HOW RAILROADS ARE MADE.

BY JACOB ABBOTT.

THE CHARTER.

When the grant is obtained from the Legislature, it is inscribed in a very distinct and legible manner upon parchment, and authenticated by the proper signatures and seals, and is delivered to the Company. Such a document as this is called a Charter.

THE COURSE OF THE ROAD.

The general course of the road is usually prescribed in the charter. The precise line, however, cannot be determined without much careful study and examination, and many accurate surveys. There are a great many different considerations which have to be taken into the account in deciding the question. If the only thing to be inquired into was the conformation of the land on the different possible routes, with a view to determining on which of them the track could be laid most easily, with the gentlest inclines, and the least expense for bridges, culverts, and the like, the question would be very simple. But there are many social and business considerations to be regarded—such as the position of towns in the neighborhood of the line—not only of those already existing, but of those which may be brought into existence in consequence of the road; the points where freight of different kinds, and passengers from the surrounding country, may most easily be concentrated; the facilities for the construction of stations; and other similar points.

Sometimes, indeed, it is found, after making a careful calculation, that it is better to go through a hill by means of a tunnel, rather than to make a circuit to avoid it. The calculation, in this case, is very complicated, involving, as it does, a great number and variety of considerations—such as the nature of the formation; whether consisting of solid rock or of beds of sand or gravel, which is to be cut through, or of loose and friable strata of any kind, requiring an arch of masonry to sustain the roof, as seen in some tunnels; the saving of fuel and of time in the subsequent working of the line by going straight, and on a level, instead of pursuing a devious course up and down inclines; and, finally, the advantage of not disturbing the public roads on the surface, or the private property which would have to be paid for, and of avoiding the necessity of building bridges or culverts which might be required on any feasible route that would avoid the hill.

In the same manner, a complicated calculation has to be made, to determine whether it is best to shorten a distance by constructing an expensive work for carrying the line across a river, a marsh, or a pond, or to avoid the obstacle by a circuit and save that money.

All these things, which have to be taken into the account in the calculations which the directors have to make, would seem to render the case complicated enough, but the difficulty and embarrassment are vastly increased by the number and variety of conflicting interests which are brought into action. These interests are, of course, much more important, and much more serious, in the pressure which they bring upon the directors in the old and more densely populated countries in Europe, where land is much more valuable, and towns more numerous, where rich estates, costly gardens, and elegantly ornamented pleasure grounds are more frequent, and more highly valued than with us. One line of towns competes with another, each wishing to have the road pass through them. One nobleman, or great landed proprietor contends against another, each wishing to keep the road away from his parks or gardens. The baron trembles for his castle, for fear that the road will cut through the grounds of it. The farmers adjoining him tremble lest the road should not come that way, and so deprive them of the opportunity of sending their produce conveniently to market; and different manufacturers, who cannot all be accommodated, severally urge the directors to run the line here, there, or in the other place, each wishing to secure facilities for himself in bringing materials to their establishments, and taking away the manufactured goods.

All these things the directors have to consider before they can decide upon the location of the line; and a very perplexing and embarrassing work they often find it.

GENERAL SURVEY.

The principal towns through which it is finally decided that the line shall pass, form usually fixed points for the track, both in respect to position and level, so that the construction of the line going from one town to another, becomes, as it were, in some respects, a distinct and independent work. Of course, the best determination of the track, were it practicable, would be in a direct line from one terminus to the other, and a uniform incline, in case of any difference of level. But this is seldom possible. The track must rise and fall, to follow gentle but extended undulations in the land, and deviate to the right or to the left, to avoid all high hills and deep valleys, and sometimes to avoid exceptionally valuable estates, the traversing of which would involve too great an expense for damages. To enable the directors to judge intelligently on these points, a careful survey of the country must often be made, and accurate maps and profiles constructed, showing not only the natural scenery, such as the course of the streams, the positions of the villages, the situations of forests, marshes, ledges of rocks, and other such characteristics, but also the differences and the exact gradations of level in every part.

TRIANGULATION.

All surveys of land for such purposes as this are made by a very curious process called triangulation. Very few persons—except those who have had their attention particularly called to the subject—have any distinct idea of the nature of this process; and yet, after all, it is very simple in principle, though very curious, and is very easily understood.

The method consists in dividing the whole territory of the country to be surveyed, into triangular areas, by means of signal posts, set up at proper intervals on the summits of hills, or on any commanding positions, and connecting these stations by imaginary lines. These lines are so drawn, however, and so connected at the points where they meet at the stations, that each side of every triangle forms, also, a side of the triangle next to it. In other words, the triangles are formed by sets of lines radiating from the same points—namely, the signal posts on the eminences above mentioned.

The reason why the triangle is employed for this purpose in preference to any other figure, is, because it is so much more easy to be measured with accuracy than any other; and the reason why it is so much more easy to be measured, is, because the work may be done chiefly by the measurement of angles; and angles may be measured much more easily and accurately, on a great scale, than lines.

DIFFERENCE OF BEARING.

The angle formed by two lines running from any station on a hill or mountain, to objects in the field of view, is simply the difference of bearing of those objects. Now, if an observer stands at a signal post on a mountain, and sees the spires of two villages at a distance across the country, he can measure the exact bearing of each of the spires from the place where he stands, and can obtain thus the difference of direction of the two lines running toward them, very easily, and with great precision, by means of extremely accurate instruments constructed for the purpose; and could do it, moreover, in a moment, without leaving the spot where he stands. On the other hand, to measure the distance of one of the spires by means of a rod or chain applied to the ground, would require him to scramble down the sides of the mountain, over rocks and precipices, and to traverse the intervening country, through forests and bogs, perhaps, and over all sorts of impediments. The work would be, in all cases, one of great difficulty; in many cases it would be impossible, and without the expenditure of great labor and expense in the mode of performing the operation, there could be no reliance whatever in the accur. cy of the result.

This is the reason why it is so much easier, in surveying, to measure angles than lines.

Still, it is not possible, wholly, to dispense with the measurement of lines on the earth's surface, in surveying. There must be one line measured for every survey as a means of beginning the calculation. One line being thus measured by mechanical means, and made one of the sides of the first triangle, the other sides of the first triangle, and all the sides of all the other triangles, can be obtained by calculation from the measurement of angles alone.

THEORY OF THE CALCULATION.

A glimpse of certain mathematical properties of the triangle, on which these calculations are based, may be obtained by means of the supposition that two huntsmen, standing at a certain distance from each other, are aiming at the same mark. Each one is pointing his gun in a certain direction—that is, so that it forms a certain angle with the line we may imagine to be drawn between them. Now, it is plain that if the mark is moved from its position in any way—whether it is carried farther off or brought nearer, or moved to the right or to the left—one or both of the huntsmen would have to alter his aim.

In the same manner, if the distance between the huntsmen is increased or diminished, while the position of the mark remains unchanged, then, too, the aim must be changed.

In other words, it is plain that all the dimensions of the triangle are controlled, or, as the mathematicians express it, determined, by the length of one side, and the bearings from it of the other two sides; in other words, by one side and the adjoining angles.

PRACTICAL SOLUTION.

This principle, so obviously true, may be reduced to practice by a very simple method. We have only to draw a triangle upon paper of the same proportions and form with the one on the field, and then measure the two unknown sides by the same scale that was used in laying down the known side. For instance: suppose that the distance from one huntsman to the other was found to be sixty paces. We conclude to take for the scale a tenth of an inch to a pace, which would give sixty tenths of an inch, or six inches for the length of the corresponding line upon the paper. Then, from the two extremities of this base line, we draw two other lines at the same angles of inclination with it as were made by the lines of aim of the two guns, and then prolong these lines until they meet.

We shall now obviously have upon the paper a triangle of the same form and proportions with the one imagined in the field, and we have only to measure the two lines converging toward the mark by the same scale to which the first line was drawn—namely, one tenth of an inch to a pace, to ascertain the distance in paces from the station of each huntsman to the mark

INACCURACY.

It is plain that the principle of this operation is perfectly correct in theory, but the imperfections in the methods of measurement, as described above, would render the result quite uncertain as to accuracy. Pacing gives only a very rough approximation to the actual length of any distance on land. The terminations of the line, too, at the point where the huntsmen stand, are very indefinite; and then the huntsmen cannot be supposed to have any other than very imperfect means of estimating the bearing of their respective lines of aim, in relation to the base line between them. The drawing of the triangle on the paper to a scale, would admit of a greater accuracy than any other part of such an operation; but even this could not be performed with a degree of precision that would satisfy the ideas of a skilled mathematical surveyor.

ACCURACY.

The example given above is only intended to afford some general idea of the principle that certain parts of a triangle determine, necessarily, the other parts, so that, if the former are ascertained by measurement, the latter can be ascertained by calculation. The surveyors have the means of determining the lengths of lines measured on the earth's surface, and the magnitudes of the angles formed by the bearings of different signals from the same point, with a precision almost inconceivable. It would, however, be out of place to describe those instruments or methods here.

Then, moreover, they depend for their results, not on drawings made mechanically on paper, but on mathematical calculations made by the help of trigonometrical tables, constructed with infinite labor and study. Still, although the processes necessary to secure exactness in the results are laborious and complicated, the principle on which the work is based stands out in all its simplicity in the midst of it—namely, this, that

"If two lines converge toward each other at the ends of a third line, the length of which is known, the amount of the convergence, as measured by the angles, will determine the distance at which they will meet."—*Riverside Magazine.*

Fire-Proof Construction.

On the 11th of last month the Drake, Farwell & Thatcher block, Chicago, one of the most beautiful and costly business structures ever erected in this country, was burned to the ground. Several lives were lost, and the total amount of property destroyed is estimated to have been two and one half millions of dollars. The building was designed by and erected under the supervision of Mr. John M. Van Osdel, a most highly accomplished and skillful architect, and, while not intended to be fire-proof, it was supposed to be among the most substantial structures of its class.

In writing of its destruction at this late date we do not purpose to enter into detail, because the catastrophe was but a repetition of similar disasters which have occurred in this and other cities. In every essential particular the structure, on the morning before the fire, would not have suffered by comparison with buildings of its class in any city in America. The walls were equally heavy, and a careful examination of the ruins afforded convincing evidence that the masonry had been executed with scrupulous care. The Mansard roof, about which so much has been said contained less wood than the majority of similar roofs in New York, Philadelphia, and Chicago. According to the American idea it was a first-class building. It was as good as any building of similar size not intended to be fire-proof. And now, after all this, if it can be proved that the walls were of insufficient thickness, that the roof was of material too inflammable, that the system of anchoring joists was bad, what does it all signify? It simply signifies a condition of things which the *Builder* has from the beginning denounced. We have said, again and again, that our entire system of building needs reforming. If not, then why are we compelled to witness these fearful conflagrations? Why do we not hear of such fires in the great cities of the old world? Do we ever read of a fire like this in Paris? No: the elder civilization builds better than we; and, building better; it builds cheaper. The expense of iron girders is not a serious matter in the construction of a building which is to contain millions of dollars, worth of merchandise in its several departments, because it is not difficult to construct fire-proof floors after the French method where no wooden joists enter the walls. Our underwriters clamor for thicker walls.

We have been referred, time and again, to the recent fire on Randolph street, where the walls are standing; but those walls were built under Mr. Van Osdel's direction, and differ little, if any, from other walls. The fire went through them in twenty different places, and all that saved the adjacent building from burning was the Babcock extinguisher in the hands of the firemen and citizens, prominent among whom was Mr. Murphey, secretary of the Home Insurance Co.

It is hardly fair to charge all the evils of the present system of building on the architects, because the evil is back of them. Property owners demand a liberal percentage on their investments, and in order to secure it buildings must be erected with special view to cheapness. When the *Tribune* Company desired a building that would not burn down, there was no difficulty in finding an architect to execute its will. The greed manifested by property owners to secure the largest percentage possible on rentals, and the extreme willingness of insurance companies to make good all losses, are the saddest features of this whole building business.

ELASTIC AND SWEET GLUE.—Good common glue is dissolved in water, on the water bath, and the water evaporated down to a mass of thick consistence, to which a quantity of glycerin, equal in weight to the glue, is added, after which the heating is continued until all the water has been driven off, when the mass is poured out into molds, or on a marble slab. This mixture answers for stamps, printers' rollers, galvano-plastic copies, etc. The sweet glue, for ready use by moistening with the tongue, is made in the same way, sub stituting, however, the same quantity of powdered sugar for the glycerin.

WHATEVER be the issue of the struggle between France and Germany, Von Moltke has won his place in history. The student of European warfare can no more think of 1866 or 1870 without having in mind a picture of that small, thin, silent old man, than he could think of Silesia and forget Frederick the Great, or Austerlitz and not remember Napoleon

Improvement in Woodworth's Surface Planer.

The accompanying engraving shows a very neat and compact machine for planing wood surfaces, being a modification of the well-known and justly popular Woodworth planer. It is, in fact, a consolidated Woodworth planer with four rolls above and two below, with a narrow table under the knife, and having the rolls all geared together. The compactness of this arrangement, and the economy of space and cost secured thereby, will be apparent upon inspection of the engraving.

N, in the engraving, represents the cylinder knives on the shaft with main-pulley and feed-pulley. E is one of the front feed rolls, four inches in diameter. The other front feed roll is three inches in diameter, but is hidden by the roll, E.

The position of the back rolls, which are precisely like those in front, except that they are not fluted, is indicated by the letter W. Caps, G, contain compression rubber springs which serve to hold the rolls in place, yet to allow them to accommodate themselves to varying thickness of stuff.

L is one of the under rolls four inches in diameter. A similar one is on the back side of the machine, not shown in the engraving.

A represents the feed shaft and pulleys, D is a clutch coupling with lever for running the working parts of the machine into gear with the shaft, A. The cone pulley next the clutch lever forms a part of the clutch coupling, and runs loose on the shaft when not clutched. The feed is regulated by the cone pulley, M.

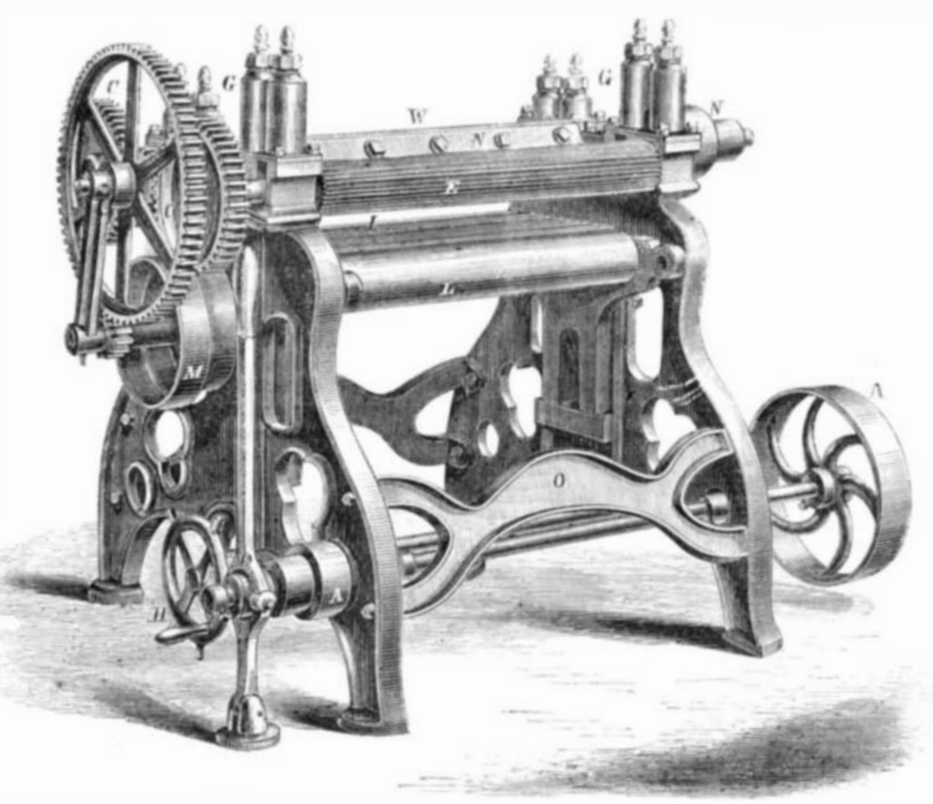
C is the gearing which drives the feed rolls.

The table, I, is raised or lowered by the hand wheel, H, which acts through bevel gearing, not shown, to turn vertical screws playing in nuts fastened to the bottom of the table.

The sides of the frame are massive and strong, and are firmly connected by the heavy brace pieces, O.

A hood, not shown in the engraving, serves to throw off shavings. It is so constructed as to rise and fall with the feed-rolls, and to completely cover the back smooth rolls, so that no shavings can get on either these rolls or on the board, to mar the latter after it has been planed. This attachment is regarded as a great improvement.

For further particulars, address the New England Machine Co., Fitchburg, Mass.



IMPROVED WOODWORTH SURFACE PLANER.

Pekin as It Is.

A correspondent of the Sacramento *Union*, writing from China, thus describes Pekin:

No long description, be assured—only this: From the observatory one sees a large portion of the town. Built of mud-brick, and gray stone, dotted with sparse foliage, of magnificent distances, curious architecture glimmering in the light, serpentine lanes and by-ways, the scene is not enchanting. In the streets, the scenes to be encountered are revolting. Sand, filth, pools of fetid water, miserable mud huts, and occasional tawdry temples; innumerable braying donkeys; such carts; dromedaries; occasional chairs; long lines of mules; dense throngs of coolies, of whom not one in twenty—aye, fifty—is half-clad in dirty rags; crawling beggars festering with disease; among the people scenes of gross indecency on the very sidewalks—a perfect disregard for what even a "Digger's" modest would revolt at; women, Tartars, small merchants, peregrinating restaurants, naked children eight or ten years of age; shops filled with earthenware of coarse manufacture; tea houses about every mile; the habitation of some high Chinese officials—one-storied, and that would make a second-rate stable in America; half-a-dozen temples, once massive and costly, but with no trace of beauty; the principal street, paved with rough blocks of granite that is worn in deep ruts and almost impassable; the emperor's palace and grounds—a dingy, barren walled inclosure, guarded by slaves; streets almost impassable with rubbish, ruts, and rocks; in brief, the most wretched, decayed, crumbling, repulsive spot we ever saw, with a semi-civilized, conceited, inhospitable, lazy, lousy populace, with no trace of anything that tells of content or happiness equal to their associates and superiors—the dogs and pigs of the Imperial capital.

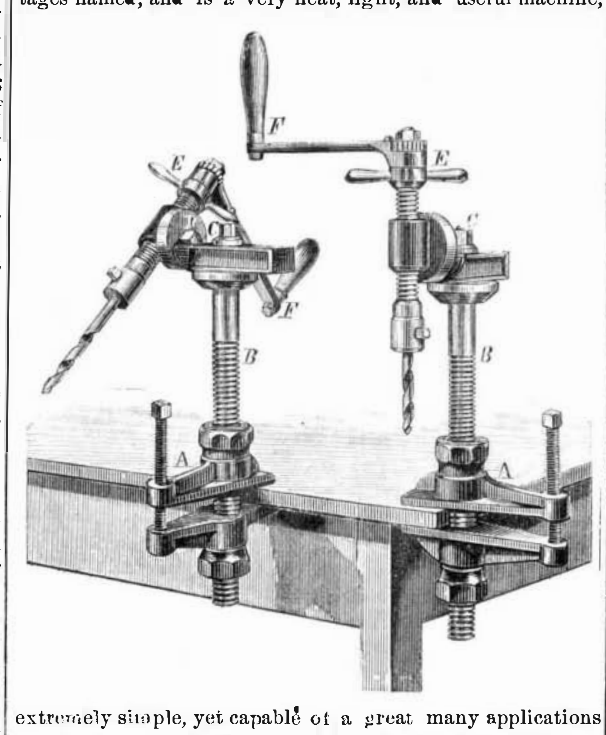
This is Pekin, with its millions of wretched inhabitants. I confess to unmitigated disgust. I abhor those enthusiastic chroniclers who have shed untruthful ink in praise of this horrible place. If proof is required to substantiate my views, I would refer to an esteemed resident of Sacramento, now a thoroughly disgusted resident of Pekin.

The Love of the Beautiful.

What are half the crimes in the world committed for? What brings into action the best virtues? The desire of possessing. Of possessing what?—not mere money, but every species of the beautiful which money can purchase. A man lies hid in a little, dirty, smoky room for twenty years of his life, and sums up as many columns of figures as would reach half round the earth, if they were laid at length; he gets rich; what does he do with his riches? He buys a large, well-proportioned house; in the arrangement of his furniture he gratifies himself with all the beauties which splendid colors, regular figures, and smooth surfaces can convey; he has the beauties of variety of association in his grounds; the cup out of which he drinks his tea is adorned with beautiful figures; the chair in which he sits is covered with smooth, shining leather; his table-cloth is of the most beautiful damask; mirrors reflect the light from every quarter of the room; pictures of the best masters feed his eyes with all the beauties of imitation. A million of human creatures are employed in this country in ministering to this feeling of the beautiful. It is only a barbarous, ignorant people that can ever be occupied by the necessities of life alone. If to eat, and to drink, and to be warm, were the only passions of our minds, we should all be what the lowest of us all are at this day. The love of the beautiful calls man to fresh exertions, and awakens him to a more noble life; and the glory of it is, that as painters imitate, and poets sing, and statuaries carve, and architects rear up the gorgeous trophies of their skill—as everything becomes beautiful, and orderly, and magnificent—the activity of the mind rises to still greater and to better objects.

IMPROVED HAND-DRILLING MACHINE.

The convenience of a hand-drilling machine that can be easily and quickly set to drill at any desired angle, and which combines with this attainment the conveniences of the ratchet drill will be appreciated by every machinist. The hand-drilling machine herewith illustrated combines the advantages named, and is a very neat, light, and useful machine,



extremely simple, yet capable of a great many applications in practical use, which we need not specify, as they will at once suggest themselves to all practical men.

A clamping vise, A, serves to sustain the screw post, B, in any required position on the bench, or upon the framework or other portion of machines where it may be requisite to use the drill for special service. Strong nuts receive the screw-post, B, and acting against each other, hold the screw-post firmly after it is adjusted to the proper hight from the bench.

A horizontal arm is pivoted to the top of the screw-post, and may be turned radially about the axis of B to any desired position, and then secured by turning down the nut, C.

To the end of the horizontal arm is pivoted a plate which carries the drill and feed screw. The latter may be turned radially about the axis of the horizontal arm to any required position and secured there by turning home the nut, D. The feed-screw is actuated by the lever nut, E, in the usual manner.

A winch, F, operates a ratchet and pawl on the arbor of the drill, so that it may be revolved entirely around or through any arc of its revolution in cramped positions where entire revolutions are not practicable.

It will be seen that within certain limits, depending upon the size of the machine, there is not a point to which the drill cannot be set and made to operate with ease and facility.

Patented, through the Scientific American Patent Agency, April 5, 1870, by James E. Hunter. Address, for rights, machines, or other information, James Hunter & Son, North Adams, Mass., or Kelly, Howell & Ludwig, agents, 917 Market street, Philadelphia, Pa.

A Chicago Street Locomotive.

Mr. D. J. Lake, who was the contractor for constructing the lake tunnel, has invented and constructed a peculiar road engine, which has been tried of late in our streets. It has the apparatus of a steam fire-engine attached. The following description we copy from the Chicago *Times*:

"In an ordinary locomotive, the steam from the cylinder acts upon the piston and is communicated directly to the crank of the driving wheels. In Mr. Lake's machine, when desirable, the motion can first be communicated to balance wheels. When these wheels have reached a very high rate of speed, the power can be communicated by a 'clutch' to the driving wheels. The communication can be made gradually, or as rapidly as may be thought desirable.

Any one can see the benefit of this style of communication. Suppose the vehicle in a place where it requires extra force to start it. By applying the power at once no movement is effected; but by storing it up in the balance wheels, and then communicating it to the drivers, one gets almost precisely the same benefit that he would by getting, say, a heavy wagon under rapid motion just before running it up an incline.

"He has another novelty. The machine has two sets of driving-wheels, one of which is considerably smaller than the other. By a simple use of the screw, either set can be raised, leaving the other on the ground. The power can be applied at will to either. The object of these two sets is, of course, to obtain either greater power or speed, as may be desired. In hauling heavy loads, the small wheels will be used, and in excursions, where there is no great weight to be hauled, rapidity is secured by the employment of the large drivers.

"A pump and air-chamber furnish a complete apparatus for throwing water; while a hand wheel allows the transfer of power to a thrashing machine, or any other article of the kind.

"The engine itself is a very handsome one. It weighs about three tuns, and moves without difficulty, and guides as easily as a well-trained horse."

Patented through the Scientific American Agency.

HISTORY OF CHLOROFORM.

The story of the discovery of the properties of chloroform in England is this: A Mr. Waldie, a chemist and bookseller at Linlithgow, had one day some of the liquid in a saucer, when a gentleman entered the shop with a little dog. The chloroform was placed on the ground to be out of the way, and presently the dog was discovered lying by the side of the saucer, unconscious, and apparently dead. After a time, however, while the stranger was mourning over the loss of his pet, the dog moved his limbs and gradually regained consciousness. Mr. Waldie began to think that he had made a discovery, and, after having administered chloroform to a number of cats with the same result, was confirmed in his belief. He went to Edinburgh to relate his story to some medical men, and at the suggestion of a friend, called upon Professor James Y. Simpson. After that interview Simpson tried a number of experiments, and proved beyond all question the virtues of chloroform as an anæsthetic. Professor Simpson published the results of his experiments in 1847, and gave full credit to Mr. Waldie for his share in the matter; but, as the learned physician had previously tried ether, protoxide of nitrogen, and everything in fact that was suspected to have anæsthetic properties, it is more than probable that he would soon have hit upon chloroform.

It was Dr. Simpson who first applied chloroform in childbirth, and for this he is justly celebrated. Although chloroform was discovered by an American, Guthrie, in 1831, and the editor of the *Pharmaceutical Journal* of Philadelphia, in publishing an account of it, even at that early date, anticipated for it an extensive application in medicine, it was not until the news of Dr. Simpson's experiments reached this country in the winter of 1847, that this valuable compound was introduced as an anæsthetic. The scientific properties of chloroform were first investigated by Liebig and Dumas, and they gave it its present name from its supposed chemical constitution—terchloride of formyle, which was abbreviated to chloroform.

LINEN can be glazed by adding a teaspoonful of salt and one of finely scraped white soap into a pint of starch.