WIRE AND TUBE DRAWING.

[By John C. Anderson, C.E., in the Cantor Series of Lectures before the Society of Arts.]

Wire has been used in Europe for more than 400 years. At first it was made by drawing down, in blacksmith fashion, with the hammer upon the anvil. The draw-plate was invented in Germany about 300 years ago, but it was comparatively little used until recent times. Now, the rolling-mill and the draw-bench are combined into one system of manufacture, by means of which the rate and diminished cost of production have developed the trade so enormously as to have led to the use of iron and steel wire for ropes, bridges, fencing, telegraph, and so many other new purposes, that it has at length become a great branch of industry.

Hollow tubes are now manufactured of all sizes, and out of all the ductile metals. This apparently difficult process is accomplished in several ways. With one system it is done by first forming a hole through a short, dumpy piece of metal, either by casting or drilling; into this hole a mandril is inserted, and then the dumpy mass, by means of the drawing process or by rolls, is passed through a succession of holes until it covers the mandril from end to end. This mandril may be a fine wire, or large enough to form the tubes for a steam boiler. A similar process, but substituting rolls for the draw-plate, is mostly employed for the larger sizes. The same or similar principle is frequently employed to make tubes, close at one end, these tubes being of various sizes; in such case the holes are not passed entirely through the mass; the mandril is inserted and is then pushed through the successive holes in the draw-plate, until the metal is extended over the mandril. Sometimes the piece is formed from a disk into a thimble-form, and then put on a mandril to be elongated. There is also an extensive manufacture of iron wire and of iron tubes, both being covered with a thin brass tube, by which means not only beauty but greater strength is obtained at a reduced rate; and for such purposes as these articles are used, viz., picture-rods, hand-rails, shop windows, carpet rods, and such like, the arrangement fulfills the object equal to an entire brass structure. The iron wire or tube is made as before described; the outer brass tube is made in a similar manner, but sufficiently large to admit of its being slipped over the iron. The iron may now be considered as a mandril, and the two are drawn through the draw-plate together, thus fixing the thin brass tube upon the iron, while the whole surface exposed is brass.

The so-called copper wire which is now extensively used by upholsterers for the spring cushions of sofas, beds, and similar purposes, is merely iron wire, which is made in the ordinary manner until just before the last process, when it is immersed in a solution of sulphate of copper for a short time, sufficient to allow a thin film of copper to be deposited on the surface of the iron wire. The iron wire thus covered with copper is now drawn through a draw-plate, by which it is rendered hard and elastic and suitable for a spring, at the same time the dull surface of the deposited copper is made as bright as a new farthing, and serves to protect the wire from oxidation.

There is yet another application of the natural law, which a few years ago would have been reckoned an impossibility—it is the process for drawing conical tubes. Nothing yet said will explain how this can be done. A taper mandril will suggest itself, which, so far, is simple. But the die of varying diameter, how is that to be obtained? For a long time rolls for rolling taper gun-barrels have been in use, in which a succession of tapering grooves are formed, while, by dexterous management, the roller contrives to insert the thick end of the gun barrel at the precise point in the revolving rolls, and thus the gun-barrel is elongated towards the muzzle by means of the narrowing groove in the rolls; bayonet blades are likewise drawn out in the same manner. In the process to which I now refer, for the drawing out of the long tapering brass tubes, an expanding die is used for a draw-plate. This die consists of a ring of block-tin containing a small percentage of copper, to give it a little greater rigidity; this ring is applied at the smaller end of the mandril, and the brass is drawn through the die. By this means two effects are produced, first, the metal is drawn over the mandril to a small extent, and secondly, the die is destroyed, from the extension to which it has been subjected; it is therefore thrown into the melting-pot, to be cast into a new die, and thus by a succession of new dies, the metal is gradually drawn over the steel taper mandril, until it is covered with brass from end to end, when the steel mandril is withdrawn.

There is yet another remarkable process in connection with this natural property, which is taken advantage of in the formation of ornamental twisted tubes of various patterns, such as we see in the gas fittings of churches and other places. To produce such tubes, the brass is first drawn into a plain tube upon a mandril, in the way described; this plain tube is then passed through a succession of revolving blunt screw-tools, having the required form upon their interior surface. In form the tool is arranged as a screw-nut, but not being adapted to cut the metal, and the plain tube being without a mandril, its surface is slightly depressed by the screw pressure, and by a succession of such screw-tools, or nuts, it is finally depressed to the finished ornamental pattern as required.

We sometimes see these ornamental tubes of a diamond screw pattern, where the spiral is crossed by another spiral, uniformly along the entire surface. This is done by means of two sets of screw tools, one set turns to the right hand, the other set to the left hand, and between the two the pattern is formed. This pattern may be of any section, plain, square, octagonal, ribbed, rounded, or otherwise, all depending on two principles; first, the flowing properties of the atoms of the metal, and secondly, the copying arrangement, by which the required pattern is transferred to the tube under operation, thus shifting the relative position of the molecules, yet without cutting the metal.

Referring again to the wire-drawing process, such is the effect produced by the operation that, contrary to what might have been expected, the strength of the wire or steel is greatly increased. In the case of iron of an ultimate strength of 25 tuns per inch, it is increased in strength fully 10 tuns, and some of the best iron, with a strength of 28 tuns, is raised to 40 tuns. The most remarkable change in this respect is in the case of steel music-wire. The mild steel out of which this is made has a strength, when in the natural state, of from 30 to 40 tuns, according to its steeliness, but when tempered mildly, by being made red-hot and then cooled in oil, and elongated into wire, its strength is increased fully three-fold. At the same time, if such steel or even iron wire is made red-hot, so as to allow the natural law to assert itself, all these high conditions vanish, with only one redeeming quality, that the wire then becomes more pliable, and similar in strength to the iron or steel out of which it was made.

The knowledge that this treatment of steel has the effect of increasing its strength and toughness so enormously, has produced fruits in several directions. One of these, bearing on the present subject, is the attempt to draw steel tubes of any length, or section or substance. Throughout the engineering world there are many purposes (indeed wherever motion is involved) for which a strong light material would be extensively applied, provided it could be obtained at a moderate cost. To accomplish this operation, a hole or slit, according to the section required, is first formed in a short thick mass of steel; two dies are employed, the one internally (which remains in use throughout the operation), the other externally (which has to be exchanged for a smaller one at every passage). Then enormous hydraulic pressure is brought to bear in pulling it through the vacant space between the internal and the external dies, thus leaving a portion of the steel behind, which forms a reservoir of steel for the increased length, by future elongating with that which could not pass through at the rate of motion of the apparatus, but to follow suit as it has opportunity, and then, by annealing the mass of steel, and using smaller and smaller external dies in succession, the thick lump becomes gradually elongated into any length of any section, and, if necessary, with the high qualities of the music wire.

With the object of carrying out such a manufacture, a company was recently formed in London, to produce steel tubular forms of any size or section. A variety of remarkable specimens was produced by them which made every engineer's mouth water, and although commercially it has not succeeded (simply because the arrangements of the world were not quite ripe for it), still that, judging by all past experience, does not affect the question any more than the receding wave affects the rising tide. The grand fact remains that it is a possibility, by sufficient pressure and patience, to cause solid steel to flow into any hollow form of section without breaking its continuity; it is a wonderful triumph of mind over matter which cannot be ignored, and which has yet to accomplish most important results in the future history the mechanism of the working world of applied mechanics, and the advantages are so apparent and so numerous that its ultimate success is only a question of time.

My chief object in making the foregoing remarks, is chiefly to show that the natural laws which govern materials and things, are a great lesson to be taught to our young students, before they enter the workships of applied mechanics, and to show that the varied operations of the practical worker are thus intimately blended with the profoundest philosophy, and that the fashioning of matter into the various forms required by our civilization, is not the drudgery to a thinking mind which it is generally considered to be, but that we are fellow-workers in carrying out and taking advantage of the natural laws, as laid down for men by the Grand Designer of the Universe.

VARNISH ROOMS.

From the Hub.

There are few good varnish rooms in this country—very few. Consequently, there are plenty of poor ones, and, for the sake of example, which may illustrate those features of a varnish room which are objectionable and should be avoided, we shall describe a certain poor one which we have in mind, and which we assure our readers is by no means the very worst of its class.

This shop is situated in the outskirts of a city. The varnish room is a small one, in the second story, and directly over the blacksmith's shop, while above it is an unfinished garret in which stock is stored. The room has two windows, which open only at the bottom. One window is shaded by a large elm tree, which is considered very attractive, but as the room is dark and this tree shuts out half the light which would otherwise enter, its shade is very objectionable. The light from the other window is partly obstructed by a series of shelves, upon which are arranged a variety of varnish and japan cans. The ceiling and walls are of rough boards black with age, and here and there pictures have been hung. In the middle of the ceiling newspapers have been tacked up, in order to prevent the passage of dust which rattles down from the cracks between the boards every time any one enters the third story.

It is not difficult to perceive that in such a shop the varnisher must be obliged to labor under many serious disadvantages. In the first place, his room is dark, whereas he needs the best light possible. Not only are the windows too few in number, and partly obstructed, but the walls and ceiling, being dark, cannot reflect and make the most of what light there is. Again, he has no proper ventilation, and this he must have in order to guarantee good work. The windows cannot be opened, for if this were done, an inward draft would be created and dust might be brought in. Even the cracks in the ceiling are rendered useless as ventilators, being covered with piles of lumber. Consequently, if you visit this shop on a warm summer day, you will find this room as hot as an oven, and the air so drenched with the moisture which comes from the rapid evaporation of the water upon the floor that it is difficult to see across the room. Every painter knows the effect produced upon varnish by a moist, muggy day; then who can expect that varnish will do its best in such an atmosphere as we have described. In the third place, the work in this shop is never safe from dust, for the walls and the ceiling being rough, they will hold a great amount of dust suspended, and this is liable to sprinkle down upon the fresh varnish whenever any jarring is caused by the workmen below, or by heavy teams, or even by the movement of the door, when the varnisher leaves the room at night. His work is therefore in constant danger of being spoiled in this way. If, under all these disadvantages, a varnisher is able to turn out perfect jobs even occasionally, he may be considered as eminently fortunate as well as skillful, and he cannot justly be blamed for frequent bad jobs.

As we have already mentioned, the shop which we have described is by no means the worst of its class, but is one that is looked upon by its owner as a "very comfortable sort of a place," and as we once heard him remark—"Anybody who can't dew good worruk in that 'ere shop, better jest go and try it with my gran'ther, who allus did all his varnishing in the back yard. That 'ere shop is where I done all my varnishing when I was a young 'un, and if there's anybody can do betterer varnishing than me in 1840, I'd just like to look at him."

In past times it seems to have been the policy to set apart, for varnishing, the odd room which couldn't be used for anything else; whereas, the varnisher ought to have first choice, and should have the best situated and the best fitted room in the building. The varnish room should be the "parlor" of the factory, for it is there that the most delicate part of the operation is performed. In some new shops we are glad to say that some improvement may be noticed in this respect, but still there are very few that approach perfection.

In conclusion, we shall briefly mention the several requirements of what we consider a model varnish room. These requirements refer to the railroad shop as well as the carriage shop, but more particularly to the latter, because the class of work is nicer, and also for the reason that in the carriage factory we find the faults are generally more serious. The paint room in a car shop must of necessity be roomy, and this will help ventilation, and the light is generally good.

1st. Every varnish room should have the best degree of light that is possible. A corner room with plenty of windows, is therefore to be preferred; and, if situated in the upper story, skylights will aid very considerably. The ceiling and walls should be white and smooth, as they will then reflect the rays and greatly increase the degree of light. Rays of sunlight must not be allowed to fall directly upon work, and each window should therefore be provided with a white curtain, which can be drawn when necessary.

2d. The varnish room should have a perfectly arranged system of ventilation. The windows should all be made to open at the top, and one or more of them ought constantly to be opened for an inch or two. If the room is in the upper story, as is usually the best situation for the varnish room, skylights will be found to give the best ventilation.

3d. Every precaution should be used to prevent the presence of dust. In the first place, the walls and ceiling should be finished smooth, so that dust cannot find place to lodge. Plaster, with hard finish, gives the smoothest surface, and we would advise its use in all new shops. When finished with wood, the boards should be planed and matched, and a coat of varnish or permanent wood filling added. In old shops, finished roughly, it is well to tack sheets of brown paper over the ceiling. In the second place, no shelves, cans, clothes, or pictures, should be allowed in the varnish room, as they are all liable to hold dust. The varnish room should be a perfect void—bounded by six blank smooth surfaces Then let the room be carefully dusted, swept, and sprinkled, and two or three hours afterwards the carriage may be wheeled in lightly, and the work of varnishing can be commenced with some confidence. Some varnishers have a silk suit to slip on before entering the varnishing room. This is a good plan, as they thus avoid carrying in much dust which would be likely to cling to their ordinary clothes. Thirdly, no one except the varnisher should be allowed to enter the varnish room. It should be the "*sanctum sanctorum*" of the factory.

4th. An even degree of temperature should be maintained. For this reason, it will be seen that the best situation for the varnish room is in the northern end of the building or in the northeast corner, for there the sun will not lie in during the day and raise the temperature. Steam is the best method of heating the varnish room. When this cannot be employed, care should be taken to select a good stove, that does not require constant attention, and this should be placed near an aperture in the wall, in such manner that it may be fired from the adjoining room, and furthermore, it should be inclosed in a tin or sheet-iron casing, made conical at the top, and this will prevent any dust from arising when the fire is replenished, or the ashes shaken down. The degrees of heat