

parts are together, so they have to be forced home by the closing of the joint. Generally, however, stub tenons are not wedged. Fig. 8 also shows how the saw-cuts, both in stub and ordinary tenons, should be slightly out of parallel with the tenon, to lessen the risk of withdrawal.

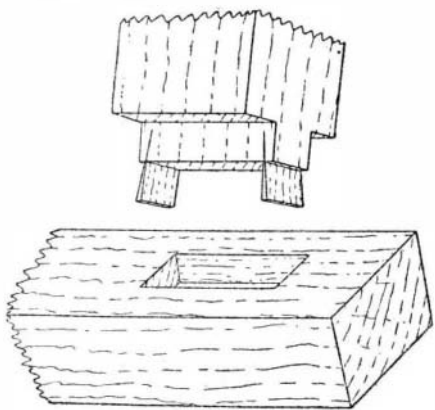


FIG. 8.

When pins are employed for holding the joint, they are inserted from one face of the work, at right angles to the direction in which wedges are used. Screws or nails are often employed in this way, but more commonly wood pins or pegs, roughly pared to octagonal section, with a slight taper lengthwise, which are glued and driven into holes bored for them. Us-

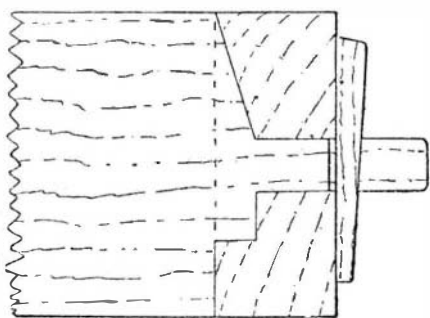


FIG. 9.

ually they do not go completely through the parts, but remain visible only from the face they are driven in at. When pins are used, they are made to assist in pulling the parts together by draw-boring; that is, by making small holes in the tenon slightly out of center with the larger ones in the side of the mortise where the pins are entered. The work is usually cramped

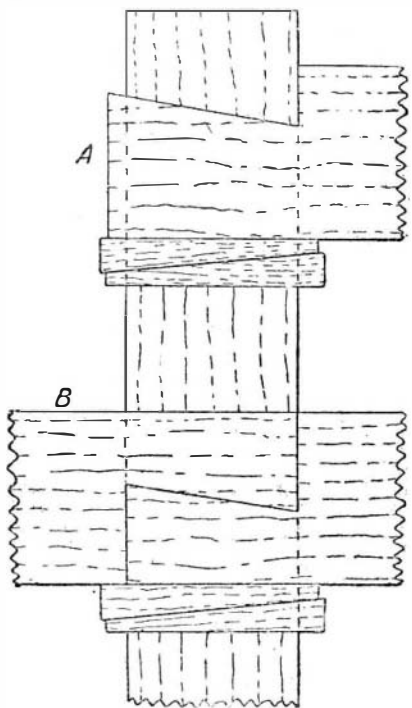


FIG. 10.

together before the pins are inserted, so that their function is not so much to pull the parts together as to maintain them so when the cramps are removed.

In some joints the end of the tenon is made to project considerably beyond the mortise, and a tapering pin is driven through the tenon only, as in Fig. 9. In

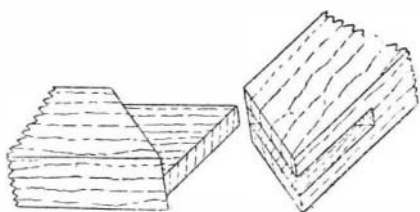


FIG. 11.

such a case no glue is used, but the pin itself pulls and holds the joint together as tightly as may be required, and also permits it to be taken apart again by knocking the pin back. Fig. 9 is called a tusk tenon, and is employed for uniting heavy timbers which meet in a horizontal plane, the joint being designed specially to afford the maximum support to the

tenoned end, with the minimum weakening of the mortised timber which supports it. As a beam is strained least in the central plane, it is only in that part that the tenon is allowed to pass through. Below the root of the tenon a short tusk is formed to prevent its getting sheared off, and it is similarly strengthened above by a projection which tapers to nothing at the top, in order to cut as little as possible from the mortised beam. The weight of the tenoned timber is carried partly by the portion the tusk rests on, and partly by the longer support in which the slender tenon bears. In some cases, when the supporting beam is wide, or when timbers enter on both sides, the tenon is not carried through, but held by a pin inserted through a hole in the mortised timber. All the parts of a tusk tenon are of the same width as the timber they are formed on.

Fig. 10 A and B show dovetailed tenons held in place by folding wedges. In A one timber only is tenoned into the post, which is usually thicker than the timber that enters it. In B two ends meet, entering the mortise from opposite sides. These joints are employed more for work which has to be taken apart again than for fixtures. They are suitable when the timber in which the mortise is cut is thick, and the tenoned pieces thin. The latter, in fact, are generally not, strictly speaking, tenoned at all, but enter at their full thickness, and are dovetailed on one edge. Stub tenons also can be secured in this way.

Fig. 11 is an open mortise and tenon with shoulders mitered instead of square, like Fig. 6 A. It is, of course, not so strong as the latter, and is mitered for appearance. In cases where only one face shows, its strength is often increased by mitering the front only, and leaving the back shoulder square.

In large, well-equipped shops, mortises and tenons are cut by machines. By hand, mortises are partly bored out with a bit, and finished to the lines with a mortise chisel, or they are cut by chisel and mallet alone. Tenons are sometimes sawn to the line, but more frequently their shoulders are finished with a chisel, and their faces with a rebate-plane. Scribed and gaged lines are used everywhere in preference to pencil. The thicknesses of tenon and mortise are gaged with a mortise gage, which marks both lines simultaneously. The shoulders of the tenon and ends of the mortise are marked with square and scribe. If the tenon is a thorough one, it should be long enough to allow for dressing off after it is in place. A stub tenon should be a trifle short in its mortise to insure a close fit at the shoulder. The latter should be slightly undercut to insure close contact at the exterior.—English Mechanic and World of Science.

WEIGHT OF MAN ON THE PLANETS.

If the planet Mars is really inhabited, the people who live there must be an exceedingly nimble race. The average weight of a man is about one hundred and forty pounds, but the force of gravity on Mars is so much less than on the earth that the hundred-and-forty-pound man would weigh only fifty-three pounds if he were transported there. With such light weight, and still retaining the same strength, an individual would be able to run with the speed of an express train, go skipping over ten-foot walls, and do various other extraordinary things. On the moon, a man would be even lighter.

But on the sun, our hundred-and-forty-pound man would have his troubles. Instead of being an airy individual, he would weigh in the neighborhood of a ton and three-quarters. He would probably have the greatest difficulty in raising his hand, for that member would weigh about three hundred pounds.

According to scientific computation, a man who on the earth weighs one hundred and forty pounds would on the other celestial bodies weigh as follows:

	Pounds.		Pounds.
Moon	23	Uranus	127
Mars	53	Earth	140
Venus	114	Saturn	165
Mercury	119	Jupiter	371
Neptune	123	Sun	3,871

EIGHTEEN HUNDRED YEAR OLD BACTERIA.*

DURING the bacteriological examination of the contents of an old Gallic-Roman grave in the vicinity of Troussepoil, in Vendé, where a considerable number of such graves may be found, a most remarkable discovery was made. In the shaft of the rather deep grave, whose contents were entirely undisturbed, a large number of objects was found, which prompted the conclusion that in all probability it had been built in the second century after the birth of Christ. Besides the remains of previously burned corpses, the grave contained a number of skeletons of domestic animals, which had been placed therein without previous burning. All these remains, as well as the ornaments buried with them at the time, were enveloped in a rather strong layer of slime, which was bacteriologically examined by Dr. M. Boudoin. He announced the result of his investigations in the French Academy of Sciences.

The slime was richly intermixed with the remains of the skins and bristles of animals, but otherwise consisted mainly of a mixture of sand and water. Bacteria cultures were obtained from it with comparative ease, and consisted principally of the coli bacillus and of various species of the sphaero-bacteria, both of which are so frequently found in animals. The question now is: How can the presence of these

bacteria at such great depth (the slime experimented with was taken at a depth of ten meters under the surface of the ground), be explained, after the generally accepted experience that even at two meters under the surface, the ground is usually almost entirely germ free.

As an initial theory, we might be led to think that the bacteria, in consequence of bad filtration, had forced their way into the inner parts of the grave from the upper strata, that is, from the surface. However, owing to the geological condition of the entire surrounding country, this theory must be excluded altogether, and we must accept it as certain that the bacteria do in fact find their source in the goat, dog, and cow carcasses found in the grave. That there is nothing improbable in itself in this assumption, lies in the fact that the appearance of the so-called "retarding life," is long and well known in bacteriology. Many species of bacteria are able to maintain life for an abnormally long period on a ground which offers them no nutritive material whatever; when, however, they are transplanted into more favorable nutritive mediums, they again begin to reproduce. The bacteria now under consideration, seem to furnish a case of this state (though, to be sure, an extraordinarily long one), of the "retarded life." They have evidently been imbedded into the slime of this grave nearly eighteen hundred years without suffering a loss of their vigor and vitality.

ROPE DRIVES—VARIOUS METHODS OF ARRANGING ROPES ON THE SHEAVES.*

By R. HOYT.

THERE seems to be considerable difference in opinion regarding the various ways of applying rope to the sheaves in rope driving, viz., multiple- or separate-rope system, continuous-wrap or single-rope system with the rope from one of the grooves running on a traveling take-up device, continuous-wrap or single-rope system with the take-up working directly on all the wraps.

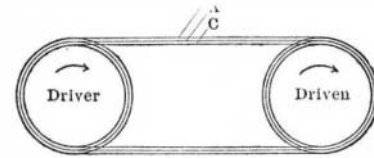


FIG. 1.

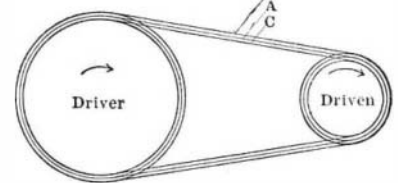


FIG. 2.

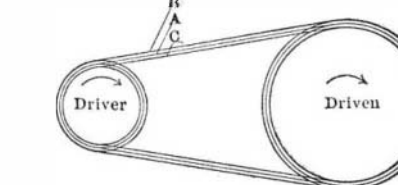


FIG. 3.

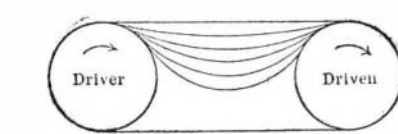


FIG. 4.

The multiple- or separate-rope system on a horizontal drive where the distance between centers is great enough so the weight of the rope will give the required tension, having the tight or pulling part on the lower side and the sheaves of the same diameter, as in Fig. 1, should be very satisfactory, as old or worn ropes may be replaced by new ones of larger diameter or some of the ropes may be tighter than others and still not alter the efficiency of the drive. It will be noticed in this case that a larger rope does not alter the proportional pitch diameters of the rope on the driving and driven sheaves; but if one of the sheaves is larger than the other, as in Figs. 2 and 3, and a new or larger rope is substituted for a worn or smaller one or if some of the ropes are a great deal tighter than others, a differential action will be produced on the ropes owing to the fact that the larger or slack rope will not go as deeply in its grooves as the smaller or tight one, and consequently the proportionate pitch diameter on the rope on the driver and driven sheave will be changed. The action will depend upon whether the large or small sheave is the driver. If the driver is the largest and of course assuming the slack or large rope is weaker than the combined tight or smaller ones, then it will have less strain on the pulling side; but if the driver is smaller, then the new or large rope will have greater strain on the pulling side. Whether the driver is larger or smaller, a large or slack rope affects the action oppositely to a small or tight rope. Fig. 3 shows how the action is reversed from Fig. 2.

For clearness we will exaggerate the differences in diameter in the sketches and figure the speeds that the different size ropes would produce. We will take A as normal, B 1 inch farther out of the groove, producing a difference in diameter of 2 inches; C 1 inch

* Translated for Pure Products from Tageszeitung für Brauerei.

* Power.

deeper in the groove, producing a difference in diameter of 2 inches. In Fig. 1 assume for the normal diameter of driver and driven 40 inches, and 42 inches for *B* and 38 inches for *C*, with a speed of 200 revolutions per minute for the driver. Either *A*, *B*, or *C* will give 200 revolutions per minute for the driven sheave, omitting slippage, of course. In Fig. 2, say the normal diameter of the driver for rope *A* is 60 inches and of the driven 30 inches, a speed of the driver of 200 revolutions per minute will give the driven sheave a speed of 400 revolutions per minute; *B*, with the driver 62 inches and the driven sheave 32 inches diameter, will give the latter a velocity of $387\frac{1}{2}$ revolutions per minute. With *C* the driver is 58 inches, the driven 28 inches, and the speed given the latter $414\frac{2}{7}$ revolutions per minute. In Fig. 3 the normal diameter of the driving sheave being 30 inches and the driven 60 inches, a speed of the driver of 200 revolutions per minute will give a speed of the driven member of 100 revolutions per minute. With *B*, if the driver is 32 and the driven 62 inches, the driven sheave will have a speed of $103\frac{7}{31}$ revolutions per minute; *C*, with the driver 28 inches and the driven sheave 58 inches, will give the latter a speed of $96\frac{16}{29}$ revolutions per minute. So it will be readily seen what effect a large or small rope would have.

There are some who claim that slack ropes will transmit more power owing to more wrap on the sheaves, while others claim that tight ropes are better. I think if one had a drive and the ropes were all slack and they were troubled with the ropes slipping, the first remedy they would try would be to tighten the ropes. But, if the conditions were like Fig. 3, I don't see that it would be particularly harmful to have some of the ropes longer than others; in fact, it might be well, as the longer ropes would not make a complete circuit as quickly as the shorter ones; consequently the position of the splices would be continually changing. However, it seems more natural, and I should consider it best, to have about the same pull on all the ropes, that is, not have them as shown in Fig. 4. In conclusion for the system, it should be noted that it has no means of tightening the ropes except by resplicing; it is not as well adapted to various conditions as the other forms; it is the cheapest form to install and in some cases should give excellent satisfaction.

With the continuous-wrap system having the rope from one of the grooves pass over a traveling take-up, the latter has a tendency to produce an unequal strain in the rope. In taking up, or letting out, the rope must either slide around the grooves, or the strands having the greatest pull will wedge themselves deeper in the grooves, producing a smaller pitch diameter than the ones having less pull, making a differential action on the ropes. It is, therefore, probable that it is the differential action that takes up or lets out the ropes, the take-up merely acting in a sense as an automatic adjustable idler. In tightening, when the rope stretches, or dries out, or even in running normal, the greatest pull will be near the take-up, but if the drive is exposed to moisture, and the rope shortens, it will be farthest from the take-up, depending proportionately on the number of grooves the take-up controls; so in large drives it is best to have more than one take-up.

If one should use an unyieldable substance, as, for experiment, a plain wire on two drums wrapped a number of times around and also over a take-up, and the drums were moved together or apart, he would find that the wire would have to slide around the drum; but, of course, with a rope in a groove it is different. The rope will yield some. It will also go deeper in the groove. This system costs more than the preceding form, owing to extra expense for the traveling take-up, but may be applied readily to different conditions, and will be quite satisfactory in general, if properly designed and installed.

The continuous-wrap system with a take-up or tightener acting directly on all the wraps has practically none of the objectionable features mentioned in the other two forms, and is quick in action, making it applicable where power is suddenly thrown on or off. If the tightener is made automatic, it may be controlled in numerous ways, as with a weight or weight and lever or tackle blocks and weight, etc. It also may be fitted with a cylinder and piston, with a valve to prevent too quick action if power is suddenly thrown off or on. There is ordinarily practically no unequal strain on the rope. This system may be applied to different conditions as readily as the preceding form. Its cost is more than that of either of the others, as the tightener must have as many grooves as there are wraps. It must also have a winder to return the last wrap to the first groove, and to give its highest efficiency it must be properly designed and installed.

In either of the continuous-wrap systems, if a portion of larger rope is used, it will produce a greater strain directly behind the large rope, owing to its traveling around the sheave quicker. In angle work there is always extra wear on the rope in the side of the groove, as only the center or one rope may be accurately lined; so it is not advisable to crowd the centers in angular drives, as the shorter the centers and wider the sheaves the greater the wearing angle. It must be remembered that the foregoing applies to ordinary simple drives as shown in the sketches; where the drive is complicated, it may be necessary to make other allowances.

Good material should be used and competent parties employed for designing and installing rope drives. Don't be hasty to condemn a drive in general because of a poor rope, a flaw in a sheave, or because of its being erected in an unworkmanlike manner.

ELECTRICAL NOTES.

An inventor has devised an electrical machine for bleaching flour, thereby imparting that palatable-looking whiteness to the foodstuff. There is a small closed chamber containing an electric arc of great length and at high voltage. While the arc is struck a current of air is forced through the chamber, and coming into contact with the flame is burnt, being then passed through the flour as an agitator and bleaching the powdered cereal in the process. Apparently under the influence of the electric arc the air becomes resolved into compounds of oxygen and nitrogen, which are thereby converted into powerful bleaching agents. It will be seen that this system is essentially different from the ordinary electrical whitening process, in which the air is not burnt, but is ozonized in a chamber containing a silent electric arc. The former method, however, is stated to be cheaper and more successful than that already in vogue.

A report was submitted recently by George Nicolaus to the telegraph section of the Elektrotechnischen Verein, dealing with the testing of small motors such as are used in telegraph and other similar work. The dynamometer is of the air-vane type, and consists simply of a split sleeve which may be slipped over the end of the motor shaft and clamped in place. The outer end of this sleeve carries a rod at right angles to the motor axis, which forms arms upon which are placed two circular disks fitted with clamps for holding them in any position on the two arms. Definite positions are marked on the arms, and by means of curves the power developed by the motor with the vanes in any position and at any given speed can be read off directly. The dynamometer is calibrated by means of a cradle dynamometer, upon which the test motor is placed. The apparatus is simple and gives a steady load, besides being cleanly and easy to control. —Electrical Review.

Messrs. Sidney Leetham and William Cramp, of Manchester, read a paper on the "Electrical Discharge in Air and its Commercial Application." When experimenting with the sterilization and bleaching of flour by ozone, they stated, Mr. Leetham observed in 1903 that a much more powerful bleaching agent than ozone was produced if the ozonized air was afterward passed through boxes in which electrical discharges between spark-points were taking place. Prof. H. E. Armstrong had ascribed the improved effect to the presence of nitrogen oxides. The authors perfected their apparatus, which now consists of a compact steel plate case containing alternator, transformer, ozonizer, and spark-box, the latter two in series on the secondary circuit. The air is supplied by a small Root blower, filtered, ozonized, exposed to sparks, and sent through a valve flange straight to the reel-box through which the material to be bleached is passing. With a feed of 100 cubic feet per minute, the resulting gas contained in 40,000 parts (by volume) of air, 3 parts of ozone, and 1 part of oxide of nitrogen. The temperature, air velocity, pressure, current frequency, and wave form, the number, shape, and distance of the spark-points, all have their influences. As long as the air resistance is high, ozone is the chief product; when the resistance breaks down, nitrogen oxides appear, which, contrary to many authorities, can exist side by side without mutual destruction. The bleaching appears to be an oxidation process; about two-thirds of the micro-organisms contained in flour are destroyed, and the treated flour seems to absorb more water than untreated flour.

The Siemens & Halske firm of Berlin are now manufacturing a dry battery of a new type, which is intended to replace the preceding batteries and is claimed to be an improvement. It is known as the "T" type. The new battery when put upon short circuit after remaining standing for a year, was able to give 12 amperes current and worked very well. A comparison which was made by the Physico-Technical Institute of Charlottenburg between the new battery and the Hellesen dry battery, one of the best of the preceding types, showed the following results as to the capacity in ampere hours: The weight of the new battery is 1.5 kilogrammes, and the dimensions are 7 by 3 by 3 inches. On the test the first discharge was made at the rate of 0.1 ampere. Here the Hellesen battery showed 46.8 to 47.1 ampere hours, while the "T" battery gave 65.3 ampere hours, which is quite in its favor. The second test was made by discharging the batteries through (a) a resistance of ten ohms and (b) through twenty ohms. For the Hellesen and the new batteries respectively we have 54.3 to 61.1 ampere hours and 84.3 to 82.7 ampere hours for test (a). On test (b) the cells showed 69.8 and 109 ampere hours. Thus it is seen that the Siemens & Halske cell has a yield of about forty per cent above what the Hellesen battery gives. On the other hand, it is found that the cells are more uniform in capacity and are able to recuperate more rapidly. The exact arrangement of the interior of the cell has not yet been made public.

A paper written by D. L. Lindquist, which described the two or more phase magnet, appeared in the Electrical World. It is shown that the pull is constant at any instant, and that the resultant pull is always exerted through the axis of the magnet, thus preventing rocking and consequent chattering. The power-factor of a certain magnet is practically independent of the length of air-gap, but with increased air-gap, the losses in the core increase very considerably. In order to get the maximum pull the air-gap must be in the center of the coil. A polyphase magnet should never be loaded to such an extent that the load ex-

ceeds the minimum instantaneous pull of the magnet. A magnet will commence to be noisy at about one-half full load, but will in general hold without noise all the load it can lift, so long as the length of motion is not too short. The paper is largely illustrated with curves. In the second part, the influence of coil resistance and also of external resistance is investigated; the former was before taken as negligible. It is illustrated with curves from the test of a two-phase magnet supplied with two-phase current, and with several vector diagrams, showing the allowance that must be made for the resistance of the magnet coils at zero air-gap and $\frac{1}{4}$ -inch air-gap, also when an external resistance is in series with the magnet. It is shown that in general neither resistance nor inductance of a fixed amount can be used for regulating the voltage in an alternating-current magnet, unless used in conjunction with a switch for inserting more resistance or inductance after the magnet has lifted its load. It is also shown that an alternating-current magnet has a starting pull depending on the instant at which the circuit is closed, and that under the most favorable conditions this maximum starting pull may be four times the maximum pull after equilibrium has been established; since, however, it is uncertain at what moment the circuit may be closed, the possible or probable starting pull cannot be counted on. The magnet can naturally only be used to do work when the necessary lifting force is less than the effective pull of the magnet; and if the current is left with the cores apart the magnet is liable to become overheated due to too great a current on account of the inductance being too small. The high starting pull often causes the magnet to lift very quickly, thereby causing a hard blow when the cores meet; to avoid this it is necessary to arrange the magnets with dashpots.

SCIENCE NOTES.

It has been decided to carry out careful and thorough excavation of the site of the ancient Roman town near Corbridge, about eighteen miles distant from Newcastle in the north of England. This country is particularly rich in Roman remains, many important military stations having been established in this district to repel the invasive tactics of the Picts from across the Scottish border. The present site is believed to be the remains of Corstopitum, an old market town built by the Romans. It differs materially from the surrounding military encampments. It is anticipated that discoveries of great value from an archaeological point of view will result, since already many interesting relics have been found upon the site. The excavation work is to be carried out by an influential committee, of which the Duke of Northumberland is the president, and the work will occupy some five years.

Owing to the large number of fires that have occurred within the past few months upon vessels engaged in carrying wool from New Zealand to England, the causes of which have been somewhat mysterious, the government of the Australian colony has appointed a commission to investigate the liability of wool to spontaneous combustion. In this direction some striking evidence has been offered. Upon the arrival of two bales of wool at Wellington from a station near Hawera, conveyed in a steel truck, signs of overheating were observed. The truck with its contents was thereupon sidetracked and a vigilant watch maintained. The heating was found to increase until at last one of the bales commenced to steam. The bales were thereupon secured by the commission and removed to a more convenient point for closer observation, since it is expected that in time they will burst into flame, thereby conclusively showing that wool is subject, when stored and carried under certain conditions, to spontaneous combustion.

The government of New South Wales are engaged in experimenting with the bacteriological treatment evolved by the French scientist, Dr. Danysz, a professor at the Pasteur Institute, for exterminating rabbits. Owing to the ravages and enormous damage inflicted to the crops by this pest—despite the large and increasing trade that has developed in exporting frozen rabbits to the European markets for consumption, their numbers are still rapidly increasing—the farmers subscribed a sum of \$50,000 to enable Dr. Danysz to visit the colony and carry out investigations upon the spot with his process. This scientist claims to have discovered a microbe which though fatal to the rabbit is perfectly innocuous to other animals and human beings. A number of tubes containing the bacteria were taken by the professor to New South Wales, but upon his arrival the bacteria were promptly impounded by the Australian quarantine authorities. It was considered too dangerous to permit the professor to carry out his investigations at random, owing to the speculative nature of his discovery, so he has been isolated upon Broughton Island, where the necessary facilities were provided, together with the services of the government expert. Consignments of rabbits are dispatched weekly together with other animals to the professor's quarters, where he is engaged upon his experiments to demonstrate the innocuous nature of his microbe to aught but the rabbit. Directly his contentions have been conclusively proved, Dr. Danysz will be permitted to continue his investigations upon the mainland.

There can be no permanent advance for any people except it is based on the Gibraltar of technical education. The education of the people is the building up of the nation. There should be less education for intellectual gymnastics and more training for useful-