HANDBOOK OF THE RUBBER PAVILION

EMPIRE EXHIBITION, GLASGOW

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A Brief Account of Rubber, its Properties, Manufacture and Applications, together with a Description of the Exhibits

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RUBBER

ITS PROPERTIES, MANUFACTURE AND APPLICATIONS

The Manufacture of Raw Rubber

Most people are familiar with the appearance and general properties of such common substances as glass, earthenware, wood, leather, metals and concrete, but their conception of raw rubber is very vague and were it not for crepe rubber soles, the majority of people whose occupation does not bring them into contact with raw rubber would not recognise it when placed before them. This is because rubber can be so modified during manufacture that only an expert can recognise it in all its forms. It is customary to refer to the material in its manufactured form as " rubber ".

Rubber is a vegetable product obtained chiefly from certain tropical trees by making incisions in the bark, which puncture the tubes or vessels found situated just under the bark of these trees. There then exudes a white fluid of the colour and consistency of milk. This fluid is termed " latex " and consists of an emulsion of rubber globules.

On the plantations of the Eastern countries of Malaya, Ceylon, the Netherland Indies, etc., rubber trees are raised and propagated on well-managed estates under European supervision. In developing these estates the dense tropical jungle must first be cleared away, the land carefully prepared to allow proper drainage and to prevent the washing away of valuable soil by the heavy tropical rains, and the seedling rubber trees—raised on special nursery plots—planted out in regular rows. During the following five to six years the trees are carefully tended and the plantations kept clear of harmful weeds until the trees become large enough to yield a profitable amount of rubber.

The principal species of rubber tree is the *Hevea brasiliensis* and this is now propagated either from seed of selected trees or by bud-grafting methods similar to those used for propagating fruit trees in this country. By continuous selection in this way, it has been found possible to raise the annual yield of rubber from 500-600 lbs. to 1500-2000 lbs. per acre. The introduction of scientific methods of manuring, either by chemical fertilisers or the planting of " cover crops " to provide green manure, has also greatly enhanced the productiveness of the rubber plantations. A constant watch must be kept against fungoid and other diseases that would cause irreparable damage if not checked in time. Treatment of the trees with sprays of sulphur dust and other fungicides is now regularly used for this purpose.

The " tapping " of the trees to obtain the latex is done by making a slanting cut in the bark a few feet from the ground. At the lower end of this cut is fixed a galvanised iron spout down which the latex flows into a small cup. As the tapper cuts into the inner bark the latex exudes at first in drops and then a continuous flow sets in until after a time, depending on the tree and the atmospheric conditions, the flow stops. The latex from each cup is collected as soon after the cessation of flow as possible and is taken to the plantation factory. Here it is strained and converted into either concentrated latex or to " raw rubber " for shipment all over the world.

In order to convert the latex into raw rubber, it is mixed with a small quantity of acid, when it sets somewhat like a junket gradually contracting and leaving a clear whey or " serum ". This process is known as " coagulation ". In one method the rectangular lump of coagulum is first passed through the smooth rollers of a milling machine under light pressure in order to express the serum and water and to consolidate it in sheet form. It is then passed through a second smooth-faced roller under greater pressure to eliminate all water and to reduce it to the required thickness. These sheets are then finally finished off by passing through a diamond or similar patterned roller to produce ribbed marked sheets. The sheets are then hung on racks in a smoke house to be dried and the resultant material is known as " smoked sheet ".

In another method of manufacture which produces " crepe rubber " the lump of coagulum at the outset is passed through a milling machine under heavy pressure. This produces a thin lace-like strip which is then folded twice or thrice, and again passed through the rollers several times to bring it to the desired thickness, shape and adhesion free from all perforations. Crepe rubber is not smoked but hung on racks to dry.

Mention should also be made of " Para " rubber, which is produced by a native-smoking process using latex derived from trees growing wild in the tropical forests of the Amazon. Originally this was the main source of the world's supply before the development of the plantation industry of the East, which began about 1876 when H. A. Wickham and R. M. Cross (a Scottish gardener in the employment of Kew Gardens) and others at the instigation of the India Office independently collected seeds and seedlings from the rubber trees in the Amazon Valley. These were brought to England and delivered to Kew Gardens for attention and subsequent distribution to the Botanic Gardens at Ceylon and other places in the East.

Since ordinary latex (the natural product) contains about 60-70 per cent. of water, and in order to reduce costs of transport, several methods of concentrating the product so that it contains only some 25-40 per cent. of water have been devised. The most widely used of these processes is that known as " centrifuging ", which is carried out in a machine similar to that used in dairies for separating cream from milk. As the lightness of the fat globules in milk causes them to be concentrated in the cream produced by the milk separator, so the lightness of the rubber particles enables a concentrated " cream " to be obtained from latex. It is also possible by special treatments to cause a " cream " of rubber to rise to the surface of latex, just as real cream forms on milk. Another process for concentrating latex consists in evaporating part of the water in special machines designed to avoid coagulation of the latex. Before concentration or shipment, ammonia or some other preservative is added to the latex to prevent premature coagulation.

Large quantities of latex, both ordinary and concentrated, are now shipped from the rubber-producing countries of the East to manufacturers in Europe, America and elsewhere.

Properties of Raw Rubber

The most characteristic property of raw rubber is its plastic nature. When stretched, or otherwise deformed, with considerable force it does not completely return to its original shape although it will often stretch to several times its original length without breaking. The completely elastic nature usually associated with a rubber band or catapult elastic can be conferred on raw rubber by the process of vulcanisation, which will be described below. Although it is somewhat plastic, it must not be assumed that it is of the nature of putty, as it is used with considerable success for shoe soles and its length of life for this purpose is a remarkable tribute to its wearing qualities, or more precisely, its resistance to abrasion.

Manufacturing Processes

Mastication and Mixing. The raw rubber is first masticated on a mill which consists of two horizontal heavy steel rollers, heated by steam, between which the rubber is passed. When sufficiently plastic various compounding ingredients are added. The actual mixing operation is often carried out on an " open mixer ", a machine of similar construction to a masticating mill. After the masticated rubber has formed itself into a sheet around the front roll, the other ingredients, mostly in the form of fine powders described below, are spread over the surface of the rubber and are gradually worked into its mass as it passes between the rolls. For this mixing operation, however, the enclosed type of mixer has become increasingly popular especially for large-scale production. It consists essentially of a strongly-made container, outwardly cylindrical in form, but inside shaped to conform to the movements of one or more rotors which by their kneading and tearing action bring about the uniform mixing of the rubber and chemicals introduced through a hopper at the top.

It might also be mentioned here that it is in this masticated state, and modified by the addition of certain chemicals, that rubber is most easily dissolved in solvents such as benzene, petrol or naphtha, to produce rubber solutions.

Compounding Ingredients and Compounding. In practically all rubber mixings that are required to be vulcanised, sulphur is essential, since it is chemical combination with this material under the influence of heat which effects vulcanisation. When only about 5 per cent. of sulphur is added, ordinary soft vulcanised rubber is obtained. If, however, large amounts of sulphur, say 30-40 per cent., are added, with prolonged heating " hard rubber " or " ebonite " is produced. By the addition of small quantities of substances known as accelerators, the temperature and time of heating can be considerably reduced and the properties of the product improved. Various amounts of other materials are also added with a view to modifying, improving or cheapening the vulcanised product. Where strength and resistance to abrasion are important, as in motor tyres, reinforcing agents such as carbon black, fine china clay, magnesium carbonate or zinc oxide are used. When a toughening effect is desired, as in shoe soles or flooring, fairly large proportions of French chalk, whiting or china clay are employed. Owing to the extensive range of synthetic dyes now available for mixing into rubber, it is possible to obtain almost any desired colour in the finished article. The idea, formerly extensively accepted, that red rubber is superior in quality to other coloured

GENERAL VIEW OF RUBBER PLANTATION SHOWING NATIVES TAPPING THE RUBBER TREE, AND COLLECTING THE LATEX

GENERAL VIEW OF RUBBER PLANTATION FACTORY

Sheeting Battery in background; Coagulating Tanks on extreme left; Tank Partitions in centre; Rubber Sheets hanging on racks on extreme right rubbers, has no basis in fact, unless it is that the red coloration was formerly obtained with the aid of antimony sulphide, a relatively expensive pigment and therefore only used for high grade goods. Other ingredients usually included in rubber mixings are " softeners ", which as waxy or oily materials assist in obtaining uniform dispersion of the powders throughout the mass, and " antioxidants ", which prolong the life of the vulcanised rubber by decreasing its tendency to " perish ".

Shaping and Assembling. Further treatment of the mixed or " compounded " rubber depends upon the type of article for which it is intended. To produce rubber tubing or strip, the material is forced through a shaped orifice or die in an " extruding machine ", which is somewhat similar in principle to the domestic mincing machine. Many articles can best be built up from sheet rubber of suitable thickness obtained by passing the material between the rollers of a " calender ". This machine consists of three or four large horizontal steel rollers, placed one above the other in a massive iron framework. Calenders are also used to " friction " rubber on to cloth or canvas. This is done by altering the relative speed of one of the rolls, and this smears the rubber on to the surface of the cloth and forces it into the interstices. Waterproofed cloths may also be produced by " spreading ", or the uniform distribution of a thin layer of rubber solution of the consistency of dough over the fabric by means of a spreading machine.

The plastic rubber having been made available in suitable form is next assembled into something like the shape of the finished article. With some articles this is quite simple but with others, *e.g.* tyres, complicated kinds of machinery are needed.

Vulcanising. This is effected in several different ways according to the type of product. Articles required to have sharply defined shapes are always vulcanised in moulds heated externally. Where outline is not so important, or it is inconvenient for other reasons to use moulds, rubber can be vulcanised directly in contact with steam or by embedding in French chalk in a vessel filled with steam. Moulds are heated in hydraulic presses, between steam-heated platens or in steam-containing autoclaves ; in the latter case the moulds are securely clamped or bolted together or held in place by powerful rams during the process. During the early stages of the process the rubber softens and accommodates itself to the contour of the mould, but as vulcanisation proceeds it becomes more rigid and permanently acquires the shape which has been imposed on it.

It is possible to vulcanise thin articles by the action of sulphur chloride, either vaporised or in solution. This process is known as " cold vulcanisation " and is used especially for rubber-coated fabrics.

Latex-Processes. The fabrication of rubber articles directly from latex is a modern development in rubber manufacture which is becoming of increasing importance. Compounding ingredients and vulcanising agents are added to the latex in a finely ground and wetted condition and, when a liquid of suitable consistency has been obtained, various processes are available for the production of articles. The simplest process is known as " dipping ", in which shaped formers are immersed in the latex composition, withdrawn, dipped in a coagulant, dried and vulcanised. Such articles as balloons, household and surgeons' gloves can be produced by this method. Compounded latex is also used for making waterproof cloth for garments by spreading processes, while by extrusion through small orifices fine threads for use in elastic fabrics can be obtained. An interesting and important development is the production of sponge rubber for upholstery, etc. by frothing the compounded latex, which is poured into shaped moulds, allowed to set, and subsequently vulcanised to a permanently spongy product.

Properties of Vulcanised Rubber

The properties of vulcanised rubber, which have led to its adoption for so many and varied applications, are its unique elastic properties, its comparative insensitiveness to temperature changes over a fairly wide range, its remarkable resistance to wear or abrasion, its excellent properties as an electrical and heat insulator, its imperviousness to water and gases and its resistance to a great variety of corrosive chemicals.

No other material combines the very high extensibility of vulcanised rubber with its ability to recover from severe deformations ; neither is there any other material which will absorb and store so much energy as vulcanised rubber.

Its resistance to temperature changes is shown by the fact that vulcanised rubber is used in equipment for high-altitude flying, where temperatures far below zero are encountered, and in conveyor belting handling hot coke in gas-works. In its resistance to wear vulcanised rubber has proved in some cases superior to the toughest steel. Rubber gloves are used by electricians when working on high-voltage apparatus on account of their excellent insulating properties against electric shocks, while ebonite is one of the best electrical insulating materials.

The efficiency of rubber as a waterproofing and gas-proofing material is sufficiently illustrated by its extensive use in making rubber-proofed "macintoshes" and balloon fabrics. Suitably manufactured vulcanised rubber will withstand concentrated alkali solutions and all but the most corrosive acids.

The Applications of Rubber

It would be impossible to describe all the known uses of rubber in the space available, but those applications have been selected which demonstrate the versatility of the product.

The proportion of rubber goods utilised in an ordinary motor car amounts to over 5 per cent. of the total weight of the car; a figure that is likely to be greatly increased as the valuable properties of rubber are fully understood. Only too clearly is this demonstrated in railway engineering, where more and more uses are being discovered.

Owing to its resistance to the attack of acids properly compounded rubber finds many applications in chemical engineering, etc.; either soft or hard rubber can be used, depending on the purpose for which the lining is intended. In some cases the process of rubber lining can be carried out on the site, although generally the work must be done in the rubber factory. Rubber hose finds employment in many industries owing to its flexibility, durability and resistance to corrosion and abrasion. Each particular application has to be met by a specially compounded rubber composition, which may be reinforced with fabric or metal. During the last few years there have been rapid developments in the use of rubber for making joints in pipe-lines conveying water, gas, air, oil, etc., so that to-day there are various designs of joints which employ rubber as the sealing medium. The employment of rubber allows for considerable flexibility of the pipe-line without affecting the leak-tightness of the joint.

Rubber's great resistance to abrasion is often employed for such purposes as the lining of launders and chutes. For the same reason it is now becoming a standard fitting on dredges, especially in Malaya, while sand pumps and sluice boxes are being lined with rubber. Mine water, which usually contains abrasive substances, is frequently of an acid nature and liable to attack metal pipes, and rubber has been found an extremely valuable material for lining such pipes.

A considerable amount of research has been carried out in the evolution of the rubber road block, and several types have been produced. The rubber block, which is very durable, absorbs noise and vibration and resists abrasion, does not absorb dirt or wet and is therefore easily cleaned. Rubber compositions have also been produced for expansion joints for roads.

An outstanding development of recent years is the adaptation of pneumatic tyres for use on farm vehicles such as tractors and carts, and, in fact, for most agricultural implements. There is reason to believe that farmers in all parts of the world would welcome a flooring material for cowsheds which is warm, damp-proof, easily laid, and comparatively inexpensive. Much attention has lately been devoted by rubber manufacturers and others to the production of a rubber material for this purpose. Rubber horseshoes and horseshoe pads are increasing in popularity for use on modern roads in various parts of the world. A passing reference need only be made to such other applications of rubber in agriculture as milking machine rubbers, rubber footwear and clothing for dairy workers, rubber hose, rubber belting, etc.

Rubber plays an important part in the efficient working of a home, adding both comfort and quietness. These domestic applications include rubber flooring in a variety of colours, solid or sponge backed, sheeting or separate tiles ; rubber upholstery of various types, ebonite lavatory seats and toilet fittings, rubber brushes, rubber-shod pails, coal-scuttles, etc., which besides reducing noise prevent the utensil from scratching the floor.

Just as rubber is necessary for the comfort and safety of the passenger in the motor car so is it equally vital for the hospital worker and patient. The rubber gloves of the surgeon allow him to handle easily the most delicate instruments while performing the most intricate operations on a patient who is lying on a sponge-rubber bed. After the operation the patient more than likely recuperates on a rubber bed. Other surgical applications include syringes, finger-stalls, bandages, rubber bowls and waterproof sheeting.

The increasing use of rubber is not a last-minute decision to introduce something new but the result of years of practical experience supported by constant research and investigation into the properties of this unique material.

DESCRIPTION OF EXHIBITS

Plantation Section

The central feature of this section is a large diorama of a Rubber Plantation illustrating the tapping of the rubber tree and the collecting and transport of the latex.

Propagation of the Rubber Tree. As a result of investigations on the plantations it has been found possible to develop uniformly high yielding strains either by vegetative or other means. At the present time the use of vegetative means has become well established and many plantations have appreciable areas of " budded " rubber in tapping.

The method employed in the budding operation with rubber is illustrated in a series of transparencies. The stocks on which budding is carried out are vigorous young seedlings which may either be grown in the nursery or in their permanent places in the field. In Malaya budding is generally carried out in the field, and nursery budding is used for developing supplies of budwood.

Tapping of the Rubber Tree. The latex is obtained from the rubber tree by making suitable incisions in the bark of the trunk and collecting the bark " sap " in a cup, attached to the side of the tree. This process, which is known as tapping, is commenced when the trees are from five to six years old, and various systems are employed, some of which are illustrated by models, together with examples of tapping knives, collecting cups and other utensils used on the plantation.

Latex. Rubber latex as it issues from the tree consists approximately of two-thirds of water and one-third of rubber. Latex if left unpreserved rapidly undergoes putrefactive changes which result in clotting and the formation of various undesirable products. Latex which has been preserved by the addition of an alkali may be stored or transported.

For the preparation of raw rubber latex as soon as it is collected on the plantation is carried to the estate factory, where it is treated with a dilute solution of acid, which forms a coagulum from which sheet or crepe rubber is manufactured.

Liquid rubber latex is also exported from Malaya and other rubber producing countries in tins, drums and tank steamers. For this purpose the latex as soon as it is collected is preserved by the addition of a strong alkali, *e.g.* ammonia. Rubber latex is sometimes concentrated before shipment.

Raw Rubber. The commodity which is handled commercially may be in the form of sheet, crepe or blanket, and examples of each are exhibited. Sole crepe is a particular variety which is made on a limited number of plantations. This type of rubber is used without undergoing vulcanisation, although most raw rubber is subjected to various manufacturing processes including vulcanisation.

Rubber Manufacturing Processes

Two-Roll Mixing Mill. Before rubber can be manipulated in the factory it has to be masticated. This is often done in a mixing mill, which consists of two metal rolls having smooth surfaces. Means must be provided for heating and cooling the rolls, and this is done by making the rolls hollow through which steam or water is allowed to pass.

After mastication the rubber is in a sufficiently plastic state to allow for the incorporation of the various compounding ingredients required to modify its colour and physical properties, as well as the sulphur necessary for vulcanisation. A range of compounding ingredients are exhibited together with a model illustrating the progress made in the reduction of time for vulcanisation by means of modern accelerators.

Extruder. The extruding machines used for making all descriptions of solid sections and also hollow articles, such as tubing, both for garden hose and for motor tubes, and was one of the first machines ever employed in the rubber industry for forming rubber into the required shape. The machine consists of a horizontal hollow cylinder connected to a charging hopper into which is fed the unvulcanised rubber mixes. Through the centre of the cylinder is an endless screw driven by gearing, which forces the material through a die fixed at the exit end of the machine. These dies are interchangeable, so that it is possible on the same machine to obtain a variety of extruded articles of different cross-sections. The extruder material has subsequently to be vulcanised.

Internal Mixing Machine. As an alternative method of compounding rubber on the two-roll mill, the operation can be performed in an internal mixer. This consists of an enclosed mixing chamber, in which operate mixing rotors or blades, a hopper superstructure into which the materials are fed and a discharge door in the bottom. The mixer is altogether an enclosed machine, and the construction is strong and suitable for the heavy work required of it. Cooling water is circulated through the mixing blades and the walls of the mixing chamber. The machine can also be heated by steam.

Vulcanising Press. The vulcanising press is used in the manufacture of such rubber goods as soles and heels, pram tyring, buffers, rubber rings, and other similar articles. The rubber has already been compounded with the necessary ingredients either on the two-roll or the internal mixer, and the press is utilised in connection with appropriate moulds to form the rubber into the final shape and subsequently vulcanise it.

A suitable quantity of compounded rubber is placed in the mould, which is then inserted into the press, where it is firmly squeezed between the two heated platens for a period depending upon the temperature and constituents in the rubber mix. The platens are usually heated by steam, but in this particular exhibit they are electrically heated.

Latex Processes (Demonstrations). Latex processes permit the manufacture of rubber articles in a particularly convenient manner. They eliminate the need for a preliminary separation of the rubber from the latex and also obviate the heavy milling which raw rubber has to undergo in the standard methods of manufacture. They also permit the use of processes which have previously been possible only with rubber solutions. Latex is easily compounded by the addition of the desired solid or liquid ingredients dispersed or dissolved in water. The avoidance of hot milling permits the safe use of even the most powerful accelerators of vulcanisation and bright organic colouring matters which would not withstand the more drastic conditions of mixing and vulcanisation in the older methods of rubber manufacture.

Such processes as dipping, electrodeposition, manufacture of rubber thread and latex sponge are demonstrated.

Scientific Section

Tintometer for Colour Tests. The extensive use of coloured rubbers, particularly rubber floorings and other articles for the home, involves the exact matching and standardisation of colours and shades. For this purpose instruments known as colorimeters have been devised. The widely used Lovibond Tintometer depends upon the principle of matching a colour by an equivalent combination of three glass slides graduated in red, yellow and blue respectively.

Grit Tester. The presence of grit or large-sized particles in a component of a rubber mixing may seriously affect the appearance and serviceability of the finished article. The apparatus illustrated has been devised for conveniently checking the suitability of the various pigments and powders used for incorporation in rubber. It depends upon subjecting a suspension of the powder to a high-pressure jet of water which washes the finer particles through a small standard wire sieve leaving behind any residual coarser particles.

Extraction Apparatus. The apparatus shown is employed for determining the amount of the constituents in rubber materials which can be removed by hot acetone or other similar low boiling solvents.

Lamp for Fluorescence Tests. The property possessed by many materials of developing characteristic fluorescent colours when exposed to ultra-violet light serves as a rapid method of distinguishing between finished rubber articles or raw materials which appear identical in ordinary light, and of detecting the presence of impurities in different samples of a particular raw material. The lamp exhibited represents the latest type of high-pressure mercury arc, generated in a quartz tube giving a high output of ultra-violet light. A black glass filter in front of the lamp serves to absorb the visible radiation while transmitting the ultra-violet rays which excite fluorescence.

Oven for Accelerated Ageing. Tests which provide an index of the durability of rubber articles are of importance to both manufacturer and user. In the Geer test the changes taking place under ordinary storage conditions are accelerated by exposing test specimens to a temperature of 70° C. in freely circulating air. Under such conditions a period of sixty hours may be regarded as equal approximately to twelve months' normal life.

Hardness Gauge. The hardness of rubber materials can be varied over a wide range to meet the requirements of technical use, for instance in rubber floorings and in the rubber covered rollers used for many industrial purposes. In the apparatus shown this property is measured in terms of the depth of the indentation of a steel ball ¼" in diameter applied to the surface of the rubber and subjected to a load of 1000 grams. The indentation, expressed in 1/100 of a millimetre, is termed the Hardness Number.

Plastometer. The fabrication stages in the manufacture of rubber goods depend for their success upon accurate control of the uniformity of the preparatory processes during which the rubber is softened or plasticised and mixed with other ingredients. To measure the softness or consistency of the resulting unvulcanised rubber compound an instrument known as a plastometer is employed. In this a pellet of the rubber of standard size is placed between two parallel plates and subjected to a standard load for a definite time at a constant temperature. The deformation of the rubber under these conditions provides an index of its processing characteristics.

Abrasion Test Apparatus. The determination of the resistance of rubber to abrasive action is of importance in relation to many of its uses, notably tyres and footwear. In the machine illustrated the rubber, in the form of a moulded disc, is rotated in contact with an emery wheel, an abrasive action being produced by a difference of 15° in the alignment of the specimen and the wheel.

Ring Thickness Gauge. The calculation of the breaking load in a tensile test involves the measurement of the original cross section of the test specimen. The apparatus shown is one devised for determining quickly and accurately in one operation the average thickness of test rings at three equidistant points on the circumference.

Tensile Test Machine. The determination of the load required to stretch a rubber material to the breaking point and of its elongation at break is a test of obvious practical importance. The machine exhibited is one widely used for this purpose and is designed to take dumbbell-shaped samples of standard dimensions. Ring specimens of rectangular cross-section are also used for carrying out the test.

Applications of Rubber

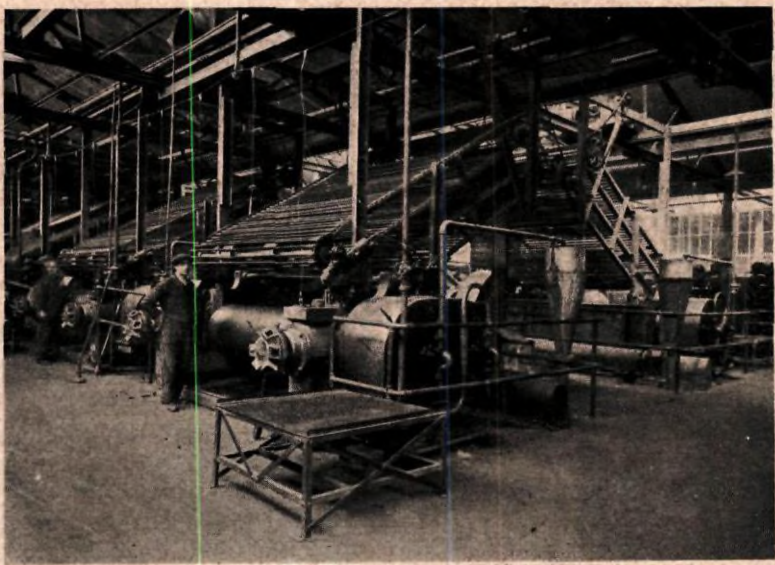
Rubber in Engineering. It cannot be too often stressed that rubber in one form or another constantly plays an important, although unseen, part in the efficient working of engineering equipment, and perhaps this cannot be better exemplified than in rubber joints for pipes, for which rubber gives flexibility while ensuring a leak-tight joint over a long period. Several designs of rubber-jointed pipes are displayed together with a model demonstrating the flexibility of such joints. Rubber hose is now used for a variety of purposes, and it is often reinforced with either canvas or metal or both as will be seen from the display in this section.

Rubber oscillatory bearings, which have been used for many years in motor cars, are now finding increasing employment in general engineering, *e.g.* in jigging screens, a model of which is in operation in the Pavilion.

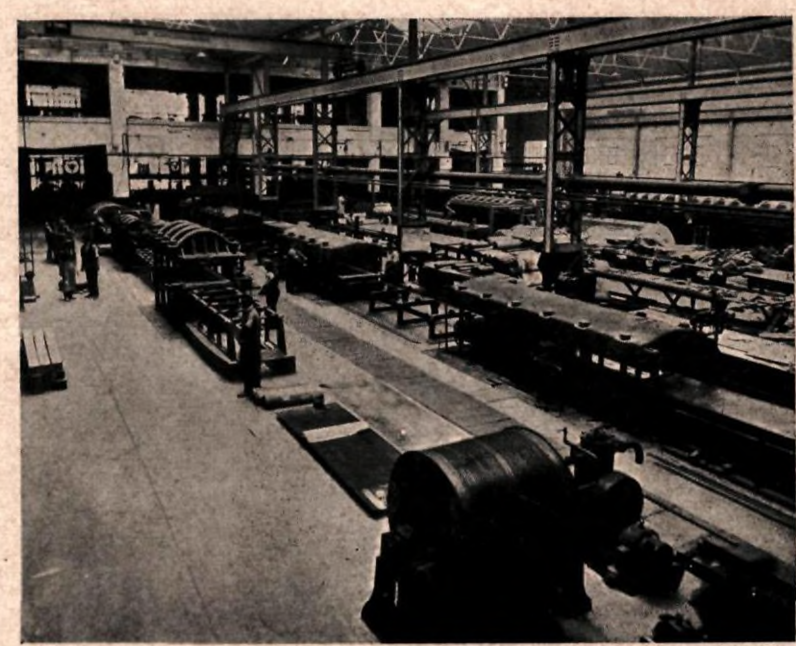
For the conveyance of abrasive or corrosive liquids, equipment can be lined with rubber either of the soft or hard variety depending upon the conditions of service. Such rubber linings are very durable and can be applied to pumps, valves, pipes and similar equipment. Ebonite alone is also employed for the conveyance of corrosive liquids and a range of such fittings is included.

Rubber in the Mining Industry. Another of the outstanding properties of suitably compounded rubber is its resistance to abrasion, and thus it finds many applications in the Mining Industry for the lining of chutes, launders and pipes. Models of some of this equipment will be on display together with a model demonstrating the resistance to cutting of " Linatex " rubber. Experience has shown that properly manufactured rubber will outlast many times the toughest steel.

Rubber in Ship Construction. The central figure in this section is a scale model of the *Stirling Castle*, around which is staged some of the applications of rubber utilised in ship construction, such as rubber bearings of particular use for boats operating in gritty waters, rubber compositions for decks, ship's fendoffs and buoys and various forms of draught strips and jointings.



RUBBER MIXING ROLLS SHOWING CONVEYORS
FOR COOLING RUBBER "STOCK"



GENERAL VIEW OF RUBBER FACTORY SHOWING VULCANISING PRESSES USED IN THE MANUFACTURE OF RUBBER FLOORING

Rubber Road Blocks. A considerable amount of research has been carried out in the evolution of the rubber road block, and several types have been produced, samples of which are exhibited. The rubber block, which is durable, absorbs noise and vibration and resists abrasion, does not absorb dirt or wet and is therefore easily cleaned.

Rubber compositions have also been produced for expansion joints for roads, and samples are displayed in this section.

Movable Floor Lorries. An interesting application of rubber is the utilisation of rubber belting for the floors of lorries, which greatly facilitates the loading and unloading of the vehicle while obviating the necessity of a tipping mechanism. A working model of a lorry fitted with a rubber floor demonstrates the method of operation.

Rubber in Automobile Construction. Rubber is being increasingly employed in the construction of automobiles. About 80 per cent. of the raw rubber produced is absorbed in the manufacture of tyres and tyre sundries. Coloured diagrams illustrate where rubber has been applied and actual samples are also displayed. An interesting exhibit shows the manufacture of a pneumatic tyre.

Rubber in Railway Rolling Stock. The use of rubber in railway rolling stock has greatly increased during the present century. Coloured illustrations of a locomotive and coach depict these applications, samples of which are also exhibited.

Rubber in Airplane Construction. Rubber is used in a variety of ways in the construction of airplanes and similar craft and actual specimens together with models demonstrate some of these applications.

Rubber in the Printing Industry. Rubber plates are being increasingly employed in the Printing Industry for various types of printing and especially where " long runs " are to be made, for the rubber plate is durable owing to the light pressures which are employed with this type of plate. Exhibits demonstrate two types of plates and methods of their production, while printers' rollers and blankets are found in this section.

Rubber in Agriculture. Many of the applications of rubber in the various branches of agriculture, including horticulture and poultry farming, are included in this section. By reason of their lower draft pneumatic tyres are finding increasing application for tractors, carts and other farm equipment, and these are illustrated by means of photographs. Milking machine rubbers are on view together with types of floor materials for use in cowstalls and pig-pens. Rubber boots for sheep and cattle to prevent the spread of disease, rubber prongs for potato diggers, tubes for grain drills, rubber tree ties, grips for cloches and rubber nest boxes are among the exhibits to be found in this section.

Rubber in Sports. Without rubber many of our favourite sports and pastimes would be impractical if not impossible. In this section, therefore, the uses of rubber for tennis, golf, squash and other kinds of play-balls are shown. Seaside beaches are enlivened in the summer by gaily coloured pneumatic rafts, surfing boards, aquatic toys and portable boats, specimens of which will be seen. Rubber bathing caps and shoes, beach bags and holdalls, together with hard rubber " woods " for bowling enthusiasts are also included in this section. Bathing costumes in which rubber thread has been incorporated are also shown.

Rubber Footwear and Clothing. Specimens illustrate the applications of rubber to the many forms of footwear for sports and everyday wear, and include shoes fitted with plantation finished crepe rubber soles, beach sandals, promenade shoes, flying boots, galoshes, and wellingtons for wet weather and agricultural use. An interesting feature is the progress exhibit showing the stages in the manufacture of a wellington boot. Various types of water-hats and coats, together with exhibits showing the use of elastic thread are also on display in this section.

Rubber in the Home. To demonstrate the applications of rubber in the home a bathroom and nursery together with a lounge have been erected. Attention is drawn to the following items in the bathroom: rubber flooring, rubber panelling above bath, rubber-proofed bath curtain, rubber brushes, rubber-shod jugs which reduce noise and eliminate damage to the floor, bath mats and ebonite toilet seat.

In the nursery there are sponge-rubber backed flooring, rubber panelling, toys, model buildings made from rubber bricks, sponge-rubber cot mattress and rubber pictures.

In the lounge there are rubber flooring, rubber topped tables, table lamp, and several forms of rubber upholstery: pneumatic, sponge rubber and rubberised hair. Thus, in pneumatic upholstery several methods are adopted by manufacturers to eliminate the "rolling" tendency adherent to early forms of such upholstery. Sponge-rubber upholstery is in some designs built up from bars of sponge-rubber or direct from rubber latex. Demonstrations of this latter process are given at specified times during the day. In rubberised hair upholstery the hair is massed together in a condition of a coarse loofah to which concentrated rubber latex is added during manufacture. The rubber ensures adherence of the hairs, while imparting additional resiliency to the upholstery.

Rubber in Hospitals. To illustrate the applications of rubber in hospital equipment an operating theatre has been erected. Attention is drawn to the following items: sponge-rubber operating table bed which can easily be cleaned and sterilised; surgeon's gloves, gauntlets and aprons, rubber bandages, rubber-tyred apparatus, rubber flooring, coving and panelling.

Research Exhibits. In this section exhibits have been collected which illustrate developments in recent research investigations. Among the exhibits are expanded chlorinated rubber, which is extremely light and non-inflammable; heat modified rubbers; and rubber resins; rubber paints and the treatment of wool with rubber.

Historical Section. Although the Rubber Industry is of relatively recent growth, some interesting items are included in this section, such as the experimental machinery designed and used by Thomas Hancock, the "Father of Rubber Industry"; examples of native Brazilian Footwear; the original plastic cast of Sir Henry Wickham; and figures carved in Ebonite.

Films. Films illustrating various branches of the Rubber Industry are being shown at periodic intervals.

LIST OF CONTRIBUTORS OF EXHIBITS

Advertex, Ltd.
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Allen & Hanbury's, Ltd.
Avon India Rubber Co., Ltd.

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Batemans, Ltd.
Batteries, Ltd.
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G. Bohanna, Esq.
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Bristol Aeroplane Co., Ltd.
British Tyre & Rubber Co., Ltd.
Bromford Tube Co., Ltd.
Bromilow & Edwards, Ltd.
Bruntons (Sudbury 1919), Ltd.

Caxton Floors, Ltd.
The Chemical Research Laboratory, Teddington.
Clark, Son & Morland, Ltd.
The Clyde Rubber Works Co., Ltd.
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P. B. Cow & Co., Ltd.
The Craigpark Electric Cable Co., Ltd.
W. Currie & Co.

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Gascoignes (Reading), Ltd.
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Little Mother Feeders.
T. Locker & Co., Ltd.
London Advisory Committee for Rubber Research. (Ceylon & Malaya.)
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Malayan Information Agency.
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Research Association of British Rubber Manufacturers.
Roadless Traction, Ltd.
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Rubtex, Ltd.
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Wool Industries Research Association.

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