

ted. This paste is made with melted wax; into which is put ten times its weight of powder of zinc, and about 1-50th of tallow or oil.

*Tenth;—process of making a zined paper.*—For protecting small polished metal articles, a zined paper, or wrapper, is employed, manufactured by mixing powder of zinc, ground very fine, with the pulp of the paper while making, or by powdering common paper previously covered with some adhesive substance, such as gum, or flour paste, taking care always to exclude the use of animal glue, which has a tendency to cause the iron to rust.

*Eleventh and lastly;—process of plating copper, iron, and other metals with zinc.*—Solid plates of zinc may be combined with other metals for their protection from oxydation, by plating in the following manner:—The iron, copper, or other metal, being previously cleansed by the acidulated bath, in the manner before described, it is covered with thin sheet zinc, well powdered with sal ammoniac, and the two sheets of metal are passed through heated rollers, from which they are received into water in a state of perfect adherence.

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*On Caoutchouc.* By ANDREW URE, M. D., F. R. S., &c. &c.

(TO THE EDITOR OF THE LONDON JOURNAL OF ARTS.)

SIR,—Since writing the article CAOUTCHOUC for my “Dictionary of Arts, Manufactures, and Mines,” now in course of publication, I have received, from several quarters, some valuable information; and have also made a series of experiments upon the subject, the results of which I have now the pleasure of transmitting to you for insertion in your journal.

Hitherto the greater part of the caoutchouc has been imported into Europe from South America, and the best from Para; but of late years a considerable quantity has been brought from Java, Penang, Singapore, and Assam. About twelve months ago, Mr. William Griffith published an interesting report upon the *Ficus-elastica*, the caoutchouc tree of Assam, which he drew up at the request of Captain Jenkins, agent in that country to the Governor-General of India. This remarkable species of fig tree is either solitary, or in twofold or threefold groups. It is larger and more umbrageous than any of the other trees in the extensive forest where it abounds, and may be distinguished from the other trees, at a distance of several miles, by the picturesque appearance produced by its dense, huge, and lofty crown. The main trunk of one was carefully measured, and was found to have a circumference of no less than 74 feet; while the girth of the main trunk, along with the supports immediately round it, was 120 feet. The area covered by the expanded branches had a circumference of 610 feet. The height of the central tree was 100 feet.

It has been estimated, after an accurate survey, that there are 43,240 such noble trees within a length of 30 miles, and breadth of 8 miles of forest near Ferozepoor, in the district of Chárdwár, in Assam.

Lieutenant Veitch has since discovered that the *Ficus-elastica* is equally abundant in the district of Naudwar. Its geographical range in Assam seems to be between 25 deg. 10 min. and 27 deg. 20 min. of north latitude, and between 90 deg. 40 min. and 95 deg. 30 min. of east longitude. It occurs on the slopes of the hills, up to an elevation of probably 22,500 feet. This tree is of the banyan tribe, famed for “its pillared shade, where daughters grow about the mother tree,” which has furnished the motto *tot*

*rami quot arbores*, to the Royal Asiatic Society. Species of this genus afford grateful shade, however, in the tropical regions of America, as well as Asia.

Many species of other trees yield a milky, tenacious juice, of which bird-lime has been frequently made; as *Artocarpus integrifolia*, and *Lakoocha*, *Ficus indica* and *religiosa*, also *F. Tsiela*, *Roxburghii*, *glomerata*, and *oppositifolia*. From some of these an inferior kind of caoutchouc has been obtained.

The juice of the *Ficus-elastica* of Chárdwár is better when drawn from the old than from the young trees; and richer in the cold season than in the hot. It is extracted by making incisions a foot apart, across the bark down to the wood, all round the trunk, and also the large branches, up to the very top of the tree; the quantity which exudes increasing with the height of the incision. The bleeding may be safely repeated once every fortnight. The fluid, as fresh drawn, is nearly of the consistence of cream, and pure white. Somewhat more than half a *maund* (42 lbs.) is reckoned to be the average produce of each bleeding of one tree; or 20,000 trees will yield about 12,000 maunds of juice; which is composed in 10 parts, of from 4 to 6 parts of water, and, of course, from 6 to 4 parts of caoutchouc. The bleeding should be confined to the cold months, so as not to interfere with, or obstruct, the vigorous vegetation of the tree in the hot months.

Mr. Griffith says, that the richest juice is obtained from transverse incisions made into the wood of the larger reflex roots, which are half exposed above ground, and that it proceeds from the bark alone. Beneath the line of incision, the natives of Assam scoop out a hole in the earth, in which they place a leaf of the *Phrynium capitatum*, Lin., rudely folded up into the shape of a cup. He observes that the various species of *Tetranthera*, upon which the *Moonga* silk worm feeds, as also the castor oil plant, which is the chief food of the *Eria* silk worm, do not afford a milky caoutchouc juice. Hence it would appear that Dr. Royle's notion of caoutchouc forming a necessary ingredient in the food of silk worms, and being "in some way employed in giving tenacity to their silk," seems to be unfounded. If Botany discountenances this idea, Chemistry would seem to scout it altogether, for silk contains 11.33 per cent. of azote, and caoutchouc contains none at all;\* being simply a solid hydro-carburet, and, therefore, widely dissimilar in constitution to silk, which consists of oxygen 34.04, azote, 11.33, carbon 50.69, and hydrogen 3.94 in 100 parts.

This hydro-carburet emulsion is of common occurrence in the orders *Euphorbiacea* and *Tulicea*, which may be looked on as the main sources of caoutchouc. The American caoutchouc is said to be furnished by the *Siphonia elastica*, or the *Hevea guianensis* of Aublet, a tree which grows in Brazil, and also in Surinam.

Dr. Royle sent models of cylinders, of  $1\frac{1}{2}$  to  $2\frac{1}{2}$  inches in diameter, and 4 or 5 inches in length, to both the Asiatic and Agricultural Societies of Bengal, to serve as patterns for the natives to mould their caoutchouc by. Mr. Griffith says that this plan of forming the caoutchouc into tumblers or bottles, as recommended by the committee of the London Joint-stock Caoutchouc Company is, in his opinion, the worst that can possibly be offered; being tedious, laborious, causing the caoutchouc to be blackened in the drying, and not obviating the viscosity of the juice when it is exposed to the

\* See my paper on the ultimate analysis of vegetable and animal substances, in the Phil. Trans. for 1822.

sun. He recommends, as a far better mode of treating the juice, to work it up with the hands, to blanch it in water, and then subject it to pressure. I shall presently describe a still better method which has recently occurred to me, in experimenting upon the caoutchouc juice. This fluid, with certain precautions, chiefly exclusion from air, and much warmth, may be kept in the state of a creamy emulsion for a very long time.

*New Experimental Researches of Caoutchouc.*

The specific gravity of the best compact <i>Para</i> caoutchouc, taken in dilute alcohol, is . . . . .	0.941567
The specific gravity of the best Assam is . . . . .	0.942972
“ “ Singapore . . . . .	0.936650
“ “ Penang . . . . .	0.919178

In the process of making the ELASTIC TISSUES,\* the threads of caoutchouc are first of all deprived of their elasticity, to prepare them for receiving a sheath upon the braiding machine. For this purpose they are stretched by hand, in the act of winding upon the reel, to 7 or 8 times their natural length, and left two or three weeks in that state of tension upon the reels. Thread thus *inelasticated* has a specific gravity of no less than 0.948732; but when it has its elasticity restored, and its length reduced to its pristine state, by rubbing between the warm palms of the hands, the specific gravity of the same piece of thread is reduced to 0.925939. This phenomenon is akin to that exhibited in the process of wire-drawing, where the iron or brass gets condensed, hard, and brittle; while it disengages much heat: which the caoutchouc thread also does in a degree intolerable to unpractised fingers, as I have experienced.

Having been favoured by Mr. Sievier, managing director of the Joint Stock Caoutchouc Company, and by Mr. Beale, engineer, with two different samples of caoutchouc juice, I have subjected each to chemical examination.

That of Mr. Sievier is greyish brown, that of Mr. Beale is of a milky grey colour; the deviation from whiteness in each case being due to the presence of aloetic matter, which accompanies the caoutchouc in the secretion by the tree. The former is of the consistence of thin cream, has a specific gravity of 1.04125, and yields, by exposure upon a porcelain capsule, in a thin layer, for a few days, or by boiling, for a few minutes, with a little water, 20 per cent. of solid caoutchouc. The latter, though it has the consistence of pretty rich cream, has a specific gravity of only 1.0175. It yields no less than 37 per cent. of white, solid, and very elastic caoutchouc.

It is interesting to observe how readily and compactly the separate little cloths or threads of caoutchouc coalesce into one spongy mass in the progress of the ebullition, particularly if the emulsive mixture be stirred; but the addition of water is necessary to prevent the coagulated caoutchouc from sticking to the sides or bottom of the vessel and becoming burnt. In order to convert the spongy mass thus formed into good caoutchouc, nothing more is requisite than to expose it to moderate pressure between the folds of a towel. By this process the whole of the aloetic extract, and other vegetable matters, which concrete into the substance of the balls and junks of caoutchouc prepared in Assam and Java, and contaminate it, are entirely

\* See "Dictionary of Arts, Manufactures, and Mines."

separated, and an article nearly white and inodorous is obtained. Some of the cakes of American Caoutchouc exhale when cut the fœtor of rotten cheese; a smell which adheres to the threads made of it, after every process of purification.

In the interior of many of the balls which come from both the Brazils and East Indies, spots are frequently found of a viscid, tarry-looking matter, which, when exposed to the air, acts in some manner as a ferment, and decomposes the whole mass into a soft substance, which is good for nothing. Were the plan of boiling the fresh juice along with its own bulk of water, or a little more, adopted, a much purer article would be obtained, and with incomparably less trouble and delay, than has been hitherto brought into the market.

I find that neither of the above two samples of caoutchouc juice affords any appearance of coagulum when mixed in any proportions with alcohol of 0.825 specific gravity; and, therefore, I infer that albumen is not a necessary constituent of the juice, as Mr. Faraday inferred from his experiments published in the 21st vol. of the Journal of the Royal Institution.

The odour of Mr. Sievier's sample is slightly acescent, that of Mr. Beale's, which is by far the richer and purer, has no disagreeable smell whatever. The taste of the latter is at first bland and very slight, but eventually very bitter, from the aloetic impression upon the tongue. The taste of the former is bitter from the first, in consequence of the great excess of aloes which it contains. When the brown solution which remains in the capsule, after the caoutchouc has been separated in a spongy state by ebullition, from 100 grains of the richer juice, is passed through a filter and evaporated, it leaves 4 grains of concrete aloes.

Both of these emulsive juices mix readily with water, alcohol, and pyroxilic spirit, though they do not become at all clearer; they will not mix with *caoutchoucine* (the distilled spirit of caoutchouc), or with petroleum-naphtha, but remain at the bottom of these liquids as distinct as mercury does from water. Soda caustic lye does not dissolve the juice; nitric acid (double aquafortis) converts it into a red curdy magma. The filtered aloetic liquid is not affected by the nitrates of baryta and silver; it affords with oxalate of ammonia minute traces of lime.

In a continuation of this paper I shall lay before your readers, next month, several interesting facts concerning the manufacture of caoutchouc on the great scale, supplementary to the account given in my Dictionary of Arts, &c.

Jour. Arts and Sciences.

February 18, 1839.

### *Hydrostatic Weighing Machine.* By CAPTAIN ERICSSON.

The object of this invention is that of dispensing with the use of weights, in all ordinary weighing in which ounces are not counted. The principal features are:

1. That the instrument is not subject to any friction; hence, that its accuracy is not, like the balance, affected under heavy weights.
2. That the motion of the parts is almost imperceptible, wear and tear being thereby prevented.
3. That the weight may be read off the moment the article is suspended.
4. That by suspending the instrument in the ordinary hoisting tackles,