

is to serve as a pioneer in original investigation, no cost can be too great which is required to facilitate these studies. But while the colleges of this country have vied with each other to increase the facilities for instruction, they have done almost nothing to encourage the higher work of their professors, and what has been accomplished for science and scholarship is due solely to the untiring efforts of devoted men working under adverse circumstances and against great odds.

A college professor cannot successfully conduct any of this work unless his occupation of teaching leaves him sufficient leisure of energy as well as of time. No original work can be expected of a teacher whose energy has been exhausted in the class-room. Moreover, in conducting scientific investigation, it is all important that the attention should be engrossed with the work. To secure the best result whole days or weeks should be left otherwise unoccupied, and if this object were regarded as of primary importance, the colleges might easily conform their exercises to meet this requirement. On the other hand, however, a limited amount of teaching is a help rather than a drag to the investigator.

But in the distribution of work, a far greater economy of resources might be used than is usual in our colleges. To employ trained veterans to do drill work which could be done equally as well by younger men is as great a waste of skill as it would be to set a cabinet maker to frame a house. If the administration of our colleges relieved their experienced professors from drudgery by transferring elementary instruction to young men, the efficiency of these institutions as sources of knowledge would be greatly augmented. But, even if relieved from the irksome work of elementary instruction, our college professors cannot secure the largest results as producers of knowledge, unless they are provided with the assistance required to carry forward with success the work of investigation. In all departments of experimental science original research involves an immense amount of purely mechanical labor. Mechanical difficulties have to be overcome, and the resources of every art and trade are called into requisition. To those who are accustomed to secure a return proportionate to the labor expended, as in most literary enterprises, such work would be utterly discouraging. We spend days and weeks to find the cause of an anomaly in our results, and discover at last only an impurity in our materials or a leak in our apparatus. Thus it is that the mere physical labor in a chemical experiment becomes so great. As well expect an architect to build with his own hands the house he had planned as to expect the experienced chemist or physicist to do the mechanical work which his investigations require. The productiveness of our universities as centers of thought can never be brought up to the higher interests of the community until provision is made for supplying with necessary assistance those who are capable of directing scientific investigation. We should never have been able to accomplish the work that has been done in our laboratory had we not been able in a more or less irregular or spasmodic way to secure a limited amount of excellent assistance. Some advanced students have been willing to give their labor for such small pecuniary remuneration as will enable them barely to live at the university. This mode of securing assistance is objectionable for several reasons. No dependence can be placed upon it, and the assistance is constantly wanting when most needed. A large university should provide and organize the assistance required by its working professors just as efficiently as it actually does its instruction. Of course, to do this requires endowments. The only department where the endowments are adequate for the purpose is the observatory, and its large contributions to astronomical science is the natural result of the large amount of assistant labor it employs. There are just as large problems in physics and chemistry, and just as important ones for the advancement of knowledge as in astronomy, but these have to wait for the want of such endowments as the older and more popular science readily secures. At this moment there is a very important problem in chemistry which corresponds to the great problem of mapping out the stars, with which so many astronomical observatories are occupied, and that is the determination of the accurate values of the atomic weights. A great deal of work has been done on that problem in our laboratory, and a plan has been devised for carrying forward the investigation, which cannot fail to bind the results obtained into a consistent whole, but the plan lags for want of laborers. Our laboratory has actually no endowments, and the cost of all scientific work, except actual instruction, must be borne by those who seek to extend the boundaries of knowledge.

Some years ago a plan to endow research was drawn up and submitted to the criticism of several prominent men of science in this country. The plan contemplated supporting with large endowments a body of trained experts wholly devoted to scientific investigation, and the interest which it aroused plainly indicated the national importance which was attached to such work.

It seems to me that the chief defect of the plan was to connect the endowments with the universities or other existing educational institutions. It is not possible to secure by any system of competition first-class investigators, and endowments distributed on such a basis would lead only to commonplace results. Like the poet, the investigator is born, not made, and the higher educational institutions are the places where such powers are naturally discovered and developed, and they afford the best field for its exercise. I believe that the most effective method of endowing research would be to multiply at the larger universities professorships, with strict limitations as to the amount of teaching that could be required, and with an income sufficient to pay for assistance and defray all other costs of investigation. I should recommend that such professorships be open at large to any one who had special aptitude for investigation.

Another condition of successful investigation is freedom from anxiety in regard to means of support. The divine afflatus is rarely accompanied by wealth, and the investigator must live, and live decently. The average salary of the schoolmasters of the country is better than that of the professorships in most of our colleges, and it seems strange that recruits can be had for such positions; but, in fact, they are eagerly sought, and by a class of noble and devoted men. Students who in our laboratory acquire an enthusiasm in the pursuit of truth will constantly give up every chance of pecuniary gain and take a position where they can devote their life to study, provided only it promises a bare support. Their first question in regard to an opening is not what is the salary, but what are the facilities for investigation. The world would profit from the labor of such men if they were relieved of all pecuniary anxiety.

Large salaries are not expected, indeed are not desirable. It is not best that men should be led into such a career who have not so marked a call that they are willing to sacrifice to it the larger emoluments of professional success.

(Further talks with professors of Harvard and other universities will follow.)

MISCELLANEOUS NOTES.

To what extent may mechanical designs be copied? From a legal standpoint the answer would be: Only up to the point of infringement. But in the current practice in the machinery trades, unless the design be wholly novel, little, if any, objection is made to infringement in the line of improvement. Hammers, saws, chisels, files, and the like are constantly undergoing changes in design; he whose design is improved upon borrowing the improvement, adding something to it, and selling it as his own; another taking it from him by similar means, and so on. A large manufacturer of machinery said to the writer recently: "It doesn't pay to bring suit save where the interference is very clear. Saws and planers and drills and the like have been made time out of mind, their principles having been utilized in a thousand and one ways. Even where one of our draughtsmen leaves us and goes to a rival house, carrying many of our ideas with him to be worked out with close resemblance to our own designs, it scarcely pays to fight. We take the result and make as much improvement as we are enabled to and let it go at that. The machinery trade generally is doing the same, the result being as usual—the man with the longest pole gets the most persimmons."

Too much cavalry, so it is claimed, is a serious defect of the German war establishment. Indeed, a suggestion of reducing the present force of 64,162 troopers and 62,469 horse one-half is now being seriously considered by the general staff. "Cavalry armed with sword and lance, like the uhlan," says a general of division, writing on the subject, "is more likely to encumber an army than to advantage it." He reviews the history of recent wars to prove the utter fatuity of pitting mounted men against infantry, citing the failure of the cavalry at Milaslaw, Wiesenthal, Balaklava, Solferino, Worth, Mars la Tour, Beaumont, etc., to prove his point. His mention of Balaklava, it is evident, refers to the charging of the Light Brigade upon a Russian battery, this having always been regarded as a great blunder, the result of a misunderstanding of orders. On the other hand, the charge of 500 men of the heavy brigade, under Col. Scarlett, was a remarkable triumph for the trooper, but not, however, over infantry. "The improvement in small arms," continues the general, "has led to the abandonment of the old bayonet drill. A man who started at a distance of 1,000 paces to attack an enemy with fixed bayonet would be regarded as a candidate for a lunatic asylum. What, then, of the cavalryman, who offers six times the front to marksmen, who cannot take advantage of the protection afforded by the contour of the country, but who is expected to advance in solid array on an enemy 3,000 paces distant?" He believes it to be the province of cavalry to reconnoiter and force an unestimated enemy to show his strength, and would have wagons carrying infantry to storm fortified places during aggressive reconnoitering. As to opposing cavalry with cavalry, he

does not believe in it; insisting that infantry fire is the best physic for charging troopers.

Electricity for passenger service, steam for freight trains. That, so some good authorities declare, will be the apportionment of the rival energies on the railroad of the future. Steam at high speed requires quantities of coal and water, thus largely increasing the weight to be carried, while the wear and tear of the generating apparatus is thought to be almost doubled when continuously forced. With electricity, on the other hand, it is quite otherwise. The faster you go, the greater is the economy over steam. Indeed, as the speed increases the relative value of electric propulsion increases enormously, an expert before a recent meeting of the Institute of Electrical Engineers declaring that at 120 miles an hour it is something like six times more economical than steam. "If," said he, "you can get 90 per cent efficiency out of your electric service and have a frequent service at 20 miles an hour, electric propulsion is even then slightly more economical than steam propulsion." One of the best known electric motor manufacturers recently declared it to be his belief that in the future express trains between populous centers like New York and Philadelphia would consist of two electric cars, to be started every ten minutes, and running at a speed of a mile a minute.

The Electric Transmission of Power.

Switzerland seems to have taken the lead of all countries in adopting the system of electric transmission of power in a large way and for all purposes. Mr. Gaspar Kapp, in a recent lecture before the British Society of Arts, gives some most interesting details, including cost, of the principal installations, as follows:

Distance in Miles.	Horse Power Delivered.	Speed of Machines.	Cost in £.			Total Cost.*	Cost per Horse Power.
			Generator.	Motor.	Line.		
1-870	85	450	640	560	440	1880	22.2
0-280	195	500	760	680	132	1800	9.7
0-280	51	600	320	280	60	720	14.1
0-375	90	550	520	480	80	1240	13.8
0-560	71	600	440	400	60	1040	14.6
0-280	40	700	260	240	20	640	16
0-375	75	600	480	440	68	1120	15
0-500	87	500	520	480	100	1260	14.5
1-560	150	600	760	720	320	2060	13.7
0-220	93	450	440	420	232	1270	13.7
6-250	11	900	132	110	480	960	87
2-200	51	600	360	320	300	1140	22.4
0-187	60	900	240	220	18	600	10
5-000	41	750	240	200	344	1020	24.8
3-750	220	600	1040	960	640	2060	13.5
0-002	15	600	112	104	8	252	16.8
0-250	19	700	160	160	20	390	20.5

*This includes regulating apparatus, instruments, posts, insulators, lightning arresters, erection, and supervision.

At the Schaffhausen Spinning Mills a larger plant than any of the above is being erected, to have five turbine wheels of 350 horse power each, of which three are in position and two are in use. Four cables are employed, each having 0.437 of a square inch section, and they are carried on towers across a river span of 336 feet. At the power station there are two dynamos of 300 horse power over-compounded, and there are three motors at the mill, one a twin machine of 380 horse power, and two of 60 horse power in different parts of the premises. The commercial efficiency of the plant at full load is 78 per cent; it is guaranteed to have a capacity of 20 per cent in excess of the normal for 1½ hours; the brushes wear 2,000 hours, and the commutator 20,000 hours. The cost of the installation was \$68 per horse power delivered, and the cost of power is \$14 per horse power per year at the rope pulley of the turbine.

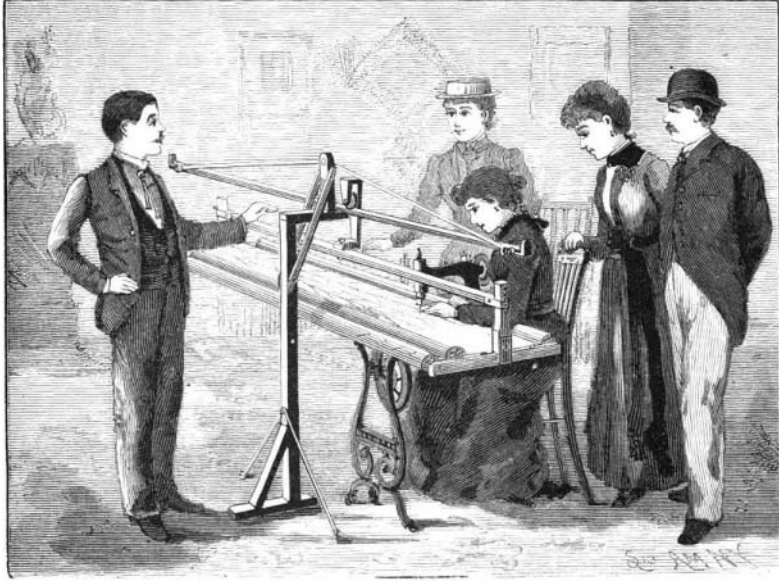
The Iron Port of the World.

Escanaba is the county seat of Delta County, Michigan. It lies at the foot of the great pine forests, and overlooks Little Bay de Noquet, the headwaters of Green Bay. Five years since it was practically a village in the wilderness. To-day finds it a city with a population of 8,000, lighted by electricity, having a well equipped fire brigade, waterworks with a capacity of 4,000,000 gallons per day, a high school and three other schools, six churches, three newspapers, a railway station where 216 trains arrive and depart daily, and it will shortly have an electric street railway in full work. Its annual retail trade is estimated at \$3,000,000, and its wholesale trade, including iron ore, pig iron, lumber, and coal, at about \$25,000,000.

According to Mr. Nursey's carefully written report, capable of the fullest verification, Escanaba is the greatest iron port of the world. He tells us that during the navigation season of 1890 it shipped 3,700,000 tons of iron ore, or nearly double that of all the ore ports of Michigan, Wisconsin, and Minnesota combined. Its lumber output amounted to about 120,000,000 feet, while the freight capacity of the vessels entering and clearing from its port exceeded 8,000,000 tons. This compares with the tonnage of the greatest seaports of the world, which are: (1) London, 19,000,000; (2) Liverpool, 14,000,000; (3) New York, 11,000,000; and next comes Escanaba with 8,000,000 tons.

Wood Pulp.

Wood pulp making by the sulphite process is thus briefly described: The wood is peeled, discolored or decayed parts are removed, the wood is cut across the grain into thin chips, which are elevated to the top of the mill and dropped into large drums about 14 feet in diameter, 24 feet long, and strong enough to sustain a pressure of from 75 to 200 pounds to the square inch; when packed full of chips the drum is filled with sulphuric acid and other chemicals, and the cotton-like product is pressed dry and mashed, mixed with water,

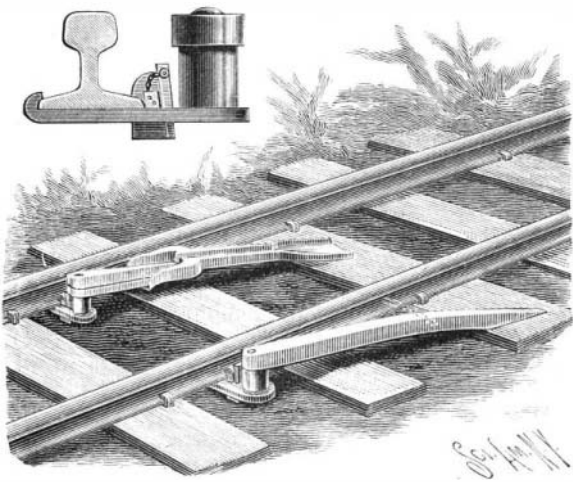


TOUCHSTONE'S QUILTING FRAME FOR SEWING MACHINES.

rolled flat, and cut into shape for bundling, being 60 per cent moisture and 40 per cent fiber. Thus it goes to the paper mill. One cord of spruce makes 1,200 pounds of dry fiber, worth from \$1 to \$1.50 a hundred pounds. Freight is paid on the water contained rather than use dry pulp, which packs hard. A sulphite plant that will consume from 8 to 15 cords of wood every twenty-four hours will cost about \$10,000.

A READILY APPLIED CAR REPLACER.

The device shown in the accompanying illustration, which has been patented by Messrs. William Stephens and Joseph Mott, is designed to afford a ready means of replacing a derailed car or engine upon the track at



STEPHENS & MOTT'S CAR REPLACER.

any point in the length of the road. An outer and an inner frog or skid are provided, each made in two sections—a bar or track section and a base section for securing the device to a track rail. A sectional view of the device applied to one rail is shown in the small figure, the base plate having at one end a flange gripping the flange of the rail base on one side, while an adjustable clamp and key, projected through an aperture in the base plate, are adapted to clamp the device on the other side of the rail base, the key being attached to the clamp by a small chain. The bar or track section is pivoted at one end to a short post at the other end of the base section, and is curved downward and flattened on its under face to rest upon a tie, a pin or pins in its flat under face being adapted to enter the sleeper and retain the track section in fixed position. In the inner frog or skid, the upper face of the track section is provided with side flanges, each of which has an angular recess, while a switch point is pivoted to the pivotal end of the section, and adapted to be swung into or to enter either of the recesses, according to the direction in which the switch point is to be thrown. Attached to each skid near its lower end is a suitable length of chain having at its free end a double hook for engagement with a rail flange when the device is placed in position.

For further information relative to this improvement address the inventors, Redding, Cal.

A QUILTER FOR SEWING MACHINES.

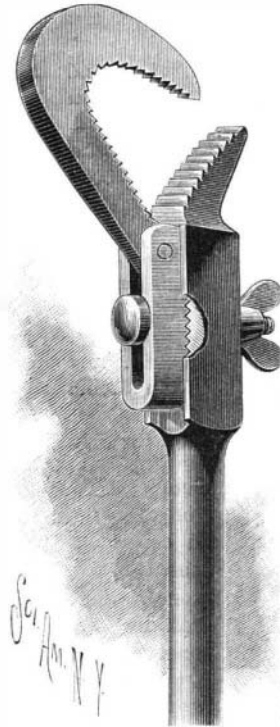
The illustration represents a device designed to be easily and nicely adjusted to hold a quilt in convenient position for work upon it, and so that it may be readily adapted to the feed of any sewing machine. It has been patented by Mr. James N. Touchstone, of Ida, Texas. A properly braced standard resting upon the floor has a forwardly extending arm carrying a vertical post connected by side braces with the standard. Upon the projecting end of the arm rests the central portion of a cross beam or track having its upper edges beveled to receive a pulley, the track having an end stop to prevent the pulley block from running off, and rods extending from each end to a pivotal connection with the upper end of the vertical post, whereby the track may be tilted to any desired inclination. A pulley block with a grooved pulley is carried by the track, and through the lower portion of the pulley block extends a vertical bolt, on which is pivoted a cross beam, at each end of which is a loop adapted to receive an upright of the quilt-holding frame. By the insertion of a bearing pin in one of several holes in the upper end of the uprights the latter may be readily adjusted as to height, and at the lower ends of the uprights are loops, through which extend the end pieces of the frame, in which are journaled three rollers adapted to support a quilt placed thereon in the usual manner. The rollers have at one end perforated disks adapted to be engaged by latches, whereby the rollers will be held from turning, except when the latches are disengaged. With this construction, the frame supporting the quilt may be readily brought into any desired position, the suspended frame moving freely, and the device permitting of such arrangement in connection with a sewing machine that the feed of the machine will draw the quilt and frame through it. This quilter is designed for adaptation to all family sewing machines, for the quilting of any desired pattern.

A PROPELLING MECHANISM FOR VEHICLES.

This is a further invention of Mr. M. A. Libbey, of South Berwick, Me., for an improved vehicle, styled by the inventor the "Princess of the Highway," described in our issue of March 14. It is designed to afford a strong and light tubular construction containing frictionless, telescopic, ball-bearing slides and balanced steering and driving gear, adapted for application to ordinary light road vehicles, to the varying lengths and widths of which it is adjustable. Fig. 1 is a view in perspective of a vehicle provided with this mechanism, Fig. 2 being a broken plan view, and Fig. 3 an enlarged detailed sectional view of the steering mechanism. The power by which the vehicle is propelled is applied to a vertical shaft having its bearing in a bracket projecting forward from the front end of the wagon body, a solid collar, forming the upper end of a stiff spiral spring, being firmly connected to the shaft, while the lower end of the spring is fixed to the flange of a tube on a shaft in a frame connected with the front end of the reach rods, a depending arm from this frame carrying the connecting rod which drives the rear wheels. The spring on the power shaft is not intended to yield vertically, but is adapted to spring laterally, to allow for the swaying of the vehicle, the spring being turned like an ordinary shaft. Clamped to each of the rear wheels are annular flanges with inwardly projecting flattened rims, the flanges having a rib extending around their inner surfaces and being provided with recesses or indentations, while a circular gear is adapted to fit closely within the flanges, to abut with the rib and receive the indentations. The gears are adapted to mesh with pinions on transverse shafts, so that when the pinions are turned, the rear wheels will be revolved. A hollow shaft, carrying at its top a hand wheel or handle bar, extends upward through the wagon body in front of the seat, the lower portion of this shaft being connected with a forwardly extending steering mechanism, whereby the forward wheels and axle may be turned to one side as desired, as shown in Fig. 2. The main parts of the mechanism are inclosed, so as to be unaffected by mud and dust, and the driving parts are designed to remove the weight and strain from the axles and place the weight in continued suspension on the circumference of the advancing half of the drivers. Other modifications of the invention, on the same general principle, are designed for application to heavy passenger vans, etc.

AN IMPROVED WRENCH.

A wrench which is simply and strongly made, and is readily adjustable to grip larger or smaller work, is shown in the cut, and has been patented by Mr. Benjamin B. Farris, of Rocky Ford, Ga. The stock has an angularly extending fixed jaw, provided with serrations, and on one side of the stock are serrations as shown in a broken-away portion in the picture. The serrations in the side of the stock are engaged by corresponding serrations on the inside of a head sliding between two parallel flanges at the edge of the stock. A bolt, passing through a longitudinal slot in the stock, secures the head thereto in the desired adjustment, and in the outer end of the head is pivoted a hook-shaped, serrated jaw. When the head is in the proper position, the work is engaged at one side by the serrations of the fixed jaw, and as the operator turns the work the hooked jaw has

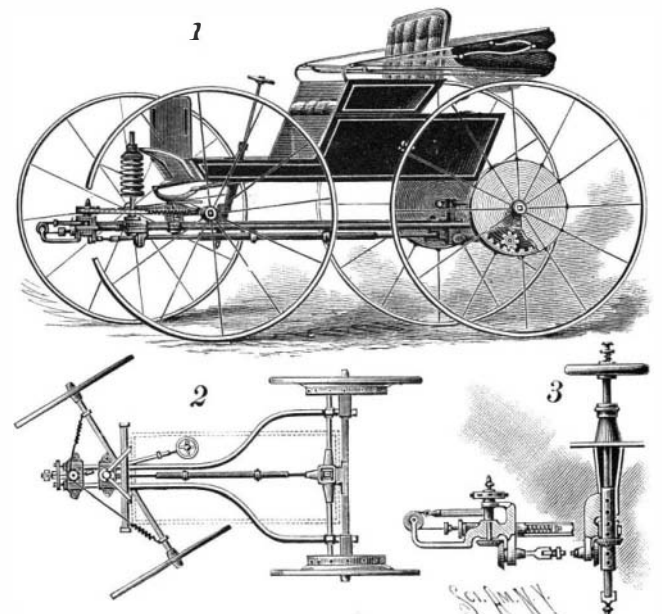


FARRIS' WRENCH.

a tendency to be firmly drawn toward the fixed jaw, so that the wrench does not slip on the work.

Wesley's Electricity.

While the religious sect which he founded has been celebrating the centenary of John Wesley, how many of his followers have been made aware that he was the author of a work on electricity? This curious brochure was published in 1759, under the title of "The Desideratum; or, Electricity made Plain and Useful by a Lover of Mankind and of Common Sense." The titles of the sections are decidedly suggestive: "Electricity the Soul of the Universe;" "The Cat in the Oven, curious Electrical Experiment;" "A Person with Small-pox cannot be Electrified;" "Electricity the greatest of all Remedies." The reverend author goes in for a serious argument to demonstrate that it is "just as innocent to keep our rooms tight from lightning, as from wind and water." One of the entries is as follows: "Exp. 32. A person standing on the Ground cannot easily kiss an electrified person standing on the Rosin." About half the volume is taken up with narratives of cures supposed to have been wrought by electrifying, the diseases being of the most varied



LIBBEY'S DRIVING DEVICE FOR VEHICLES.

kind, from fistula to epilepsy. Even the cure of moral diseases is attributed to electricity. "Felons are speedily cured by drawing Sparks. If any disorder be superficial this Operation suffices: But if it lie deeper, then the giving of Shocks is found to be more effectual." The good old divine had probably little idea what mischief his well-meaning recommendations of electricity might work. Happily, in science more weight is attached to proved facts than to the authority of a great name. And Wesley's attempt to intervene in science was less successful than his intervention in ecclesiastical organization.—*The Electrician.*