

INDUSTRIAL OUTLOOK.

The Indian Glass Industry.

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THE manufacture of glass in India is probably of great antiquity although until quite recently the practice of the art appears to have been confined almost entirely to the making of spangle glass and glass bangles rather than to the manufacture of blownware utensils. The rapid perfection of the technique of glass-blowing in Syria immediately prior to the Christian Era, a technique which is believed to have originated at Sidon about the third century B.C., and which, through the agency of the Syrian blowers, soon spread throughout the Roman Empire, founded the great glass houses of Alexandria and Rome, and later sent skilled Syrian workmen to the more modern but equally famous glass industries of the Rhineland, Venice (Murano), Spain, France and England, apparently left India untouched. Practically no blownware was made in this country until the end of the nineteenth century. This is more than strange when it is remembered that many famous and beautiful pieces, chiefly domestic vessels, originated in Persia and Egypt during the Middle Ages. One explanation is that glass was commonly supposed to contain bone-ash as an essential constituent and this undoubtedly helped to make its use unpopular in India.

Early Indian glass appears to have been made exclusively by fusing the alkaline earths, *Reh** which are common throughout the country in the plains, and there is no evidence that potash and soda for the manufacture of high class "metal" were made from wood and seawood, as was done in the early days of the industry in other countries. Spangle glass manufacture and, more particularly, bangle-making, have undoubtedly been practised for many centuries in a desultory fashion wherever *reh* deposits occur.

ANCIENT BRANCHES OF THE INDUSTRY.

Spangle Glass.—At the present time indigenous spangle glass is made only at Panipat in the Punjab, although Sir George Watt in his *Dictionary of the Economic Products of India* (1890) speaks of nearby Karnal as being a centre for this industry.

The method of manufacture consists of fusing together 'red stone', a form of sandstone from Agra District, *sajji*,† an alkaline earth similar to *reh* obtained from Bahawalpur State, and *shora* or saltpetre obtained locally, and blowing the resultant glass into globes which are 'silvered' internally.

The sandstone is first broken down by heating in kilns and crushing. The materials are then mixed together and melted in crude, wood-fired, tank furnaces of archaic design. The refractory bricks for the furnaces are made from an aluminous clay obtainable locally, and are sun-dried after moulding and bonded by the inclusion of straw. When the furnace is fired the bricks are fused to a certain extent and so attain some mechanical strength. The furnaces are extremely wasteful of fuel but are interesting as relics of an ancient technique.

	%	
Loss on ignition ..	16.35	(Representing moisture, organic matter, carbon dioxide and volatile salts.)
Silica ..	40.80	"The excess over 100% is presumably due to the fact that the loss on ignition was determined separately, and consequently possibly included some loss of alkali salts by volatilisation. This loss has not been taken into account in the final analysis resulting in duplication of this alkali."
Iron oxide ..	3.76	
Titania ..	0.50	
Alumina ..	10.84	
Copper oxide ..	0.13	
Lime ..	7.80	
Magnesia ..	2.33	
Sodium oxide ..	13.90	
Potassium oxide ..	3.54	
Chloride ..	1.68	
Sulphuric anhydride ..	0.73	
	102.26	

The glass made is very high in alkalis and, of course, strongly coloured by the iron and other impurities. It is blown into globes which are 'silvered' internally by coating with an alloy which usually consists of fifteen parts by weight of lead to one part of tin. The globes, after 'silvering', are broken into small mirrors and spangles, and sold for the decoration of buildings or fabrics. Most of the spangle glass goes to the North West Frontier Province, Baluchistan and Sind, but the

* Chiefly silica and crude sodium carbonate.

† Analysis of sample of *sajji* made at the Government Test House, Alipore, Calcutta.

demand is decreasing and the industry appears to be dying out. In 1936 the value of the industry was estimated at approximately twenty thousand rupees annually.

Cottage Bangle-making.—The art of glass bangle-making is probably the oldest surviving branch of the Indian glass industry. The bangle has always been a favourite adornment of Hindus, and the manufacture of bangles was one of the first uses to which glass was put in this country. As practised to day by the cottage bangle-makers all over India, but particularly in the United Provinces and the Bombay and Madras Presidencies, the same methods and materials are used as were used hundreds of years ago.

Bangles are made by the villages as a part-time employment. *Reh* is fused in open fire-clay pots or crucibles, usually about four in number and containing anything from a few seers to a maund or more of glass. The pots stand in a ring on the ground, and are heated by a wood or charcoal fire in a pit excavated from the earth in the centre of the ring. They are covered by a crude fire-clay dome which is provided with an opening in front of each pot for the removal of the glass, and through which the smoke from the fire escapes. There is no chimney. A few simple coloured glasses are produced by the addition of the *reh* of coloured earths found in the neighbourhood, or of iron rust (green) or crushed coal (amber).

A bangle is shaped by taking out from the crucible a small quantity of molten glass on the end of a pointed iron rod, and then working the end of the rod through the glass so as to form a thick ring. The ring is afterwards expanded down a fire-clay cone until the correct diameter for the bangle is attained. Sometimes the outer face of the bangle is embellished by imprinting a rough geometric design upon it while the bangle is on the cone. A carved wooden die is used for this purpose and is simply pressed round the circumference of the bangle. The bangles are not specially annealed after making, but the method of manufacture does not involve chilling the glass to any appreciable extent so that the bangles on completion are in a partly annealed condition. Skilled bangle-makers can work with extraordinary rapidity and some of them produce as many as 1,000 bangles a day.

The *desi* bangles just described are very crude and are nowadays looked upon with disfavour by all save the very poorest of the people, or those living in isolated districts: the factory-made or imported glass bangle is generally preferred.

The Bangle Industry at Firozabad.—Firozabad, a town in the United Provinces near Tundla with a population of about twenty thousand, is almost entirely given over to the manufacture of bangle glass and bangles. The great demand for glass bangles in India has produced here a large body of men, the *Shishagars*, descended from those who made *desi* bangles from the local *reh* deposits, who have succeeded in concentrating almost the entire factory-made bangle industry of India in the town. Not only are the great majority of the Indian factory-made bangles produced at Firozabad, but large quantities of block glass are also made there for sale to the *desi* bangle furnaces all over the country. (By remelting Firozabad glass, the cottage bangle-makers can produce bangles which, although crudely formed, are superior to those made from *reh*. These bangles are still of inferior quality, nevertheless, as with the very low temperatures available in the cottage furnaces the glass has to be made readily fusible by the addition of a high percentage of alkalis, and it is consequently lacking in lustre and 'tinkle'.) It is estimated that the total value of the bangle and bangle glass industry at Firozabad is in the neighbourhood of Rs. 30 lakhs annually.

The factory-made bangles of Firozabad set a much higher standard than the *desi* bangles both for finish and 'metal' as the glass is made in coal-fired furnaces, provided with chimneys and, moreover, the *Shishagars* have a very high manipulative skill and are experts at producing beautifully coloured glasses. The best varieties of Firozabad solid multicoloured and hollow silvered bangles (these bangles are sprayed with silver nitrate after forming) can hold their own with imported Japanese bangles of the same types; but both Indian and Japanese bangles are inferior to those imported from Czechoslovakia. Pressed bangles from Czechoslovakia (a type of bangle not yet made at Firozabad) have recently become very popular in India.

Although Firozabad factory-made bangles are greatly superior to *desi* bangles they are by no means yet as perfect as they

might be. This is largely due to the fact that the furnaces in which the glass is melted, known colloquially as 'Japanese' furnaces, are direct fired pot furnaces without means of air preheating. In these furnaces the temperature of the glass rarely exceeds 1200° C., and consequently a high percentage of alkalis have to be used to secure ready melting. The glasses are, therefore, lacking in the much prized ring or, 'tinkle', and tarnish rapidly. Since the chief alkali used is soda ash, a chemical not manufactured in India, the glass is also relatively costly, and the cost is still further increased by the fact that the furnaces are thermally inefficient and consume large quantities of coal. The bangles are made on a semi-mass production scale, but much of the equipment used is cumbersome and inefficient. A description of the process commonly practised will be of interest.

Glass is collected from one of the glass pots in the furnace on the end of an iron rod. If multicoloured bangles are to be made, the gob of glass is shaped on a 'marver', a kind of anvil, into a rough block or 'parison', with as many sides as there are different colours to be added to the original block. During this operation the glass remains attached to the rod. Quantities of various other coloured glasses are then obtained from other parts in the furnace by the same method and are roughly welded to the various facets of the original glass block, which is reheated at "glory-hole", a small reheating furnace, from time to time if necessary.

When the glass 'parison' is ready for the manufacture of bangles it is taken over, still attached to the rod, to a man known as a *tarwalla*, who is seated in front of an open furnace. Holding the rod the *tarwalla* reheats the 'parison' and draws out the end of it into a thread by attaching it to another iron rod which is passed through the furnace to him. The thread of glass is then drawn out over the fire and attached to an iron roller on the far side of the furnace. This roller is mounted on a steel shaft which is supported in semi-circular notches in two wooden posts, one on either side of the furnace and it is wound rapidly by another man, the *belanwalla*, by means of a small crank-handle. One of the notch bearings is threaded and engages in a thread on one end of the shaft. When the *belanwalla* winds the crank-handle a transverse

motion is imparted to the roller by the thread in the supporting post, and the glass is wound on to the roller in the form of a spiral.

The success of the operation depends upon the skill of the *tarwalla* who has to maintain an even tension on the glass thread, and he does this by moving the glass near to, or further away from the fire as required at the same time imparting the necessary tension. When a multicoloured bangle is being made he has to show still more dexterity by twisting the 'parison' as the glass is wound off.

When the glass spiral has been completely wound on to the roller the thread of glass is cut by another worker who then lifts the roller and spindle from its bearing at the end distant from the *belanwalla* and removes the glass coil by means of a hooked iron rod. The coil is next broken into a series of open rings by scratching it down its length with a piece of carborundum. The ends of the separate rings, or bangles, so formed are afterwards joined in the flame of a kerosene or petrol lamp.

One of the principal defects of Indian bangles of this type is due to the fact that during the joining process the side of the bangle opposite to the joint is often discoloured by the joining flame, as the flame used is too large and not sufficiently hot. The crudest method of joining bangles practised at Firozabad consists of blowing air by means of hand-driven blower, down a length of piping fitted with a series of jets. The air is simply blown through the flames of kerosene or petrol lamps. Another more efficient method consists of blowing compressed air from a hand bellows through a container in which is a small quantity of petrol, the vapour being burnt in burners similar to those just described.

Hollow bangles are manufactured by blowing in a mould glass 'parison', roughly the shape of a bottle, and then drawing this out into a tube which is wound on to the roller in the usual way. After removing from the roller, the end of the hollow spiral of glass is attached to a bellows, and by this means a colouring material such as cadmium sulphide or copper oxide is blown through the spiral while it is still hot.

Bangles are not annealed after making, and they are usually not packed, but are merely strung together in lots of six or

dozen pairs. It is an interesting experience to visit the godown of a large bangle factory at night. By the light of a lantern the godown with its thousands of richly coloured bangles, strung together and piled in glistening heaps on the floor, is like some fabled Alladin's cave.

Subsidiary to the Firozabad bangle factories are the bangle cutting and decorating works. Here glass bangles are decorated with patterned facets cut on small grinding wheels. After cutting, the facets are painted with liquid gold, or 'china glass', an opaque glass which is powdered, mixed with water and applied as a paint, and the bangles are then dried in small muffle furnaces. Bangle decorating is also carried on at Firozabad as a cottage industry on a considerable scale, and some of the bangle factories do their own decorating.

So much for the ancient branches of the Indian glass industry. What of the modern?

The Modern Glass Industry of India.

The manufacture in India of glass utensils by methods comparable with those at present practised in industrial countries commenced in 1892. Between that date and the outbreak of the Great War in 1914, when there were three factories in existence, a number of works were operated for short periods without much success, and the industry did not enjoy any real prosperity until the War prevented the importation of glassware from Germany and Austria. Under the stimulus of high prices and

immunity from competition the industry flourished for a space, and in 1918 twenty factories were working. But other countries had also been developing their glass industries during this period, and soon after peace was signed the Indian glass industry was feeling the effects of keen competition, particularly from Belgium, Czechoslovakia, and the rapidly industrialising Japan.

The early factories were under European management, and some employed European trained executives, but few of the latter adapted themselves successfully to Indian conditions, and their places in the industry were taken by a number of Japanese blowers and 'experts'. The industry, which has never been properly organised nor attained the degree of perfection on the technique of glass manufacture achieved by the importing countries, bears to day the stamp of the Japanese more clearly than any other influence, and nearly every glassworks contains what are colloquially called 'Japanese' furnaces, direct fired pot furnaces provided with chimneys.

At present the industry is located in five main areas, the United Provinces, Bengal, the Bombay Presidency, the Central Provinces, and the Punjab, and there are about forty factories in existence for the manufacture of blownware, as distinct from the twenty or more bangle factories and numerous cottage bangle furnaces at Firozabad.

(To be continued.)

Indian Science Abstracts.

THANKS to the efforts of the National Institute of Sciences, India, the publication of an annotated Bibliography of scientific work done in India has been accomplished. The Bibliography for 1935 was published in two parts, the last part appearing in May last. The success attained in this venture is as much due to the commendable organising ability of the General Editor, as to the co-operation of the scientific workers in India.

In any effort of such a magnitude especially, if it be the first one, some omissions are inevitable. The General Editor informs us

that references to a large number of papers published in Mathematics, Dairy Science, Engineering Science and probably some other sciences also, do not appear to have been included in the publications. Scientific workers are requested to look through the two parts that have already appeared and send abstracts of such of the papers published in 1935 as have not already found mention to the General Editor. It will be appreciated that for making this work complete, the co-operation and help of the scientists in India is essential.