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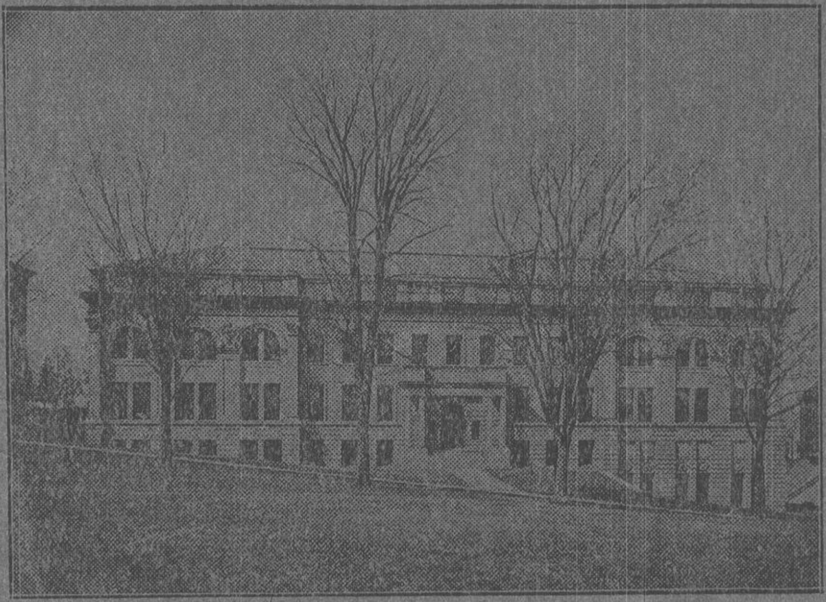
THE WISCONSIN ENGINEER

VOL. 6 APRIL, 1902 No. 3



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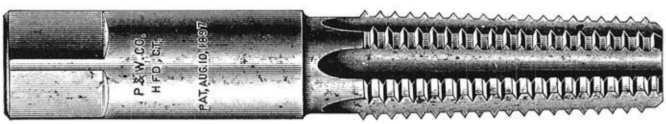

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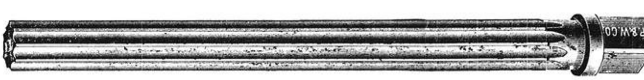

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Published Quarterly by the Students of the College of Engineering, University of Wisconsin.

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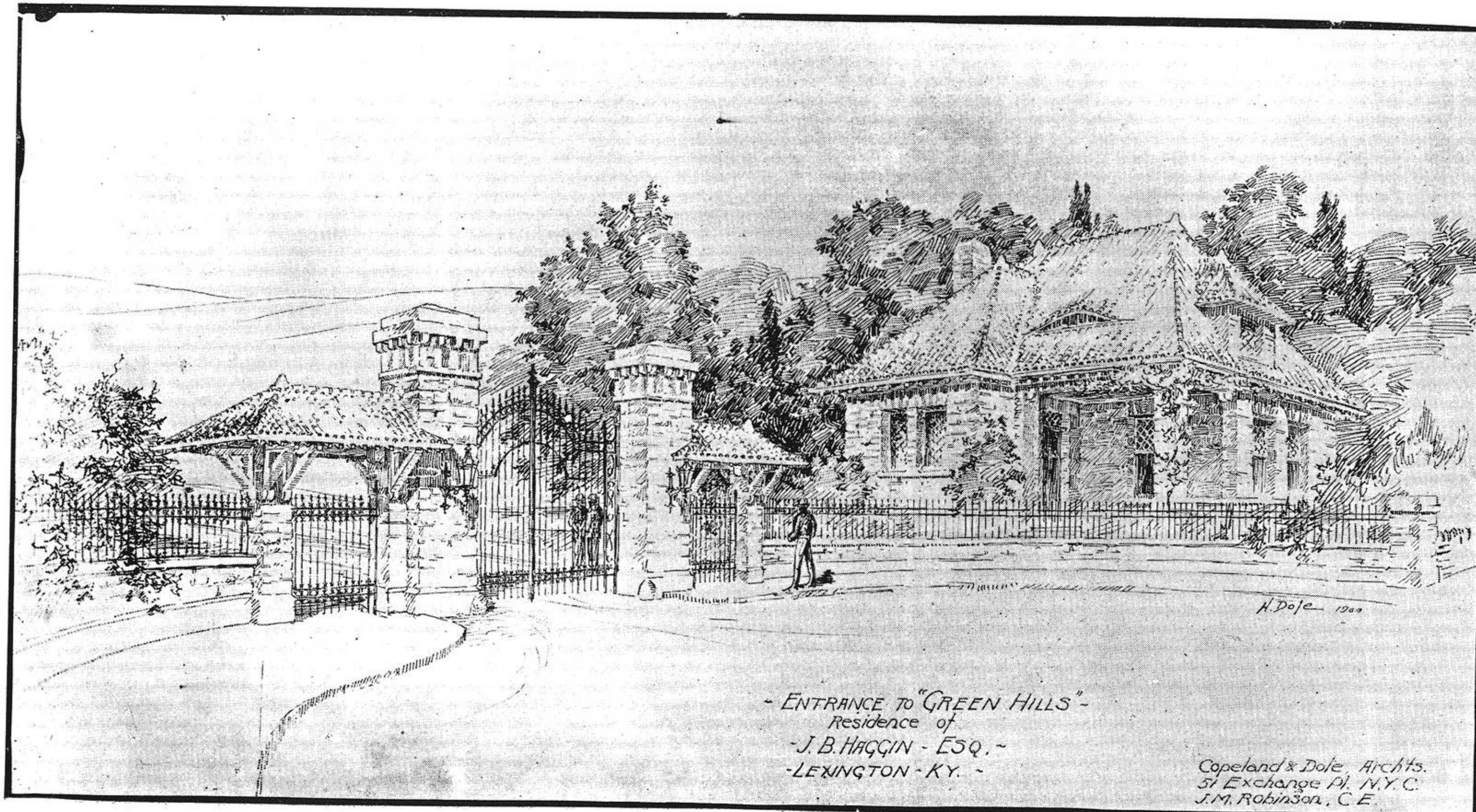


- ENTRANCE TO "GREEN HILLS" -
Residence of
- J. B. HAGGIN - ESQ. -
- LEXINGTON - KY. -

THE WISCONSIN ENGINEER

VOL. 6. APRIL, 1902. NO. 3.

THE NEW EDUCATION.

Remarks made by Dean Johnson at a banquet held in Chicago, March 19, by the American Railway Engineers and Maintenance of Way Association.

GENTLEMEN: I come to present to you the greetings of the members of another society having a name nearly as long as yours, the Society for the Promotion of Engineering Education. With your permission I will consider that I stand here to-night in a merely representative capacity, and that I am asked to say a word on behalf of my co-workers who are devoting their lives to the training of men who will know what to do and how to do it. It is my privilege, therefore, for the moment, to stand as the representative of your own alma maters and of those numerous agents and engines of progress which the technical schools have become.

The old education looked backward and plumed itself on teaching over again and again the learning of the ancients. The new education looks forward and prizes only what can be of some use either to ourselves or to our children.

The old education was prized as an ornament, a kind of mental adornment, or decoration. The new education is prized as a powerful tool, as a means to an end, as an instrument of pleasure and profit to oneself and of service to the world. The old education was "flat, stale and unprofitable," so far as intellectual and material progress was concerned. The new education is instinct with life and progress and has already supplied the keys to some of nature's profoundest secrets.

The old education was haughty and aristocratic. The new education is humble and democratic.

The old education prized the useless and despised the useful. The new education cultivates the useful and neglects the useless. The new education recognizes that "whatever is mean enough to vex the lowest man is not too mean to receive the attention of the wisest."

The old education was fixed and unyielding. The new education is flexible and readily adapts itself to new demands. And these demands are ever changing. Fifty years ago such technical schools as we had, taught but very few subjects, and these in a very elementary way. To-day the subjects taught have increased to hundreds, and these are gone into with great thoroughness. The result is, of course, a division of the work of these schools into many courses of study, only one of which can be covered in four years time. Of necessity the work of the schools must increase with the increase in scientific knowledge and with its practical applications. In America our engineering schools are keeping well abreast of the demands of commerce and industry in most directions. In some we are lamentably behind these demands, as in the chemical industries, for instance. We have very few schools in which chemical engineering is adequately taught. But notwithstanding the great number of these schools of engineering, all of them overcrowded with students, they fall far short of supplying the demands of their graduates. The time is near at hand when the schools will be asked to supply men for all the leading positions of trust and direction in the fields of industry and commerce, both constructive and operative. I am almost daily in receipt of requests for graduates of the college of engineering which is under my charge, almost none of which can be complied with. Most of our men are placed before they graduate, and some receive such flattering offers that they do not remain to graduate. I have seen a positive revolution in the West in this particular in the last ten years, and I never expect to live to see the day when this demand for highly trained men in pure and applied science will be even approximately satisfied in this country. The demands will increase more rapidly than the schools can supply them.

But for every highly trained man, such as the engineering colleges are turning out, there is need for a dozen men of less training, such as our high schools and manual training schools turn out, and for every one of these there is need for a dozen others having special training in their particualar trades or vocations. In this last particular America is woefully behind Europe. We can not copy their trade schools because we cannot predict in advance what an American boy is coming to. His career is not determined for him before he is born as it commonly is abroad. We must be careful to leave his career entirely open at the top. Our greatest men in all lines have come from the most lowly beginnings, simply because their careers were open at the top. This now is the great American educational problem: What kind of industrial and industrial-art education can we fit into our free democratic institutions which will aid the born artisan to become a master of his art without withholding from the more talented ones that higher learning which they need to fit them for the leadership in the great fields of statesmanship, industry, commerce? To this problem many of our educatorsand philanthropists are devoting most earnest thought. This is Mr. Carnegie's problem at Pittsburg, and this is the problem which is staring all our manufactures in the face. The old apprenticeship system is dead, and we have nothing to take its place. What are we going to do about it?

However, you are not manufacturers except as you manufacture transportation, but your problem is quite similar. Whether you take a graduate from an engineering college, or from a manual training school, or a high school, or from a grade school, you still have to teach him the practical side of your business, or else let him learn it by dear experience, dear that is to say, to the company.

Some fifteen years ago I sat in Baltimore, for many days, as one of a group of men who were asked to lay out a school for the training of men for all branches of the railway service. This was then fathered by the B. & O. Ry., but before the elaborate plan we formulated could be inaugurated the bottom fell out of that corporation, and the school was never heard of again so far as I know. I guess that school proposition was the last straw that broke the camel's back, and this may explain why no other similar proposition has been since proposed. Something, however, I think every railway corporation could do to give systematic and competent training to their employees of every grade, and I have no doubt many of you are feeling your way in this direction. It stands to reason that what can be learned can be taught, and that if properly taught it is much better and quicker learned than if every man must blunder into this knowledge through his own sad failures. If "it is a fool who learns only by experience," it must be idiotic to force men to learn only in this way. A wise man learns by the experience of others, *if he can.* But if the experience of others is shut out from him, what can he do but to gain experience for himself? And what is the imparting of the experience of others but the highest and most effective teaching? And where there is systematic teaching is there not a school?

My argument comes to this, that the present organized public and technical schools must of necessity be supplemented by schools of practice, where practical experience along particular lines can be systematically taught by those who have had this experience to those who have not had it, so that these may profit by the experience of others. This work cannot and should not be put upon the schools which give themselves to the teaching of the scientific foundations of the given employment. All our technical schools now undertake to make their science teaching practical, and available to the students, by having them carry out or test in the laboratories, all the principles taught in the class rooms. They also get a very considerable amount of shop and field experience, besides practical designing in the drawing room, but all this serves only to make vital and concrete the theoretical instruction. The knowledge of actual practice can only be acquired in the practice, but some systematic means of acquiring this knowledge could usually be provided. My friend Onward Bates, whom you all know, did for many years conduct something of this sort when he was with the C. M. & St. P. Ry., and I think to great profit both to his employees and to the company.

It is to this union of scientific and practical education that Germany owes her wonderful industrial and commercial development. Without natural resources or a large home market, she has risen in the past twenty-five years to be the third commercial nation in the world. On the other hand, England, with neither a scientific nor a practical education worthy the name, and with no education whatever corresponding to that given in our public high and manual training schools, England, I say in the absence of these educational facilities is steadily losing ground in all the lines of trade and manufacturing. The future of England is indeed dark, and all, as I conceive it, from their gross neglect of the new education. They have stood still while the rest of the Anglo-Saxon and Teutonic world has gone rapidly forward. And while they are now alarmed they are making very little progress towards remedying their faults. Educational institutions are the most conservative of all human agencies. A general educational policy and practice is a matter of slow evolution. England cannot, if she would, now quickly change her course. And before she can possibly put herself in line educationally, her leading manufacturers will have retired from business and most of her ships will have disappeared from the sea. A hundred years from now and England will have ceased to be a world power, and all because of her educational blindness, as I see it.

In many respects our American educational system is nearly ideal, and its rate of development in its higher departments is phenomenal. We now have a veritable educational mania in this country. It remains only to wisely direct its course.

With our new imperial sway and responsibilities many new educational demands are made upon us. We are, however, rising to meet these demands. We are establishing high schools and colleges of commerce in which foreign languages, commercial geography, business organization and management, banking and finance, political economy, commercial and international law, consular duties and regulations, and many like subjects are taught systematically. Pure science is taught in all our secondary schools and in all our colleges and universities, while the applications of science to the needs of society are effectively taught in more than a hundred technical schools of college grade. If now we can devise and establish a general system of schools for artisans, in which the scientific ground-work and manual practice of these respective vocations are adequately taught, then shall we see in this country such a rate of progress as has never been witnessed or even dreamed of. With our inventive genius, our ambition to rise, our splendid initiative, our industrious habits, our free institutions offering the highest rewards to the most lowly born, our invigorating climate, our infinite resources, our tremendous home market, our public libraries, and our training schools of all kinds and grades, both theoretical and practical, by which the rising generation is constantly placed in the van of the world's progress, with these glorious opportunities and conditions all conspiring in our favor, there comes to us almost in spite of ourselves, the joys and the responsibilities of the world's leadership which we cannot shirk and which it behooves us to prepare for as no nation has ever been called on to prepare hitherto. And the making of this preparation is the work of The New Education.

A DESCRIPTION OF THE FEEDER REQUIREMENTS AND INSTALLATION ON THE ELEVATED SECTION OF THE BOSTON ELEVATED RAILWAY COMPANY'S SYSTEM.

C. H. HILE, '94, SUPERINTENDENT OF WIRES.

The elevated structure over which the Boston Elevated Railway Company began operating its elevated car service June 10th, 1901, comprises 15.62 miles of track, lying between the Dudley St. Terminal at the southern part of the city, and the Sullivan Sq. Terminal at the north.

The general plan of the route shows a loop in the heart of the city, using the Subway for the western leg and comprising 4.44 miles of double track, while north and south from the loop double tracks extend 1.66 miles to Dudley St. Terminal and 1.71 miles to Sullivan Sq. Terminal.

The running distance between the two terminals is 5.015 miles, via the Subway, or 5.567 miles, via the Atlantic Ave. leg of the loop.

The running time between the two terminals via the Subway is twenty-two minutes, the trains making nine stops.

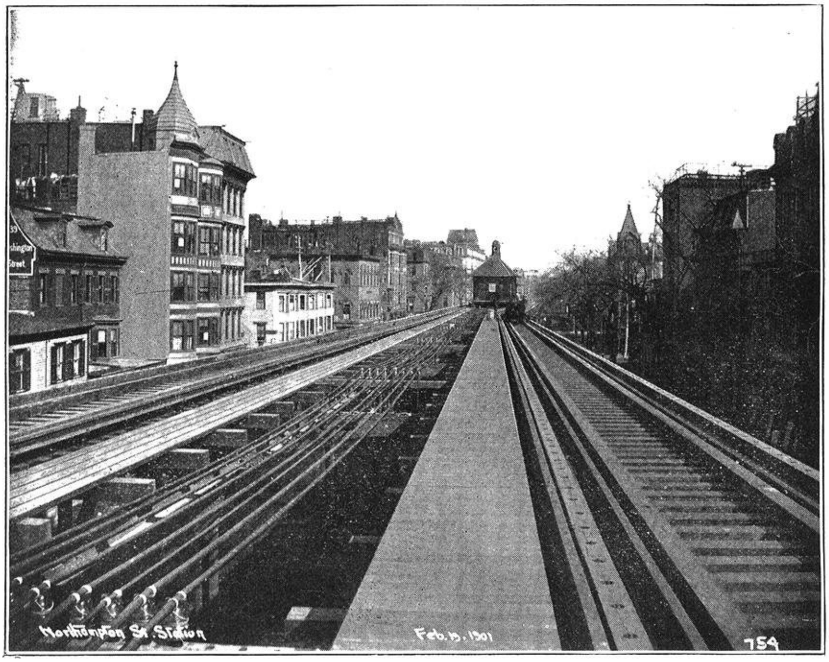
The Subway is used by the elevated trains for a distance of 2.32 miles, and in thus using the Subway as a part of the "L" route, trains must pass from the level of the elevated structure, at an average of sixteen feet above the street to the Subway level of about nineteen feet below the street surface.

Within the 2.56 miles of the so-called Subway section of the elevated system, trains take grades varying from three to eight per cent. for twenty-nine per cent. of the total distance run, and pass around curves varying in length of radius from 1,600 feet to 90 feet for fifty-four and six-tenths per cent. of the distance run.

The maximum train service for the present, and immediate future, is intended to furnish four car trains on two or three minutes headway on the main line, and three car trains on seven minutes headway on the loop, thus giving about twenty-four trains on the line at one time.

Each car is 46 feet 10½ inches over all, weighs when fully equipped 29.5 tons. The cars are equipped with two 150 H. P. motors.

The trains are operated on the Sprague multiple-unit system. The average power consumed by each four-car train is 219 K. W. at the switch-board, or a current consumption



of 368 amperes. The maximum power consumption for one four-car train accelerating on one of the five per cent. grades is 924 K. W. or a current consumption of 1,700 amperes.

With the trains operated under the foregoing conditions the power required to operate the entire elevated system is, on an average, 4,718 K. W., or requiring an average current consumption of 7,929 amperes. This includes power for light and heat in the cars.

It is the object in this paper to treat only of the electrical equipment of the elevated system, so far as the transmission of power is concerned.

The power for the system is furnished from three of the Company's power stations, all in the vicinity of the structure, one feeding in on the southern section at a point about one and two-tenths miles from the Dudley St. Terminal, another

feeding in on the Atlantic Ave. leg of the loop, and the third feeding in at the northern end of the systen or at the Sullivan Sq. Terminal.

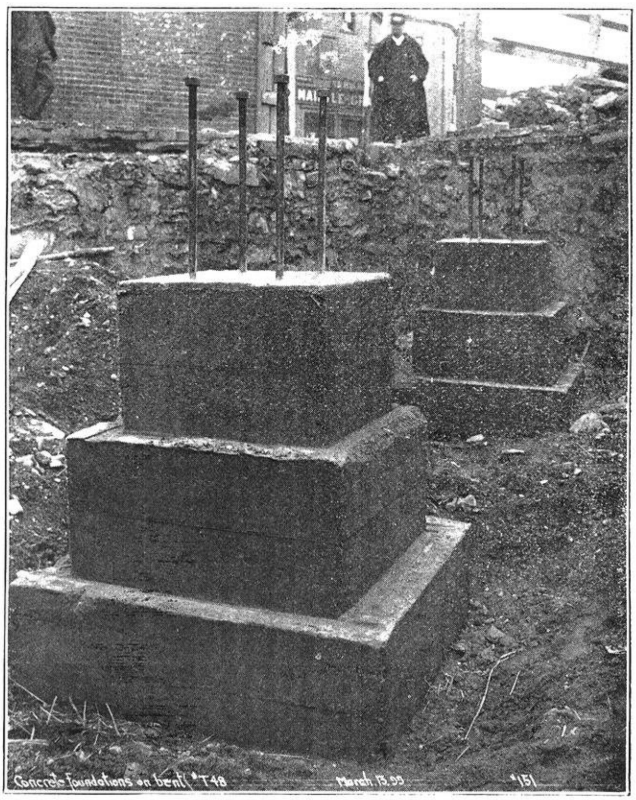
The feeder system may be divided under the following heads:

Feeder Mains, Third Rail, Feeder Connections, Return System.

Feeder Mains:

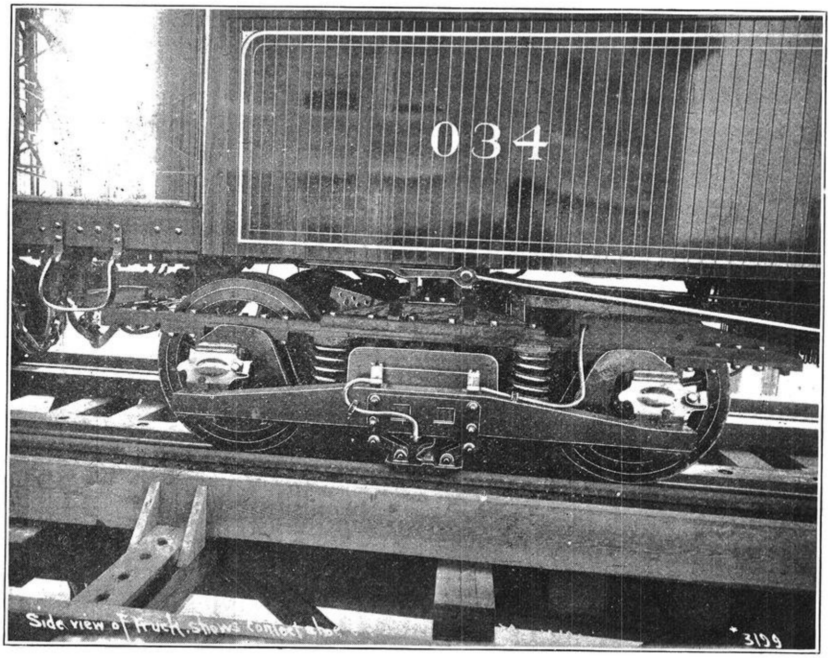
In calculating the copper required for transmitting the power to the motors, a 2,000,000 c. m. wire was determined upon as a unit in the feeder system.

At the switch-board each feeder panel carries one carbon break circuit breaker, having a capacity for carrying three thousand amperes continuously without overheating, one ammeter measuring up to six thousand amperes, and one quick break switch having a capacity of three thousand amperes continuously without overheating.



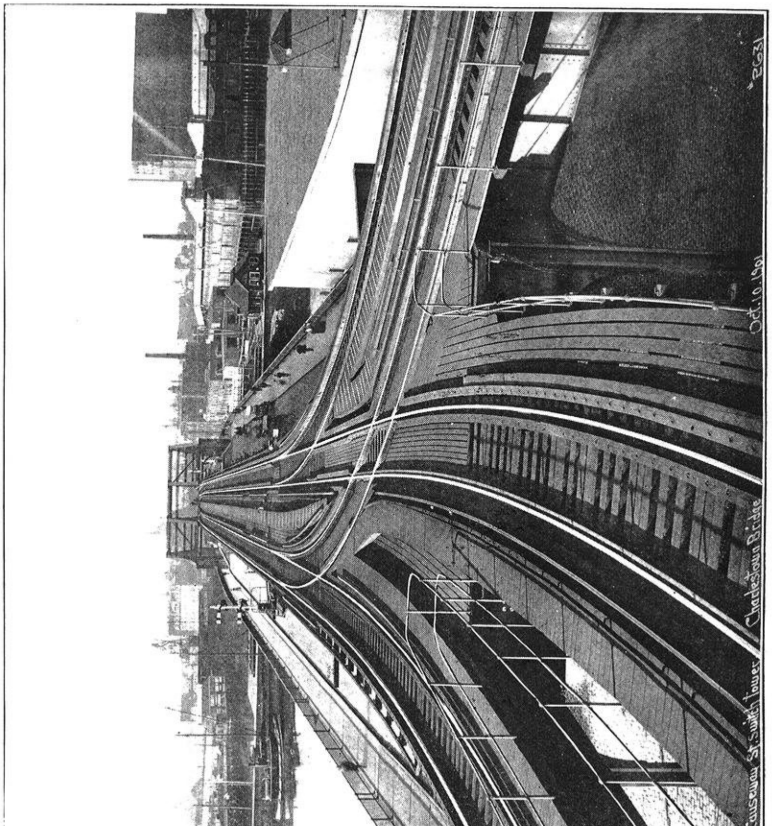
The power is carried from the station to the elevated structure using 2,000,000 c. m. lead covered rubber insulated cables, which are drawn in conduits built of vitrified clay pipe.

The conductor in each cable is insulated with five-thirty-seconds of an inch of rubber compound, covered with a tape and protected with a lead covering one-eighth of an inch in thickness.



At each end of the cables, where they are carried through the vault of the station to the switch-board and up the posts of the elevated structure to the bare feeders, it was deemed desirable to discontinue the lead covering and splice on from forty to sixty feet of rubber insulated triple braided wire. At the structure end the cables are carried from the man-holes, which are built about the bottom of the elevated supporting posts, on the inside of the posts, being insulated from the iron by wood supports. The cables terminate in switch boxes placed on the structure, where they terminate on switches, which makes it possible to cut out a cable from the feeding system at any time, for making tests or repairs.

The feeder mains on the structure leading out from the


Causeway St. Switch tower. Charlestown Bridge
Oct. 10. 1901
#2631

switch boxes are 2,000,000 c. m. bare copper wire, concentric laid and made up of sixty-one tinned copper strands.

These are carried along the structure in enclosed feeder boxes built between the tracks and having a capacity for six feeders. The feeder boxes run parallel with the tracks throughout and are closed at the sides and top. The top covering is built in sections of planking laid crosswise and tightly fastened together. Each section is about five feet in length and can be easily and quickly removed when it is necessary to get to the feeders. The feeder boxes with their top covering affords a safe and convenient walk along the tracks.

The supports holding the box are placed about every six to eight feet and inside the box are used to hold the the wood pins which carry the insulators, which, in turn, support and protect the feeders.

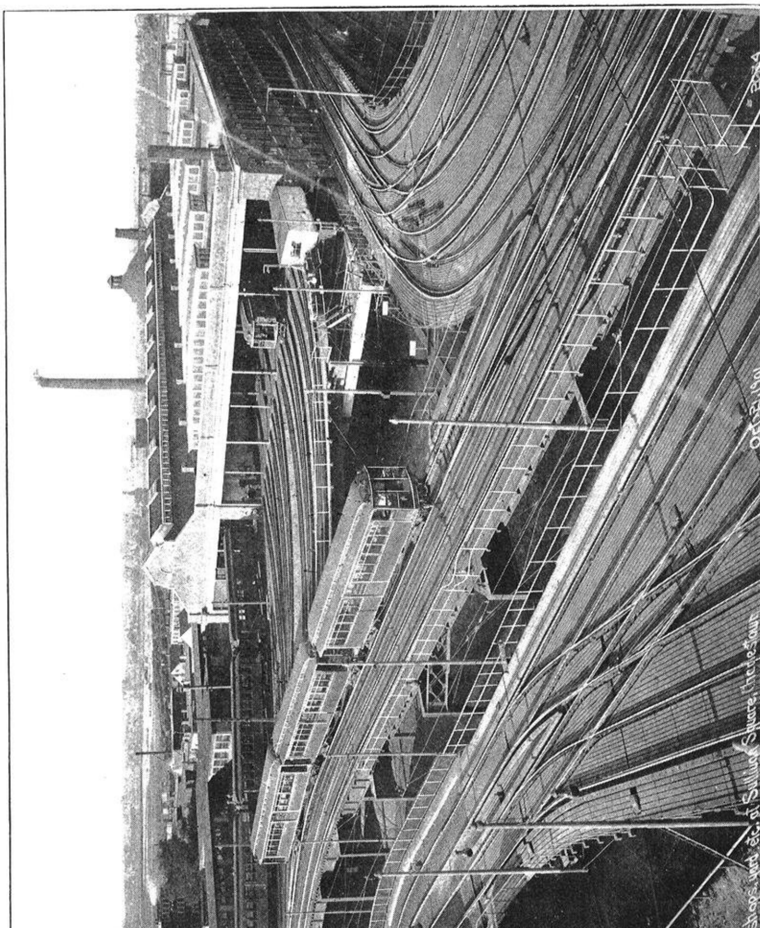
The wood support on which the boxes are built, the locust pins, and the glass insulating supports, constitute the means by which the bare wires are insulated from the structure.

Third Rail:

The so-called third rail system is used in transmitting the power from the feeder system to the cars. Each car carries four contact shoes, carried outside the forward and rear trucks and hanging at such a distance as to come in contact with the third rail, which is so placed outside the running rails that its contact surface is $19\frac{1}{8}$ inches from the guage of the running rail and, approximately, 6.2 inches above.

An ordinary "T" rail eighty-five pounds to the yard, is used for the third rail. It is supported on specially designed insulators built up of malleable castings with "Aetna" insulation between the upper and lower parts. These chair insulators are placed on the end of every third tie, which is about fifteen inches longer than the regular ties, and are held in place by lag screws.

At each joint the third rail is bonded with the short "protected" type of rail bond, enough bonds being used to bring the joints up to the same carrying capacity as the rail.


Car shops, yard etc. at Sullivan Square, Charlestown. Oct. 21, 1901.
2034

At all special work and cross-overs, where the third rail must be broken, cast iron run-offs are fastened to each end, and the continuity of the rail as a feeder is maintained by running a 1,000,000 c. m. rubber or weather-proof insulated wire underneath the structure and connecting with the ends of the rail by means of terminal or feeder tap bonds.

Feeder Connections:

The feeder taps or connections through which the power is transmitted from the feeder mains to third rail, are placed throughout the system at such points as the conditions require, and convenient for access. 1,000,000 c. m. and 500,000 c. m. rubber insulated triple braided wire has been used for making the connections, and all connections between the third rail and the feeder mains are carried through switch-boxes, so as to make it easily possible to cut out from the feeding system, either a section of the third rail or one of the feeders.

Return System:

The steel in the elevated structure throughout is used as a part of the return system. In addition to this, one rail in each track constitutes part of the return circuit.

The joints on the rail, which is of the eighty-five pound "T" type, are bonded nearly to the full capacity of the rail itself, and at five to six hundred feet intervals, the rail is bonded to the longitudinal girders of the structure.

One rail of each track is used as a part of the signal circuit and is, therefore, not available for the return system.

As the Company controls and operates all surface lines paralleling, crossing under and leading into the elevated system it has been found desirable to connect the elevated structure with the surface tracks and return wires at frequent intervals, thus giving a well balanced return system.

The same power stations feed both the elevated and surface lines, but through separate feeder systems.

PARTY LINES.

OSCAR M. LEICH, '98.

The enormous growth of the Independent Telephone Companies has made them a formidable competitor of the American Bell Telephone Company, which, due to the exclusive rights of the patents of the original Bell receiver, has gained such a strong foothold in this country during the earlier years of telephony.

This keen competition has made it necessary for both Bell and Independent Companies to endeavor to give the best service possible in order to keep their subscribers from changing to the 'phone of the opposing company and, at the same time give such service at a cost sufficiently low to enable them to get enough subscribers to make their exchanges remunerative.

As the biggest expense of a telephone exchage is the line construction, it is possible for the operating companies to furnish a telephone to the public at an exceedingly lower rental by putting more than one party on a line. So great is the saving that it was found advisable to put as many as sixteen parties on to one line when the distance of the furthest subscriber was five miles or over from the exchange.

The ringers were all of the polarized type and wound to a low resistance and connected so that normally they were all in series with the line. The generators in the subscriber's instruments were normally not in the line, but were constucted so that when the subscriber turned the crank to call central or any of the other subscribers, that generator by means of a mechanical device would also be brought in circuit with the line, when it was operated.

As it is necessary to have every bell of all the subscribers normally on the line, every bell was, of course, actuated when any one subscriber desired to call any of the remaining subscribers or central, when such a line terminated in a central exchange. Combinations of long and short rings had to be used to select the desired party which proved rather unsatisfactory and at the same time the impedance of the ringer coils, which were all in series with the line, cut down the voice currents materially, which made it impossible to get good voice current transmission.

When it became apparent that metallic circuits had to be used in order to give good talking service and that the line had to be kept clear from coils having impedance in series with the receiving device, the advantage of bridging the bells was soon realized. The practical limit of bridged bells was found to be about ten on one line; that is, bridging five from either leg of a metallic circuit to the ground, thus reducing the number of bells actuated when one of the subscribers was called to one-half of the total instruments on the line.

The magento calling device in the subscriber's instrument is supplied with a commutator to produce either a continuous or pulsating current and is constructed so that it will bridge itself across the two limbs of the metallic circuit and throw a line drop at the switch board (such lines usually terminate in a central exchange). This continuous, or pulsating current, will not have any effect on the bells bridged to ground as they are constructed so as to respond to an alternating current only, which makes it possible for any subscriber to call central without disturbing any of the remaining parties of that line.

The temptation for people to listen on a party line when one of the other parties is using his telephone seems to be a very great one, especially when the parties on the same line are neighbors. This, of course, cannot very well be avoided if the signaling is not selective or a complete lockout system used.

When the ringing is done selectively, that is to say, when one subscriber can be called without ringing the other subscriber's bell, the objection of the parties listening on the lines becomes a very slight one, as they soon get tired of taking the receiver and holding it to their ear waiting till a party is called. On the common battery systems this is eliminated altogether, as the subscriber signals the operator by removing the receiver from the hook.

The great advantage of selecting the signals has caused a great amount of time and work to be spent on apparatus to perform these functions and the number of patents issued up to the present time upon this particular branch of telephony amount to several hundreds. Nearly all of these patents pertain to so-called step by step methods or step by step selector systems.

These devices usually consist of a combination of magnets, rachets, springs, dials, and parts too numerous to mention, the complications of which will cause numerous errors, and, therefore, this method of selecting has not found its way into the practical telephone field.

On the larger switchboards of the present day it requires a complete set of multiple jacks for every three operators, and it is, therefore, very important that the amount of time required to connect two parties be as short as possible, enabling the operator to take care of a greater number of lines, thereby reducing operating expenses and first cost of multiple equipment.

Devices for selecting signals to call subscribers that require more time than the pressing of a key or button are, therefore, not found to be practicable in connection with modern exchanges.

For resident 'phones it is found that four parties on one line with selective signaling apparatus is still within the limits of good service and has given excellent satisfaction as far as the subscriber is concerned.

Some years ago the Bell Telephone Company began putting a four party line selective telephone in connection with its exchange, using ordinary polarized ringers as those used when alternating currents are applied, with an additional spiral spring on one side of the armature, keeping it on a bias and tending to pull it back to one position. If an intermittent or pulsating current is sent over the line in one direction, it tends to pull the armature of the polarized bell in the same direction as the spring and, therefore, the bell is not operated by that current. If such a current is sent over the line in the opposite direction, it will actuate the bell as the current is strong enough to cause the armature to be drawn to the other side, while it is flowing and the spring will return to its original position during the intermission of the current. In this way, two bells may be made to work selectively from one limb of a metallic circuit and two from the other limbs, making four altogether. This system works very satisfactorily in a laboratory, but when in actual service, there are so many difficulties to overcome that it is very apt to cause a great amount of trouble.

We will first take up this system in connection with common battery exchanges. It is necessary to have the signaling device normally connected to the line, so the operator may call the subscriber when desired, and, as the signaling at central station, by the subscriber, is done by means of current generated at the exchange, the line must normally be alive so that the subscriber may at any time signal the exchange operator.

The signaling of the operator by the subscriber is done by means of a direct current from a battery, and the signaling of the subscriber on single lines with an alternating current. On single lines, a condenser is, therefore, introduced in series with the bell preventing the battery current, which is normally on the line, from flowing continuously over the ringers which, otherwise, would be a great waste of current. An alternating current will readily flow over the condenser and actuate the bell and in this way the condenser plays a very great part in modern telephone systems.

Again referring to the four party line selective system, where the selection depends upon the direction of an intermittent current, a condenser cannot be put in series with the ringers in the subscriber's instrument, as the condenser will become charged during the period the current is on the line and discharge in the opposite direction to that of the charging current, thus putting an alternating current on the line which actuates both bells.

It is, therefore, necessary to introduce some high resistance in circuit with the bells and in practice six thousand ohm resistance spools wound with German silver wire are placed in series with the bells. This high resistance will, of course, not stop the battery flow altogether, and the current flowing over two bells in parallel is at times sufficient to keep the supervisory relay from releasing when the subscriber hangs up his receiver and thus interfere with the operator's supervision of the line when used as a two-party metallic. Many attempts have been made to keep the line normally clear from the grounded bells by relays bridged across the line with condensers in series, but the troubles that arise, due to the complication of relays, do not make this system a practical one.

Six thousand ohms in series with the bells also reduces the signaling current materially and since there is no reversal of the current when an intermittent current is employed, the armature has a tendency to stick to one side of the magnet due to the lines of force of the permanent magnet, making it necessary to use a spring strong enough to pull it back. This requires a very delicate adjustment and at times a material change of temperature will bring the instrument out of adjustment, causing the bell either to ring when the other subscriber on the same line is called, due to line capacity, or not to ring at all, even when the direction of current is such as would actuate the bell if the spring were properly adjusted.

The current for ringing the subscribers' bells is mostly supplied by a power generator, the intermittent current being produced by splitting a collector ring and replacing one-half of it by an insulating material. It is necessary to place this collector ring in such a position on the shaft that the current is cut from the line as soon as it tends to reverse.

The load of this ringing generator is apt to vary considerably, depending upon the number of operators ringing at one time. This change of load will shift the plane of commutation and as it is not possible to have this collector ring shift with the plane of commutation, a small quantity of current is apt to be sent out over the line in the wrong direction, which at times is enough to actuate both bells on one side of the line.

The instruments in connection with generator call exchanges, require no condenser in circuit, as normally the line is not kept alive by a battery current. There are, however, other difficulties to overcome, and the chief one of them is that the bells are very apt to ring when one of the subscribers signals central by means of the generator in the instrument. A low wound drop at the switch-board bridged across the line will overcome this difficulty to a great extent, but is apt to cause trouble with the signaling of the operator.

Three bar magnet generators are commonly used in subscribers' instruments for local work, and in many of the smaller Bell Exchanges, where this system is used, you will find two of the magnets removed from the generators so the current will not be strong enough to effect the other subscribers' bells, which usually have a three thousand ohm resistance coil in series; and here is where the greatest trouble arises, as in wet weather some of the lines will become slightly grounded and the subscriber cannot signal central, due to the weak generators in their instruments.

When a subscriber cannot get central he knows that his telephone is out of order, or that the operator is neglecting her duty, but if the operator is unable to call the subscriber, an inspector may be sent out to repair the line or telephone without having the subscriber know that his 'phone was out of service.

This system seems to be very limited and we can hardly expect any improvements on selective signaling systems operated by means of current of different polarity as some of the best and most expert telephone men of this country have developed this system and spent much time on it; in fact, most every leading telephone man has spent more or less time on selective signaling systems.

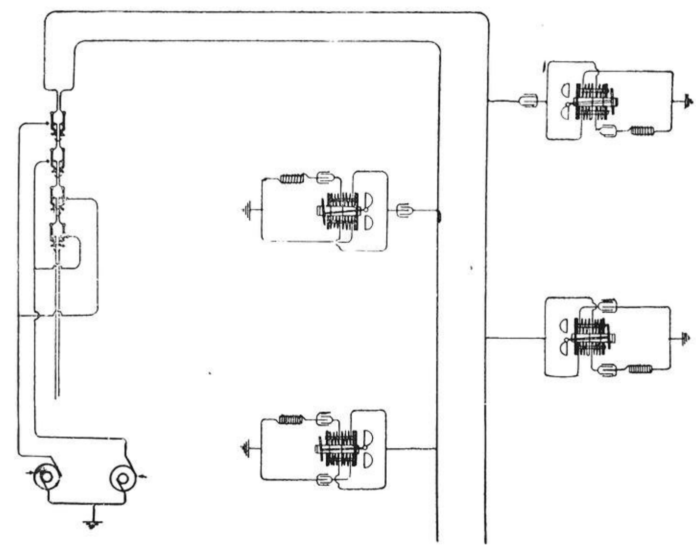


FIG. 1

We shall now take up a system that has been developed within the last year and which is simple enough to come into quite extensive use.*

The principle upon which this system is based depends upon the great change of impedance offered to the flow of an alternating current by a condenser and an impedance coil in series when the frequency is altered, and also upon the phase relation of the currents in the differential windings of the bells.

This large variation of impedance and change of phase re-

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*Leich Four Party Selective Station. Electrical World & Engineer, Vol. 38, July 27, 1901.

Selective Signaling System for Telephone Party Lines. American Electrician, Vol. 13, October, 1901.

A Four Party Line Selective Telephone Signaling System. Electrical Review, Vol. 39, Nov. 2, 1901.

The Construction of Small Telephone Exchanges, by A. E. Dobbs. Electrical Review, Vol. 40, Jan. 25, 1902.

lation precludes the possibility of the device being at all marginal.

Due to the relative change of impedance in the differential windings, the distribution of current there through may be varied by changing the frequency, making it possible to cause a bell to operate or remain silent on any desired frequency.

Fig. 1. shows diagrammatically a metallic line associated with four selective bells and a four way ringing key, the cord circuit and the subscriber's talking sets being omitted for the sake of clearness.

The first bell on each side of the line is adapted to ring when a current of a low frequency (16 cycles per second) is sent over that line, and the second bell when a current of a higher frequency (26 cycles per seeond) is used.

One of the low frequency ringer windings is in circuit with a condenser and an inductance coil which are so proportioned that they will neutralize at a frequency of 26 cycles per second. A high frequency current will divide equally through both of the windings of the low frequency bell and not ring it; but a low frequency current is stopped by the high impedance thereto by the condenser in circuit of one of the windings, so that the greater portion of the current will flow through the remaining winding and thus operate the low frequency bell.

In the high frequency bell, one winding of the two differential windings is again included in circuit with a condenser and an inductance coil, proportioned to neutralize at the high frequency (26 cycles per second), while the other winding is included in circuit with a condenser. As the impedance offered by the condensers, which are in circuit with the two windings of the high frequency bell, to the flow of the low frequency current is very great, this low frequency current will divide equally through both windings and not operate the bell, as the impedance offered by the inductance coil is very small at this frequency (16 cycles per second). The high frequency current will flow readily through the winding included in the circuit with the condenser, and the inductance coil as the capacity and inductance neutralize on this frequency; the flow of this current through the other winding is greatly impeded however, by the condenser in circuit therewith, so that this high frequency current divides through the two windings sufficiently unequal to operate the bell.

The advantage of this latter system are as follows:

1. Instruments have no springs that need adjustment.

2. There are no relays to get out of order.

3. The Bells have condensers in circuit to prevent battery loss.

4. Line Inductance and capacity, as met with in practice, do not interfere with its operation.

This system is totally distinct from the so-called tuned or Harmonic systems, such as that gotten out by Professor Elisha Grey, prior to 1876.

His method consisted in tuning a number of reeds similar to the tongues of a music box. These tongues would respond only to currents of certain frequencies. While this seems an easy solution for Selective Signaling, there are quite a number of difficulties to overcome in practice, and although the Patent Office was flooded with applications for patents on systems of this kind about twenty years ago, it has never been applied to any extent.

A Selective Signaling system adapted to only one particular form of switchboard system could not come into very extensive use, as the common battery or so-called Central Energy Switchboards, differ widely as far as their circuits are concerned, some having one side of all the metallic lines a common tie, some with both sides permanently tied through impedance coils to each side of the common battery, etc.

The difficulties to overcome are too numerous to mention and the problem of selective signaling adapted to all exchanges is indeed a hard one.

ENGINEERING IN CUBA.

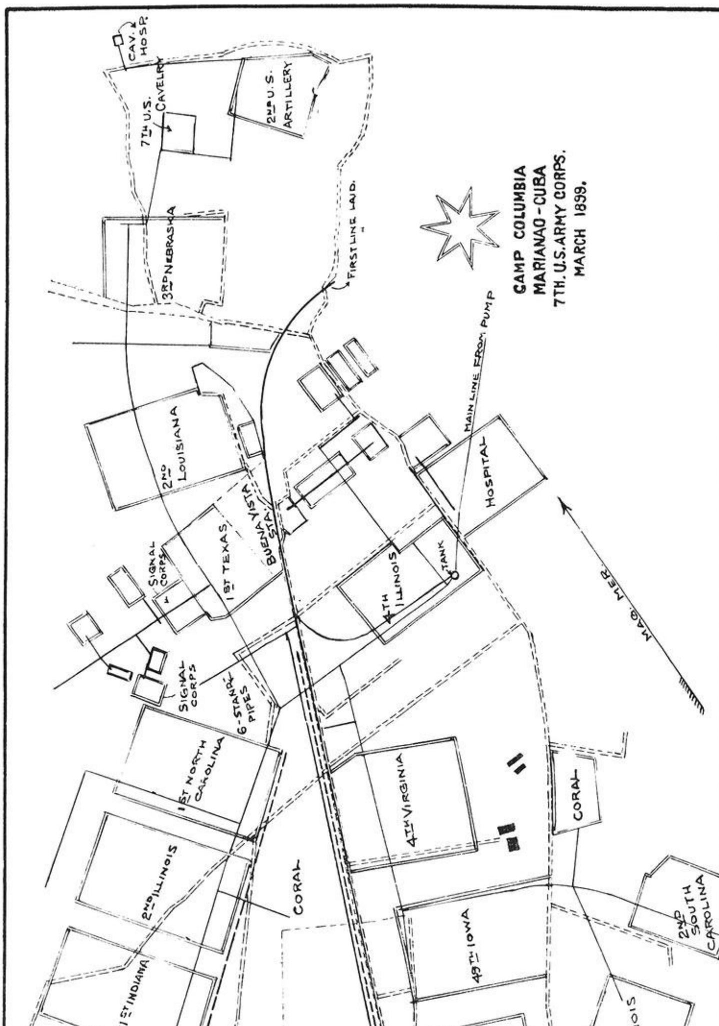
C. J. CARLSON, U. W. '96, 1ST LIEUT. 2ND U. S. V. ENGINEERS.

The following article is an extract from a field order of the 2nd W. S. V. Engineers, and deals with the water and sewage systems of the army camp at Quemador, Cuba; that being the particular branch of work which the writer had in charge.

A detailed account of the variety and amount of work performed by the engineering branch of the army would be of vast interest, as it would deal with that part of army life of which least is known; space, however, will not permit.

Work similar to ours was performed at Montauk Pt., N. Y., Middletown, Pa., Huntsville, Ala., Savannah, Ga., Augusta, Ga., and Honolulu, H. I. In one particular the water department was very prominent. The newspapers never ceased harping on "the insufficient water supply," and "the water is so polluted it cannot be used, not even for stock," whereas, if a little time had been spent in investigation, the falseness of such statements would have been apparent. I have had newspaper men visit with me in my tent, drink of the water, pronounce it excellent, and then immediately write a "sensational" on "the impure water supplied to our soldiers." If a small leak occurred in one of the branch lines they would immediately report the system crippled. They were there for the sensational news and fulfilled their contract. Where can clearer or purer water be found than that supplied abundantly by the celebrated Venta Springs? This, however, is in the past.

Most of the laborers employed on the water and sewerage system were either Cubans or Spaniards; our men acting as gang foremen. At different times large numbers of soldiers were used on the work. In some cases interpreters were used as gang foremen, but as a rule we found it more convenient


CAMP COLUMBIA
MARIANAO-CUBA
7TH. U.S. ARMY CORPS.
MARCH 1899.
CAV. HOSP.
7TH U.S. CAVELRY
2ND U.S. ARTILLERY
FIRST LINE LAID.
3RD NEBRASKA
2ND LOUISIANA
MAIN LINE FROM PUMP
HOSPITAL
BUENA VISTA STA.
1ST TEXAS
SIGNAL CORPS
4TH ILLINOIS
TANK
MAG. MER.
SIGNAL CORPS
6-STAND PIPES
1ST NORTH CAROLINA
4TH VIRGINIA
CORAL
2ND ILLINOIS
CORAL
2ND SOUTH CAROLINA
49TH IOWA
161 ST INDIANA
9TH ILLINOIS
6TH MISSOURI
FIRST MAINE HEAVY ARTILLERY
2ND ENG'RS
SWIFT & CO.
2ND DIVISION HOSP.
QUEMADOS STA.
CORAL
DET. HOSP.
ENG'R HEADQUARTERS.
MARIANAO
HEAVY SOLID = WATER MAINS
" DOTTED = SEWER "
DOUBLE " = ROADS OR PATHS.

to study the languages and deal with the laborers direct, the interpreter not always being honest or reliable in their services. Prices ranged from \$.75 for helpers to as high as \$2.25 for mechanics per eight hour day. Interpreters received \$3 or \$3.50 per day.

Our Cuban camp work began the day we left Port Tampa, Fla.; the journey over being employed in making drawings and estimates for camp material, barracks, etc. The article, therefore, begins with that date. We left Port Tampa, Fla., Nov. 14, '98, on the steamer Marcotte, arriving at that quaint old Spanish-English town, Key West, about dusk. After a two hours' stop we put out again bound for Havana. Shortly after daybreak the following morning we sighted the coast of Cuba and within a short time Havana could be distinctly seen. About 8:00 A. M. a pilot was taken aboard and about 8:30 we passed the old frowning fort Morro and anchored in Havana harbor, less than forty feet from the wreck of the Maine. Our detachment was the first American troops in the province of Havana and consisted of twelve officers and ten enlisted men (one of this company was Major H. J. McGrath, formerly military instructor U. of W., since killed in the Philippines).

The scene presented to us was not only picturesque and novel, but of intense interest as well, presenting to us the very center of Spanish rule in Cuba.

Quemados, a small village about seven miles southwest of the limits of Havana proper, was selected as our headquarters and remained as such during our entire stay in Cuba.

Nov. 18, two surveying parties were sent out to make preliminary survey for a camp site. The location finally chosen was to the north of Marianao Railroad extending for a mile and a half east of the road to La Playa and comprised an area of about four square miles. The survey of this tract was rapidly pushed. An estimate of the amount of pipe, fittings, tools, etc., for water and sewerage systems was prepared and submitted to Col. Willard Young and was approved by both him and Gen. F. N. Greene. The material was immediately ordered by telegraph. This estimate was based on a camp of six regiments and the system laid out for such. The original plan was modified somewhat as the camp, instead of consisting of six regiments was increased to sixteen, though not all of full strength. This increase necessitated another estimate for water and sewerage material.

The first order included pipe from ¾ to 10 inch diameter with fittings, valves, etc. Two 300,000 gallon pumps, two horizontal flue boilers with 50 foot stacks, a 66,000 gallon tank, a 24-inch screw cutting lathe, power pipe cutters, for 2-inch to 12-inch pipe, various sizes of wrenches, tongs and small tools and a 5 H. P. Mash Gas engine. The second order was sent Dec. 12, '98, by Gen. Humphrey, and consisted of 114,000 feet of block pipe (screw joint) ranging from 6,300 feet ¾-inch pipe to 20,000 feet 6-inch pipe, 1391 valves ¾-inch to 6-inch, 1600 ¾-inch Bibbs, 8910 assorted Ells T's and various fittings, 600 shavers and various small tools—stocks, dies, etc.

Dec. 7, '98 the first installment of water and sewerage material arrived but could not be unloaded for several days because of the congested condition of the receiving docks.

The pump-boilers arrived in Aerega Dec. 15, and was unloaded the following day. The tank was delivered in sections at Buena Vista about a week later.

The scheme for camp water system was to take water from the acqueduct supplying the city of Havana, at Cerro, about six miles from camp, and to pump and deliver it in the various camps, using tank pressure for system regulation.

All pipe used for both water works and sewerage was screw joint.

The main pressure pipe from pump to tank was 6-inch, while the main feeder from tank to system was 8-inch; feeding a two way main branch of 6-inch each, with laterals from these mains for each regiment or camp.

At the tank a by pass with 3 valves was installed so as to give direct pressure on line in case of fire.

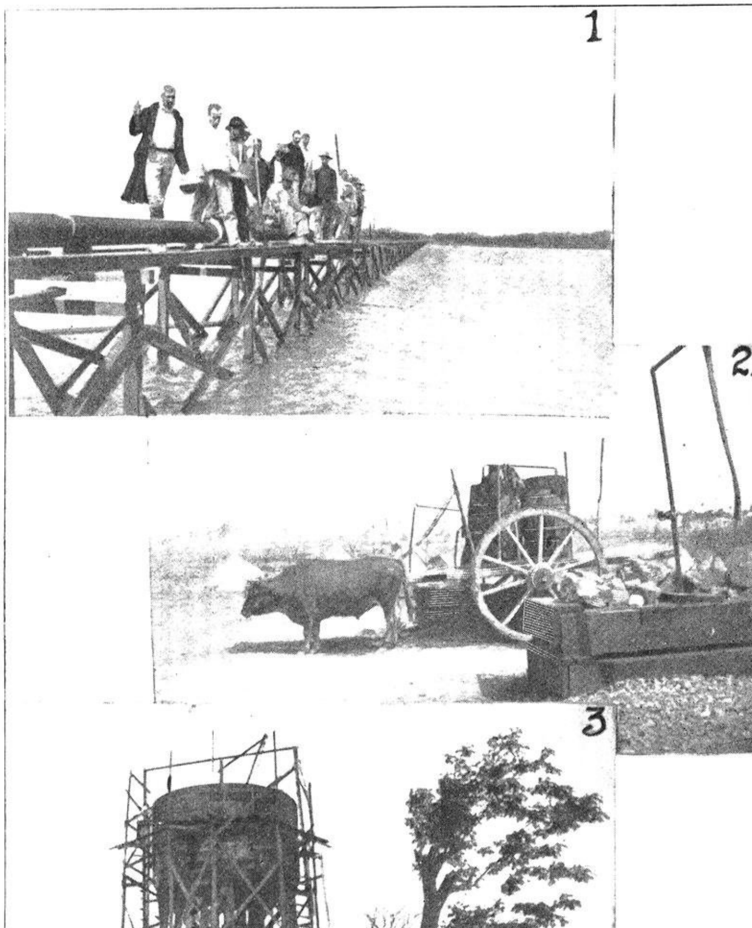
As it was necessary to get the system in operation as quickly as possible, it was necessary to take advantage of whatever would aid us regardless of cost. For example, the shorter run for main line from tank to pump was across country, from tank to Puentes Grandes, but by far the quicker route was via the railway right-of-way, for there we could take advantage of delivery direct from cars to where we wanted to use material, making but one handling. This route was therefore taken, the pipe being delivered at night between 11:00 P. M. and 5:00 A. M.; the direct route, however, was put in later, and this run via railway taken up. It answered its purpose, however, as we were enabled to get pipe connected up in about six days by this route.

Among the obstacles encountered in laying the main line, were the crossing of three railways and the Almandarez river. Pipe distribution began Dec. 14, and Dec. 15 connecting work was begun on the main line. The distance from tank to pump was divided into four equal parts.

At three intermediate points, two gangs were started, working in opposite directions.

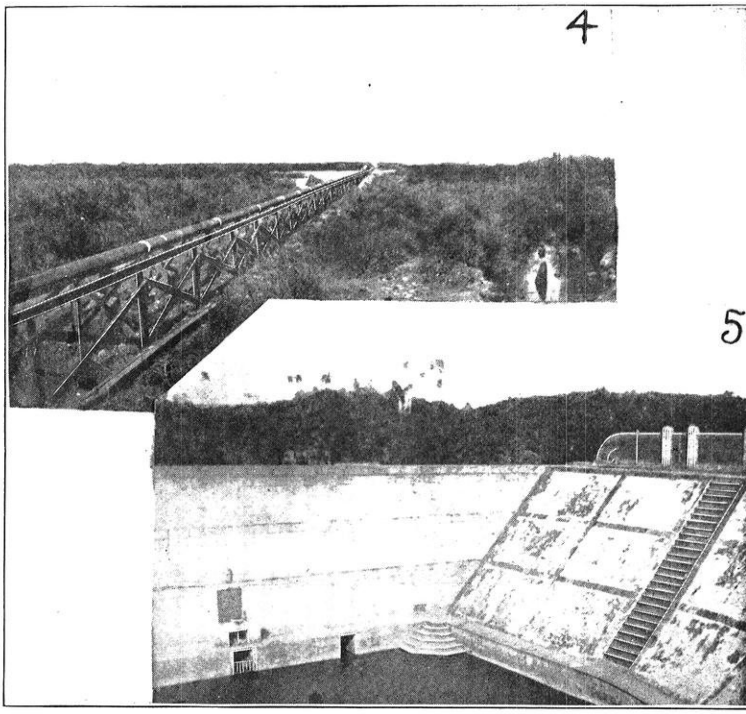
Gangs were also started from tank and pump respectively. Where gangs met large union connections were made. Three shifts were used, eight hours each, and each gang consisted of six men; a staller and five pipe men. Each gang was preceeded by a fitter who filed and fitted the threads so pipe would roll up easily, thus making pipe ready for gang. On this way each gang was able to put up about twenty joints per eight hour day or about 400 feet per gang. The main pipe was connected and ready, Dec. 21, 1898.

The two pumps were installed at Cerro, about 40 feet from the main acqueduct. The section pipe entering just above flow line with an L and strainer extended to near the bottom and turned in the direction of flow. As the pump end of pipe was about three feet below this flow line a gravity flow into suction chamber of pump was obtained. Boiler pressure carried was about 100 pounds, and pump pressure for line work about 75 pounds, which could be increased to 160 or 180 pounds for fire purposes. The placing of the 50 feet



1. Connecting Two Ends of Sewer with Flange, Union Extension Joints.
2. Method of Carrying Water, While Pipes were Being Laid.
3. Water Tower.

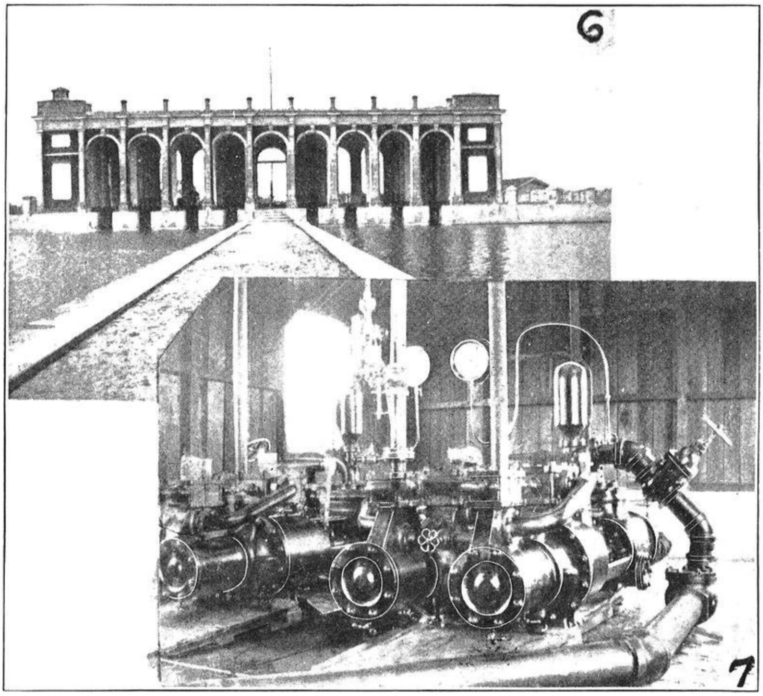
stacks on boilers was no easy task with the facilities at hand; the work was accomplished by rigging up a small frame work to act as derrick, hoisting stack with block and tackle, making three bites and lashing stack to derrick for each take back. The stack was steadied by the guys while being



4. Completed Sewer Line from Camp to Ocean.
5. Venta Springs, Havana.

raised, paying out the guy lines as the stack was hoisted up. By evening, Dec. 23, one boiler and pump were ready, and water was pumped into line to wash out the pipe. Dec. 24, six stand pipes were erected at Buena Vista to be used for filling water barrels, until the service pipe could be run to the various camps.

The first distribution pipe was run to Swift & Co.'s refrigerating plant at Quemador. They had attempted to sink a well but had failed to obtain a supply sufficient for cooling purposes. From this time on it was merely a question of making branch lines for each regiment as quickly as possible. Water was furnished for each company mess, for bath rooms, for corals, for hospitals and headquarters, and in many cases lines were run to houses in Marianao for officers' headquarters.



6. Gate House and Resovoir.
7. Pumping Station.

As the area actually covered by the camp was about three times as great as originally planned it was necessary to order additional supplies, as before stated, and this considerably delayed the completion of the work.

The amount of pipe laid for the water system, counting all sizes, was about 42 to 43 miles, with about 3,000 faucets and about 1,800 shower baths connected and in operation.

SEWER SYSTEM.

The plan was to lay a line of 8-inch pipe from La Playa, following the grade of railway approximately, to a point on the bank of a ravine and thence to the rear of camp. Another line was to continue along railway through Quemador, and as far up as Buena Vista, a distance of about 3½ miles.

Established grade of sewer .7 inch between camp and high tide La Playa. All branches and connections, from bath houses and lines, were of the long sweep Y type.

The run from Buena Vista to near La Playa was comparatively straight away work. About a quarter of a mile above La Playa station it was necessary to cross under railway and strike directly across a swamp for about 1,200 feet. The mud was soft and yielding with bed too far below surface to be available. It was necessary to build trestle work, supporting same on mud sills. Trestles were made of 4x4-5 in. in width spaced every 4 feet with footing extending 8 feet into the mud. Each section was made as a separate member with mud sills of 2x12 timbers interlaced fastened to lower portion of trestle to carry load. The structure was braced in both directions truss form, and the whole was firmly stayed by 4x4 top timbers on each side securely fastened to uprights.

This swamp was decidedly unhealthy, and it was very difficult to get men to work there. At the end of the swamp we encountered another railway, narrow guage, and it was necessary to elevate this in order to maintain our grade.

On the other side of the track was a small lake or lagoon, making it necessary to build trestle work here also. It was built in the same manner as the preceeding, but each section was 6 feet center, built separately and carried to position on raft. Bracing was all done under water, and all parts of each section were built and made ready before being set. In most cases it was necessary to anchor the sections. This was done by building a cradle in the bottom of a section and filling with rock; the water depth in places was from 15 to 18 feet. This trestle was about 2,800 feet in length.

At the other end of the lake was a small swamp similar to that previously encountered, and was crossed in the same manner. Beyond the swamp was a small hillock, which it was neccessary to cut through before we reached the ocean, the depth at one place being about 14 feet. The discharge end of pipe was carried to a point in the ocean, beyond the back flow, and the end of pipe supported in a cradle and guyed either side.

The major part of the work on water and sewerage system was done between Dec. 15, 1898, and Feb. 9, 1899, most of the work thereafter being purely maintenance; total pipe laid, both systems, during this interval, about 47 to 48 miles.

All pipe was buried 12 inches to 18 inches after being laid.

In raised letters on the buttons worn by the Engineer Corps, U. S. A., is a single word, Essayons, meaning "We work."

SOME HINTS ON SPECIFICATIONS FOR AN ENGINEER'S TRANSIT.

PROF. L. S. SMITH, B. S. C. E. '90; C. E. '95.

Repeated inquiries from students regarding the best type of transit for topographic work, would seem to indicate that a brief discussion of this topic would be of interest. A careful review of the available literature* on the subject, discovers comparatively little of direct value. As a penalty for this seeming indifference, instrument makers, with few exceptions, have been slow to devise improvement which would keep pace with the constantly increasing needs of the practitioner. Mr. Edward Moliter, Mem. Am. Soc. C. E., in his paper on precise leveling, above referred to, says: "Another difficulty in the way of progress is that the makers are pecu-

*The most important exceptions to this statement are the discussions by officers of the U. S. Coast Survey on merits and defects of topographic instruments, mostly plane-tables, see U. S. C. & G. S. Report, 1891 and 1892; the discussion brought out by Edward Maliter's paper, on precise leveling, in Transactions of the Am. Soc. C. E., Vol. 45, and a recent article, by W L. Webb, entitled, "Some devices for increasing the accuracy or rapidity of surveying operations." Proceedings Am. Soc. C. E for December, 1901.

liarly obstinate, and show a marked indisposition to alter their designs of instruments to better suit the requirements of the engineer. A battle of words is generally necessary to convince the maker of a desirable improvement, and, when convinced, he will adopt the improvement only when specially ordered. This applies more especially to American makers, probably because American engineers, generally, are

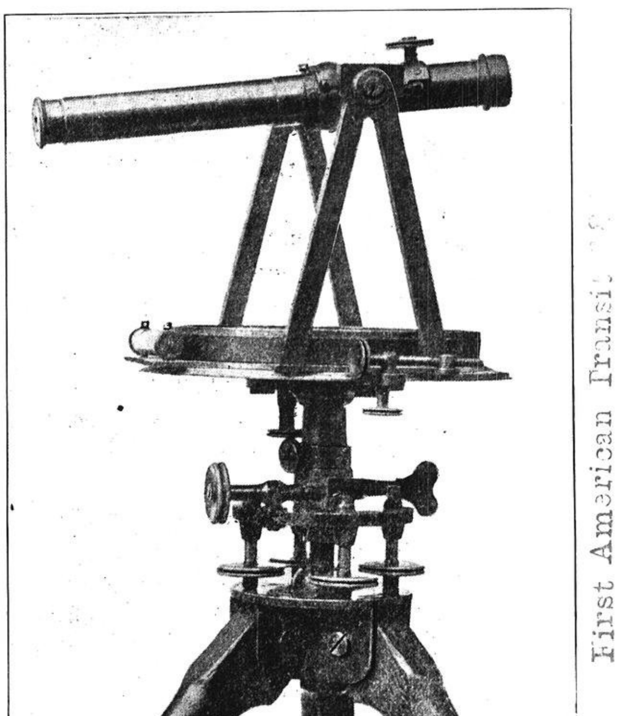


FIG. 1.

more easily satisfied and seem to entertain a high degree of confidence in the ability of the maker to produce the best possible instrument."

The writer believes another reason why American engineers have not more generally demanded and secured desired improvements is that almost invariably the instrument makers require an extra price for any change, even if the alteration is less expensive in design than the regular detail. In this way the buyer's pocket book is made to pay the penalty of its owner's progressiveness.

Aside from the natural conservatism to be expected, this non-progressiveness is largely due to the fact that very few instrument makers have ever used their instruments in the field. This precludes them from discovering the short-comings of their instruments, the first step in the direction of an improved design. Under such circumstances it is unfortunate that experienced observers have not been more *insistent* upon improvements in design suggested by their experience.

It has seemed to the writer that some of the oldest American instrument firms have shown the least enterprise in this matter. On the other hand, much younger firms, while still holding firmly to the many good points of the established types of instruments, seem more ready to adopt improvements suggested by experience.

It is encouraging to note, that during the past few years American instrument makers have shown much more interest and enterprise in meeting the demands for improvements.

The knowledge of what constitutes an excellent topographic transit and the methods of testing to discover the actual facts in a particular case, have seemed so important to the writer that he has recently made the study of the sources of error in instrumental design, and the necessary laboratory work for their detection, an integral part of the required work of his surveying classes. In fact, part of the data upon which his criticisms are based, (and including tests of fifty field instruments belonging to this college), was secured by his students in their regular work above referred to.

Let us now inquire what are the features of the usual complete engineer's transit or tachymeter which are most open to criticism, and what are the proper remedies. It is the writer's observation that the performances of the vertical circle and telescope level fall far short of what reasonably should be expected, and thereby greatly limit its usefulness as a topographic instrument. The causes of this deficiency may be stated as follows:

(a) Too small a vertical circle.

(b) The omission of a sensitive level from the vertical circle for the control of its zero.

(c) The use of irregular and non-sensitive telescope level vials.

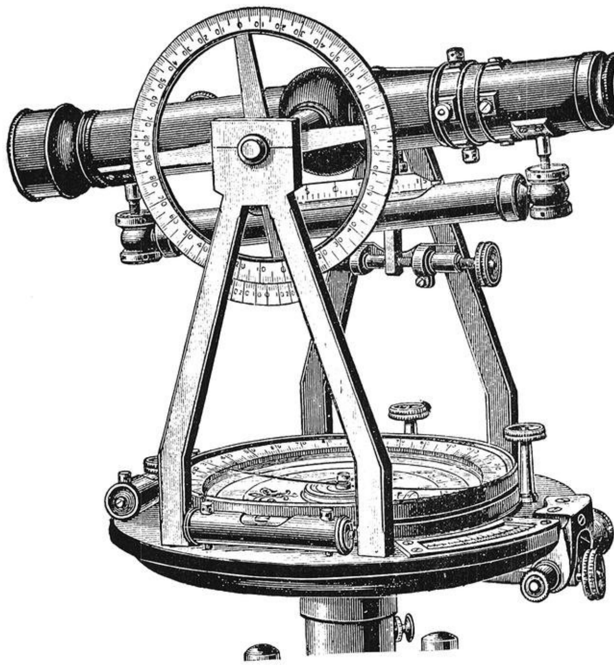


FIG. 2.

It is a well known fact that an error of several feet in the horizontal location of a topographic point would scarcely be discernable on a contour map of ordinary scale, while an equally large error in its vertical location would entirely vitiate the map for its designed purpose. In view of this fact, the time honored custom of using transits with large horizontal circles, frequently reading to fractions of a minute, results in simply strengthening the work at a point already the strongest, while the custom which sanctions the use of small vertical circles weakens the work at a point where the greatest accuracy is needed. With a transit provided with horizontal and vertical circles of *equal* size, the elevations will still constitute the weakest part of the work.

The usual excuse for the common practice of furnishing transits with smaller vertical than horizontal circles is found

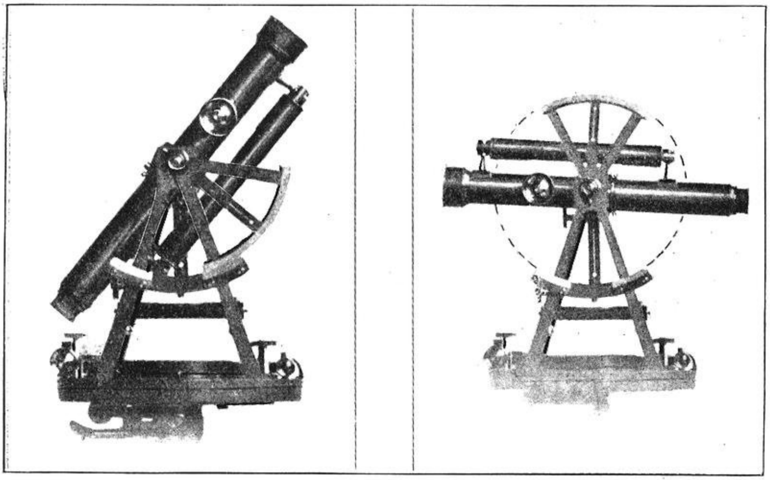


FIG. 3.

in the supposed danger of injuring the larger sized circle. The writer's experience under the most trying circumstances, incidental to rugged mountain climbing, would indicate that this danger is greatly overestimated. In fact, if the circle is protected with a cast metal guard, and it always should be so protected, there can be little danger. Another very good solution for this problem, provided the engineer is willing to forego a complete vertical circle, is found in a device described by Walter L. Webb* and consisting of a short arc of very large radius provided with two verniers whose zeros are exactly 60° apart. The graduated arc attached firmly to the tele-

*"Some devices for increasing the accuracy or rapidity of surveying operation." Proceedings Am. Soc. C. E. Dec. 1891.

scope axis, is numbered in two rows from 0° to 60° each way. For elevated reading (plus) the right hand vernier is used, while for depression (minus) angles the left-hand vernier is read. Such a device readily allows of an arc of seven inches in diameter which would insure ease and certainty of its readings to half minutes.

This device is more clearly shown by Fig. 3, taken from Webb's paper above referred to.

Whether an arc or a circle be furnished, its vernier should be provided with an accurate and easy method of adjusting the zero.

One objection to the substitution of the verticle arc for the complete circle is, that it precludes the *reversion* of the circle for the elimination of errors of adjustment in such problems as, for example, the determination of azimuth by the direct solar observation, now so commonly used in the west.

Although the small verticle circles generally furnished by makers ostensibly read to single minutes, experienced observers are well aware that this accuracy is seldom realized, because of the uncertainty of the reading. Such circles should be provided with permanently mounted magnifying glasses.

A second element which introduces error into the vertical work of a transit is the common practice of depending upon cheap non-sensitive plate levels for the control of the vertical circle zero. If not specified, makers send out plate levels with a sensitiveness between 40 and 360 seconds per one-tenth inch of level. Now every topographer knows that after the orienting backsight has been taken and before the foresight can be taken, the instrument will get out of level, a condition indicated by the plate bubbles getting off center. This introduces errors in the verticle circle readings, it may be of equal angular amounts. Nor can the plate levels be re-leveled without introducing an error in the orientation which will effect all subsequent azimuths. But even if this displacement does not always take place, a sensibility of 40 to 360 seconds is quite inadequate to control the vertical circle. The proper remedy for this evil is found by placing an extra level on the standard or upon the verticle circle guard, made adjustible so as to read zero when the telescope level is horizontal. The American makers usually charge $10 for this extra level.

The writer would advocate two double verniers on the vertical circle were it not for the fact that the reading and recording of the extra vernier consumes valuable time. Besides, the modern excellence of graduating an d mounting circles reduce to a minimum the errors sought to be corrected by the extra vernier.

A third needed change in the design of the transit and one certain to improve the accuracy of its vertical work is found in a rational increase in the sensibility of its telescope level.

Except in very mountainous regions a properly run topographic traverse by the "transit and stadia method" allows a considerable proportion of the vertical angle readings on turning points to be replaced by level readings, thereby correspondingly reducing the amount of required office work, while at the same time insuring a higher degree of accuracy in the resulting levels. This would be notably the case of a combined hydrographic and topographic survey of a river and its adjacent valley. This point was first brought to the writer's attention while making a survey of the Colorado River for a distance of about 25 miles near Yuma, Arizona. At this point the river flows in a wide sandy valley of light gradient so that practically all elevations were taken by level readings.* Although this survey was executed under the most trying conditions of weather, and with an. average length of sight of about 300 meters, its levels checked on bench marks determined by accurate spirit leveling within about one-half a foot.

Equally close results have since been observed on topographic lines and which lead the writer to the conclusion that a

* A. Brandis Son & Co., light transit with sensitive level was used. See also for a discussion of such survey Journal of the Asso. of Engineering Societies. Vol. 14, page 219, by J. L. Van Ornum.

properly devised level on the transit telescope is quite sufficient to secure results under favorable circumstances comparable to that of common Wye levels, and expressed by the formula, error = 0.05 ft. $\times$ the square root of distance in miles as the highest limit, and perhaps twice this for lowest limit, the latter being expected only under very unfavorable circumstances of length of sight and weather conditions.

If the above statement of the accuracy of transit levels be accepted as true, and a fast increasing number of topographers have accepted it, the field for the engineers' wye level is small indeed.

However, such high grade work cannot be expected with transits furnished with the non-sensitive and irregularly ground level so frequently furnished the unsuspecting purchaser. After considerable experimental work to determine this point, the writer would suggest a sensibility corresponding to one-tenth inch, equal to from 15 to 20 seconds of arc. Of course the sensibility of the levels and the magnifying power of the telescope are inter-related.

Other important requisites of a rationally designed engineers' transit, not always complied with, may be considered under the following heads: (a) Magnifying power, (b) Chromatic and spherical aberration, (c) Definition, (d) Flatness of field, (e) Illumination, (f) Centering of lenses. The limits of this paper will allow only a very general treatment of the above points. Preliminary to testing a transit, the owner would do well to look carefully into the telescope barrel through the objective in order to discover the presence of an interposed diaphragm, sometimes inserted by the maker to prevent the discovery of the many evils resulting from poor lenses and poor workmanship.

Such a diaphragm should never be tolerated, because it must reduce the effective diameter of the objective correspondingly, and thereby seriously interfere with its function as a light gatherer. The presence of such a diaphragm may always be taken as *prima facie* evidence of poor workmanship.

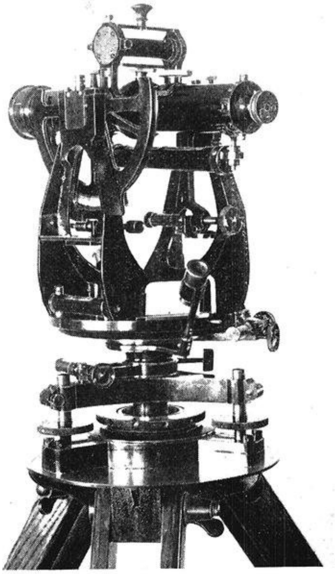
The magnifying power of a transit should be a function of the least count of its vernier and the size of the objective. An ideal magnification would be one such that a movement of the alidade corresponding to the least count of its vernier, should cause a perceptible movement of the line of sight on the object sighted. As the diameter of the objective largely determines the illumination of the image, it should be as large as possible and be consistent with other details. It should also be transparent and highly polished. If d be the diameter of the objective in millimeters, and m the magnifying power of the telescope in diameters, then the illuminating power of the telescope $i = \frac{d^2}{5m^2}$ the natural illumination being taken as unity.

The flatness of the field depends largely on the sphericity of the eyepiece. This may be tested as follows: Draw a heavy lined square eight inches on a side, and place it at such a distance from the instr uments that it shall nearly fill the entire field. When the telescope is focused its side should appear perfectly straight, though a slight curve at the *extreme* limits of the field should cause no appreciable error in stadia work.

The definition of a telescope depends upon three conditions, the accuracy of the curvature of the various lenses, upon their centering and upon their movement in focusing. If the eccentricity of the eye piece is large or if the optical axis of the lens be not parallel to the line of sight, the definition may be so poor as to seriously effect the focusing of the extreme stadia wires. Displacements of the objective are even more serious in producing poor definition of the image.

Lateral displacements of either eye pieces or objective may be discovered by taking the telescope of the transit out of the standards, and, after focusing the threads and objective on some distant point, turn the telescope in improvised wooden wyes. The image and the threads will appear to move in the arc of a circle above the telescope axis even when the wire or reticule adjustment has been perfectly made. Not infrequently makers send out even wye levels whose lenses, the above test show, have very large eccentricities, such an instrument should be promptly returned.

During the past six years this university has purchased about forty transits and levels for the use of the rapidly increasing number of students in the engineering



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college. Thinking that the specifications under which these instruments were in most part purchased would be of interest to the reader, they are here given in full. It may be remarked, that the custom of purchasing instruments by competive bids and of allowing each bidder to write his specification is obviously unfair to all concerned. Besides making all bids comparable, carefully drawn specifications should insure the purchaser receiving exactly what he proposed to buy. Surely the specifications of so important a part of the field engineer's outfit as is his transit, should receive at least as much thought and care as he gives to the purchase of his thirty-five dollar bicycle. That this care and caution should be often entirely lacking is alike discreditable to his professional knowledge and business skill.

SPECIFICATIONS FOR COMPLETE ENGINEER'S TRANSITS TO BE FURNISHED TO THE UNIVERSITY OF WISCONSIN.

General Conditions. All constructive details shall be of superior workmanship and design. Weight not essential to the stiffness of the instrument, shall be avoided by the standard rib construction. The instrument without tripod should weigh not more than ten pounds. Especial attention shall be given to making extra strong all parts likely to be injured by accident. Only the hardest bell metal and phosphor bronze shall be used for centers and telescope axis, and soft brass shall be everywhere avoided. Tangent screws and head of tripod shall be made of aluminum bronze and provided with German silver spiral springs. Prices shall be F. O. B., Madison, Wis.

Horizontal Circle. The diameter at the edge of graduation shall be five (5) inches. The graduation shall be to half degrees on solid silver, and every ten degrees shall be distinctly numbered from zero to 360 in both directions, the numbers sloping in the direction they are increasing.

The circle shall be provided with two double verniers, A and B, exactly 180 degrees apart, and reading to single minutes.

The zeros of the verniers shall be placed at an angle of 35° to the line of sight, and shall be provided with ground glass reflectors. Eccentricity of vertical axis and of all verniers must be as perfectly eliminated as the highest mechanical skill will allow.

Complete Vertical Circle. Transit shall be provided with a complete vertical circle with a diameter not less than 5.5 inches, graduated on solid silver and read to single minutes by one double vernier. The vernier shall be provided with a ready and reliable means of adjustment. The vertical circle shall be furnished with a cast metal guard to protect the entire edge of the graduation. An extra level vial sensibility 1-10 inch = 20 seconds with suitable means of adjustment, shall be firmly mounted on this guard so as to control the zeros of the verniers. The horizontal axis shall have a radial clamp and slow motion screw.

Magnetic Needle. Instrument shall be provided with the usual compass box and a sensitive and accurate needle about $3\frac{1}{2}$ inches long.

Telescope. The objective shall have a clear aperture of not less than $1\frac{1}{8}$ inches in diameter, perfectly achromatic and with a flat field, suitable for accurate stadia measurements. Both the objective and angular lenses shall be mounted so that their optical centers lie in the geometrical center of telescope tube, and provision shall be made to insure that the optical centers shall describe straight lines when focused.

Eye piece shall be inverting and magnifying between 20 and 24 diameter and be free from chromatic aberration. It shall also be provided with a prismatic eye piece with a solar shade.

The regular eye piece shall have the usual focusing screw or worm and a dust guard.

The horizontal axis of the telescope shall be provided with means of adjustment and shall be fitted with a suitable base for the attachment of a Saegmüller solar attachment.

Stadia wires. Two extra fixed stadia wires, very fine and opaque, shall be furnished and placed equidistant from the middle crosswire. The total distance apart of the stadia wires shall be 1-100 of the focal length of the objective.

Telescope level. The level shall be ground to a uniform curvature of 1-10 inch = 20 seconds. The graduations shall extend over the entire exposed length and shall be numbered both ways from zero at the center.

Plate levels. Both plate levels shall be accurately fixed to the transit with the most approved and stable provision for their adjustment. Both levels shall be graduated and their curvature shall be 1-10 inch = 30 seconds.

Clamps. The heads of all clamps shall be one-third smaller than usual pattern to prevent injury from inexperienced hands.

Finish. The telescope, telescope level, vertical circle guard, and standards shall have the so-called "cloth finish," the remainder any good standard finish.

Tripod shall be of the split leg pattern and provided with shifting center. Its weight shall not exceed seven pounds. The steel shoe of tripod shall be provided with a shoulder for forcing it into the ground.

Box. The instrument shall be furnished in a neat hard-wood-box with lock, together with a sun shade, reflector, magnifying glass, plumb bob, wrench, adjusting pins, and silk or water proof bag. The box shall have a leather strap and rubber cushion on the bottom.

That there may be no doubt in the reader's mind regarding the need of definite specifications similar to the foregoing, it may be said, that before this plan was adapted at the university, the instruments were seriously lacking in important details. For example one of the oldest and best known American firms furnished a transit whose telescope level had a sensibility of 1-10 = inch 72 seconds, (about suitable for a hand level), and whose plate bubbles had a sensibility of one-tenth inch = 360 seconds. Though the horizontal circle of this instrumenc is nearly *seven* inches in diameter, the vertical circle furnished has a diameter of only *four* inches. The results obtained by this instrument have shown a uniformly larger error than that attained by the standard instruments purchased later.

A comparison of the plate bubbles of ten similar instruments purchased simply by catalogue number, shows that not only do different firms use widely different levels on the same grade of instrument, but even the same firm at different times, the range on plate babbles being from 40 to 360 seconds, and on telescope levels from 8 to 72 seconds per one-tenth inch division. The conclusion, that makers frequently use whatever they happen to have in stock, quite regardless of suitability, seems warranted by the facts. Some will not fail to urge the impossibility of buying a transit at a reasonable price under such rigid specifications as suggested above. In answer it can be said that the average price paid for a transit under these specifications has been considerable less than formerly, without specifications. It should be said, however, as bearing on this point, that later contracts have called for larger numbers of instruments. The present year the lowest bid, from an American maker, was $175 per transit. The University owns several transits made by this maker, and severe field tests have shown them the equal of any, both in accuracy and durability. The transit, shown in fig. 4, was purchased of a German firm this season. It cost, delivered in Madison, about $136, being admitted duty free. This instrument would cost about $225.00 in this country.

THE PISTON VALVE AS APPLIED TO THE LOCOMOTIVE.

J. E. DIXON, '00.

In the United States, especially, recent years have shown very rapid development, accompanied by radical changes in locomotive construction. The most noteworthy of these developments perhaps, is first the almost general adoption of the wide firebox, whereby it has been made possible to obtain grate area of sufficient size to reduce the rate of combustion to economical limits and insure free steaming with our poorest grades of coal; secondly, the use of longer flues, giving greater heating surface and the more complete combustion of the gases, and lastly the subject I wish to present to you by this paper, the application of the piston valve.

Piston valves have been in use a great many years in marine and stationary practice. In locomotive design however it is only in the last few years that they have received any special attention, although there are records showing that locomotives with piston valves of a crude form were experimented with many years ago, both in the United States and in Europe.

The first successful application of the piston valve to expansion locomotives in the United States must be accredited to Mr. Hartswell, who at that time. about twelve years ago, was general mechanical engineer of the Flint & Pere Marquette Rail-road. These valves were $6\frac{1}{2}$ inches diameter and about the length of the ordinary slide valves, applied in the ordinary steam chest with a loose cage. The live steam was taken at the ends of the valve and exhausted at the center, just as it is with the slide valve. Such a valve is called an external admission valve; when however the live steam is admitted to the center of the valve and exhausted at the ends, the valve is called an internal admission valve.

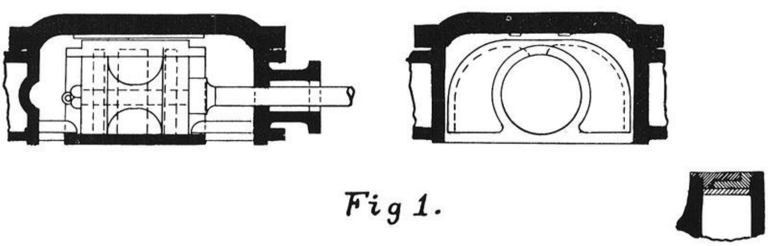


Fig 1.

Cut No. 1. shows the construction of Mr. Hartwell's valve. The packing used upon the F. & P. M. valves was similar to that used upon the Tremain valve in Europe. The packing rings were L shape extending out over the follower, giving a square cut off edge. When the rings were fitted up, $\frac{5}{16}$ inches was cut out; they were then put in a chuck and squeezed up tight and the outside turned off to an exact fit for the steam chest cage. This gave them a perfect bearing at once, so they lasted for a long time. An engine provided with such a set made 390,000 miles without refitting. The valve rod was coupled to the valve stem by a T head to allow for lateral motion of the rod or valve.

After a few of these valves had run for a long time they were taken out and the ordinary slide valve put back, but as the engines failed to do as much work, the piston valves were replaced.

Shortly after the application of these valves by the Flint &

Pere Marquette R. R., the Brooks Locomotive Works constructed some large 12 wheel engines equipped with similar valves for the Iron Range & Huron Bay Ry. These engines gave very good results, handling nicely owing to the small amount of valve friction. The separate valve cage and small diameter of the valve necessitated a large clyinder clearance which of course was detrimental to the economical running of the machine.

The Baldwin Locomotive Works, when they introduced their four cylinder compound, employed the piston valve in an especially designed cylinder. This is supposed to be the first so designed in the United States.

In 1897 the Brooks Locomotive Works took a contract to build some large 12 wheel engines for the Great Northern R. R. These engines were the largest in the world at that date, and were specified to have cylinders 21x34 inch and to carry 210 pounds boiler pressure.

After much careful study as to the advisability of using slide valves on cylinders of this size, the conclusion was reached that if slide valves were used, the cylinder clearance due to the long ports would be excessive, or the valve would be required to be of such a length as to make it hard to handle, due to increased bearing surface. An external admission piston-valve with an especially designed cylinder was then applied to these engines. By the use of this form of valve it was not only possible to obtain steam ports of the required area with a small amount of cylinder clearance, but also to construct a locomotive which would handle very much easier than one equipped with a slide valve.

Soon after the completion of this order, the Brooks Locomotive Works commenced the application of the piston valve to their locomotives in earnest in place of the slide valve, for it was found with the latter, when made of sufficient size for large cylinders and high pressures in use upon heavy power, that the wear not only of the valves and seats, but also the entire valve motion was excessive, and that such engines were hard to handle. They therefore constructed an im-

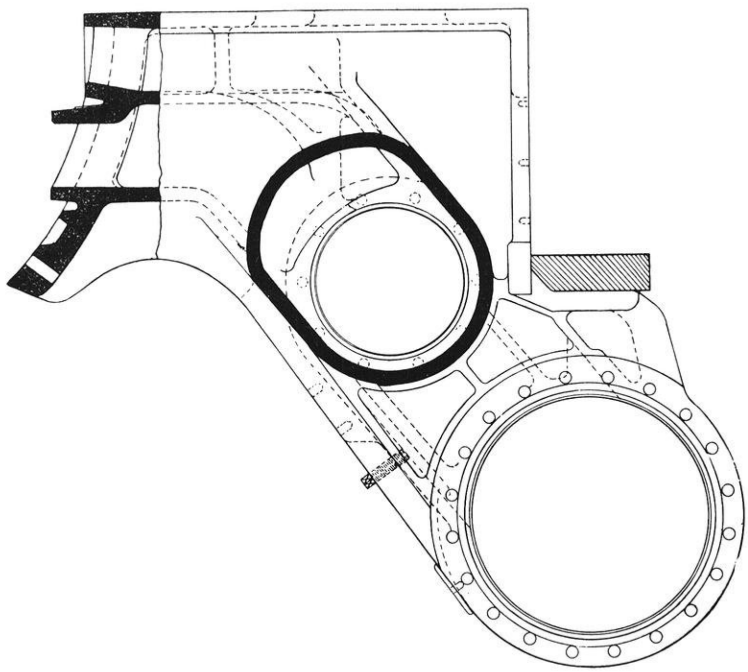
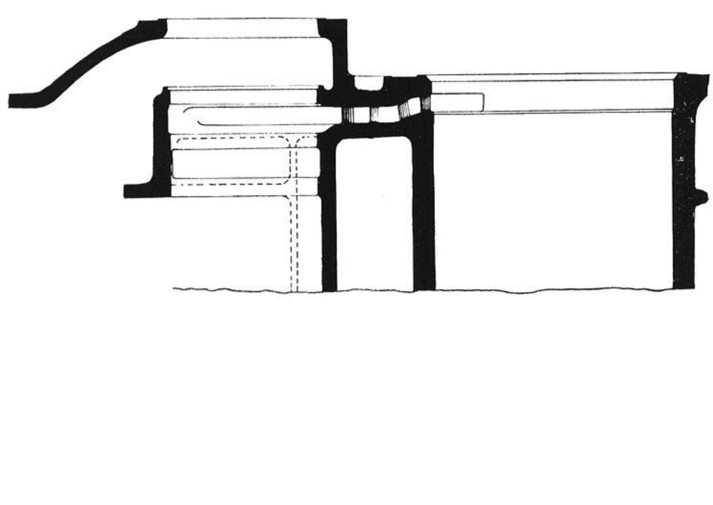


Fig 2.



proved form of cylinder having the valve chests cast integral therewith and improved piston valves arranged with internal admission, securing, by this form of cylinder, the shortest possible steam passage from the top of the cylinder saddle to the admission edges of the valve. This passage or chamber is of extremely large area, with a very small surface exposed to external cooling influences,—even this portion being jacketed. The steam ports from the valve chest to the cylinder are as short and direct as possible, and on account of their shortness may be made of much larger area than is possible in the slide valve cylinder, thereby reducing the loss of pressure due to frictional resistance.

A general outline of this form of piston valve cylinder is shown by Fig. 2.

Considerable prejudice was expressed by engine men when the piston valve was introduced on the locomotive, because an engine so equipped did not exhaust like an ordinary slide valve engine. The reason for this difference being that the exhaust from one end of the cylinder caught up to the exhaust from the opposite end, leaving the stack in two long blows per revolution instead of four short barks. While this form of exhaust was no detriment to the performance of the engine, it has nevertheless been entirely done away with in the latest forms of piston valve cylinders, in the following manner: The exhaust cavities at the ends of the cylinder, which formerly opened into a common cavity at the center, are now kept entirely separate. The exhaust pipe is also divided for a part of the way up, thus dividing the base of the pipe into four cavities instead of two; the result being that the piston valve engine exhaust is similar in every respect to the slide valve engine. The engine men therefore have not this unusual sound to listen to and worry over.

The construction of the piston valve cylinder makes it possible to use a "single rail" front end frame thus doing away with the unequal strains set up in the "two rail" front ends. These unequal strains are often very great, especially where a four wheel engine truck is used, and the distance to the front pair of drivers is considerable.

Owing to the construction of the saddle, the frame rail may be raised up to a central position, and not have to be kept as low as possible in order to get sufficient metal in the saddle to withstand the strains set up therein, as is the case of the slide valve saddle. This being able to raise the frame rail up into a central position, not only in the line of thrust of the cylinder, but also in the line of pull of the draw gear, is an important feature in modern construction. For engines frequently have to be coupled up to use the front end in heavy service.

As is apparent by Fig. No. 2, the cylindrical valve chest is cast in the cylinder saddle as close to the cylinder as it is

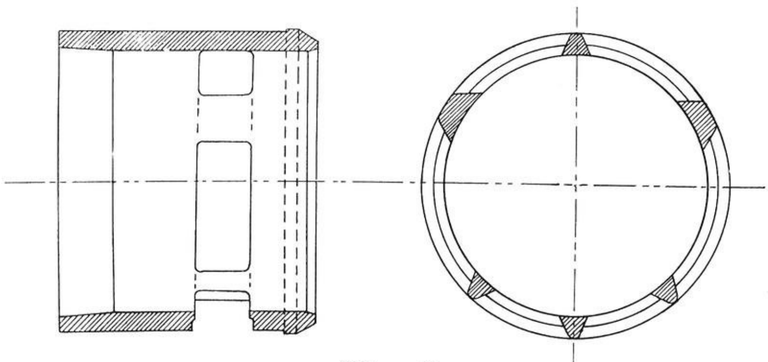


Fig 3.

possible to get it. The main steam passages leading to and from the valve chest are cast larger than the finished ports. The steam chest is bored out enough larger than the diameter of the valve, to permit the use of a hard cast iron bushing for each end of the valve chest. These valve chest bushings are accurately bored and the steam edges carefully lined up giving accurate cutting edges for the steam. Each bushing is then forced to its seat by sufficient pressure to insure a steam fit and is still further secured by means of a set screw extending through the saddle and partially through the wall of the bushing. The valve packing rings are prevented from entering the ports by means of several bridges cast in the bushing as shown in Fig. 3. Many different kinds of packing are used in connection with the piston valve. The Tremain packing gives very good results with low steam pressure, but when high pressure is used with this form of packing, the friction produced is considerable, owing to the very broad rings. A change was therefore made in this form of ring giving much better results. The marine form of packing has been used with varied results, by different roads. The Santa Fe R. R., perhaps have obtained the best results so far from the marine form of packing on their tandem compound. The stresses and strains which are set up in the ordinary locomotive cylinder saddle, and which distort the form of the value chest, have been greatly reduced in the Santa Fe Ry's design of cylinder saddle. The cylinder and valve chest are cast separate from the saddle, and bolted to a large saddle casting between the frames, thus obtaining a cylinder and

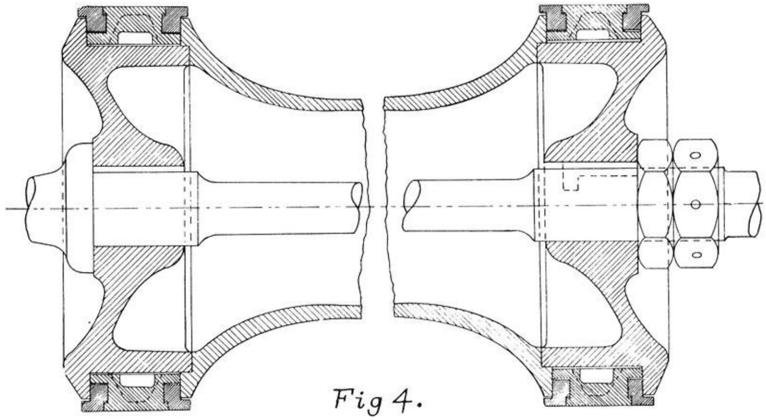


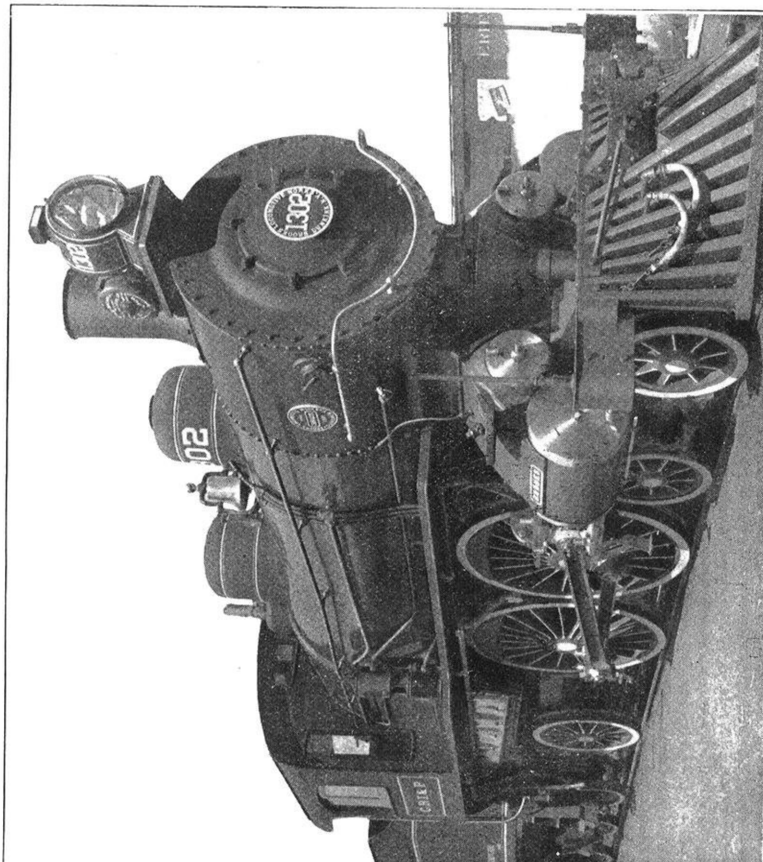
Fig 4.

valve chest similar to marine construction. Fig. 4 shows the construction of the piston valve, and a section of the packing which probably has given the best results thus far. The rings are turned 1-32 of an inch larger than the diameter of the bore of the valve chest bushing and are L shaped extending out over the follower and the valve spindle thus giving perfectly square cut off edges. In case the ring should break up, portions of it are prevented from falling into the port by means of a 1-16 inch lip which enters a corresponding recess in the bull ring.

The first piston valves, being external admission valves, were actuated by the standard American valve motion. That is the travel of the eccentrics was transmitted to the valve by means of the rocker arm the same as the ordinary slide valve motion. When however the internal admission piston valves were applied, the steam lines being the reverse of the slide valve steam lines, necessarily the motion of the valve itself had to be reversed. The eccentrics therefore where rocker arm motion was employed had to be reversed on the axle and the rods crossed. This occasions a considerable offset to the saddle pin and a large amount of slipping in the link. Recently however the valve motion has been greatly improved, giving a direct motion to the valve. An intermediate valve rod actuates a vertical rocker having both of its arms either above or below its point of oscillation. The steam distribution obtained by the use of this valve motion is far superior to any that can be secured by employing the side valve motion.

Piston valves may be set in the same manner that slide valves are, with the valve chest covers removed, bearing in mind that the inside bearing edges of your valve are the cut off edges. Or when, as is often the case, the piston valve cylinder is provided with peep holes the valve may be set without the removal of the chest covers. Brass plugs fill the peep holes while the locomotive is in service. These peep holes are usually $1\frac{1}{4}$ inches in diameter, so located that you can look directly down into the cylinder port and see the cutting off edge of the port and consequently the edge of the valve as it passes it. A lighted taper inserted in one of the peep holes illuminates the openings in the bushing, showing the edge of the port, and by moving the valve until the internal edge of the piston rings comes against the cut off edge of the port, the exact position of the valve for cut off or admission can be distinctly seen. With the valve in this position, make the regular scribe marks on the stem. Repeat the operation at the other end of the cylinder and you have the two scribe marks on the valve stem for front and back admission. The rest of the process being identical with the setting of an ordinary slide valve needs no further description.

Where high pressure steam, that is from 180 lbs. and upwards, is used, the piston valve offers considerable less resistance than does the slide valve, thus reducing the work which the entire valve gear has to perform as well as the internal resistance of the locomotive. The question of valve lubrication is very much simplified and the difficulties of cut valves and seats are very much diminished. For it is an established fact that a piston valve properly set up will run comparatively dry as to lubrication without any apparent wear. A run of 200 miles can easily be made on one pint of valve oil or less, the valve being perfectly lubricated when enough oil is supplied for the use of the cylinder. Owing to the small amount of friction incident to the piston valve, your running repairs are necessarily decreased by its use. When the stem packing is kept in proper adjustment, all that bear upon the valve bushing are the packing rings themselves,—the wear therefore to both the bushings and the packing rings is very slight, a set of rings lasting from 18 months to two years with apparently little or no wear. The bushings may be rebored, when necessary, by an ordinary boring bar, the same as is used in reboring the cylinder proper, or by a recent type of boring bar by which the bushings may be bored without removing the rear steam chest cover. In this manner the boring is done in less time than it takes to face an ordinary slide valve seat. After reboring several times the old bushings becoming very thin, and may be removed by being split with a narrow cape chisel, thus saving time, as the bushing is fit for scrap only. The new bushings may now be drawn to place by means of a draw screw, or by hydraulic pressure. Not only the area of admission but also the area of exhaust may be materially increased by the use of the piston valve. This of course is a very great advantage, for in order to obtain the highest efficiency of a locomotive, it is not only necessary to get steam into the cylinder



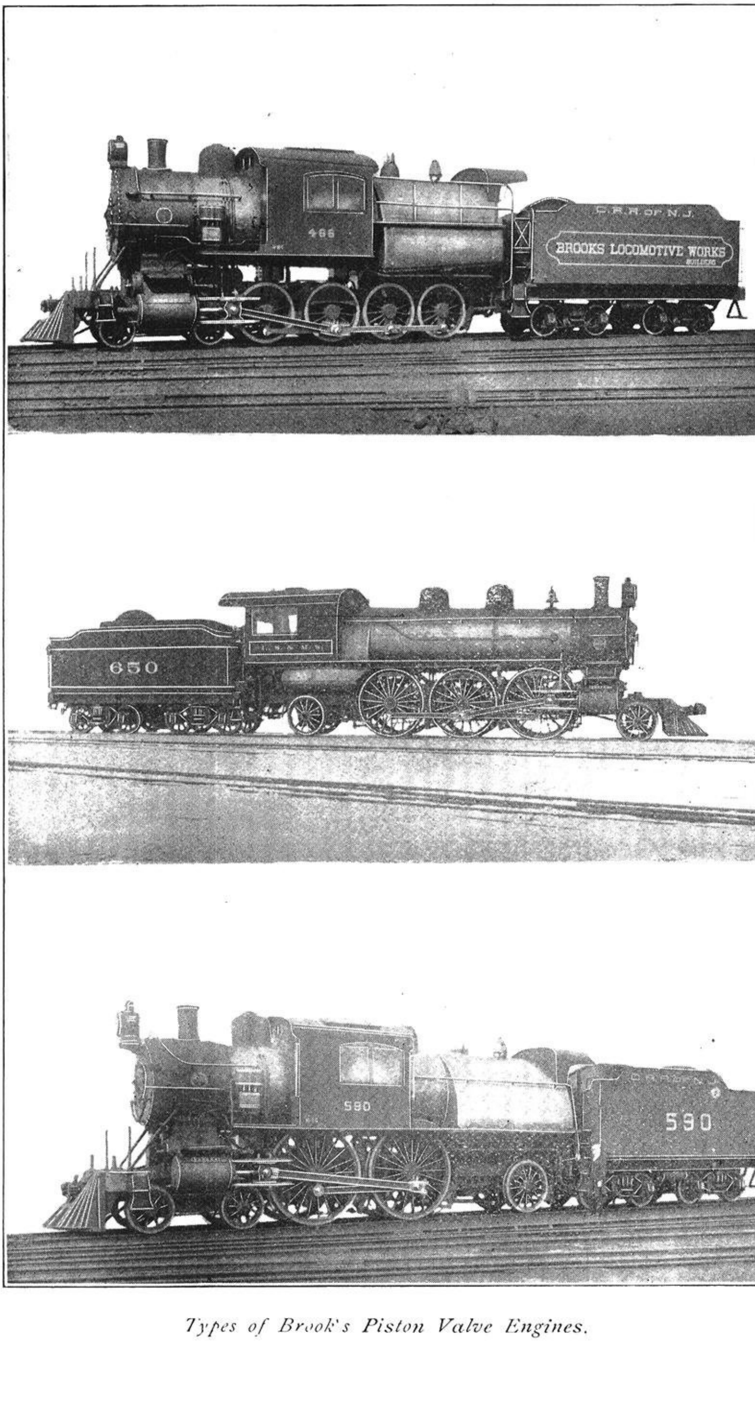
Brooks Locomotive Showing Location of Piston Valve.

promptly, but to get it out again as quickly as possible to reduce the back presure. The piston valve has therefore overcome the great disadvantage of the Allen valve, which when running with a short cut off, gives nearly double the port opening for admission than it gives for exhaust. When set with lead and running at short cut off, the Allen valve gives a great amount of preadmission and an enormous back pressure.

Piston valves have a circumference, and therefore a steam edge about twice as long as the port opening used with a slide valve, and when working at a short cut off and partial port opening, give from 50 to 75 per cent. greater port area than is obtainable from the slide valve for that cylinder. This is true after the area of the bridges in the valve bushings has been allowed for. A 12 inch piston valve bushing gives a steam edge about 30 inches in length. This great length of cutting edge is one of the strongest points in the piston valves favor. The piston valve with internal admission and extended stem does not spring or mar the motion to the extent that the slide valve does, and adjustments made can be counted upon to last for a much greater length of time. Another great advantage with this form of valve is that the valve stem requires packing to withstand exhaust steam pressure only.

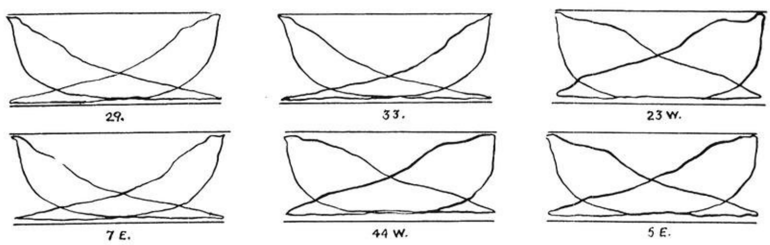
Aside from the benefits derived from the piston valves themselves there are many beneficial features in the construction of the locomotive to be obtained by the use of the piston valve cylinders.

Not only are you permitted to use the best form of front end, as before mentioned, but the piston, valve, cylinder and all its allied parts, and the motion-work are used in connection therewith, weighing less than the same parts used on an equal capacity, slide valve engine, and so you are at liberty when the weight of the locomotive is limited, to use this weight saved, in increasing the capacity of the boiler and other parts of the engine. The valve motion is direct, doing away with the lost motion accompanying intermediate hangers



Types of Brook's Piston Valve Engines.

and motion rods so often used to obtain a proper valve motion on slide valve engines. As the valve chest is placed directly over the top of the frame, the valve motion may all be hung inside of the frames where it is out of the way. Space for the rocker arm, therefore, does not have to be taken into account in spacing the drivers, and you are then at liberty to use a larger wheel or so locate them as to obtain a better distribution of weight and brake arrangement than is possible in the case of a slide valve engine of equal proportions. The engine truck wheels may also be of larger diameter, for the front end of the frame is up and out of the way.



These advantages, as well as many others applicable to the construction and performance of the locomotive, show very conclusively the superiority of the piston valve.

The American Engineer and Railroad Journal for April, 1901, gives a full description as well as the following data of the "Chatauqua Type" fast passenger locomotives, built by the Brooks Works, for the Chicago, Rock Island & Pacific R'y. "A very direct and stiff valve motion is secured on these engines by the use of box links and straight connections with a parallel motion to pass the forward driving axle. As laid out, the slip of the links is very small and special care was taken to obtain square port opening, lead and cut off. In the steam chests, special efforts were made to obtain free passages for the steam to reach the valve ports, the exhaust passages are also large. The least area through the cylinder casing being 75 square inches. The effect of this in low back pressure is seen in the cards "here given."

The accompanying "head on" photograph shows 1302, one of these Chicago, Rock Island & Pacific, Chautuaqua locomotives.

DATA FOR INDICATOR CARDS, "CHAUTAUQUA" TYPE LOCOMOTIVE, CHICAGO, ROCK ISLAND & PACIFIC R'Y.

					Front End.			Back End.			
Card Number.	Boiler pressure, lbs.	Revs. per minute.	Miles per hour.	Card length, inches.	Area of card.	M. E. P.	I. H. P.	Area of card.	M. E. P.	I. H. P.	Total I. H. P.
29	207	250	58.2	4	1.89	56.4	298.5	1.95	57.6	293.7	1,184.4
33	202	280	65.2	3.96	1.75	52.8	311.9	1.69	50.4	285.8	1,195,4
23 W	210	160	37.2	3.88	3.06	92.4	311.9	3.08	94.8	287.3	1,198.4
7 E	205	280	65.2	3.98	1.78	52.8	311.9	1.73	51.6	294.7	1,213.2
44 W	203	200	46.5	3.94	2.69	81.6	342.3	2.80	85.2	347.6	1,379.8
5 E	205	260	60.5	2.94	2.37	72.1	395.5	2.60	78.0	413.7	1,618.5

Cards 29 and 33 were taken from the right side of the engine, on local train No. 1, March 8, 1901, consisting of 10 cars, with 120 lb. indicator spring. On this run the valves were set with $1\frac{1}{8}$ "lap, exhaust clearance $\frac{1}{8}$ and with 1-32" lead in full gear both forward and back. Cards 33 W. and 44 W. were taken on an extra freight west bound March 6, weighing 640 tons consisting of 30 empty and 6 loaded cars. Cards 7E and 5E were taken on an east bound extra freight on the same day, the train weighing 341 tons, consisting of 10 loaded cars. These cards were also taken from the right hand side of the engine with the valves set for no exhaust lap, but otherwise the same.

It is noteworthy, that with the assumption that the horsepower was the same on both sides of the engine, a locomotive has shown a capacity of 1,618 indicated horse power at 60 miles an hour and it is fair to assume that this power can be sustained for some time, because in the 32 indicator cards constituting this record there it no indication of failure in keeping up the high hoiler pressure.

VALVE MOTION REPORT.

Cylinders $20\frac{1}{4}$ in. x 26 Drivers $78\frac{1}{2}$ in. No. 4.

VALVES	Piston—Improved	Link Kind—Box	Valve Travel—5 3-8 in.
	Slide—	" Radius—62 in..........	Steam Lap—1 1-8 in.
ADMISSION	Internal—Yes....	" Centre—59½ in........	" Lead F'rw'd—1-16in
	External—	" Crs. Eyes—13 in	" " B'k'wd—1-16in
MOTION	Direct—Yes	" Lift—13 in.............	Exhaust Lap—
	Rocker—Yes..........	" Slip Max 1¼n;at 6n.½n	" Clearance—1-8 in
ROCKER	Valve End—15 3-4 in...	" Saddle Offset—9-16 in..	Ex. Pipe Kind single plain
	Ecc. End—15 3-4 in....	" Lifter Off't, Top—½in.	Exhaust Nozzle, Dia. 5 in.
ECCENTRIO	Travel—5½ in.........	" Blk.above cr.ax.—1½in	Steam Port—1 7-8 in.

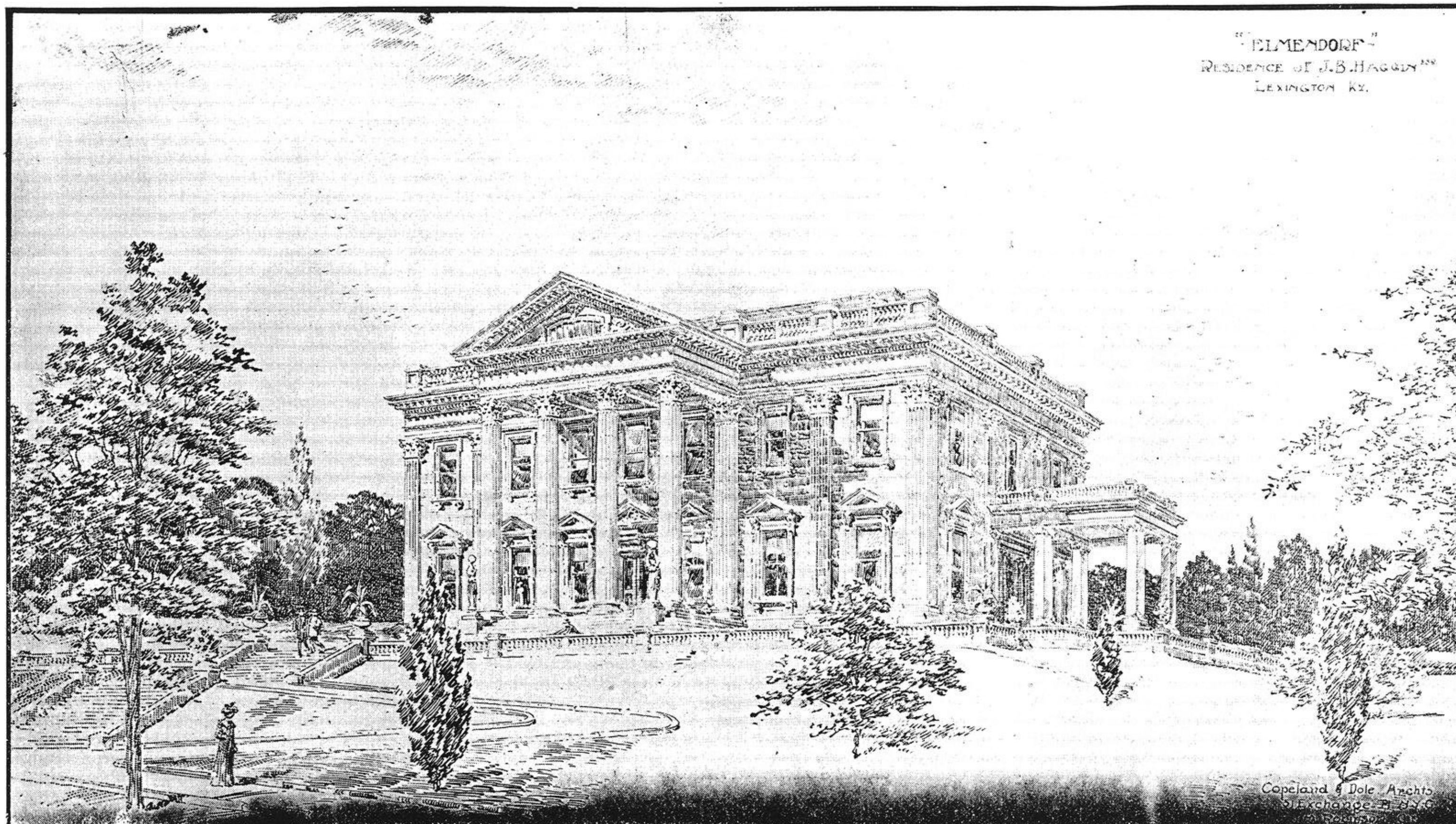
POSITION			PRE-ADMISSION	LEAD	PORT OPENING	CUT OFF	RELEASE	CLOSURE
FORWARD MOTION	R. H. SIDE.	Full Gear ..	0 in.	+1-16 in	+1½ in.	21¼ in.	24½ in.	1½ in.
		16 in. Notch.	....	....	....	....	....	....
		12 in. "	5-16 in.	¼ in.	5-8 in.	12¼ in.	20¾ in.	5¼ in.
		8 in. "	13-16 in.	9-32 in.	3-8 in.	8¼ in.	18¾ in.	7¼ in.
		6 in. "	1 3-16 in.	10-32 in.	11-32 in.	6 in.	16¾ in.	9¼ in.
BACKWARD MOTION	R. H. SIDE.	Full Gear ..	0 in.	+1-16 in	1⅜ in.	21¾ in.	24¾ in.	1¼ in.
		10 in Notch	½ in.	19-64 in.	15-32 in.	10 in.	19½ in.	6¼ in.

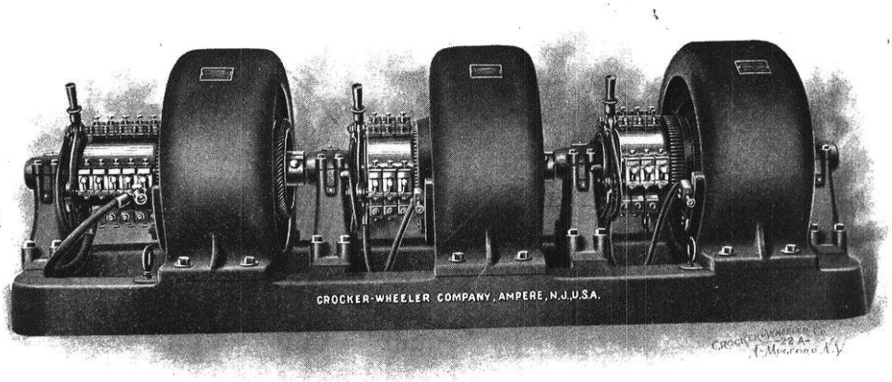
ELECTRICAL EQUIPMENT ON A KENTUCKY STOCK FARM.

A. R. SAWYER, '96.

Kentucky is noted for its politics, its whiskey, its horses, its pretty women and its colonels in about the order named; and they all flourish best in the blue grass region of which Lexington is the center.

By looking at the railroad map you will notice that the railroad lines seem to radiate in all directions from Lexington like spokes from the hub of a wheel. Pike roads, well macadamized, radiate in the same way, no less than fifteen stretching off in as many directions, permeating the whole of


"ELMENDORF"
RESIDENCE OF J. B. HAGGIN ESQ.
LEXINGTON KY.
Copeland & Dole Archts
3 Exchange Pl. N.Y.C.

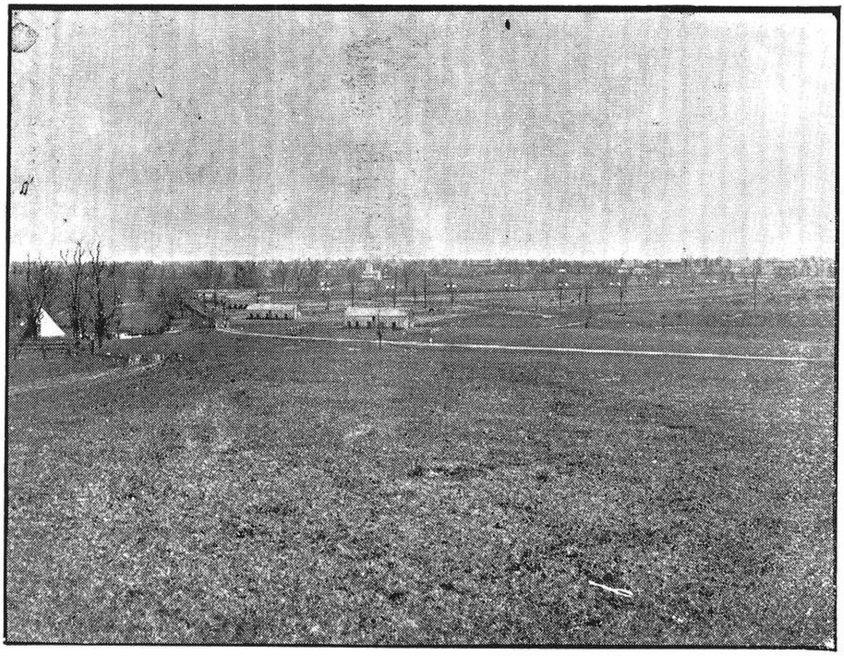


the blue grass region, and at every half mile lives a colonel. Every colonel is a horse-breeder, some being more extensive than others. About seven miles to the north of Lexington is probably the most extensive stock farm in Kentucky, containing 5,000 acres of land and having constantly 20 stallions, 500 brood mares and from 250 to 300 other horses. One hundred to one hundred and twenty-five yearlings are sent to the New York sales yearly.

The owner, Mr. J. B. Haggin, a man about eighty years old, has built a mansion on it costing $300,000, and is preparing to make himself comfortable for the remainder of his days. Pike roads pass along the south and east sides of the farm and the house is back three-quarters of a mile from each pike road.

The electrical equipment consists of a power house, transmission lines, electric motors and lamps, and a twenty-five station telephone system. The contracts were let and work done under the supervision of Cory T. Hutchinson and Louis Duncan, of New York city. The power house is a 25 x 50 foot, one story building of bronze tile with slate roof, and contains a battery room 25 x 25 feet, and engine room 25 x 25 feet. Two generating units consisting of two 50 horse power Westinghouse three cylinder gasoline engines, each direct connected to a multipolar, 25 K. W. Eddy 500 volt generator furnish all the power. One generating unit is used at a time, the other being held as a relay.

The engines are remarkably even in their running—are controlled from the first panel of the switch-board so that the auxiliary parts of one engine can be used to operate the other.



Elmendorf Looking East from House

These engines are started by compressed air which is stored in a large tank by the Christensen air pump driven by the storage battery.

The ignition circuit is supplied by a small dynamoter the driving motor being 220 volts, while the ignition circuit is 8 to 15 volts and 4 amps.

This circuit can be used for either engine—each engine also drives a small sparking dynamo giving 2 amperes at 10 volts.

The ignition circuit of either engine can be changed at the switch-board from one of these generators to the other without stopping. A voltmeter in each engine circuit enables the engineer to tell at a glance whether his engine is igniting properly.

The generators are of the Standard Eddy type—Compound wound—built to run at 300 r. p. m. and to carry a 50 per cent. overload for three consecutive hours.

The switch.board is placed against the partition between the two rooms, extends the full width of the building, and consists of six marble panels, four feet wide by eight high, five of which with one engine can be seen in the third picture.

In the engine room are also two motor-driven Crocker-Wheeler boosters—one is series wound for raising the voltage on the main house feeders when fully loaded and is wound to carry fifty amperes and generate 50 volts—the other is shunt wound and is used in charging the storage battery so that the voltage of the charging generators can be constant as the battery becomes fully charged.

In both of these boosters the 500 volt driving motor is direct connected to a generator on each side.

The generators feed directly to panel 2 of the switch board where they may be run in multiple or used separately either to charge the storage battery or to furnish power to the various motors about the farm. There is an ammeter for each engine.

Panel 3 of the switch board contains one Weston voltmeter with illuminated dial connected to read voltage of No. 1 generator, No. 2 generator, battery, or voltage at main house.

Also one portable voltmeter reading as above and also to either side of storage battery.

Also one single pole underload circuit breaker for protecting battery, one overload circuit breaker and one Weston illuminated dial ammeter reading the whole engine output.

Panel 4 contains three voltmeters for registering the output, thus enabling the management to accurately estimate the cost of power or light. These are connected as follows:

No. 1. In the main Bus Bar circuit, which registers total output of engines.

No. 2. To battery terminals, thus registering battery output.

No. 3. So connected that it registers all current used at 500 volts except that used for charging the battery.

Thus it is easy to figure the cost of the battery or light and also the cost of power.

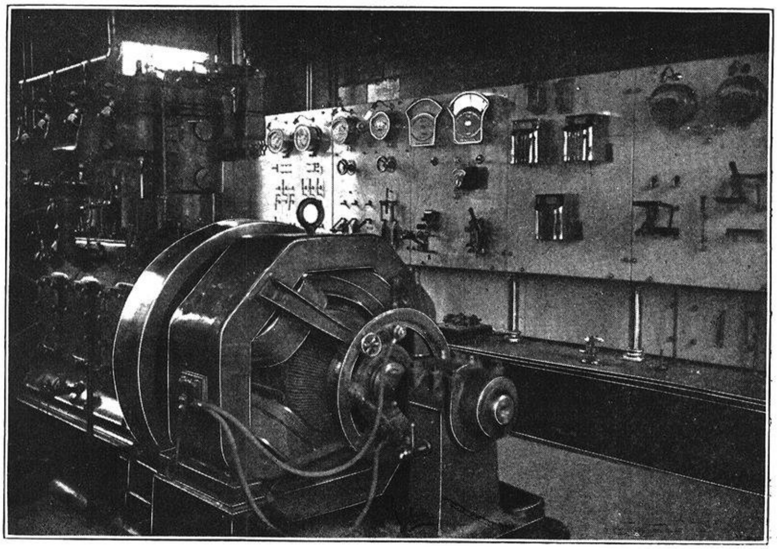
Panel 5 is the booster panel and contains the switches for operating the charging booster and the line booster. The line booster is adjusted to take care of a 10 per cent. line drop.

The main house is wired on the three wire system with 450 volts between outside wires and the neutral grounded.

The middle point of the storage battery is also grounded.

The switching is so arranged that the charging booster can be used or not in charging the battery.

There are on this panel two ammeters in the battery circuit and a switch controlling the neutral.

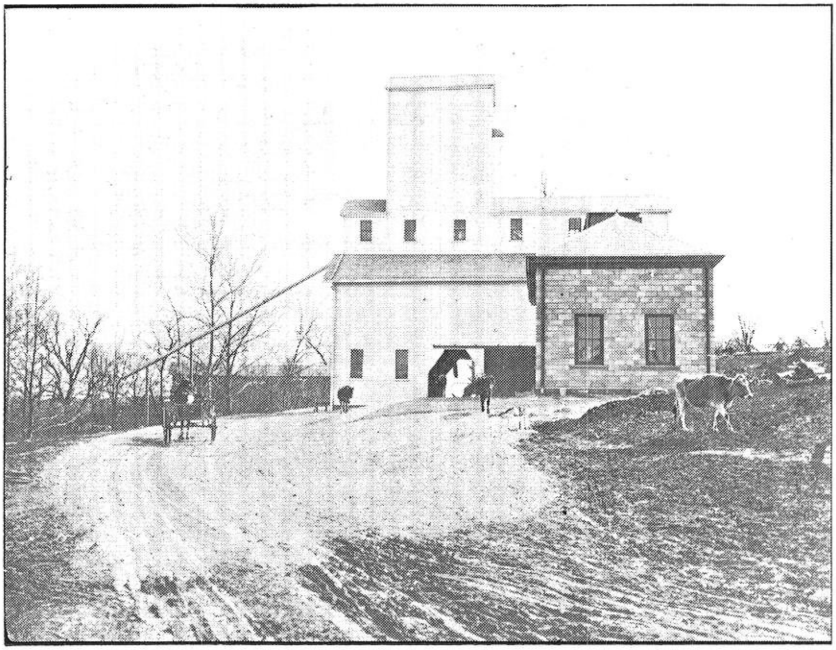


Dynamo and Switchboard.

Panel 6, not shown in the picture, is the feeder panel and contains a switch and circuit breaker in each of the four circuits leaving the Power House.

Circuit No. 1 leads to the elevator shown in the same picture with the power house, where motors are used entirely for power—for running the elevator—crushing feed, grinding feed and pumping water.

Circuit No. 2 leads to the main house. The feeders are of No. oo copper in duplicate on 30 foot poles, are a mile long to rear of coach house, thence 650 feet underground to main house.



Elevator and Power House at Elmendorf.

Circuit No. 3 is 1,000 feet long, of three No. 4 wires, to the blacksmith shop and saw mill where are several motors, and temporarily the telephone central.

Circuit No. 4 is to south entrance and lodge, shown in fourth picture. This circuit extends along the pike roads—part of the way on the interurban telephone poles.

The wiring in the main house, and in all the buildings, stables, etc., is in Greenfield conduit—even to the drop lights everywhere except main house.

The storage battery consists of 224 cells of type F–13 chloride accumulators, and type F–7 plates giving a 180 amp. hour capacity, which can be doubled by putting in F- 13 plates at any time.

Power is furnished for pumping water to the various parts of the farm and to the main house, for two elevators in main house, grinding corn and oats, shelling corn, grain elevator, saw mill, blacksmith shop, carpenter shop, lighting.

The cost of the electric equipment was between $35,000 and $40,000.

The main house which cost $300,000 is wired more elaborately than most houses of its class, perhaps more than any other house in the United States.

For example:

Three chandaliers light the dining room, switches in the butler's pantry are arranged so that one third of the lights in each chandalier can be turned on at a time.

The ten light chandalier in the parlor is controlled in the same way from the same place, and in addition three-light brackets around the sides of the parlor are wired in three circuits so that lights can be controlled from either side of the room.

Over the reception hall, which is two stories, is a venetian dome lighted from above by 40 lights arranged as footlights on a stage and in addition are 40 more in a circle above which can be raied or lowered to vary the effect.

One is surprised to find with all this lavish expenditure a twenty-five station telephone system with a central requiring an operator. In fact an automatic central was tried and because it gave some trouble was thrown out without an effort to improve it.

THE THEORY AND PRACTICE OF LIGHTNING CONDUCTORS.

BY G. W. WILDER, PH. D.

It is now one-hundred and fifty years since Franklin made the practical application of his famous kite experiment, to the protection of buildings from the disasterous effects of lightning discharges. In this long interval of time less has been learned in the theory and practice of lightning rod construction than in any other branch of electrical science, and to-day finds us in this, as in many other branches, further advanced in the theory than in practice. Considering the wonderful advances made in the last thirty years in electrical practice, it is rather remarkable to find that up to the present, almost no progress has been made along this very important line. The theory, also, has remained as it was in Franklin's time until within the last decade, and even now the general notions regarding the behavior of lightning seem to be the same as those held at that period.

The popular explanation of a lightning discharge is familiar to all. A difference in electrical potential between the earth and the clouds is established. When this potential difference becomes very great, the air between the earth and the cloud allows a discharge to take place, and the electrical equilibrium between the two is again restored. We have in this case an example of a condenser or a Leyden Jar, in which the earth and the cloud act as the two conductors and the intervening air as the dielectric or insulating medium. Different opinions exist as the cause of the difference of potential between the cloud and the earth; the most generally accepted views give as an explanation the sudden condensation of water vapor and the friction between water particles and the rocks or other portions of the earth's surface prominently exposed to the action of the winds. It is naturally assumed that the discharge seeks the easiest path possible and in a uniform dielectric, as air, this would be the shortest distance between the cloud and the earth. Hence, the greater the height of the objects upon the earth's surface the greater is the liability they incur of being struck by a lightning discharge.

Franklin considered that when a lightning discharge took place a current of electricity flowed from the cloud to the earth, and as it was known that metals were good conductors, he conceived the idea of erecting iron rods upon houses in order that the current might find an easier path to the ground. Later on copper was substituted for iron, since, being a much better conductor than iron it would offer a still easier path. The fact that buildings well provided with conductors were struck, resulting frequently in much damage, gave rise to much speculation regarding their form and distribution. It was soon found that all conductors must be well earthed, well insulated from the buildings which they served to protect, their upper ends must terminate in sharp points, etc. In fact, many rules were adopted; often changed or discarded as the occasion demanded, until it seemed that no rule could be found which did not have its many exceptions. Whenever a protected building was struck and injured the cause was thought to lie in some imperfect connection, either in the conductor itself or between it and the earth. It is claimed even to-day that the circuit between the conductor and the earth should be frequently tested and its electrical resistance measured in order to see if the contacts are good, although lightning-rod men are at a loss to explain why the lightning often damages a building whose conductors seem to be in the best condition. The French people have devoted much thought to the protection of buildings. In 1782 the extensive buildings of the Palace of the Louvre were elaborately equipped with a system of lightning rods which did good service until 1854 when a severe thunder storm did some damage, although the conductors were still in good condition. Since that time thousands of similar cases have happened and are happening right along. Instances have become so numerous that in some localities a strong prejudice exists in the public mind against lightning conductors.

Ten years ago Dr. Lodge accounted for many of the peculiarities of the lightning discharge by considering that the discharge itself was of an oscillatory nature and of very high frequency. He also reached conclusions which were in contradiction to the old theories and which threw a doubt upon the protecting qualities of a good conductor. He was the first to recognize that there are two very distinct kinds of lightning discharges and that each kind must be handled in a separate way. He showed by experiments, which are now included in the regular work of many large laboratories that a good conducting rod does not, in many cases, offer as good a path for lightning as a poorer one.

With all the experience of the past to guide us, it is even now extremely difficult to say just what takes place in a lightning discharge. What is probably true is that there are many kinds and whatever we may say in a general way will truthfully apply to at least one kind. It is even disputed as to whether the lightning discharge is oscillatory or not. Those who claim that it is, point with pride to the non-production of a magnetic field. However, it is doubtful if the effect of such a field could be detected, the time of its existence being so small. Another proof advanced is that of the well known laboratory experiment which allows the spark from a Leyden Jar or an electrical machine to puncture a card. Such a puncture shows that the paper protrudes from either side, thus indicating no direction to the discharge. Again, it is doubtful if this proves anything, for the same thing could happen by supposing that the air filling the interstices of the paper becomes heated to such a degree during the spark discharge that the violence of the explosion due to rapid expansion is sufficient to drive the paper outwards. One thing upon which all would agree is that if the discharge is oscillatory then its frequency must be very great. The frequency probably varies in wide limits, the minimum value being up in the millions per second.

Experiments with an electrical machine show that the discharge between two points is vastly different from that between two spheres. The difference is more noticeable when large spheres are used and is due to the effect of capacity. With the points a steady discharge is obtained and when the experiments are performed in darkness, the points are seen to glow and peculiar brush-like formations spread out from the points into the surrounding region. Such a discharge is called a brush discharge, and when a cluster of points is used on each electrode of the machine, the discharge is silent and only the appearance of a few brushes would indicate that a discharge is going on. When the spheres are used, the discharges occur at longer intervals of time but are intense in volume, brilliant and accompanied by a loud, sharp, explosive sound. In the former case, the discharge is said to occur as rapidly as the potential between the two points is built up and is called by Dr. Lodge *steady strain.* In the latter case potential is built up and no discharge takes place until the value is reached, such that the air breaks down and the whole quantity of electrification stored up is discharged at once. Such a discharge is called *disruptive discharge* and is due merely to the larger quantity of electrification handled. By using Leyden Jars with an electrical machine the quantity can be greatly increased and the spark made very large. With the large Wimshurst of the Physics Department, a discharge can be obtained which produces a painful noise and heat sufficient to deflagrate small wires placed between the discharging balls. It is evident from the foregoing that we can have discharges varying in nature all the way from a purely *steady strain* or *brush discharge*, entirely harmless and quiet in character to the greatly exaggerated case of a *disruptive discharge* in which a great deal of damage may be done.

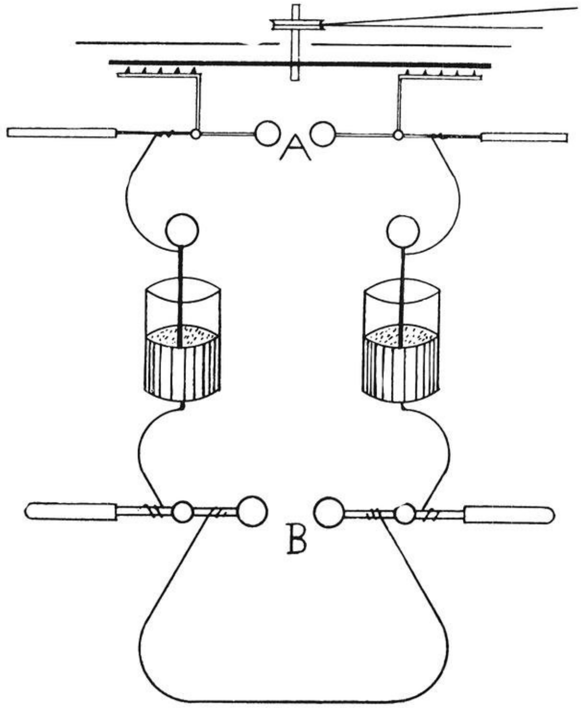
The capacity of any conductor not only depends upon its size and configuration but also upon the proximity of other conductors. This can also be shown by the electrical machine in the following way: If we were to observe the nature of the discharge between the electrodes, while using spheres of difference sizes for the spark terminals, it would be found that the larger the spheres the shorter the distance is through which the spark jumps in the air; that is, the larger spheres must be nearer together. Hence, the larger the spheres, the lower is the potential between them. Since the capacity of a sphere varies as the area of its surface, the larger the capacity the lower the potential, which is one of the fundamental laws of electrostatics.

If a charged body is moved about in the neighborhood of other charged bodies, a relative change in potential takes place between the bodies. The difference in potential between any two can be made so great that the intervening air breaks down and allows a discharge to take place. Such is, perhaps, the case with the clouds. A potential difference exists between the earth and some of the adjacent clouds. The winds drive other clouds highly charged into the neighborhood, and the potential changes rapidly. When this change is too rapid for a *brush discharge*, then the air gives way and a *disruptive discharge* is produced.

Another important relation between the two kinds of discharges was discovered by Dr. Lodge and can be shown by a large machine. A brush discharge will take place between a point or a surface and another point through a greater distance than between a point or surface and a sphere. In fact, the sharper the points, the greater can be their distance apart during a silent discharge. This would lead us to believe that a pointed conductor would protect better than one provided with a sphere, and this theory is often illustrated by placing variously shaped conductors, including a sharply pointed one, on a flat surface, and connecting the latter with one electrode of an electrical machine. A similar flat surface attached to the other electrode is placed at some distance above the objects and discharges allowed to pass. A brush discharge will always seek the sharply pointed conductor although it may be at a much greater distance than the others from the upper plate. If the same experiment be performed, using a disruptive discharge (which is difficult to get on a sufficiently large scale with ordinary hand machines) it is found that the discharge will always take place between the plate and the nearest object regardless of its form or the kind of material, provided that it is not an insulator. Assuming that the lightning discharge is similar in nature to that of an electrical machine, this would account for a few cases where point conductors did not seem to be of any advantage.

Another line of argument remains, concerning the material of the conductor itself; and it is this which has so greatly affected the older theories regarding lightning rods. We are certain that a discharge takes place in a very small interval of time. This has been determined, by means of a revolving mirror, to range between 0.041 and 0.110 seconds; (see B. Walter, Physikal, Zeitsch. Jan., 1902). If we consider that during the time of discharge a current flows which is oscillatory in its nature, then it is questionable if we can apply any of the ordinary laws for alternating currents to such phenomena, for such laws are derived and reduced to simple forms by discarding a great many factors which are considered negligible in practice. Here we have, however, an alternating current in which the frequency goes up into the millions and hence the effect of impedance is very great. The resistance of the conductor no longer follows Ohm's Law. Lord Rayleigh (1866) has shown that with excessively high frequencies the effective resistance of a conductor is greater than its ohmic resistance; incidentally, he has also shown that the magnetization of the conductor is very small. The impedance can become so enormously large that a conductor may act as an obstruction to the passage of the discharge and in such a case the latter would seek a path offering less obstruction. It can also be shown that the impedance is larger when the conductor is better, since there is no magnetic effect and, hence, no effect due to magnetic permeability. Another peculiar condition arrived at is that for such excessive high frequencies the current does not traverse the interior of the conductor but merely the outside or surface. The depth to which the current penetrates can be calculated and has been known for a long time. It is rather interesting to note that for years observers noticed an effect of this kind in lightning rods and many held the opinion that the conductors should be made in the form of thin ribbons rather than cylindrical rods. A bitter controversy was waged for years; some declaring, like Faraday, that the sectional area of the conductor was the important thing, while others claimed that surface was more essential. Experience has decided in favor of the surface theory, although it is difficult to draw parallel cases for illustration. *Tape*, as it is called, is extensively used in England at present, but is little used in this country.

An interesting experiment taken from Lodge and showing that a spark prefers jumping across a considerable air space rather than to go through a good conductor is given in the following diagram which represents an electrical machine, the



terminals of which are connected to the inside coatings of two Leyden jars. The outside coatings are connected by two electrodes as is also a copper wire; the electrodes and the wire forming a choice of paths for the discharge. The jars are now charged until a spark passes at A. A similar discharge occurs at B, provided that the electrodes are close enough together, or that the wire forming the alternative path is long enough. By varying the distance between the electrodes at B, a limiting value will be found at which as many sparks pass through the wire as go through the air space between the balls, showing that the wire has an *effective* resistance equal to the given length of air gap. If an iron wire be substituted for the copper wire it is found that the distance between the balls must be greatly reduced in order that sparks may jump across the air-gap. This shows that the iron wire offers less resistance to the discharge than copper and if the experiment be carried out with the aid of the large Wimshurst machine and if the relative distances between the electrodes be measured by a micrometer, quantitative results can be obtained which will agree well with calculated ones.

From the preceding theory it will be seen that it is rather difficult to get a conductor which will ideally fill all the conditions imposed upon it. A pointed copper conductor may serve very well in cases where the discharges are slow and steady, as in moderate storms, and yet be even dangerous where the discharges are of a disruptive nature. A myriad of points is advantageous for a brush discharge. A wire of high ohmic resistance is desirable for a disruptive discharge and the greater its area of surface and the less its cross-sectional area the better. To combine all of these conditions is the problem which must be solved before good protection can be secured.

Another important element is the arrangement of conductors upon a building. The experiment with the electrical machine, just alluded to, shows that care must be taken that the air-gap, between the conductor and various parts of the building which are in connection with the ground, is not too small. It is probable that short bends and turns in a conductor will increase this effect, and, hence, angles should be avoided.

As a practical solution of all of these difficulties, Dr. Lodge advocated the use of iron barbed wire instead of the usual form of copper rod. He suggested that in order to fully protect a building it should be covered with a sort of network of wires extending down the sides and into the ground. This idea of a closed network is an old one and comes from a well-known proposition in elementary electricity, in which it is shown that no electrical or magnetic effect is present inside a hollow, closed metallic body. Dr. Lodge's suggestion is particularly valuable, however, from a commercial standpoint, in that iron serves much better electrically for a lightning conductor than copper, and, of course, is less expensive. A building well covered with barbed wire is an example of a large area covered with an infinite number of points. A great many paths are furnished for the dissipation of a disruptive discharge and, consequently, the heating effects which are often so noticeable in copper conductors are reduced to a minimum.

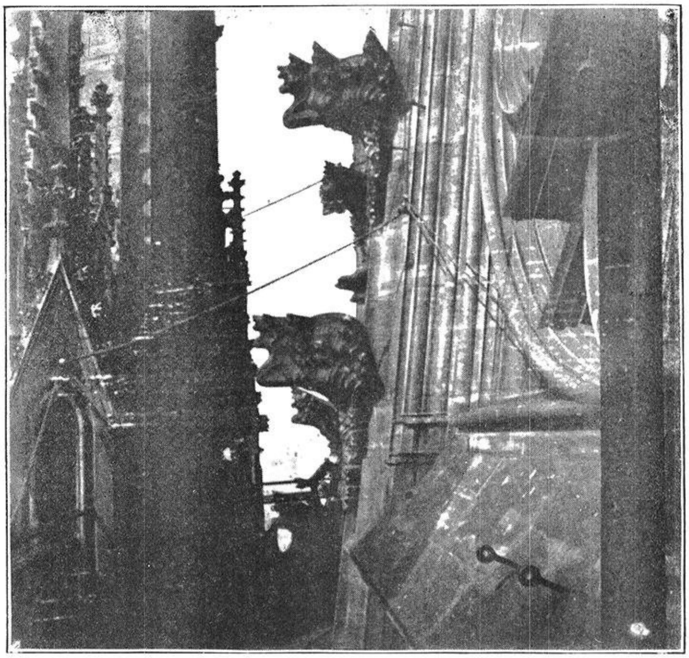
It is of interest to note the numerous attempts which have been made to find out the probable value of the current which traverses a conductor during a discharge. Until recently, it was thought to be some function of the difference in potential between the earth and the clouds only. Now we know that with exceedingly high frequencies the cross-sectional form, and the kind of material which constitutes the conductor are of much more importance. On account of the shortness of duration of a lightning discharge, the current in a copper conductor must be enormous in order to produce some of the heating effects which have been observed. No reliable measurements have yet been made, nor are any likely to be made, owing to our inability to measure the small interval occupied by a lightning flash. It is also quite probable that the current value is extremely variable, reaching into the thousands of amperes as an upper limit. The time of a disruptive discharge is so short and the intensity of light from the flash is so great that if it were possible to produce a continuous discharge of equal brilliancy, the effect upon the eyesight would be very disastrous.

The commercial development of lightning conductors has, unfortunately, led to much swindling of the public. The well-known exploits of *lightning-rod agents* have had the effect of making the public skeptical regarding the efficiency of any kind or form of conductor; hence, the introduction of any new scheme, however simple or practical, is met with considerable antipathy. This is probably the chief cause of the extensive use of thick copper rods in this country. It is almost impossible to arouse interest in the barbed-wire scheme. Even the insurance companies are loth to grant risks on buildings thus protected. Considering the great number of violent storms and the consequent losses, the comparative cheapness of barbed wire, together with that willingness, peculiar to Americans, to try anything new, which may lead to improvement, it is astonishing to find to-day, with all of our prominence in other electrical lines, that we are at a complete stand-still regarding lightning protection.

In England great progress has been made and the people are beginning to realize that the old style of copper rod so familiar to us, is a thing of the past. They have devoted considerable attention to the architectural arrangement of wires, with the result that in many cases they are only visible at very slight distances.

Upon the continent the old style of copper rod still exists and in a very exaggerated form. The religious prejudices which served against the introduction of conductors for almost a century have disappeared and now there is scarcely a Cathedral or chapel which is not well equipped with heavy and expensive copper rods. In the cities the number of lightning conductors is so great that the whole city can be said to form an area protected by a countless number of points, which, together with all the telephone and telegraph wires, form a complete metal network insuring the best of protection, although expensive. When we consider that the average electrical storm in Europe is tame compared to our summer storms, it will be seen that the amount of damage is necessarily much less than in our country.

In Europe, great emphasis has been laid upon the size of the copper rod, hence, the amount of money expended for the protection of a Cathedral is enormous. One or two such rods are considered more efficient than several smaller ones, and are to be found on all large edifices. The mechanical



arrangement seems to have been sadly neglected and it is a very common thing to find copper rods an inch in diameter bent at right angles in order to follow the contour of the building.

An illustration of the general method prevalent is given in the accompanying cut, which is a kodak view, taken from one of the towers on the celebrated Cathedral at Cologne.

The large conductor is of twisted copper wires forming a rope about one inch in diameter and is fastened to the stone tower by large iron spikes. Notice the sharp bend in the conductor. The smaller rope is about one-half inch in diameter and crosses over to the neighboring tower and thence to the ground.

THE U. W. ENGINEERS' CLUB.

On February 7 the club held an informal meeting. It was the last meeting before the February examinations and all programs and business were suspended in order that the evening might be spent in having a good time. The attendance was not very large owing to the fact that many of the members had examinations next day, but all who did attend enjoyed themselves. Songs, jokes, stories, jigs and refreshments kept everybody happy until the censor locked up the building.

February 14:

Singing by the club.

Parliamentary practice relating to the appointment and reports of committees constituted the first part of the program.

A discussion as to the relative merits of Steam Turbines, of the De Laval and Parsons types, took the place of a debate which was to have been given on this subject.

H. E. Bailey gave a paper on the "Handling of Orange Crops in Southern California."

February 21:

Music: Piano solo, H. E. Bailey.

Talk: "A Year with the General Electric Co," A. B. Marvin.

Paper: "Manufacture of United States Paper Money," R. R. Caskey.

Current Events: A. F. Alexander.

Paper: "Horseless Carriages," J. G. Zimmermann.

At the business meeting it was voted to hold a Freshmen Blowout on March 21st.

February 28:

Music: By club.

Paper: "Wireless Telegraphy," F. H. Petura.

Debate: "Resolved, That the Nicaragua Route is preferable to the Panama Route, granting that the United States will select one of these routes.

Affirmative—W. L. Thorkelson, J. C. Potter, A. B. Ziegeweid.

Negative—E. A Ekern, C. I. Zimmermann, R. Jones.

Current Events: R. H. Whyman.

Parliamentary Practice by the Freshmen of the Club.

At this meeting a constitution was adopted for the newly organized Joint Debate League of the College of Engineering.

March 7:

At this meeting Prof. W. D. Taylor read a very interesting paper on "The Negro in the South." Prof. Taylor is a Southern man and made his paper very interesting by citing personal experiences and reminiscences. Having spent his boyhood in the south Prof. Taylor was in a position to present the views of the Southern people in regard to the negro. The society feels itself indebted to Prof. Taylor for his excellegt and instructive paper.

Recitation: "The Overworked Word," J. N. Cadby.

Current Events: W. R. Mott.

Paper: "Installing a Modern Telephone Exchange", S. J. Lisberger.

At the business meeting a Joint Debate Team was elected to debate against the team of the N. O. Whitney club. The members of the U. W. Engineer's Joint Debate Team are E. A. Ekern, G. W. Garvens and F. W. Huels.

March 14:

A short business meeting was held after which adjournment was taken on account of the Junior Oratorical Exhibition.

March 21:

The program for this evening was carried out entirely by the Freshmen, this being the occasion of the "Blowout."

President of the evening: R. R. Caskey.

Music: H. B. Kirkland.

Declamation: H. H. Hunner.

Debate: Resolved that Immigration into the U. S. should be restricted by the exclusion of Illiterates.

Affirmative: R. H. Whyman, L. E. Rice, D. McArthur.

Negative: E. S. Burnett, R. Jones, V. McMullen.

Reading: S. W. Cheney.

At a business meeting after the "Blowout" the following were elected as officers for the remainder of the year.

President: J. G. Hammerschlag.

Vice President: W. R. Mott.

Secretary and Treasurer: G. C. Dean.

Censor: F. C. Stieler.

Assistant Censor: W. E. Crandell.

THE JOINT DEBATE LEAGUE OF THE COLLEGE OF ENGINEERING UNIVERSITY OF WISCONSIN.

For several years we have heard a great deal about the good old days when the Engineering College could support more than one Literary Society. And with the rapid growth of the college, the members of the U. W. Engineers Club and members of the Engineering Faculty, interested in that club, have anticipated a sister society to share the benefits of such a club and increase the profit and interest in debating and literary work, by making possible friendly competition in debate and joint sessions and to consider matters of particular interest to engineering students which should from time to time arise.

With the coming into the new building the matter of organizing another society was agitated and by several discussions and by an article in this magazine, last year, the present good state of affairs was finally brought about. No new society was organized, however, until the opening of the present school year. In October, 1901, not one, but two societies were organized, the N. O. Whiting Association and the J. B. Johnson Association. The first steps taken in intersociety work was on Jan. 10. The question came up, in the U. W. Engineers Club, of challenging one of the other societies to debate. In the discussion it was suggested that a league of the three societies, with a systematic series of debates, would be preferable and on motion a committee of two was appointed to confer with similar committees from the other societies, as to the advisability and prospects of forming such a league. The committee was composed of Spalding '03 and Burling '05, of the J. B. Johnson Ass'n, Rowe '04 and Whitney '04, of the N. O. Whitney Ass'n., and Quigley '03, and Cadby '03, of the U. W. Engineers Club. The committee reported on Jan. 24, recommending that a Joint Debate League be formed and that if possible one debate be held before the close of the present school year. They further recommended that a committee of one man from each society be appointed at once to draw up constitution and by laws and complete the organization of a Joint Debate League of the engineering societies. This committee consisted of Rowe '04 from N. O. Whitney Ass'n, Cadby '03 U. W. Engineers' Club and Boldenweck '02 from the J. B. Johnson Ass'n.

On Feb. 28 a constitution was adopted by the three clubs and the election of officers took place.

According to this constitution two debates are to be held each year, any one contest to be between the society winning the last debate and the society not being represented in that debate. After this year the debates are to take place just before the Christmas and before the Easter recesses. Special provisions were made for the first debate and then the rotation system will be followed.

The officers elected were, John N. Cadby, '03 president, Milan R. Bump '02, vice-president and James E. Smith '02, secretary and treasurer. The officers decided by lot that the first debate should be between the N. O. Whitney Ass'n, and the U. W. Engineers' Club; the latter submitting a question and the former choosing their side of the submitted question. The U. W. Engineers' Club, is to be

Officers of Joint Debate League.

represented by G. W. Garvens '03, E. A. Ekern '03, and F. W. Huels '03. The N. O. Whitney team is W. A. Rowe '04, W. Bradford '04, and E. A. Goetz '04.

The following question has been submitted and the N. O. Whitney Club have chosen the affirmative side.

"*Resolved*, That after July 1st, 1907, the units of measure of the metric system shall be legally adopted as the standard of weights and measures recognized in the United States and its possessions; it being conceded that nothing herein specified shall apply to any contract existing, or government survey, on or before July 1st, 1904, and that Congress is empowered by the Constitution to enact a law to that effect."

NOTES.

We feel that we owe it to ourselves and our readers to offer a few words of explanation in regard to our last number. We trust that this issue will go to show the standard we had hoped to attain in our other two numbers. To us the last number was certainly a disappointment, for although the articles were most excellent, the very poor paper on which they were printed, made the general appearance anything but flattering to those who are behind the *Journal* this year. We want our friends to know that we ordered and expected to have a first class quality of paper, but a mistake (?) on the part of the printer spoiled our high aims. We are very sorry that this change in paper will necessarily mar the uniformity of Vol. VI, yet we feel that the best we can do under the circumstances is to still try to make the last two numbers strictly first class, although the first two numbers did, to some extent, fail of our expectations.

During the current school year numerous additions have been made to the machinery in the shops. Four new lathes, one milling-machine, and one planer have been purchased and put in operation. These machines represent the latest and best practice.

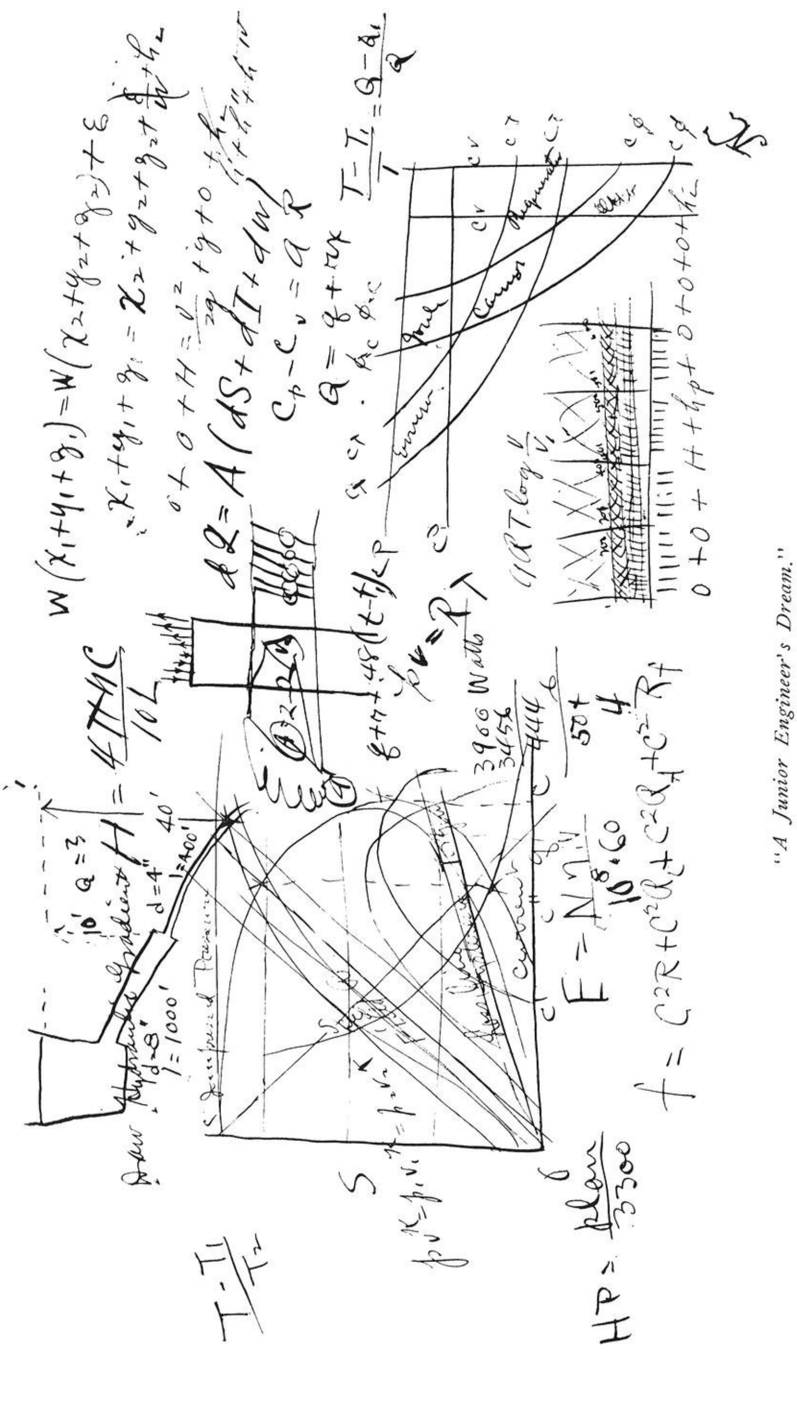
In the wood department, one dozen lathes with counter-shafts have been installed, and are now in use. They are of the same general character as the older lathes, although better in certain details. They were made entirely by students in the various shop courses, and the instructors in charge find that the students take a deal more interest in their work than they otherwise would, when they know that their output is to go into some useful machine. The new lathes were put in operation just in time, as without them it would have been impossible to accommodate the large number of students in the wood-work course.

'04—"Hear about the accident in Science Hall?"

'05—"No! What was it?"

'04—"A Junior, who was working on the Wheatstone bridge, fell off and was drowned in the current."

On February 28, Prof. A. H. Sabin of New York, lectured on the "Protective Coatings of Metallic Structures." This subject is one of very great importance in all engineering constructions, and Mr. Sabin who is head chemist of one of the



"A Junior Engineer's Dream."

largest varnish manufacturing companies in the world, was well qualified to speak upon it.

On February 27, Prof. Kahlenberg lectured before the Science Club on the theory of electrolytic dissociation. His lecture was a refutation of the present accepted theory of electrolytic dissociation and was very clear and interesting to the large audience that heard it.

On February 21, Bertrand S. Summers lectured on "The Chemical Engineer and the Obligation of Waste Material." He dealt chiefly with the use and utilization of the waste products in the manufacturing industries.

Another interesting lecture was that of Mr. A. J. Wurtz, on Friday, February 13, on the "Nernst Lamp." Mr. Wurtz who is in the employ of the Westinghouse Co., of Pittsburg, is probably the best authority on the subject, he having more to do with its development in this country, than perhaps any other man. The subject was profusely illustrated and several lamps with all accessories were exhibited and operated, which made it all the more interesting.

Before the first general meeting of the American Electro-Chemical society, held in Philadelphia April 3, 4 and 5, three papers were read by U. W. Professors. "The Relative Speed of the Ions in the Solutions of Silver-nitrate in Pyrindine and Aceto-Nitrile," by Dr. Schlemdt; the "Electrolytic Rectifier," by Prof. Burgess and Carl Hambrechen; and "Current Electro-Chemical Theories," Prof. Kahlenberg.

On March 14, Prof. J. C. Monaghan lectured on the "Engineer as a Builder of Empires."

The junior members of the Tau Beta Pi, who were elected shortly after the opening of the second semester are as follows: Clarence I. Zimmerman, E. E., and Jas. G. Zimmerman, E. G., Milwaukee; Courtney C. Douglas, M. E., Fontana; Howard S. Elliott, E. E., Mazomanie; H. P. Howland, M. E., Springfield, Mo.; August Fremberg, C. E., Ashland; William Huels, E. E., Madison; W. O. Hotchkiss, C. E., Eau Claire.

An addition has been built on to the steam laboratory to accommodate the superheater, as this necessitates the use of gas as a heater, it had to be placed on the outside of the building.

The old 75 H. P. high-speed engine in the dynamo laboratory has been replaced by a 150 H. P. Ideal high speed engine.

The General Electric Co. has loaned 3-phase 220-volt induction motor for a graduate thesis. A 5 K. W. Stanley Static transformer and a 1 H. P. single phase Emerson induction motor have also been added recently.

Prof.—"What is a reverbaratory furnace?"
Student—"One that vibrates."

We wish to remind a *few* of our subscribers that they have not yet paid this year's subscription to THE ENGINEER. We have done our best to let everybody come in on the dollar rate, even extending the time of payment twice, (since this was the first year that the $1.50 rule has been in effect.) The last call has been issued, and therefore $1.50 is now due on all subscriptions still unpaid. And those who must pay the extra amount should not think it unfair. If you had given us our choice, we would have taken your $1.00 at the first of the year rather than your $1.50 now. We ask you, therefore to pay up now without delay. "Act in the living present." Remember, that now, since we are issuing 500 pages to a volume instead of 200 or so, as for the last two years, *every man who forgets or neglects to pay his subscription, occasions us an actual* LOSS of very nearly one dollar.

Will anyone who knows of any correction in or addition to the Alumni Directory as it appeared in our last number, please impart such information to members of the board, before May 10. We wish to make our directory complete and accurate and we beseech both Alumni and undergraduates to aid us in this work.

PERSONALS.

Mr. J. G. Culver, ex-'69, spent several days at the University and hereabouts, studying electrical machinery and appliances for railway use. Mr. Culver, who was one of the founders of Philomathia, and was its first president, is at present interested in the establishment of an electric railway in Luzon, Philippine islands.

On February 20th, in Chicago, occurred the marriage of Miss Alice Carleton and Mr. Otto F. Wasmansdorf, C. E. '00. Miss Carleton is a graduate of the University, and a member of Kappa Alpha Theta sorority.

Mr. F. W. Bently, M. E. '98, is at present instructor in manual training at Muskegan, Mich.

Mr. Lewis E. Moore is a student at the Boston "Tech."

In our last issue, we referred to an article in the *Electric World*, on a Two Party Line Ringing system patent of Messrs. Leich and Zabel, both '98 men. This is erroneous, as the patents which pertained to a Four Party Line Selective System as well as a a Two Party line, were gotten out entirely by Mr. Leich, and the patents are all in his name. Mr. Zabel is the inventor of a "Heat Coil," or so-called "sneak current arrestor," which is of great value in the present telephone situation.

Mr. Charles H. Williams, M. E., '96 and Miss Laura Wilby, of Baraboo, were married on February 6th at the home of the bride. Miss Lula Horr, of Baraboo, was bridesmaid and Mr. Leonard G. Van Ness, E. E. '96, of Denver, a classmate of the groom, was best man. Another classmate, Mr. H. H. Scott, came from Lincoln, Neb., for the event. Mr. Williams is the superintendent of the Madison Gas & Electric Co.

Carl Stillman, '02, left on February 12th, for Hibbing, Minn., where he had accepted a position with the Lake Superior Consolidated Mining Co.

Dean J. B. Johnson and Prof. W. D. Taylor, attended the meeting of the American Railway Engineering and Maintenance of Way Association, recently held in Chicago. Dean Johnson responsed to a toast, at the banquet, on the "New Education."

Earl E. Hunner, '00, is at present mining engineer of the Tom Thumb mine in northern Washington, one of the largest gold mines in the state.

H. B. Whittemore, M. E., '02, left the university to accept a position with the steam pipe covering works of Milwaukee.

Clarence Taylor is installing mining machinery in Nova Scotia, for the Sullivan Machine Co. His headquarters are at Claremont, New Hampshire.

Prof. Storm Bull was a candidate for mayor of Madison at the spring election.

FRESHMEN ENGINEERS' NOTICE.

We want 25 copies of Vol. VI., No. 1, being the December issue of 1901. We will pay 20 cents each for copies delivered either at the engineering building, or at 202 Langdon street, to A. J. QUIGLEY, *Business Manager.*

OBITUARY.

Word was received a few weeks ago by Prof. Turneaure that John R. Hegg, a graduate of the engineering department at the university last June, had been murdered, January 25th, by a native, while working as a civil engineer in the Philippines. The accounts of his death were very meagre and it could not be learned whether the body had been recovered or not.

Mr. Hegg went to the Philippines last June to accept a position as civil engineer in charge of the construction and repair of roads in the islands. He was recommended for the position by Prof. Turneaure, and was the son of John Hegg, of Cumberland, to whom Prof. Turneaure broke the sad news.

Mr. Hegg and Mr. J. Thomas Hurd, of Stoughton, left after commencement last June to take charge of the provincial supervision of roads and repairs. Mr. Hegg had told in letters of the difficulties encountered with the natives, and it is thought one of his employees killed him in a fit of rage.

Mr. Hegg was very quiet and modest. He was regarded by both professors and students as a man of great industry and perseverance. He was a man who was well known at the university and well liked by every one.

WHEREAS, Mr. John R. Hegg, graduate in the civil engineering course in the class of 1900, was killed by natives in the Philippine Islands, on January 28, 1902, while in the performance of his duties as Provincial Supervisor, be it

Resolved, By the Faculty of the College of Engineering, that the death of Mr. Hegg under these especially sad circumstances, and when he was just at the threshold of his professional career, is greatly to be deplored. As a student Mr. Hegg was characterized by great industry and perseverance. In manner very quiet and modest, he was of unimpeachable character, and well worthy of the trust imposed in his position of responsibility with the government. By his death the University loses a worthy alumnus, and his teachers a valued friend.

Resolved, That these resolutious be published in the college papers, and that a copy be sent to the parents of Mr. Hegg, to whom the faculty extend their sympathy.

F. E. TURNEAURE,
E. R. MAURER,
LEONARD S. SMITH,
Committee.

Mr. Olaf Lindem, C. E. '00, died of tuberculosis at San Antonio, Texas, on Dec. 25, 1901. Mr. Lindem had been in poor health for some time, and went to Texas, to recuperate, about six months before his death. Previous to this time he was in the employ of the National Bridge and Iron Co., at Minneapolis, as draughtsman. The funeral took place on Jan. 1st, at his old home in Marinette.

Mr. Lindem was of a quiet and taciturn nature, and did all his work faithfully. He was a gentleman in every respect, and earned well the trust and respect of every one that knew him. His early demise, at the commencent of his professional career, comes as a sad blow to his former classmates, and to all those that knew him.

ENGINEERS' SOCIABLES.

One of the most recent and interesting features of the engineering students' life, has been the sociables held in our building at various times this past year. Owing to their popularity and the limited space in which the four hundred and more had to be entertained, only the engineering students with the lady friends and members of the faculty have been extended invitations. Two objects have been sought by this means; to aid in a closer acquaintance between the faculty and their wives with the engineering and lady students of the University; and to encourage our students to sing the typical college song more than they now do.

These are advantages which our alumni will appreciate, for even in the middle '90's we had to crave a higher place in the estimation of the fair ones then being looked upon as candidates for a machinist apprentice or as one capable only of running a threshing engine out in the woolly west. One needs but look into the *Badger*, of that time, to find how marked was their longing.*

The same Alumni cannot fail to remember also how one engineeress attempted to plod her way up the ladder to fame. She received so much attention that we are unable (?) to explain her demise, as she was daily surrounded and aided by twenty or more Romeoes. Those days, however, are gone and where one reigned we see hundreds glad to understand us as we are, and who are willing to sing and dance with us.

As to the singing, each one who has heard cannot fail to think that it has come to stay. We owe much to Mr. Bredin for his method of inspiring all to sing and also much to his interpretations of some of the songs. Prof. Mack too, deserves the favorable comment so often heard, for his novel idea of having the songs thrown upon the screen by the lantern, where both they and the leader can be easily seen and followed.

To have heard the Auditorium ring with 400 Whoop-de-doodles, Co-ca-che-lunks, U-pi-dees, or the more tender

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* See page 213, '94 *Badger*.

Bonnies and Quilting Parties, will cause each of us to crave a repetition of the same. Some of the songs are being sung at Convocation, and the Engineers whistle the tunes in drafting rooms or sing them before classes.

No college student should go out into the world without a fund of songs to draw from, and here is where Dean Johnson's desires are being fulfilled. Many of us will come together in the future years, not with our alumni only, but with those of other colleges, and we must be able to join in verse and song when spirits rise at banquets and reunions.

In order that those of the alumni who wish may brush up in this line, we print herewith a number of songs which are most commonly sung.

Some of the features of this season of socials, which will be recalled by the singing of these songs, will be the following: The energetic leading of Mr. Bredin; the explaining to lady friends of the new lighting system, the drawings, tests, and steam engines; the wanderings in the tunnels; the magic moving of the piano; and the competing efforts of the lantern lecturers, with the sound of orchestra and dancing.

Among those who have added to the enjoyable evenings have been Prof. J. F. A. Pyre and Mr. J. E. Boynton '05, with readings; Mrs. J. C. Monaghan and Mrs. Lehner, with songs; the orchestra of University experts; Mr. W. H. Dudley with a lantern lecture on "Switzerland", and Dr. O. G. Libby with a lantern lecture upon "Wisconsin Birds."

It is the hope that we shall soon wish to sing out of doors upon the campus on the summer evenings, or upon the steps of some of our beautiful buildings, to fasten still more deeply the charms of our college songs and days.

O. B. ZIMMERMAN.

JINGLE, BELLS.

Dashing thro' the snow,
  In a one-horse open sleigh,
O'er the fields we go,
  Laughing all the way;
Bells on bob-tail ring,
  Making spirits bright,
What fun it is to ride and sing
  A sleighing song to-night!

(CHORUS.)

Jingle bell! jingle bells!
  Jingle all the way!
Oh! what fun it is to ride
  In a one-horse open sleigh!
Jingle, bells! jingle bells!
  Jingle all the way!
Oh! what fun it is to ride
  In a one-horse open sleigh!

A day or two ago
  I thought I'd take a ride,
And soon Miss Fannie Bright
  Was seated by by side.
The horse was lean and lank,
  Misfortune seem'd his lot,
He got into a drifted bank,
  And we, we got unsot.

(Chorus.)

Now the ground is white;
  Go it while you're young;
Take the girls to-night,
  And sing this sleighing song.
Just get a bob-tail'd bay,
  Two-forty for his speed,
Then hitch him to an open sleigh,
And crack! you'll take the lead.

(Chorus.)

NELLIE WAS A LADY.

Down on the Mississippi floating,
  Long time I trabbel o'er the way;
All night the cotton-wood I'se toting,
  Singing for my true lub all the day.

(Chorus.)

Nellie was a lady, last night she died;
Toll de bell for lubly Nell, my dark Virgina bride.

Oh, Nellie was a lady, last night she died.
Toll de bell for lubly Nell, my darkey bride.
Oh, Nellie was a lady, last night she died.
Toll de bell for lubly Nell, my darkey bride.

Now I'se unhappy and I'se weeping,
Can't tot the cotton-wood any more;
Last night when Nellie was a-sleeping,
Death came a-knocking at the door.

(CHORUS.)

After last verse.

Nellie was a lady, she was, last night she died, she did.
Toll de bell for lubly Nell, my dark Virginia bride, she was.

THE QUILTING PARTY.

In the sky the bright stars glittered,
On the bank the pale moon shone;
And 'twas from Aunt Dinah's quilting party,
I was seeing Nellie home.

(CHORUS.)

I was seeing Nellie home,
I was seeing Nellie home;
And 'was from Aunt Dinah's quilting party;
I was seeing Nellie home.

On my lips a whisper trembled,
Trembled till it dared to come;
And 'twas from Aunt Dinah's quilting party,
I was seeing Nellie home. (CHORUS.)

On my life new hopes were dawning,
And those hopes have lived and grown;
And 'twas from Aunt Dinah's quilting party,
I was seeing Nellie home. (CHORUS.)

SOLOMON LEVI.

My name is Solomon Levi.
At my store on Salem street,
That's where you'll buy your coats and vests,
And ev'rything that's neat;
I've second handed ulsterettes,
And ev'rything that's fine,
For all the boys they trade with me,
At a hundred and forty-nine.

(Chorus.)

O, Solomon Levi! Levi! tra la la la!
Poor sheeny Levi,
Tra la la la la la la la la la,
My name is Solomon Levi.
At my store on Salem street,
That's where you'll buy your coats and vests,
And ev'rything else that's neat;
Second handed ulsterettes and ev'rything else
    that's fine,
For all the boys they trade with me,
At a hundred and forty nine.

And if a bummer comes along
  To my store on Salem street,
And tried to hang me up for coats
  And vests so very neat,
I kicks the bummer right out of my store
  And on him sets my pup,
For I won't sell clothing to any man
  Who tries to set me up.

(Chorus.)

CO-CA-CHE-LUNK.

When we first came to this campus,
    Freshman we, as green as grass;
Now, as grave and reverened seniors,
    Smile we over the verdant past.

(CHORUS.)

Co-ca-che-lunk-che-lunk-che-la-ly,
Co-ca-che-lunk-che-lunk-che-lay,
Co-ca-che-lunk-che-lunk-che-la-ly, Hi!
O chick-a-che-lunk-che-lay.

We have fought the fight together,
    We have struggled side by side;
Broken is the bond that held us—
    We must cut our sticks and slide.

(Chorus.)

BONNIE.

My Bonnie lies over the ocean,
  My Bonnie lies over the sea;
My Bonnie lies over the ocean,
  O bring back my Bonnie to me.

(CHORUS.)

Bring back, bring back,
Bring back my Bonnie to me, to me,
Bring back, bring back,
Bring back my Bonnie to me.

Last night as I lay on my pillow,
Last night as I lay on my bed;
Last night as I lay on my pillow,
I dreamt that my Bonnie was dead.
(Chorus.)

THE BULL-DOG.

Oh! the bull-dog on the bank,
And the bull-frog in the pool,
Oh! the bull-dog on the bank,
And the bull-frog in the pool,
Oh! the bull-dog on the bank,
And the bull-frog in the pool.
The bull-dog called the bull-frog,
A green old water fool.

(CHORUS.)

Singing tra la la la lei-di-o,
Singing tra la la la lei-di-o,
Singing tra la la la la la,
Singing tra la la la la la,
Tra la la la, tra la la la,
Tra la la lei-di-o.

Oh the bull-dog stopped to catch him,
And the snapper caught his paw,
(Repeat twice.)

The pollywog died a-laughing,
To see him wag his jaw.
(Chorus.)

Says the monkey to the owl,
"O! what'll you have to drink?"
(Repeat twice.)

"Why, since you are so very kind,
I'll take a bottle of ink."
(Chorus.)

Pharaoh's daughter on the bank,
Little Moses in the pool;
(Repeat twice.)

She fished him out with a telegraph pole,
And sent him off to school.
(Chorus.)

IT'S A WAY WE HAVE AT WISCONSIN.

It's a way we have at Wisconsin,
It's a way we have at Wisconsin,
It's a way we have at Wisconsin,
To drive dull care away.

(CHORUS.)

To drive dull care away,
To drive dull care away,
It's a way we have at Wisconsin,
It's a way we have at Wisconsin,
I'ts a way we have at Wisconsin,
To drive dull care away.

For we think it is no sin, sir,
To take the Freshmen in, sir,
And ease them of their tin, sir,
To drive dull care away.
(Chorus.)

For we think it is but right, sir,
On Welnesday and Saturday night, sir,
To get most gloriously tight, sir,
To drive dull care away.
(Chorus.)

OLD KENTUCKY HOME.

The sun shines bright in the old Kentucky home,
'Tis summer, the darkies all are gay,
The corn-top's ripe and the meadows are in bloom,
While the bird's make music all the day.
The young folks roll on the little cabin floor,
All merry, all happy, gay and bright;
By an' by hard times comes a-knocking at the door,
Then my old Kentucky home, goodnight.

(CHORUS.)

Weep no more, my lady,
Oh! weep no more today,
We will sing one song for the old Kentucky home,
For the old Kentucky home far away.

They hunt no more for the possum and the coon,
On meadow, o'er hill and by the shore;
They sing no more by the glimmer of the moon,
On the bench by the little cabin door.
The day goes by like a shadow o'er the heart,
With sorrow where once was all delight;
For the time has come when the darkies have to part,
Then my old Kentucky home, goodnight.
(Chorus.)

The heart must bow and the back will have to bend,
Wherever the darkey now must go;
A few more days and the trouble all will end,
In the field where the cane and cotton grow.
A few more days for to tote the weary load,
No matter, it never will be light;
Just a few more days we will totter on the road,
Then my old Kentucky home, goodnight.
(Chorus.)

THERE IS A TAVERN IN THE TOWN.

There is a tavern in the town, in the town,
And there my dear love sits him down, sits him down,
And drinks his wine 'mid laughter free,
And never, never thinks of me.

(CHORUS.)

Fare thee well, for I must leave thee,
Do not let the parting grieve thee,
And remember that the best of friends must part, must part.
Adieu, adieu, kind friends, adieu, adieu, adieu;
I can no longer stay with you, stay with you.
I'll hang my harp on a weeping willow tree,
And may the world go well with thee.

He left me for a damsel dark, damsel dark;
Each Friday night they used to spark, used to spark,
And now my love once true to me,
Takes that dark damsel on his knee.

(CHORUS.)

Oh! dig my grave both wide and deep, wide and deep;
Put tombstones at my head and feet, head and feet,
And on my breast carve a turtle dove,
To signify I died of love.

(CHORUS.)

WISCONSIN'S FOOTBALL SONG.

For its always fair weather
When good fellows get together
With a team that won't waver
Till the championship we hold.
For its always fair weather
When good fellows get together
Wisconsin forever!
And her football heroes bold.