protoplasm and make all return to life impossible, but if the protoplasm has already reached its maximum concentration by drying, and consequently its minimum of action, it escapes the action of the cold and does not freeze, thus retaining the germinating principle. The above experiments seem to show, at least as far as they have gone, that the argument in favor of a suspension of life in the grain will not hold.

INTERESTING REPAIR WORK ON A GERMAN STEAMSHIP.

BY DR. ALFRED GRADENWITZ.

A highly interesting repair work on the aluminothermic process was recently carried out at the Bremerhaven imperial docks. The steamship "Friedrich der Grosse," of the North German Lloyd, the sternpost of which had to be repaired, had lost one of her propeller blades on sailing home from Australia to Bremen. As a consequence of the resulting inequality in the working of the propeller, the Siemens-Martin steel propeller shaft bracket had been broken.

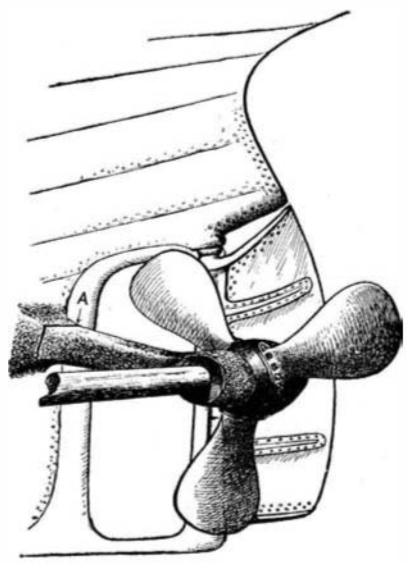
The position of the fracture will be seen from the diagram. In order to obtain access to this point during the welding operation, the plating of the hull had first to be removed to the necessary extent, after which the fracture was widened by 30 mm. (0.12 in.) to make room for the intermediary thermite iron casting. In order to avoid any displacement of the propeller shaft bracket during the operation, it was maintained in the proper position by heavy steel struts and chains.

The mold used is seen in one of the views. As horizontal displacements of the molding box had to be provided for, it was placed on a small sliding way. In order to avoid any leakage of the thermite iron, due to a defective tightness of the mold, the latter was surrounded by an external casing, the intermediary space being tamped in strongly with sand. Besides the admission funnel and the ascension funnel, the mold was provided with a third opening, through which any ashes penetrating into the mold could be blown out. This opening had obviously to be closed entirely before the casting was commenced. A dry sand core was introduced to this effect, the aperture in the walls of the molding box being fitted with a blind flange.

During this preparatory operation, a preheating furnace of sufficient size was erected, and an electrically-driven fan (a so-called sirocco blast) was placed in position. The fire gases for preheating the fracture were allowed to enter through the ascension funnel and to issue through the admission funnel and the aperture just referred to.

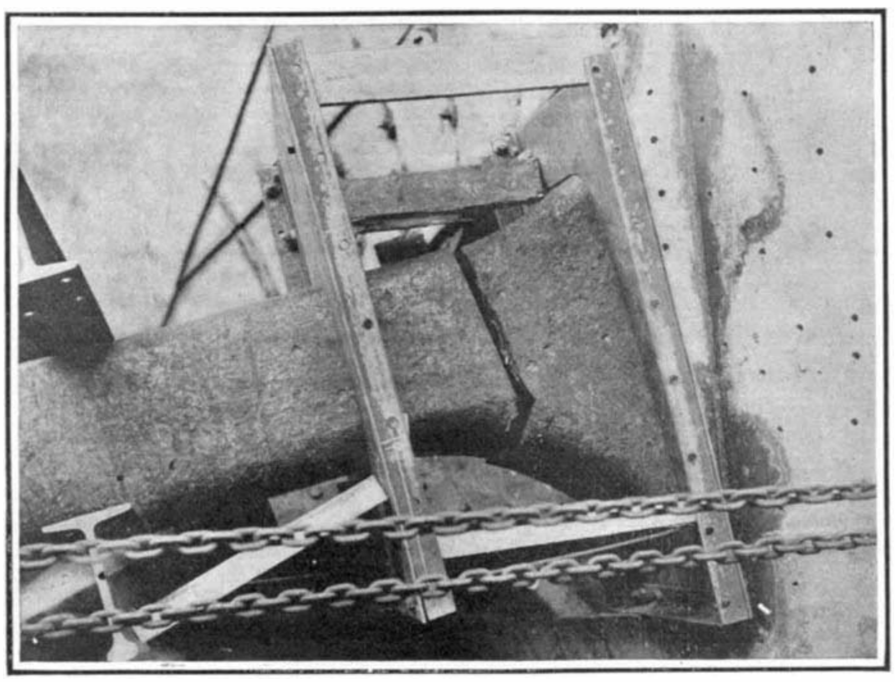
The crucible was surrounded by another sheet-metal jacket, the intermediary space between this and the crucible being filled in with moist sand, thus avoiding the risk of the mold being burned through or the thermite iron escaping. After four hours' preheating the furnace was removed and the crucible placed in position, being held in a ring attached to the ship. A casing, lined with chamotte, was provided, to receive any escaping slags, and the crucible was filled with 350 kilogrammes of thermite, 75 kilogrammes of small shot, and 3½ kilogrammes of powdered manganese, and the mixture was ignited.

The ensuing reaction was quite normal, as expected; and for a full description of this welding process reference is made to articles published in the SUPPLEMENT of January 5, 1901, and September 26, 1903. In this process the mixture of metallic oxide and pulverized aluminium in the crucible was ignited, and the temperature of reaction of about 3,000 degrees reduced the oxide and gave a pure metal, which welded the fracture. About 50 kilos (110 lbs.) thermite was filled in gradually after the casting into the ascension funnel. On the next morning the mold was struck off, when the surrounding thermite iron casting was found to be free from any defects, while the ascension funnel struck off the mold showed a fracture surface of perfect density.

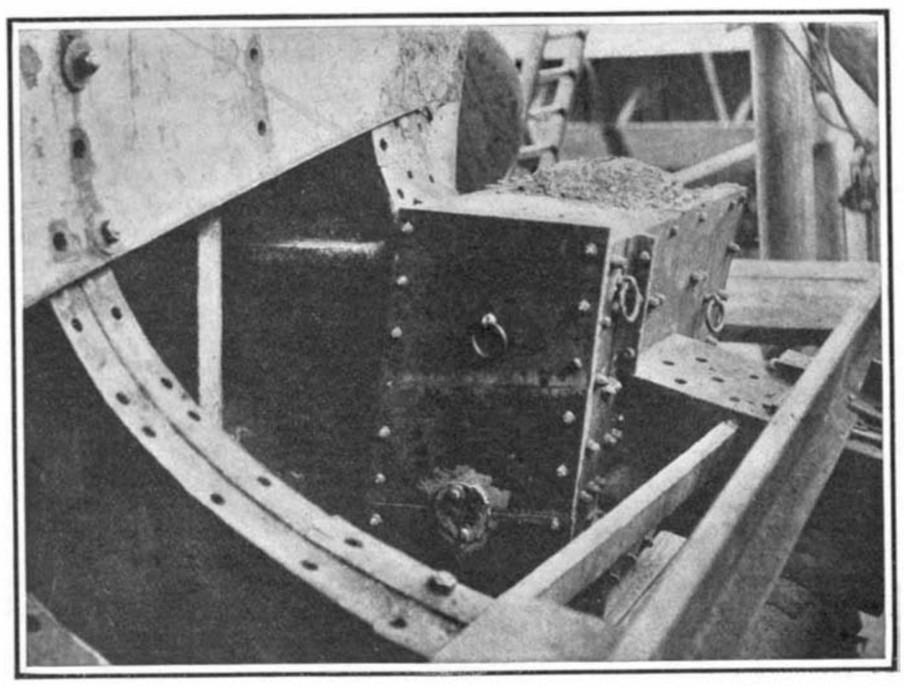


Where the Break Occurred.

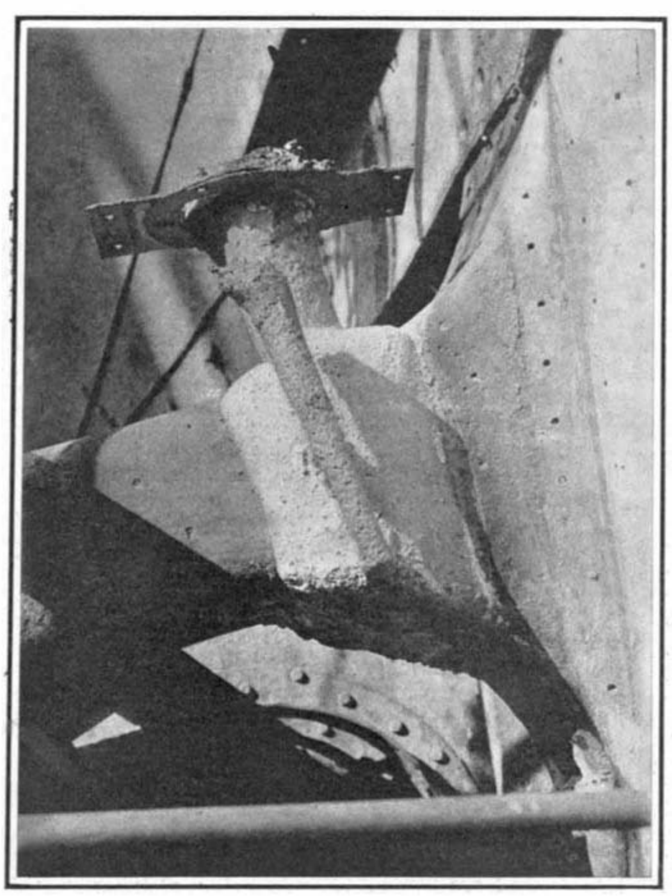
By using the thermite process in connection with this repair work, the North German Lloyd was enabled to place the ship in commission again after a relatively short time, whereas an interval of some months would have been required to prepare a new propeller bracket and to fit it ready for operation.



Sternpost of the "Friedrich der Grosse" Before Welding. The Fracture Has Been Widened 1.18 Inches. The Molding Box is Half Completed.



The Mold Attached to the Fractured Post.



Welded Fracture, Showing Iron Cast Around the Break. The Admission and Ascension Funnels Have Been Left in Position.

INTERESTING REPAIR WORK ON A GERMAN STEAMSHIP.

Care of Hair and Scalp.

One of the most sensible articles on what the "tonsorial artist" calls the "hirsute adornment" of man has appeared in the American Physician and is from the pen of Dr. George W. Spencer. The doctor says:

"With our environments the question of cleaning the hair and scalp is one of great importance.

"Women have an excellent method of washing the hair; this is made necessary by the fact that its length and thickness do not permit of a rough and unsystematic rubbing and scrubbing.

"On the other hand, boys and men think they have to have their scalps and hair scrubbed with soap and water and then dried by violently rubbing with a rough towel, or submitted to a most wonderfully beneficial preparation, called a shampoo, which leaves the scalp in a tender and congested condition favorable for infection and sensitive atmospheric changes.

"The cleaning of the scalp should be very carefully and tenderly performed, using warm water with a mild soap, rubbing in gently and with the ends of the fingers, then rinsing with tepid water and drying by gently pressing the hair and scalp with a very dry towel, continuing until thoroughly dry; or, still better, dry it by fanning. If any application is necessary to bring hair thus dried into shape, dampen with a bichloride of mercury solution 1-2,000.

"Ordinarily this thorough cleaning need not be done oftener than once a week and in the interim the hair needs only to be brushed with a soft brush without allowing the brush to scratch the scalp.

"The stiff brush, and especially that most injurious of all brushes, the military brush, which is frequently used for months several times daily until it becomes filled with dirt, can only be of great injury to the scalp, because of the vigorous scratching, as well as breaking the hair. All brushes should be destroyed and only blunt-toothed combs used to dress the hair, and these should be thoroughly cleaned after each using; and no two persons should ever use the same comb.

"The practice of barbers is a fruitful cause of diseased scalps. They use the same brush for all customers; before combing or brushing the hair, they rub the scalp violently with the ends of the fingers, thus rubbing out other than the hair that, physiologically, is being shed all the time; by this rough usage they injure the scalp and aggravate any pathological condition that may exist, however slight.

"Much injury is done by the use of lotions and dressings for the hair. It would be impossible to mention the many articles used for this purpose. The mixture called 'bay rum' is one of the most common and injurious of those used. Oils of different kinds, highly perfumed (to cover their nastiness) were at one time extensively used, but are now, fortunately, falling into disuse. Normal hair has all the oil needed; the addition of some doubtful article will result in decomposition and consequently be poisonous. Even when the scalp is affected with that most common and little noticed disease, dandruff, the above instructions apply to the care of the scalp. The only lotion that need be used is pure water, unless some disturbance is indicated by slight itching, then a bichloride-of-mercury solution, 1-2,000, can be sparingly used.

"The mistake of civilization is having lost sight of the fact that the hair is ample for the immediate covering of the head, so it has instituted the custom of wearing hats or caps.

"The English tourist's hat is an ideal hat both for winter and summer.

"When possible no hat should be worn. The opportunities for leaving the hat off are many more than one would think.

"The leaders of fashion could do much toward bringing to pass the leaving off of the hat. The only specific advice that can be given, is to take off your hat whenever possible."

Correspondence.

The Teaching of Science in Schools.

To the Editor of the Scientific American:

The study of elementary science, or "nature study" as it is often called, is a branch of steadily-gaining popularity in the modern school. In many curricula it absorbs perhaps a third of the pupil's time, and probably much more than half his interest. Classes in elementary ologies of all kinds are supplanting the classics and more formal studies of the past. Whether this is an advantage or not is a question I shall not discuss; but no one will deny that it is of the utmost importance that these new studies, if they are to be of any real value, if they are to produce mental fiber of any strength, must be taught thoroughly and well. Grave doubts of such thoroughness inevitably assail many a college examiner after he has waded through the dreary morasses of mental confusion found in numerous entrance papers.

Last June the writer set an examination in physics based upon a well-known college textbook with questions of a fundamental character, and no more difficult than those asked of freshmen who have completed the first year's college course. The result was most discouraging. Many of the candidates did not attempt to answer but one or two of the ten questions required. Those who were more courageous floundered hopelessly through part of the examination, but showed a confusion of mind that spoke ill for the methods of teaching used in the schools they came from.

Before quoting from the papers of these candidates, it will be well to explain that physics is not one of the entrance requirements at Trinity, but like certain other subjects it may be offered to make up the requisite number of courses for admission. The candidate who passess it is then eligible to the second year's college course. In fact, he would not be allowed to take the first course, and count that toward his degree, on the assumption that he has already covered that ground once by his entrance examination. It is thus essential that the questions asked shall be similar to those put to students who have completed Physics I.

The first question was one on fundamental units, and here are some of the replies, taken not from the worst papers, but from an average selection:

"Angular velocity is the distance an object travels when it is thrown up in the air or on its downward course."

"Angular velocity is the distance a body covers in centimeters when moving in another direction to that which gravity would tend to make it go." (This was on the best paper handed in.)

"Acceleration is the speed with which an object travels."

"The unit of the C. G. S. system is the dyne, of linear velocity is the foot, of acceleration is the foot per second, of force is the foot-pound, work is the horse-power, of potential and kinetic energy is the foot per second."

"Energy is the power which *every* body has for doing work." (The universality of this dictum is delicious.)

"The momentum of a body is the rate of speed of that body per second over a certain space."

"The C. G. S. is the unit of force."

Two problems in mechanics were asked, one on a ball projected at an angle of 30 deg. to the horizontal, involving of course a very simple trigonometric solution. This naturally was beyond the ken of those who had not yet learned the meaning of sine and cosine. Another involved the calculation of the moment of inertia of two weights at the extremities of a revolving weightless bar. Neither problem was solved correctly by any one.

The theory of the simple pendulum was left untouched by most. Those who attempted it described how a pendulum swings, and said a little about kinetic and potential energy as exemplified by that useful illustration. Archimedes's principle was variously described. One attempt follows: "Archimedes's principle was based upon the fact that if a solid was placed in water, which exactly filled a receptacle, the water which overflowed would exactly equal the weight of the solid. This made it possible to weigh an elephant, for the water could be collected and weighed a little at a time."

Another is of the opinion that on account of the "impenetrability of matter, . . . when a substance is placed in water it must displace its own weight of water." This view of equal masses was quite popular; about half the papers made a similar assertion.

Such questions as the frequency of the note G♯ when C = 256, or the proof of the electrostatic formula

Potential $= \frac{Q}{K d}$ were quite beyond the scope of all but one or two, who made feeble attempts to answer them. But one would look for more information when such concrete subjects as the Wheatstone's bridge were called for, for there is at least some form of wire bridge in any school laboratory; so it was a genuine surprise to have a boy who came from an excellent preparatory school say: "Wheatstone's bridge consists of two bars (hor.) some inches from each other. Across them a string is strung, one end hanging over having a weight attached" (diagram here), etc. (Of course an attempt to describe some method for finding the modulus of elasticity of a wire.) Other attempts at the famous bridge gave incorrect diagrams, usually a faulty picture of the piece of apparatus used in the school laboratory; and even the fundamental proportion was often incorrectly stated.

Questions on the electrical and magnetic units produced some amazing information.

"Susceptibility is the power of showing the slightest current."

"Magnetizing force is the power which does the magnetizing measured in volts and amperes."

"The magnetizing force is the force required to magnetize a body."

"Magnetic induction is the magnetism excited inside a helix, although no electrical connection has been formed." One sees in this last reply what ideas were groping in the poor confused brain, but the wonder is how the clear-cut mental focus of a future bank president or manufacturer can evolve from such vagueness and inability of expression.

Apparently no one had ever heard of the diffraction grating, and the spectra of incandescent solids and gases are both hazily described as having "lines," by the few who ventured into the realm of optics at all.

These samples taken almost at random give an idea of the sort of paper that was handed in. Of course, some questions were answered correctly, but the impression left in the examiner's mind was one of having come in contact with an intellectual fog, and his belief in school science has been (perhaps unfairly) correspondingly shaken.

As physics is the author's department, this discussion must necessarily take its departure from that subject, and I am convinced that work in what might be called the more descriptive sciences, such as botany or geology, or even chemistry, is of a more satisfactory nature. Physics, next to mathematics, is the most exact science in the sense that there are known to physics more fundamental laws capable of exact mathematical expression than to any other science. Even astronomy does not precede it, for the exact position of astronomy is a branch of mechanics, and the science of astronomy is still in its infancy. In teaching such a subject, then, one cannot lay too much stress on the underlying principle, the law behind the experiment, that the experiment is only intended to illustrate. When a certain phenomenon follows by an unassailable chain of deductions from a certain great principle, the experimental demonstration of this phenomenon fails entirely in its purpose if the connecting logical links are not understood. And it is this lack of the logical or mathematical background to the experimental course that seems to me most apparent in the papers just discussed. The boy has carefully plotted the field about a magnet with the aid of a compass, but to him it is only the particular case of a compass and a magnet, and underlying notions of magnetic induction, tubes of force, law of inverse squares, etc., have nothing to do with the diverting little task in hand. The teacher perhaps has a class of thirty or more working together in the laboratory, and he is able to do little more than see to it that the experiment is done correctly, a neat report handed in, and certain explanatory references given to the pupil, who goes out with a recollection of only a certain particular example of a great law. If that law is presented to him in a slightly different form, he is utterly at sea, and flounders about for some support from among the concrete experiments that lie scattered about in his mind, unconnected and far apart.

This clinging to the concrete belongs to extreme youth, so the sciences that deal largely with the classification of concrete cases are better taught in our schools, and are usually more palatable to the pupils. But by the time a boy is seventeen or eighteen years old, it is a mistake to let him cling too closely to the concrete. When he thinks of numerical relations, he no longer has to cut imaginary apples into fractions, or distribute oranges in certain ratios among little boys. Why, then, is he not able to grapple with the abstract generalizations of science? I do not mean that he should abandon the laboratory exemplification of the laws he is learning, but the principle should be made the central idea which experiment is only to prove and illustrate. Of course, historically speaking, experiment preceded principle, at least in most cases, but the inductive method in teaching is far too apt to confuse the pupil, who seldom has the maturity of mind necessary for unaided generalization. Moreover, it is the glory of modern science that new phenomena can be predicted from known laws, and the deductive side is to-day as essential to progress as the inductive.

The cause of this unsatisfactory condition, at least in the teaching of physics, lies largely in the textbooks used in schools. Why must the boy taking physics in his last year at school study from the childish book often used, when if he begins the science a year later in college he studies from such authors as Watson, or Hastings and Beach, or Carhart (to mention only a few admirable college textbooks)? Surely, a year cannot make so much difference in his mental equipment! It will be urged that the books named above involve an understanding of trigonometry. True, but the amount of trigonometry needed by the student of Watson, for instance, could be readily mastered in three or four lessons, so this is no serious barrier to the teacher who really wishes to use a "college textbook." In many elementary courses no textbook is used, and the lecture system is followed. This may give satisfactory results in some subjects, but in physics it cannot be too severely condemned. In order to train the student to think, he must be compelled to work for himself; and though the lecturer may give references and advise study, those who have tried it know how hard it is to exact the outside work so necessary in a mathematical science like physics: and the ability to wrestle with a difficult problem or concept is not fostered by what may be termed the "kindergarten method" in science.

Too little time in the classroom, or, what amounts to the same thing, a disproportionate stress on the laboratory end, is also in part the cause of the evils we are discussing. This would not be so if classes were small, and the instructor could devote himself individually to his pupils, thus making the laboratory a more efficient lecture-room; but generally the classes are too large, and the pupil depends upon printed directions, and an inexperienced assistant instructor, so the two or three hours spent in the laboratory are not the equivalent of a well-conducted recitation involving a preparation of an hour or more of hard study.

Among the causes of inefficiency in teaching school science, that which one would least anticipate is the extraordinary opinion which seems to prevail among school boards and principals that any youth who has had a year or two in a science at college is capable of teaching the subject. This careless attitude toward a field rapidly overtopping many more time-honored subjects of school instruction, is almost inexplicable. Why should a teacher of Latin be chosen with so much more care than the teacher of physics and chemistry? With the increasing reaction in favor of science, this is the more surprising. If science is to supplant the classics in popular esteem as a fitting for an active useful life and the development of a well-trained mind, then let the teacher be one of sound knowledge as well as high intellectual ideals, and not merely a genial spirit who can play football with the boys in recess and bluff successfully when cornered by an inquisitive pupil in the classroom. I have seen appointments made by excellent schools that for unfitness on the part of the appointee rival the political appointments of a Tammany administration unchecked by even a pretense of civil service restraint.

The main reasons for teaching science in school are to awaken the pupil's interest in nature, give him some information about its chief laws and phenomena, and to train his mind to think clearly and with concentration. It certainly is open to question whether either of these aims is realized in many otherwise excellent schools. The interest possibly is stimulated in a general sort of way, but the misinformation that seems to remain as an ultimate residuum is worse than valueless, and the power of clear, concentrated reasoning has apparently not been fostered to any very high degree.

If science cannot be taught well, it is far better to let it alone in preparatory courses. The final result will be more satisfactory, even to a boy who means to study engineering in college. The truth of this assertion was well illustrated in the writer's experience by the case of a pupil who, though far from dull or lazy, was almost the poorest in his class. On being questioned, he replied that he had had physics in school, and when he came to study his lesson it seemed familiar, and he was tempted to trust to his recollection of what he had learned in school, although his recitations always showed that knowledge to be valueless. If he had never had the subject before, he would have been forced to work and might have learned something. The school that has a long list of science