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(Illustrated articles are marked with an asterisk.)

GOVERNMENT AID TO SCIENTIFIC INVESTIGATION.

Those who had the good fortune to hear the closing lecture of the series delivered by Professor Tyndall in this country will not soon forget the eloquent tribute he paid to scientific investigators, intent on the discovery of truth regardless of its bearing on practical ends, or the earnestness with which he insisted on the public duty of supplying them with means for their work.

The appeal was as plausible as eloquent. At first sight nothing would seem more reasonable than that the public at large, whose indebtedness to Science is so great, should do something towards supporting those who carry on the work; or that any means which should honorably relieve original investigators of the daily drudgery of earning a living, and at the same time supply them with the fullest apparatus for their researches, would immensely increase their productions.

But when we remember that in every age there have been plenty of scientific men who have had at command all that money or position could give, yet have remained comparatively barren, while the great discoveries, more especially the original views opening up new lines of thought and giving new directions to human industry, have usually come from seemingly less favored workers, we cannot escape the suspicion that original thinking is quite as likely to be hindered as helped by easy circumstances. Besides, the best work in Science has rarely been done by men either dependent or very closely allied with the ruling clique of their day, freedom from class prejudice being an essential condition of independent thinking.

No doubt a good deal of honest work might be furthered by aiding the right men at the right time: but such men are rarely the ones that would be reached by public enactment, even if it were possible for them to maintain intellectual independence in connection with personal dependence. Radically new truths are inevitably unpopular, and none but popular men would derive much assistance from the public funds. The endowment of Science would therefore act very much as the endowment of religion has always done, by creating a class of nominal "leaders" whose instincts would be opposed to progress. Having risen to place and power by the advocacy of certain views, how could they give their countenance to men laboring to overthrow such views?

Run over the list of names—from Copernicus to Darwin—of those whose influence has been greatest on the progress of human thought. How long would their owners have been allowed to continue their work at public cost, in the face of popular clamor against their heresies? Had Professor Tyndall's plan been adopted a few hundred years ago, the world would still be flat, the center of the Universe, and only six thousand years old.

In applied Science, the case is equally strong. How long would Fulton have been allowed to squander public money in his "crazy" attempt to propel shipping against wind and tide with "boiled water"? Or Stephenson, in the equally wild project of drawing wagons across the land at the extravagant rate of twelve miles an hour? What administration could sustain the sarcasm of the opposition party after supplying Draper with money to waste in foolish experiments for painting with sunshine, or Morse with means to develop his impious scheme of annihilating time and space? What committee of wise men, having to render an account of their expenditures, would have dared to aid the experiments, of Goodyear in rubber, Young's attempt to make candles out of shale, Bessemer's scheme for making steel direct from the ore, or any one, in short, of the great achievements which, until the events proved their practicability, were accounted visionary, if not impossible, by practical men?

There is another fallacy underlying Professor Tyndall's proposal—one that he has strikingly exemplified in his own person quite recently—and that is the assumption that abundant and complicated apparatus is required for, or at least helpful in, the work of discovery. In some cases it may be; but ordinarily it is quite as apt to absorb the experimenter's attention so that he misses the point of the phenomena entirely. That was a brave array of steamers, fog whistles, artillery and the like, which Professor Tyndall took down to the coast to study the effects of different atmospheres on the transmission of sounds; but he had scarcely published the results of his costly observations when Professor Reynolds made known a few experiments with a hand bell which upset entirely the conclusions the government-aided observer had so jubilantly arrived at.

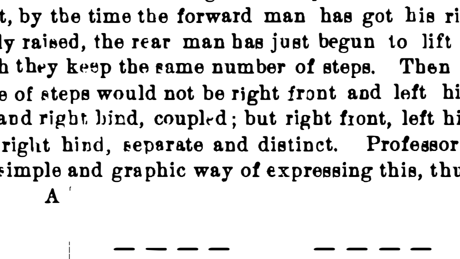
As a rule, the greatest discoveries are made with the simplest apparatus, the keys which have unlocked the grander mysteries of the Universe being mental rather than material: or, if material, have proved effective through simplicity and skillful handling rather than because of their complexity.

FOUR FOOTED MOTION.

The present exhibition of paintings of the Royal Academy in England contains a picture, by Miss Thompson, entitled "The Roll Call," which depicts a muster of soldiers on the day after a battle.

From the drawing of a horse in the painting, a very interesting discussion has arisen, extending even to eminent naturalists, regarding the motion of four footed animals while walking. The horse, in the picture, is represented walking, and has its left foreleg raised, bent, and nearly extended, its right foreleg on the ground and perpendicular to the same, its left hind leg also on the ground, full forward, and its right hindleg on the ground and well back. With Professor Garrod's able elucidation of the subject, published *in extenso* in *Nature*, as a guide, the problem quickly loses its perplexing features.

Let two men be supposed to place themselves so that the hinder one has his hands on the shoulders of the man in front, and that both walk in step—State's prison gait. Reverting this to the horse, we have the amble, a mode of progression natural to the giraffe, but only acquired by special training in the horse. Again, suppose the two men to put the opposite feet forward simultaneously, in other words, to walk out of step. This will exemplify the trot. Suppose, however, the two men to walk out of step; but instead of the diagonally opposite feet being set down at the same moment, imagine the first man to begin his step a little in advance, so that, by the time the forward man has got his right leg entirely raised, the rear man has just begun to lift his, although they keep the same number of steps. Then the sequence of steps would not be right front and left hind, left front and right hind, coupled; but right front, left hind, left front, right hind, separate and distinct. Professor Garrod has a simple and graphic way of expressing this, thus:



The dark dashes mean the times of contact of the right foot, the dotted lines same of the left foot. The two upper horizontal rows refer to the fore legs; the lower, to the hind. The dotted lines, beginning exactly where the continuous ones end—considered horizontally—indicate that one foot is lifted exactly when the other is put down.

From this it will be seen that, in walking, the horse never has more than two legs on the ground at a time. Draw a vertical line through any portion of the diagram, as at A, and it will be clear that only two of the horizontal foot lines are cut. The same line shows the picture referred to in the beginning to be correct, with the exception of one slight error. Following line A down, we find the first dotted line at the top, meaning the left fore foot, not cut; hence it is off the ground. The next line is divided squarely in the middle, and hence the right fore foot must be firmly planted. The dotted line below is just met at its beginning, consequently the left hind foot is about to commence its step; and the next line being at its rear end indicates that the right foot has just finished, and is being removed from the ground. If the reader will compare this with the foregoing description of the painting referred to, he will find that the correspondence is complete, excepting as regards the right hind foot, which, instead of being on the ground as represented, should, according to our diagram, be just leaving it. This also would be in accordance with the rule that no more than two legs can be down at a time, and thus the mistake which the artist makes in fixing three would be avoided.

We would commend the diagram herewith presented as a very simple guide for artists and draftsmen generally, as, by following its indication, they can hardly fail to depict the horse correctly. A general idea of the position of the animal being first settled upon, it is only necessary to draw perpendicular lines at various points, and try the results until a suitable *pose* is obtained. The figure very clearly solves a question over which many heads, wise and unwise, have often puzzled.

THE RAILWAYS OF THE UNITED STATES.

The seventh annual "Manual of Railways of the United States," by Henry V. Poor, 68 Broadway, New York, has just been published. It is a work of over eight hundred pages, and contains a large amount of carefully prepared information, including official particulars of all railways in operation, their extent, cost, capital, earnings, dividends, indebtedness, names of officers, directors, etc. The tabulated general statements concerning the American railway system afford valuable and instructive information.

The inauguration of railways in this country may be said to date from the year 1830, when railways were in operation to the extent of 23 miles. At the close of 1873 there were *seventy thousand, six hundred and fifty one miles* of railway in operation. This great increase, during the brief time of forty-three years, is something marvelous to contemplate. The grand average cost is put down by Mr. Poor at $60,000 per mile, or upwards of four thousand millions of dollars in the aggregate. The total earnings were over $526,000,000, and the operating expenses 65 per cent thereof, or $342,000,000, leaving as net earnings the sum of $183,810,000, out of which interest on bonds and stock dividends were paid. The average of the latter were 3 45 per cent on the capital stock, the aggregate of which is one thousand nine hundred millions of dollars.

During the year 1873 the increase in railway construction was 3,916 miles, against 6,167 miles for 1872. The expenditure for construction in 1873 is less by 50 per cent than in 1872. This sudden great contraction in payments, amounting to more than $120,000,000, was disastrous in its effects upon the various branches of industry connected with railway building. But as soon as Congress shall fix upon some decisive settlement of the national finances, whereby a lower rate of interest for the American indebtedness can be established, then railway bonds will improve in value, and a more extensive construction may be expected. As compared with Europe, the United States are considerably in advance in the matter of railway mileage.

The aggregate of railways in 1873 in the various countries of Europe was as follows: Germany, 12 207 miles; Austria, 5,865; France, 10 333; Russia, 7.044; Great Britain, 15,814; Belgium, 1,301; Netherlands, 886; Switzerland, 820; Italy, 3,667; Denmark, 420; Spain, 3 401; Portugal, 453; Sweden and Norway, 1,049; Greece, 100

	Miles.	Population.
Railroads in 1873 in Europe	63,360	282,456,742.
" " United States	70,650	40,232,000.

SOME OF THE USES OF PARAFFIN.

In addition to the properties which have brought it into such extensive use for illuminating purposes, paraffin has qualities which give it an exceedingly wide range of useful applications. White, clean, incorruptible, odorless, tasteless, plastic, water repellent, a non-conductor of electricity, and but slightly affected by most chemical agents: it needs only to be better known to become the most variously useful of the hydrocarbons.

For waterproofing fabrics for wearing apparel, military equipment, and the like, it is much better than rubber, since it is odorless and does not become sticky with heat. Among the most gratefully acknowledged of the many gifts sent out to Livingstone in the wilds of Africa, were boots and blankets thus prepared, the one enabling him to travel through mud, the other to sleep in it with comparative comfort. For the waterproofing of tent cloths, ground sheets for soldiers, and other articles of the sort, it has been found equally serviceable.

A more generally useful application of paraffin is for the lining of casks and other wooden vessels, to keep them sweet and to prevent either the absorption of their contents by the wood or their escape through the pores. Already it has been largely applied to beer barrels, wine casks, and other vessels of the kind, with the happiest results. It keeps them from becoming musty and foul; and still more, by filling the pores and joints of the staves, it prevents the escape of the life of the liquor, carbonic acid gas. Water buckets, butter firkins, and other wooden articles of domestic use might be similarly treated; and as the material is cheap, easily obtained, and easily applied, it can be tried on as large or small a scale as one may feel disposed.

Being indifferent to most chemicals, paraffin serves the same purpose equally well in the laboratory of the chemist and chemical manufacturer. In the manufacture of gun cotton, for example, wooden tanks lined with paraffin have been used for holding the mixture of concentrated sulphuric and nitric acids employed in that process, the protection of the wood being complete and lasting. Wooden boxes, protected in the same way, have been similarly employed in the construction of voltaic batteries. As a non conductor of electricity, paraffin is further useful, as an insulator, for which it is now extensively employed in electric telegraphy; also in connection with batteries for medical use, especially as an acid-proof coating to insulated conducting wires. In surgery, it has been found an excellent material for covering for splints in cases of fracture.

Those troubled with loosely fitting plates of artificial teeth, owing to absorption of the gums, can easily remedy the defect by dropping upon the plate a little melted paraffin, from

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