AMERICAN INDUSTRIES.—No. 91.

[SEE FIRST PAGE.]

THE MANUFACTURE OF FINE PRINTING PAPERS.

In no other department of industry have there been more marked advances in recent years than in the manufacture of paper. Modern printing presses, and a society of which nearly all are large readers, as well of tastily printed books and periodicals as of the daily papers, have increased the demand many fold within the present generation. It would have been impossible to meet this greatly enlarged call for paper if it were all manufactured of rags, as was the case a few years ago, and to use the cotton, flax, etc., in their raw state would have made the product very expensive; therefore, in this country, wood has been largely used, either in connection with rags or alone for the cheaper grades, and in England the Spanish esparto grass has, since 1856, furnished a very large proportion of all the paper stock. Materials of which paper can be made are found in nearly all vegetable life, but the cellulose is in many cases so intimately associated with coloring and other matters as to require the use of expensive chemicals, while rags, having been originally purified during the manufacture of the cotton and flax, yield a large percentage of fiber with comparatively little cost for chemicals. They give a very pure white with exceedingly strong fiber, and are used alone for only the finest qualities of paper, although pulp from inferior fibers is often mixed therewith in making medium grades of paper. Of the wood used in paper making poplar is most esteemed, as it gives a very white fiber; pine gives a long and strong fiber, but the wood has so much resinous matter that it requires stronger chemicals and more work to fit it for the paper machine. The manufacture of paper pulp from wood is principally confined to the United States and Sweden, though wood pulp is somewhat used by English and European paper manufacturers.

In practical paper making the assorting and dusting of the rags is the first step. They come in great variety, differing according to the locality where gathered, and are divided into many classes and grades, this market receiving many from the Baltic and Mediterranean ports. When stored in large quantities great care should be taken that they are perfectly dry, many fires having occurred from the heat developed by the slow decomposition of rags stored in a damp condition. The sorting of the rags is necessarily done by hand, but cutting them up into pieces about two by five inches or less is now done principally by machine. Both before and after the sorting they are passed through thrashers or dusters, which beat the rags and drive the dust through wire gauze partitions.

The boiling, which comes next, may be done in various kinds of vessels, but a horizontal cylindrical boiler, which revolves, gives a more perfect circulation of the liquor, and is generally preferred. The chemical used is lime, carbonate of soda, caustic soda, or a mixture of the two former, which is equivalent to the latter. The quantities used, as well as the pressure and time of boiling, vary with the quality of rags, and afterward the rags must be thoroughly washed, which is effected by running on water, and with more or less pressure of steam. The breaking and washing usually require from two to four hours, and the machinery therefor is represented at the right in two of our first page views.

The bleaching may be effected with a liquor made by dissolving bleaching powder in water, although bleaching with gas and sour bleaching are sometimes followed, but, whatever the method adopted, any excess of bleaching agent must be got rid of.

The sizing is effected by the precipitation and intimate mixture with the pulp of a substance which will, when dry, to some extent fill up the interstices between the fibers of the paper, and which will not readily take up water. Common resin and alumina, with carbonate of soda, through the medium of a resin soap, make a mixture which may be thoroughly incorporated with the fiber, and it is here that a small quantity of china clay is added, for some qualities of paper, to close up the pores and enable it to take a good surface, such addition, to the amount of five per cent, not being considered detrimental, while more than that would weaken the fiber.

The Fourdrinier paper machine, of which several may be seen in the large view near the middle of the page, forms in itself one of the best representations of the high attainment reached by modern mechanical skill. Improvements have been steadily made in it through many years, for the better working of different kinds of pulp, and the making of a greater variety of product, but the original features of its construction have been maintained. The pulp is fed to it over sand tables and strainers, to remove lumps and imperfections and separate the fibers, then to an endless cloth of very fine wire carried by a large number of small rolls, the wire cloth also having a shaking motion from side to side to weave and intertwine the fibers; thence it passes to an endless felt, traveling over rolls, and between press rolls, till the water is so taken out and the fiber knit together that it can be passed over drying cylinders and between heated and polished rolls for surfacing and calendering. There are, of course, many different modifications of machines, the details being variously contrived for the best results in different kinds of work, but these are the essential features in all of them.

The calendering machines, a view of which is given at the bottom of the page, are for the purpose of giving a hard finish, the paper being here passed around steam heated cylinders and rolls, where powerful pressure can be applied.

The Jessup & Moore Paper Company, whose establishments furnish the subjects of our illustrations, have four paper mills, the Augustine, the Rockland, the Delaware, and the Chester, the two former being on the Brandywine, near Wilmington, Delaware, the Delaware mill on the Christiana River, and the Chester mill near Coatesville, Pa. In selecting a site for a paper mill, it is absolutely requisite to obtain one which shall have an abundant supply of pure water, not only as a matter of economy in working, but fine paper cannot be made at all with the water found in many localities. In respect of this prime essential, these mills have exceptionally advantageous locations.

The Augustine mill was the first built and run by the firm, but it has been successively changed until now nothing remains of the original structure, and it stands to-day one of the most costly and complete paper mills in the world for the manufacture of fine grades of book paper. It has Jonval turbines for a water power equal to 300 horses, besides a 20 inch, a 30 inch, and two 15 inch cylinder Corliss engines. The largest and heaviest leather belt ever then sent from New York was furnished for this mill about five years ago. The engine room forms a striking feature of the establishment. The entire mill is of stone and iron, fireproof, and lighted by electricity, and all the machinery is of the latest and most improved description, the engines for the preparation of the stock being of iron, and there being at work here two 90 and one 76 inch Fourdrinier machines. Many of the most artistic publications in the country are printed upon paper made at this mill, and it has for years furnished the paper for the SCIENTIFIC AMERICAN. The capacity of the mill is 30,000 pounds a day.

The Rockland mill, built in 1860, was designed for the manufacture of newspaper, and was among the first to utilize the process of making printing paper from chemically prepared straw pulp. Reconstructed, after a fire in 1864, of stone and iron, its capacity was greatly enlarged, the straw process abandoned, modern machinery introduced, and good grades of paper for book work and weekly newspapers have since been made. Besides the water power furnished by Jonval turbines there are employed here two 20 inch and a 16 inch cylinder Corliss engine, and one 28 inch cylinder Babcock engine. Three Fourdrinier machines are used, one 74 inches and two 86 inches wide, and the product is 26,000 pounds of paper a day.

The Delaware mill has a production of 32,000 pounds a day, and the Chester mill 8,000 pounds daily, and both are completely equipped with the best modern appliances.

The firm of Jessup & Moore was organized in 1843, by Augustus E. Jessup, of Westfield, Mass., and Bloomfield H. Moore, of Philadelphia, and the corporation of the Jessup & Moore Paper Company was organized December 1, 1878, its officers consisting of C. B. Moore, President; D. W. Evans, of New York city, Vice-President; F. W. McDowell, Secretary; and J. R. Moore, of New York, Treasurer—under whose management the business is still conducted. The business offices of the house are in the Bennett Building, New York, and 28 South Sixth Street, Philadelphia.

The history of this house has been in a marked degree typical of the progress of paper making for the past half century. It has kept fully abreast of the times, and its exhibit of cellulose at the last Paris Exposition was a great surprise to the papermakers of Europe, showing, as it did, that American paper manufacturers were decidedly in advance of their European competitors in the utilization of new raw materials in the manufacture.

Death of a Pioneer in Machine Shoemaking.

Mr. Edwin C. Burt, the widely known New York shoe manufacturer, died at his home in Orange, N. J., May 23, 66 years of age. It is doubtful whether any other manufacturer in this business ever attained the wide reputation which he achieved, in a short space of time, from the success with which he employed the sewing machine in making the finest grades of ladies' shoes. Previous to 1862, when machinery began to be introduced generally in shoe factories, it was not thought possible to make fine goods in this way, but Mr. Burt bought the finest kids and the best sole leather, employed a high class of workmen, and then, himself superintending the work, used machinery to make a finer class of goods than had ever before been offered as ready made, and which was rarely equaled in the best handmade goods. The success which attended his efforts did much to hasten that industrial change from which it now appears that about nineteen-twentieths of all the boots and shoes worn in the country are factory made, and the "bespoke" shoemaker of the olden time has almost gone out of existence.

Annual Convention of Civil Engineers.

The American Society of Civil Engineers will hold its annual convention for 1884 at Buffalo, N. Y., June 10th to 13th. A special train over the New York, West Shore, and Buffalo line will convey members from this section. Reports are expected and discussions will be had on "Standard Time," a "Uniform System for Tests of Cement," the "Preservation of Timber," and other topics.

AN illustrated article on paper making machinery, as manufactured at the Pusey & Jones Works, at Wilmington, Del., will appear in the SCIENTIFIC AMERICAN in next issue.

Science and Manufactures.

There was never perhaps a time when the special industries of England were more depressed, or their outlook more gloomy. The fact that the steel rail makers of England have banded themselves with those of France and Belgium into an association for the maintenance of remunerative prices speaks volumes, not only as to the severity of competition, but as to the sources from which that competition comes. On the other side we see the ironmasters of America extending their output year by year, and her manufacturers entering into competition with us in neutral markets, while jealously excluding us from their own.

What is to be the remedy for this state of things? How is the demand for manufactured articles, and for the raw materials out of which those articles are made, to be once more equalized with the supply? Unless some vast market, such as China or Central Africa, can be opened up to European commerce, the only chance seems to lie in a new departure; in some great cheapening of production, or cheapening of transport, comparable to that which was effected by the development of railways. Now, what is the physical fact lying at the basis of railway locomotion? It is simply this, that iron laid in the form of a track offers a resistance to rolling which, as compared with an ordinary road, is insignificant, while at the same time it offers a resistance to sliding large enough to utilize to the full the vast tractive power of the modern locomotive. The first point had long been known; the second was seized by the practical genius of George Stephenson, and enabled him at once to solve the problem of high speed locomotion. In so doing he owed nothing to science; but science might have discovered the fact, and would have done so with small trouble, if the idea had been put into her head—if, in fact, there had been in England that union of theory with practice which it is our present aim to advocate.

What is wanted now is that science shall point out some other fact of nature, new or old, which practice may seize upon, turn to her own ends, and make the basis of some new industrial development. It is easy to indicate various directions which such a development might take. Thus there is great need of some system of light railways which can be laid down on ordinary roads, and so cheaply that the traffic available on such roads may be sufficient to pay a fair return on the capital. It is impossible to calculate the advantages which would spring from the wide extension of such "third class railways," as they are called in Germany. Again, the storage of power, such as that of the tidal wave, with cheap and ready means for giving it out when and where it is needed, offers a wide field for invention, and may lead to the most fruitful results. The transmission of power to long distances, whether by electricity, compressed air, or otherwise, is a somewhat similar problem, which at present occupies the attention of many engineers and men of science. Lastly, the more homely subject of house building offers at this moment special inducements to constructive genius. If houses could be built, by the use of iron or otherwise, at, say, half their present cost, the problem of sheltering our poor would be solved; unsafe and ruinous tenements would disappear, and a demand would set in for building materials and labor such as the world has never known.

Here, however, the question arises, Supposing that science and art should combine successfully for any such purpose, is it in England that the development will take shape?

At the time of the last industrial epoch, that of the introduction of railways, it would have been safe to prophesy that this would be the case. It is by no means so certain now. As regards cheap transport, for instance, the most promising recent invention in this field, viz., the caustic soda condenser previously described by us, was brought out in Germany. Other improvements in the same field, such as the portable railways of De Cauville, the rack railway of Riggenbach, the cable tramway of Hallidie, the fireless engine of Francq, the iron sleepers which are rapidly becoming universal in Germany, have all taken their rise either on the Continent or in America. The storage of power, in its only practical form, that of the secondary battery, owes its origin to Plante and Faure. The transmission of power is being worked out by Siemens in Berlin, and by Deprez and Tresca in Paris. Lastly, as to building, no one can travel abroad without seeing that as regards scientific architecture England stands far nearer the bottom than the top in the scale of civilized nations.

What is the reason of this? Why is England thus lagging behind in the race? The answer is not far to seek. In America, in France, above all in Germany, the union between science and art is far more close and cordial than with us. Every practical constructor or manufacturer is anxious to know all he can of science, every scientific professor desires to mix practice with his theory. Thus on the one hand we find ordinary engineers drawing on all the resources of mathematics for the solution of such problems as the proper sections of rails or the resistance of trains; on the other hand we see Clausius, perhaps the greatest of German physicists, devoting two long papers to investigate the working theory of the dynamo machine. But a concrete instance will make our meaning clearer. Within the last few days we have inspected a safety lamp, of which some thousands have already been sold for the German mines. It has many points of excellence, but we need only dwell upon one. It is well known to be most important that a miner's lamp should be locked in such a way that he cannot, if he will, open it; and it has been found very difficult to provide any simple kind of lock which it is beyond the resources of a clever workman to tamper with. In this lamp the difficulty is got over by making the upper part screw into the lower, while inside the lamp there is a catch or pawl, which, as in a common ratchet, prevents the screw from being turned the opposite way. Hence, that the lamp may be unscrewed, the pawl must be drawn out of place. In the overseer's office this can be accomplished by means of a powerful horseshoe magnet. The pawl has a tail, which is attracted by the magnet when the latter is placed in contact with the side of the lamp. The tail moving toward the magnet, the pawl moves in the opposite direction, and so allows the upper part of the lamp to be unscrewed, while the lower is held as if in a vise by the same magnetic power.

Now, here we have a simple and beautiful contrivance for effecting an important practical object. It is merely the application of a well known scientific principle to solve a special problem in construction ; but it never could have been invented except by one to whom the resources of science and the needs of art were equally familiar—who was at once a physicist and an engineer. Now, it cannot be questioned that in England we can boast many of the highest authorities in science, many men of the highest skill in practical construction; but the union of the two is comparatively rare, and yet it is this very union—the application of the scientific spirit to the things of common life—which is the vital necessity of the age.

We by no means wish to imply that no progress is being made in the direction here pointed out. The work undertaken by the City and Guilds Institute, the foundation of scientific colleges, such as those at Birmingham, Sheffield, Leeds, Nottingham, and elsewhere, the appointment of a Committee on Technical Education, the delivery of scientific lectures at the Institution of Civil Engineers—these are all signs that the gap existing between art and science is at last recognized, and that endeavors are being made to draw them together. Moreover, the old "rule-of-thumb" engineer is rapidly passing away, and a new generation is springing up, who, if they do not possess much science themselves, are at least alive to its value. The testing machine, for instance, is becoming a recognized institution in large workshops, where not many years ago it would have been scouted as absurd. In the skillful hands of a practical engineer, Mr. Wicksteed, of Leeds, it has been made to record its own variations of stress by a self-drawn diagram, and this record seems likely to throw fresh and unexpected light on the physical problems of extension and rupture. The same gentleman has both discovered and applied a new and most remarkable phenomenon in friction; the fact, namely, that if we give a rotary motion to a body which is in contact with another, not only is the friction diminished in the direction of motion, but the friction in the perpendicular direction is also diminished, apparently in at least an equal degree. Hence, for instance, by rotating the leather packing of a hydraulic ram, it becomes quite free to move in its cylinder in obedience to a difference in pressure on one side or the other. Here we have, once more, science helping art, and art in return throwing light upon the path of science.

These facts, and others like them, are encouraging signs, but we must repeat that something more than signs is needed. The work must be not only begun but finished, the bonds of union must be drawn close, and that quickly, or England will find that it is too late, and that she is once more ready to do the work of the world just when the world has left her no work to do.—*Nature.*

Opera by Telephone.

When the new opera "Lauriana" was produced recently for the first time, at the Lisbon Opera House, the King and Queen of Portugal were in mourning for the Princess of Saxony. The etiquette of courts prevented their royal highnesses from attending, and their despair thereat added to their grief at the loss of the Princess was like to have overwhelmed them. If Mohammed could not go to the mountain, the mountain must come to Mohammed. And so he brought the opera to their royal highnesses—by telephone.

Six microphone transmitters were placed about the front of the operatic stage in multiple arc. They were mounted on lead and soft rubber pedestals to prevent disturbance from the vibration of the building. Each transmitter was fed by three sets of batteries, which were switched on every twenty minutes in succession to keep on the current strength. There were receivers at the palace end for the use of the royal family, who thus heard the opera from beginning to end.

Germs at Sea.

It has generally been thought, and direct observation has confirmed the notion, that the air above the sea is singularly free from the low forms of organic life. MM. Moreau and Plantymansion have taken advantage of their leisure during a voyage in the Gironde from Rio de Janeiro to Bordeaux to obtain some data bearing on this question. They have found that over the open sea, at a distance from the vessel, the air contained very little solid matter. The land breezes appear to become rapidly free from the multitude of organisms which they carry with them from populous districts. M. Miguel, of the Montsouris Observatory, regards the fall of germs into the sea as a reassuring fact; breezes blowing from the distant continents, which might otherwise bring epidemics with them, become purified, it is supposed, in crossing the ocean. The gentlemen above named have found that the atmosphere immediately about the vessel practically swarmed with micro-organisms; the vessel seemed to be surrounded by an "atmosphere of microbes."

Correspondence.

Illustrations of Electrical Phenomena.

To the Editor of the Scientific American :

Having occasion to illustrate in a lecture some of the phenomena of atmospheric electricity, I desired to obtain as long strokes as possible. With the apparatus at hand the longest stroke I could obtain in air was 4¼ inches. I tried iron filings sprinkled on varnished glass, paper, and wood, but the results were not satisfactory. After several experiments I hit upon the following exceedingly successful method:

I fastened dry boards together to make a plane surface, 4 feet long and 3 feet wide. One side of this I varnished, and before it was dry pressed over its entire surface sheets of tin foil. After letting it stand over night to dry slightly, with a ruler I passed a sharp knife across the foil in lines about one-eighth to one-quarter inch apart. Allowing it to dry again a short time, I passed the knife across it right angles

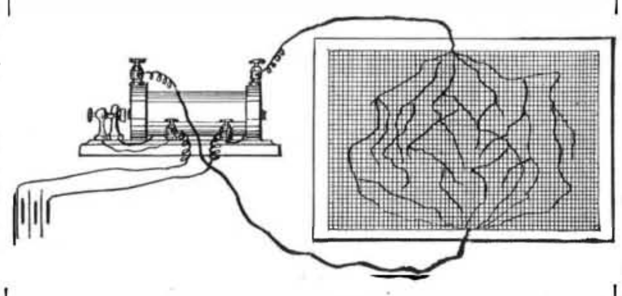

Fig. 1.

to the former lines, thus cutting the foil into squares, separated by very short distances—only the thickness of the knife edge. Connecting the poles of my coil to opposite ends of the board, a phenomenon of dazzling beauty was produced. Every time the circuit broke, from six to twenty streaks of lightning zigzaged from one end of the board to the other. These were exceedingly brilliant in the dark, when the circuit was broken only about 180 to 200 times a minute. Judging from the resistance of vacuum tubes placed in the circuit at the same time, I believe I can obtain strokes from 15 to 20 feet in length by this method, if the foil be placed in a narrow strip along a pole of that length.

The drying mentioned above is necessary, as it is very slow under the foil, and the strips will be pulled out of their places in the second cutting.

REYNOLD JANNEY.

Wilmington, O., March 16, 1884.

My coil is made on the same plan as that given in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 160, and contains about 30,000 feet of No. 36 naked copper wire. The circuit break is a combination of the ordinary platinum contact break and a mercury break, so that either can be used at will. The mercury break produces much better effects. It consists of a platinum wire dipping into mercury covered with alcohol.

The condenser consists of 40 sheets of tin foil, 6 inches by 12 inches, with varnished paper between.

The battery consists of three cells of the Grenet type, each containing about 50 square inches of zinc surface, counting both sides.

With this battery and coil I to-day obtained strokes in air 4½ inches long between a brass disk, 1½ inches in diameter, and a point.

Over a tin foil surface as described I obtained a stroke 10 feet long, with sufficient force to make it much longer had I had a greater length of tin foil.

There is one peculiarity about these strokes depending upon the connections. If the opposite ends of the board

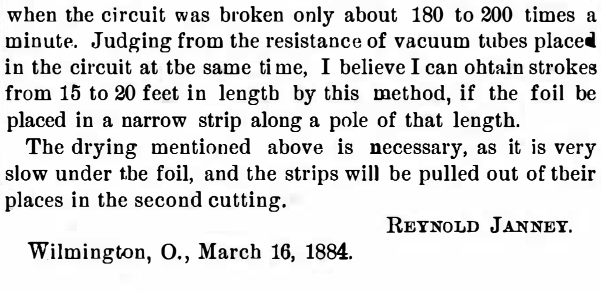

Fig. 2.

covered with the foil be connected directly with the poles of the secondary coil, the discharge seems to scatter over the whole surface, making several simultaneous strokes and producing a very beautiful appearance. (See Fig. 1.)

If the connections remain as in Fig. 1. but also the poles of the coil be connected one with the inside and the other with the outside of a small condenser containing about 4 to 6 inches of tin foil, the electricity no longer scatters over the board, but makes only one much more direct and more intense stroke. (See Fig. 2.)

REYNOLD JANNEY.

Wilmington, O., June, 1884.

Intermarriage of Cousins.

To the Editor of the Scientific American :

There is a popular belief that the intermarriage of first cousins is likely to produce offspring imperfect in intellectual or physical development.

Is this belief sustained by scientific observation and statistics? S.

[*Ans.*—The prevalent idea that the offspring of the intermarriage of first cousins are specially liable to be below the average intellectually and physically is not found to be sustained by good evidence. Mr. G. H. Darwin, in a very carefully prepared paper, before the Statistical Society of London, comes to the conclusion, as the result of close comparison of all the records available, that the evidence will not "enable any one to say positively that the marriage of first cousins has any effect in the production of insanity or idiocy. . . . With respect to deaf mutes, there is no evidence whatever of any ill results accruing to the offspring in consequence of the cousinship of their parents." And again, "It tends to invalidate the alleged excessively high death rate among the offspring of cousins." And once more, "The safest verdict seems to be that the charge against consanguineous marriages on this head is not proven."—EDS. S. A.]

Dangers of the Proposed Treaty.

To the Editor of the Scientific American :

I write to call attention to a great danger which hangs over the patent interests of the United States. It lies in the proposed new reciprocity treaty. The danger is just in this: There are a great number of patented machines making *goods* that are not patented. The patent is on the machine; remove the tariff, and what is to prevent the Canadians building the machine, and killing the patent. The Canadian patents have had but small value, for the conditions are not favorable to a numerous class of patents, such as are obtained to protect a line of manufacture which, from its nature, should be held in the hands of one party, so as to secure uniformity of quality and degree of excellence. This treaty will kill all such patents, to the injury of the public and to the ruin of those who, on faith in protection, have made large investments.

Any treaty entered into with Canada which virtually destroys protection obtained in good faith should not be entered into, and the foundation of such treaty should be founded upon a reciprocity of patent protection. R. T. SMITH.

Nashua, N. H., June, 1884.

Soda Water Profits.

Under the caption of "A Business that Pays," a large dealer in soda water apparatus thus enlightens the trade on "the profits which dealers in carbonated beverages may reasonably hope to make," which he says "can be readily inferred from the following accurate estimate of the cost of manufacturing each beverage." In the "dispensing department"—that is, selling from the fountain—the following are the actual costs:

One glass of plain soda water costs one-tenth of a cent.

One glass of soda water with sirup costs one cent and a half.

One glass of mineral water costs one cent.

One glass of root beer costs one cent.

One glass of ginger ale costs one cent and a quarter.

One glass of fine draught champagne costs four cents.

In the "bottling department" the following scale of costs, prevails:

Plain soda water, best quality, put up in bottles closed by corks and fasteners, costs eight cents per dozen.

Ditto, with gravitating stoppers, costs three cents per dozen.

Soda water, with sirup, in bottles closed by corks and fasteners, costs fifteen cents per dozen.

Ditto, with gravitating stoppers, costs ten cents per dozen.

Ginger ale, in bottles, with corks and wires, costs seventeen cents per dozen.

Ditto, with gravitating stoppers, costs twelve cents per dozen.

Mineral waters in siphons costs three cents per siphon.

Sparkling champagne (domestic), best quality, costs twenty-five cents per quart bottle.

From a simple comparison of the foregoing scale of costs, and the well known retail charges for the same articles, the inference drawn by the manufacturer, that it is "a business that pays," appears to be a correct one.

Then a list is given of the materials included in the outfit for this business. We find in this catalogue the following items:

Sulphuric acid and marble dust to make the carbonic acid gas, which gives the sparkling quality.

Chemical extracts for the flavors.

Coloring to imitate raspberry, strawberry, and other fruits.

Gum foam to give it an artificial foam, which enables the retailer to sell half a glass of soda as a brimming glassful.

Tartaric and citric acid to do duty for lemon soda.

Coloring for making something sold for sarsaparilla.

There is one item called an "acid dispenser," which appears to be essential in handling "acids and other corrosive" ingredients. We are not informed if such acids and corrosive substances are eliminated during the manufacture or during their passage into the human stomach. Such facts remain among the mysteries of "a business which pays."