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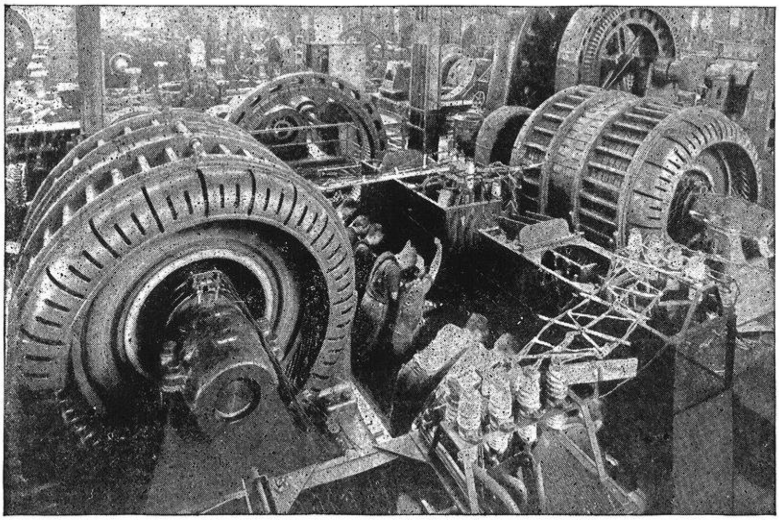

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CONTENTS

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The Wisconsin Engineer

VOL. XVII OCTOBER, 1912 NO. 1

THE PROPAGATION OF THE WAVES OF WIRELESS TELEGRAPHY AROUND THE EARTH.

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Assistant Professor of Mathematics.

In this note I give a brief summary of an article which I recently published on this subject [1] and mention some recent experiments on long distance wireless telegraphy.

For some time an explanation has been sought of the fact that the waves of wireless telegraphy overcome the curvature of the earth so that it is possible to send messages to stations which lie considerably off a tangent plane through the initial station. Several theoretical investigations, none of which offered a satisfactory explanation, were made before the one which is the subject of this note. We shall mention only the investigations of Messrs. Nicholson [2] and Poincaré,[3] who almost simultaneously published results which agree essentially with one another, though the methods by which they obtained them were quite different. They find that on a perfectly conducting sphere surrounded by a vacuum, the radius of the sphere being large in comparison with the wave length, the intensity of the magnetic (Nicholson) or electric (Poincaré) field falls off exponentially with the angular distance θ from the sending station measured along a meridian through the sender as pole. In accordance with this result it is impossible to explain the actual success of long distance wireless telegraphy by the hypotheses made. It has been suggested that the waves might possibly be

[1] "Ueber die Ausbreitung der Wellen der drahtlosen Telegraphie auf der Erdkugel." Ann. d. Physik, 37, 29, 1912.

[2] J. W. Nicholson, Phil. Mag. April, July, 1910; Jan., 1911.

[3] H. Poincaré. Rendiconti Palermo. 29, 1910.

reflected from the upper layers of the air which are ionized by the ultra violet rays of the sun. However, since it is possible to send signals over greater distances at night than in the day-time it does not appear that an explanation is to be sought in this direction.

At the suggestion of Professor Sommerfeld in Munich, who has given a complete discussion of the problem of the propagation of the waves of wireless telegraphy along an infinite plane surface.* I investigated the same problem for the sphere and the result at which I arrived is entirely different from that obtained by Messrs. Nicholson and Poincaré with the same hy-where θ has the same meaning as above. As we shall see, this result shows that the waves are of the surface type and this explains, it appears, the actual success of wireless telegraphy in overcoming the curvature of the earth. In the following paragraph we give a brief outline of the process by which this result is established.

We represent the sender schematically by a Hertzian oscil-potheses. The intensity is found to fall off proportionally to

$$\frac{1}{\sqrt{\theta \sin \theta}}$$

lator of frequency ω in 2π sec. and set up the Maxwell equations of the field due to this oscillator. The periodic character of the phenomnon is represented by the factor $e^{i\omega t}$ and this factor is omitted throughout the discussion so that all magnitudes that occur are functions of the space co-ordinates alone. We have in each case to multiply by $e^{i\omega t}$ and take the real part of the product. The Maxwell equations expressed in a system of spherical co-ordinates give six equations connecting the six components of the electromagnetic field. From these it is found without difficulty that the field components are determined as the derivatives of a potential Π which satisfies the differential equation:—

$$(1) \qquad \triangle \Pi + k^2 \Pi = o$$

where $\Delta \Pi$ denotes as usual

$$\frac{1}{r} \frac{\delta^2 r\Pi}{\delta r^2} + \frac{1}{r^2 \sin \theta} \frac{\delta}{\delta \theta} \sin \theta \frac{\delta \Pi}{\delta \theta}$$

* A. Sommerfeld. Ann. d. Physik. 28, 665, 1909.

and k is a constant depending on the electric and magnetic properties of the medium and on the frequency of the oscillator. The solution of this equation subject to the boundary conditions at the surface of the sphere is then expressed for any point outside the sphere by an integral containing in its integrand zonal harmonics and functions related to the cylinder functions. It represents the potential for the case of a sphere of any material surrounded by any medium. We then obtain a first approximation to the solution of the actual problem for the earth by assuming the earth to be a perfect conductor surrounded by a vacuum. The earth behaves very much as a perfect conductor in the presence of waves of such high frequency as those we are considering. The integral then takes on a simpler form and its approximate value can be calculated. It is found to be

$$(2) \qquad \Pi = \frac{2}{a} \frac{1}{\sqrt{\theta \sin \theta}} e^{-ik_a a \theta}$$

where a is the radius of the earth and k_a is a real constant. *For points on the earth's surface this is the approximate expression for the potential due to a sender on the surface of the earth when the latter is considered to be a perfect conductor.* It can then be easily shown that the field intensity varies according to the same law.

The formula (2) does not show the rapid decrease of field intensity which Poincaré as well as Nicholson have found. With them the decrease of intensity is shown by the factor*

$$e^{-\text{Const}\,(k_a a)^{1/3}\,\theta}$$

instead of by $\frac{1}{\sqrt{\theta \sin \theta}}$

In order to interprt our formula (2) we write it in the form:—

$$\Pi = 2 \frac{1}{\sqrt{a\,\theta}} \frac{1}{\sqrt{a \sin \theta}} e^{-k_a a \theta}$$

The change of amplitude is thus determined by two factors.

---

* Nicholson gives this factor in the form $e^{-\beta(k_a a)^{\frac{1}{3}}\theta}$ where $\beta = 0.696$. For a wave length of 2 kilometers k_a is approximately 2.10^4.

The first $\frac{1}{\sqrt{a\theta}}$ is equal to the reciprocal of the square root of the spherical distance between the receiving station and the sender. The other $\frac{1}{\sqrt{a \sin \theta}}$ is proportional to the square root of the radius of the latitude circle through the receiving station. Now the latter factor gives the change of amplitude of the field in the case of pure surface waves on the sphere, since for such waves the same amount of energy goes through each circle of latitude. Consequently the energy decreases (or increases when $\theta > \frac{\pi}{2}$) as $\frac{1}{a \sin \theta}$. Hence the amplitude of the field would change as $\frac{1}{\sqrt{a \sin \theta}}$. The first factor $\frac{1}{\sqrt{a\theta}}$ shows a decrease of the amplitude which, however, is not very rapid. For example its value for $\theta = 150^\circ$ is 1/5 of its value for $\theta = 6^\circ$. We conclude that the waves of wireless telegraphy, although they are not pure surface waves, are of the surface type. Besides the change of amplitude which corresponds to surface waves there is a decrease determined by the factor $\frac{1}{\sqrt{a\theta}}$. Formula (3) gives a minimum of intensity in the vicinity of $\theta = 110^\circ$. From this point on it gradually increases and becomes infinite at $\theta = \pi$. The existence of such a pole opposite to the sender is to be expected in the case of surface waves. Actually there would be no infinite concentration of energy in this pole just as there is none in the foci of geometrical optics. Our formula leaves this possibility open since the approximation formula for the spherical harmonic was used in deriving it, so that it is no more rigorously true at $\theta = \pi$ than at the sender $\theta = 0$. The behavior of the intensity as a function of θ is shown in Fig. 1.

The foregoing discussion applies to the ideal case of the transmission of waves along the surface of a perfectly conducting sphere of large radius, the source of the electro-magnetic disturbance being situated on the surface of the sphere. Furthermore the medium surrounding the sphere is taken to be a vacuum. For the actual case of the earth surrounded by an atmosphere this formula can be regarded only as a first approximation. It explains, however, the mode of propagation of the waves, showing that they overcome the curvature of the earth because they are of the surface type. The actual intensity that

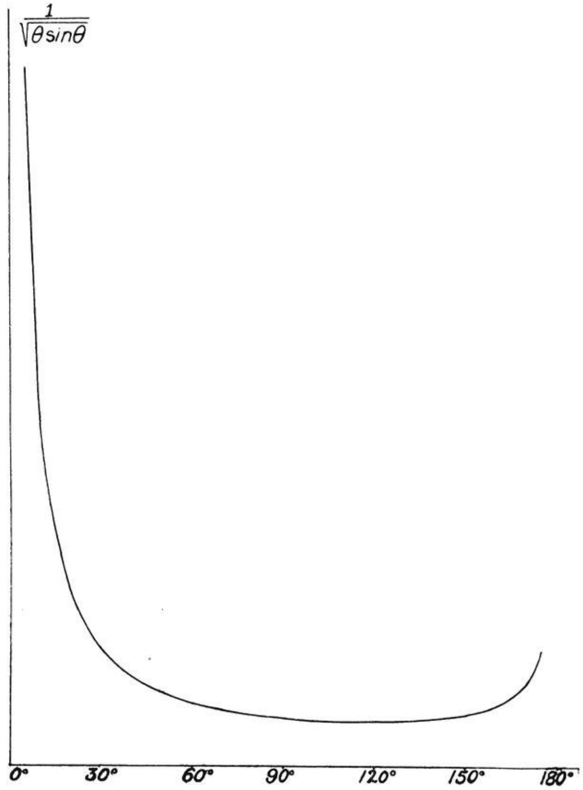

FIGURE 1.

would be observed at a given distance from the sender would be less than that given by our formula owing to the absorption of energy in the earth and air.

Experiments to determine the change of intensity with the distance have recently been carried out by Mr. L. W. Austin* of the Bureau of Standards for distances up to 1,000 nautical

* Bulletin of the Bureau of Standards, Vol. 7, No. 4, p. 315, 1911.

miles. In order to express his results by means of a formula he assumes that if there were no absorption the intensity would be inversely proportional to the distance *d*, a result previously experimentally determined for small distances for which the absorption does not play an important role. He then takes an absorption factor of the form e^{-Ad} so that the empirical law of the falling off of intensity is:—

$$I = \frac{K}{d} e^{-Ad} \qquad (3)$$

where *K* is a constant. The constant *A* was determined from the series of measurements. It was found to be the small quantity $\frac{0.0015}{\sqrt{\lambda}}$ where λ is the wave length. λ and *d* are expressed in kilometers. Now it is interesting to note that for distances up to 1,000 nautical miles and indeed for considerably greater distances, we may replace in our formula (2) sin θ by θ without introducing an error as large as the experimental error, and that with this approximation, formula (2) shows that the intensity is inversely proportional to *d*. That is, according to our result,

$$I = \frac{K}{d}$$

so that for distances up to say 2,000 nautical miles (2) and the empirical formula (3) agree except as to the absorption factor in (3). The presence of such a factor was to be expected owing to the absorption of energy in the imperfectly conducting earth and in the air.

I hope to be able to treat the case of the imperfectly conducting earth surrounded by an atmosphere by the same method. The principal result of the foregoing investigation will undoubtedly remain true, viz.: The waves of wireless telegraphy are not deflected off by the curvature of the earth, as they would be in the case of rectilinear propagation in the sense of geometrical optics, but overcome it by a mode of surface propagation.

NOTE.—Since the foregoing note was written the following correction and explanation have become necessary.

The formula (2) was found as the result of a series of approximations to the value of a certain integral. In calculating one of the path of integration was deformed in the complex plane and an approximate value of the integrand was integrated along the path. Now Poincaré* has pointed out that owing to the character of the integrand the integration of this approximation to its value may not in this case give an approximation to the value of the integral. On calculating the approximate value of the integral in another way I find a result differing from (2) in that it contains in addition the factor $e^{-\gamma (k_a a)^{1/3}}$ viz;

$$(2, a) \qquad \Pi = \frac{2}{a} \frac{1}{\sqrt{\theta \sin}} e^{-i k_a a\theta} e^{-(k_a a)^{1/3}\theta}$$

when $\gamma = 0.32$

This is a result which so far as the exponential factor is concerned is of the same form as those obtained by Poincare and Nicholson. However the exponential factor which we have found indicates a much less rapid falling off of the intensity with increasing distance from the sender than that estimated by Poincare and calculated by Nicholson, and from which it appeared to be absolutely impossible to explain the success of long-distance wireless telegraphy under the hypotheses made. In fact, the relative intensity at a given distance given by (2, a) is of the same order of magnitude as that determined by Austin in the experiments above referred to. It is however smaller than that measured by Austin. It is to be hoped that the remaining discrepancy between the theoretical and experimental results will disappear when the effect of the imperfect conductivity of the earth is taken into account.

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* Comptes Rendus, Mar. 25, 1912.

THE MONROE STREET BRIDGE.

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The Monroe Street Bridge at Spokane, Washington has several features of interest. It has the longest concrete arch span in this country, and probably the longest concrete arch carrying cars and

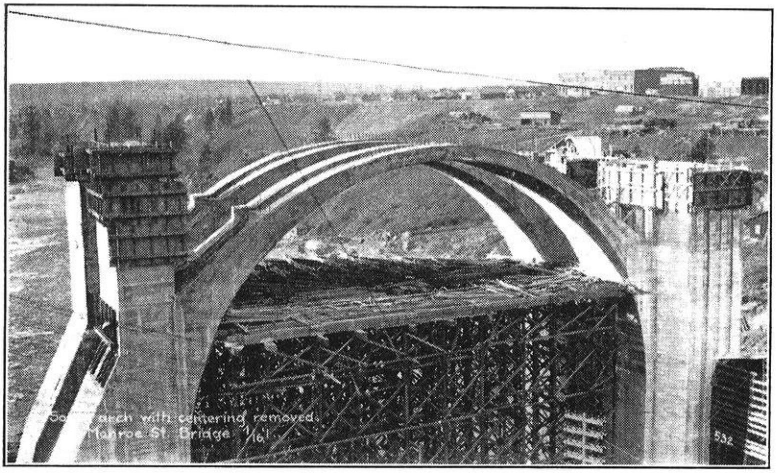

FIG. 1.—*Timber Arch at the Time of Removal of Old Steel Bridge.*

heavy city traffic in the world. It had a number of unusual problems in its design and construction, and while being erected met with an accident which caused widespread interest and comment among engineers. A former Wisconsin student, Morton Macartney, City Engineer of Spokane, was in charge of the construction of the bridge by force account, although the direct supervision of the work was by Mr. Macartney's assistants.

Monroe Street is one of the main thoroughfares to the northern part of Spokane, and near the center of the city crosses the gorge of the Spokane river just below the falls of the same name. The maximum height of the street grade above the water surface is

140 feet and the distance between banks is about 1000 feet. The river itself at the point of crossing is very swift, and the channel has been eroded by the falls to a maximum depth of 50 feet. The site before the construction of the new arch bridge was occupied by a cantilever steel structure with truss approaches, erected some 20 years before and much weakened by overloading and corrosion by spray from the falls. This bridge had to be removed entirely, but was made use of, as will be shown later, for erection of the arch falsework.

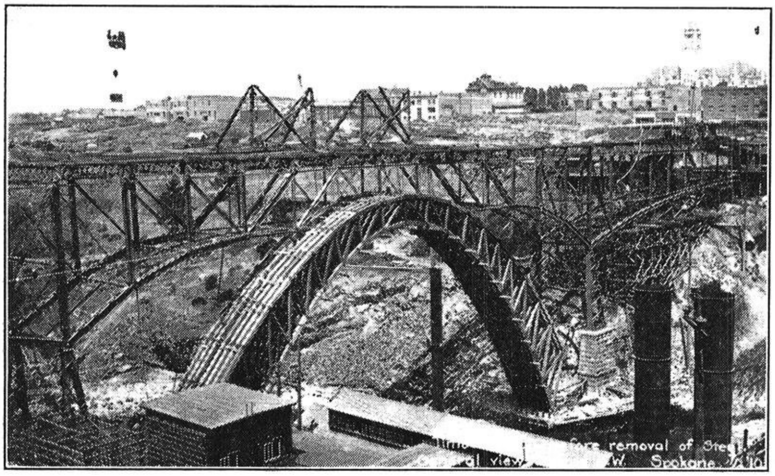

FIG. 2.—*South 120 Foot Arch with Centers Struck.*

The width and depth of the channel necessitated for the river span of the new bridge a length of 281 feet, one foot longer than the greatest span of the Rocky River bridge in Cleveland, Ohio, America's second concrete arch. The site was conveniently fitted by one 120 foot span on each side of the main arch, an approach of small arches at the north end, and a high earth fill to take the place of a temporary trestle at the south end. The total length of the concrete bridge is 791 feet.

The design of the arches is very similar to the Walnut Lane Arch at Philadelphia, which will be found completely described in the Transactions of the American Society of Civil Engineers, Volume LXV, page 423, consisting of twin arch ribs acting independently, and supporting a concrete incased structural steel floor. The arch ribs are practically plain concrete. Those of the main span are 16 feet wide by 6 feet 9 inches deep at the crown and 36 feet apart, center to center, flaring to a width of 19 feet 9 inches at the springing. The spandrel piers, which run transverse to the axis of the ribs, are 20 feet center to center, and topped by semicircular arches which support the floor.

The deck of the bridge has a clear width of 68 feet, consisting of a 50 foot roadway with two car tracks, and two 9 foot sidewalks cantilevered outside the spandrel walls and arches. On account of the heavy loading of 60 ton interurban cars coming midway between the arch ribs, a structural steel floor system, consisting of transverse beams supporting stringers under the rails was chosen in preference to a straight reinforced concrete design. The walks are supported by structural steel cantilever brackets and longitudinal I beams. The steelwork is entirely incased in concrete, and the open panels of the floor filled by wire mesh reinforced slabs, making a construction similar to that used in fireproof steel frame buildings. The roadway is waterproofed by a bitumenous membrane, and paved with wood blocks.

The preliminary work for the construction of the new bridge consisted in shallow excavation for the piers, which rested on solid basaltic rock; the erection of a cableway and a temporary suspension bridge crossing the river channel at low level; and the building of a mixing plant, a cement shed, carpenter and blacksmith shops, and an office building. Material yards were laid out on the sidehill west of the bridge with a push car track covering the same. The cableway, which is a conspicuous feature in all the accompanying pictures of the work, had twin wooden towers supporting fixed cables over the center lines of the parallel arch ribs. The existence of the old steel bridge made easy the stringing and fitting up of the cableways.

As the central 281 foot arch offered the most difficult problem of the entire bridge, work was first concentrated on this span. The falsework designed for this arch was supported by a combination timber and steel two hinged arch of 192 foot span. This was made up of seven similar and parallel ribs with timber chords and diagonals, cast iron joint blocks, and steel loop-rods alongside members taking tensile stress. It was supported on wedges upon concrete piers, and was to be used for centering one of the arch

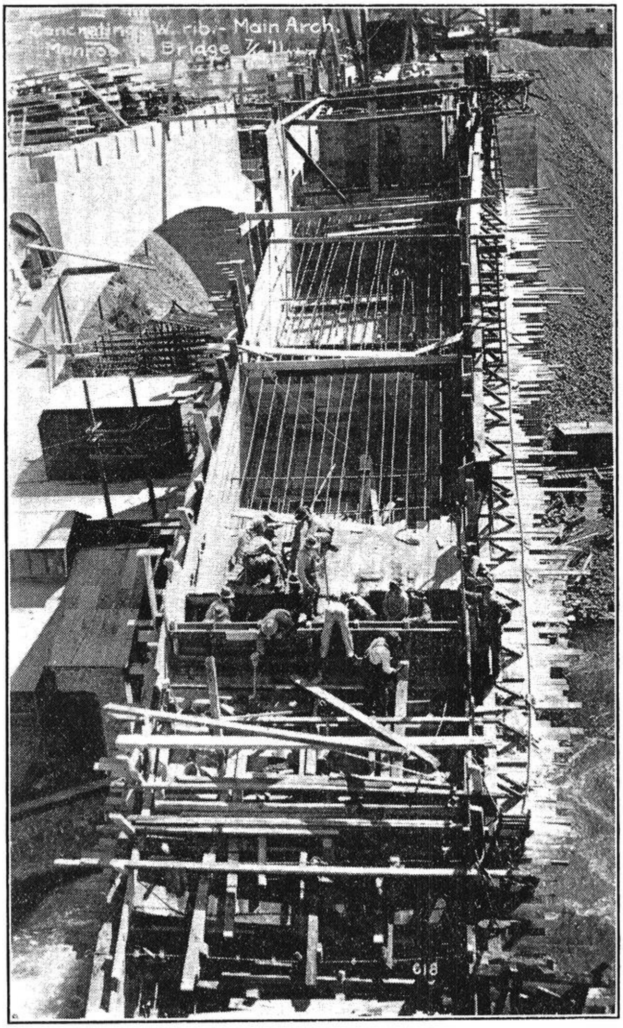

FIG. 3.—*Concreting the Second Rib of the Main 281 Foot Arch.*

ribs, lowered, and moved along a track into position for the concreting of the second one.

This timber arch was conveniently erected on cables suspended from the old steel cantilever bridge. Six of the seven ribs were successfully assembled and joined at the crown. The seventh, one of the inside ribs, interfered with a chord of the steel bridge, and the partial removal of the steel was necessary before it could

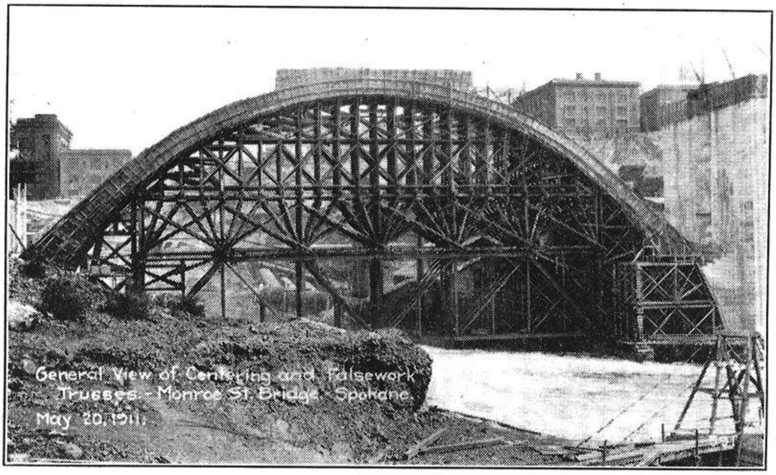

FIG. 4.—*Steel Trusses and Timber Centering for 281 Foot Span.*

be connected up. Being a cantilever structure, this was readily accomplished by light derricks working and backing up on the top chords.

At the time the dismantling of the steelwork was started the seven ribs of the timber structure were tied together only by timber struts bolted to the lower chord, and shown in one of the accompanying views; and the arch as a whole was guyed by about twenty cables extending up and down stream and fastened to iron rods set in rock. The ribs, made up of comparatively short sticks bearing on the cast iron joint blocks, possessed very little lateral stiffness. It will be seen that to make up a completely braced structure diagonal bracing was needed in each panel in addition to the guy cables which supplemented the narrow base. Such bracing was shown on the plans of the arch, but was left off awaiting the completion of the last rib.

While the arch was in this condition, and the day after the last of the interfering steel had been cut away, Spokane was visited by a violent squall, the wind rising suddenly, and probably reaching a velocity of 50 miles per hour at the bridge. The wind struck the bridge at an angle producing a severe twisting effect, and as might be expected, the ribs were thrown out of line, doubled up, and the arch dropped almost vertically into the river.

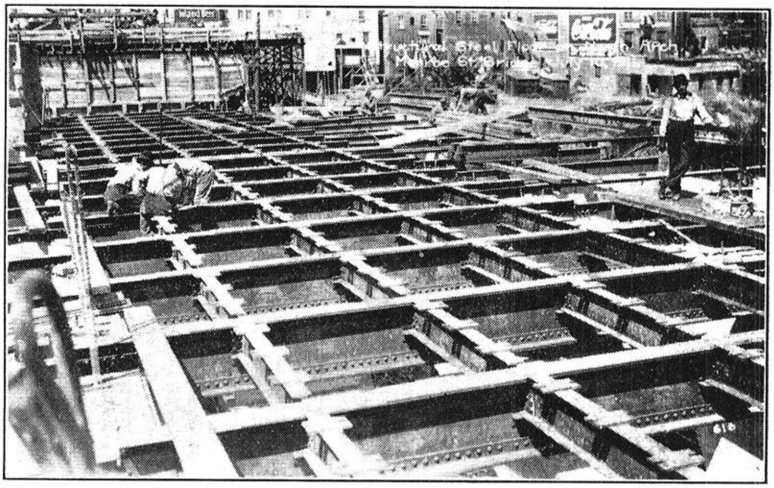

FIG. 5.—*Steel Floor as Used on All Arches.*

After this failure, the problem of centering for the 281 foot concrete arch had to be attacked from an entirely new angle. The possible salvage of the timber arch being considerable, it was possible to rebuild the arms of the steel bridge that had been removed, and carry out the erection as before. The steel had, however been found in poor shape for re-erection, and the wrecking had not been done with all possible care. The greatest factor influencing the re-design of the centering was, however, popular opinion. This was a public work, carried out in a conspicuous place near the center of the city, and had been the object of comment by all citizens and criticism by certain newspapers. To rebuild in kind the wrecked structure would, to the layman, be provoking providence, even if to the engineers in charge it seemed feasible and economical.

A successful alternative, which was adopted, was the use of steel trusses designed for later re-use as through highway spans, and supporting timber falsework. The arrangement used was four pin connected Pratt trusses, (with sub-panels for the highway loading) spaced 10 feet center to center, and having an especially designed system of laterals independent of that provided for their highway location.

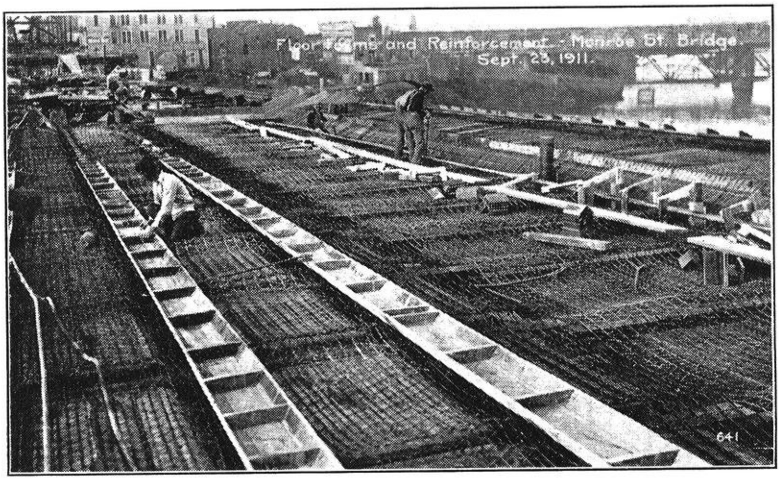

FIG. 6.—*Forms and Reinforcement in Place for Floor.*

While the steel trusses were being designed and fabricated, work on the smaller 120 foot arches was pushed. The springing lines being at a different level, they were not dependent on the adjacent longer span for their support. The falsework for these arches was of simple trestle construction with radial bents above the level of the springings. The concrete arch rings were poured in three sections, first a section at the springing line, then the crown, then the haunches.. The 120 foot arch rings were complete and centers struck when the steelwork for the trusses was received.

The trusses were erected as cantilevers from both ends, the top chords tied by eye bars and toggles to anchors set in the concrete abutments of the arch, which had been carried up as the piers supporting the smaller arches. The timber falsework carried by the trusses concentrated the loads at the panel points.

Its form is clearly shown in the photograph printed with this article. The transverse caps of the bents carried stringers cut to the form of the intrados, and upon these rested the transverse lagging.

To prevent cracking of the concrete arch rings from settlement of the centers, they were cast in sections. Boxes were set in between the side forms to separate the ring into blocks, which were kept from sliding down the sloping lagging at the haunches

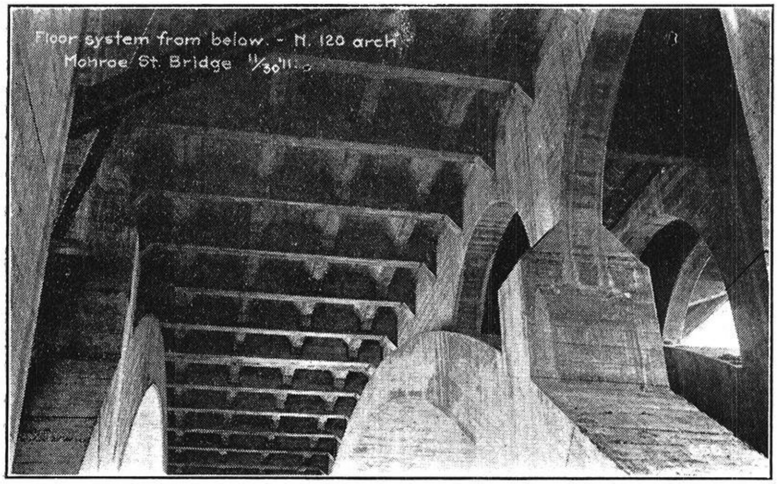

Fig. 7.—*View Underneath 120 Foot Arch. (Style of Floor Construction Was Practically the Same for 281 Foot Arch.)*

by small concrete struts at the neutral axis. After all these blocks had been poured, and the falsework had settled under nearly its total loading, the intermediate spaces, or keys, were filled with concrete, surrounding the concrete struts and bonding the entire arch rib into a monolith.

As has been noted, the arch was made up of two separate and parallel ribs. The centering for the main arch was of a width and strength to support only one concrete rib. After this was complete and had been allowed thirty days for setting, the steel trusses were lowered by means of cast-iron wedges beneath the shoes, dropping the centering clear of the arch, and bringing the weight upon steel rollers resting on a track. Jacks were applied, and the whole structure moved transversely 36 feet, where it was raised by the wedges to the proper elevation for the second arch rib.

The casting of both ribs was carried out without particular difficulty. The main arch as well as the small arches were designed to avoid tensile stresses, but as a precaution light reinforcement was put in at the intrados and extrados. This reinforcement certainly was not an economy, as it prevented the

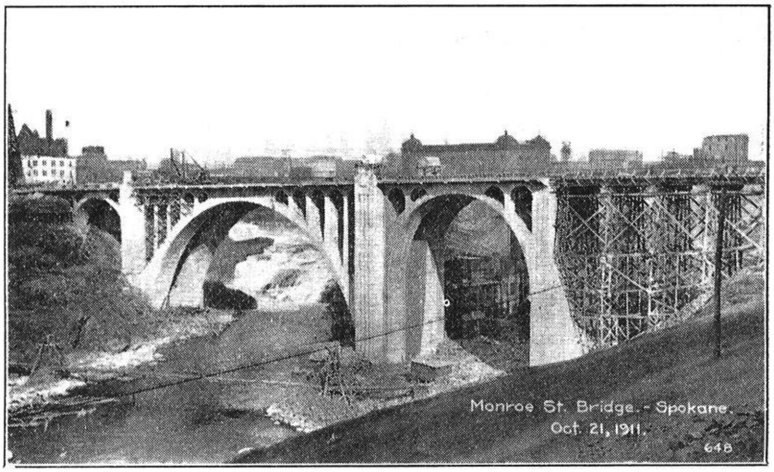

FIG. 8.—*The Finished Arches.*

placing of plum stones in the arch, which might have reduced quantity of concrete and perhaps increased its strength.

From the arch ring the narrow spandrel piers were carried up, and the spandrel arches poured on simple semicircular centers. The relation and form of the spandrel piers and arches shows clearly on the view looking upward at the floor system. The steel floor was assembled and riveted in position over the spandrel arches as is shown in another cut. Between the steel beams were supported form boxes resembling very closely those used in floor construction for the University buildings. The concrete for the floor, received on the center of the cableways was distributed transversely by chutes carried on a car which moved along the deck as the work progressed.

The architectural treatment of the Monroe Street Bridge is worth mention, as an instance of the co-operation of two professions. It was the work of a Spokane architectural firm. The piers at the ends of the main span are carried out beyond the face of the bridge, their height emphasized by vertical panelling, and topped by ornamental structures spanning the sidewalks, called by the architects, "kiosks" and dubbed by the workmen "dog houses." The handrails are of massive design suiting the rest of the structure. They terminate at the north end in appropriate columns, and will have a similar treatment at the south end after the timber trestle has been replaced by an earth fill. The entire bridge is lighted by clusters of electric lamps supported on electroliers and brackets of special design.

Certain features in the construction of the Monroe Street Bridge seem to the writer to deserve special attention. One was the use of a gravity concrete mixer. A Hains mixer installed in a stationary plant at the north end of the bridge was used for practically all the concrete. The mixture secured was uniform, and although it was found necessary to use an excess of sand, was of good quality. However, a force of at least six men was necessary to operate the mixer for the smallest output. A gravity mixer of this type may be economical on jobs where it can be constantly worked to its full capacity, but where the output is limited by the distributing plant or other factors, a machine mixer seems preferable.

On this bridge, the use of sectional forms was carried out very consistently. The pieces were built in the shop where all machinery and conveniences could be used, were carried out to place by the cableways, and required a minimum amount of skilled labor for assembling. Where wooden forms are used, and there is means of transporting and handling large sections, the use of shop-built forms offers the engineer a chance to exercise a great deal of ingenuity, and work considerable economy.

The total cost of the bridge is given as $477,682. In arriving at this figure, an allowance of 50% of the original cost was made for cableways, engines, and construction plant in general. The steel trusses were valued for reuse as highway spans at $31,000.

DOES PURE IRON RUST?

CHAS. F. BURGESS.

Professor of Chemical Engineering.

To the question "Does Pure Iron Rust?" answer can be made positively that it does not, if by pure iron we mean iron which is entirely free from all other elements. In fact, there is no pure iron in existence and it is therefore a matter of conjecture as to whether pure iron if obtainable would rust.

A prevailing supposition which is frequently expressed is that if iron could be produced in a highly pure condition it would be rust-proof. For obvious reasons this is not capable of direct proof or disproof; but when we go a step further and assert that the resistant power is proportional to the purity and that consequently certain grades of iron or steel are superior to certain other grades and this because of the higher purity of the former, we enter upon a discussion and a live controversy which is being waged by iron and steel people. There are advocates for "purity" and there are defenders of "impurity" and the debate does not appear to be close to a settlement.

The line of reasoning by the purity advocates appears forcible and conclusive if the problem is judged solely from their point of view. The electrolytic theory of corrosion which is now commonly accepted as an explanation of the deterioration of iron and steel predicates the presence of two or more materials comprising the iron, this combination of materials setting up galvanic couples by which the electrolytic corrosion proceeds. If there were but one material, i. e., iron without impurity, there would be no galvanic couples, therefore no possibility of electrolytic corrosion and therefore no rusting. They refer to the fact that chemically pure zinc is practically unattacked by acids but that the attack becomes vigorous when an impurity such as copper or platinum is added to the zinc. Pure tin behaves in a similar way, and it is therefore a most natural supposition that if equally pure iron could be obtained it would withstand the attack.

The arguments against the purity theory are based largely upon the facts that the pure materials do not always act as theory dictates. Cast iron, for example, is notably impure, but it has a high rust resistant property. Its impurities are segregated as well as being partly in the form of solid solutions. It is decidedly nonhomogeneous under the microscope and yet it resists the action of the elements better than certain grades of steel which are much more homogeneous and pure.

The Chemical Engineering Laboratories at the University of Wisconsin have probably produced more electrolytic iron than has been produced in any other one place; several tons of this having been deposited and used for experimental purposes. By double refining processes and by special care, iron of a purity of 99.98 per cent. or two parts of impurity in 10,000, has been produced. This is perhaps as close an approach to absolute purity as has been produced for iron by any one and the observation has been made that electrolytic iron *does* rust and has a marked tendency in this direction. The iron as deposited contains hydrogen in an excluded or combined form and in expelling this hydrogen, the rust resistance seems to increase, and therefore speaks for the greater durability of pure iron. On the other hand, it has been found that this purified iron with the hydrogen removed appears to rust more readily than do certain grades of commercial materials less pure. This, then, argues for the beneficial action of impurities and in fact if a small amount of copper be alloyed with electrolytic iron it increases its corrosion resistant properties.

The writer believes most emphatically that as far as it contributes to homogeneity and uniformity, purity is desirable and important in that homogeneity and uniformity contribute to corrosion resistance. Of the numerous impurities possible in iron and steel, it is evident that some of them are accelerators of corrosion and purity is therefore a barrier to such impurities and therefore advantageous. On the other hand, there appears to be no ground for the belief that all impurities are bad.. Some of them are undoubtedly good and like the "friendly bacteria" will help to prolong life. This view is believed to be an important one in the further study of this important question, "The Corrosion of Iron." Investigation should be directed to determine which impurities are beneficial and under what conditions they may be beneficial; and the effort at elimination of impurity should, therefore, be restricted only to those impurities which are known to be harmful.

During investigations carried on by our department, a large number of binary alloys of electrolytic iron with various materials and in various proportions were made. Among the tests to which they were subjected were corrosion by acid and by atmospheric conditions. The acid test consisted of immersion in a 20 per cent sulphuric acid solution for periods of one hour; and the atmospheric test consisted in exposure to the weather conditions for 162 days. The results of this investigation are given in some detail in a paper recently presented before the International Congress of Applied Chemistry. It was a matter of some surprise to the writer that of the 71 binary alloys subjected to corrosion nearly all of them were found to be more resistant to corrosion than was the electrolytic iron itself. Copper and nickel appear to be decidedly advantageous while silicon was found to be detrimental.

These results are not set forth as settling in a conclusive way the question as to the quantitative influence of various impurities, but the results are indicative of the importance of making further check investigations and of a careful study of the influence of each individual impurity. The statement that this line of investigation has hardly been begun may occasion some surprise, but when we look into the matter and find the serious difficulties and the tremendous field which is offered we can readily appreciate the magnitude of the work yet to be done. We have to study not only the influence of each one of the elements when associated with iron but these must be combined in a wide range of proportion.. Then in addition, each impurity must be studied with reference to its influence in iron when associated with one or more of the other impurities and thus the possible combination becomes unlimited.

No one has apparently discovered as yet that material which can be added to iron in homeopathic amounts and which will make it immune from the rusting disease. The investigative work which has been done indicates that no one of the elements probably possesses this property, but it is not beyond reason to hope that some combination of elements added to iron may give it the desired longevity. The writer believes that the most promising method of studying iron corrosion is with the assistance of the microscope and the study of the metallographic ingredients. Comparatively little has been done in this direction, although it is known that an impurity in the form of a solid solution may have an influence different from that which it possesses in a segregated condition.

A brief exploration in this field will indicate the large number of problems which offer themselves for study, one of them which is of immediate practical importance is the influence of copper on iron and steel. Copper being electronegative to iron, the electrolytic theory seems to imply that it is a harmful impurity and that this idea is generally held is shown by numerous specifications for industrial material which require copper to be in a minimum amount.

In our own experiments we have found that apparently copper when added in small percentages to electrolytic iron is decidedly beneficial from the corrosion standpoint. Not only is copper up to one or two per cent advantageous chemically but it has been found to be advantageous from the standpoint of strength. It is believed that a certain decided field for usefulness exists for iron-copper-alloys, which view accords with that expressed by certain manufacturers who are now purposely adding copper to their material, while certain other manufacturers are decided in their opposition to the use of copper. The microscope shows that in small amounts copper forms a solid solution with iron and is not detectable by the microscope. In larger amounts it segregates in the form of globules of copper-iron solution and these microscopic structures indicate that differences should exist as indeed, they do in the behavior of these materials under corrosion tests. It is possible that our conclusions on the value of copper might be negative when we study the influence of this material in combination with certain other impurities, and this is a problem upon which we hope to carry on investigations during the coming year.

APPARATUS FOR THE STUDY OF PUMP VALVE ACTION.

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The valves used in the water end of pumps of the present day are of several distinct types which have been developed, largely, through practical experience.. In the early, slow-moving pumps, operated directly by a steam cylinder through a walking beam, the valves were simply large disks hinged on one side, and usually lined underneath with leather. As our modern civilization has developed, larger and larger pump capacities have been required, resulting in a great increase of both the piston speed and the number of strokes or reversals per minute. On account of this increase the old form of flap or hinged valve became unsatisfactory, and more efficient forms were developed to meet the new conditions.

One of the most common in use at the present time is a disk of hardened rubber which is held in place over its seat by means of a stud bolt that passes down through an opening in its center. Between the head of the bolt and the valve is placed a coiled spring which tends to hold the valve to its seat and forces it shut at the close of a discharge stroke.

Some German manufacturers have striven to develop a type of valve which has as little weight as possible to its moving parts, and which, also, avoids the deflection of the stream of water passing through the valve, as much as possible.

It is thought the mass of the valve causes it to rise higher and to seat later than when this mass is replaced as far as possible by an equivalent spring load.

In this country, manufacturers have endeavored to produce a valve with good life under the various unfavorable conditions it is likely to meet (such as gritty water, etc.) rather than to make one which would oppose the least possible amount of resistance to the flow of water.

It is inevitable that a valve and its seat will interpose some resistance to the passage of the water and fail to perform perfectly its function of preventing all backward flow of water both because some time is required for the valve to reach its seat after the forward motion of the water ceases, (resulting in some water escaping backward through the valve before closure), and also because of the difficulty of maintaining a perfectly tight fit between the valve and its seat when closed.

Further a practical valve must work smoothly and quietly, have good life, and be of such design and material as to be commercially producible.

As water is, practically, a non-compressible fluid, the volume which the piston displaces in a given time must pass through the valve seat in the same time.

Evidently then, the velocity of the water through the valve seat is dependent on the velocity of the piston at the given instant, and upon the ratio of the area of the piston to the area through the valve seat.

The height to which a valve will be raised by the jet of water coming through the seat will depend upon the force exerted on the valve by the jet and upon the resistance to its opening offered by the spring and the valve mass or weight. The shape of the valve will affect the total force exerted on it by a jet of given velocity depending on just how much the stream is reversed and the interference created.

The losses will increase as the rate of flow through the valve increases, varying nearly as the square of the velocity. The quietness and smoothness of operation, the loss due to backward flow through the valve when seating and loss due to the resistance offered by the valve and its seat then, are dependent on the size and number of valves, their material and construction, the strength of the spring used, etc. for any given piston speed, area, and displacement. It is desirable then to know just what the action of a valve is under any given set of conditions, in order that its operation may be fully anticipated by the designer.

As pump valves work in a chamber where the water pressure is ordinarily from 50 to 100 pounds per square inch and as their action is influenced by any mechanism attached to them, it is difficult to provide a means of recording their movements correctly.

Comparatively few experiments have been made up to the present time, the design of valves being empirical and dictated by experience.

One method which has been used is to attach to the valve a small rod which passes through a stuffing box in the chamber wall to the outside.

An ordinary steam engine indicator is then so arranged that its piston may be attached to the exposed end of the rod and its pencil made to draw the diagram of the valve movement on the paper drum of the indicator.

Difficulty is experienced with the stuffing box added to the fact that there is an unbalanced area the size of the rod to be counteracted.

Another plan that has been employed is to extend a rod out through the chamber wall, at right angles to the valve motion, this rod being made to turn partly around by an arm resting on or attached to the valve. A second arm attached to the rod outside the chamber reproduces the valve motion on a paper drum as in the first instance.

In beginning the experiments on valve action here at the University of Wisconsin a device was sought which would avoid the necessity of having any mechanism connected to the valve which would project outside the valve chamber and thus have to pass through a stuffing box.

A photographic scheme was resorted to, the valve operating a metal shield in such a way that a single beam of light passing through a little window could be made to reproduce the valve motion on a moving sensitized paper.

Fig. 1. is a photograph of a pump valve with a stem and shield attached just as it is when in position in the pump.

In Fig. 2. is shown the top of a valve chamber removed and the valve hanging below it by means of the stem.

This view shows the projecting casing in which the shield moves up and down as the valve rises and falls when water is being pumped.

On two opposite sides of this projecting case are slots in which are little windows of mica or celluloid that permit the passage of light. When the shield is in place no light can pass from one side to the other except for a single small hole that is made in the shield itself. This single opening permits a ray of light to pass through from one side to the other, and this ray will move upward and downward as the shield moves. If one holds an incandescent light on one side of the casing and watches the other

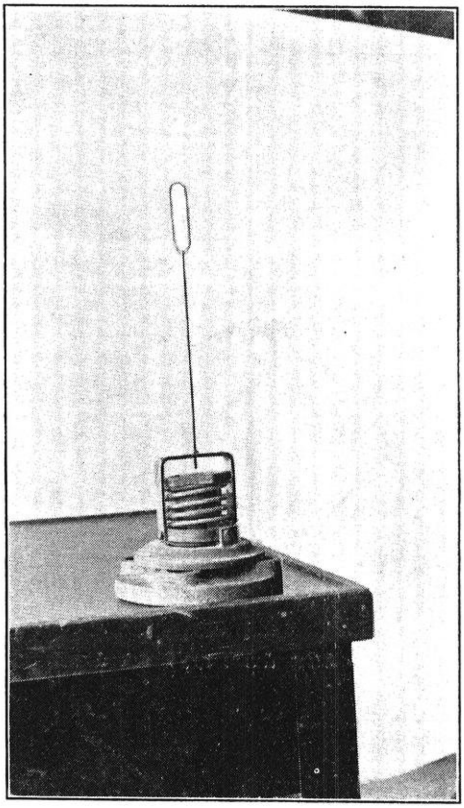

FIG. 1.

as the pump works, the ray or beam of light is seen to rise and fall when the valve operates.

Water can pass upward freely into the shield casing and its interior is under the same pressure as the water in the pump proper.

To obtain a permanent record of the valve movement which could be studied, it was only necessary to provide a source of light on one side and a sensitized paper on the other.

Figure 3 is a photograph of the device used for this purpose. "A" is a part which slips down over the shield casing when a card is taken. At "E" there is a small arc light, the light from which can pass through a slot in the part "A" and appear at slot

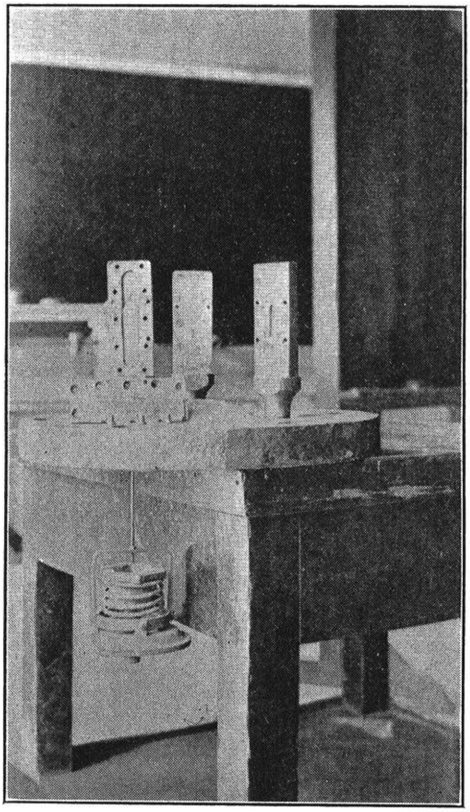

FIG. 2.

"D" after passing through the shield casing and the small hole in the shield.

"B" and "C" are cylinders or drums on which to wind sensitized paper.

(The paper used is known as Eastman's Velvet Bromide paper and comes in rolls 2 inches wide and 10 yards long.)

To put the paper into the machine, drum "B" is removed and the roll of paper wound upon it. After replacing drum "B" the free end is carried past slot "D" and fastened to drum "C." Drum "C" can be made to revolve at will by means of the small electric motor on top of the instrument.

The compartment containing the paper is light proof when the lid is in place. When the paper is in and the machine in place on the pump the ray of light which can get through the shield from the arc light will play vertically upward and downward on

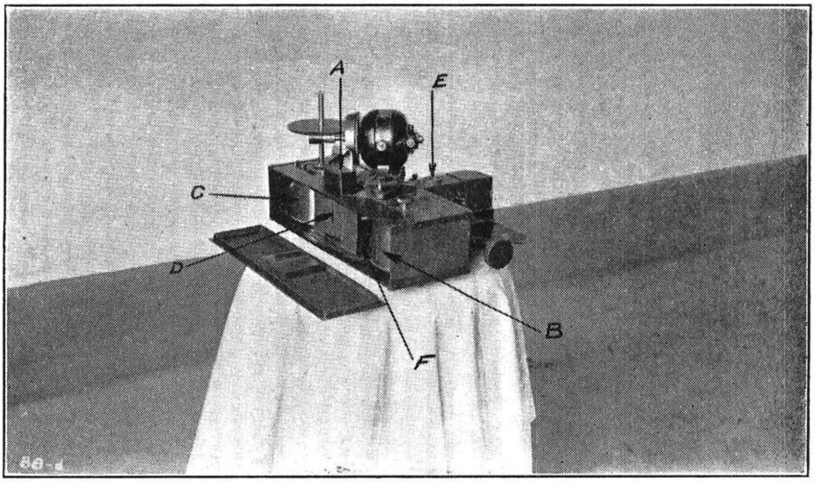

FIG. 3.

the paper opposite slot "D" and appear as a black mark when the paper has been developed. If the drum "C" is made to turn by means of the little electric motor the ray of light will then trace a line on paper similar to Fig. 4 which is an actual diagram taken during one of the experimental runs. To mark the position of the end of each stroke on the card, a little shutter was provided that was made to open and shut by the electro-magnet "F."

Contact points were so placed that an electric circuit was made and broken at the end of each stroke this circuit operating the electro-magnet.

The record on the card appears in the form of short dashes. They can be seen in Fig. 4. and are off set a definite distance from the true dead center because it was not convenient to have the auxiliary shutter in the same vertical line with the opening in the shield.

There are a number of important problems relating to valve action which this apparatus will help to solve such as the effect

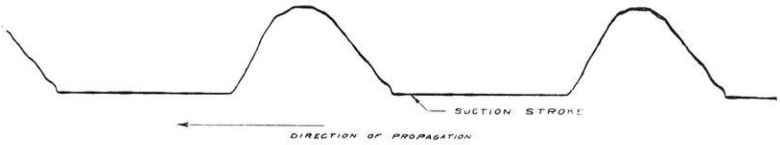

FIG. 4.

of the shape of the valve, and the length and strength of the springs, the best height to which a valve should lift for any set of conditions, and effect of weight of a valve on its time of closing and height of rise.

There is opportunity along these lines for several good theses which will produce data of practical value. Some results have already been obtained which will appear shortly as a University bulletin.

THE LOCK MACHINERY CONTROL OF THE PANAMA CANAL.

The design of a control system for the lock-operating machinery of the Panama Canal is of vital importance to the successful operation of the canal. The importance of securing a rapid safe and economical control of the movements of the gates and valves cannot be over estimated. This design is the work of a Wisconsin man, Edward Schildhauer, '97, E. E. '11, the chief electrical and mechanical engineer at Culebra. The system is described in a recent number of the Canal Record as follows:

The gates, valves, and fender chains of the locks will be operated by electricity, and remotely controlled from a central point; that is, there will be a central control station for each of the series of locks at Gatun, Pedro Miguel, and Miraflores.. In passing a ship through the locks it will be necessary to open and close miter gates weighing from 300 to 600 tons, fill and empty lock chambers containing from three and one half to five million cubic feet of water, raise and lower fender chains weighing 24,098 pounds each, and to tow the vessel through the locks. All these operations, except that of towing, will be controlled by one man at a switchboard. The towing will be done by electric locomotives running along the lock walls.

The control system for Gatum Locks is typical. Water is let into the lock chambers or withdrawn from them by means of culverts under the lock floor, which connect with larger culverts in the lock walls, through which water is carried from the higher to the lower levels. The main supply culverts are 18 feet in diameter, and the flow of water through them is controlled by rising-stem gate valves, which can be completely opened or closed in one minute. In the center wall the culvert feeds both lock chambers, and therefore at each outlet into the lateral culverts there is a valve of the cylindrical type, in order that water may be let into or withdrawn from either chamber at will. A complete opening or closing of these cylindrical valves takes ten seconds. The miter gates are never opened or closed with a head of water on either side of them, the chambers being first emptied or filled by means of the valve and culvert system. The time required either to open or close the miter gate is two mniutes.

A ship to be raised to the lake level will come to a full stop in the forebay of the lower lock, prepared to be towed through one of the duplicate locks by electric towing locomotives. The water in the lower lock chamber will be equalized with the sealevel channel, after which the miter gates will be opened, the fender chain lowered and the vessel passed into the first chamber, where the water is at sealevel. Then the miter gates will be closed. The rising stem gate valves at the outlet of the main culverts will be closed, while those above will be opened, allowing water to flow from an upper level into the lower chamber, which, when filled, will raise the vessel 28⅓ feet, to the second level. This operation will be repeated in the middle and upper locks until the ship has been raised to the full height of 85 feet above the level of the sea. At Gatun in the passing of a large ship through the locks, it will be necessary to lower four fender chains, operate six pairs of miter gates and force them to miter, open and close eight pairs of rising-stem gate valves for the main supply culverts, and thirty cylindrical valves. In all, no less than 98 motors will be set in motion twice during each lockage of a single ship, and this number may be increased to 143, dependent upon the previous condition of the gates, valves and other devices.

Each gate leaf, valve and fender chain is operated by a separate motor mounted near the machinery in chambers in the lock wall, the motors acting through suitable gears (or pump in the fender chain) upon the various machines. In each machinery chamber will be erected a starting panel containing contactors by which current will be applied to the motor and these panels will in turn be controlled from a main unit in the central control house. Some of the machinery chambers at Gatun will be 2,700 feet distant from the point of control; 90 per cent of them will be within 2,000 feet, and 50 per cent of the total within 1,200 feet.

All contactors will be operated directly from the central control house without the intervention of relays, and without resistance in the control circuit. Small and medium-sized motors will be started and reversed by throwing directly on the line which will normally be at 220 volts and 25 cycles. The larger motors, above 25 horse-power, will have in addition one starting point in each direction with resistance in the primary. All motors are of the squirrel-cage type, except the locomotive traction motors which are of the slip-ring type. Starting resistance is specified in preference to compensators in order to obtain the simplest possible arrangement with a minimum number of contactors, and to obtain an unlimited range of adjustment in the starting resistance. Reversing will be done by double pole contactors, mechanically interlocked, and, in order to have all contactors on a panel alike, when a starting resistance is used, the resistance will be in two legs only of the three-phase circuit, and short-circuited by means of a double-pole contactor. Single-phase alternating current at 220 volts and 25 cycles will be supplied for the operating circuit of all contactors. Contactors will be designed for normal operation at this voltage, but shall continue to operate successfully if the voltage at the contactor coil terminals falls as low as 70 per cent of normal.

The motor for the rising-stem gate valve machine will have a rating of about 50 horse-power, miter gate moving and guard valve motors, 35 horse-power; cylindrical valves and other motors, 7½ horse-power; the chain fender pump motor will probably be rated at about 25 horse-power. In all there will be a total of 951 motors of all sizes and descriptions at all the locks, this total including 207 motors required to drive various pumps and pumping machinery.

The station from which control will be exercised over the movement of all the machines will be on the center wall at the lower end of the upper flight of locks at Gatun, and similarly placed at Pedro Miguel and Miraflores. It will be in a building raised high enough above the top of the wall to allow a towing locomotive to pass under, a height of 16 feet, and to command an uninterrupted view of every part of the locks. In this house will be a double control board duplicated to conform to the duplication in locks. The control board will be in the nature of a bench or table, 32 inches above the floor, containing a representation, part model and part diagrammatic, of the flight of locks controlled by the respective series of switches. Standing at his switchboard the operator will throw the switches, and before him will see in model or diagram the progress of the fender chains as they rise and fall, the movement of the miter gates inch by inch, the opening and closing of the gate valves in the main culverts at every stage, the operation of the cylindrical valves, and, in addition, indication of the gradual rise or fall of the water in the lock chambers. The switches controlling the various motors, together with their indicators, will be mounted upon the board in the same relative position as the machines themselves in the lock walls. Some distortion of scale will be allowed, to give room for the switches. The board must not be over four feet in width, in order that the operator may be able to reach beyond the middle of it, and the length of the board is limited to 30 feet at Gatun, and proportionally at the other locks.

The system will be interlocking, so that certain motors cannot be started in a certain direction until other motors are operated in a proper manner to obtain consistent operation on the whole, and to avoid any undesirable or dangerous combinations in the positions of valves, gates, or fender chains. In this way and by the use of limit switches the factor of the personal equation in operating the machines is reduced to a minimum, almost mechanical accuracy being obtained. Before the operating pair of valves in the main culverts can be opened at least one pair of valves at the other ends of the locks, both upstream and downstream, must first be closed. This limits an operator to the act of equalizing water levels between locks, and keeps him from allowing water to flow from, say the lake level to the middle lock past the upper lock, thus preventing a possible flooding of the lock walls and machinery rooms. Interlocks, devoted to the control of action between the gate valves in the main culverts and the miter gates, prevent valves being opened a lock length above or below a miter gate which is being opened or closed, and thus prevent an operator causing a flow of water while the miter gates are being moved. Interlocks for the cylindrical valves guarding the openings from the center wall culvert to the lateral culverts will keep those of one side or the other closed at all times, except when it may be desired to cross-fill the chambers, when they may be opened by special procedure. An interlock prevents the operator from starting to open a miter gate before unlocking the miter forcing machine. The miter gate guarded by a fender chain must be opened before the chain can be lowered, and the chain must be raised again before the gate can be closed, or more exactly the switches must be thrown in this order, but the operations may proceed at the same time. The simple interlocks will prevent such a mistake as leaving the chain down through lapse of memory when it should be up to protect the gate.

A commutating switch is used in connection with the miter gate moving machinery, and serves two functions. First, when the miter gates come to the closed position, and not until then, it completes a circuit from the control house, by means of which the miter forcing machine may be closed, for forcing and holding the gates in proper miter. In this way there is given an interlock by virtue of which the operator in the control station cannot close the miter forcing machine too soon. The other function is to alter the circuits controlling the rising and falling of the handrail of the foot walk over the gates, so that should the handrails be up when the gates start to open they will be automatically lowered. The circuits for raising the handrails are disconnected so that they cannot be raised as long as the gates are open. If the handrails were allowed to be up when the gates are opened back into the recesses of the lock wall they would interfere with a passing towing locomotive.

An auxiliary cut-out switch is provided for the miter gate strut. The gates are opened and closed by means of a strut or connecting rod acting between the gate and crank pin on a large driving gear. The relation of parts is such that a toggle effect is produced near the ends of travel, and the motor would be capable of doing damage to some of the parts should the gate meet with an obstruction. One end of the strut is allowed a telescoping movement of a few inches against the action of a nest of stiff springs. These springs oppose equally a lengthening or shortening of the strut and hold the telescoping parts against stops with sufficient initial tension so that with ordinary water resistance to the gate in normal operation there will be no change in length of the strut. Should the gate meet a solid obstruction near one end of travel, where the motor is capable of producing overload on the mechanical parts, the strut is compressed or extended according to direction of forces. The cut-out switch is mounted upon one end of the telescoping members, while a rod entering the switch casing is attached to the other. The movement of this rod in and out of the casing operates the switch to open the control circuit and stop the motor. It is necessarily arranged so that if the switch is operated by compression of the strut, that side of the control circuit is opened which produces a rotation of motor corresponding to compression, and the other circuit remains unbroken for reversing and drawing the gate away from the obstruction. If operated by tension and the motor is stopped, it is possible to reverse and apply compression to the strut.

Limit switches for opening the control circuit when a machine has reached the proper point in its travel will be attached to all machines. It will be necessary for the operator in the control house to follow up the progressive movements of some machines, such as rising-stem gate valves and miter gates. These will accordingly be provided with synchronous indicating devices which will show by means of instruments on the control switchboard the movement and position of the machines at all times. In the case of certain other machines, like cylindrical valves and miter forcing machines, it is necessary for the operator to know only when the movement is completed. For this purpose there will be attached to the limit switch an indicator switch, which will indicate, by lighting lamps or otherwise, that a machine has reached the end of its travel.

In the masonry walls float-wells are provided and connected to all lock chambers. At these wells suitable apparatus will be installed for operating instruments on the control board, which instruments will show at all times the water levels in the various locks and approaches.

OIL MIXED CONCRETE.

A bulletin of the Department of Agriculture, Office of Public Roads, has recently been issued which describes investigations of the effect of mixing oil with concrete.

While experimenting in the Office of Public Roads in an attempt to develop a nonabsorbent, resilient, and dustless road material, one capable of withstanding the severe shearing and raveling action of automobile traffic, the writer's investigations led him into a very promising discovery. He found that, when a heavy mineral residual oil was mixed with Portland cement paste, it entirely disappeared in the mixture, and, furthermore, did not separate from the other ingredients after the cement had become hard. The possibilities of oil-cement mixtures for waterproofing purposes were recognized and extensive laboratory tests were immediately begun to determine the physical properties of concrete and mortar containing various quantities of oil admixtures.

Many valuable data have been obtained from these investigations. The damp-proofing properties of concrete mixtures containing oil have been demonstrated very definitely by laboratory and by service tests which establish this material as one of great merit for certain types of concrete construction. It has also been shown that the admixture of oil is not detrimental to the tensile strength of mortar composed of 1 part of cement and 3 parts of sand when the oil added does not exceed 10 per cent of the weight of the cement used. The compressive strength of mortar and of concrete suffers slightly with the addition of oil, although when 10 per cent of oil is added the decrease in strength is not serious. Concrete mixed with oil requires a period of time about 50 per cent longer to set hard than does plain concrete, but the increase in strength is nearly as rapid in the oil-mixed material as in the plain concrete. Concrete and mortar containing oil admixtures are almost perfectly nonabsorbent of water, and so they are excellent materials to use in damp-proof construction. Under pressure, oil-mixed mortar is very efficient in resisting the permeation of water. Laboratory tests show that oil-mixed concrete is just as tough and stiff as plain concrete, and furthermore its elastic behavior within working limits of stress is identical with that of plain concrete. The bond or grip of oil concrete to steel reinforcement is much decreased when plain bars are used. Deformed bars, however, and wire mesh or expanded metal will reinforce this material with practically the same efficiency as in ordinary concrete.

A very interesting experiment showing the nonabsorbent and nonpermeable character of oil-mixed mortar when subjected to low pressure was made in the laboratory. Four mortar vessels, 8 inches in outside diameter, 2½ inches high, and about ½ inch thick, after hardening in moist air for one week, were immersed in water to a depth of about 2 inches. A mortar mixture of 1 part of cement to 3 parts of sand was used. Vessel No. 1 contained no oil in the mixture. About one minute after immersion a damp spot showed on the bottom. After one hour the whole vessel was wet even above the water level, since the water had climbed by capillarity. Within a few days water had penetrated the plain mortar vessel until the water level inside was the same as that outside. The remaining three vessels, made of 1:3 mortar and mixed with 5, 10, and 20 per cent of oil, respectively, have remained perfectly dry on the inside during immersion for one year.

All of these experiments have given very encouraging results and point to the use of oil-mixed mortars and concretes as a cheap and effective solution of the problem of waterproofing for a great many types of concrete construction.

All of the laboratory and service tests thus far made on oil-mixed mortars and concretes are indicative of a wide future usefulness for these materials, principally in damp-proof construction. There are many types of structures through which the permeation of moisture is ruinous to either the appearance or the efficiency of the construction, or is seriously detrimental to the health of either animal or human life. The efflorescence due to the leaching out and subsequent carbonization of the lime on the surface of a concrete wall might well be prevented by the incorporation of an agent capable of excluding all moisture. Again, the dampness of many cellars, with its danger to health, could have been prevented had the walls and floors been damp-proofed. The following types of structures might be damp-proofed at an exceedingly slight extra expense by the incorporation of a small amount of the proper kind of mineral oil residuum with the mortar or concrete used in construction: Basement floors, basement walls, watering troughs, cisterns, barns, silos, concrete blocks, roofs, stucco, and numerous important engineering constructions.

The Wisconsin Engineer.

EDITORIAL.

The College of Engineering welcomes all students, those who return to continue their studies and the new students who are here for the first time.

The former know our ways and traditions, and therefore a word to the new students.

In the College of Engineering are five general courses, Chemical, Civil, Electrical, Mechanical and Mining Engineering, and from these you will make your choice of a profession, which probably most of you have already done. The subjects of fundamental training in all these courses are the same, the special professional studies increasing in proportion toward the senior year.

The various fields of engineering overlap to such an extent that it would be impossible to classify more than nominally in these or other groups the work of most practicing engineers. This explains why it is that in each engineering course certain fundamental subjects are included which belong to the special field of another, as the steam and electrical work which are required in the civil engineering course. Many similar illustrations could be given of this broadening of each course along technical lines, which is carried as far as the various courses will permit.

It is for the student himself to obtain the widest possible view of other branches of engineering than the particular one he is studying.

There is, however, another thought for the engineering student to have constantly before him if he wishes to take full advantage of his opportunities and prepare himself for the larger fields of activity. A dictionary of authority gives the following definition of engineering: "The science and art of making, building or using engines and machines, or of designing and constructing public works or the like requiring special knowledge of materials, machinery, and the laws of mechanics."

A detailed definition of a ship using Noah's Ark as a basis would be open to substantially the same objections if applied to the "Oceanic," as is the above definition. It is quite true that both vessels would have the fundamental similarity of being able to float on water, and it is axiomatic that the engineer must have command of certain fields of knowledge.

In addition to this, however, the engineer must know how to deal with men and he must know the relations of men to one another as individuals and groups. Nearly every engineer is part of an organization and the higher executive positions require a knowledge of modern business methods. The engineering student, therefore, should endeavor during his college course to elect such subjects as will give him this larger training and better fit him for his profession, for with technical knowledge alone he will not advance a great distance.

You are here because you expect much from the University in training you for your future career, but remember that the University expects much from you. To do the daily tasks and pass the required examinations is not enough, for if you do no more than this you will be a disappointment to yourself, in having failed to take advantage of the opportunities either set before you, or which you can make for yourself, to obtain a broader and better view of life.

JOHN G. D. MACK.
Acting Dean, College of Engineering.

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Well, we're back again! We are back with more experience, more determination to accomplish something *this* year, more optimism. We are back with more or less permament good resolutions about the proper relation between work and play. And while our resolutions are strong let's subscribe to the Wisconsin Engineer! We want every student enrolled in the College of Engineering to subscribe, but not only to subscribe. We want him to *read* the magazine and to think about it. We want him to feel that it is his magazine and that it is a vital and necessary part of his course. If he feels that such is not the case, we want him to tell us what it seems to lack, to suggest improvements or additions. If every student will look at the matter as a business man considering an investment rather than as a man with a dollar trying to dodge a hold-up man or an impecunious friend, we feel that we will have very few refusals.

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You alumni, however, need not construe the foregoing to mean that the Wisconsin Engineer is intended solely for undergraduates. It is our ambition,—and not a fruitless one, judging from the number of last year's articles reprinted in technical papers,—to make the articles in the Engineer equal to those in the leading technical magazines. We think that the articles alone will make your subscriptions worth while. In our Alumini Notes we try to keep an up-to-date record of the changes in address and employment of all our alumni.. If we fail in this, it is because you have neglected to let us know of your changes.

If the question, "Why did you want to study engineering?" were put to each one of us, how would we answer it? Some would say that it was because an established engineering business or practice was waiting for them when they finished the course. Others would say that it appealed to them for its own sake, that they had always liked machinery, liked to plan and make things. Still others would say that they did not want to be a lawyer, doctor, merchant or clergyman, that engineering seemed a broad field, a strong man's type of work. Others would have combinations and variations of these reasons; some might produce some entirely different ones.

Behind them all, however, the one fundamental principle which dominates all engineers is at work. This principle may perhaps be termed constructive ambition. What engineer-to-be has not in his inmost dreams, felt himself swell with pride at his mental and successful completion of his masterpiece,—some great bridge joining districts once widely separated, some extensive irrigation project making the very desert bloom, some immense power-plant turning the mills of a state, some revolutionizing machine doing the work of twenty men. One graduate engineer stated his ambition, yet to be realized, as follows: "I want to be able to sit in a big cool office wtih my feet on a mahogany desk and charge the other fellow a thousand dollars for telling him that his work is all right." Through this phrasing his true ambition shows. He wanted to be an expert, a man recognized as having so comprehensive and thorough a grasp of his subject that other less experienced engineers should wish to seek his confirmation of their plans before proceeding with the actual construction.

The engineer must be ambitious. There is little room at the bottom of any profession. The lower rings of the ladder are crowded with weaklings imploring the stronger men to help them along. Here in the University the engineer receives the technical training necessary to his success. He is allowed to practice on short trial ladders with mattresses below so that those who fall shall not be severely injured. At the end of his course he is shown the real ladder. Where possible the University puts his foot on the first ring. It can do no more. Whether he goes to the top of the ladder, clings timidly to a low rung, or steps off to hunt for an easier path up, depends solely upon his determination to succeed. The man who would be satisfied to stop at the fifth ring will probable never get above the third. But the man who wonders if they have an extension on the top of the ladder that they will put up for his benefit,—and who will make one if they have not,—is the man who will get to the top and stay there. He is the true engineer, the man who dreams of success and, on awaking, goes out and builds up his dreams.

DEPARTMENTAL NOTES.

CHANGES IN THE ENGINEERING FACULTY.

Dean Turneaure, accompanied by Mrs. Turneaure and their son Stewart, sailed from Montreal in July for an extended trip abroad. They have visited England and are at present in France but will spend the larger portion of their time in Germany. The Dean will return at the end of the first semester, Mrs. Turneaure and Stewart remaining for the year. During Dean Turneaure's absence, Professor John G. D. Mack, will act as Dean.

The Engineer will publish in later issues letters from the Dean giving his observations.

Professor Leonard S. Smith of the department of Topographical Engineering is also on leave of absence for the coming year. Professor Smith and his family left for Europe, by way of Canada, early in August.

Professor Carl C. Thomas and family, who have been abroad during the past, year, will return to Madison in September. Professor Thomas has been engaged in scientific work. He has spent most of the time in Germany, but visited in Italy, France and England.

Professor Geo. J. Davis, Jr. has resigned from the Hydraulics department to become the Dean of the College of Engineering of the University of Alabama. Professor Davis is succeeded by Professor Charles I. Corp of the University of Kansas who did graduate work in hydraulics here in 1909-10, and who has since done summer research work in the Hydraulics Laboratory here.

W. J. Copp, '08, instructor in machine design has resigned to accept a position with the American Locomotive Co. He is succeeded by P. H. Hyland, Mech. Eng. Purdue, '09, who has been with the mechanical department of the Pennsylvania Railroad in the Ft. Wayne shops.

Mr. J. A. Cutler, '09, instructor in topographical engineering, has resigned to accept a position with the Johnson Service Company. He is succeeded by Mr. Morris, who has been instructor of surveying and descriptive geometry in Lawrence College, Appleton, Wis.

A number of changes have been made in the personnel of the Department of Electrical Engineering. Mr. C. R. Higson has accepted a position in the Engineering Department of the Salt Lake City Light and Power Company. Mr. Belsky leaves to take up consulting work with Mr. Harris, formerly of the Wisconsin Railway Rate Commission. Mr. H. B. Sanford becomes Instructor in Electrical Engineering at the Imperial Polytechnic Institute, Shanghai, China.

The new appointments to fill these vacancies are: the promotion of Mr. B. E. Miller, Instructor in Electrical Engineering; the appointment of Mr. Herbert Woolhiser, who graduated in Electrical Engineering at the University of Wisconsin last spring, as Instructor in Electrical Engineering. Mr. L. E. A. Kelso has been appointed Instructor in Electrical Engineering. Mr. Kelso is a graduate of the University of Missouri, class of '07, and since that time has been connected with the Telluride Power Company of Provo, Utah. Besides teaching Mathematics and Physics in the Telluride Institute, he has done considerable research work in connection with transmission problems for the Telluride Power Company.

Mr. Oliver W. Storey, '10, has been appointed instructor in chemical engineering, to take up work in metallography, metallurgy of iron and steel and the constitution of alloys. Mr. Storey has had two years of engineering experience; he is recognized as being one of the few experts in this country on the process of sherardizing and has occupied the position of chemical engineer for the National Metal Molding Company, of Pittsburg.

Mr. L. T. Richardson, '10, has for the past year or more been chemist for Armour & Company, of Chicago. He has been appointed Research Assistant for the coming year and will take up the product of electrolytic iron and investigation of various alloys made from it.

Mr. James Aston has recently resigned as instructor in chemical engineering to take a position with the University of Cincinnati in charge of their Metallurgical Department.

ALUMNI NOTES.

John W. Cunningham, '08, is Assistant Engineer of the Kittitas Reclamation District, a $5,000,000 irrigation project, in charge of all designing.

Edwin M. Ball, '09, has recently been promoted to the position of Superintendent of Mines for the Ishkooda Division of Tennessee Coal, Iron & R. R. Co., in charge of five mines with an average of 400 men on the pay rolls.

The graduates in Chemical Engineering for the past year are now located as follows:

John H. Wolfe, Rockford Gas & Electric Company.

R. G. Waltenberg, Department of Metallography, Bureau of Standards, Washington, D. C.

A. C. Shape, Mineral Point Zinc Co., Sulphuric Acid Department, Depue, Ill.

A. C. Pope, Mineral Point Zinc Co., Roasting Department, Depue, Ill.

E. H. Carus is in Europe where he intends to take graduate work in mathematics at Cambridge, England.

H. H. Rogers is with the Tanning Company, Rockford, Ill.

J. N. Lawrence, Ph.d. '12, is with the Research Department of the General Electric Company, at Pittsfield, Mass.

Some of last year's graduates in Mechanical Engineering are at present located as follows:

E. F. Week,—Mr. John Strange, Neenah, Wis.

C. E. Bennett,—State Insurance Department, Madison, Wis.

J. Fraser,—with his father in the Engineering business in Milwaukee, Wis.

C. J. Jacobson,—Structural Steel Co. Pittsburg, Pa.

F. C. Ruhloff,—The Bucyrus Co., South Milwaukee, Wis.

O. G. Ward,—Johnson Service Co., Kansas City, Missouri.

F. R. Zimmerman,—Johnson Service Co., Chicago, Ill.

F. W. Braasch,—In the woodworking business, Sheboygan, Wis.

To the Alumni and Students of the Engineering College

THE WISCONSIN ENGINEER is the University agent for the following technical Periodicals:

Engineering Record
Electrical World
Electric Railway Journal
Practical Engineering

When you subscribe to any of the magazines, we would appreciate your doing so through The Wisconsin Engineer.