

friction." The results of the experiments correspond, on the whole, approximately with the following value: Modulus of elasticity of silk fibre, 3,000,000 feet = 1,300,000 lbs. on the square inch. If we take the proof load, or greatest safe load, at one-third of the breaking load, the modulus of resilience or power of bearing shocks, which is a third proportional to the modulus of elasticity and the proof strength, is found to be as follows, for the thicker specimens of silken thread: 473 feet, (that is, 473 foot-pounds for a prism weighing 2 lbs.,) corresponding to 205 foot-pounds for a prism 2 feet \times 1 inch \times 1 inch. The resilience of a tie-bar 2 feet long, and 1 inch square, has the following values for some other substances: Very strong tough steel, 60 foot-pounds; strong hard steel, 46; soft steel, 31; good iron wire, 36; good bar iron, 14; strong plate iron, 12; strong tough cast iron, 4. Occasions may arise when it is necessary to have cordage of the least possible weight for a given strength or for a given resilience, without regard to expense; and then, without doubt, the best material is silk.

The Cohesive Force of Red Sealing Wax.

From the London Mechanics' Magazine, January, 1866.

The cohesive force of the best red sealing wax has been proved to be equal to 1500 lbs. per square inch, and that of the black sealing wax rather more than 1000 lbs. to the square inch; the deficiency in the latter is attributed to the diminished quantity of lac used in the composition. The cohesive force of solid glue was found to be 4000 lbs. per square inch, that of cast iron is 25,000 lbs.

On the Properties of Parkesine, and its Application to the Arts and Manufactures. By ALEX. PARKES, Esq., of Birmingham.

From the London Journal of the Society of Arts, No. 683.

In introducing to this meeting the subject of Parkesine, the author wishes to explain the reasons that led him to the production of this substance.

For more than twenty years the author entertained the idea that a new material might be introduced into the arts and manufactures, and, in fact, was much required; he succeeded in producing a substance partaking, in a large degree, of the properties of ivory, tortoise-shell, horn, hard wood, india rubber, gutta percha, &c., and which will, he believes, to a considerable extent, replace such materials, being capable of being worked with the same facility as metals and wood. This material was first introduced under the name of parkesine, (so called after its inventor,) in the Exhibition of 1862, in its rough state, and manufactured into a variety of articles in general use; it then excited the greatest attention, and received a prize medal, Class IV., 1112.

Parkesine is made from pyroxyline and oil, alone or in combination

with other substances; the various degrees of hardness or flexibility are obtained in the easiest and most expeditious manner by varying the proportions of pyroxyline, oil, and other ingredients.

The pyroxyline, used as the base in the manufacture, can be made from any vegetable fibre, or fibre-producing grasses, starch, &c., but preferably of waste from cotton and flax mills, old rags, paper makers' half stuff, or any fibrous waste material capable of being reduced into a soluble condition by the action of acids. To subdue the inflammable nature of this compound, the inventor has introduced several substances, such as iodide of cadmium, tungstate of soda, gelatine, chloride of zinc, several carbonates, sulphates, phosphates, and other substances.

The oils employed are some of the vegetable and some of the animal kingdom; they may be used alone or combined, either in their normal condition, or changed by a solidifying agent, chloride of sulphur being preferred, which has the remarkable property of completely solidifying the oils almost instantaneously; but the chemical combination can be modified according to the per centages of the chloride of sulphur employed, which may be varied to meet the exigencies of commerce. These solidified oils, although unchanged by ordinary reagents, are readily soluble in the author's solvents of pyroxyline, by which means the two ingredients are combined to form one of the descriptions of parkesine.

The inventor, after much research, labor, and investigation, observed that the solid residue left on the evaporation of the solvent of photographic collodion produced a hard, horny, elastic, and water-proof substance. This led him to employ, in all his experiments, pyroxyline, xylodin, or some collateral matter, as his base for future operations. By the word pyroxyline, the author wishes to be understood a less explosive preparation than the more highly converted compound "gun cotton," and his constant aim has been to apply to peaceful industrial purposes a material hitherto only used for military, blasting, and photographic purposes. The solutions of collodion known at the time of his first patent, in October, 1855, were practically unsuited to carry out the manufacture in solid masses and other large forms. This necessitated a new series of experiments, to discover a more economical mode of production, and he found that, by improving the manufacture of pyroxyline, and using different solvents, considerable success was attained. As an illustration, to show the impracticability of using collodion for the manufacture of solid articles, we have here a bottle of ordinary collodion, which is submitted to your notice. This is a solution of pyroxyline in the well known solvents, ether and alcohol, and when you are told that, in one pint of these mixed solvents there is only one-third of an ounce of solid material, and the whole of this pint of solvents must be evaporated to obtain this small quantity of hard substance, you will readily conceive that the cost of production would be much too high for large commercial purposes. The cost of 1 lb. of the mixed solvents would be 2s. 6d., the pyroxyline being 10s. per pound, and as 1 lb. of pyroxyline would require 48 lbs. of solvent to make photographic collodion, there will be a total cost of 130s. per

pound for the solid material which could be obtained from the evaporation of such solvents. The small specimen of pyroxyline now exhibited is the exact weight of that contained in the bottle, whereas, by employing the same quantity of the author's patented solvents, this large bulk of unconverted cotton, which, for the sake of safety, represents a similar bulk of pyroxyline, can be dissolved sufficiently for the manufacture of parkesine.

The author commenced his investigations in face of the above-named difficulties, and endeavored, by more economical methods of manufacturing the pyroxyline or other similar compounds, and by the use of improved and less costly solvents, to produce a new and cheap material. This, after many years of labor and thousands of experimental trials, he has succeeded in doing, and at the present time almost any quantity may be made per day, (many tons—simply depending upon the apparatus,) at a cost of less than 1s. per pound and upwards, according to the quality required.

The two specimens shown illustrate the great difference between the two productions. The small piece is made from the collodion of commerce, at a cost of 130s. per pound; and the sheet is the result of that made from the present mode of manufacture, at a cost of less than 1s. per pound. This will at once establish in your minds the practical value of the invention.

Having then satisfied himself as to the possibility of producing the material at such a price as would allow of its application in the arts, his next step was, by the combination of various substances, to counteract the inflammability of the material—to produce various colors—and to modify its hardness, toughness, and elasticity; and, although from the above statements the object sought to be obtained may appear exceedingly simple, it nevertheless necessitated an enormous amount of application to arrive at the knowledge which has enabled him to produce the specimens which are now laid before you.

One of the greatest difficulties in the earlier stage of his experiments was caused by the excessive contractile properties of the dissolved pyroxyline, as the piece now produced, as compared with the comparatively large bottle, will clearly exemplify, being the whole of the solid residue contained in 35 cubic inches of collodion; in fact, if a stiff solution of pyroxyline were made, such as would not flow from a bottle, still such a preparation would contract to from ten to fifteen times its volume, whilst in the present workings only from one-fourth to one-fifth of a pound of solvent is used to one pound of pyroxyline; consequently the contraction is reduced in proportion to the solvents used.

The author had long to contend against the adverse opinions of many, that his efforts to introduce such an article for the general purposes of manufacture, from such expensive materials, appeared hopeless; and even since specimens were shown at the Exhibition of 1862, much discouragement has been thrown in the way of the progress of the invention by many who had conceived the idea that it would be impossible to produce the material at a price that would render it

valuable for general application ; the inventor feels proud that he has been enabled to surmount these obstacles in so far establishing a new manufacture which—by the intelligence of practical minds, which he trusts will be devoted to its further development—will, he ventures to hope, eventually become one of considerable commercial importance.

The innumerable trials and investigations required, involved no less than twelve years labor and expenditure of many thousand pounds, before the material could be proved to be really of commercial importance ; and although this may appear a long time to pursue one object, the author wishes to explain that time itself has been of the utmost importance in developing this manufacture, as it has enabled him to test the effect of time on the material, and also of atmospheric changes, and many other influences ; this has proved of great value in arriving at his present knowledge of the material. Although he has been much engaged in other important business he was determined not to relinquish the manufacture of parkesine until the truth of what he stated at the Exhibition, in 1862—that the material could be produced in some of its qualities at 1s. per pound—was proved, and this he has satisfactorily established by twelve months practical working. One of the means which enabled him to produce parkesine at a cheap rate, is the employment of waste cotton, in the shape of rags or otherwise, which are procurable at an exceedingly low price, and also the use of improved solvents, and the means of recovering them by special machinery ; also the being able to dissolve the pyroxyline in a wet state, thus avoiding the time and great space and risk of drying, which was the practice until recent important improvements enabled him to accomplish this most important desideratum.

When it is necessary or desirable to increase the flexibility or elasticity of preparations of pyroxyline, the author combines therewith oil, solidified or partly solidified by the action of chloride of sulphur, a reaction discovered by him some twenty years ago, when engaged in investigations relative to the cold process of vulcanizing india rubber, patented by him about that time. The chloride of sulphur is dissolved into bisulphide of carbon or mineral naphtha, the proportion suitable for the purpose being from 10 to 15 per cent. of chloride of sulphur to the cotton-seed, castor, or other oils. This will be found (as will be exhibited to you by experiment) to be of a solid or semi-solid consistence, according as more or less of the chloride of sulphur is used, so that the physical condition of preparations of pyroxyline may be considerably modified to suit special application by the use of gums, resins, paraffin, stearine, tar, glycerine, and other substances combined therewith.

The author would observe that the result of using a large proportion of the chloride of sulphur is to solidify the oil, (even to a jet-like mass,) but it is preferable to use about 15 per cent. to produce a tough elastic substance. He wishes it to be observed, generally, that in proportion as the oils predominate, so is the elasticity of the materials regulated.

Another important improvement in the manufacture of parkesine

is the employment of camphor, which exercises an advantageous influence on the dissolved pyroxyline, and renders it possible to make sheets, &c., with greater facility and more uniform texture, as it controls the contractile properties of the dissolved pyroxyline; camphor is used in varying proportions according to requirement, from 2 per cent. to 20 per cent. Another of the author's improvements for the like object consists in the use of gelatine dissolved in glacial acetic acid.

The author believes he was the first to employ colors in the dissolved pyroxyline. The solvents used in the manufacture of parkesine are also good solvents of the aniline colors; this gives the great advantage of producing the most beautiful colors in a transparent substance, as well as in opaque or solid masses, as the specimens will show; and when these colored articles are carved, the most exquisite effects are produced, imitating amber, malachite, and many other natural substances; moreover, as the material can be moulded by pressure, the most beautiful works of art can be copied at a very small cost. For many large and cheap applications, as much as 60 per cent. of pigments, sawdust, or cork-dust can be introduced with advantage, and thus is produced a beautiful and solid substance, very strong, which can be moulded and turned in a lathe or rolled into sheets, the cost, owing to these admixtures, being exceedingly low.

In all large manufactures the most important point to be considered is the production of raw material, which, in many cases, fails in quality and supply. The substances the author employs in the manufacture of parkesine are procurable in any quantity, and having a perfect control in the manipulation of the materials used, he can always ensure a regularity in the various qualities required, thus placing at the command of the artisan a material to be had at all times of a uniform standard quality, which he conceives to be no slight boon to the manufacturer.

There is another important feature in the economy of this material—no loss in manufacture is experienced, every particle, scrap, or dust can be reworked, and the most beautiful effect produced. Specimens will show the effect of some of the waste scraps remanufactured, and it will be readily seen that by careful admixture of colors very pleasing results may be obtained. This is another important advantage over other materials, such as ivory, tortoise-shell, india rubber, vulcanite, gutta percha, &c., with which this substance is calculated to compete.

The difficulties in manufacturing this material on a commercial scale were at first very great, as before explained, but by steadily persevering, the manufacture is now rendered very simple and rapid. From five to ten tons of parkesine sheets can now be produced in less time than one ton of india rubber. Sheets of large size and of any thickness, solid blocks, tubing, or other forms, can be made in a few minutes, and from the cheapness and unlimited supply of the raw materials employed, the price of parkesine will, it is believed, be much less than that of india rubber, ebonite, gutta percha, ivory, tortoise-shell, and many other materials.

Many specimens on the table have been produced from materials made ten years ago, in which no change or decomposition has taken place; the substance is not affected by sea-water, in which it has been immersed for a period of four years without the least deterioration, nor is it softened by heat like gutta percha, and, therefore, it is not likely to be affected by the heat of tropical climates.

It can be made transparent, or in any colors, variegated to imitate tortoise-shell, marble, malachite, hard or flexible; can be moulded, shaped, by dies or pressure, turned in a lathe, worked into screws, cut with a saw, planed, carved, engraved, rolled or pressed into sheets, as all the articles in the case before you will clearly show; it is very agreeable to the touch, and is susceptible of the highest polish; it can be inlaid with metals without any injurious effect upon them after years of exposure; it is also invaluable as a water-proofing agent, and can be used as a varnish for a variety of purposes, and as a non-oxidizing agent for the protection of iron ships, &c.

The various stages of manufacture are fully illustrated by the variety of specimens now before you, from the unprepared cotton waste to the ultimate conversion into the finished articles.

Perhaps one of the most interesting facts in connexion with this new manufacture is the employment of nitro-benzole, or aniline, by which improvement very great facilities are obtained in dissolving pyroxyline, and as these materials are also solvents of india rubber and gutta percha, a combination of these substances may be readily obtained which will be valuable for many purposes. A specimen of this combination is on the table.

The applications of this material to manufactures appear almost unlimited, for it will be available for spinners' rolls and bosses, for pressing rolls in dyeing and printing works, embossing rolls, knife handles, combs, brush backs, shoe soles, floor-cloth, whips, walking sticks, umbrella and parasol handles, buttons, brooches, buckles, pierced and inlaid work, book-binding, tubes, chemical taps and pipes, photographic baths, battery cells, philosophical instruments, water-proof fabrics, sheets, and other articles for surgical purposes, and for works of art in general.

There is one application of the parkesine which, as far as experiments have gone, promises to be of great importance, viz: insulating telegraph wires. It will be at once evident, from the nature of the ingredients used, that by simple mechanical and chemical processes, perfect freedom from impurities or foreign ingredients can be attained—a most important property in a material which it is intended to employ for electrical and insulating purposes. The difficulty of producing a pure and homogeneous article, has, there is reason to believe, resulted in the total failure of some thousands of miles of submarine cables and underground wires. Parkesine is placed upon the wire by being forced through a die in successive coatings with the same facility as gutta percha, and the author believes it to be far less liable to faults than india rubber.

A few specimens of the application of the material for electrical and

telegraphic purposes are exhibited. It is, however, deemed advisable to state, that extensive experiments have been made under the direction of Mr. Owen Rowland, (electrician to the late Joint Committee of the Board of Trade and the Atlantic Telegraph Company, appointed to inquire into the construction of submarine telegraph cables, &c.,) with the view of ascertaining to the fullest extent the electrical properties and applicability of the material for the above important purposes. The results of these experiments leave no reason to doubt that, on the completion of the necessary machinery, a most excellent and efficient insulator will be produced, (and, indeed, it has already been produced, even by imperfect and inadequate machinery,) possessing all the requirements of insulation.

Short specimens of insulated wire (made by hand) in this substance for underground and ariel lines are exhibited, the latter in the form of a multiple cable, according to the valuable patent of Professor Wheatstone, containing an insulated sustaining iron wire, and seventy-nine insulated conducting copper wires, both insulation and protecting envelope being effected by parkesine, which, possessing great strength and flexibility, and being a non-oxidizing material, is extremely well adapted for the latter purpose. This cable is believed to be capable of bearing its own weight in air for a distance of upwards of one mile.

In its hard and solid form, by virtue of its high insulating and non-oxidizing properties, this material is peculiarly well adapted for electrical instruments, terminal boards, testing boxes, batteries, insulators for poles, and many other philosophical purposes, and the advantages to be derived from the employment of a material which remains free from oxidation under all conditions, will be duly appreciated by electricians and experimentalists in their daily operations and investigations. Its tensile strength is considerably above that of either gutta percha, india rubber, or any other insulating material. Joints can be made with the greatest facility and perfection.

In the following instruments on the insulating power of parkesine as compared with various other materials, the greatest care was taken to secure a correct and reliable result. The temperature was constantly maintained at 61° ; the pieces were thoroughly dried, to avoid surface conduction; the same surface length of each made to rest on the metallic stand in contact with earth; the blotting paper between the *piece* and the metal kept saturated with water, so as to ensure complete surface contact; the leakage of the instrument itself frequently ascertained; the full tension at the commencement of each test recorded as well as the exact time. The tests, in some instances, were repeated several times with uniform results.

Experiments made at Hackney Wick, on the 29th August, 1865, on the loss of insulation on the lengths of variously coated copper wires, &c.; instrument employed, a Peltier electrometer. Full tension, 40; temperature, 61° Fahr.

Parkesine,	5° in 1' 45''
Plain gutta percha,	5° " 0' 37''
Gutta percha and Chatterton's compound,	5° " 1' 8''
Plain gutta percha covered with parkesine,	5° " 1' 4''
India rubber, (masticated,)	5° " 1' 15''
India rubber, (virgin,)	5° " 0' 30''
Ebonite disk,	5° " 2' 10''
Parkesine disk,	5° " 2' 35''

The author has been furnished by Mr. Owen Rowland with the result of a further series of experiments made recently by him on the insulating properties of the material. These tests were made upon slabs and sheets of various qualities, hardness, and flexibility. Specimens are exhibited.

The value of the insulating properties of each piece in comparison with ebonite is shown in the following table:

No. 1 specimen,		Leakage.	Time.
" 2	"	11·5° in	1080''
" 3	"	11·5° "	510''
" 4	"	11·5° "	180''
" 5	"	11·5° "	360''
" 6	"	11·5° "	210''
" 7	"	11·5° "	185''
" 8	"	11·5° "	212''
" 9	"	11·5° "	509''
" 10	"	11·5° "	25''
" 11	{ Prepared oil or base of Parkesine. }	11·5° "	2046''
" 12	Ebonite,	11·5° "	1050''

The third column shows the time occupied by the needle of the electrometer in falling from the maximum tension of the electric charge to one-half tension thereof, or from 50° to 38·5°.

It is satisfactorily proved that the more perfect the means adopted for rendering the material free from impurities, the more its efficiency for insulating purposes increases.

(To be continued.)

On the Flow through Apertures of Solid Bodies.

From the London Practical Mechanic's Journal, February, 1866.

In the preceding number of this Journal a review was given of the part for July, 1865, of the *Annales du Conservatoire Imperial des Arts et Métiers*, in which prominence was chiefly assigned to a memoir by M. Tresca on "The Flow (*écoulement*) through Apertures of Solid Bodies." These experimental investigations have done science so important a benefit by demonstrating as laws what have hitherto been more or less hypothetical, that the writer has deemed it expedient to place on record, in English technical literature, a *résumé* of the principal experiments upon which the conclusions hereafter given are based.