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The Wisconsin Engineer

MARCH, 1913

Volume 17 Number 6

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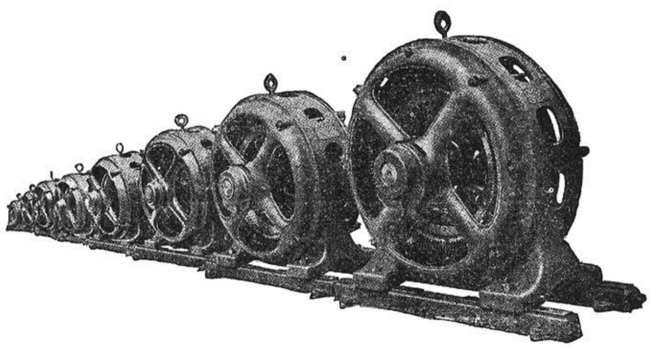
WISCONSIN ENGINEERING JOURNAL ASSOCIATION



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The Wisconsin Engineer

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The Wisconsin Engineer

VOL. XVII MARCH, 1913 NO. 6

PRECISE LEVELING IN PRIVATE PRACTICE

W. E. Jessup

U. W., 1912

In 1897 the United States geological survey was authorized by congress, and the money was appropriated, for the purpose of running bench levels throughout the United States. Since that date some 250,000 miles of these levels have been run by this bureau alone. Besides, the geological survey, the army engineers, the Great Lakes survey, and the coast and geodetic survey have been running levels also and their lines added to the geological survey and those of the reclamation service would total nearly 375,000 miles. In this work some 33,000 bench marks of permanent character have been set and the resulting elevations published. These publications may be obtained at a nominal cost and usually for the asking from the various departments.

Levels have been run along all the principal highways, and railroads and bench marks may be found in almost every conceivable place in the United States. Most practicing engineers are not aware of this multitude of valuable data nor of the method of getting at it. However one of the purposes of these levels is to make them available to whoever may need such results for any engineering or leveling operations.

The work is all carried on within an accuracy of .05 ft. per square mile and the work of the coast and geodetic survey is as accurate as modern instruments and the most refined methods can make it and none better is done anywhere upon this earth. In reducing and adjusting the results, allowance is made for factors which the ordinary county engineer or surveyor had never heard of. The instruments are made of nickel-steel alloy which has a coefficient of expansion from one-twentieth tapes made of this same metal have had a negative coefficient of expansion! The rods are carefully made of paraffine soaked pine to prevent expansion, are carefully painted, graduated, and calibrated. Their lengths are tested at frequent intervals during the progress of the work and a correction applied to the resulting bench mark elevations to allow for any discrepency. Corrections are applied for the differences of curvature of the earth between north and south and east and west lines. Allowance is made for curvature whenever on account of local conditions the foresights cannot be maintained equal to the backsights.

From an investigation of the reports of the various commissions it has been found that an average error of but .0036 feet per mile of levels run has been made. In a 4,800 mile line of levels from Sandy Hook to Seattle an error of about 0.615 feet was found. Every possible effort is made to have the work of the government leveling as near correct as human effort can make it and no expense is withheld to obtain these accurate results. The bench marks set are absolutely permanent and are located, described and their elevations given in the publications referred to and obtainable from the Superintendent of Documents at Washington, D. C.

Such is the extent and accuracy of the government leveling operations available to every surveyor and engineer for his private work. Railroad levels, aqueduct levels, highway profiles, canal and river levels may all be checked by reference to the previously set B. M. S. of the various government surveys.

Previous to 1900 a very cumbersome program of operation at each level set up was used. So long, that before the operations of reading the instrument was completed unequal temperature effects, settlement and handling of the instrument had destroyed the accuracy of the results so much sought after. The design of that instrument used previous to 1900 was such that the program of readings at each set up could not well be varied. With this difficulty in mind and the previous high cost and low speed of precise level operations, the coast survey under the direction of John F. Hayford determined to design a new level, one which would be simple of operation and adjustment, and which could be manipulated both accurately and rapidly. This level has proved a great success and thousands of miles of precise levels have been run with greater speed and more accuracy than ever before. It is held by the designers and by those who have used this level that this type of level can compete successfully with any kind of a wye level on work of any degree of accuracy and Mr. Hayford entertains a belief that an examination of the merits of this instrument would and will lead to its gradual adoption in the place of the wye level for general leveling practice.

This 1900 type precise level is distinctly of the dumpy type and is non-reversible. The level bubble is not mounted on a striding level high above the line of collimation but is recessed in the barrel of the level close to the telescope tube itself where it is protected from expansions and contractions due to the sun's heat. The material of the level itself is of nickel steel and is therefore subject to very little change due to unequal expansion. Nickel steel has a coefficient of expansion of .0000002 or about one-thirtieth that of ordinary tool steel. The leveling is done with three screws set on a very wide base. By means of a unique arrangement of a mirror, two prisms and a small auxiliary telescope offset from the main telescope by the width between the observers eyes, the level bubble may be seen at the same time the wire readings are taken, the bubble being kept centered by means of a milled and graduated screw beneath the eye end of the telescope. The telescope is an inverter and the marks on the level rod are placed inverted so that they may be read more readily. Only one field adjustment is necessary in this level, that of making the line of collimation and the bubble tube parallel. This is done by the peg method modified to suit the instrument.

The method of precise leveling now used with this instrument is as simple as that of ordinary wye leveling, and it is believed, and results bear out this belief, that the manipulation of the instrument and the observing at each station takes less time than is the case with the wye level and target rods used in ordinary leveling. It is this fact that makes this a level that should be considered whenever a very considerable amount of levels of any degree of accuracy is wanted. The observations at a precise leveling station consist simply in reading each of the three horizontal wires of the reticle as seen projected against the rod to the nearest millimeter. The mean of these three readings is treated as the single reading that is taken in ordinary target leveling. These three readings may be taken in less time than a rodman and observer can make a single accurate target setting and reading.

The cost of this class of leveling has been from $7 to $11 per mile and levels have been run at the rate of two and one-tenth miles per hour in good country and at the rate of eighty-five miles per month in more difficult territory. Two rodmen, a recorder and an observer usually constitute the party. A level of this type with two United States geological survey rods cost about $375.

In the United States the use of the precise level has been limited almost entirely to such government work as required the greatest accurcay. The precise level is regarded by many engineers as an unnecessarily complicated instrument requiring a specially trained observer and at its best slow and costly to operate. Following is an account of the satisfactory use of a precise level of the type described above for running levels for location and construction on the 235 miles of the Los Angeles Aqueduct. The length of the aqueduct, the roughness of the territory traversed and therefore the heavy cost of construction, the light slopes (.00035 to .002) and the absence of correct profiles led to the running of the lines of precision levels.

The rod and the method of reading it was unique in that the divisions were made in yards and tenths. The advantage of such a division is obvious. The graduations are larger and therefore more accurate observations can be made. In order to obtain a mean reading for any set of three observations on the rod it is merely necessary to add the three readings in yards and the result is the mean reading in feet. By coloring the various sections a distinctive color the chance of recording the wrong yard was obviated. This rod is a straight, non-extensible twelve foot rod of the United States geological survey pattern.

Bench marks were set about every two and one-half miles in open country and closer in rough country. They were designed after the standard used by the geological survey. They were set by drilling a hole in a rock ledge and setting them in with cement grout or with a mixture of litharge and glycerine. The latter was found to be the better because the very dry atmosphere of the desert dried out the water of the grout before the cement could set. Bench marks were set near tunnel portals and along the highways adjacent to the route of the aqueduct.

The two rod method was used with two rodmen, each rodman acting alternately as back rodman and fore rodman. In this way the fore and back sights could be taken almost simultaneously. This enhanced the accuracy of the work to a considerable extent. In general the specifications of the precise leveling done by the geological survey were used.

Very severe weather conditions had to be contended with on the desert. The temperature often rose as high as 120° Fahrenheit and was in winter sometimes down to the freezing point along the upper end of the aqueduct route. Besides this very high winds usually came up about ten o'clock in the morning and continued until about three in the afternoon. However in this work no delay was allowed in any wind that the observer could stand up against. An extra man shaded the instrument from the sun and another held up a triangular piece of canvas stretched against a frame work to protect the instrument from wind gusts. The rodmen had difficulty in holding their rods plumb until they commenced the use of three props to help brace the rods against the wind. This method proved successful and although the speed was materially reduced on account of the heat and wind they had to contend with, the accuracy of the results shows beyond doubt that this 1900 type of level can do accurate work under the most trying circumstances.

The instructions followed in carrying out the work were essentially those prescribed by the United States geological survey. The maximum length of sight 360 feet. No sights taken closer than one and one-half feet from the ground. Fore and back sights were kept equal. All lines of levels consisted of lines run independently in both the forward and backward direction. Temporary bench marks were established at distances ranging from three-fourths to one and one-fourth miles. The requirement prescribed for the main control line that forward and backward runnings differ by less than $0.017\sqrt{d}$ necessitated the rerunning of 10 per cent of the work a third time. The main control line was 247 miles in length.

From an examination of the results obtained on this survey it is seen that in the longest closed circuit run—181 miles—the error of closure was but .021 foot. The largest error of closure on any accepted circuit was .096 feet for 250 miles which was over very rugged and mountains country. The average speed made was sixty-four miles per month or five and two-tenths miles per working day. The cost of accepted levels per mile was $13.20.

In the precise level work for the Panama canal the old style Kern precision level was used with the Kern and Fauth level tube. Two parties working from both sides toward the middle, were employed. An average tide gage reading for a long period previous to the commencement of the work was used as the 0.0 or datum on each side. When the parties met near the center of the Isthmus they found an error of .2065 foot which disproved the popular idea that one ocean was much higher than the other. Because this total error (.2065 ft.) could not be attributed to poor leveling it was believed that tide gage readings had not covered a long enough period to accurately determine the average elevation of the ocean.

Because of frequent passing of trains and blasting in the adjacent excavations the results were somewhat vitiated. To overcome this as much as possible two independent set ups were taken at each instrument station and the fore and back sights taken independently. Bench marks were set in pairs one on the line of the Panama railroad and the other on the canal alignment. The length of line run was 47.4 miles, the distance from ocean to ocean. The bench marks were made by imbedding a brass or copper bolt in the middle of a slab of stone or concrete 18″ square and 6″ thick which was buried in the ground about 3′. This plug was made accessible from the surface of the ground by means of a 4″ galvanized iron pipe capped with a brass cap and plug. This pipe reached down to and surrounded the plug in the concrete block and extended some 18″ above the ground. An elevation for popular use was written on this upper brass cap. For more accurate work two special wrenches were supplied by which the upper cap could be removed and then the rod could be held directly on the plug in the buried slab.

The location of each bench mark was plainly marked by surrounding it with a white fence on which a sign of warning for destructive minded natives was posted. It was believed that publicity of location was a better protection than hiding.

The ordinary railroad levels of the Panama railroad were found to be but three-tenths of a foot in error in the middle of the route which speaks well for the accuracy of ordinary level operations carried on under difficult circumstances of atmospheric conditions.

On the New York Aqueduct the levels were run in duplicate lines with a 15″ Inverting Berger instrument, having a focal length of 13″, a 1¼″ objective diameter, a magnifying power of thirty-five and bubble of a sensitiveness equal to thirteen sections per one-tenth inch of tube. Self reading rods were used the three wires of the instrument being read on the rod at each observation. An average accuracy of $.02\sqrt{d}$ was attained with a speed of thirty set ups per hour. Of these 7 per cent had to be rerun to attain the required accuracy. The usual type of New York extension target rods was tried but without success, on account of the wear of the moving parts. A party of four men was found to be the most economical, there being two rodman, a recorder and an observer.

Mr. Ralph D. Libby in running government precise levels from Ogden, Utah to Pocatello along the railroad determined to use the rail as a support for his rod. Previous to this innovation he had been considerably annoyed and delayed by finding systematic minus errors in his level operations that is the discrepency between the forward levels and the backward levels was always negative. This showed that his turning points had settled slightly each time. By using the railroad rail he found that this minus error was not apparent but that a greater speed could be attained—one to two miles further per day could be run. This greater speed obtained because the rear rodman could start forward as soon as his rod had been read and before the readings had been recorded and the results checked by the recorder. A chalk mark on the rail marked the position of the rod and was easily found again should it be desirable. It could not be depended upon that the rail would return to the same elevation it held previously, after the passage of a train so whenever a train was known to be coming or was due the turning points were taken or the regulation pin driven into the ground off to one side. The use of the railroad rail as a rod support was also successfully used by J. A. Paige of the United States geological survey between St. Paul and Duluth. These facts go to prove that because of its availability, simplicity of use and accuracy, the railroad rail is more desirable than the regulation turning pin and should be used in private as well as government practice whenever possible.

This paper has had as an object, the setting forth of facts that will make precision levels more desirable in private practice than heretofore because of their low cost, speed, simplicity, reliability and most of all their accuracy. The fact that precise levels may be run as fast and much more accurately than target levels of the ordinary kind should make every engineer intending to run long lines of levels for construction work investigate very thoroughly this precise method of leveling.

METALLOGRAPHY AND HIGH SPEED STEEL

OLIVER W. STOREY

To the lay mind the expression "High Speed Steel" means something mysterious that can be treated in the magazine section of the Sunday papers. To the average machinist it is quite often, when introduced into his particular shop, a sign for revolt, while to the blacksmith and tool maker unaccustomed to its peculiar properties it is often a Waterloo.

Robert Mushet's air hardening tool steel was probably the first alloy steel invented and was the forerunner of the modern high speed steel. Mushet's patent is dated 1861 and for many years his product was the acme of cutting steels. But a remarkable evolution has occurred during the past two decades and now Mushet steel is out of date. This steel contained from four to twelve per cent of tungsten with two to four per cent of manganese and 1.50 to 2.50 per cent of carbon. The remarkable property of it was that it was not capable of being made soft by any known process and was non-magnetic.

The value of Mushet steel lays in its capacity for performing a large amount of heavy cutting work, retaining its cutting edge for a long time under very severe service. The cutting speed at which it was used was not any higher than that of ordinary carbon tool steel but the economy of its use was due to the fact that it would take deep cuts and last long without regrinding.

The next development of importance occurred in 1888 when Robert A. Hadfield, the famous English metallurgist, presented his paper on manganese steels before the Institution of Civil Engineers. He showed that a manganese steel containing from three to six per cent of that metal with not more than 0.6 per cent carbon was an exceedingly brittle and hard product, yet by doubling the proportion of manganese, that is, from twelve to fourteen per cent, a remarkable material resulted. This steel was exceedingly hard and tough, thus offering a higher resistance to abrasion than any other alloy yet produced.

After this development various alloy steels made their appearance but it remained for Frederick W. Taylor and Maunsel White of the Bethlehem Steel Works to carry out a series of investigations in alloy steels that resulted in the modern high speed steel. The Taylor-White steels were first exhibited publicly at the Paris Exposition in 1900, where they created a sensation. The tools made from these steels could be made to travel through the metal that it was cutting at such a high rate of speed that the tool became red hot and yet did not lose its edge. The result was that the output of a machine on which this tool was used was increased many times.

The high speed steels now on the market vary in composition over wide limits; they may contain from 0.25 to 1.00 per cent carbon, generally not over 0.60 per cent; generally from 10 to 20 per cent of tungsten; 2 to 8 per cent of chromium and zero to 0.40 per cent of manganese. Tungsten may be replaced by molybdenum, generally one part of molybdenum being as effectual as two parts of tungsten. Vanadium in small amounts, from 0.2 to 0.4 per cent is often added and is said to greatly increase the efficiency.

The treatment of the high speed steel is very simple and consists in heating the steel to incipient fusion and then cooling in an air blast. This hardens it and the tool may be used to a red heat without becoming soft.

In studying the high speed steels the microscope is found invaluable. A chemical analysis fails to give the combination of elements, while the microscope does.

By a metallographic study which includes a thermal analysis the reasons for the peculiar properties of this class of steels were explained.

The ordinary carbon tool steel when slowly cooled from a cherry red becomes soft but if plunged in water from that temperature this same material will be exceedingly hard. If the softened and hardened steels were analyzed no difference would be detected but if the materials were examined under the microscope two unlike substances would be seen. The annealed tool steel would consist principally of a laminated structure, the laminations consisting of iron carbide and pure iron. On the other hand the hard quenched steel would consist of a needle like structure called martensite. This so-called martensitic structure is explained by the solution theory. At a cherry red the iron carbide is in solution in the pure iron, and, as such is a hard brittle material. When plunged into water this solution of iron carbide in iron has not sufficient time to separate with its constituents, which is the case with slow cooling which gives a softer material. This solution is only stable below 200° C. and with application of higher temperatures the carbide begins to separate from the iron, causing a softening or tempering. These transformations are readily detected with the microscope.

If it were possible to form this martensitic structure by slower cooling, that is, making it normal to the ordinary temperatures instead of at a cherry red or 900° it would be possible to use such a steel without danger of over-heating when taking heavy cuts. The addition of metals like nickel, chromium and manganese, was found to perform this function.

When five per cent of nickel is added to a medium carbon steel martensite is obtained and the steel is very hard and brittle. Even when slowly cooled this martensitic structure remains. In the case carbonizing of nickel steels the material is slowly cooled yet the outside shell is hard, since the martensite does not decompose as with carbon steels. With ordinary steels the iron carbide and iron would not have stayed in solution below 700° C. but would have separated out into a softer material, but here the nickel prevents this separation and the hard martensite is normal to ordinary temperatures. This structure is ideal for a case hardened material.

When ten to fifteen per cent of manganese is added to steel as in the Hadfield steels, austenite, another form of a solution of iron carbide in iron is formed which is normal to the ordinary temperatures. Martensite is a variety of austenite and while the former is hard and brittle, the latter is hard but is much tougher and quite ductile. This explains the results that were obtained by Hadfield. The steels containing 3 to 6 per cent manganese and 0.6 to 1.0 per cent carbon are brittle and an examination under the microscope shows they are composed of the brittle martensite. Above this percentage of manganese the steel becomes austenitic and is tough and ductile.

In high speed steels several alloying metals have their influences on the material. If such a steel is hardened by air cooling after heating to incipient fusion, this being the proper method of treatment, a uniform material results. The uniformity is due to the dissolving at this high temperature of the various carbides present. The cooling is sufficiently rapid to prevent these carbides from separating out again and as a result the martensitic or austenitic steel results.

This steel may then be heated to a red heat before becoming soft again and retains its cutting edge, thus allowing it to be used up to such a temperature. Above that temperature the carbides again begin to separate out of the solution and thereby annealing the steel.

With the aid of the metallographic microscope these structural changes with various heat treatments were easily obtained. Upon these structural changes depended the usefulness of the high speed steel. Although the actual heat treatment of a high speed steel was worked out before it was subject to microscopic study, the reasons for these phenomena were immediately apparent when viewed in this manner. And when the causes of the valuable properties of high speed steels were known, not only could these steels be applied in the shop with more intelligence, but their manufacture could be carried out more intelligently and the causes of failures could be discovered and remedied.

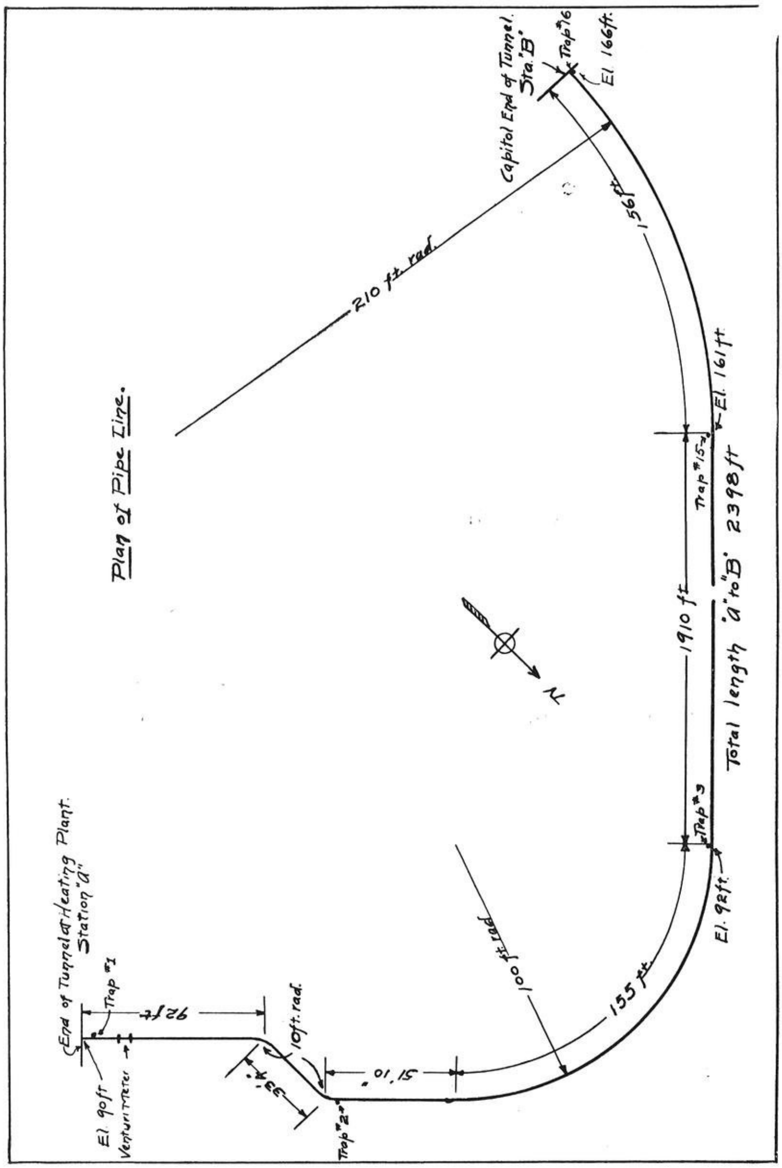
THE FLOW OF STEAM IN PIPES

A. E. Berggren
Instructor in Steam and Gas Engineering

The size of piping for the transmission of high pressure steam has come to be of especial economic interest to the consulting engineer in the design of steam plants, as he must not allow too great drop in pressure on account of pipes too small to carry the load nor must he allow sizes larger than necessary to increase excessively the first cost of installation. Many tests of piping, both in laboratories and in actual installations, often of special construction, have been made, and valuable data and formulas proposed for the flow of steam through pipes of standard dimensions, but existing data on tests of long pipes are hard to find.

During the summer of 1911, a series of runs was made on the twenty-four hundred foot line of three inch pipe carrying high pressure steam from the Capitol Heating and Power Station to the State Capitol here in Madison, to determine as a matter of research of enginering interest, the losses that effect its efficiency as an energy carrier. This data lends itself to checking the generally accepted formulas for the flow of steam in pipes, and this article is to deal with an application to one of these.

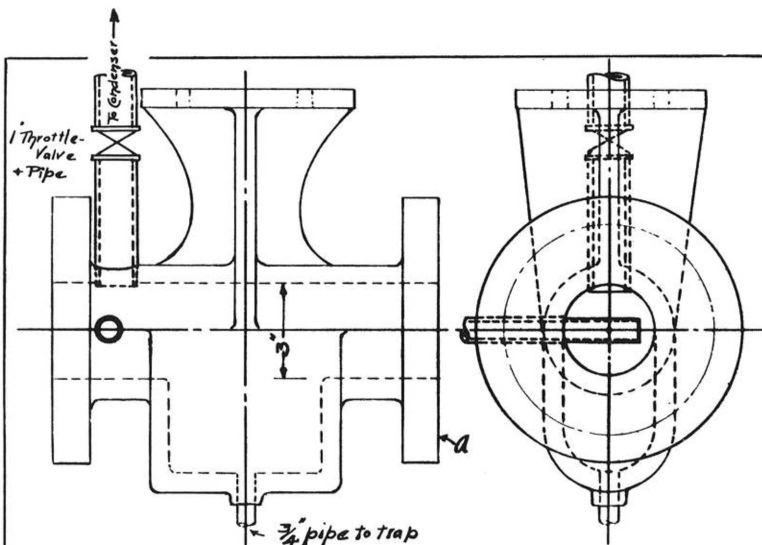
The line tested is one of several in the tunnel connecting the Station and the Capitol, and Fig. 1 shows the general plan and arrangement of the pipe and the test. All curves are seen to be easy bends of long radius, so that the pipe may be regarded as straight as far as pressure losses are concerned. The pipe is of standard dimension, with screwed, smooth-face, flange couplings, anchored at about every 150 feet, with slip-expansion-joints of special design by Supt. J. C. White of the Station, located at each anchor station. The pipe is covered throughout its length with $2\frac{1}{4}''$ thickness of 85% magnesia, with molded forms for the flange couplings. There is a difference in elevation of seventy-six feet in the length of the pipe,


Plan of Pipe Line.
210 ft. rad.
Capitol End of Tunnel. Sta. "B"
Trap #16
El 166 ft.
156 ft
El. 161 ft.
Trap #15
1910 ft
Total length "A" to "B" 2398 ft
Trap #3
El. 92 ft.
100 ft. rad.
155 ft
10 ft. rad.
Trap #2
92 ft
Trap #1
End of Tunnel at Heating Plant. Station "A"
El 90 ft
Venturi Meter
N

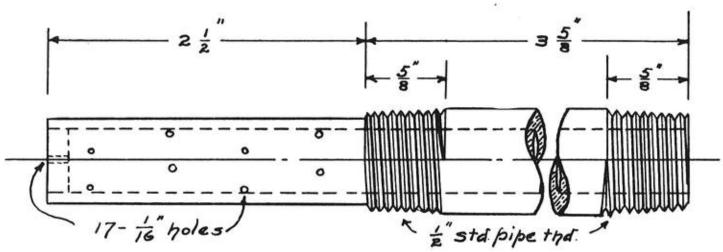
the upper or Capitol end being at the higher elevation. Drainage of condensation in the pipe is effected by ordinary tilt traps, ½″ pipe connection being made to drain-pockets on the under side of the special anchor tees, and discharging into a separate 2½″ return main to the sump at the lower end of the tunnel.

The series of runs was made up of two condensation or no load runs, in which no steam was delivered, and records only of pressures and condensation were made; and of six proportional loads up to the limit of the take-off pipe at the upper end. This discharge or take-off was of standard 1″ pipe, a long nipple being placed vertically on the top side of the last anchor tee (see Fig. 2) and controlled by a throttle valve, from which the discharge led to a Wheeler surface condenser of 144 sq. ft., set up inside the Capitol basement wall. The condensed steam from the condenser was led by a swinging connection to alternate barrels set on scales, one being weighed and emptied while the other was filling.

Steam pressures were taken at both ends by recording gauges, the average pressure used in the tabulation and calculations of Fig. 3 being found by use of plainmeter and corrected by calibration with a dead weight tester. Throttling calorimeters were used to determine the qualities at both ends, the one at the supply end in the 3″ vertical pipe coming from the top side of the 8″ loop header in the boiler room, and the one at the upper or discharge end in the side of the last anchor tee, a trifle ahead of the centre line of the take-off pipe, so as to be in the current of steam passing to that pipe (see Fig. 2). The sampling tubes were of special design, the features being (1) that the threads were turned off on the inserted portion to a diameter below the bottom of the threads, doing away with the usual rough surface that would tend to catch more water than it should, (2) the closed end, with only one small hole instead of the usual open end, and (3) the limited number of 1/16″ holes instead of several ⅛″ holes, the theory being that with the limited number of smaller holes, the sample would be drawn from the whole traverse of the pipe rather than from the few large holes nearest the calorimeter orifice. To get the condensation in the pipe, the 2½″ return taking the



Anchor Tee at End of 3" Pipe Line
showing steam take-off and calorimeter sampling tube.
Scale—1/4 size



Calorimeter Sampling Tube of 1/2" Brass Pipe.

trap discharge was broken at the mouth of the tunnel and connection so made as to discharge into convenient weighing tubs. All thermometers were calibrated by comparison with standard thermometers and barometer readings were obtained from the U. S. Weather Bureau at the University of Wisconsin. Average data and results of the various runs are tabulated in Fig. 3.

It is general practice to allow from one-half to four pounds drop in pressure per one hundred feet of pipe (Gebhardt's "Steam Power Plant Engineering," p. 636) with the average between one and two pounds. Assuming a drop of one pound pressure per one hundred feet of pipe at full load, then for this 2,400 foot line, full load is being carried when a drop of twenty-four pounds occurs. If a curve were plotted between pressure drop and steam delivered, as tabulated in Fig. 3, the full load would be about 3,100 pounds of steam delivered per hour. As it is the delivered steam which does the desired work, the formula will be checked on this amount:

Babcock's formula, $W = 87\sqrt{\frac{y\ P\ d^5}{L\ \left(1 + \frac{3.6}{d}\right)}}$ is the one most generally accepted (Gebhardt's "Steam Power Plant Engineering") and is probably meant for dry steam carried the full length of the pipe. In the line tested, the condensation was taken out at drain pockets and by traps at intervals of from 150 to 175 ft., and taking such installation as typical of good practice, the constant "87" in the formula can be changed to make it applicable to such installation. As seen by inspection of Fig. 3, the condensation remains practically constant, regardless of load and at full load amounts to over ten per cent of the steam delivered.

The formula, $W = K\sqrt{\frac{y\ P\ d^5}{L\ \left(1 + \frac{3.6}{d}\right)}}$, can be simplified to read

$$W = K\sqrt{\frac{y\ P\ d^6}{L(d+36)}} \qquad 1$$

where W = weight of steam delivered in pounds per minute,
P = drop in pressure in pounds per sq. in.,
y = density of steam at mean absolute pressure,

DATA AND RESULTS OF TESTS.

No. of Run	Av'g'e No. 1 + No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
1 Barometer ins. hg.	29.03	29.1	28.98	29.06	29.07	29.05	29.04
Pressures							
2 Gauge at "A"	135.0	135.5	133.7	132.5	133.3	133.2	133.
3 Gauge at "B"	134.	133.	128.4	122.8	116.	115.2	103.1
4 Calorimeter at "A" ins. hg.	1.55	2.7	2.5	2.3	2.03	3.14	3.1
5 Calorimeter at "B" ins. hg.	....	3.76	7.14	6.74	6.25	5.9	5.4
Temperatures							
6 Calorimeter at "A" °F	287.	293.3	292.	290.7	289.	283.7	285.7
7 Calorimeter at "B" °F	....	297.	293.35	289.4	241.	242.7	282.7
8 Average Tunnel °F	84.5	85.	86.	85.3	84.7	83.7	84.5
9 Quality at "A" %	99.2	99.5	99.5	99.4	99.3	99.0	99.1
10 Quality at "B"	....	99.75	99.5	99.4	96.8	96.95	99.4
In Pounds Per Hour							
11 Condensed Steam at "B"	.0	570.6	1200.3	1800.3	2492.	2658.	3460.
12 Cal. Discharge at "B"	.0	88.	84.	75.	65.	64.	50.
13 Total Steam Del'v'd at "B"	.0	658.6	1284.3	1875.3	2557.	2722.	3510.
14 Discharge from Trap No. 1	11.2	14.3	15.3	15.	16.5	12.	6.5
15 Condensation in Line	383.3	386.	398.6	394.	399.	390.	342.8
16 Total Steam Sup'l'd at "A"	394.5	1058.9	1698.2	2284.3	2972.5	3124.	3859.3
17 Heat Supplied at "A" in thousand B.T.U's.	468.	1259.1	2018.8	2713.5	3528.7	3700.	4574.8
18 Heat Delivered at "B" in thousand B.T.U's.	.0	784.2	1526.2	2225.	2974.7	3169.	4154.1
19 Line Efficiency %	.0	62.2	75.7	82.	84.3	85.7	91.

NOTE.—The above data is corrected by calibration.

d = diameter of pipe in inches,
L = length of pipe in feet,
and K = coefficient of friction.

In applying the formula to the line tested, d = 3″ and L = 2,400 ft. Then

$$\sqrt{\frac{d^6}{L\ (d+3.6)}} = \sqrt{\frac{.729}{2400\ (3+3.6)}} = \sqrt{.046} = .2145$$

and $W = K\sqrt{.046\ y\ P}$

Previous to 1900, several experimenters seem to agree that the weight of steam delivered is effected by the length and diameter as shown by the function $\sqrt{\frac{d^6}{L(d+3.6)}}$ (see Carpenter's Experiment on the "Flow of Steam through Pipes," Trans. A. S. M. E., Vol. XX), hence that part of the formula will be accepted. Then the weight of the steam flowing must be effected by some coefficient which may vary with the different loads on account of the changes in density resulting from the changes in the mean pressure at the different loads.

To find the value of this coefficient K, transpose equation (2) to the form

$$K = \frac{W}{\sqrt{.046\ y\ P}} = \frac{4.66\ W}{\sqrt{y\ P}} \tag{3}$$

Tabulating from Fig. 3, and substituting in equation (3),

FIG. 4

No. of Run	P	Mean absolute Pressure	y	y P	W / min	K
3	2.5	148.52	.3286	.822	11.	56.5
4	5.3	145.25	.3218	1.705	21.4	76.4
5	9.7	141.9	.3148	3.054	31.25	83.8
6	17.3	138.9	.3084	5.34	42.6	86.
7	18.	138.45	.3074	5.53	45.4	90.
8	29.9	132.3	.2946	8.82	58.5	91.8

This shows that a value of K = 88 would be the average of the last four and heavier runs and that 91 would be more nearly correct for full load conditions for this particular line or similar installation.

If the value of K is effected by the changing densities due to the different drops in pressure for the various loads, it is possible to find some function of the product of the density and drop in pressure, as $\sqrt[n]{y\ P}$, for which K will remain practically constant. Values of "n" in the above expression equal to 1.4, 1.5, 1.55, 1.6, 1.65, 1.7 and 1.8 were used instead of 2 in equation (3) and the resulting values of K tabulated below:

FIG. 5

No. of Run	n = 1.4	n = 1.5	n = 1.55	n = 1.6	n = 1.65	n = 1.7	n = 1.8	n = 2.
3	58.9	58.4	58.2	58.	57.7	57.5	57.1	56.5
4	68.	69.9	70.6	71.4	72.1	72.9	74.1	76.4
5	65.7	69.2	71.	6.96	74.1	75.5	78.4	83.8
6	60.	65.	67.4	69.6	72.	74.2	78.3	86.
7	62.35	67.6	70.2	72.5	75.	77.4	81.8	90.
8	57.5	63.9	67.	70.	72.8	75.8	81.4	91.8

On inspection of this table we find that K is quite constant for values of "n" from 1.55 to 1.65, decreasing with increasing loads when "n" has values below 1.55, and increasing with increasing loads when "n" has values above 1.65. Choosing 1.6 as the value giving the most constant values of K, averaging close to 70 for the four heavier runs, equation (3) becomes

$$K = \frac{4.66\ W}{\sqrt[1.6]{y\ P}} = 70 \qquad (4)$$

$$\text{and } W = \frac{70\sqrt[1.6]{y\ P}}{4.66} = 15\sqrt[1.6]{y\ P} \qquad (5)$$

Equation (5) would apply, then, to this pipe for all loads within reasonable limit, excluding very light and possibly extremely heavy loads, certainly within the range of the drops in pressure from one to four pounds per hundred feet of pipe allowed in current practice.

To apply to other diameters and lengths of pipe, we must include that part of equation (1) which is a function of the diameter and length. The modified formula for the steam delivered in such installation as has been here analyzed would be

$$W = 70\sqrt[1.6]{y\,P}\ \sqrt{\frac{d^6}{L\,(d + 3.6)}} \qquad (6)$$

It seems rational to assume that in any particular installation, the effect of the diameter and length would be constant for all loads and the square root of these two values in the formula would become a constant and part of the coefficient of the function of the varying density and pressure. Equivalent lengths of straight pipe should be allowed for valves, elbows, etc. The designing engineer, having calculated the steam required for the selected engine units or other purpose, assumed a working pressure and allowed a certain drop in pressure in transmission, and knowing the length of line required from the plant lay-out, has, or can find by use of steam table, all the data required in the equation (6) to find the diameter. By transposing and bringing to the form

$$\frac{d^6}{d + 3.6} = \frac{W^2\,L}{\left(70\sqrt[1.6]{y\,P}\right)^2} = \frac{W^2\,L}{4900\,(y\,P)^{1.25}}, \qquad (7)$$

standard values of diameter can be substituted until the equation is nearest to balance. This could be reduced so that the left hand member would be the first power of "d," but the right hand member would become very complex in so doing, and it seems advisable to use it in the form of equation (7). Standard sizes must be chosen anyhow and the engineer's judgment will indicate what reasonable values to try in this formula.

It should be emphasized that condensation is a function of difference in temperature between steam and surrounding air and can be modified by proper covering. It has nothing to do with the load, except as that load lowers the average pressure and corresponding steam temperature. It is meaningless to give the condensation in percentage of the steam delivered as this percentage would change with every load, the condensation remaining practically constant. Normal, or full load, for a pipe means little when we note the wide range of pressure drops allowed in current practice. In this test, the condensation due to the actual work done in raising the weight of delivered steam to a height of seventy-six feet has been neglected, as it would be less than one-half pound. Also of the difference in pressure due to the column of steam of that height, as it would be less than a fifth of a pound when the mean density was the greatest.

In conclusion it is desired to call attention to the comparative values which Babcock's formula and this modified formula give for this pipe. It should be kept in mind that the modified formula gives weight of commercially dry steam delivered from a drained pipe, where any condensation due to radiation is taken out at various equal intervals. Babcock's formula gives the correct value, as determined in actual experiment, for one load (see Fig. 4), where the drop in pressure is but little over three-quarters of a pound per one hundred feet, giving values increasingly too large as loads decrease from this three-quarter load and giving values decreasingly small as the actual load goes above that three-quarter load, assuming that the steam flow with one pound drop per one hundred feet is full load as before mentioned. It should be noted also that in the modified formula, the coefficient remains constant throughout the ordinary change of load, the weight of delivered steam, or the diameter to be calculated, being dependent on the values of density and pressure drop. This equation, or one of this form, as further experiment shows need for change, should give the designer a more rational and economical pipe size than would be given by the generally accepted Babcock formula.

Limited time has prevented application of this formula to other existing test data or making of further tests with such data in mind, but it is planned to continue the study and either check the formula as it stands or suggest such changes as would make it more generally applicable.

AIR CONDITIONING

Air conditioning is a term which is applied to the positive production and control of desired atmospheric conditions within an enclosure, with respect to moisture, temperature and purity. In the various industries, air conditioning has been demonstrated to be of the greatest economic importance. In the manufacture of high explosives, candy and food stuffs, and in drying of tobacco, some attention has been given to the question of humidity. It is safe to state that the most effective work in artificially controlling the atmospheric conditions has been done in the textile industry and in the manufacture of pig iron.

In the textile industry, prior to the adoption of artificial methods, one of the main reasons that the American mills could not successfully compete with European mills was largely due to the atmospheric conditions in the American mill centers. English manufatures, ignorant of the principles of hygrometry and mechanics of air and water, found that certain districts possessed climatic characteristics which fitted them for textile manufacturing districts. These districts were well sheltered vales with many cloudy days and a fairly constant humidity.

In this discussion no attempt will be made to set forth the laws governing the many phenomena of atmospheric moisture. It is desired merely to show the application of air conditioning to the industries and to consider the results that have been obtained.

Temperature and humidity readily effect the composition of cotton. It may be said that cotton is composed of an infinite number of very close filaments stuck or held together by a waxy or gummy substance. This substance has a melting point at 180° F.; thus it is seen that the pliability of the fibres is directly dependent on the temperature. Modern high speed spinning machines will cause a static or atmospheric charge of electricity to be set up in the fibres and cause them to stand out radially. It is necessary to produce atmospheric conditions of correct humidity and temperature to kill the electricity and to sufficiently melt the gummy binder. Various methods are employed to obtain these conditions. At the outset the floor was sprinkled and the evaporation of the water was supposed to increase the humidity. This crude method was replaced by channels, lined with porous brick which absorbed the water from the channels and gave it to the air. Steam was tried, but due to its temperature of 212° against 180° fusion point of the cotton binder, was not used extensively.

At present several mechanical devices, called humidifiers(are employed.

Humidifiers may be classified into spray and evaporative types. The spray type introduces a finely divided spray directly into the room, while the evaporative type introduces only the water vapor. The amount of moisture which is introduced is usually automatically controlled by devices which are not unsimilar to thermostats.

AIR CONDITIONING IN THE STEEL INDUSTRY

In the previous instance the object was to increase the moisture content or humidity of the air. In the metallurgical industry it is desirable to decrease the moisture content.

In the steel industry the various operations have been highly developed. The iron ore used varies but ten per cent in composition and is made as uniform as possible. Seven thousand two hundred pounds of ore are used per ton of iron and 11,700 pounds of air are used, or 1.6 the weight of ore. Yet this air will vary from 20 to 100 per cent in its moisture content from day to day and even from hour to hour.

The usual size of blast furnace uses 40,000 cubic feet of air per minute and the air varies from one to eight grains of moisture per cubic feet. Under conditions of one grain of water and 1,000 feet of air per minute, one gallon of water will be introduced into the furnace per minute. Since 40,000 cubic feet per minute are used, forty gallons of water per hour for each grain of water per cubic foot are introduced; or the figure which is frequently given, 2,588 gallons of water per hour.

This water must be raised to the furnace temperature and an incombustible vapor results which causes an unproductive consumption of coke due to calories of heat required by the decomposition of the water. The decomposition of water into H and O takes .82 B. T. U. per grain of moisture. From this the heat loss is apparent. The moisture will further cause an unproductive use of coke by using the carbon in the following manner:

$$\text{Coke} + H_2O = CO_2 + H,$$

which shows that some of the carbon is used to combine with the oxygen of the water and hence leave a less amount to combine with the oxygen of the iron ore ($F_{e2}O_3$).

The following example will show the amount of coke unproductively used with humid air:

Average moisture content, 5 gr.

60 cu.-ft. of air / lb. of coke, or 300 grains of moisture per pound of coke.

One lb. of coke if burnt to CO_2 = 12,600 B. T. U. (⅓) = 4,200
One lb. of coke if burnt to CO = 3,800 B. T. U. (⅔) = 2,530

6,730 B. T. U.

300 gr. × .82 = 246 B. T. U. used to decompose the water.

$$\frac{246}{6{,}730} = 3.7\%$$ of coke " " " "

With coke at $3.00 a ton, this means a loss of 11.1 cents per ton.

The moisture in the air also is of chemical importance in the manufacture of steel. The percentage of sulphur in pig iron is to be kept low. The water vapor of the air affects the proportion of this element which enters into the steel. Calcium sulphide is normally present in the slag and is not decomposed when treated in presence of dry CO, but yields an appreciable quantity of sulphureted hydrogen when the CO is moist or contains H. If the charge is burned by means of dry air, the sulphur of the coke will pass without hindrance to the lime of the slag; but should water or hydrogen from its dissociation be present, there will be a contest between the lime and the iron with the result that the iron gains the sulphur and sullies its purity.

Mr. Gayley, vice president of the United Steel Corporation, has studied this problem and has devised means to limit the moisture from the air before it is blown into the blast furnace. By his process, air is caused to pass over coils containing a refrigerating substance. The air is thus cooled to a point at which its ability to hold moisture is very low and the moisture condenses and freezes onto the above mentioned coils. When the coils are covered with a heavy coating of frost, they are removed and replaced by a second set.

In using the above process a saving of twenty per cent in coke consumption and an increase of twenty-five per cent in the output of the furnace was obtained. The work of the blowing engines are likewise decreased. Ninety-six revolutions of the engines burned one per cent more coke and produced eighty-nine tons more pig iron in twenty-four hours than 114 revolutions using natural air.

VENTILATION

Recent experiments show that the humidity of air in problems of ventilation is a factor that has been much neglected and is of great importance in the pure air problem. Proper temperature control without a consideration for the moisture content of the air will not provide comfort for the people who are subjected to air thus tempered. It has been found that there is a direct relation between the temperature and relative humidity at which "comfort" will result.

Although definite information is available concerning the effects caused by moisture in the several industries, knowledge concerning the effects of moisture on human organism is less definite.

CITY PLANNING AS PRACTICED IN EUROPE

PROF. L. S. SMITH

One of the subjects in Europe which interested me greatly was the recent development there in city planning. By that term is usually meant in the United States some city changes whose main object is the improving of traffic conditions or the grouping of public buildings into so-called *civic centers,* the latter largely for aesthetic considerations.

In addition to this, city planning in Germany and England comprehends something of far greater material importance, viz.: the proper sanitary housing of the nations laborers and middle classes. The result of good street planning influences profoundly the well being of a city for all time. The result of good housing conditions even more profoundly influences the health, happiness and general welfare of the citizens and thereby determine even the fate of the nation. This fact in large part explains the growing importance of the German nation. Nor is this the unsupported statement of some enthusiast, but instead it rests upon the most scientific investigation that it is possible to make. For example, it has been clearly proved that good housing, as described later in this paper, has resulted in a much higher birth rate and a much lower death rate. Thus in the Garden Cities of England the death rate averages about five per thousand instead of eighteen, the average of English cities. And not only is the birth rate increased but the children are larger and healthier and, as is shown later in their lives, are superior intellectually as well.

The importance of conserving human life and welfare was forced upon England at the time of the Boer War, when it was found that the enlisted soldiers were so far below standard in physique and health they were unable to pass the physical examination required by the army officials.

The cause of such degeneracy was easily traced to bad housing and labor condition and at once the work of reconstruction began in England.

It would be very difficult to overstate the importance which is attached in Europe to the subject of City Planning. Every university of any note supports a chair on this subject, and, indeed, it appears to be a most important function of the leading architects not only to plan the elevation of houses as is done in this country, but also the comprehensive and systematic planning of he houses for large tracts of land. In this latter work the architect locates the exact position of every house, and at least makes the perspective drawing for every house, public and private, that is to be built on the entire tract of land. The failure to thus plan systematically in our own country has brought about many monstrosities in the grouping of houses. Not infrequently individual houses which are models of their own class, are so placed together as to produce a most incongruous appearance.

City Planning activities fall naturally into three general classes:—first, the planning of new or the widening of present streets in the older part of a city; second, the planning of new suburban districts immediately surrounding an old city; and, third, the planning of the streets and houses of an entirely new city, the so-called "Garden City" of England and Germany.

Because of their great age and the resulting peculiar conditions under which European cities have developed, there exists a large amount of street widening, which is constantly going on in varying degrees, depending upon the locality and the laws governing such work. As a rule, the laws governing city planning in Europe are quite fundamentally different from those under which such work must needs be done in our own country; in fact, much more liberal toward the public. For example, in the city of Munich, the capital of Bavaria, the law * provides that the city officials, under expert direction, shall prepare a scheme for the future replanning of the city. This plan provides for the introduction of new streets where necessary for the new and increased traffic, and for the general widening of the narrower streets of the city. These changes, especially the latter, are brought about by a system of "evolution," rather than "revolution;" that is to say, the law provides that when

* This law applies to the capital city of Bavaria only.

any abutting owner shall replace his present building on a narrow street by a new building, he shall be obliged to move back the new building to the building line as determined by the city, and, what is most remarkable from the standpoint of an American, this virtual transfer of real estate from private to public ownership must be done without remuneration to the

private owner, unless such relinquishment exceeds one-third of the total area of his plat. Such a taking of private for public use without compensation would be unconstitutional in this country. Under such circumstances, the traffic and architectural conditions of the city constantly improve in character as the city develops instead of getting worse, as is the case in most American cities.

But not only are the streets being improved in width, but attention is also given to quite as important a feature,—the design of the outside of the buildings so that they shall produce a harmonious and naturally complementary appearance. For example, the cornice line is strictly limited, depending upon the locality in the city in question, the buildings in the workingmen's quarter being of one size, the better residence district still a different type, the streets where business shall be allowed still another type. Care is also taken to segregate the manufacturing institutions in one quarter of the city, that quarter being chosen to reduce the amount of smoke in the city to a minimum.

The American traveler in Europe will be more impressed with this matter of architectural harmony perhaps than in any other one respect. He cannot fail to note that not only is the aesthetic taste thereby greatly improved and conserved, but that such limitation of the height of buildings also improves the public health by providing for a decent amount of sunlight and air.

Under the second head, the development of the suburban district, great advances have certainly been made in Europe by Garden City planning.

It is a well recognized fact that the dreariness of our towns, the low birth rate and high death rate, are evils inherent in our American social and economic conditions. The close packing together of good houses is often caused by the enormously high price of building land in our large cities, making any other method whereby the property investor can obtain a return on his capital impossible. It is evident that no permanent relief can be secured unless limitation can be put on land values.

In general, it may be said that in working out the scheme of Garden Cities provision is made for the purchase of a large area of land at its agricultural value, which by reason of its conversion into an urban district with all the facilities of modern civilization would naturally rapidly increase in value. The dividend of such holding company being limited generally by charter to four or five per cent, by far the greater part of this increased value, the so-called unearned increment, can and is used for the benefit of the municipality as a whole, either by a reduction of rents or taxes or by the provision of parks, public halls, libraries, or other public buildings. A celebrated English authority, Mr. Lever, says: "As the house stands on the land, so the housing problems depend upon the solution of the land problem." In England and Germany it is now generally agreed that the ownership and control of the land by the few is the one great obstacle which will have to be removed before the housing problem can be really touched. This keeping down of the ground values in these Garden Cities is sometimes brought about by providing that instead of selling, the houses are rented for ninety-nine or 999 years, usually providing for a revaluation only at the end of each ninety-nine years or during the life of the lessee. Usually, too, these contracts provide that where the owner of such property desires to sell, he must sell the property to the parent Garden City corporation at an advance of only three per cent over purchase price.

The second principle fundamental to the adequate and scientific planning of land on which a new town is to be built, consists in the limiting of the number of houses per acre. Thus, in some of the Garden Cities the maximum number is twelve houses per acre, but more frequently five. Provision is always made for both a foregarden and a back garden, in the former of which shrubbery and flowers and vines are carefully and artistically cultivated, while in the rear garden the owner of the house occupies his spare time in raising vegetables. In some of the English Garden Cities these vegetables have brought the owner a return of twenty-five dollars per year, or about one-third of the total annual rent which he pays.

The third principle of such Garden City planning provides for the limiting of the building of houses to certain sections only, thereby preserving a large area as agricultural and park lands for all time. Thus, for example, at the garden city of Letchworth, near London, two-thirds of the total area of the city has been retained for agricultural purposes. Portions of these open places are rented out in small allotments to the citizens.

In this way it is possible to attract industries away from the old towns where rents are high and conditions of work often unwholesome, to the new city where rents are low and large and airy factories can be built and the workers can live near their work. This is extremely desirable as it saves the time, car fare and the welfare of the working people.

Intimately connected with this subject of good housing is the European method of profit sharing. It is regretted that the limits of this paper will not allow a description of this method of prosperity sharing, as they call it at Port Sunlight, England. Briefly stated though, provision is made so that the factory worker of all classes shares in the yearly profits in proportion to the amount which his own industry, ability and faithfulness have contributed.

Needless to say, this plan has resulted in larger profits to the company due to the increased efficiency of the labor.

The garden city laborer then not only lives in a larger and more wholesome house, but he draws a larger wage than his fellow workers in the crowded city. Again, while sharing in the profits of the business, he shares to an even greater extent in the profits of the real estate, because the profit to his capital stock held by the laborers is unlimited, while the upper limit to the bonds is rarely over four or five per cent. Then, too, unlike his old city brother laborer, the garden city renter or owner has his gardens, both flower and vegetable, he has his outdoor swimming tank, his indoor gymnasium, and last but not least, neighborhood club. No wonder that under such circumstances the laboring class have repeatedly voted against allowing the licensing of a saloon or bar room in his community.

As a result of such ideal environment it is easy to see why such communities have a death rate of only five per thousand instead of eighteen, the average of English cities.

Another element which has greatly encouraged and contributed to city planning in Europe has resulted from the superior character and fitness of their city mayors.

German cities especially demand that their chief executives shall be educated and specially trained for this position of responsibility. Contrast this with our American conditions, where not infrequently our mayor is elected as the result of some political expediency or some political accident, or even as the result of a personal spite [as was not long ago seen in this city], (Madison).

The type of men who fill the position of mayor in Germany, because of generally holding their offices for many years, understand well the complex problems of city government and strive to give efficient services to the citizens. This point can be perhaps best shown by a brief citation from the recent experience of Ulm, a town in southern Germany, where I obtained the following facts:

This city, because of being surrounded for centuries by a fortified wall, had become greatly congested, when some seven years ago it became necessary to remove all the fortification to higher and quite distant surrounding villa. The mayor of Ulm now saw his opportunity. He purchased of the federal government a belt of land around the city of several hundreds of acres between the old and the new fortifications, paying $250,000 therefor, a price which he rightly judged was only a small fraction of its true value. Within about a year he sold one-tenth of this area for a railroad depot and for a manufacturing plant, the selling price being as much as the whole tract had cost the city.

On this valuable tract of land the city, under the direction of the mayor, built many hundreds of houses for working people. Nearly as many more houses were built on this city land by building associations under regulations governing their sale and rent similar to those insisted on by the city, viz.: such as would insure low rents by preventing the future appreciation in the land values.

Besides this the mayor built side tracks and secured many new important manufacturing plants. As a result of this wise city planning the city grew apace in population and prosperity. This resulted in the taxes being reduced until they were the lowest of any city in the Germany Empire.

The permanent advantage gained in planning a whole new city, or in replanning an old city making use of trained experts is in striking contrast to the unscientific piecemeal patchwork usually seen in our American cities where such important work is with few exceptions left in whole or in large part in the hands of selfishly interested landowners.

In Germany land owners are compelled by law to plat their land as directed by competent public authority.

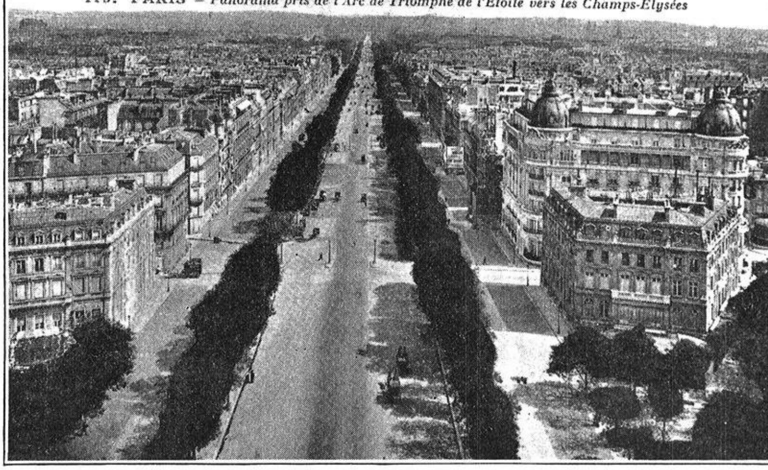
The lesson has there been learned that only by so doing long in advance of urgent use, can the public secure the necessary parks, public squares, and the best local vistas or beauty spots. It is usually not difficult to show that such planning insures the largest profits to the private owner, as well as to the public.

The city planner is thus in fact the city *doctor,* a man who cares not only for the diseases from which all old European cities are almost certain to be suffering, but who also makes it certain when he plans an entire new city that such diseases shall be impossible in the future.

American city plans are also conspicuously defective in the almost general lack of provision for ring and radial streets, a fault also chargeable to the gridiron system. This custom compels traffic to go on both sides of a right angled triangle instead of the direct route. The economic loss in the resulting street congestion is enormous but well nigh impossible of remedy because of the enormous cost of cutting through new streets in a district where values are high.

Perhaps the best example of a fundamentally false plan can be seen in New York city. Here the north and south avenues are over twice as far apart as the east and west streets, i. e., the long way of the block is east and west. If this plan had been exactly reversed there would now be available twice as many avenues running lengthwise of Manhattan Island to accommodate the enormous north and south traffic. The resulting gain to the city would have been measured in tens of millions of dollars. For in vain have her people built elevated railroads above and underground roads below the street surface. Each new provision for improved transportation service

115. PARIS – *Panorama pris de l'Arc de Triomphe de l'Étoile vers les Champs-Élysées*



is followed by such an increase in traffic as to make the congestion quite as great as before the improvement was made.

Because of an original bad city plan New York citizens can never secure what they are justly entitled to, an adequate means of north and south transportation. This must needs always act like the stone wall around the medieval cities—to effectually check the outward growth of the city. Indeed, it is far worse for unlike the stone wall, New York's wall can never be torn down.

Finally, correct city planning provides for the present and future needs of foot and vehicular traffic, but more important still, it provides for the physical and moral needs of the home. The latter provision insures happy and sanitary homes. Some of our engineers are writing books on efficiency, among other things, teaching laboring men how to economize their working movements so as to turn out a greater output for a given amount of effort and time, a refined form of ''speeding up.'' This may be termed retail efficiency, as compared to the wholesale efficiency which would come from generally improved housing conditions. Such writers are treating the symptoms, not the disease.

In the words of England's foremost city planner, Mr. Lever: ''The cottage home is the unit of the nation, and therefore the more we can raise the comfort and happiness of home life, the more we shall raise the standard of efficiency for the whole nation.''

A careful study of conditions in a score of American and European cities convinces the writer that sane, scientific city planning is most fundamental for the health, physical fitness and future prosperity of our nation.

RECENT TESTS ON CONCRETE.

The Bureau of Standards, of the Department of Commerce and Labor, in connection with the investigation of structural materials is conducting a series of tests to determine the action of high-pressure steam on Portland cement. It has been found that high-pressure steam will greatly accelerate the hardening of certain cements, increasing their strength several hundred per cent, but will cause the complete disintegration of other cements which under normal conditions appear to have the usual physical qualities. The present investigation is in part an extension of the work reported in Technologic Paper No. 5, "The Effect of High Pressure Steam on the Crushing Strength of Portland Cement Mortar and Concrete." The equipment for this purpose consists of a small steam-pressure tank, or so-called "autoclave," suitable for pressures up to 50 atmospheres (515 pounds per square inch) and a large cylindrical steel tank 12 inches by 5 feet inside dimensions suitable for working pressures up to 70 atmospheres (1,030 pounds per square inch).

It has been proposed that specifications for the purchase of Portland cement be amended to include a test of exposing cement to a steam pressure of 20 atmospheres (294 pounds per square inch) for a period of two hours. It is required that the cement remain sound and that the tension briquettes show a given increase in strength.

It has been found that certain cements which meet the steam test of 212° F. for five hours, as required by present specifications, fail under the proposed high-pressure steam test. In investigating the cause and interpretation of this failure, practically all brands of cement purchased by the Government are being subjected to the high-pressure steam test in connection with the regular routine specification test, and much valuable information is being accumulated.

Tests are also being made on specially prepared cements of various degrees of fineness and after seasoning for different periods. Other series of tests are being made in exposing cements neat, and in mortars and concretes to a series of pressures ranging up to 1,000 pounds per square inch and for various durations. Tensile and compressive strength, linear expansion and contraction, water absorption and other physical properties are being determined. The effect of temperature, pressure, and moisture content of the atmosphere, or degree of water saturation are being studied independently.

Some interesting results are also being obtained by subjecting to high-pressure steam pieces of mortar and concrete from sound and disintegrated structures, which has been in place for several years.

To determine the value of the high-pressure steam test as a determination of the soundness and structural quality of Portland cements, a large number of concrete cylinders, 8 inches in diameter by 16 inches in length, are being made of cement which fails to meet the normal 212° F. steam test, as well as of cement which passes this test but fails to meet the proposed 20 atmosphere steam-pressure test, and of cement which meets both of the above requirements. The cements are being tested in a normal 1:2:4 proportion concrete mixture and will be exposed in various localities over a period of years and tested for elastic properties and compressive strength.

THE PRESENT DAY DEVELOPMENT OF THE AEROPLANE

BERRY T. STEVENS, M. E. '14

The science and art of aviation are at the present so new, that to the popular mind they are still somewhat of a mystery, and a considerable lack of knowledge of the present day development of the aeroplane prevails among the greater majority of the people. The purpose of this article is to give the reader an idea of just what is going on in the aviation world at the present time, and what can be expected of the aeroplane in the future, and incidentally to arouse his interest in one of the most interesting and least known of engineering fields.

Records are being broken so often that it is hard work to keep track of them. It was only last month that a new world's record for altitude was established by Perreyon, a pilot of the Bleriot school in Paris in a most wonderful flight. Flying a 160-horse power Gnome-driven Bleriot monoplane, he attained the tremendous height of 19,650 feet. It is interesting to note that he climbed the first 3,250 feet in one minute and twenty-five seconds, or more than 2,000 feet per minute, and that the descent took only eleven minutes, while the whole flight required one hour. He was still climbing fast when his supply of oxygen gave out, and he had to come down. It is doubtful if a machine will ever be able to climb to a height much greater than four miles, as the atmosphere is only about one-half as dense as that at the earth's surface, and this affects the lifting power of the machine.

Last summer Jules Vedrines of France attained a sped of 105 miles an hour on a circular course. Speeds greater than this have been accomplished on a straightaway flight, in fact, Guillaux, a French aviator, made a flight in his 70-horse power Clement-Bayard, all steel monoplane from Savigny-sur-Braye to Paris, a distance of 118 miles, in just one hour. New duration and distance records were also lately established by Fourny in a Maurice Farman biplane, who flew 633 miles in thirteen hours and fifteen minutes. A new and notable record was made by Brindejone des Moulinais, a French aviator, who flew from Paris to London, a distance of 287 miles in an actual flying time of 185 minutes, with only two stops. This means that his average speed was about ninety-three miles an hour. New passenger carrying records have also been made recently. M. Frantz, flying a Savary biplane, and carrying five passengers besides himself, reached an altitude of 2,034 feet in an actual flying time of fifteen minutes, while P. Gouguenheim, chief pilot of the Farman school, on February 10th, carried four passengers, besides himself to an altitude of 3,675 feet. A remarkable flight was also made by P. Verrier in a Maurice Farman biplane against an average wind velocity of forty-eight miles per hour. As the speed of his machine was only fifty-seven miles per hour his rate of progress was about nine miles an hour.

As will be noticed all these records are held by foreigners. Europe has been fast oustripping America in aviation, piling record on record, enjoying all the fruits of an industry established and flourishing. It has been a case of the whole world learning how to fly from the United States, and then leaving her far behind in the developing of the flying industry. Also foreign manufacturers are directing their efforts mainly to supply the needs of governments, and these governments require aeroplanes chiefly for army service, and that means that the principal demand is for overland machines. Thus, Europe is leading in land aviation.

A short time ago Mr. Glenn H. Curtis gave to the world the hydroaeroplane and the manufacturers in America were not long in snapping up the opportunity offered, and now, thanks to Mr. Curtis, America is leading in aeroyachting. This needs no further proof than the fact that the governments of nearly ll the large foreign countries are buying American-made hydroaeroplanes. The next step was the flying boat, which is not only the most popular craft in sportdom, but is the ship of the future, and its possibilities are unlimited. This flying boat puts aviation on a higher plane in the confidence of the public and on a more stable commercial basis than any other single development since man learned to fly. For a time the world-wide interest in man flight showed signs of abating, but with this new discovery interest was instantly re-awakened, and the first to make practical recognition of the success of the new air and water craft was the United States Navy. This department is doing all it can to maintain for this country the leadership in this line of aviation, but this can not be done without sufficient appropriations from Congress. Our country has delayed too long already in providing this factor of national defense. This latest invention is the beginning of a new development of the machine which is destined to revolutionize our whole civilization.

The most progressive thing in aviation that is interesting the manufacturers at the present time is the Great Lakes Reliability Cruise of 900 miles, which will start from Chicago July 8 and end at Detroit, Michigan. Over twenty contestants, representing several different makes of hydroaeroplanes, will start in the cruise. The rules forbid the use of any but American made planes. The points to be impressed upon the public are safety and reliability, and a successful conclusion of this cruise will more than do so. Another interesting thing to the manufacturers is the offer of Lord Northcliff, of the London Daily Mail, of $50,000 for the first hydro flight across the Atlantic ocean, which is open to the world. The conditions provide that the voyage shall be made in seventy-two continuous hours. This feat can be accomplished by the use of machines now available, as the most efficient machines of today will carry a useful load of 1,500 pounds when a motor of about 100 horse power is used. This means that enough fuel can be carried to operate the motor eighteen hours or more, and under normal conditions only two supply boats stationed at equal distances along the route would be necessary. The kind of practical knowledge that will be obtained in the Great Lakes Cruise is that necessary to make a success of the trans-Atlantic voyage. Here, then, is the opportunity of the American manufacturers to get one of the greatest honors that the future holds out—the conquering of the Atlantic.

The science of aviation will progress more swiftly in the next few years when the men now in college will be exercising their trained faculties toward the ideal modification of the present imperfect design. The future points to the designing and building of air machines, and the promotion of aeroplane utility corporations. Engineers who fly are to be more important factors in the new civilization than canal builders, or men who lay out railroads. However, ambitions should not include only becoming an aviator, as the airman of a few years hence will occupy no more of a distinctive position in society than an automobile chauffeur of today.

What aviation needs is more trained aeronautical engineers.

The Wisconsin Engineer.

R. D. Hughes, '13, *Editor* J. W. Young, '14, *Manager*

EDITORIAL

We want to call your attention to the excellent articles that we have been printing in the past few numbers, also this number. There is not a college engineering journal in the country that has anything on us in that respect, so both our friends and enemies tell us, and considering the difficulties that we have been up against the last month or two we feel justly proud.

However, we need some more articles for the coming numbers, and we earnestly entreat anyone that has anything that might be available for the *Engineer*, to turn it in, either to the editor or the manager. The faculty and alumni members especially have lots of material under their desks, and if we could get a hold of it we would be in good shape.

If you have been a follower of the editorials in this magazine, you have probably noticed a difference in the literary quality of the above editorial. The editor was called out of town by the flood disaster in Ohio, and we are trying to get out a magazine without him,—a mighty difficult task.

Right here we want to say something about responsibility. The writer believes that there is no other quality in a man which is more essential than the ability to shoulder responsibility. The man that says he will do a thing and then does it, without having to ask someone else, who, when, why, how, etc., is the man that gets ahead in this world. There is not a business organization in the country but what will substantiate this statement. An organization is merely a train of gear-wheels, and if one wheel can not be depended upon to do its

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The following is our schedule for the remaining numbers:
March, out April 9.
April, out April 23.
May, out May 7.

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We wish to call particular attention to Prof. Smith's article on City Planning. You should read every word of the article! This subject is one of the foremost in the country at the present time, and every engineer should know something about it. We cite Chicago as an example of the agitation. At the bottom of the movement are a few engineers who are pushing things as much as possible to bring about the reconstruction of this city.

DEPARTMENTAL NOTES

HYDRAULICS LABORATORY.

A series of experiments of rather unusual interest have just been completed in the Hydraulics Laboratory on a now obsolete type of vertical water turbine which was much used throughout the state about sixty years ago for running flour mills. In those days a good many water rights were made based on water sufficient to run a given number of grinding stones, the head under which the water was to be furnished and the machinery it was to run being specified. The question now arises as to what actually is the quantity of water used by this type of wheel under the given conditions; to provide reliable information on this point was the chief purpose of the experiment.

Incidentally it becomes of interest to note how the efficiency of this type of apparatus compares with that of the present day.

The experiments involved the complete construction of the apparatus, with intake and outlet channels. The wheel, constructed of wood, is hung on a vertical metallic axis; it consists of a series of blades, properly curved, between two horizontal disks about six feet in diameter and one foot apart. The water strikes against these blades, causes them to rotate, which motion is transferred to the shaft.

ALUMNI NOTES

Chas. F. Bleyer, M. E., '07, is now holding the position of erecting engineer with the Allis Chalmers Co. at Pittsburg, Pa.

C. C. Broadman, M. E., '10, is with the United Gas and Electric Co. at Aurora, Ill., in the capacity of Assistant to the General Manager.

C. O. Brondal, E. E., '08, is the General Manager of the Peerless Lamp Works, Warren, Ohio.

E. A. Bermester, C. E., '12, is a Junior Engineer with the U. S. Lake Survey Engineering Corps at Detroit, Mich.

William Wippermann, M. E., '08, has taken an instructorship in the Department of Mechanical Engineering at the University of Pennsylvania, Philadelphia, Pa.

H. O. Hanson, '09, is in the drafting room of the American Steel Works at Detroit, Mich.

Guy A. Benedict is the Superintendent of Schools in Phillis, Wis.

Alonzo B. Ordway, C. E., '09, is the general foreman of the paving branch of the Canadian Mineral Rubber Co. in Vancouver, B. C.

William H. Adamson, C. E., '86, is in the consulting engineering business for himself and is located in Portland, Oregon.

H. M. Anderly, C. E., '11, is affiliated with the U. S. Engineers Corps at Rock Island, Ill., in the capacity of Inspector.

J. F. Alexander, E. E., '11, is in the Sales Department of the Wagner Electric Co. and is located in New York City.

Carlton H. Allen is an Assistant Resident Engineer of the International Paper Co. at Yivermore Falls, Maine.

V. R. Anderson, M. E., '08, is an Assistant Engineer with the National Fireproofing Co., Chicago.

Walter C. Andrews, Ch. E., '10, is doing research work on the reclaiming of rubber for the B. F. Goodrich Rubber Co., Akron, Ohio.

R. B. Anthony, E. E., '07, is the District Manager of the Bristol Co., Pittsburgh, Pa.

R. F. Arndt, M. E., '07, is a salesman for the Northwest Steel Co., Portland, Oregon.

Eric W. Austin, E. E., '08, is an Assistant Engineer with the New York Telephone Co., New York City.

James Aston, E. E., '08, is an Assistant Professor in Metallurgy in the University of Cincinnati, Cincinnati, Ohio.

Arthur H. Badger, E. E., '12, is in the Testing Department of the General Electric Co., Schenectady.

Robert W. Baily, M. E., '07, is a Contracting Engineer with the Des Moines Bridge and Iron Co., Des Moines, Iowa.

John W. Balch, C. E., '09, is a Locating Engineer for the Alberta Mono Rail Co., Alta., Canada.

Edwin M. Ball, Gen., '09, is with the Ishkooda Coal and Iron Co., and is the Superintendent of the Ishkooda Mines, Birmingham, Ala.

Henry E. Balsby, C. E., '09, is an agent for the American Bridge Co., at Duluth, Minn.

A. W. Bechlem, E. E., '07, is a draftsman with the U. S. Engineering Corps at Culebra, Canal Zone.

John C. Beebe, Adv. C. E., is a Hydraulic Engineer with the Montana Power Co., Butte, Montana.

B. F. Bennett, Ch. E., '10, is in the Operating Department of the American Sheet and Tinplate Co., Pittsburgh, Pa.

Joseph Bingham, C. E., '04, is an Estimator for the McNulty Bros. Co., Lakewood, N. Y.

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