill 1920s.



◄ Fig. 2 Petersen (left) with departmental managers and foremen 1920s.



◄ Fig. 3 Extruding rod for knitting pins 1920s.



◄ Fig 1 **Stamping button blanks from unformalised casein sheet 1950s**

Fig 3 **Formalin tanks containing button blanks 1950s** ▼

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Fig 2 Rotary driers for casein rod, tube and button blanks

Fig. 4 Manicure stand ►
in 'almon green' casein