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NEW PONTOON DOCK AND FLOATING WORKSHOP FOR NATAL.*

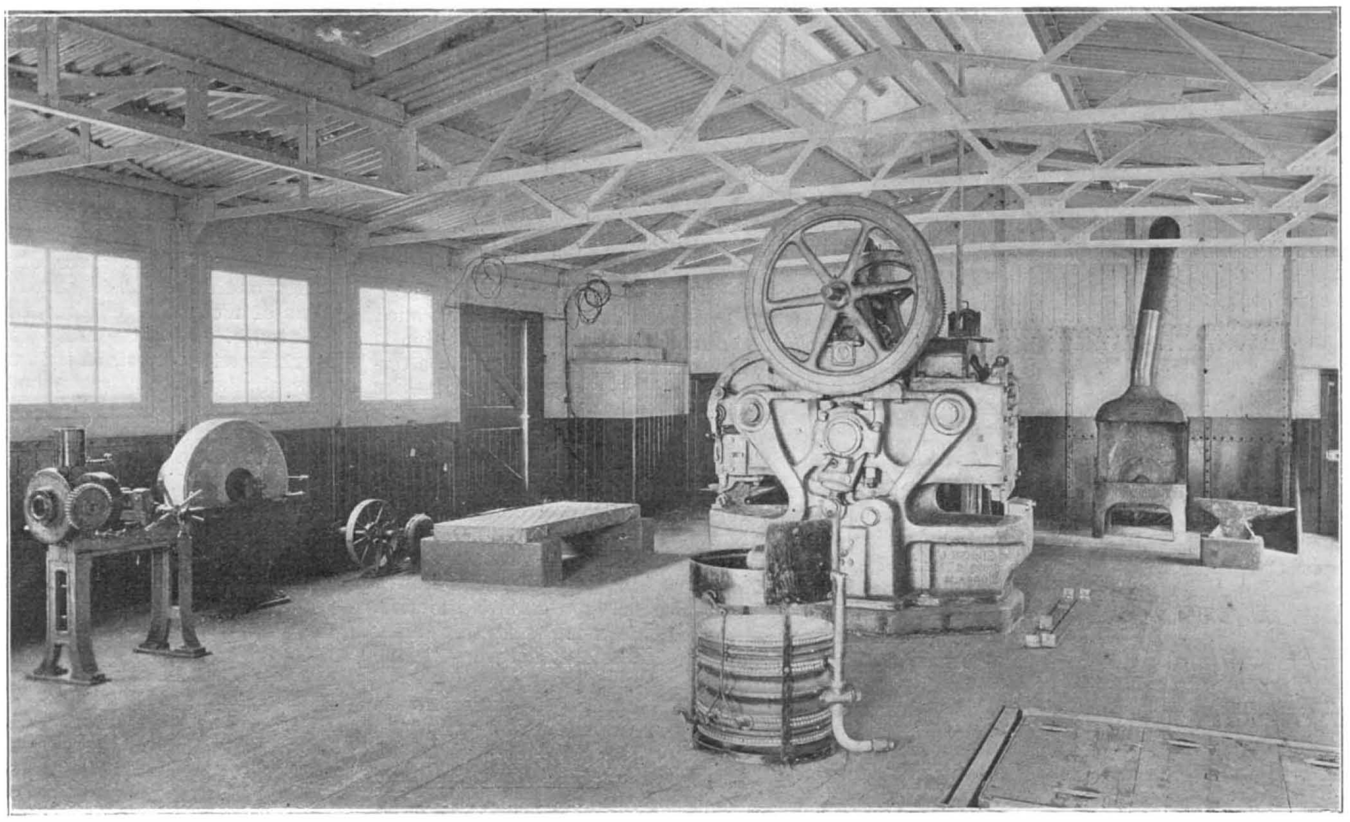
By the English Correspondent of the SCIENTIFIC AMERICAN.

THE new floating pontoon dock for the Natal government, which was constructed to replace that which was wrecked on the rocks off the South African coast during a gale while on the way to its destination at Durban, recently left the shipbuilding yard of Messrs. Swan, Hunter & Wigham Richardson, Ltd., at Wallsend, where it was erected, bearing a floating workshop also built by the same firm.

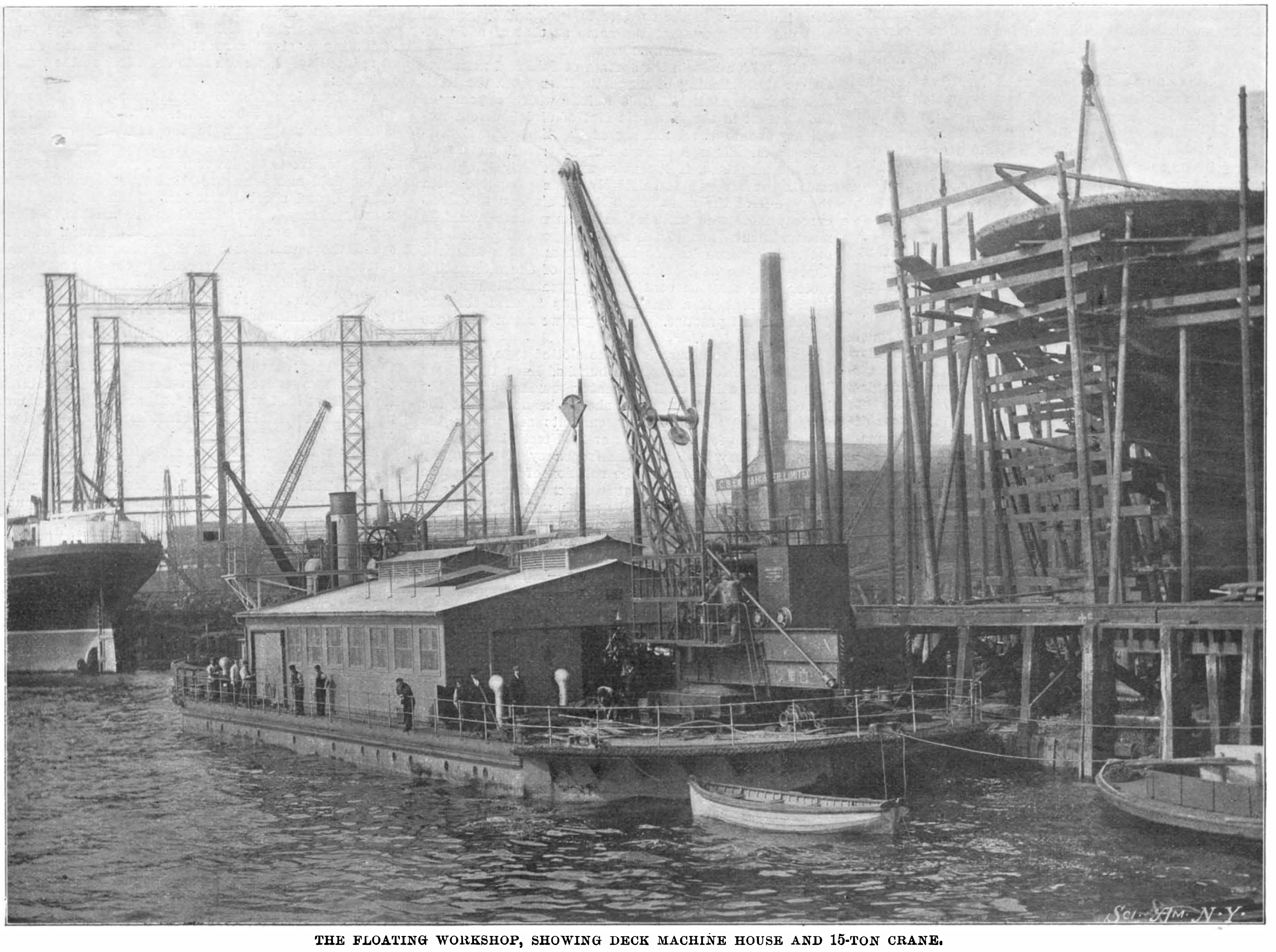
The dock is of the same type as that which was built for the British government dockyard at Bermuda. The dock is 475 feet in length over all; beam, 96 feet, 2 inches; lifting capacity, 8,500 tons. The distance between the guard timbers on the side walls is 70 feet, so that the dock can accommodate vessels up to 68 feet beam; and, while still retaining a freeboard of 4 feet, 3 inches, can take a vessel drawing 23 feet over keel blocks 4 feet high.

The dock is constructed in

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



PART OF THE MACHINE SHOP OF THE FLOATING WORKSHOP.



THE FLOATING WORKSHOP, SHOWING DECK MACHINE HOUSE AND 15-TON CRANE.

NEW PONTOON DOCK AND FLOATING WORKSHOP FOR NATAL.

three pontoons and two side walls, with which the pontoons are connected by movable joints in the usual manner. When required, therefore, any pontoon can be removed and lifted by the dock itself, thereby rendering it self-docking in all its parts.

The floating workshop, which forms a new departure in ship repairing afloat, measures in extreme length 129 feet, 3 inches; breadth, extreme, inside the rubbing fenders, 40 feet; depth, molded, 8 feet, 4 inches. The vessel is fitted with twin-screw, compound, surface-condensing engines of the following dimensions: Diameter of cylinders, 12 inches and 26 inches, with a stroke of 15 inches. The speed obtained on the measured mile trials was a mean of 7.12 knots, being considerably in excess of what had been guaranteed by the builders.

The workshop is very easily handled. On the deck of the vessel, and inclosed in a large house, is placed the workshop machinery, which consists of a punching and shearing machine, a lathe, a steam hammer, drilling, shaping, and screwing machinery, smith's fires, straightening blocks, vise bench, anvil, etc., the whole of which is driven by electric motive power. The workshop is lighted throughout by electricity, and is fitted with accommodation for both workmen and crew. A powerful cantilever crane, having a span of 40 feet and capable of lifting 15 tons, is placed on the forward end of the vessel. The workshop was floated on to the pontoon dock, and firmly secured for its passage to South Africa.

The workshop will be utilized in conjunction with the floating dock. When the vessel to be repaired has been floated into position over the submerged dock, and then raised again, the floating workshop will steam into a favorable position, so that any repairs necessary can be executed with the greatest convenience and expedition. The combination of these two vessels constitutes a complete portable dockyard, capable of dealing with all ordinary breakdowns and mishaps to ships. If necessary, it will be possible for the floating workshop to get up steam and succor a vessel in distress. The crane she carries will be of great assistance in lightening a ship that has run aground, which she could approach quite safely, on account of her shallow draft.

APPLICATION OF SINGLE-PHASE ALTERNATING CURRENT FOR TRACTION AND RAILWAY SERVICE.

By B. G. LAMME.

THE present direct-current railway system has limitations in voltage, speed control, etc., which have long been recognized by the electrical profession. Many systems have been devised with more or less success—generally with less—in order to overcome these limitations, so that the possible field for the direct-current systems could be extended. It has also been recognized by some of those familiar with the problem that a single-phase alternating-current motor, having the characteristics of a direct-current series motor, would at once furnish a means of attaining many results now impossible with the direct-current system. Such a motor obtained, the voltage limitation can at once be removed, as the transforming properties of alternating current can be brought into use. Economical operation at any desired speed can also readily be obtained through the same property of alternating current. Furthermore, the use of single-phase permits a single overhead wire where track return is used, thus retaining a most valuable feature of the direct-current system. It is thus evident that a motor of this character will permit the retention of most of the present advantageous features of the direct-current system, and also enables the use of other features not permissible without great complication and expense with the present direct-current system.

There has been perfected only one class of single-phase motors which possesses the characteristics of the direct-current railway motors, and this one class of motors very closely resembles the direct-current machine in the general features. These motors may all be given the general name of commutator type single-phase motors, as all of them have commutators on the armature or rotating member, and the armature is provided with a direct-current type of winding. Some variations from the usual types of armature winds have been proposed, but the various direct-current types have proven most successful.

All these commutator types of motors, which have the variable speed characteristics suitable for railway service, may be broadly classified as belonging to the series type. By this we mean that the field or exciting current is in series with the armature circuit, either directly or through transformer action, either in the motor itself or outside the motor. The series type of motor can be sub-divided into two classes, viz., the straight series motor, in which the current in the field wholly or partly passes through the armature, or *vice versa:* and those in which the field or armature forms a secondary circuit, the primary of which can be either part of the field structure of the motor, or may be outside of the motor. All these motors—whether of the straight series or of the transformer type—have the property that the field magnetism varies with the load, although not necessarily in direct proportion. Hereafter we will refer to these two types as the straight series and the transformer types of motors. All these motors are related to a greater or less extent in their characteristics, and in many instances one type can be readily changed to the other type. In fact, by closing a single switch, we have changed a straight series motor into the transformer type with the armature closed on itself, forming a secondary circuit, with a change in performance, apparently due only to the amount of material in the magnetic circuit being insufficient for the best performance as a transformer type.

In these commutator type single-phase motors, the two most important elements, besides the speed characteristics, are the efficiency and the power factor. The efficiency of such motors will usually be less than that of a direct-current railway motor of the same output. The losses in one of these alternating-current motors can be considered as made up of the following elements:

First. Iron loss due to reversals of magnetism in armature and field at the frequency of the supply circuit.

Second. Armature iron loss due to variations in magnetism dependent upon rotation of the armature.

Third. Iron loss in the surface of field and armature due to the bunching of magnetic lines from the teeth of either element.

Fourth. Losses in field windings.

Fifth. Loss in armature windings.

Sixth. Brush losses.

Seventh. Friction and windage.

Comparing these losses item by item with those of a direct-current motor, we see at once that certain losses will necessarily be greater than in the direct-current motor.

First. Iron loss due to the frequency of the supply circuit and induction in the primary element. No such loss exists in a direct-current motor, as the machine is excited by continuous current. This loss in the alternating-current motor will not be a relatively large per cent, unless the motor is worked at a very high induction, or unless the construction of the magnetic circuit is such as will allow eddy current losses. It is at once evident that the field magnetic circuit must be laminated as completely as the armature circuit, and that there are no local circuits permissible in the field structure. It is also evident that a field structure of a straight series motor will, in general, have lower losses than of the transformer type, where the field itself forms part of the transformer, as in this latter case the total induction in the field structure will generally be greater than in the series type.

Second. Armature iron loss due to variations in magnetism dependent upon rotation of the armature. There will be a loss in the armature due to the alternating magnetisms from the primary or field circuit. This can be charged against the field loss or primary loss, as maintained above. In addition to this loss, there is a loss due to the rotation of the armature in the field. This will be dependent upon speed of rotation, inductions in the core, teeth, etc., and in general will practically average the same as that of a direct-current motor of the same capacity.

Third. Iron loss in the surface of field and armature due to the bunching of magnetic lines from the teeth of either element. This is a loss which appears to some extent in the field pole face of direct-current machines, due to the bunching of the lines from armature teeth. This loss is relatively small on direct-current machines, if the poles are properly laminated and if the air gap is relatively large compared with the width of the armature slots. This loss in direct-current motors is included in the armature iron loss measurements, due to the methods generally used for determining iron loss on such motors. This loss will appear in the field surface or face of the alternating motor, and may be considerably greater than in the direct current, if a smaller air gap is used than in direct-current practice. By air gap we mean clearance from iron to iron.

If the field structure is of the slotted type, the slots being of such form as to give bunched lines, then there will also be a loss in the armature surface due to the bunching of these lines. It should be noted that the frequency of the secondary currents set up by the bunched lines from armature or field teeth is generally very high compared with the frequency of the supply circuit, or of that due to the rotation of the armature in the field. We believe that in general the loss due to the bunched lines will not be much greater in the alternating-current single-phase motor than in the direct current, except where very small air gaps are used on the alternating-current motor.

Fourth. Loss in Field Windings.—This loss is very similar to that in direct-current machines, as the amount of copper in the field windings will generally be no greater than on direct-current motors of same capacity, and may even be considerably less. The straight-series motor will generally have a lower copper loss than the transformer types where the field structure is used as the primary of the transformer.

Fifth. Loss in Armature Windings.—The loss in the armature windings will be very similar to that in a direct-current machine, as far as the working current is concerned. In addition to the working current, there may be secondary currents in the armature turns short circuited by the brushes, which still further increase the armature loss. The resultant armature loss may, therefore, be somewhat greater than on a corresponding direct-current machine, unless the normal resistance of the armature winding is reduced below that of a corresponding direct-current machine. In practice, the loss in the armature winding is made practically equal to that of the direct-current machine, in order to avoid increased heating.

Sixth. Brush Losses.—The brush losses due to the reversal of current in the single-phase alternating motors are generally somewhat greater than in a direct-current motor. Such motors are usually wound for a comparatively low voltage on the armature, and thus greater brush capacity is required than in direct-current practice. The brush losses are thus increased, due to the greater number of branches, and in addition there may be local currents in the short-circuited coils, which may produce additional loss in the part of the brush next to the commutator. In practice this loss is evidently comparatively small, as our experience shows no signs of deterioration in the brushes in regular service. Therefore, the increased brush loss may be considered as principally due to the increased number of brushes required.

The brush loss due to the local currents in the short circuited turns can be reduced considerably by the use of very narrow brushes, a brush spanning one bar or even less. With such a brush there would be short circuiting only while the brush is bringing two bars, while at intermediate positions there would be no local current. As, in general, the commutators of such motors have a relatively large number of bars, this would mean a very thin brush, possibly less than ¼ inch in thickness. Such brushes we consider too thin for street car purposes, as any roughness on the commutator would tend to break the brushes. In some of our very early experiences with such motors, we used brushes of ¼ inch in thickness, but found they required entirely too much attention, and, therefore, they were abandoned in favor of brushes of a thickness corresponding to direct-current practice, the later designs of motors permitting the use of such brushes.

Seventh. Friction and Windage.—The friction in bearings and the windage loss in such motors will be very similar to the corresponding losses in direct-current motors, but the brush friction loss will, in general, be somewhat greater, due to the increased brush capacity. Also the large number of commutator bars generally used, tends to increase brush friction to some extent.

It is evident from the above considerations that the various losses in different parts of the single-phase alternating-current motors are either equal to or greater than the losses in the corresponding direct-current motor, although no individual loss, except that due to the reversal of magnetism in the field, may be much greater than in the direct-current motor. The sum total of the slight increases makes a difference of from 1 per cent to 5 per cent in the efficiency of the motor, this difference being less with larger motors.

The frequency of the supply circuit has a small effect on the efficiency, although the relation of the losses in the various parts is so involved that no definite figure can be given for this effect.

The losses in the single-phase motor are, to a certain extent, dependent upon the speed at which the motor is operated, with a given current and torque. Assuming a given current, with the motor running at reduced speed, we can note the effect on the losses as follows :

The iron loss due to the frequency of the supply circuit is changed but little. The iron loss due to changes in magnetism in the armature and due to bunching of lines from the teeth are very considerably decreased, due to the lower armature speed. The losses in the field and armature winding are practically unchanged, and short-circuit loss in the brushes is not greatly changed. Friction loss in brushes, bearings, and windage are all decreased. Therefore, at lower speed, the actual losses in the motor are considerably decreased, but not in proportion to the decrease in output of the motor. Therefore, the efficiency decreases slightly with the reduction in speed with a given torque, this efficiency decreasing more rapidly the more nearly the zero speed is approached.

With changes in load, with a given voltage applied, the efficiency curve has very much the same shape as the efficiency curve of a direct-current motor, starting low at light load and high speed, and rising to a maximum, and then falling off considerably at very heavy overloads.

After efficiency, the next most important consideration in the performance of such motors is the power factor. This is a feature which does not appear at all in direct-current machines, as the apparent input in such motors represents true energy. In the single-phase railway motor the apparent input in general does not all represent true energy, as a certain component of the input is required to magnetize the motor, and this component represents practically no energy. Also magnetic leakage in the alternating-motor represents a component of the apparent input which is practically wattless.

In a straight series motor a certain magnetizing current is required with a given field winding. The alternating flux through the field winding set up alternating E. M. F.'s which lag practically 90 degs. behind the energy component of the motor, and the product of the field current by the field voltage thus represents a wattless component of the input of the motor. With increase of load, the field current increases, the induction increases, and therefore the field volts also increase. The wattless component in the field thus varies with the product of two values which are both increasing with the load. The energy supplied to the motor increases approximately in proportion to the current supplied. Therefore, the wattless component in the field increases more rapidly than the energy component. Consequently, if this were the only wattless component in the motor, the power factor would decrease with the increase of load, and would be highest at no load. Other wattless components of the input

are represented by the cross magnetizing effect of the armature, if such exists, and by the stray field around the windings. As these effects will also increase more rapidly than the energy component, it is therefore evident that the power factor in this type of motor will be highest at no load or at highest speed, and will decrease with the load or speed with a given voltage applied. But if the windings are so proportioned that the wattless component at the rated capacity is relatively small, then a high power factor will be obtained at the rated load and speed. At lighter loads and higher speeds the power factor would be considerably higher. Such a motor can give very high power factors at half loads with correspondingly increased speed. If the motor is operated at lower voltages, then the power factor at a given speed will be very nearly the same as when operated at the same speed at a higher voltage and higher load. Therefore, it is evident that as the speed is reduced, no matter what load is carried, the power factor will be decreased, and at start the power factor will be lowest, as the energy component in this case represents only the losses in the motor. We have tested a 100-horsepower motor showing 92 per cent power factor at 100 horse power, and approximately 98 per cent power factor at one-half load, the voltage being the same in both cases. This question of power factor is largely a question of design, as the magnetizing or exciting compound of the input depends upon the air gap, amount of material, etc. In general, larger air gap means more exciting current.

The magnetic leakage in these motors may be relatively high, or may be comparatively low, this being to a considerable extent a function of the design of the motor, just as in all alternating-current machinery. Generally it is made as low as possible without sacrificing other important features.

If the armature cross induction in a series motor is large, due to excessive armature ampere turn per pole, small air gap, etc., the armature self-induction will be large. Increasing the number of poles will reduce the cross-magnetizing effects, but at the same time will require somewhat smaller air gap, or increased excitation. These two features are, therefore, to a certain extent balanced against each other.

There are various schemes for improving the power factor of the commutator type single-phase motors. These are generally most effective at high speeds, but at start or at very low speeds the improvement is small. In certain designs of both straight series and of the transformer type motors, the magnetizing current can be supplied in whole or in part to the armature circuit instead of the field magnetic circuit by means of brushes on the commutator. At certain speeds, this current can be supplied at a considerably reduced voltage, thus requiring a reduced magnetizing input compared with excitation applied to the field. This excitation can be supplied from the secondary of a series transformer, the primary being in circuit with the primary winding of the armature. The armature excitation will thus vary as the field excitation would normally vary, thus giving the varying field induction and the series speed characteristics. While this arrangement is effective in improving power factor at certain speeds, yet, as a rule, this gives the least effect at the time when it is most required, viz., at start and at very low speed. This method also requires a second system of brushes on the commutator, thus spacing the brushes on the motor the same distance apart as if double the number of poles were used. For instance, a four-pole motor would have brushes spaced 45 degs. apart, instead of 90 degs. At start there should be practically the same input required for magnetizing, whether the current is supplied to the armature or to the field.

Comparing the straight series with the transformer type of motor, it should be noted that the straight series motor requires less magnetizing current, as the magnetizing current is only supplied to one element of the field. With the transformer type of motor a magnetizing field must be furnished, as in the straight series, but there is also a second field set up due to the transformer action, and this also requires a magnetizing current. In other words, it may be considered that there are two magnetic fields set up, approximately, 90 degs. apart, each field requiring a certain magnetizing current. These two fields may be considered as forming one resultant field of higher value than either of the components, with a magnetizing current of higher value than either component. In the series motor the transformer part of the field can be made to practically disappear, only the exciting field remaining; the resultant induction is, therefore, much less than with the transformer type, the field having an approximate average value of 70 per cent of that of the transformer motor, the magnetic circuit being reduced in proportion.

It thus appears that the straight series motor can be made to give a somewhat higher power factor than the transformer type, with the field used as a transformer, and this is obtained with somewhat less weight. This difference in power factor could be compensated for at higher speeds by some means of excitation applied to the armature through the commutator, as indicated above. But for traction service, where the least weight with great compactness of design is desirable, it appears to us that the straight series motor possesses some advantages. The transformer type of motor, with the transformer in the motor itself, can be compared with the straight series motor with a separate transformer, if high voltages are to be used in the line. We consider that a number of more compact motors under a car with one separate reducing transformer forms a more suitable combination than a similar number of larger motors, each with its transformer inside itself.

There is one other method of improving the power factor on these motors, and that is by the use of resistance in series with the motors. If the voltage on the motors is controlled by the use of an external rheostat, as in common with direct-current motors, then the power factor with a given torque will be constant and independent of the speed. With a given torque the wattless component of the input of the motor is practically constant independent of the speed, and if the speed is controlled by rheostatic loss, then the energy component will also be practically constant, and the power factor can be made higher at all loads. This may appear to be a good feature to those who have not considered the problem carefully, but it is a fact that high power factor obtained in this way represents a less desirable condition than the low power factor, which would be obtained if the rheostatic method of starting were not used. With a given wattless input from the circuit, the best possible condition as regards effect on the supply system is that represented by the minimum expenditure of energy. A wattless component has a certain effect on the regulation of the system, and any improvement in power factor by increasing the energy component, means that much additional effect on the supply system.

It is surprising that so many are so imbued with the idea of high-power factor that they are even willing to obtain it by increasing the losses in the apparatus, thus in reality increasing the load on the system. A high-power factor obtained by rheostatic control would represent no more advantageous condition than the use of resistance in series with an induction motor, when running, to increase its power factor. If a permanent resistance connected be parallel with an inductance motor, it will not increase the power factor of the motor itself, although any measurements of the input to the motor and resistance will show a higher power factor than that of the motor itself; but anyone can readily see the absurdity of this combination, although it does raise the power factor. The use of resistance in series with a motor in order to give higher power factor at starting would represent a similar absurdity, although it would not be as evident on the face of it.

Leaving out the question of power factor, the rheostatic method of starting and controlling the motor will, in certain instances, possess advantages over other methods, especially where the loss in the rheostat will average but a small part of the total power expended over a given period. This method of operation should not necessarily be abandoned in all cases, simply because voltage control can be obtained.

The next point, and one which is of considerable interest to the electrical fraternity at large, is the question of commutation in the commutator type of single-phase alternating-current motor. In the early times in the electrical business it was discovered that there were many things that could not be done with alternating current, and among these was the commutation of alternating current without excessive sparking. This opinion has become so well established that at the present time many engineers are very doubtful of this point. This opinion is based principally upon experiments in commutation of alternating current, mostly made many years ago, and not upon the theory of commutation itself. In many cases it was considered that the alternating current had some mysterious property which caused sparking when attempts were made to commutate it.

If we go back to the early periods we also find many things which could not be done with direct current, but which are done at the present time. I well remember the time—about thirteen years ago—when I was informed by a number of the leading engineers of that time, that it was useless to consider the construction of slotted armatures for railway generators of the then gigantic size of 200 kilowatts. At that time the Westinghouse Company had a railway armature of this size almost completed, and this advice was very discouraging. But as the armature was so nearly ready to test, it was decided to assemble the machine and find out how badly it would work. The result of the tests was such that the Westinghouse Company immediately abandoned the surface-wound type of direct-current armature in favor of the slotted type. Other companies probably had similar experiences, for the slotted type is now almost universally used. The above is merely given as an illustration that in direct-current apparatus many early opinions have been abandoned. If one of the 200-horsepower New York subway motors had been attempted ten or twelve years ago, conclusions undoubtedly would have been drawn by many engineers, showing the absurdity of attempting to make high-class motors of this size.

In the same way advances in the art have led to a more complete understanding of the underlying principles of commutation among those interested in the design of commutating apparatus, although such knowledge, except in a general form, is limited to a small number of engineers. Very few of all those who handle modern direct-current generators or motors, really know why their machines commutate so much better than some of much older designs which were apparently built on the same lines.

Motor designers with a wide experience in the problem of commutation are now awakening to the fact that commutation of alternating current does not furnish a set of new and mysterious phenomena, but that the laws which apply to direct-current commutation also apply to alternating-current commutation, and that the problem is one of degree principally. If a continuous current of X amperes have its direction reversed in a coil without sparking as the coil passes under the brush, then there should be no difficulty in reversing this current if it varies periodically from X amperes to zero and up to X amperes again. The trouble is that when opinions on commutation of alternating current were originally formed, it was not known how to commutate the current of X amperes.

The principal difficulty in commutation of alternating-current motors has been the presence of local secondary currents in the coils short-circuited by the brushes, such currents being due to pulsating or alternating magnetism through the short-circuited coils. Various arrangements have been tested at different times for lessening the effect of these secondary currents. Such motors are usually built with a comparatively large number of commutator bars, with a very small number of armature turns per bar, to lessen the effect in the short-circuited coil. Very narrow brushes have been tried in order that the period of short-circuit may be lessened, and two or more parallel windings forming the so-called "Sandwich" type have been tried. These windings lie side by side on the core, but are practically independent of each other and connect to alternate commutator bars or to every third bar, etc., dependent upon whether two or three parallel sets are used. With two of such parallel windings on a core a commutator brush of a width slightly less than one bar could be so placed that it would never short-circuit a coil of either winding. In this case the brush passes from one winding to the next, and breaks connection with the first winding before passing to the next bar of the first winding. With this arrangement the short-circuiting of the coils would be diminished, but the type of winding is one which we do not consider satisfactory for railway motors. We consider that this is simply transforming the trouble due to the short-circuited coil to another trouble, which would in the end be just as serious, viz., the tendency of such windings to produce blackening and pitting of the commutator bars. Such an arrangement would require very thin brushes, if but two parallel windings were used, while with three parallel windings the brush could have a thickness corresponding to two commutator bars.

A number of other devices have been tested at various times by different experimenters, but these are attempts to cure an existing difficulty rather than to lessen or eliminate the cause of the difficulty.

Within the past year or two there has been a great awakening to the possibilities of this problem, with the consequence that there is now a world-wide appreciation of the field of operation for commutator types of single-phase motors which will accomplish results not hitherto attainable. Single-phase motors having good commutating properties are now on the market in this country for the commercial frequency of 25 cycles per second. Higher frequency motors could probably be built with reasonably good results, but as 25 cycles has become a commercial frequency in this country, it is probable that this will become the standard for traction service for single-phase motors.

A single-phase motor having series characteristics having been obtained, it is at once evident that it opens up various methods of control hitherto not utilized in railway service. Having the motor which can be controlled in speed by variations in the voltage supplied to it, then voltage control can at once be obtained due to well-known properties of alternating-current transformers. Such methods of control are dependent upon the use of alternating current, and have not been applied in railway apparatus heretofore, because there was no suitable motor on the market.

Many forms of apparatus for varying the voltage on alternating-current circuits have been known and used, and most of these devices permit voltage variations with comparatively small loss in power. Therefore, with an alternating motor with the series characteristics, it is at once evident that we can obtain a traction system in which the power expended is practically proportional to the work done, and therefore the least power will be consumed at starting at low speeds. This is an ideal condition for railway service, but has not been permissible with the direct-current system, except by great complication.

There are a number of ways in which the various single-phase commutator type of motors can be controlled in speed. With the straight series type, the voltage applied to the terminals can be varied, the field windings can be varied, commutated, etc., or the relative values of armature and field strength may be varied. With certain designs of motor, exciting brushes may be placed on the commutator, as we have indicated before, and the voltage applied to these brushes may be varied. All these methods may be used also with the transformer types of motors.

By shifting the polarity of the fields to one side or the other of the normal position, the speed can be also affected to a greater or less degree, and similar results can be obtained by shifting the armature brushes. The latter method we do not consider a suitable one for traction motors. Series-parallel control can also be used, if desired, just as on direct-current motors, and rheostatic control can also be used. These two methods have practically the same effect on economy as found with direct-current motors with these methods of control.

The single-phase motors of all types, in common with polyphase induction motors, have one feature which is not shared by the direct-current motors, viz.,

there is an active voltage between the field turns. The alternating magnetic flux through the field of the alternating motor generates an e. m. f. in the field windings, just as in the case of an alternating-current transformer. In the direct-current motor the only voltage in the field coils is that represented by the current flowing against the resistance of the windings. Therefore, in a direct-current motor a short-circuit can occur between one or more turns of the field coil without immediate disastrous effects on the motor. Those who have had a wide experience in the operation of electric railways and are familiar with the extremely high temperatures momentarily obtained under certain conditions, will appreciate the importance of this good feature of the direct-current motors. If direct-current motors were so designed that short-circuit between two turns, due to overheating or other conditions, would immediately disable the motor so that it could not be operated, then it would be necessary to very considerably increase the dimensions of such apparatus in order to get emergency capacity. It will at once be appreciated that the alternating-current motor, with an active voltage between field turns, must be designed to stand heavy overloads without danger of short circuits between field turns. Therefore, either these motors must be designed with more margin of temperature than the direct-current practice, or the windings used must be such as will permit of more perfect insulation between turns than is used in direct-current practice. If such motors are wound for voltages corresponding to direct-current railway practice, then there is a greater danger from short circuits in the field than with direct-current motors, and if the motors themselves are wound for comparatively high voltages—say 3,000 volts, for instance—then the danger from this source is very considerably increased, for with a 3,000-volt motor a large number of comparatively small wires must be used in each coil, and these must be well insulated from each other, and the entire winding must be well insulated from the ground. Experience with alternating-current, high-voltage stationary motors has shown that such motors are not nearly as safe as those wound for 200 volts or 400 volts, and we believe that for motors under a car, subjected to the extreme variations of traction service, the danger from short circuits and grounds will be very much greater than in the case of stationary motors. If such traction motors are wound for low voltages, say 200 volts approximately, then heavy conductors and but a very small number of turns will be necessary on the field, and each conductor can be separately insulated both from other conductors and the ground. Therefore, the alternating current permits the use of a low-voltage motor, with the consequent advantageous construction of field coils where the conditions of operation in direct-current practice prevent the use of any lower voltage on the motors than that supplied by the line. Troubles from oil and dirt, such as frequently occur with direct-current motors, will become of great importance in alternating-current railway motors wound for very high voltages. We believe that, except for very special cases, it will be found safer to step down the voltage on the car by a transformer, thus supplying the motors with low voltage from the secondary circuit, rather than to wind each motor so that it becomes a transformer subjected directly to the high voltage of the system. In cross-country work, where high voltage would preferably be used, the step-down transformer method also furnishes additional protection from lightning, as it is well known that it is easier to insulate one transformer from lightning than to insulate two or four motors. The question of safety to the passengers and apparatus in the car must be considered in this matter.

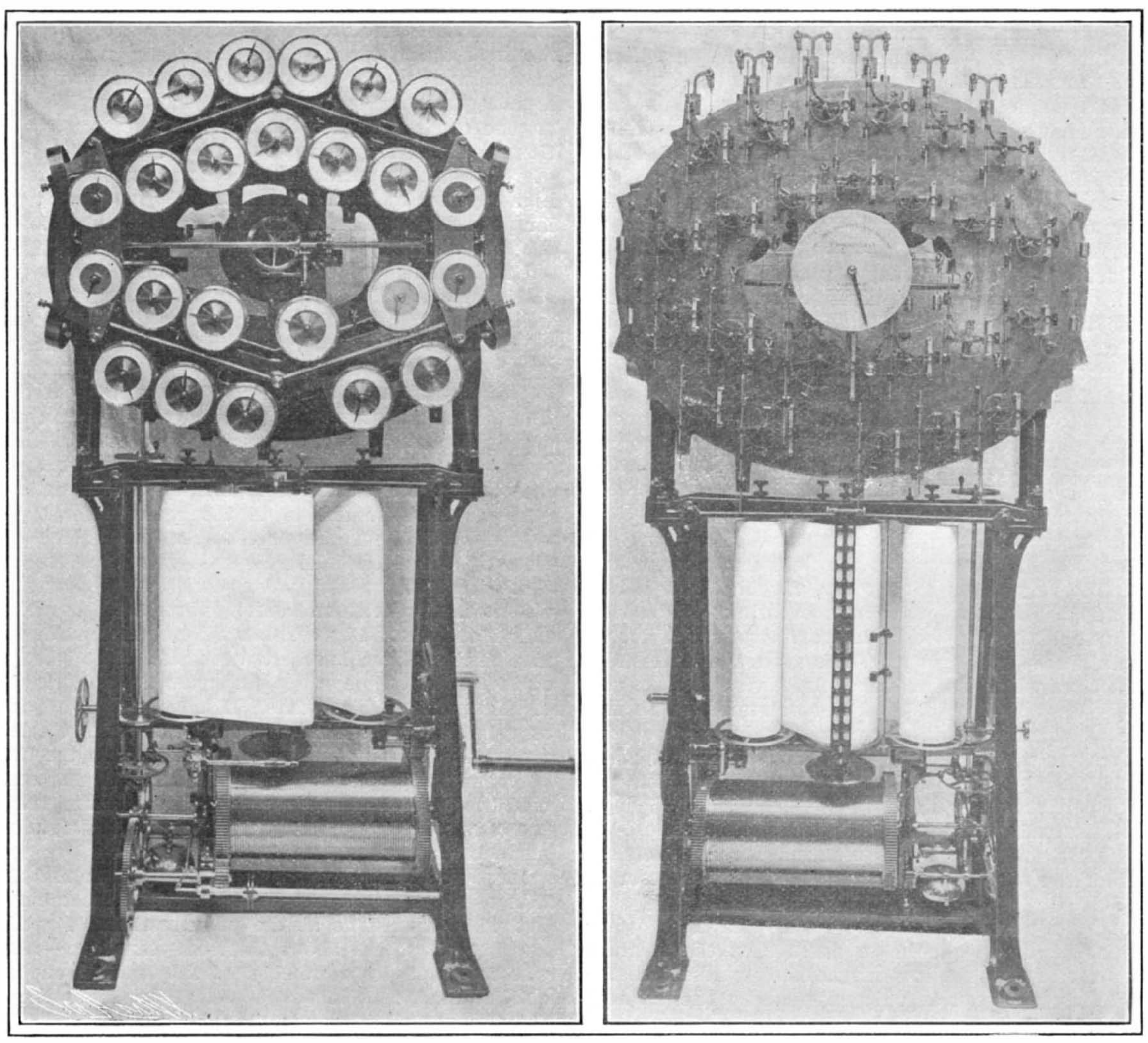
A large number of estimates have been made comparing the general performance, cost, etc., of equipping roads with single-phase alternating-current motors, instead of direct-current motors, supplied from rotary converter sub-station. In all these cases the advantage has appeared decidedly in favor of single-phase, except in a small number of cases where some small limiting condition was placed upon the alternating-current system. If starts are very infrequent and the running periods long, then the gain in efficiency by elimination of the rheostatic losses at start may be more than compensated for by the slightly lower efficiency of the motors themselves. Where such conditions apply, generally high trolley voltage will be used, and there will be enough gain in efficiency in the transmission and distributing to more than balance the loss in the equipment. Furthermore, the elimination of the rotary converters will furnish a still further gain in efficiency. In estimates made up to the present time, we have in practically all cases found higher total efficiency for the single-phase railway than for the direct-current railway with sub-stations. In cross-country work the gain in the transmission and distributing system and the rotary converters compensates for other losses. In city work where starts are very frequent and low speeds necessary at times, the gain by elimination of the rheostatic control has appeared as a very important item in the efficiency.

It thus appears that, while suburban work was once thought to be the most important field for the single-phase railway, it has now become evident that city work, where traffic is very congested in parts of the system, will prove to be one of the best fields for this system. Of course, it is recognized that for heavy railroad service, where all kinds of speeds should be obtained economically, the single-phase railway system will undoubtedly show to great advantage compared with any known direct-current system. But as considerable time will be required to equip any railroad service, it is probable that the single-phase railway system will be well tried out before there is a good opportunity to give it a thorough trial for heavy work. There is no difficulty in designing single-phase motors for sizes up to 300 horse power or larger, and of sufficiently small dimensions to be used with a single reduction gear on locomotives. There is also no difficulty in designing regulating devices for controlling the power of such motors. For example, a 600-kilowatt induction regulator manufactured by the General Electric Company has been in commercial operation at Niagara Falls for many years, and a regulator of this capacity would be sufficient to control a 2,400-horse-power locomotive. The induction regulator furnishes an ideal method for locomotive control, as the voltage supplied to the motors can be varied over a wide range without making or breaking the circuit.

In conclusion, we would say that the subject of the commutator type of motor is now being thoroughly studied by engineers in all the principal manufacturing companies in the world, and there is no longer any question that such motors can be built successfully for commercial service. When it is once shown that such motors are feasible and that, therefore, a new field of development is opened, there is immediately a willingness on the part of most of the manufacturing concerns to undertake the perfection of such apparatus. What is needed in any line of development is a promise of success, and it may be taken as true that success will then be obtained.

LORD KELVIN'S AUTOMATIC TIDE PREDICTOR.*

THE National Physical Laboratory of Great Britain has recently acquired possession of the automatic tide-predicting machine invented by Lord Kelvin when Sir William Thomson. This apparatus was designed as far back as 1876, and is the only one of its type that has ever been constructed. It has been utilized with conspicuous success in all parts of the world, notably in the Indian and Pacific Oceans. As may be gathered from reference to our illustrations, the apparatus is somewhat complex in character; and although only one of the many scientific conceptions of this distinguished scientist, it is nevertheless one of the most beautiful from the point of mechanism that he has ever designed.



LORD KELVIN'S TIDE-PREDICTING MACHINE.

The present appliance is the third machine designed for the purpose of predicting the tides. The two previous machines were somewhat rudimentary in character, especially the first, in comparison with this beautiful piece of work. The two predecessors naturally contained some imperfections, but in this third machine these disadvantages were surmounted or obviated, and several new ideas incorporated, which improvements tended to render it as near perfection as possible.

The present machine represents the outcome of Lord Kelvin's patient investigations and experiments with the tidal harmonic analyzer, which task alone occupied some six years' laborious work on the part of the inventor.

While engaged in the construction of the harmonic analyzer, Lord Kelvin conceived the idea of designing an instrument for performing the mechanical work of adding together the heights (positive or negative) above the mean level, due to the several simple harmonic constituents determined by the analysis, from observations or from the curves of a self-recording tide gage, for any particular port, so as to predict for the same port for future years, not merely the times of high and low water, but the position of the water level at any instant of any day of the year. There are many known ways of combining two or more motions in the same or in parallel lines by levers and otherwise. The number of separate motions to be combined rendered it, however, difficult for Lord Kelvin to discover any very acceptable detail for the application of levers to produce the combination which he desired for the tide predictor.

The solution to this seemingly insurmountable difficulty was found in a romantic manner. Lord Kelvin was on his way to the Annual Congress of the British Association for the Advancement of Science in 1872. His companion in the railroad car was Mr. Tower, whose remarkable inventive faculty is well known. Lord Kelvin was engaged in the explanation of his idea, and related the difficulty which confronted him and prevented him from realizing his idea. He demonstrated his plans and several experiments to solve the problem. Suddenly Mr. Tower interposed with a suggestion. "Why not use Wheatstone's plan of the chain passing round a number of pulleys, as in his alphabetic telegraph instrument?" Lord Kelvin accepted his friend's idea, and it proved the missing link in the scheme. The plan was completed in the railroad carriage, except that a fine steel hair-spring or wire was adopted in preference to the chain used by Wheatstone, as the latter was obviously too frictional for the tide predictor. Everything but the precise mode of combining the several simple harmonic motions had, in fact, been settled long before. At the Brighton meeting of the British Association, the inventor described minutely the tide-predicting machine thus completed in idea, and obtained the sanction of the Tidal Committee to spend part of the funds then granted to it, on the construction of mechanism to realize the design for tidal investigation by the British Association.

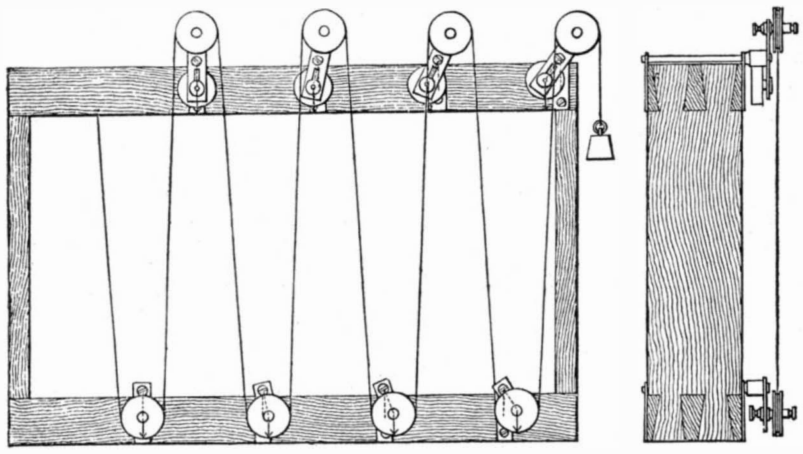
Before the meeting ended, Lord Kelvin ordered the construction of a model to help in the designing of the finished mechanism for the projected machine. This instrument has eight pulleys on cranks, and a cord, passing over and under them alternately, is fixed at one end, and carries a weight representing the marker, at the other. In this instrument, which is now in South Kensington Museum, the inventor did not succeed in carrying out the counterpoising, one of the most prominent features of his subsequent tide predictor.

In this tide predictor, according to the description in the Museum's volume of Scientific Apparatus, the object is to predict the tides for any port for which the tidal constituents have been found by the harmonic analysis, from tide-gage observations, not merely to predict the times and heights of high water, but the depth of water at any and every instant, showing it by a continuous curve, for a year, or for any number of years in advance.

This object requires the summation of the simple harmonic functions representing the several tidal con-

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

stituents to be taken into account, which is performed by the machine in the following manner: For each tidal constituent to be taken into account the machine has a shaft, with an overhanging shaft, which carries a pulley pivoted on a parallel axis, adjustable to a greater or less distance from the shaft's axis, according to the greater or less range of the particular tidal constituent for the different ports for which the machine is to be used. The several shafts, with their axes all parallel, are geared together, so that their periods are to a sufficient degree of approximation proportional to the periods of the tidal constituents. The crank on each shaft can be turned round on the shaft, and clamped in any position; thus it is set to the proper position for the epoch of the particular tide which it is to produce. The axes of the several shafts are horizontal, and their vertical planes are at successive distances one from another, each equal to the diameter of one of the pulleys (the diameters of these being equal). The shafts are in two rows, an upper and a lower, and the grooves of the pulleys are in one plane perpendicular to their axes. Suppose now the axes of the pulleys to be set each at zero distance from the axis of its shaft; and let a fine wire, or chain, with one end hanging down and carrying a weight pass alternately over and under the pulleys in order, and vertically upward or downward (according as the number of pulleys is even or odd) from the last pulley to a fixed point. The weight is to be properly guided for vertical motion by a geometrical slide. Turn the machine now, and the wire will remain undisturbed, with all its free parts vertical, and the hanging weight unmoved. But now set the axis of any one of the pulleys to a distance $\frac{1}{2}$T, from its shaft's axis, and turn the machine. If the distance of this pulley from the two on each side of it in the other row is a considerable multiple of $\frac{1}{2}$T, the hanging weight will now (if the machine is turned uniformly) move up and down with a simple harmonic motion of amplitude (or semi-range) equal to T, in the period of its shaft. If next a second pulley is displaced to a distance $\frac{1}{2}$T, a third to a distance $\frac{1}{2}$T, and so on, the hanging weight will now perform a complex harmonic motion equal to the sum of the several harmonic motions, each in its proper period, which would be produced separately by the displacements $\frac{1}{2}$T, $\frac{1}{2}$T, $\frac{1}{2}$T. Thus, if the machine was made on a large scale with T T equal respectively to the actual semi-ranges of the several constituent tides, and if it is turned round slowly (by clockwork for example) so that each shaft goes once round in the actual period of the tide which it represents, the hanging weight would rise and fall exactly with the water-level as affected by the whole tidal action. This, of course, could be of no use, and is only suggested by way of illustration. The actual machine is made of such magnitude that it can be set to give a motion to the hanging weight equal to the actual motion of the water level reduced to any convenient scale; and provided the whole range does not exceed about 30 centimeters, the geometrical error due to the deviation from perfect parallelism in the successive free parts of the wire is not so great as to be practically objectionable. In the actual machine there are ten shafts.



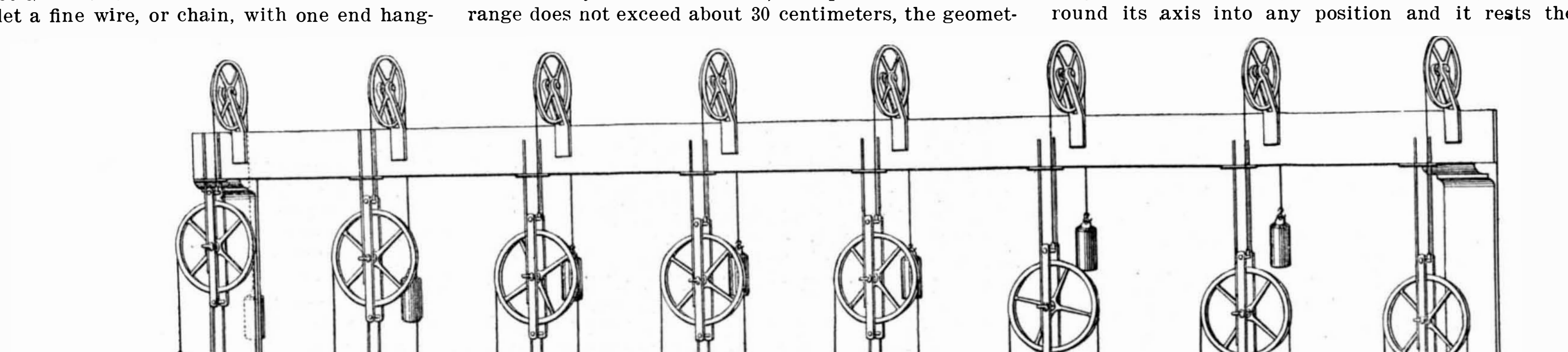
FIRST MODEL FOR TIDE PREDICTOR.

The hanging weight consists of an ink-bottle with a glass tubular pen, which marks the tide level in a continuous curve on a long band of paper moved horizontally across the line of motion of the pen, by a vertical cylinder geared to the revolving shafts of the machine. One of the five sliding points of the geometrical slide is the point of the pen sliding on the paper stretched on the cylinder, and the couple formed by the normal pressure on this point, and on another of the five which is about 4 centimeters above its level and 1½ centimeters from the paper, balances the couple due to gravity of the ink-bottle and the vertical component of the pull of the bearing wire, which is in a line about a millimeter or two farther from the paper than that in which the center of gravity moves. Thus is insured notwithstanding small inequalities of the paper, a pressure of the pen on the paper very approximately constant, and as small as is desired.

Hour marks are made on the curve by a small horizontal movement of the ink-bottle's lateral guides, made once an hour, a somewhat greater movement giving a deeper notch to mark the noon of every day.

The machine may be turned so rapidly as to run off a year's tides for any port in about four hours. In this apparatus it was intended that each crank should carry an adjustable counterpoise to be adjusted so that when the crank is not vertical the pulls of the approximately vertical portions of wire acting on it through the pulley which it carries shall, as exactly as may be, balance on the axis of the shaft, and that the motion of the shaft shall be resisted by a slight weight hanging on a thread wrapped once round it and attached at its other end to a fixed point. This part of the design, planned to secure against lost time or backlash in the gearings of the shafts, and to preserve uniformity of pressures between teeth and teeth, teeth and screws, and ends of axles and end-plates, was not carried out in the first machine but was applied to the later instrument.

The system of realizing the counterpoising can be realized from the diagram of the first model. Each pulley with its central stud is equal to twice the weight of the marker hung on one end of the wire. The slotted crank of each shaft of the lower row is permanently balanced by a counterpoise rigidly connected with it in its prolongation on the other end of the shaft. Each pulley of the upper row is over-counterpoised by an adjustable counterpoise to such a degree that if the shafts are all loosed from the gearing so as to be each free to turn round its axis, every one of them rests in position. Thus any one of them may be turned round its axis into any position and it rests there.



THE TIDE PREDICTOR.

This condition is clearly not vitiated by shifting out or in the stud of any of the pulleys of the lower row in its slot; but if any of the pulleys of the upper row be shifted its counterpoise is also shifted a corresponding distance out or in on the other side.

It will be seen that the plan of this first tide predicter involves a great simplification in attaching the bearings of each pulley direct to its crank-arm, in a proper position adjustable to be either at the center, in which case its contribution to the resultant motion

will be zero, or at any distance from the center to correspond to the range of the harmonic constituent which it is to represent, instead of having a crank-pin adjustable to any distances different from the center, and causing this crank-pin to produce simple harmonic motion. Thus the more obvious plan has the advantage of imparting simple harmonic motion to the center of each pulley. On the other hand, the simpler plan gives circular motion to the center of each pulley, which is equivalent to simple harmonic vertical motion compounded with an equally simple harmonic horizontal motion. The deviation from verticality which the horizontal motion gives to the straight intermediate parts of the thread is a derogation from perfect accuracy in the desired composition of simple harmonic motions, and is a serious drawback to be weighed against the advantage of its great simplicity of mechanism.

In the first tide-predicting apparatus the inventor refrained, owing to the great expenditure that would have been incurred, from venturing to carry out the vigorous plan for a sufficient number of tidal constituents to be practically useful, even with all the improvements anticipated in the way of proper geometrical and dynamical designs for the slide, and vertical motion for the marker. Although somewhat rudimentary in design, the excellent principles of Lord Kelvin's appliance attracted considerable attention, and the inventor was soon engaged in the production of a second tide predictor upon an improved form for the Indian government. It was intended to be utilized for the prediction of the tides for the Indian ports, for which, in consequence of the large diurnal tides, the ordinary plan of tide tables, showing the time and height of high water on the days of full and change, or on every day of the year, does not afford information enough for practical purposes. A design by Mr. Roberts, who had calculated the arithmetical design of the gearing of the first machine, and had supervised its construction, together with M. Légé, who had built the first apparatus, was submitted to Lord Kelvin for his approval. In this design were involved the true simple harmonic motions for the centers of the pulleys, instead of the circular motions of the first machine. This modification, although it made the instrument less simple, was rendered in fact necessary by the large range which it was proposed to give for the resultant curve, and which would have required inconveniently long lengths for the straight parts of wire between the upper and lower rows of pulleys nearly enough to annul the geometrical error of the simpler plan. Lord Kelvin generally approved of the plan and recommended to the Indian government that the instrument should be built by M. Légé under the superintendence of Mr. Roberts. The details of the slides were not brought before Lord Kelvin in the original plans; and after some progress had been made, Mr. Roberts proposed, instead of slides, to introduce for converting circular into rectilineal motion a system of link-work, of which the suggestion had come from France in some of the numerous pieces of ingenious mechanism which followed the celebrated "Peaucellier's cell" in rapid succession. Lord Kelvin did not approve of this idea, and pointed out that the simplest mechanism sufficed, and that no advantage could be gained by abandoning the elementary slide. As a suggestion toward details, he sent a working drawing of the slide which he had then designed for his harmonic analyzer. In every other respect the India Office machine was a replica of his first instrument, with twice as many tidal constituents, greatly improved arithmetical exactness in respect to the periods of the several shafts, and on an enlarged scale. In the India Office instrument the inventor adopted the same principle of counterpoising as that of the original wooden model, but carried out, not by counterpoises fixed oppositely to the crank-arms on the shafts, but by cords passing vertically upward from the slides over fixed pulleys, and stretched by proper weights hung on their other ends. The condition fulfilled is precisely the same, being that when each shaft is loosed from its gearing and left free to turn without friction, it remains in whatever position it is placed.

The same general plan of gearing as that devised in the first tide predictor was also adopted in the second instrument. The motions were transmitted from a main driving shaft by intermediate shafts bearing endless screws, to toothed wheels on the tidal constituent shafts. In designing the mechanism to give the requisite speeds to the several shafts, it did not occur to the inventor till he began to design practical details for the harmonic analyzer, after the tide predictor for the Indian government was more than half finished, that the simpler plan of merely toothed wheels, gearing into one another, was preferable to any use of intermediate shafts with endless screws. Besides the great unnecessary complication which it gives to the machine, the system by endless screws involves the practical disadvantage that speed is got up very high and run down again between the driving and the driven shafts. Thus in the India Office tide predictor, when working at such a rate as to trace a year's curves in four hours, some of the wheels and screws turn at from 1,100 to 1,600 revolutions per minute. In the former tide predicter the high speed of the intermediate screw-shafts had not been noticed as a fault, because the mode of marking time on the curve in that instrument had limited the speed of working to something less than the greatest speed that, so far as wheelwork was concerned, could have been easily attained. But the jigging and motion of the ink-bottle for marking time had been discarded from the designer's tide gages before the India Office predictor was designed, and never entered into the design of this instrument; and he was disappointed to find that its rate of working was limited to one year per four hours, through the great speed that this required in the screw shafts.

To move the ink-bottle marker up and down through the range of the semi-diurnal tide in two seconds is a very moderate speed of working, and this would produce a year's curve in twenty-four minutes. But this was just ten times the speed to which the method of mechanism chosen limited the practical working of the India Office instrument.

In his third predictor, the inventor so designed the mechanism that there was no getting up of speed and running down again. The proper speeds for the several tidal shafts are obtained by the simple and obvious method of toothed wheels. In this arrangement it is even unnecessary to have the intermediate idle shafts of the harmonic analyzer, and thus in the new tide predictor there was only one main shaft carrying eleven toothed wheels; and separate tidal shafts each carrying one toothed wheel gearing into one of the wheels on the main shaft except in four instances, in each of which the toothed wheel on the tidal shaft geared into another toothed wheel on another of the tidal shafts.

The main shaft goes once round in the period corresponding to twenty-four solar hours, and a crank-pin is supplied to allow the meteorological tide of that period to be taken into account in the tide prediction for any port for which it has been found to exist in sufficient amount to be of practical importance. Each of the other fifteen shafts carries a crank-arm and pin, giving simple harmonic motion to the center of one of the pulleys by means of a crosshead and slide. In this machine there is no idle shaft, for each shaft carries a crank contributing to the general result. The greatest speed of any one shaft is one with a speed corresponding to a revolution in four mean lunar hours.

The several slides, pulley-frames, and pulleys in the upper row are not all of the same weight, those for the small tidal constituents being lighter. Those of the lower row corresponding to the smaller constituents are weighted so as to be of the same weight as those for the larger constituents. The weight of each slide, with attached pulley-frame and pulley of the lower row, is about 60 grammes. This weight is exactly borne by the two straight portions of wire passing upward from the pulley (in vertical lines at equal distance on its two sides from its center of gravity), and the weight of the ink-bottle marker is therefore exactly equal to half this amount. Each slide, pulley frame, and pulley of the upper row is pulled downward by the same amount (60 grammes) by two straight portions of wire passing downward on each side. Hence the counterpoise is made to balance exactly this amount added to the weight of its own pulley, pulley-frame, and slide. Thus if the crank-pins were removed, and the slides and pulleys left perfectly free, with the ink-marker on one end, and the other end fixed, all are in equilibrium. Hence, if the machine turn infinitely slowly, the pressure on the guides is zero, and the pressure to be provided for in the actual motion is just what is needed to balance the couple constituted by the upward or downward pressure of the crank-pin in its slot, and the reaction against acceleration of the slide pulley-frame and pulley, and of the counterpoise and its revolving pulley, in the case of the upper row of tidal pulleys which is in a vertical through the center of inertia of the whole.

In working at as slow a rate as one turn of the main shaft per four seconds (or one year's curves in twenty-four minutes) the reactions against acceleration in all parts of the machine are so small as to be scarcely perceptible in the main mechanism, however slight it may be made. A form and arrangement of guides and sliding pieces has been chosen, which admits of the moving parts being very much lighter and less frictional than those of the harmonic analyzer, or of the second tide predictor. The wire, fixed at one end, passed over and under the pulleys, and carrying the 30-gramme ink-bottle, is steel, of No. 50 B. W. G. weighing 1-20 gramme per meter. Its whole length is 300 centimeters. Its elongation by a difference of pull of 1 gramme is 1-40 millimeter; and it is strong enough to bear a weight of 500 grammes, or over fifteen times the weight of the ink-bottle.

The tide predictor built for the Indian government proved most successful and accurate in its operation—the greatest amount of error was only 1.95 deg. per half year. The instrument occupied approximately five hours to work off the tidal curves of a given port for one year, which time also included the winding up of the driving weight of the mechanism, etc. This speed enabled the whole of a year's tides for five hundred different ports to be predicted in less than a year. The driving weight represented 560 pounds descending 26 feet for four months' work, so that the weight had to be wound up to a height of 26 feet three times a year to work off a year's calculation. The process of winding occupied twenty minutes, during which operation the machine ceased work.

The machine which has been acquired by the National Physical Laboratory has been thoroughly overhauled. Some of the parts were found to be somewhat worn, but these have been renovated, so that now the appliance is in perfect working condition.

To Bleach Gutta-Percha.—Dissolve gutta-percha in twenty times its weight of boiling benzine, and add plaster of the best quality to the solution, shaking from time to time. After a few days of repose the plaster will have settled to the bottom, carrying along the impurities soluble in the benzine. Introduce the clear (decanted) liquid in small portions into a vessel containing double its volume of alcohol of 90 degrees, stirring continually. During this operation the gutta-percha precipitates in the form of a perfectly white paste-like mass. The drying of the gutta-percha thus purified requires several weeks' exposure to the air; this may be accelerated by triturating it in a mortar, and removing from it the water that separates.—Translated from Les Corps Gras Industriels.

GRANTS MADE BY THE CARNEGIE INSTITUTION.

At the last annual meeting the trustees set apart $200,000 for grants for research during the fiscal year 1902-3. The following is a list of grants made by the executive committee under such authority:

ANTHROPOLOGY.

G. A. Dorsey, Field Columbian Museum, Chicago, Ill. For ethnological investigation among the Pawnees. $2,500.

Abstract of Report.—This scheme of investigation will require four or five years for its completion. It is a study of the religious ceremonies of the Pawnee Indians, with direct reference to the mythological origin of each ceremony, and to obtaining a clear and comprehensive understanding of the religious systems of the Pawnees.

The work of collecting and arranging the details of the region of the religion was begun early in the year, and has been pushed forward as rapidly as possible. The work of the first year was to obtain the mythology of the Skidi on the one hand, and the Chaui, Kitkahahki and Pittahauirata bands of Pawnees on the other, and of the Wichita and Arikara. The second result sought for was to gain a comprehensive insight into all the ceremonies of the four bands of the Pawnees and of the Arikara. Of these two results as much has been achieved as could be hoped for, inasmuch as the work has progressed for only about nine months.

With the beginning of the first of the Skidi ceremonies early next spring, it will be possible to select certain of the more important ones for more detailed observations. Thereafter each ceremony will be studied independently and in detail, and the observations thus made, together with the ritual as sung, will be prepared for publication.

William H. Holmes, Director Bureau of American Ethnology, Washington, D. C. For obtaining evidence relative to the early history of man in America. $2,000.

The phenomena to be considered are scattered and obscure. The geological formations of both continents, ranging from Eocene to Recent, abound in various records, but investigation has been in the main desultory and unscientific, and the isolated observations are today without adequate correlation.

Mr. Holmes proposed to begin his work with the compilation of all data respecting previous investigations, and then to begin field work which should extend to deposits in caves and caverns where men have lived, and should also include their ancient sites, such as kitchenmiddens, shell heaps, and earthworks.

Abstract of Report.—The field work in this investigation was done mainly by Mr. Gerard Fowke, archeologist, who began work in Indiana and carried his examinations into Illinois, Kentucky, Tennessee, and Alabama, exploiting many caves and making careful investigation of a few. Results were distinctly negative with reference to the principal question at issue, the entire season's work having developed no fact that will tend to establish a theory of the great antiquity of man in America. The season's work, however, was not a failure on this account, since the question is one that must be solved, if not by the discovery of positive evidence, by establishing the universality of negative evidence.

Late in the season explorations were begun on the Atlantic slope by Mr. F. B. McGuire, archeologist, in the caves of the upper Potomac in West Virginia. Mr. Holmes personally made a reconnaissance in Georgia and Alabama for the purpose of collecting definite information regarding the caves of the South.

With the aid of Mr. F. B. McGuire and Dr. J. W. Fewkes, a cave in Porto Rico was explored without expense to the Institution. The present report can be regarded as only one of progress, since Dr. Fewkes and Mr. McGuire are still in the field.

George F. Kunz, New York city. To investigate the precious stones and minerals used in ancient Babylonia in connection with the investigation of Mr. William Hayes Ward. $500.

Abstract of Report.—This is an investigation in co-operation with that of Mr. William Hayes Ward. It was deferred until winter in order to secure the co-operation of Mr. Ward after his return from his investigations in Europe.

William Hayes Ward, New York city. For study of Oriental Art recorded on seals, etc., from western Asia. $1,500.

Dr. Ward has been for fifteen years devoting his spare time to Oriental archeology, with special reference to the beginnings of art and mythology, as shown in recovered monuments and especially in the seal cylinders, which preserve a large part of the early art. He has handled thousands of seals and has paper impressions of thousands. The investigation covers a period from about 4000 B. C. to about 400 A. D. and will include a study of the mythological representations and various designs, emblems, and inscriptions contained in them.

Abstract of Report.—During last summer Dr. Ward has visited museums in the United States and in Europe, where he examined the great collections of Paris and Berlin. Every facility was granted by the authorities in charge, and he made notes and obtained casts of such cylinders and seals as were required for his investigations. He is now engaged in the preparation of manuscript and illustrations. It is estimated that it will require about two years to complete the study and prepare the results for publication.

ASTRONOMY.

LEWIS BOSS, Dudley Observatory, Albany, N. Y. For astronomical observations and computations. $5,000.

Abstract of Report.—This work has for its ultimate object an investigation upon the motions of the brighter stars (all down to the seventh magnitude), and of all stars, of whatever magnitude, supposed to have motions as great as 10 sec. per century, and of many other stars which were specially well determined prior to 1850.

During the year Prof. Boss's attention was given to—

(a) The compilation for each star of all observations for position that have been made upon it during the history of astronomy. Some stars are found in more than sixty catalogues.

(b) Investigation of the systematic errors with which each series of meridian observations seems to be affected, in order that the precision of the results may be notably increased. This involves in the first place the establishment of a standard of reference, which must include the positions of all those stars which have been most frequently and accurately observed.

The entire work is proceeding upon a logical plan carefully studied and formulated through the results of experience during past years, with a view to economy in the succession of individual investigations designed to contribute to the final result. In an extensive investigation of this kind there is always an element of danger. If the work is so planned that definite results can not be realized until the completion of the whole work, there is liability to serious loss from the ordinary accidents of life which can not be foreseen. Therefore this work has been so planned that useful results can be secured and promptly published at every successive stage of the work. Each step grows logically out of those which have preceded it. The computations are so planned that successive improvements in the fundamental basis can be introduced with the least possible duplication of work.

It is intended that the catalogue of more than 2,500 standard stars shall be offered for publication to the Carnegie Institution early in 1905, and if no unforeseen accidents occur this programme should be entirely feasible.

During the present year the catalogue of 627 standard stars has been passing through the press and is now nearly ready for issue. Subsidiary investigations connected with this catalogue have been carried out under the grant of the Institution for this year.

BOSS, HALE AND CAMPBELL. For investigating proposal for a southern and a solar observatory. $5,000.

In the Year Book for 1902 a proposition for the establishment of a distinctly solar observatory was presented by Prof. S. P. Langley. In the same report (page 89) the astronomical advisers called attention to the lack of observatories in the southern hemisphere, and in an appendix (pages 99 to 104) they treated the subject still more fully.

In order that the board of trustees might be enabled to arrive at appropriate conclusions, Prof. Lewis Boss, chairman; Prof. George E. Hale, and Prof. W. W. Campbell were requested to investigate, as a committee, the subject more fully and to consider the question of suitable sites for such observatories.

The result of the work of this committee is submitted in the Year Book.

W. W. CAMPBELL, Lick Observatory, Mt. Hamilton, Cal. For pay of assistants to take part in researches at the Lick Observatory. $4,000.

Abstract of Report.—Owing to the difficulty of obtaining satisfactory assistants from the East and providing living quarters for them on the mountain, it was not found possible to provide for an effective use of the grant for the employment of assistants and computers until late in the year. Investigations were begun with the meridian circle work and in spectroscopy. With the construction of additional residence quarters on the mountain, Prof. Campbell will soon employ the full number of assistants rendered possible by the grant.

HERMAN S. DAVIS, Gaithersburg, Md. For a new reduction of Piazzi's star observations. $500.

American and European astronomers have urged that a fresh reduction of these observations by known methods for obviating certain errors should be made. Prof. Porro, of Turin, undertook a part of the reductions and Prof. Davis the rest. Assistance from private persons and from observatories has contributed to the prosecution of this undertaking. The Carnegie Institution was asked to make a small contribution.

Abstract of Report.—The work accomplished under this grant has been in connection with work that was already begun. This makes it difficult to define specifically the exact amount done under the grant from the Carnegie Institution. The period of nine months, during which the grant has been available, has marked the transition from the routine work of reducing the observed "apparent" positions of the stars to a common "mean" epoch to the next large step of deducing therefrom the instrumental errors and compiling the final catalogue. This rendered it necessary to spend this time in rounding out and perfecting all the divers portions of the computations which have been going on uninterruptedly for the past seven years. This has been finished, and also some preliminary work done for the next great and distinct stage of the work: (a) To deduce the errors of the telescope for each night of observation; (b) to correct all observations for these maladjustments, and (c) finally, to combine the definite separate positions into means for each star included in the catalogue, which is the goal of the long labor.

GEORGE E. HALE, Yerkes Observatory, Williams Bay, Wis. For measurements of stellar parallaxes, solar photographs, etc. $4,000.

Abstract of Report.—Work was begun on the photographic investigation of stellar parallaxes early in May with a forty-inch telescope. Up to October, 114 plates, containing about 350 exposures, had been obtained. These included: (a) Twenty experimental plates, (b) eighty-eight plates suitable for parallax determinations, and (c) six plates of loose star clusters.

Considerable work was also done in the measurement of photographs of star clusters.

Another line of investigation was the photometric determination of stellar magnitudes. Considerable progress was made in this, fields being measured with the six-inch reflectors and the twelve and forty-inch refractors. Measures were also made upon the Pleiades group of stars to determine the constant of the equalizing wedge photometer. Measurements were also made of comparison stars for faint variables.

Much progress was also made in the measurement and discussion of photographs of the sun, taken with the spectroheliograph at the Kenwood Observatory in the years 1892-6, and in other minor investigations connected with the work in hand.

SIMON NEWCOMB, Washington, D. C. For determining the elements of the moon's motion and testing the law of gravity. $3,000.

Much of the material for this investigation, consisting of computations of places of the moon from Hansen's tables and their comparison with observations, was preserved in the archives of the Nautical Almanac Office, awaiting an opportunity for their working up. By permission of the Secretary of the Navy, Hon. William H. Moody, these papers were intrusted to the Carnegie Institution and by the Institution to Prof. Newcomb.

Abstract of Report.—The importance of this work grows out of the fact that new tables of the moon are urgently required for the purposes of astronomy and of navigation. For a long period the problem of constructing and perfecting such tables has been delayed by an unexplained discordance between the observed motion of the moon and the motion which should result from the action of all known bodies upon it. The exact cause of this discordance can not be recorded, because the observations from 1750 to 1850 have never been worked up and compared with the tables. The problem of determining the exact nature of the deviation of the moon from its predicted place is twofold. The observations since 1750 must be worked up, and in order to compute the comparison the action of the planets on the moon must be recomputed with a view to determining whether any correction to the past computations is necessary.

By aid of a grant from the Carnegie Institution an important term of long period, produced by the action of Venus, has been recomputed.

Prof. Newcomb has taken up the work on the adopted plan of the occultations of stars by the moon, a work that he had begun in connection with the Nautical Almanac. This, in connection with the incorporation of other important observations, can probably be completed in two years more.

E. C. PICKERING, Harvard University, Cambridge, Mass. For the study of the astronomical photographs in the collection of Harvard University. $2,500.

Abstract of Report.—The grant made to Prof. Pickering was applied to a great variety of uses. These included sums paid to nineteen different assistants and computers, and for other assistance in connection with the Harvard Observatory.

Each of the numerous investigations is of importance in carrying forward the work going on in the observatory, but they do not appear to be upon sufficiently definite and specific problems, as given in his report, to permit of a distinct statement, in most cases, of the progress of the work under the Carnegie Institution grant.

Prof. Pickering reports that in forming a corps of observers to study the photographs, time and money being limited, it was difficult to decide what subjects to select from this vast amount of material. A number of problems have accordingly been studied which serve to illustrate the various investigations which might be undertaken. Abridged results of a portion of these were promptly published in the Harvard Observatory Circulars Nos. 69 and 70. The principal researches carried on are as follows: (1) Eclipses of Jupiter's satellites; (2) light curves of Algol variables; (3) position and brightness of stars in clusters; (4) observations have been made of the changes in light of nine variable stars of long period, during several years before they were discovered; (5) early observations of stars of the Algol type and other variables of short period; (6) transit photometer; (7) Nova Geminorum; (8) variations in brightness of Eros; (9) proper motion of stars; (10) missing asteroids, and (11) many images of interesting objects like new stars, variables and asteroids doubtless appear on the photographs. An examination has accordingly been made of several of the plates to determine whether it would be advisable to examine a large number of them systematically for the discovery of such objects.

WILLIAM M. REED, Princeton Observatory, Princeton, N. J. For pay of two assistants to observe variable stars. $1,000.

Abstract of Report.—Owing to the difficulty of obtaining an observer, work was not begun till March 1. During the seven months from March 1 to October 1, the 23-inch telescope of the Halsted Observatory, exclusively for photometric work, was used on every clear night from early in the evening until daylight. In all 9,015 observations were made on about fifty different stars.

Three classes of stars were observed:

(a) Such variable stars as are too faint to be reached by any except the largest telescopes. In particular, selection was made of stars that have become too faint for the Harvard observers and those co-operating with them.

(b) Measurement of faint stars that are to be used as standards of magnitude. In this work they are connecting stars of the thirteenth magnitude with those of the fifteenth magnitude. The Lick and Yerkes observatories are connecting the fifteenth magnitude stars with the sixteenth magnitude, and the Harvard Observatory is connecting the eleventh magnitude with the thirteenth magnitude.

(c) A special study of the newly-discovered Algol variable, 4.1903 Draconis, has been made, and a preliminary article giving the results of these observations has been sent to the Astronomical Journal.

MARY W. WHITNEY, Vassar College, Poughkeepsie, N. Y. For measurement of astronomical photographs, etc. $1,000.

Abstract of Report.—This work consists in the measurement and reduction of stellar photographs taken at the observatory at Helsingfors, Finland, by Prof. Donnor. The measurement of the eight plates is finished and the reduction is well along. A preliminary catalogue of the mean places of 404 stars within two degrees of the pole is nearly completed. The work was pressed during the last quarter, as Prof. Whitney then secured the services of an expert computer. The intercomparison of the plates and the determination of proper motion remain to be studied.

(To be continued.)

CONTEMPORARY ELECTRICAL SCIENCE.*

ELECTRIFICATION OF THE BRAIN.—S. Leduc summarizes the facts known concerning the action of electric currents upon the brain, and gives some additional information concerning the electric production of sleep. According to Von Ziemssen, the brain substance is the best conductor in the human body, being about 3,000 times more conducting than muscle. That electricity has not been more frequently used in the treatment of brain disease is largely due to an exaggerated notion concerning the dangers involved. Generally speaking, a continuous current passing from one ear to the other produces giddiness, the objects appearing as if mounted on a wheel turning round, so that the top seems to pass from the anode side to the cathode side. Currents from back to front appear to be innocuous, and even beneficial. Thus, a current brought up to 5 milliamperes in five minutes and kept at that strength for another five minutes, with electrodes on forehead and neck, increased the muscular power by 6 or 7 per cent, as measured on the ergograph. The best arrangement for the electric production of sleep is a current of 4 milliamperes at 30 volts, interrupted 100 times per second for nine-tenths of the period of interruption. The author has tried that on himself. The faculty of speech disappears first, then the motor faculties. Respiration and pulse are unaffected within the limit stated, but their temporary or final stoppage may be brought about by increasing the current. Short of that, awakening is instantaneous, and the resulting feeling is one of refreshment.—S. Leduc, Arch. d'Electr. Méd., July 1, 1903.

IONIZATION OF AIR BY WATER.—F. Himstedt has accumulated a mass of experimental material for studying the process of ionization of air by water. Some of the experiments repeat those of Thomson, and of Sella, and Pocchettino; but as they were made along independent lines and lead to novel conclusions, they are of intrinsic interest. The author found that air bubbled through water becomes highly radio-active. The radio-activity disappears very slowly, taking several weeks to vanish altogether. On conducting the air through a copper tube surrounded by liquid air, the radio-activity is annulled, but is restored on heating up the tube. There is, therefore, a kind of emanation, which can be condensed and evaporated, like the radium emanation. The addition of a salt to the water makes no difference. Other liquids show no effect, with the possible exception of alcohol and nitro-benzol, both of which have a pretty high conductivity. The transmission of the air through a tube filled with moistened glass wool is as effective as bubbling it through water. The author supposes that molecules or groups of molecules of air are inclosed in a very thin sheath of water, so thin that it does not make them settle down like drops of spray, and allows them to traverse cotton wool. The water might still preserve its great ionizing power, and release the ionized molecules by the breaking of the sheath. This chimes in with Kohlrausch's theory of electrolytic conductivity.—F. Himstedt, Ann. der Physik., No. 9, 1903.

* Compiled by E. E. Fournier d'Albe in the Electrician.

GRAPE, RAISIN, AND WINE PRODUCTION IN THE UNITED STATES.*

By GEORGE C. HUSMANN, Expert in Charge of Viticultural Investigations, Bureau of Plant Industry.

THE GRAPE-GROWING INDUSTRY.

EARLY HISTORY.

WHEN America was discovered the wild vine was so prominent a feature of the vegetation that the name

FIG. 1.—A TYPICAL EASTERN VINEYARD, NEAR BROCTON, N. Y.

Vineland was more than once applied to the country. Considerable wine was produced from a native grape in Florida as early as 1564. The London Company planted vineyards in Virginia prior to 1620, and many succeeding attempts at grape growing were made by William Penn and by German and Swiss settlers. Of more recent attempts to cultivate the vine on the Atlantic coast, the first were confined to European varieties, and were not successful. The Mission Fathers in California were the first to successfully grow the European grape in the United States. They grew grapes at the missions for their own use only, the work being principally done by Indians. They had but one variety, which is still largely grown, and is known by the name of Mission. It is first heard of as introduced into Mexico in 1520. Chronologically, it was brought to the California missions, as follows: San Diego, 1769; San Gabriel, 1771; Los Angeles, 1781; and Santa Barbara, 1786. The Mission vine planted at Montecito, Cal., in 1795, was exhibited at the Centennial Exposition in Philadelphia. It was 18 inches in diameter, and in one season had produced over 5 tons of grapes. From the missions, the viticultural pioneers received their inspiration as well as their start of cuttings.

NEW ERA IN GRAPE GROWING.

Mr. John Adlum made the first really successful efforts at grape growing on the Atlantic coast. In 1820 he planted a vineyard near Georgetown, D. C., consisting mostly of native vines. His introduction of the Catawba variety into general cultivation was the beginning of a "new era in grape history." In a letter written by him to Nicholas Longworth in 1825, he says that "in bringing this grape into public notice I have rendered my country a greater service than I would have done had I paid the national debt." Since its first introduction, grape culture has gradually increased, and interest in it has become general throughout the land. Such rapid progress was made that in 1830 Mr. W. R. Prince, in his treatise on the vine, enumerates 88 varieties of American vines. To-day there are at least 1,000.

Mr. Ephraim Wales Bull is deserving of lasting gratitude for raising from seed and giving to the world the Concord grape, destined to become the most widely known, most generally planted, and, for all purposes, the best American grape yet introduced. Only a few miles from Concord, Mass., stands Bull's cottage, in the dooryard of which still grows the first Concord vine, from which stock the unnumbered millions of vines of this variety came. On one side hangs a square oak board on which these words are artistically burned:

"I looked about to see what I could find among our wildings. The next thing to do was to find the best and earliest grape for seed. This I found in an accidental seedling at the foot of the hill. The crop was abundant, ripe in August, and of very good quality for a wild grape. I sowed the seed in autumn of 1843; among them the Concord was the only one worth saving.—Ephraim Wales Bull."

The Concord is included in nearly every collection where American vines are planted. To illustrate what a boon it has proved to be, it need only be stated that the Chautauqua grape belt, on Lake Erie, in 1900, produced 192 million pounds of grapes, at least nine-tenths of which were Concords. Mr. George Husmann, the father of the writer, in 1865, said: "One-third acre of Concord, planted five years ago, has produced me, in fruit, wine, layers, and plants, the round sum of $10,000 during that time."

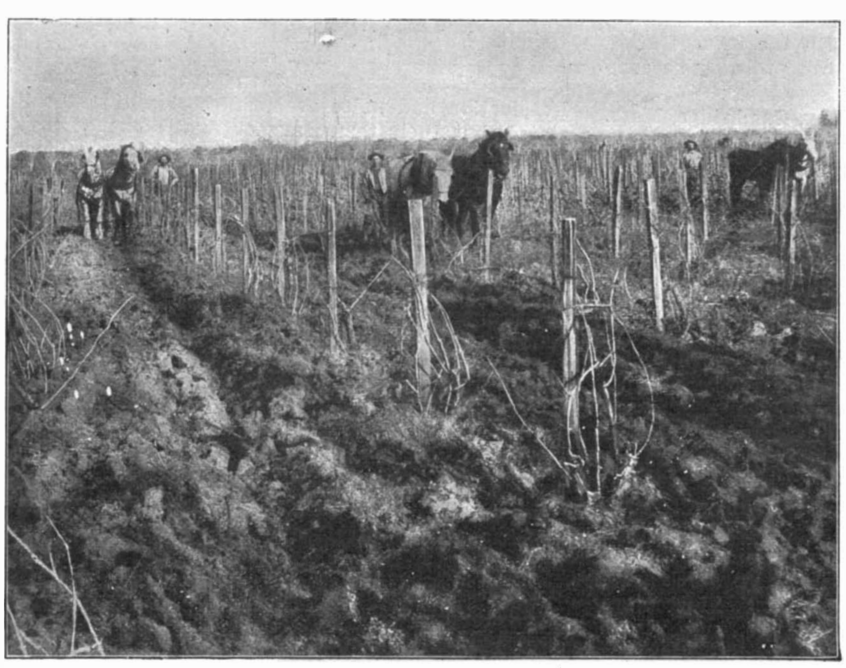


FIG 2.—HARROWING A CALIFORNIA VINEYARD PRUNED TO CANES.

FIG. 3.—PLOWING A CALIFORNIA VINEYARD PRUNED TO SPURS.

In the United States there are two distinct grape-producing sections, one east of the Rocky Mountains, where the American varieties are largely and profitably grown, the other in California, where the Vinifera varieties have found a congenial home. These sections differ not only in their products, soils, and climate, but also in their methods of pruning, culture, gathering, working, and marketing of crops, so that only those familiar with both sections are able to make a just comparison.

BEGINNING OF A COMMERCIAL INDUSTRY.

The decade closing the first half of the last century witnessed the birth of commercial grape culture in the United States, leading up to the making of choice wines from American grapes. The manufacture of sparkling wine and unfermented grape juice has been developed in the Eastern States, while the Pacific coast has entered into direct competition with the choicest European wines, and has captured the raisin market of this country. The efforts of Longworth and others at Cincinnati in grape growing and wine making were followed by many in other States, especially in New York, Missouri, Virginia, Indiana, Illinois, Kentucky, Pennsylvania, the Carolinas, and Michigan. In California, where the Mission had so far been the only variety cultivated, introductions of the choicest European varieties soon followed. In 1850 the country produced almost 250,000 gallons of wine. In 1860 the product had reached over one and one half million gallons, and all the States and Territories except four were growing grapes. The census of 1860 shows California, New York, and Ohio as the three leading wine-producing States. From 1860 to 1875 rapid progress was made. In 1870 Missouri produced more than any other State except California. With this exception, California, New York, and Ohio have taken the lead. In 1900 their combined output was 22,404,085 gallons of wine out of a total of 23,425,567 gallons for the whole country. From 1875 on, quite a decline occurred, especially in Missouri, owing to the black-rot and other diseases.

To sum up, American wines and brandies have taken high honors at all important expositions, including that at Paris in 1900, and they are rapidly finding their way into all the principal markets of the world.

* From Year Book of Department of Agriculture.

GRAPE CULTURE.

Soil, Location, and Site.

Soil, location, and site will differ greatly with the object in view. Some varieties of grapes may be grown on almost any soil. Usually those lands are selected that can be prepared and planted with the least labor, that are the easiest to cultivate, and which produce the largest crops. Quality and quantity, however, in most cases do not go hand in hand. The best soils are a gently sloping, well-drained calcareous loam, of sufficient depth, with porous subsoil; gravel or small stones in a soil are not a detriment. Some prefer a sandy soil with a gravelly substratum. The place should have a good water supply, be easy of access to market, and free from late spring frosts. The cellar or packing house should be centrally located on the place, and if possible so that the grapes can be hauled down grade, or at least on a level. For this purpose a hillside into which a cellar can be excavated, facing so that each story can be easily approached by wagon, is to be preferred.

Preparing the Soil.

The soil should be well prepared. It should be cleared of large stones, stumps, and other obstructions, and not only be thoroughly and deeply plowed, but subsoiled as well. If it be virgin soil it will be of benefit to raise a crop of grain on it the season previous to planting, as this gives a better opportunity to put it in good shape. Any wet spots should be carefully drained. After being plowed and subsoiled it should be thoroughly harrowed and the clods crushed with drag or roller.

Manures and Fertilizers.

On partially exhausted or poor soils such manures and fertilizers should be applied as will give them those substances in which they are deficient. Broadly speaking, if the soil lacks in fruit-producing qualities, potash is needed; if more wood growth is desired, nitrogenous fertilizers should be applied.

Choice of Varieties to Plant.

As to varieties of grapes to plant, each locality must in a measure determine this for itself, grape growing being perhaps more dependent on selection of varieties with reference to soil, climate, location, and other conditions than any other fruit industry. The writer has seen such radically different results with the same varieties, planted in vineyards only a short distance apart, that it would hardly seem possible they were the fruit from the same variety.

It must be decided whether to grow raisin, table or wine grapes. Usually it will be well to select such varieties as have proved valuable for such purposes in the immediate vicinity. Should a grower embark in an entirely new district, where grape growing has not been tried, he will have an opportunity for displaying good judgment, and perhaps gain the distinction of becoming a pathfinder for those who follow in his lead, or perhaps, like Mr. Bull with his Concord, will raise a new variety adapted to the locality.

The American varieties most generally grown are Concord, Catawba, Moore Early Missouri Riesling, Elvira, Isabella, Delaware, Norton, Niagara, Herbemont, Lenoir, Ives, Clinton, and Eumelan; the Vinifera varieties are Zinfandel, Valdepenas, Petit Sirah, Beclan, Mataro, Petit Pinot, Carignan, Mission, Chablis, Semillon, Sauvignon Vert, Green Hungarian, Berger, Thompson Seedless, Alexandria (Muscat of), Sultana, Feher Zagos, Flame Tokay, Emperor, and Cornichon.

Planting, Plowing, and Cultivating.

Throughout the Eastern States vineyards are usually planted in rows 8 feet apart, with the vines 8 to 10, even 12, feet apart in the rows. A plain trellis of posts, 24 by 30 feet apart, with two parallel wires, the first 18 to 20 inches from the ground and the second 36 inches, is mostly used, but in some instances a grower uses three wires (Fig. 1) Of late years many use the Munson trellis or a modification of it. In California the usual method has been to plant 7 feet apart each way, no trellis but simply stakes being used. This enables growers to plow and cultivate lengthwise and crosswise (see Figs. 2 and 3). There is a tendency to plant farther apart, some planting 8 by 8, others 6 by 10, and others 9 by 9 and 8 by 10. The writer prefers to plant 6 by 10 in most localities. This divides the distance in such a manner as to make the plowing, cultivation, etc., better, easier, and cheaper. The vineyards are all plowed twice. In the first plowing the soil is thrown away from the vines, and in the second it is thrown up to them again. The vineyards are cultivated frequently early in the season. In the Eastern States too late cultivation, it is claimed, keeps the vines growing too late in the season, causing much unnecessary growth of wood, which does not ripen and weakens the vine. In California cultivation is abandoned after the spring rains are over.

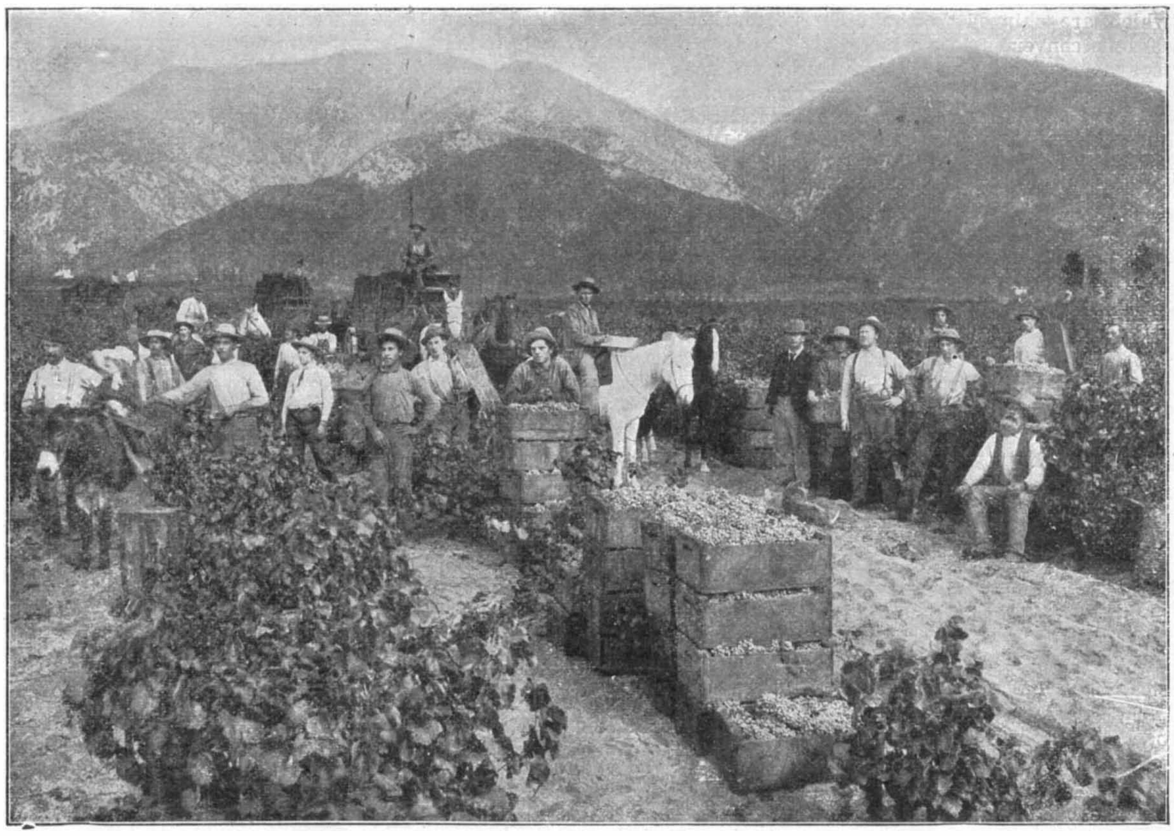


FIG. 6.—PICKING GRAPES IN CALIFORNIA.

Pruning and Grafting.

So many different methods of pruning and grafting are practised that the details of them can not be discussed in this paper. In the Eastern States the Kniffin system or some modification of it is mostly used. However, this varies greatly. In California two principal methods are practised, commonly called cane and spur pruning. All of the systems have one underlying principle. As the grape bears its fruit mainly on shoots on the wood of the previous year's growth, the pruning should be so as to renew the wood at a given point from year to year, thereby regulating its production and keeping the plant thoroughly shaped and under constant control. With a thorough knowledge of the nature of the vine nothing is easier than to prune it correctly. Perhaps the nature of no fruit-bearing plant is so poorly understood by the average horticulturist as the vine. There are many who easily learn to prune fruit trees who fail to master the vine, and the same statement is equally true of grafting.

Insects and Diseases.

In many of the Eastern States, the black-rot, anthracnose, and mildew have wrought such serious damage that many vineyards have been abandoned. In some sections the grape rootworm and the thrips have been very destructive. In California the Phylloxera and the Anaheim disease have worked very serious and extensive injury, and it will require systematic experiments and earnest work and study to cope with them.

PICKING, MARKETING, AND STORING GRAPES.

In picking, the grapes are placed either in boxes or trays. Those selling in baskets accept the price of the day as satisfactory or send to commission houses to sell on commission; others who are fortunate enough to have built up a reputation sell on direct orders at fixed prices. Those disposing of the product in bulk sell the entire crop at a stipulated price per ton delivered at the wineries or aboard cars, and receive their settlement after the last of the grapes have been delivered. Quite a few sell their crops on the vines at so much an acre, or a stipulated sum for the entire crop, the buyer in such instances doing all the work, picking, hauling, etc., and assuming all risks.

The methods of picking and packing practised in the leading table-grape districts of the country are as follows: Grapes are picked in trays, all the stems being placed upward; the grapes are then allowed to wilt at least forty-eight hours, but are often stored away in the trays in cool, dry rooms, frequently as long as two months, and in extreme cases even longer. From these trays the grapes are carefully picked over, all decayed and inferior berries being removed; they are then packed in four-pound baskets for shipment. In some of the less up-to-date sections, larger-sized baskets are still used. Some of the buyers have their own packing houses, but as a general rule each grower does his own packing, the baskets and labels being furnished by the buyer. In order to insure honesty and good quality, each packer receives his number, which goes on every basket furnished by him. The baskets are loaded into the cars and sent directly to the principal markets.

Late storage is practised with good success. A leading packer at Hammondsport, N. Y., informed the writer that in 1901 he shipped his one hundred and seventy-fifth and last car the 6th of May. The different varieties are stored in separate houses. The houses are cooled by means of ventilating doors on the ground floor, around the sides and at the ends of the buildings, and also by ventilators with strong heating lamps in them overhead. The temperature is constantly watched by means of electric thermometers, and when-

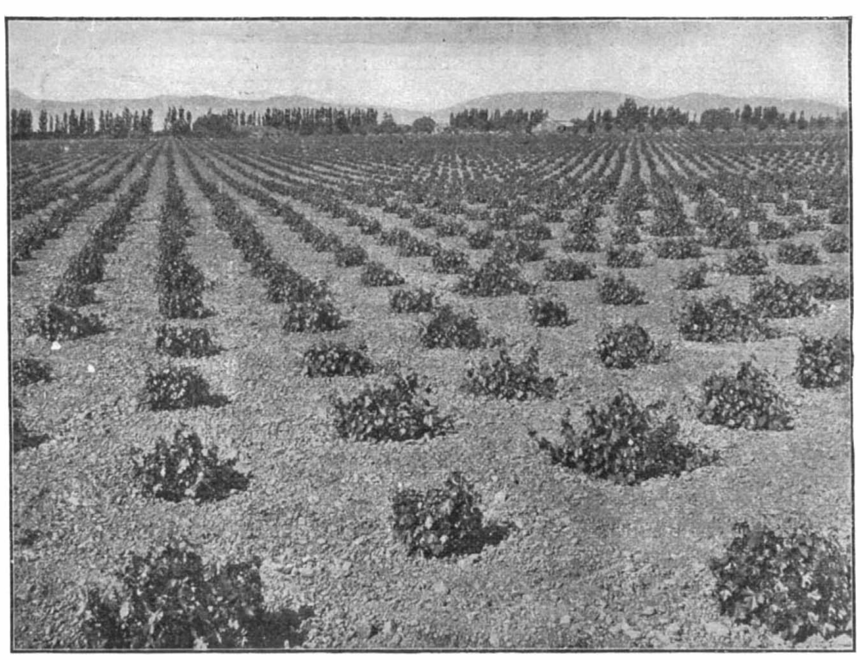


FIG. 4.—A CALIFORNIA VINEYARD IN ITS FIRST YEAR.

FIG. 5.—A CALIFORNIA VINEYARD IN ITS THIRD YEAR.

ever there is a cool spell, either day or night, the doors and ventilators are opened, and if necessary the lamps are lighted to create a draft. In this way the temperature is often lowered as much as 10 degrees in an hour. In 1845 the first shipment of a crop of grapes (consisting of 50 pounds) was made from the Hammondsport district to New York city by way of the New York and Erie Canal. The grapes sold well, and the next year the grower shipped 300 pounds. Now, about 30,000 tons are grown in the same district, 15,000 tons of which are shipped to the different markets, and 15,000 tons converted into wine.

COST AND RETURNS FROM AN ACRE OF VINEYARD.

The cost of an acre of vineyard varies considerably, owing mainly to differences in the character and price of the land. A fair average estimate would be about $200 an acre. The average annual returns are from $125 to $500 an acre, while the annual cost of maintenance, including interest on capital invested, is from $40 to $75. The yield in tons, the number of gallons of wine per ton, and the quality of the grapes and wine vary greatly with the methods pursued, the soil, climate, locality, season, and varieties. In some seasons the quality is superior, while in others the quantity is heavy. Usually the heavier the crop the poorer the quality, and *vice versa*.

(To be continued.)

COMMANDER PEARY'S ARCTIC EXPLORATIONS.

At a meeting of the Royal Geographical Society on Tuesday, Commander Peary, U. S. N., read a paper entitled "Four Years' Arctic Exploration, 1898-1902." Sir Clements Markham, F. R. S., the president of the society, occupied the chair, and there was a large and distinguished gathering, including Mr. Choate, the American Ambassador, the Danish Minister, Gen. Sir J. Hills-Johnes, V. C., Sir Henry Bulwer, Sir S. G. Mackenzie, Vice-Admiral Sir L. Beaumont, Col. Sir T. Holdich, Vice-Admiral Sir J. Bruce, and Lieut. Shackleton, R. N.

Commander Peary, in the course of his address, said that sailing from Sydney, Cape Breton, on July 7, 1898, the preliminary work was completed by August 13, and the "Windward" headed north from Etah. Five days later she had fought her way under Cape D'Urville on the northern side of Princess Marie Bay, when further progress was stopped by a large floe. The autumn work comprised the survey of the Buchanan Strait, Hayes Sound, and Princess Marie Bay region, the securing of a winter's supply of fresh meat, and the transportation of supplies northward along the coast.

THE FIRST YEAR'S WORK.

On December 20, 1898, he left the "Windward" and pushed on with light sledges in an attempt to reach Fort Conger. Although at Cape Desfosse their supplies gave out, they groped their way, in complete darkness, across the broken and snow-covered ice which filled Lady Franklin Bay and stumbled into Conger just after midnight on January 6, 1898. In consequence of both his feet being seriously frozen Commander Peary was kept on his back until February 16, when the returning light enabled them to attempt to return to the ship, and the distance of 250 miles was covered in eleven marches. The mean minimum temperature during this time was —53 deg. F., the lowest reading being —65 deg. On March 13 the amputation of eight of his toes was effected, and on April 19 he started for Conger again, returning to the ship on May 31. In his journey the material abandoned by Greely at Conger was invoiced, 25 musk-oxen killed in the vicinity of the fort and cached for future use, and an attempt made to reconnoiter the northwest Greenland coast. On June 29 he started west to complete the details of the Princess Marie Bay, Buchanan Strait region, and to endeavor to cross to the west coast. From this trip he returned to the ship on July 28. The return journey was somewhat disagreeable, but he was repaid by the results. He had been fortunate in crossing the Ellesmere Land ice cap, and from elevations of 4,000 feet and 4,700 feet had looked down upon the snow-free western side of Ellesmere Land, and out into an ice-free fjord extending some 50 miles to the northwest, beyond which appeared yet more distant land. On August 2 the "Windward" proceeded to Etah, where he established his base for the coming year. During the year he obtained the material for an authentic map of the Buchanan Bay, Bache Peninsula, Princess Marie Bay region, crossed the Ellesmere Land ice-cap to the west side of that land, established a continuous line of caches from Cape Sabine to Fort Conger, rescued the original records and private papers of the Greely expedition, fitted Fort Conger as a base for future work, and familiarized himself and party with the entire region as far north as Cape Beechey.

THE SECOND YEAR.

On March 4, 1900, another journey was begun to Fort Conger, which was reached on the 28th. On leaving Etah he decided to take the route along the northwest coast of Greenland, and later developments showed that decision to be a fortunate one. As far as Cape Sumner, and thence to the Polaris Boat Camp in Newman Bay, they had almost continuous roadmaking through rough ice, and advanced as far as the open water east of Cape Brevoort. This open water extended across the mouth of Robeson Channel to the Grinnell Land coast. He pushed on to the Drift point of Beaumont (and later of Lockwood), a short distance west of Black Horn Cliffs, and on April 27 reached the ice-foot beyond the cliffs. Up to Cape Stanton they had to hew a road, but afterward the going was better to Cape Bryant, where, after a long search, they discovered the remains of Lockwood's cache and cairn. Three marches brought them to Cape North, whence a ribbon of young ice took them nearly across Nordenskjöld Inlet, and another strip gave a passage nearly across Mascurt Inlet. Cape Payer was a hard proposition, and Distant Cape was almost equally inhospitable, but there was comparatively fair going as far as Mary Murray Island. On May 8 they reached Lockwood's cairn, at the north end of the island, and from this he took the record and thermometer deposited there 18 years ago by Lockwood. One more march carried them to Cape Washington, and great was his relief to see on rounding it another splendid headland, with two large glaciers debouching near it. He knew now that Cape Washington was not the northern point of Greenland, as he had feared. Leaving Cape Washington they crossed the fjord to the western edge of one of the big glaciers. It was now evident to him that they were very near the northern extremity of the land, and when they came within view of the next point ahead he knew that his eyes at last rested upon the Arctic *Ultima Thule*. The land ahead also impressed him at once, as showing the characteristics of a musk-ox country. This point was reached in the next march. Continuing the journey over the ice they were brought on the 16th to the northern edge of a fragment of an old floe bounded by water, and a reconnaissance showed that they were on the edge of the disintegrated pack with a dense water sky not far distant. The next day he started back for the land and reached it in one march. For three marches they reeled off splendid distances, and reached a magnificent cape at which the northern face of the land trended away to the southeast. This cape was in the same latitude as Cape Washington, and the next two marches carried them down to the east coast to the 83d parallel. Before starting on the return journey he erected a cairn on May 22, which now afforded the most northerly record of man's wanderings. Here Commander Peary showed a photograph of the cairn surmounted by the American flag attached to an oar belonging to the "Windward." In this cairn he deposited a record.

RESULTS OF THE JOURNEY.

After describing the return journey to Conger, Commander Peary said that in this journey he had determined conclusively the northern limit of the Greenland archipelago, or land group, and had practically connected the coast southeastward to Independence Bay, leaving only that comparatively short portion of the periphery of Greenland lying between Independence Bay and Cape Bismarck indeterminate. The non-existence of land for a very considerable distance to the northward and northeastward was also settled, with every indication pointing to the belief that the coast along which they traveled formed the shore of an uninterrupted central polar sea extending to the Pole, and beyond to the Spitzbergen and Franz Josef Land groups of the opposite hemisphere. The origin of the floebergs and palæocrystic ice was definitely determined. Further than this, the result of the journey was to eliminate this route as a desirable or practical one by which to reach the Pole. The broken character of the ice, the large amount of open water, and the comparatively rapid motion of the ice, as it swung around the northern coast into the southerly setting east Greenland current, were very unfavorable features. The remainder of the summer and autumn were spent in hunting expeditions in the region of Discovery Harbor, and on April 5 of the following year Commander Peary left Conger on his northern trip. On reaching Lincoln Bay it was evident to him that the condition of men and dogs negatived the possibility of reaching the Pole, and he reluctantly turned back and reached the Windward at Payer Harbor on May 6. Here the rest of the year was spent.

THE SPRING CAMPAIGN OF 1902.

On March 6, 1902, a start was made from Payer Harbor for the northern journey. Cape D'Urville was left on the morning of the 9th. By varying stages they reached Crozier Island, and left it again on April 6 and climbed down the parapet of the icefoot on to the polar pack. After being in the field a month, they had covered not less than 400 miles of the most arduous traveling in temperatures from —35 deg. to —57 deg. F. The morning of the 7th brought fine weather, and they struggled through the irregularities of the ice (these difficulties were illustrated by photographs) until the 12th, when they were stormbound by a gale from the northwest. In the first march beyond they were deflected westward by open water, but late in the afternoon of the 14th the lead began to close and they rushed the sledges over the moving fragments of ice. They now found themselves in a zone of high parallel ridges of rubble ice covered with deep snow. Beyond they emerged upon a series of very small but extremely heavy and rugged old floes, the snow on them still deeper and softer. At the end of a 16-hour day they were only two or three miles north of the big lead. During the first portion of the next march they passed over the fragments of very heavy old floes, slowly moving eastward, and were frequently obliged to wait for the pieces to crush close enough together to let them pass from one to the other. The difficulties were so great that he wrote in his journal on April 21: "The game is off. My dream of 16 years is ended. It cleared during the night, and we got under way this morning. Deep snow. Two small old floes. Then came another region of old rubble and deep snow. A survey from the top of a pinnacle showed this extending north, east, and west as far as could be seen. The two old floes over which we had just come are the only ones in sight. It is impracticable, and I gave the order to camp. I have made the best fight I knew. I believe it has been a good one. But I cannot accomplish the impossible." When he said "impossible," he meant impossible with the party he then had with him. It was necessary to have a party large enough to send men in advance to reconnoiter and prepare the road. A few hours after they had halted, the ice to the north began to move with a sound like that of a heavy surf, and continued during their stay at this camp. A clear day enabled him to get observations, which showed his latitude to be 84 deg. 17 min. 27 sec.; magnetic variation, 99 deg. W. He took some photographs of the camp; climbed and floundered through the broken fragments and waist-deep snow for a few hundred yards north of the camp; gave the dogs a double ration; then turned in to sleep, if possible, for a few hours previous to returning.

THE RETURN.

They started on their return soon after midnight of the 21st. It was very thick, wind from the west, and snowing heavily. On reaching the last lead of the upward march, instead of the open water which had interrupted their progress then, their tracks now disappeared under a huge pressure-ridge, which he estimated to be from 75 feet to 100 feet high. As a result of the difficulties met with he set a compass course for the land, and began making a new road. In the next march they picked up their old trail again. Early in the morning of April 22 they reached the second igloo out from Cape Hecla, and camped in a snowstorm. At this igloo they were storm-bound during the 27th and 28th, getting away on the 29th in the densest fog, and bent upon butting their way on a "bee-line" compass course for the land. Floundering through the deep snow and rough ice they reached Crozier Island after a long and weary march. As they now had light sledges he risked the short cut across the base of Feilden Peninsula, and camped that night under the lee of View Point. Four more marches carried them to Conger, where they remained three days, drying clothing and repairing sledges and giving the dogs a much-needed rest. Leaving Conger on May 6 eleven marches brought them back to Payer Harbor on May 17. On August 5 the new "Windward" sent north by the club, and bringing Mrs. Peary and his little girl, steamed into the harbor. As soon as people and supplies could be hurried aboard her she steamed across the sound to the Greenland side. Here his faithful Eskimos were landed, and, after devoting a week or so to the work of securing sufficient walrus to carry them in comfort through the winter, the "Windward" steamed southward, and, after an uneventful voyage, arrived at Sydney, C. B., on September 17, after an absence of four years, three months, and ten days.

THE FUTURE.

In conclusion, referring to his future plans, Commander Peary said he hoped, if all went well, to start north next July, and if the season was favorable he would have his ship by September 1 on the northern shore of Grant Land, near the "Alert's" winter quarters. Wintering there, he would start with the first of returning daylight in the following February to make a journey across the Polar pack to the Pole and back again. The average air line from start to finish of those four journeys of his was a trifle longer than that from the northern shore of Grant Land to the Pole. To reach the Pole was an object worthy of the utmost effort. Its attainment would be the sign of man's conquest of the globe.

The lecturer was listened to with great attention throughout, and was frequently applauded.

UNIVERSITIES: THEIR AIMS, DUTIES, AND IDEALS.*

VARIETY OF TYPES OF UNIVERSITIES.

One remark of a general kind must be made before proceeding to a synthesis of the purposes of universities. It is a platitude, yet not unimportant, to the effect that they will not be (and cannot be expected to be) uniform in character. Old universities have their traditions, sometimes the growth of centuries; and though they have to review their ideals from time to time and to revise their practice to meet the challenges and the demands made by the growing needs of the nation, changes are made only gradually, and the main character tends to persist through the changes. On the other hand, new universities arise in response to new demands of diverse kinds, and their character is bound to be shaped by their origin, their circumstances, and their growth. In the later Middle Ages, the philosophy of the schoolmen yielded before the onset of the study of the humanities—a study which has largely determined the character of our oldest universities. The physical sciences, by their growth during the last century, have modified the range of education and have influenced profoundly some of the older universities, while they have had no small share in dominating the form of newer foundations. The needs of applied sciences and practical sciences in our own day are stirring ideals of education widely removed from those that reposed upon the humanities, and they are leading to the establishment of learned institutions of types hitherto unknown. Sometimes between one university and another, sometimes within the limits of a single university, there will be what is almost a struggle among the subjects in their historical assignment to courses of study. Fundamental questions are being

* Part of an address to the Southport Literary and Philosophical Society, delivered on September 17 by Prof. A. R. Forsyth, F.R.S.

asked. Should the study of modern languages displace that of the ancient languages? Will applied science diminish the attention paid to pure science? Will practical needs direct the study of applied science? Must the acquisition of so-called useless knowledge be renounced in favor of so-called useful knowledge? Can it still be possible to maintain the process of a liberal education in the presence of the demands for technical instruction and commercial instruction? These and many other questions will arise in practically every university. They must be answered when they arise, and the answers will vary, perhaps from time to time, certainly from body to body. Yet diversity of character, of circumstances, and of practice, will not exclude a certain community of spirit and a certain similarity of obligation.

WHAT IS A UNIVERSITY?

What is a university? Is it a building, or a set of buildings? Is it a federation of schools? Is it an aggregation of faculties? Is it a corporation of individuals, formally devoted to a common purpose? Is it an examining body with power to grant degrees? In each of these senses, and doubtless in several others, the word university has been vaguely used at different times and of different bodies. In its earliest use in regard to the kind of institution under consideration, a university appears to have been a sort of scholastic guild; there were societies of masters, as there were societies of students, and each of these was called a university. There were two places where these guilds grew into greater importance than elsewhere at the close of the twelfth century; one was Paris, mainly a university of masters, the other was Bologna, mainly a university of students. Indeed, so supremely important were these two universities, even while they were so distinctively different in character, that most of the older European universities have conformed to one or other of these types in many (if not in most) essential features. Thus Oxford and Cambridge are modeled on the master university of Paris; it is the graduates who have the power of electing the acting chief of the university. On the other hand, the ancient Scottish universities are modeled on the student university of Bologna; it is the undergraduates who have the power of electing the acting chief of the university. There have been variations in the detailed developments of the different universities. Most of them had several faculties, though not all of them had the same faculties. Thus Salerno, at the zenith of its fame toward the end of the eleventh century, was simply a medical school (having, it may be mentioned, several women among its teachers and writers). Bologna had a faculty of law only; Paris had faculties of theology and arts; Saragossa had one of arts only. The notion that a university was a school in which all branches of knowledge are represented was one that sprang up later, and had a considerable vogue; this literary society will readily recall Dr. Johnson's description of a university as "a school where everything may be learned." The conception of a university as a center for the cultivation of universal knowledge and the teaching of universal knowledge undoubtedly propounds a stimulating ideal, and the realization of the ideal is as nearly imperative in modern times as anything almost impossible can be. At any rate, I know of no instance in which that conception of a university is justified by actual facts; and there is on record one instance in which the conception was completely falsified by actual facts, in that no teaching of any kind of knowledge whatever was done—the old University of London, now modified into a university that not merely examines, but also teaches.

CHARACTERISTICS.

What, then, should be taken as the working conception of an ideal university? To my mind, it is a corporation of teachers and students, banded together for the pursuit of learning and the increase of knowledge, duly housed, and fitly endowed to meet the demands raised in the achievement of its purposes. In the prosecution of its academic aims, the university should be free from all external censorship of doctrine; it should also be free from all external control over the range, or the modes, or the subjects, of teaching. Above all, thought should be free from fetters of official type; whether political, from the State; or ecclesiastical, from the churches; or civic, from the community; or pedantic, from the corporate repressive action of the university itself. In its establishment, the amplest powers that wisdom can suggest should be conferred upon it. In working out its intellectual salvation, the exercise of those powers should be vested in select bodies of fit persons, sufficiently small in number to be efficient, yet large enough in number to prevent degeneration into an intellectual clique, changing sufficiently from time to time to prevent the dominance of merely personal policies, and representative enough to be in touch alike with the experience of the past and with aspirations for the future so far as these have taken shape or have acquired definition.

Access to the facilities of the university should be open to all duly qualified persons, without consideration of sex, without consideration of station in life, without consideration of intellectual beliefs, whether theological, political, or otherwise. The university should have the power of requiring both a minimum of qualification and a variety of qualifications to be satisfied by an applicant before admission to the status of student. Some test of qualification had to be imposed upon mediæval students, for Latin, then still something of a living language, was the one language of learning—and workers in science can sigh that it ever ceased to be so. That some test of qualification still is desirable probably is obvious to anyone who accepts my view of what university education should be. In my view, the school should prepare for the university, and education in the university should be, not something distinct from the school education, but rather its development, its amplification, and (on some issues) its complement. Briefly stated, the preliminary training should have been finished, and only those whose attainments show that they are qualified to profit by further training should be admitted to the courses of university study.

QUALIFICATION OF STUDENTS.

As this limitation is important, will you be patient with me while I make a digression from my main topic and indicate the kind of minimum of qualification that I, if an autocrat, should exact in order to have one security (necessary, though not sufficient) that the students shall be not unworthy of a seat of learning? Besides the usual elements of reading, writing, and arithmetic (and I would add drawing to them), his studies should have included subjects that would train and develop some power of expression, some power of reasoning, some power of observation. To give him some power of expression, I would use his own language in the first place, initiating him into the mysteries of grammar and analysis through it alone, giving him some acquaintance with selections from the best of its literature, and, above all, practising him regularly in the art of composition in his own language. Then, after a certain stage, and in order to give him, while still at school, a more accurate literary training, he should be drilled in at least one foreign language, so as to be able to read it with ease and accuracy; the contrast of the two languages in idiom, diction, method, and manner, should emphasize his critical appreciation of his own, and increase, therefore, his control over it. If he can spare time for only one foreign language, my choice would be a modern language; if he can spare time for two foreign languages, let Latin be one of them; if he can spare time for more, he is in the way of being a scholar, and he needs none of my presumptuous directions on this head. To give him some power of reasoning, I would use the elements of mathematics; his algebra should be built upon his arithmetic, without the fatuous artificialities that disfigure text books and examinations, though happily in a lessening degree; above all, he should have a training in geometry, beginning with experimental work so as to familiarize him with the matter, and gradually introducing the processes of geometrical reasoning; and if he can be taught the elements of mechanics, beginning also with an experimental basis, so much the better. To give him some power of observation, I would use some of the experimental sciences; my own choice would be the rudiments of experimental physics or inorganic chemistry. But more than all these are wanted; all the studies thus far prescribed are for the purpose of sharpening his wits, and, in the process, they will develop his intelligence. The latter must be developed also in other ways, and to my mind one of the best of ways is to give him a general knowledge of the history of his country, a general knowledge of the geography of the world, and (if possible) some rudimentary knowledge of the modern history of neighboring countries.

Such a programme provides the elements of a liberal education. A youth, so educated, is ready for the technical training now needed for so many of the occupations of life; and even if he does not devote more time to the continuance of his studies, he is provided with the elements of such intellectual interests as should make him an intelligent man and an intelligent citizen. Also, such a programme is practicable for the average boy; no exceptional ability is needed to have completed such a course at the age of fifteen or sixteen. I am not prepared to say that the average boy at any school in England will have achieved this programme before he is sixteen; if I may judge from some not entirely laudatory criticisms that are openly expressed from time to time and remain unrebutted, it seems to be the fact that the average boy at a public school does not achieve such a programme or its equivalent before he is sixteen. But I am optimistic enough to believe that, in the future as in the past, improvements can come even in English education, and meanwhile I am content to claim that the programme of training which has been sketched is not merely possible, but is practicable also, within the time allowed.

GROUPS OF STUDENTS.

Let us assume, therefore, that we have an ample supply of average students who have undergone some not inadequate preliminary training, and, as hopeful assumptions are encouraging, let us further assume that there is more than a sprinkling of students with abilities well above the average. In coming to our ideal university, which is eager to receive them, the students are actuated by varied kinds of needs and desires. Some—many of them, I should like to think—mean to devote themselves to one or other of the different forms of practical business, not intending to use their university education professionally, but preparing to take their part in maintaining and elevating the tone of the community. All the professions and callings, whether learned or technical, are to be recruited from among the students when once they have been trained. Some have the intellectual ambition, more or less defined as yet, ultimately to devote themselves to a life of learning in their own university by preference, yet, if not there, then in some other. There are men intent upon the ministry of religion; there are men intent upon the public service of the State. Last in this enumeration, there are the men of genius, as yet unproclaimed, who are to find in the university that training which will gradually reveal to them their powers, and that stimulus which will inspire them to the highest service of mankind as the discoverers and the thinkers of their generation. To all these men the university must give the means and the opportunities of obtaining the knowledge adapted to their several intellectual needs.

SPIRIT OF UNIVERSITY TRAINING.

Of course, every person would be prepared to acknowledge that a university education includes more than even the most industrious and praiseworthy absorption of knowledge, and much of the influence of a university depends upon the spirit and the circumstances in which knowledge is given and received. There is an education of character as well as of mind, and the two can be achieved simultaneously by the due conduct of studies. Thoroughness must be the dominating quality in every study; difficulties which arise must be solved, not evaded; proofs must be sternly examined and only accepted if found valid and clearly comprehended; truth, and not merely comfortable or convenient doctrine, must be the object of search; and all must be done in a spirit that would scorn dishonesty or shuffling about the affairs of the mind as contemptuously as one scorns dishonesty or shuffling about the property of one's neighbor.

Nor is it less important that the imagination should be stimulated. Some stimulus will come from every study, honestly and thoroughly pursued; according as it is greater or less, so is the greater or the smaller advantage to the student—not then alone, but throughout his life, as affecting his power, his influence, his usefulness. Above all, it is important to have what may be called the play of intellect between the teachers and the students, and, more particularly, in all liberty among the students themselves; it makes for force of character, for steadiness of character, for command over powers, for fairness, for soundness of judgment, for proper confidence in one's self, for proper consideration for others, for toleration, for knowledge of men, and for the seriousness of life. This phase of education is more important than mere instruction, and a university in which it is not secured provides but a maimed and stunted education. It stirs, it moves, it creates, the sentiment felt to the university; its operation has something of the air of spiritual romance, something also of elusive mystery. It cannot be secured by regulations or endowments; it is a product of the spirit of the place and the spirit of the time, difficult to establish as a custom, a treasure beyond value when once established as a tradition.

Each university in its own manner must evolve its own method of establishing this influence; the utmost that its formal regulations can achieve is the due provision for the intellectual needs of all classes of students.

RANGE OF INSTRUCTION.

To discharge this duty, fraught with issues so grave to the good of the community, one necessity for the ideal university is that her courses of possible instruction should cover the whole field of human thought and intellectual activity, so that she can take her part in the diffusion and the extension of knowledge. She should possess such a collection of teachers that a student could obtain instruction in any department of knowledge, and could be trained in the use of any method by which knowledge is obtained. All sources of knowledge must be open to all students as they want them; all aids to learning must be provided. She must foster the liberal studies where "nothing accrues of consequence beyond the using;" she must foster the useful studies where the revenue to be produced is of essential consequence. In every art, in every science, in any study which is neither an art nor a science, the spirit of inquiry should be encouraged; and the only dogma permitted to the teacher should be his guiding advice based upon knowledge and experience.

To those who are acquainted with the working of actual universities, my claims may be deemed excessive. But it is to be remembered that I am dealing with an ideal university, and there is no doubt that, in this form of human activity as (I imagine) in all other forms, working practice will be derived from the too lofty ideal by the omission of some of its constituents. Moreover, the omissions may reflect the wishes, the preferences, even the prejudices, of the founders and the supporters; they may also be some index of the neediness of the university in actual work. Whatever their cause, they will tend to vary from one center to another, and thus each working university will acquire its individual character, and monotony of character will be avoided.

Making this passing concession to the limitations that inevitably cramp the initial stages of great undertakings and sometimes shallow their whole course, let me return to my ideal university where all departments of knowledge are represented, and attempt some classification of these departments so as to give greater clearness and precision to some of its activities. They are set out in the order in which they arose naturally to me when considering them—no other significance, either of preference or importance, is implied in the order.

POSITION OF THEOLOGICAL STUDIES.

As a preliminary let me deal with a matter which must be settled in the case of each university specifically and particularly—the attitude toward theology. The older among our foundations include its study within the curriculum; the tendency of most of our new foundations is to exclude its study. My ideal university is to make provision for every department of knowledge, and, as theology is undoubtedly a branch of knowledge, she must make provision for the teaching of theology. But in my university, thought is to be free from all fetters of official type, including those imposed by the

churches, and the spirit of inquiry is everywhere to be encouraged. These conditions exclude all that part of theology which is expounded definitely on the basis of dogma, and, so far as I can see, admit all else. Thus dogmatics, apologetics, pastoral theology, would be excluded; exegesis, ecclesiastical history, the characteristics and distribution of religions, and the history of religion, would be included. Provision would have to be made for the teaching of these latter subjects, and it is more than probable that each of the teachers would have some definite dogmatic position. But of the intrusion of dogmatic views into the exposition of the retained subjects I am no more afraid than I should be of the intrusion of party politics into the academic exposition of history or (what is to be stirred into passionate interest in England in the very near future) into the academic exposition of economics. Nor to my mind is there any arbitrary quality in the action which would include a portion of theology and leave the rest to be obtained presumably in some theological school of the appropriate dogmatic hue. My ideal university is to include the whole field of human knowledge; but it is not to include everything based on human belief or beliefs, any more than it is to include everything based on human activity, and I do not require it to make provision for the whole training of a dogmatic theologian any more than to make provision for the whole training of (say) a surgeon or an engineer.

(To be continued.)

HEAVY GOODS ENGINE FOR THE BENGAL-NAGPUR RAILWAY.

The engine we illustrate represents one of seventeen heavy goods engines which have been designed and constructed by Robert Stephenson & Co., Limited, of Darlington, under the supervision of Sir John Wolfe Barry, the consulting engineer to the company, for the Bengal-Nagpur Railway. The boiler, which is specially large, has a Belpaire fire-box, and its dimensions are ample to provide a good allowance of heating surface, grate area, and steam space. The cylinders have ordinary slide valves, and, as will be observed from the illustration, the piston rods are carried through the front covers. The second pair of wheels are the drivers, and have no flanges. The valve gear is of the Stephenson link type, the link being lifted at the middle, and the valve-rod cranked over the leading axle. The reversing is effected by means of a steam and water cataract cylinder working horizontally and placed inside the frames. The boilers are of steel plates, with copper fire-boxes stayed with copper stays, and the tubes are of brass.

The following are the principal dimensions:

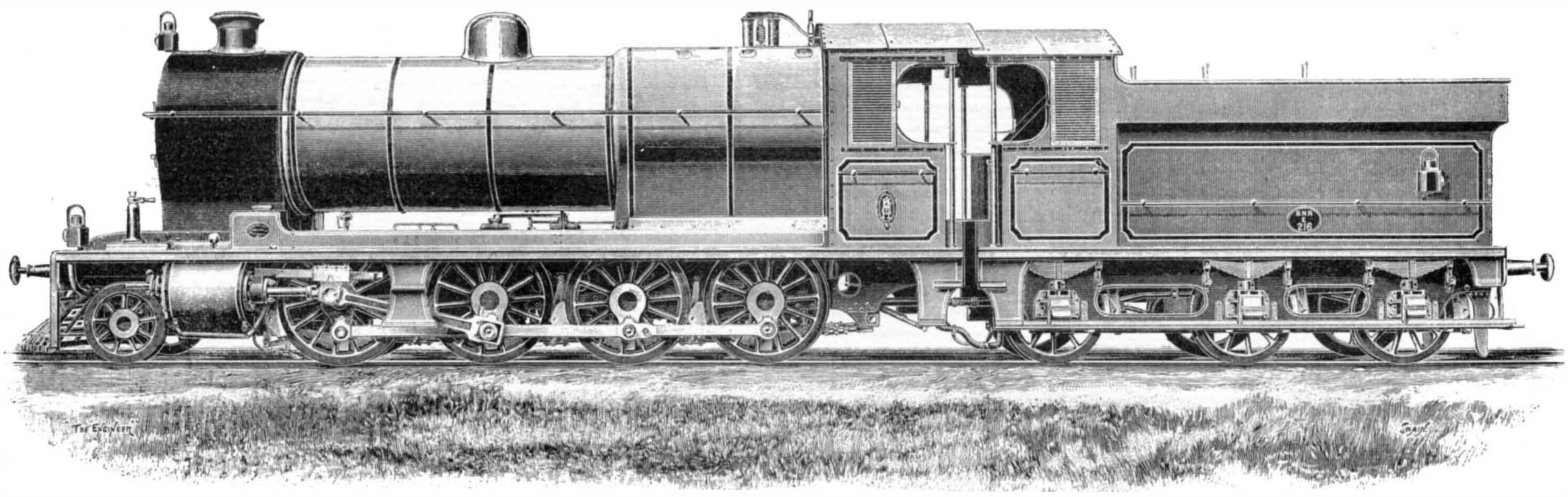
Cylinders, diameter ....21 in.
" stroke ....26 in.
Driving wheels, diameter ....4 ft. 8 in.
Bogie wheels, diameter............. 3 ft.
Wheel base—
Fixed ....16 ft.
Total ....24 ft. 2 in.
Engine and tender, total...........48 ft.
Boiler barrel, mean diameter.........5 ft. 7¼ in.
" length ....12 ft. 6 in.
Thickness of plates ....⅝ in.
Fire-box—
Length of outside shell.............8 ft. 8 in.
Width at bottom, outside...........4 ft. 9 in.
Depth at front, 5 ft. 4 in.; copper box, depth front inside..........6 ft. 7 in.
Depth at back, 4 ft. 8 in.; copper box, depth back inside...........5 ft. 11 in.
Thickness of plates—
Shell, front ....11-16 in.
" back ....⅝ in.
" top and sides ....⅝ in.
Inside box, tube plate at tubes.....1 in.
" " below tubes..⅝ in.
" back plate ....9-16 in.
" top and side plates....9-16 in.
Smoke-box tube plate ....15-16 in.
303 tubes, diameter outside.........2 in.
Heating surface—
Fire-box ....173 sq. ft.
Tubes ....2,062 sq. ft.
Total ....2,235 sq. ft.
Grate area ....32 sq. ft.
Height of boiler, center from rail.....8 ft. 9 in.
Working pressure ....180 lb. per sq. in.
Gage ....5 ft. 6 in.

The tender has six 3-foot 8-inch diameter wheels, and carries 3,500 gallons of water and six tons of coal.

The distributed weights of the engine and tender are:

	Tons.	Cwt.	Qr.
Engine.			
Bogie	7	13	0
Leading	14	3	0
Driving	15	3	0
Intermediate	15	1	0
Trailing	15	2	0
Total, in working order	67	2	0
Tender.			
Leading	12	13	0
Intermediate	13	3	0
Trailing	14	10	0
Total, in working order	40	6	0
Total, engine and tender in working order	107	8	0

—The Engineer.



HEAVY GOODS ENGINE FOR THE BENGAL-NAGPUR RAILWAY.

LOCOMOTIVE TESTS AT ST. LOUIS.

The plan and scope of the locomotive testing plant to be established by the Pennsylvania Railroad at the St. Louis Fair is described in part in the following bulletin:

The Pennsylvania Railroad Company will design and cause to be constructed a suitable plant for testing locomotives, and in co-operation with the Department of Transportation Exhibits, will install the same at St. Louis. The plant will be ready for preliminary running by the first of March next, and in perfect running condition by the first of May, at which time formal work will commence. The purpose of the whole work is to be comprehensive, and the endeavor will be to determine by the use of locomotives presenting different characteristics, the effect of the latter upon the economic performance, and the limits of the tractive power and boiler capacities.

The Pennsylvania Railroad system will organize and maintain, under the direction of its engineer of tests, a staff of laboratory attendants and computers, to the end that the plant and the locomotives thereon may be safely and properly operated and the experimental data promptly handled. It will also provide supplies of fuel and oil, and will meet all other fixed charges incident to the progress of the work.

It is planned to test twelve different locomotives, and it is hoped that a portion of this number can be of foreign design and construction. The time to be allowed to each locomotive will vary from twenty to fourteen working days, the longer time being allowed those which are tested early in the season, when both men and equipment will be new to the work.

The Pennsylvania Railroad Company will supply for all participants two grades of coal of high quality, one an anthracite and the other a bituminous. The quality of each of these grades will remain unchanged throughout the progress of the work.

It is proposed to make from sixteen to twenty formal tests of each locomotive put upon the plant, these to be preceded by one or more preliminary runs for the purpose of checking the valve setting, and of proving all accessory apparatus.

Each formal test will involve a run of approximately one hundred miles, and throughout its duration the speed, load, steam pressure, and other conditions of running will be maintained, as nearly as possible, constant. The conditions represented by the several tests upon each locomotive will be so chosen that the results will fall into sets, and when so plotted will serve to disclose the performance of the locomotive under the full range of speed and cut-off for which it can be properly worked.

Methods to be followed in running a test: In preparation for a test the locomotive will be started and gradually brought to the conditions of running which are to prevail throughout the test. When these conditions have been secured the preliminary running of the locomotive will be continued until the rate of firing becomes uniform, and until all portions of the locomotive have become warmed to their work. When these conditions have been secured two strokes of a bell will give a preparatory signal. Thirty seconds later a single stroke of the bell will mark the beginning of the test. Upon this stroke all water levels will be observed, the ash pan cleaned, and all observations taken, and thereafter all water and fuel used will be taken from a weighed supply. Throughout the test all conditions of running will be maintained as nearly constant as possible, observations being taken on the stroke of the gong at ten-minute intervals. The duration of the test will vary from two to six hours, depending upon the rate of speed and load. The element of control in fixing the length of the heavy power test will be the amount of water evaporated, no test being ended until the evaporation equals thirty pounds for each square foot of heating surface. The lighter power tests may end after from four to six hours.

A test will be ended as it began. The fire which throughout the test will not have changed greatly in its condition, will be brought as nearly as possible to the condition it had in the beginning, the ash pan will be cleaned, the water level in the boiler be made to agree with that of the beginning of the test, and upon signal the final observations will be taken, and the use of water and fuel from a weighed supply will cease. As soon as practicable after this the locomotive will be stopped, the front end cleaned, and the data of the test collected and made of record.

A test will be started not earlier than eight o'clock on each day, and when the conditions are such as will permit them to be of short duration, two tests may be run on the same day.

FIRST STEAM ENGINE IN AMERICA.

The first steam engine in America was imported in 1753 by Col. John Schuyler for use in pumping out his copper mine opposite Belleville, near Newark, N. J. This mine was rich in ore and was discovered by a curious chance. One of the Schuylers was plowing in a field when his negro slave found a large stone that was unusually heavy. His master saw that it contained copper and sent it to England for inspection, where it was pronounced 80 per cent copper. Upon receiving the report Schuyler gave his negro his freedom and granted him three wishes. The old darkey scratched his head and for the first wish chose to live with his master and have all the tobacco he could use; for his second wish, a dressing gown with brass buttons, like his master's; and for his third wish, more tobacco.

Col. Schuyler's mine had been worked as deep as hand and horse power could clear it of water. Its proprietor, having heard with what success steam engines, then called fire engines, were used in draining the mines of Cornwall, determined to have one in his own mine. He accordingly requested his London correspondent to procure an engine and to send out with it an engineer capable of putting it up and running it. A Hornblower engine was, accordingly, ordered, and Josiah Hornblower, one of the sons of the builder, became interested in the machine and came over to erect and operate it, expecting to return later. The voyage was a long and perilous one, and Mr. Hornblower's services proved so satisfactory that the proprietor induced him to remain—all the more willingly, probably, because the American girl had proved as attractive to him as she has to many other men from foreign lands, the girl in this instance being a Miss Kingsland, whom he married.

Josiah Hornblower's father whose name was Joseph, had been engaged in the business of constructing steam engines in Cornwall from their first introduction in the mines there, about 1740; and had been an engineer and engine builder from the first use of steam engines in the arts, about 1720. The engines constructed by him and his sons were Newcomen engines, or Cornish engines, using steam at atmospheric pressure. There was an immense wooden walking beam, with a segment at each end from which hung chains, the chain from one end attaching to the pump rod and from the other end to the piston rod. The

pump rod descended by its own weight and was pulled up again by the air pressure on top of the piston, the steam having been condensed under the piston by a spray of water, producing a partial vacuum.

At the time Hornblower's engines were built, Watt had not invented his separate condenser, nor discovered the use of high-pressure steam. After 1760 the Schuyler mine was worked for several years by Mr. Hornblower himself.—Machinery.

AN ELECTRIC WATER-BATH FOR INFLAMMABLE LIQUIDS.*

By N. MONROE HOPKINS, Ph.D.

IT has often been necessary for the writer to distill small quantities of such inflammable liquids as ether, gasoline, benzene, naphtha, etc., and for this purpose, vessels of boiling water were employed, the water being heated in a distant part of the laboratory or adjoining room, because of the danger of a free flame in the proximity of such bodies as those enumerated.

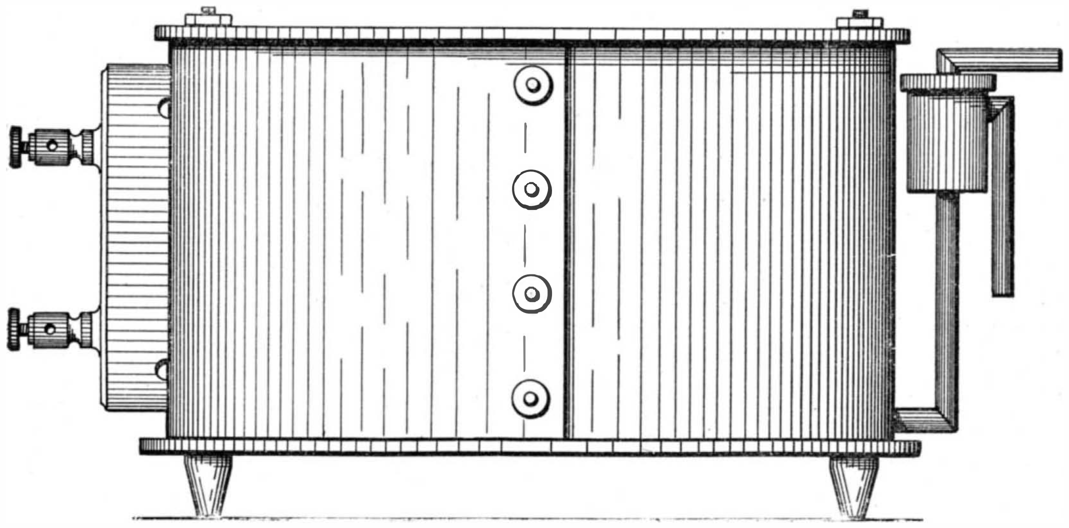


FIG. 1.—SIDE ELEVATION OF ELECTRIC WATER-BATH, SHOWING CONSTANT-LEVEL ATTACHMENT AT THE RIGHT AND THE PORCELAIN CLEAT CARRYING BINDING POSTS AT THE LEFT.

For purposes of fractional distillation, this plan of carrying water heated at a distance was not at all applicable, or even possible for the attainment of good results, and it became necessary to design and construct a piece of apparatus suitable for the purpose.

Believing that there are others who would be interested, and who would profit by a simple and easily-constructed electric water-bath, the following directions for its making are given.

It has also been a very frequent duty to instruct students in the practical determination of the molecular weights of volatile liquids, and the use of a reliable water-bath meeting the requirements of this work was kept in mind at the time of its design. The accompanying drawings illustrate the water-bath in elevation, section, plan, and operation respectively, the latter with a Victor Meyer apparatus for the determination of vapor densities.

Fig. 1, showing a side view indicating rivets, makes the initial step in the construction clear. A piece of thin sheet brass—almost any light weight of brass will answer—is cut in a strip 3½ inches wide and about 21 inches long. This strip is carefully bent to cylindrical shape around any convenient form, and is riveted up the side with copper rivets, with the end edges so adjusted as to give a diameter of 6¾ inches. Of course, if bending-rollers are at hand, the cylinder can be rolled to exact shape and size, but they are not absolutely necessary, although they do prettier work than may be done simply by bending around a form.

The bottom of the heater consists of a solid brass plate 7¼ inches in diameter turned out on a lathe from brass about 1-16 inch thick. Of course, a little lighter or a little heavier brass will answer, although 3-16 was the thickness employed by the writer in the construction of the water-bath of which this is a description. For the top, a second disk of brass is required like that employed for the bottom, but with a circular opening cut out on the lathe with a diameter of 4¾ inches.

At a distance of ⅜ inch from the outer edge of this top plate, or ring, four holes are drilled equidistant, for the accommodation of ⅛-inch brass rods, which, as indicated in Fig. 2, connect the bottom base plate to the top ring, clamping them against the cylindrical shell, which depends upon them for being held in position after the whole apparatus is finished. These rods are tapped with screw threads at both ends, upon the bottom of which the feet are screwed, and on the top small brass nuts are placed, by means of which the work is drawn together. With this construction the water-bath may be easily taken apart, should it be necessary to make a repair to the heating coil, etc. A second strip of the thin sheet brass is now cut for the water-well, which must measure 3½ inches in width by 15 inches long, and be either bent around a form of cylindrical shape, or be bent to shape and size in tinner's rollers. The diameter of this well is 4¾ inches, and must be most carefully soldered to insure a watertight vessel. A piece of light sheet brass is now cut out with the shears to a disk measuring 5 inches in diameter, to be soldered on, forming the bottom of the well.

The water-well when completed is then securely soldered to the underside of the top ring, from which it hangs as shown in the drawing. The small brass pipe, which must have an internal diameter of at least ⅛ inch, is soldered into the bottom at the center of the water-well as indicated, the pipe being cut and filed to an angle of 45 deg., and then soldered to a similar piece in order to make a simple "elbow" bend.

Some thick asbestos is now placed on the bottom, leaving a space for the pipe to run in as shown, and the water-well is well insulated and covered by bending around its outer wall a piece of asbestos board at least ⅛ inch in thickness, and tied for the time being with linen thread as securely as possible. It now remains to cut out eight asbestos rings for separating the various layers of the heating coil, and to make this coil out of German-silver wire. The drawing shows the section through these asbestos rings, making their position and arrangement clear, also the heavy piece of asbestos, which in turn is bent around the outside of these rings like a shell, which when the coil is put in, holds everything securely in position.

This heavy outside asbestos shell may be bound on securely by either wire or thin brass bands, but if bands are used they must not be soldered, but be fastened by cleating.

The coil consists of just 90 feet of No. 22 gage German-silver wire wound tightly around a ¼-inch iron bar in the lathe under considerable tension. It will require a bar 4 feet long to take this 90 feet of wire, wrapped tightly, each convolution in contact with each adjacent convolution.

For our coil, after winding this wire upon the bar, it must be slightly pulled out, that is, stretched until the respective convolutions of the wire do not touch their neighbors. This coil, now in the form of a spiral spring, is wound around the well over the asbestos insulation, and an asbestos ring is placed between each layer. This spiral winding must be put on under considerable tension, so when it heats up it will not expand enough to throw the different convolutions in contact, and also to hold the asbestos insulating shell securely in position, for the lined thread will eventually be charred through. The water-bath is most easily completed from this point. A very convenient terminal insulating block consists of an ordinary porcelain electric-light cleat designed for separating electric-light wires in buildings. Two binding posts with machine screws long enough to go through the porcelain cleat and shell of the water-bath, with about ¼ inch to spare, are necessary. Either mica or asbestos, or both, serves to make the insulating washers for the screws of the binding posts which hold in position the porcelain cleat. In the present heater both mica and asbestos were used, over which large copper washers were passed, to prevent the small head of the screws from pulling through in case the water-bath is ever picked up by the porcelain cleat.

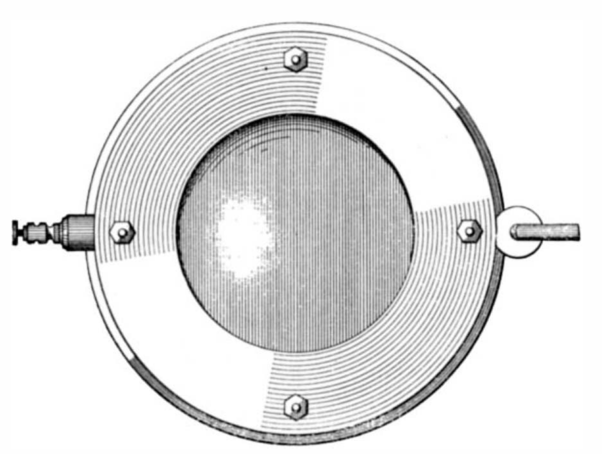


FIG. 3.—TOP PLAN OF BATH, SHOWING TURNED BRASS RING BOLTED ON STAYS RUNNING TO THE BRASS FEET AT THE BOTTOM.

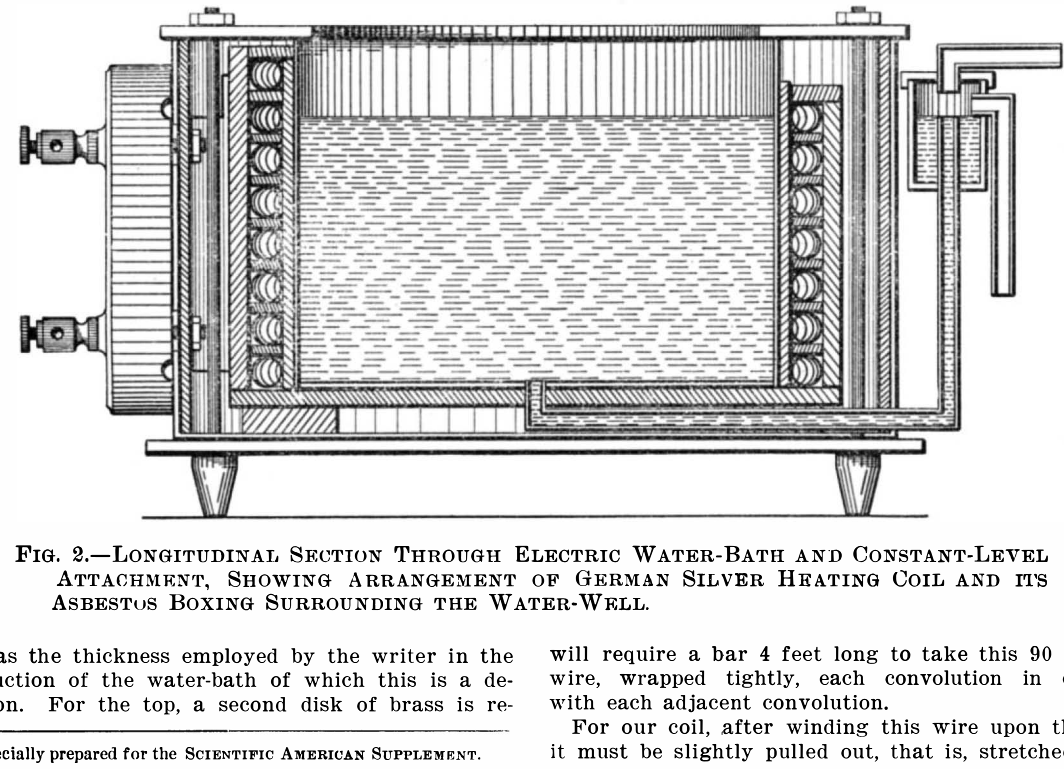


FIG. 2.—LONGITUDINAL SECTION THROUGH ELECTRIC WATER-BATH AND CONSTANT-LEVEL ATTACHMENT, SHOWING ARRANGEMENT OF GERMAN SILVER HEATING COIL AND ITS ASBESTOS BOXING SURROUNDING THE WATER-WELL.

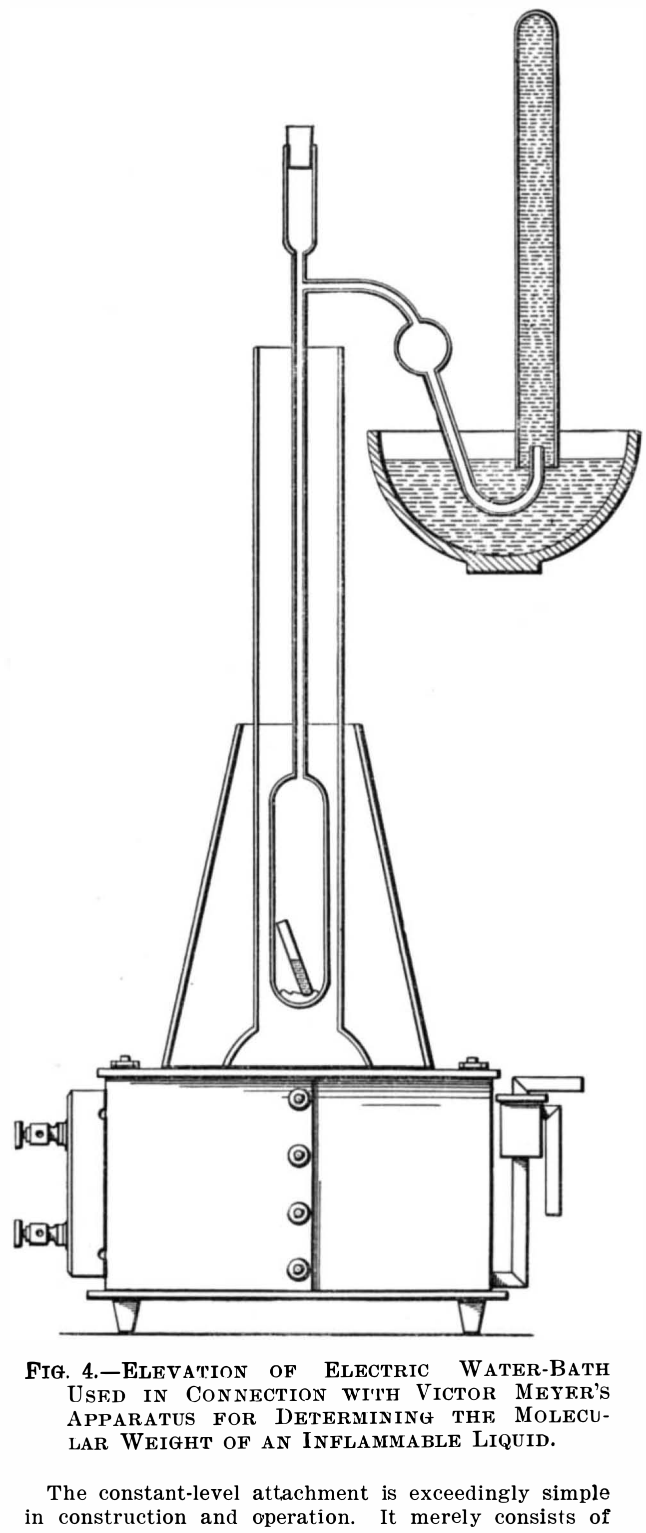


FIG. 4.—ELEVATION OF ELECTRIC WATER-BATH USED IN CONNECTION WITH VICTOR MEYER'S APPARATUS FOR DETERMINING THE MOLECULAR WEIGHT OF AN INFLAMMABLE LIQUID.

The constant-level attachment is exceedingly simple in construction and operation. It merely consists of a little turned brass box or cylinder mounted as illustrated on the top of the pipe running from the bottom

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

of the water-well, which little box is provided with an intake pipe on top and an overflow pipe at the side. The intake pipe is connected by means of rubber tubing to the water supply, which of course need only be a small stream, enough to more than supply the water for that converted into steam and carried off.

Fig. 3 illustrates a top view of the water-bath, looking down into the well and on to the top of the constant-level attachment.

The last illustration shows the use of the water-bath in connection with a Victor Meyer apparatus for the determination of vapor densities, etc. It may be said that this little equipment may be connected direct without any intervening resistance to a 110-volt lighting system, the 90 feet of No. 22 gage wire offering just enough resistance to admit about five amperes, which brings water to the boiling point in the well in about five minutes from the time the switch is thrown. It is needless to state to those familiar with electrical practice that the switch for cutting in and out this water-bath must be designed for a current of five amperes, the maximum taken by the coils of the heater, and that the switch must be placed at a distance if the distillation of such liquids as benzene, gasoline, etc., is to be carried on. Do not connect this water-bath to an ordinary incandescent lamp socket and attempt to turn on and off by the key. Lamp sockets are only intended to switch on and off currents of from ½ to 1 ampere, and a 5-ampere current would establish an arc across the short break gap made by the key switch, which would burn off the thin brass "tongue" forming an arc, which it might prove difficult to extinguish. You cannot injure the heater if you keep the well full of clean water with the constant-level attachment properly connected to a spigot. The writer has had in use such a water-bath for about two years, and it has not even been necessary to make a repair. The heater may be joined direct to the lighting mains, and where the temperature is not desired to rise to the boiling point, some resistance may be put in series, thereby the temperature may be regulated to meet any requirements.

Chemical Laboratories of Columbian University, Washington, D. C.

Prof. Hildebrandsson, director of the Upsala Observatory, speaking in French, gave before the British Association an excellent résumé of what thirty years of cloud observations and other investigations have taught us concerning the general circulation of our atmosphere. He explained his discourse by a large number of slides, illustrating chiefly the cirrus drift at different levels during the course of a year, as observed all over the globe. Cloud observations had been initiated by Clement Ley in 1872, who learned from 600 observations that the air of the upper strata moved in general away from the center of a depression. In 1878 Prof. Hildebrandsson organized the meteorological service in Sweden. Up to that time little was known about the higher atmosphere, and we had believed with Halley (1683) that there was always a wind from the equator with a counter current from the poles, and with Hadley (1733) that any air current was in the northern hemisphere deflected toward the right by gyration. Before the British Association meeting of 1857 James Thomson then expounded his theory which had so long figured in text-books: The hot air rises in the calms of the equator, flows off toward the poles, and returns as lower, colder current; the predominating southwesterly winds of our latitudes were explained by a kind of reaction current. Ferrel had given us three theoretical circulations, the last in 1889, based substantially upon J. Thomson. But it was difficult to conceive three regular currents in an atmosphere which formed a comparatively very thin layer of vast extension.

We know now that in the tropics the wind is in all altitudes from E. to W. all the year round. Above the trade winds is superposed a counter trade wind blowing from S. W. in the northern hemisphere (N. W. in the southern, as known from 3,000 observations during twenty years on Mauritius); this counter trade wind does not extend beyond the polar limit of the trade winds, but is more and more turned into a wind from W. in the higher northern latitudes. The trade winds themselves, and the high-pressure areas which caused them, have an annual oscillation, displacing themselves with the sun in the northern hemisphere; thus a large belt north of the equator is in winter covered by the N. E. trade, and in summer by the calms or tropical E. winds. As regards the temperate zones, Marc Dechevens had shown in 1895 that the general drift of the upper clouds was always from W. to E. in China as well as in Europe. The upper monsoons of Asia are simply thin strata which do not exist at elevations of 4,000 or 5,000 meters, and above them is the great polar whirl from W. to E. This great whirl embraces the whole temperate zone, and the air moves in it as in a cyclone, approaching to the center below, and receding from it above. We have no clouds above the cirrus, but balloon observations are in accord with these views. T. de Bort's balloons dropped to the right of the cirrus drift, showing that at the greatest height attained (18 kilometers) there was a current to the east with a northerly component which increased as we got higher. The current from the south of J. Thomson and Ferrel does not exist, therefore, below altitudes of 15 and 18 kilometers, and the mass of air above that level is very small. The idea of a vertical circulation and of equatorial and polar currents must hence be abandoned; it has created enough confusion. The air pressure is high in the tropics, and diminishes continuously as we approach and enter the polar circles. About the pole we have a vast whirl of the nature of a cyclone, fed from two sides by the counter trade wind on the south, and by a current from the N. W. on the northern side. This is confirmed by observations about the 40th deg. of latitude all round the globe, where the mean cirrus circulation is from the N. W. The irregularities of the earth's surface, especially in the mountains of Asia, disappear already at the level of the lower and intermediate clouds.

ENGINEERING NOTES.

The list of the principal train accidents which occurred in the United States in the month of August includes twenty-seven collisions, twenty-six derailments, and six other accidents. Thirty-six persons were killed and 193 were injured.

The Italian organ Il Secolo announces that according to the latest estimates the opening of the Simplon Tunnel will take place in December, 1905, or four months before the expiration of the extension of time which was granted the contractors. At this moment experiments are being made with locomotives between Lausanne and Brig. These trials have shown so far that the route between these two towns will not be covered in less than two hours and forty-five minutes. Therefore, the entire distance between Paris and Milan will be covered in only fifteen hours.

In order to rectify inefficient stoking of the furnaces upon battleships, due to the incompetency or carelessness of the stokers, an ingenious electrical regulator has been devised by Capt. Perroni, the manager of the extensive Ansaldo shipbuilding works at Cornigliano. The features of this contrivance are that the intervals of firing the furnaces and charges are controlled from the engine room by the chief engineer or the officer in charge of the watch, by electrical communication upon indicators. So successful has the device proved, that it is being adopted in a large number of Italian war vessels. Two ships of the British navy have also been equipped for the past nine months with a similar contrivance, and it has proved highly successful in its operation.

One of the large American companies controlling sugar plantations in Hawaii has about 23,000 acres of land, of which about 8,000 are now planted in cane. A large amount of land-surveying work has been required, and 15 miles of roads have been built, the roads being 16 feet wide, with 12 inches of Telford foundation, covered with 6 inches of broken lava. It has also been necessary to design and install transportation facilities for bringing the cane to the mill, and to develop a large water supply. This water supply is obtained by tunneling to intercept the channels of underground streams, the tunnels being 4 feet wide and 5 feet high, with shafts 5 feet diameter. No heavy timbering was necessary, and the tunnels are not lined. There are about 2,000 feet of rock tunnel and nineteen shafts aggregating 400 feet. A supply of 15,000,000 gallons daily is obtained in this way, and the watershed is at a considerable elevation above the cultivated area. The manufacturing plant consumes about 5,000,000 gallons daily in producing 175 tons of sugar, and the balance is used for transporting cane to the mill in wooden flumes or channels. The main flume is 32 inches by 26 inches, with a gradient of 1 in 530, and from it run V-shaped flumes, with sides 14 inches to 18 inches long. The largest flume is 60,000 feet, with a gradient of 1 in 40 for 40,000 feet. The lowest gradients are 1 in 80. The four flumes lead to the mill, and two can deliver 60 tons of cane per hour, which is the capacity of the mill, but three are generally used to prevent delay. In the field cane is packed or hauled to the flumes, but experiments are being made with various systems of aerial wire-rope tramways for this service, the present methods being unsatisfactory and uneconomical. A railway running through the plantation brings down the cane, which is grown at such an elevation as to be beyond the reach of the flume system.

A number of cities in the United States now have steam and hot water distributed from central stations through street mains to offices, residences, etc., for heating purposes, the central stations being generally electric stations generating electric current for light and power, and where the exhaust steam would very generally be wasted if not utilized for the distribution system. The lack of dirt and trouble as compared with coal fires are among the advantages. The city of Indianapolis has three of these systems. The Home Company operates in a district of 2¾ square miles, and has 9 miles of double piping for hot water heating and 13 miles of pole line for electric lighting. The total radiation in service is about 325,000 square feet, the service being almost entirely for residences. The electric plant has a capacity of 250 kilowatts, and the boiler one of 1,800 horse power. The water is heated by exhaust steam, automatically, supplemented by live steam as required, and is circulated through the mains and radiators by powerful pumps. The Marion Company is installing a plant with a boiler capacity of 5,000 horse power, to be enlarged to 10,000 horse power later on, distributing hot water and steam for heating and generating electric current by steam turbines for light, power, and heat. The Merchants' Company operates within the heart of the city, and distributes direct steam heat on the single-pipe system. It also generates and distributes compressed air and electricity, the street system including steam mains, electric wire conduits, and a compressed air pipe. There are at present 16,000 feet of steam pipe and 150,000 feet of conduit, and about 175,000 square feet of radiation are supplied. The temperature in the buildings is controlled by thermostats operating valves which admit or release compressed air to operate the shut-off valve.

ELECTRICAL NOTES.

Of the total, $70,138,147, reported by the Census Bureau as the income from electrical lighting for both private and municipal stations, $50,368,173, or 71.8 per cent, was derived from lighting private dwellings, office buildings, or other business properties, and $19,769,974, or 28.2 per cent, from lighting streets, parks, and public buildings. Of the total amount, $25,481,045, reported as income from arc lighting, $8,460,320, or 33.2 per cent, was from lighting commercial or other private properties, and $17,020,725, or 66.8 per cent, from lighting public places; and of the $44,657,102, reported from incandescent lighting, $41,907,853, or 93.8 per cent, was from commercial or other private, and $2,749,249, or 6.2 per cent, was from public lighting.

Central electric stations have become active competitors for purposes of illumination with plants for the manufacture of gas, but this competition has been neutralized to some extent by the control which, in many instances, gas companies have secured over competing electric stations; yet notwithstanding this and the fact that the gas industry in this country dates from 1806, while electric stations have been in existence only since 1879, the latter industry is becoming the more important. The capital stock and funded debt reported for the 2,049 central electric stations owned by corporations amounted to $627,515,875, and would possibly be a better comparison with the capital reported for gas companies. There were 827 cities and towns in which one or more gas plants were in operation at the twelfth census, and in 1902 there was a central electric station in operation in all except 153 of these places.

Dr. W. Wedding, professor of the Technical College, Berlin, has made a report on some tests he has carried out in order to determine the life and economy of the osmium lamp. In the experiments two groups, consisting of six 37-volt lamps each, were connected in series across a 220-volt circuit. In group 1, for the first 3,132 hours the average life of the six lamps was 2,853 hours, and the average candle power fell from 30.1 to 23.7. The mean consumption per candle power rose from 1.46 to 1.78. After 520 hours the first lamp collapsed, and after 3,724 and 3,940 hours respectively two others gave out, the remaining three still burning after 3,973 hours. In group 2, which consisted of six 25-candlepower lamps, the report gives the average life as 1,479 hours, the candle-power dropping in 2,198 hours from 25.1 to 19.9, and the energy consumption increasing from 1.37 to 1.75 watts per candle power. These excellent results give ground for hope that lamps of this character may be turned out before long in commercial quantities and at commercial prices.

Curie has shown that radium is a constant generator of heat, and now Wien has shown that by a suitable arrangement radium may be made a constant source of electricity. Rutherford has shown that both positive and negative electrons are thrown off by radium, and since the size of the positive electrons is several hundred times greater than that of the negative electrons, all that is necessary to separate them is a sieve which will allow the negative electrons to pass through while it retains the positive electrons. Many substances are capable of acting as sieves in this way—for example, glass. Wien (Phys. Zeit.) inclosed radium bromide in a glass tube into which a platinum wire was fused, and the positive electricity collecting inside was drawn off by this wire. This tube was suspended by a glass thread in a larger tube into which a second platinum wire was melted. The current was found to be of the order of 3×10^{-12} amperes. The radiated masses of the electrons calculated from this current came out for the positive particles 4.6×10^{-17} gramme per second, and 2.9×10^{-20} gramme per second for the negative particles. It is, therefore, totally impossible to determine the radiated masses by weighing. The energy of radiation, owing to the high velocity of the particles, is considerable, being for the positive electrons 60 ergs per second, and for the negative 8.7 ergs per second, from 4 milligrammes of radium bromide.

A new electric lamp (Boem's patent) consists of an incandescent body, requiring preliminary heating to render it conductive, and an electric heater. At starting these are connected in parallel, but are afterward placed in series, so that the heater serves as a resistant to limit the current taken. The heater may be placed within a tubular incandescent body or may itself be luminous; it may be a carbon filament, the lamp being fitted with a closed bulb, which is either exhausted or contains an inert gas. The change of connections may be effected by a hand or automatic switch. Two or more incandescent bodies may be arranged in one lamp for use simultaneously or successively. In one arrangement described two incandescent rods are surrounded by heating coils operating independently; at the middle of the lamp one end of each rod is permanently joined to a supply wire, and one end of each heater to the other supply terminal; the other ends of the rods and heaters are connected with coiled springs, which, when cold, touch contacts connected with the supply terminals, so that the rods and heaters are connected in parallel, but when the springs are heated

they touch one another and connect the outer ends of the rod and heater at each side of the lamp, so that these are then in series.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Colombian Railway Concession to Americans.—A new concession has been granted by the Department of Antioquia to two Americans—Messrs. J. T. O'Bryan and Charles L. Wright—for the construction of a railroad connecting its capital, Medellin, with the lower reach of the Magdalena River and with the Department of the Cauca. The concession has yet to be approved by the central government.

Medellin, notwithstanding its very difficult position for access, is by far the richest city commercially in the country.

The projected line runs from St. Lucia, a town on the Cauca River, along the River Porce to Medellin, a distance of 180 miles, for an adhesion railway with a 2 per cent maximum grade. The railroad is then to continue along the same valley to the head of the Porce, in the district of Caldas, 12 miles from Medellin, and to a termination on the frontier of the Department of Cauca.

The advantages of such a line would be very great, as Antioquia would be given the outlet it has so long desired and which it so badly needs. At present it requires a mule journey of three days to reach the terminus of the present existing Antioquian Railroad, which connects with the port of Puerto Berrio, on the Magdalena River.

This is the remainder of the old Punchard-McTaggart scheme to connect Medellin with the Puerto Berrio. However, the proposed line is regarded as much better for two reasons—the Puerto Berrio scheme has engineering difficulties which would render the construction and maintenance difficult and costly, while the present scheme, it is said, has practically no serious engineering obstacles to surmount.

The thing of greatest importance in comparing these two lines is the matter of the river traffic. The general opinion is that the water supply of the Magdalena is gradually diminishing, and while the causes are not clear, it is evident that the navigation of the river now presents difficulties which were quite unknown fifteen years ago. There are times in the dry season when the navigation is possible only for the smallest vessels, lightly loaded, and then three weeks have been required to make the trip from the coast to Puerto Berrio and Honda.

The new railroad terminates at St. Lucia, on the Cauca—an easily navigable river flowing into the Magdalena, not a great distance from its mouth.

If carried out, this scheme will give an easy outlet for the trade of the Department of Antioquia, the business center of Colombia.

The proposed Buenaventura route, of which I will write later on, seems to compete with this route, but it is a question whether they will act as competitors or whether the two will work to the advantage of both in establishing a network of communication converging from the capital on the one side westward through the coffee regions of Cundinamarca, the pastoral, industrial, and rich districts of the Tolima and Cauca, and from the other side drawing to itself all the commerce of Medellin, Manizales, and other business centers of Antioquia, together with its rich mineral resources, and find a common outlet through the port of Buenaventura.

A summary of the clauses in the concession is as follows:

The concessioners to construct a railroad from St. Lucia, on the frontier of the Department of Cauca, to the frontier of Bolivar.

The concessioners to have a zone of land along the line of the railway up to 50 meters (164 feet) wide, this zone to belong absolutely to said company—free, if the lands be waste; to be bought by concessioners, if private property.

All necessary articles to be introduced free of duty, including such things as medicine, victuals, etc., required by the company.

Concessioners may establish telephone and telegraph lines.

Concessioners allowed, with permission of the government, to transfer their contract to another person or company, but not to a foreign government.

Concession granted for fifty years, after which government has option of purchasing undertaking at a fixed valuation or of continuing concession for twenty-five years, and so on.

Fixes tariff in gold.

On acceptance of contract, concessioners to give bond for not less than £10,000 ($48,665).

This contract may lapse at any time through neglect or failure to carry out any of the obligations of the concessioners or of those who may succeed them. The lapse may be declared ministerially, in which case the undertaking, with all its appurtenances, will pass into the hands of the government. In case of this it is provided that the concessioners or their successors shall receive an indemnity from the government for such sum as may have been invested in the undertaking.

All differences arising over the interpretation of this contract to be decided by tribunals of arbitration constituted in conformity to laws of Colombia.

Distance between rails, 949 millimeters (3.11 feet); maximum gradient not to exceed 3 per cent nor radii of the curves to be less than 70 meters (229.6 feet); etc.—Alban G. Snyder, Consul-General at Bogota, Colombia.

Foreign Trade of German Southwest Africa.—The German Kolonial Blatt (German Colonial Paper) publishes statistical figures regarding the foreign trade of German Southwest Africa in 1902, and adds for a comparison figures showing the traffic of that country since 1897:

Year.	Imports.	Exports.
1897	$1,163,183	$296,726
1899	2,197,995	333,076
1901	2,397,968	295,539
1902	2,039,077	526,688

The total trade of 1902 is larger than any previous year except 1901, but shows a decrease as compared with that year of $127,806. The decrease as against 1901 was caused by reduced importations, which were $358,904 less than in that year, but the exportation increased by $231,098. The largest decrease in imports was in ironware, which, from 5,279 tons, valued at $424,591, imported in 1901, fell to 1,585 tons, valued at $164,934, in 1902. The importation of tools and machinery in 1902 shows a decrease of $68,306. The decrease in the importation of these two kinds of goods finds its explanation in the fact that the construction of the railroad from Swakopmund to Windhoek and of the mole at Swakopmund have been finished. The importation of live stock also diminished considerably, viz., $90,678, and that of carriages and carts decreased by $46,172. Owing to the emigration of the Boers into German territory in 1901, the importation of live stock and farm implements was exceptionally large in that year.

Among the countries from which German Southwest Africa imports her goods, Germany takes the first place, with $1,720,502; Cape Colony, with $256,802, is next; and England, with $44,268, takes the third place.

The increase of the exports by $238,000 is due, in the first place, to the fact that after the cattle plague had been vanquished and the government of the Cape Colony had opened its frontiers the exportation of cattle on a large scale became possible for the first time since the foundation of the colony. Cattle to the value of $243,712 were exported in 1902, against $28,560 in 1901.

Of the total exports, $273,962 worth went to Cape Colony, principally cattle; England, which purchases all the grain produced in the colony, took $168,504 worth; while Germany, taking $84,014 worth, comes third in the list of countries to which the exports of her colony are directed.—Oliver J. D. Hughes, Consul-General at Coburg, Germany.

German Machine Building for Foreign Markets.—United States Consul-General O. J. D. Hughes, of Coburg, Germany, in his annual report for the fiscal year ended June 30, 1903, writes as follows concerning the conditions under which German machine builders hold their place in foreign markets:

For many years German locomotive builders have had an office in Warsaw, but the news comes that it has now been closed in consequence of a lack of orders, this lack arising through instructions on the part of the Russian Ministry of Traffic that State as well as private railways must draw their supplies from Russian factories. In a speech at St. Petersburg last spring M. de Witte stated that the government would take measures to assist the home iron industry. M. de Witte also said that "only an independent industry standing on its own feet and understanding how to accommodate itself to the needs of the country was able to live."

The annual report of the Cassel Chamber of Commerce contains some interesting and significant passages, among others the following:

"Although home orders in 1902 were about a third fewer than in the year 1901, yet the firm of H—— & Son (engine builders) succeeded in avoiding material limitation of labor by accepting orders from abroad at prices which did not cover the costs of production."

The firm in question built for Egypt, Italy, Denmark, Holland, and Servia and took orders for 2,000,000 marks ($476,000) worth of work at prices that left absolutely no profit. Doubtless other German engine-building firms did business abroad on the same terms.

The Cassel chamber further observes:

"The possibility of foreign markets becomes more and more limited, owing to the customs isolation of other countries, which is on the increase. The new tariffs of Russia and Austria impose such duties on locomotives as to render importation almost if not quite impossible. In times of weak home demand, such as prevailed in 1902, the highly developed German locomotive-building industry cannot, however, do without foreign orders if it is to live."

Inheritances in France.—The French government published quite recently some very interesting facts and figures concerning inheritances in France in 1902. The report merits attention because it gives one a good idea of the fortunes of the French people and because it shows the results of two reform measures that have changed methods followed up to quite recent times. One of these provides that in every testamentary disposition of property the real estate shall be set apart by itself and the personal property shall be subject to the inheritance tax. The other creates a standard or scale upon which the tax shall be based before it is imposed. It is as follows: From 1 to 2,000 francs, from 2,001 to 10,000 francs, from 10,001 to 50,000 francs, from 50,001 to 100,000 francs, from 100,001 to 250,000 francs, from 250,001 to 500,000 francs, from 500,001 to 1,000,000 francs, from 1,000,001 to 5,000,000 francs, from 5,000,001 francs on. The purpose of the legislation was to protect the people inheriting the small amounts that so often represent an element of personal labor and again a modest existence, letting the burden fall on persons possessing or inheriting large amounts. By means of this scale one knows not only the number but the size of the inheritances left in France in 1902—363,000, covering a capital of 5,241,000,000 francs ($1,011,513,000), which, after deducting the passive, leaves 4,772,000,000 francs ($920,996,000). Of the 363,000 inheritances, 213,000 do not exceed 2,000 francs and amount altogether to 240,000,000 francs ($46,320,000). The number of inheritances between 2,001 and 10,000 francs was 91,000, covering 534,000,000 francs ($103,062,000); those between 10,001 and 50,000 francs were not more than 39,000, representing 903,000,000 francs ($174,279,000). These show how many persons there are of small capital. Then comes the category of those who might with propriety be called moderate and large capitalists—the classes comprehending those whose inheritances run above 50,000 francs. In this list there are 6,964 inheritances with 477,000,000 francs ($92,061,000) and 27 that exceed 5,000,000 francs ($965,000). Of the $32,810,000,000 that constitute the wealth of the French nation, more than $9,650,000,000 belong to the people of the middle classes who constitute less than one-fifth of the population.

Cigarette Paper Wanted in Greece.—According to the Empros, an Athenian newspaper, the Greek Minister of Finance has issued a call for bids or proposals for furnishing the Greek government with a supply of cigarette paper of different qualities, and copies of the call have been forwarded, through the Ministry of Foreign Affairs, to the diplomatic and consular representatives of Greece in Europe. Bids must be addressed to the Minister of Finance and will be received to December 13, 1903. Cigarette paper is one of the monopolies of the Greek government. The newspaper does not state what amount of paper is mentioned in this call. In 1901 the government received from consumers of cigarette paper over $534,000, and in 1902 $437,000.—Daniel E. McGinley, Consul, Athens, Greece.

An English Floating Exhibition.—The Colonizer (an English publication) of September, 1903, states that a scheme is on foot for the organization of a floating industrial exhibition of British manufactures which is to make a tour of the empire. The plan is to fit out a large ship with samples of all classes of manufactured articles which Great Britain supplies or can supply to her colonies. From fifty to one hundred firms are expected to furnish exhibits, and a representative of each firm will accompany the ship, which, in the course of a six months' voyage, will stop at every important port in the British colonies and dependencies, as well as at ports in Japan, China, and other countries to be selected. It is expected that the tour will begin in the early part of next year.

Danger in Celluloid Doll Heads.—A Leipzig trade paper, in reporting on the recent fair held in that city, speaks favorably of a new line of doll heads, made of tin and covered with celluloid. The opinion is expressed in the paper quoted that this novelty is a desirable improvement, as many lines of doll heads now in the market are composed of celluloid and are of great danger to children, on account of the liability to explosion to which celluloid is subject. The paper says the use of celluloid in the manufacture of toys is making steady progress.—Simon W. Hanauer, Deputy Consul-General, Frankfort, Germany.

Foreigners in German Technical Schools.—According to latest reports, the technical colleges of Germany are attended by 12,384 German and 2,242 foreign students, 43 per cent of the latter being Russians. Some of the German papers are again protesting against the admission of foreigners to German technical seats of learning, fearing it will injure the manufacturing and export trade interests of Germany. It is especially the fear of competition from the United States which causes this cry for exclusion.—Simon W. Hanauer, Deputy Consul-General, Frankfort, Germany.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

TRADE NOTES AND RECIPES.

Composition of Some New Meat-preserving Agents.—Dr. R. Racine gives the following results of his analyses in the Zeitschrift für oeffentliche Chemie:

1. Corning salt: Sodium nitrate, 50 parts; powdered boracic acid, 45 parts; salicylic acid, 5 parts.
2. Preservative salt: Potassium nitrate, 70 parts; sodium bicarbonate, 15 parts; sodium chloride, 15 parts.
3. Gruner's corning salt: Mixture of sodium nitrate, sodium chloride, and sugar.
4. Preserving powder: Boracic acid with sodium chloride and some potassium nitrate.
5. Corning salt, reddening: A mixture of potash, saltpeter, cooking salt, and sugar.
6. Maciline (offered as condiment and binding agent for sausages): A mixture of wheat flour and potato flour dyed intensely yellow with an azo dyestuff and impregnated with oil of mace.
7. Corning salt (warranted to meet the requirement of the German law of 1900): Potassium nitrate, 50 parts; sodium chloride, 20 parts; powdered boracic acid, 20 parts; sugar, 10 parts.
8. Meat-preserving and reddening agent, called Viandol: Opalescent liquid becoming turbid in the air, or sweetish astringent taste and smelling of acetic acid with a specific gravity of 1.0729. Price per bottle containing 800 c.cm., about $1 (4 marks) The preparation was found to be a solution of basic acetate of alumina mixed with a little sugar.

The Conductibility of the Oxide of Copper.—When two telephone wires, covered with a thin layer of copper oxide, are placed in contact, side by side, the current passing through them does not seem to be short-circuited; for the conversation continues to pass along each one without interruption.

If the layer is thick enough, the two wires may be furrowed with alternating currents produced by the magneto-call instruments of corresponding stations without a short circuit interfering with the transmission of the signals. A direct current however, seems to pass through the layer with ease. A phenomenon of this nature was observed last summer upon a telephone line between Paris and Brussels. Upon a contact being established between two wires, said contact extending over ten meters in length, a short circuit was formed.

Under these conditions the telegraph instruments ceased to perform their proper functions, but the telephone messages continued to pass over the same wires without inconvenience or interruption.

Another occurrence of the same sort happened upon branches of the service. The copper wires forming the lines were fixed upon the tops of the poles, while below them were strung a number of galvanized iron wires. Covered with ice, the copper wire sagged down upon the iron wires beneath. Notwithstanding the short circuit thus apparently produced, the telephone did not exhibit any interruption in its action. From this we conclude that a layer of copper oxide possesses a conductibility differing in degree for the direct and the alternating or pulsating currents.—Science, Arts, Nature.

Rouge or Paris Red.—Of all our polishing materials, that one which is acknowledged as the best is rouge or Paris red. It appears in commerce in many shades, varying from brick red to chocolate brown. The color, however, is in no wise indicative of its purity or good quality, but it can be accepted as a criterion by which to determine the hardness of the powder. The darker the powder, the greater is its degree of hardness; the red or reddish is always very soft, wherefore the former is used for polishing steel and the latter for softer metals.

For the most part, Paris red consists of ferric oxide or ferrous oxide. In its production advantage is taken of a peculiarity common to most salts of iron, that when heated to a red heat they separate the iron oxide from the acid combination. In its manufacture it is usual to take commercial green vitriol, copperas crystals, and subject them to a moderate heat to drive off the water of crystallization. When this is nearly accomplished they will settle down in a white powder, which is now placed in a crucible and raised to a glowing red heat till no more vapor arises, when the residue will be found a soft smooth red powder. As the temperature is raised in the crucible, the darker will become the color of the powder and the harder the abrasive.

Should an especially pure rouge be desired, it may be made so by boiling the powder we have just made in a weak solution of soda and afterward washing it out repeatedly and thoroughly with clean water. If treated in this way, all the impurities that may chance to stick to the iron oxide will be separated from it.

Should a rouge be needed to put a specially brilliant polish upon any object, its manufacture ought to be conducted according to the following formula: Dissolve commercial green vitriol in water; dissolve also a like weight of sorrel salt in water; filter both solutions; mix them well, and warm to 60 deg. C.; a yellow precipitate, which on account of its weight, will settle immediately; decant the fluid, dry out the residue, and afterward heat it as before in an iron dish in a moderately hot furnace till it glows red.

By this process an exceptionally smooth deep-red powder is obtained, which, if proper care has been exercised in the various steps, will need no elutriation, but can be used for polishing at once. With powders prepared in this wise our optical glasses and lenses of finest quality are polished.—Erfindungen und Erfahrungen.

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