through the surrounding chamber, when the mixture is drawn up and carried away by the current. A similar method has proved most useful in dredging, and even a bottom of hardpan has yielded to the force of the inrushing water, and gravel and rock been sent rattling out through the tube.

In certain smelting operations, where the fumes are unhealthful, a suction placed instead of a blast has been found to remove all traces of the noxious gases. With the blast every little hole is an outlet for the gas, but with the suction the holes become harmless because of induced currents entering them.

When the hand is held near a stream of water flowing from a faucet, wind will be distinctly felt. The volume and force of this wind depend upon the volume and velocity of the water. A sluggish stream will produce no motion of the air that can be felt, but the same stream tumbling over a fall will create a gale. More than fifty years ago this fact was made use of by a mechanic residing in Watertown, this State. He constructed a box which he placed in front of the falls, as near the water as possible, leaving the side next the water open. This was connected at the bottom to a roughly-made wooden box, through which the current of air was led some distance to his shop where it furnished all the blast required by the forge. One of the schemes for utilizing a part of the enormous energy now wasting over Niagara is identical with the above. The measure of this force can be appreciated by those of our readers who have been near enough to the descending torrent to feel its influence.

One of the most characteristic features of the induced current is the apparent increase of power resulting from its use. With the hand held in front of the tube first mentioned the force is considerable, but if the hand be held the same distance from the mouth, say three inches, the expelled breath strikes it with a slightly greater force. The difference is caused by the friction in going through the tube, the effort to draw in the outer air, and the loss of particles of air which do not enter the tube.

AMERICAN ASTRONOMICAL SOCIETY.

At the June meeting of the American Astronomical Society, held at the Packer Institute, Brooklyn, June 4, the subject of the "Fuel of the Sun" was discussed for the second time. Professor Young, of Princeton, opening the discussion, said that to account for the heat of the sun there might be some truth in Helmholtz's notion that the sun is fed on its way through space with meteors attracted to it by its immense mass.

If this theory were true, then the earth ought to get as much heat from shooting stars as from the sun, and the surface of this globe would have three tons of meteoric matter to the square mile. Yet in some way this objection could be explained away. If we are to suppose that heat is derived from matter distributed through space, we should first remember that the matter would make itself felt on the planets of the solar system. Professor Proctor must be wrong in saying this does not necessarily follow. Another thing: if, as some suppose, a current of meteors toward the sun existed, then mischief would be played with comets. They would encounter resistance. Then, too, the temperature of the sun would not be hotter from such meteoric combustion than the carbon points in the electric light.

Professor Young had always supposed that the heat in the sun was not less than 10,000 degrees Centigrade. Yet, as a very slight increase of heat produces an immense increase of radiation, the heat of the sun might be lower than he had supposed; yet he could not believe it as low as that of an electric light. Another puzzling theory had been proposed, viz., that the sun sends its heat only to that which receives it, only to each of the planets, while space outside of a direct line from the sun to the planet remains cold. The idea being that the heat action between sun and planet was reciprocal like that of gravitation. The trouble with that theory was that heat must radiate on all sides, not in one direction only. Finally, there was a theory that solar heat was due to the contraction of the sun's body; the objection to the theory was that it put a limit to the universe. If it is a true hypothesis, then the sun could not be more than 15,000,000 years old, and it could not continue to give heat more than 15,000,000 years more. Such a limitation is not to be thought of.

The subject was further discussed by Mr. S. V. White, president of the society, Mr. G. P. Serviss, secretary, Professors Stevens, Levison, and Parkhurst, Mr. G. D. Hiscox, and other members of the society. The subject selected for discussion at the October meeting is the moon.

THE FRENCH PHYSICAL LABORATORIES.

It is within the memory of many now living that the first laboratory for the instruction of students in the science and art of chemistry was instituted by the celebrated Liebig, at Giessen. Previous to that time most of the chemical work and investigations had been done either in the back room of an apothecary shop or in the kitchen of some enthusiastic preacher like Priestley. The late Professor Woehler gave an interesting account of how he pursued the study of chemistry with the famous Berzelius in Sweden, and of how the faithful Anna washed dishes in one end of the room, while master and pupil solved the mysteries of nature in the other end of the same room. Probably the laboratory of this immortal Swede differed but little from the ordinary wash kitchen of to-day.

For many years American students, beginning with the now venerable James C. Booth, president of the American Chemical Society, flocked to the laboratory of Wöehler to obtain what they could not get on this side of the Atlantic, practical instruction in chemistry. Then came Bunsen and Kolbe, Kekule and Hofmann, and now Fittig and Meyer, with a host of others, who open their willing doors to American students. But the day is passed when chemical students are obliged to cross the ocean. Nine years ago a chemical laboratory was opened in this city where analysis was taught and practiced, and six or seven years ago a laboratory for research, equal to any in Europe, was opened in Baltimore. To-day no institution worthy the name of college lacks a chemical laboratory of some sort.

Why has chemistry enjoyed such an advantage over physics? About ten years ago Professor Pickering established the first working physical laboratory for purposes of instruction in the Institute of Technology, in Boston, and at a little later date Professor Mayer did the same at Hoboken. Now most of the larger cities, excepting New York, have a well equipped physical laboratory. Probably the best equipped of these is the one in Johns Hopkins University, but a new one is to be built in Cambridge soon, and we shall be disappointed if Professor Trowbridge does not make it the best in the world.

In Germany the Professor is more thought of than his laboratory, but where the former is excellent the latter is rarely poor. At present, Professor Kohlrausch, at Wurzburg, and Professor Helmholtz, in Berlin, seem to be the favorites with our countrymen.

The object to be attained by a course of instruction in physics is twofold: First, to obtain a thorough knowledge of the laws that govern matter and force; and an understanding of the action of heat, light, and electricity upon matter. Secondly, to acquire the power of investigating these properties and discovering new laws. It is unnecessary to say that a person should be familiar with known facts and laws before attempting to discover new ones. The former may be accomplished more or less perfectly by reading books and hearing lectures; the latter involves actual work; but we believe that the former is best accomplished by actual contact with the things themselves, so that their properties and relations may become familiar as solid, first-hand mental acquisitions, for this trains the judgment as well as develops the power of *correct* observation. This is not the opinion of all educators, for Prof. T. C. Mendenhall says that he "would relegate to the lecture table of the instructor all illustrative experiments and qualitative work necessary to a good understanding of the underlying principles of the subject, which every student should possess when he enters the laboratory."

Without venturing to differ with so distinguished an authority we still think that the majority of college students and others, especially those that do not intend to devote their lives to the pursuit of this science, but to become teachers, chemists, engineers, architects, inventors, etc., may derive much benefit from a course of practical instruction. What if the crude experiments of the student do seem to disprove the law that he was expected to establish? It leads him to take into consideration the secondary causes and conditions, and to make due allowance for errors of experiments. It were well for the business man, still more for a scientific man, to learn to distrust the adage that "seeing is believing."

In all the walks of life effects are traced to the wrong causes for want of the power or habit of making allowance for secondary causes. Charlatans would find their tricks exposed, mysterious sights and sounds lose their mystery, were people more capable of drawing correct conclusions from their observations. Wonder workers now excite the admiration only of the ignorant masses, but lawyers, politicians, and theologians impose upon the better educated, and scheming financiers, Keely-motor men, and pseudo-scientists succeed in robbing men of high intelligence, while we all yield our bodies and our purses to quacks and other doctors of medicine. In proportion to our ignorance of a subject is our danger of being duped by those skilled in its mysteries.

But to return to our laboratory; while the student should not be expected to rediscover for himself the principles of physical science, he may be allowed to verify these laws by measurements and determinations of his own until he *feels* rather than *thinks* these laws are true. And while doing this he has learned his own personal coefficient of error and is gradually reducing it to a reasonable limit.

Having given our views, the results of much observation and study, as to what can be done in a physical laboratory, without, however, claiming for them any originality, we will conclude with a brief description of the physical laboratory under the direction of Professor Desain in the Sorbonne, Paris.

At the time of our visit it occupied a number of separate and distinct rooms scattered about in the old buildings that constitute a portion of that venerable institution. In each room was from one to three pieces of apparatus. Near each there hung, in a little frame, brief directions in French for performing a given experiment, and formula for calculating the results. The experiments were usually such as could be satisfactorily performed in two hours, and the sessions were limited to that time—10 to12 A.M. Professor Desain and several assistants were then on hand to give advice, explain difficulties, and offer suggestions.

The following is an incomplete list of principal experiments to be performed, but this particular order was not insisted upon, as no two men could use the same instrument the same day, and each important piece of apparatus was usually engaged a week in advance. Of course a person experimenting with light was expected to finish that before taking up electricity, or *vice versa*, but when sunlight was required, of course the clerk of the weather had to be consulted.

1. Making and graduating thermometers.
2. Estimating the density of a vapor, by Dumas's method.
3. Measuring the magnifying power of microscopes.
4. Measuring the length of waves of light by Fresnel's mirrors.
5. Ditto with Newton's rings viewed obliquely.
6. Ditto, viewed perpendicularly.
7. Ditto, with Billet's demi-lenses.
8. Ditto, with a diffraction spectrum.
9. Use of Norremberg's polarizing apparatus.
10. Use of Biot's rings.
11. Use of Babinet's compensator.
12. Use of Hoffman's polarizing microscope.
13. Circular polarization. Biot's laws verified.
14. Jellett's apparatus.
15. Measuring the rotatory power of quartz crystals.
16. Soleil's saccharimeter.
17. Laurent's saccharimeter.
18. Reflection from metals, Jamin's apparatus.
19. Index of refraction measured with a prism.
20. Ditto, by interference, Jamin's mirrors.
21. Calorific spectrum of the sun.
24. Absorption of heat.
23. Polarization of heat, and law of Malus.
22. Use of Melloui's apparatus.
25. Reflection of heat.
26. Internal resistance of batteries.
27. Resistance of wires, Wheatstone's bridge.
28. Measurement of electromotive force.
29. Measuring the horizontal component of the earth's magnetism. M. T.

It will be noticed that the experiments upon heat and light were numerous and exhaustive, this laboratory being particularly well equipped with excellent apparatus for that purpose. In certain other laboratories, where these receive less attention, electricity and magnetism are better represented.

On the whole, we cannot refrain from saying that a course of experimental physics under Professor Desain well repays the time it takes, while his kindness compensates for his ignorance of our tongue. E. J. H.

ROUND NOSES VS. DIAMOND SHAPE.

Unlike most mechanics, the machinist has a liberty of individual expression, one that is not shared by mechanics generally. It is shown in his selection and origination of shapes for tools. And yet there is no department of mechanics where so much of system and absolute rule exists as in that of the machinist; the reproduction of the same sort of machine tools and the duplicating of the same styles of producing machinery is the main object of the machine shop. The production of uniformity in the parts of machines, which is gradually extending, demands absolute system in many of the tools used— system as to form, size, material, and methods of operating. Yet with all this tendency to uniformity the machinist is largely independent in his selection of forms of bench, lathe, and planer tools. Adopted shapes of tools, which are not necessarily determined by gauge, have not been successfully introduced into any shops. Attempts have been made, in some instances, to designate the style of lathe turning tools and planing cutters for certain purposes, as roughing and finishing, which do not necessitate gauge exactness. But, even if the tool-forger works to any prescribed pattern, the tool-user can change its characteristics at the grind-stone; a right of which he is not slow to avail himself.

In the use of interchangeable lathe and planer tools—stock and bit, instead of solid tool—there has been a pressure, in some instances, to substitute a round-nosed cutter for the diamond point for roughing up and also for finishing. It would be difficult to convince any machinist, not educated to the round-nosed tool, to believe that it will do the work as rapidly and as well as the ordinary diamond point does. Different workmen have their different shapes for the diamond point. Most experienced machinists insist upon having the innermost cutting point—that which reaches nearest the center of the work—somewhat higher or more projecting than the after-cut portion. Then there are others who insist that a level top to the tool is the best, but one of the most experienced workmen, with many years of practice to draw from, insists that the point of the turning tool—the diamond point—shall be the lowest of any cutting portion, and illustrates it by a pocket knife and a round stick to prove that the cutting of the iron should not be a wedging and gouging out of the material, but a shaving of it off from the core by such a shape of the tool as to insure a drawing cut.

It would be difficult, even after experimental tests, to decide upon any one particular form for these tools, so much depends upon the user, the workman. One man will turn out a large amount of excellent work with a tool that another would condemn as almost useless; so, although the practice may be indulging "quirks" and fancies, it is probably good policy to allow freedom to the workman in this respect, so long as it does not degenerate into costly experimental folly.

Friction Wheels.

So much has been published in mechanical periodicals and manuals about belts and gears that another method of transmitting power appears to be well nigh neglected. But for many purposes where absolute contact is permissible or desirable, the use of friction wheels is an excellent substitute for gears. The advantage which they formerly possessed over gears, that of noiselessness, may no longer exist, for gears are made now to run in perfect silence—that is, gears which are properly cut. But friction wheels have other merits, not the least of which is that the machine they drive can be instantly stopped and started by the slightest separation of their surfaces. These wheels can be used in any position where gears can be run, and may be of bevel or of flat faces. The faces require, however, to be held in close contact while running, as it is upon their friction that their action depends. The face of one of the wheels must be of a somewhat yielding or elastic character, as of leather or wood. Vulcanized rubber and the composition known as "vegetable fiber" are also used. The driving wheel face should always be of the softer material, or it will speedily become worn into hollows. As an instance, let the machine to be driven be suddenly stopped by the slight lifting of the face of the driving wheel. The driving wheel continues to revolve, and when the machine is started again by pressing the two wheels together, the driving wheel will rotate against a single point on the face of the driven wheel before the inertia of the machine can be overcome. In this case, if the driving wheel face is of iron and the face of the driven wheel of leather, the leather will soon be worn into corrugations across its width.

Wheels having faces of the same material also work well together, as two wooden faced wheels, or two of rubber. The wood ought to present the ends of its fibers, the blocks being set radially in a skeleton wheel of iron. Wooden wheels should be kept from moisture, which tends to soften and swell them, rapidly impairing their shape, and rubber wheels should be kept from oil of all kinds, which soon rots this material.

Tanned Fabrics.

The *Chronique Industrielle* states that Mr. H. J. Piron has recently invented a process of rendering fabrics impermeable and preventing their rotting, without interfering with their softness or increasing their weight. This process he calls "tanning."

It is well known that the bandages that surround the heads of Egyptian mummies are always found to be remarkably well preserved. Now, this is due to the fact that they have been impregnated with some sort of resin. Mr. Piron thought, then, that in order to preserve vegetable fibers it would be necessary to have recourse to the vegetable kingdom, and he therefore turned his researches in this direction. Of all the products that he tried, the one to which he gave preference was that which is extracted from birch bark, and which serves for perfuming Russia leather. When birch bark is distilled there is obtained a light oil, one-quarter of which consists of a peculiar phenol, and this latter is what communicates that well-known agreeable odor to the above-named leather. It results from recent investigations that the green tar of birch contains neither acid nor alkaloid. This tar forms with alcohol a solution which is at first very fluid, but one which when once dried, resinified, becomes proof against the action of alcohol. This solution unites with the most brilliant colors.

As may well be imagined, these qualities permit of its entering thoroughly into every portion of a fabric. Not only does it fill the capillary vessels, but it also covers them with a varnish possessed of great elasticity, unaffected by acids and the corrosive action of sea water, and well enduring changes in temperature. Its density is slight, and it therefore but slightly increases the weight of the fabric prepared with it. This varnish is not only inexpensive, but satisfies all the conditions required of such a material; and the aromatic odor that it possesses has the merit likewise of keeping out insects. As for microscopic vegetations, such as mildews and moulds, these cannot develop in the prepared fabric, inasmuch as it is impossible for air or water to gain access to the fibers. Mr. Piron's invention is applicable to all fabrics made of vegetable fibers, as well as to rope, cordage, etc.

ACCORDING to the *Milling World*, sackcloth or canvas can be made as impervious to moisture as leather, by steeping it in a decoction of one pound of oak bark with fourteen pounds of boiling water. This quantity is sufficient for eight yards of stuff. The cloth has to soak twenty-four hours, when it is taken out, passed through running water, and hung up to dry. The flax and hemp fibers, in absorbing the tannin, are at the same time better fitted to resist wear.

THE COLUMBIA TRICYCLE.

The mechanical refinements applied in the construction of bicycles have not only created a demand for the tricycle, but have brought out the adequate means for supplying it; and it is a matter of gratification that Americans have contributed as much to the structure of the modern tricycle as they did to its precursor.

We find the latest and best development of tricycle in the Columbia of American manufacture. Two large driving and supporting wheels abreast, one smaller steadying and steering wheel in front, rotary crank action and chain transmitting devices for propelling mechanism, equal communication of power to both driving wheels, with means for differentiating it for curves, adaptation for position for driving by means of changing the weight of the rider from one point to another, in a natural and easy motion; adjustability of seat and handles; tubular metallic construction of frame, and steel suspension wheels; round rubber tires, and polygonal pedals; these are some of the necessary points in the true type of a tricycle.

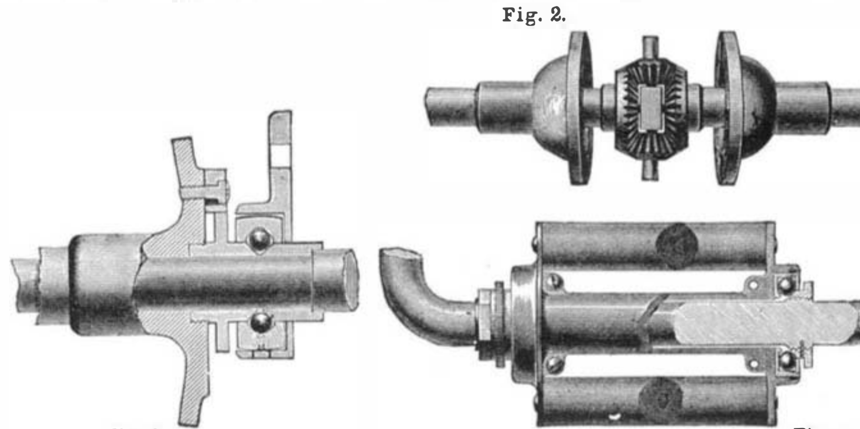

Fig. 2. Fig. 3. Fig. 4.

THE COLUMBIA TRICYCLE.

The new Columbia tricycle is the product of the largest and oldest manufacturer, the Pope Manufacturing Company, of Boston. It is made on the interchangeable system. Rotary pedal action has been adopted, because it is best, mechanically and physiologically, for easy and effective propulsion.

The position of the crank shaft, with reference to the axle of the driving wheels and to the seat, and the position of the pedals on the crank shaft, are such as both to preserve the proper balance or poise of machine and rider and to secure the advantage of driving by weight of rider more than by muscular thrust. The 50-inch driving wheels roll over obstructions with ease, and also give a certain dignity of appearance to the machine and rider, while the application of the fine chain gear is such as to increase the leverage. The Columbia tricycle is a genuine "double driver," the propulsion operating evenly and directly upon both driving wheels. This result is obtained by the very ingenious compensating gear, which consists in mounting the two driving wheels independently, and connecting them on their axles by small toothed wheels (Fig. 2), so arranged and operating in connection with the chain wheel as to distribute the power to the two wheels in proportion to the resistance, evenly on a smooth, straight course, more to the outer wheel on a curve when it travels faster than the other and more distance, and more to the trigged wheel where obstruction is unequal, and the whole is completely automatic.

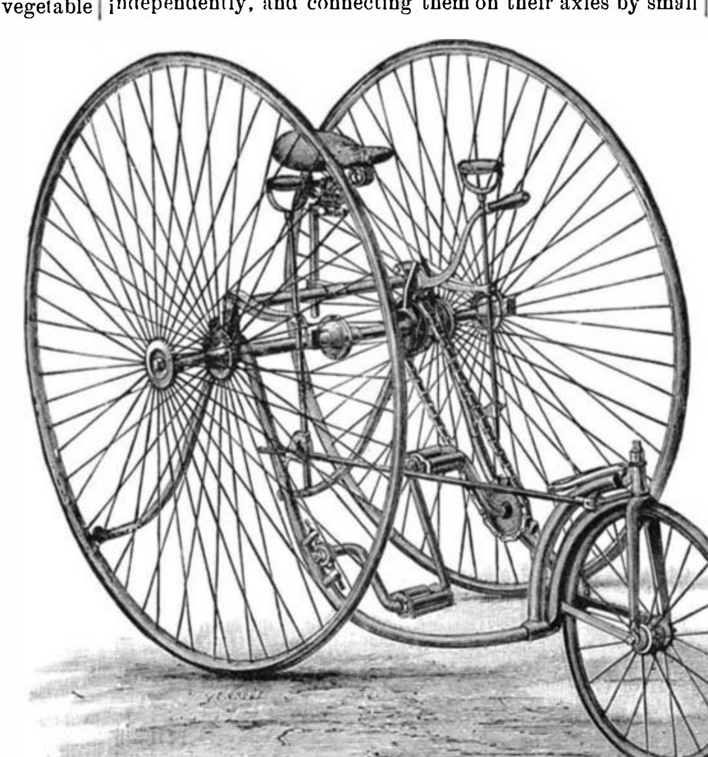

Fig. 1.—THE COLUMBIA TRICYCLE.

The frame and general construction of this tricycle is well shown in the large cut, the frame being of fine steel tubing and very rigid, the rack and pinion front steering mechanism allowing the track to be visible for all three wheels. The seat is adjustable, both fore and aft, and vertically, and the handles are inclined, so that the pull upon them is in the line of the rods, and the position of the hands is very comfortable and natural. The wheels are made with good width of hub and flange, a large number of spokes, and with deep and rigid rims. The tires are moulded in endless rings of the best rubber, and will show the earned reputation of Columbia tires for never coming loose.

One of the most ingenious and effective parts of this new tricycle is a friction brake, applied in the form of two disks to the chain wheel, with an arrangement by which almost unlimited pressure can be brought to bear, and the machine brought to a halt on the steepest incline. The Columbia ball bearing (Figs. 3 and 4) has done as much as any other one feature of construction to give the machines of this manufacture their reputation. There are two sets on the main shaft, two sets on the crank shaft, one set in the front wheel, and two sets in each pedal, so that however the weight or the speed may be distributed, friction is reduced to a minimum. Swivel or compensating bearing box cases are provided for these bearings, so that the bearings are always true.

This tricycle is constructed for general use, under all sorts of circumstances, on all sorts of roads, by ladies and gentlemen, by the light or heavy, and for taking a reasonable amount of baggage. It is a comparatively light machine, as light as it seems practicable to make without leaving out desirable things, and saving metal where it is needed, and it is exceptionally easy running.

Roofing-linen.

According to the *Deutsche Bauzeitung*, a new covering material called "roofing-linen" has been introduced, which is about half the thickness of good *carton-pierre*, and consists of a layer of coarse linen which lies between two layers of thin roll-paper. The cohesion of the three layers is effected by an asphalt composition of special make, called "roofing-paint." It is stated that this paint should be freely applied to roofs immediately after their completion, and again about six weeks afterwards. This operation should, it would seem, be repeated every few years. The linen costs about 10*d*. to 11*d*. per square yard, and the paint 10*s*. to 11*s*. per cwt. Although this new method appears to have points which deserve commendation, a real estimate of its value cannot be formed until the material has been exposed to the test of several years' use.

Mechanics' Apprentices.

In an article—"Apprentices to Mechanical Trades"—in our issue of May 19, it was stated that the facts show the popular opinion that learning mechanical trades had fallen into disfavor with our boys to be erroneous, and the experience of a single establishment was given to substantiate that view. That establishment is the Pratt & Whitney Company, Hartford, Conn. In a subsequent conversation with Mr. F. A. Pratt, the president of the company, he stated that he employs as many apprentices as can be usefully occupied, about 70 or 80 in a total force of nearly 700 hands, and in a large proportion of cases the apprentices endeavor to be retained in employment at the end of their apprenticeship. Mr. Pratt believes it to be profitable and economical for the company to educate their own workmen, and not only are their "day hands" largely from their own apprentices, but a large proportion of the contractors also. The applicants for apprenticeships come from all parts of the country, are frequently high school graduates, or from the Sheffield Scientific School, New Haven, and the applications are so numerous that the company can take their choice of boys with good school educations and proper, manly habits.

Alluding to the article in a letter, Mr. Robert Allison, proprietor of the Franklin Iron Works, Port Carbon, Pa., gives some facts relative to his own practice in regard to apprentices, which is similar to that of the Pratt & Whitney Company. With a total force of from 75 to 100, Mr. Allison educates from nine to eleven apprentices, who are taken for three and a half years on the terms of 50 cents per day for the first year, 60 cents for the second year, 70 cents for the third, and 80 cents for the last six months. Twenty-five cents per week is retained from the wages as a bond for faithful service to the end of the term, and is returned to the apprentice in its accumulated form at that time. Lost time, except holidays, may be deducted, at the pleasure of the employer. A brief probation is a preliminary to the final contract of apprenticeship, to ascertain the fitness of the candidate. Under these conditions the applications are thirty or forty to one reception, which shows that the desire to learn trades has not died out among American youth.

FRENCH silk manufacturers are reported to be very hopeful as to the capabilities of a big spider lately discovered in Africa, which weaves a yellow web of great strength and elasticity.