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FLOOD-LIGHTING

INERTIA DISTURBANCES AND TORQUE RE-ACTION IN MULTIPLE CYLINDER ENGINES

STATE INSPECTION OF PUBLIC UTILITIES

THE WATER SOFTENER AND BOILER FEED WATER

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FLOOD-LIGHTING

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Flood-lighting which sprung into sudden prominence about a year ago, because of its application on a large scale at the Panama-Pacific Exposition, and on the world's greatest skyscraper, the Woolworth building, New York, is such a great departure from, and wonderful improvement over, former methods of lighting building exteriors, that at first thought one is inclined to wonder why it was not used before. The reason is that we really did not have convenient means. Incandescent lamps were unsuitable, not only because of their low light giving capacity, but chiefly because their luminous element deviated so greatly from the point source so essential for projection purposes. Arc lamps required expensive reflecting accessories, and expensive maintenance. This combination of reasons perhaps accounts for the persistence with which we have stuck to outline lighting with incandescent lamps.

While incandescent lamps may be used with good effect in outlining a building structure, they do not illuminate the building. In fact they very effectively obscure the finer architectural detail. Hence this system, although used for advertising purposes, in illuminating theater fronts, amusements parks, dance halls, and in some cases mercantile establishments, has not been very extensively applied for lighting public buildings, churches and monuments. With flood-lighting, on the other hand, a building may be illuminated in a manner which closely simulates daylight, under which the architect judges the design. Thus a historical architectural gem may be revealed to the public gaze at night, without loss of dignity.

To flood the entire surface of a building so that it is illuminated, and the means of lighting is not made evident, the lighting usually must be done from a distance. This requires the use of a projector, employing a mirror reflector of the parabolic type or a lense projector. With either of these types of pro-

The world's greatest skyscraper, the Woolworth Building, New York, is illuminated by the new flood-lighting. The entire structure from the 30th to 58th story is bathed with light from projectors concealed on the building itself.

jectors an approximate point source of illumination is needed. The recently perfected concentrated filament gas-filled tungsten lamp places at our disposal such a light source, and one of great light giving capacity. In Fig. 1 is illustrated this lamp in the

250 watt size. Note how the filament is coiled in a very small volume at the center of the spherical bulb. The second requirement is a suitable projector reflector, enclosed in a ventilated and weatherproof housing, since these units are for exterior use

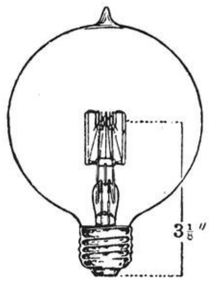


FIG. 1.—250-Watt tungsten lamp.

where they are subject to rain, sleet, and snow. A commercial projector unit is shown in Fig. 2. It consists of an enameled metal housing, containing a silver mirror projection reflector, weatherproof socket, and a device for focusing the lamp. It is thoroughly ventilated in a manner which will prevent the en-

FIG. 2.—Projector for use with 250-watt lamp.

trance of moisture to the lamp or reflector. The glass cover is made of heat resisting glass which withstands extreme and sudden temperature changes, as would occur were the lamp lighted with a coating of snow on the glass.

FLOOD-LIGHTING BUILDINGS

The flood-lighting of a building requires careful planning by the man on the job, who will be called upon to decide how many projectors will be needed, whether to locate them at a distance or on the building itself, and at what angles the beams from the various projectors must be directed.

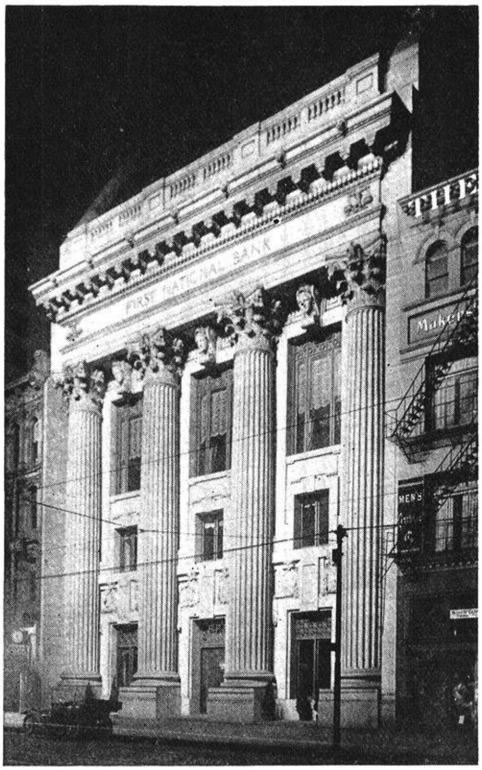


FIG. 3.—First National Bank, Cleveland, Ohio. Illuminated with 24 projectors installed on roof of opposite building.

Take a building like the bank illustrated in Fig. 3. The design of this building front, which is 80 ft. high by 70 ft. wide, makes necessary installing the required twenty-four projectors on the roof of the building across the street. In order that the lighting would be uniform like daylight, it was necessary to uniformly space the projectors. Furthermore, the beam of light from each projector was carefully adjusted to get the ideal results indicated by the picture, and so that pedestrians on the street receive no glare in the eyes.

Frequently, the design of a building is such that a marquise extending over the sidewalk or a cornice at one of the lower

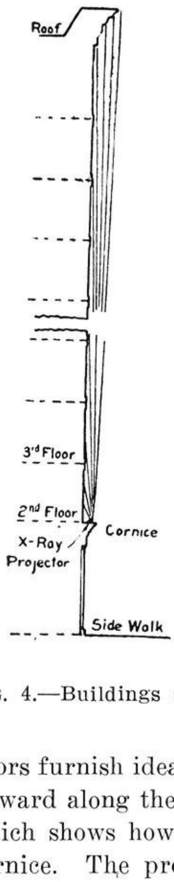


Fig. 4

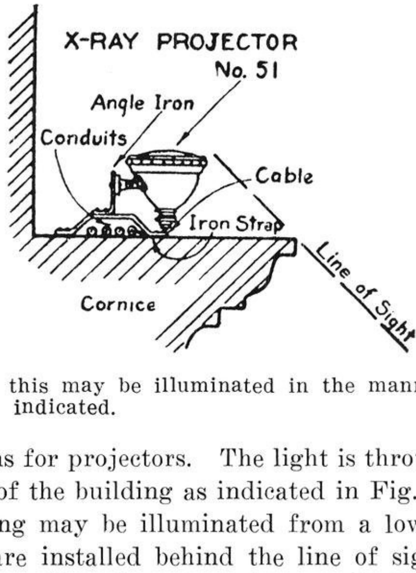


FIG. 4.—Buildings similar to this may be illuminated in the manner indicated.

floors furnish ideal locations for projectors. The light is thrown upward along the surface of the building as indicated in Fig. 4, which shows how a building may be illuminated from a lower cornice. The projectors are installed behind the line of sight from the street level, as indicated, and their axes inclined slightly towards the face of the building. The amount of this inclination of course, depends on the height of the building. In order that the illumination may not be non-uniform and streaked, the projectors must be installed on about 3 ft. centers.

The lighting results produced may be described as a "flame effect." The illumination of the lower portion of the building surface is brightest, and from there upward the intensity gradually diminishes. However, the intensity of illumination of the top-most cornice is sufficient to make it stand out in bold relief against the dark sky.

SIGN LIGHTING

Many a sign works only during the day. The owner appreciates that this sign would be a still better business producer if it were illuminated at night. Not only would the working hours be increased from 50 to 100 per cent, but the sign itself would attract greater attention. The reason the sign is not lighted is because it is hard to reach. The maintenance of lighting equipment for illuminating it is difficult and expensive. By means of projectors, a sign may be lighted from a distance. The projector may be located at a convenient point, and a strong beam of light directed to the sign.

A chimney sign may be illuminated by means of projectors lo-

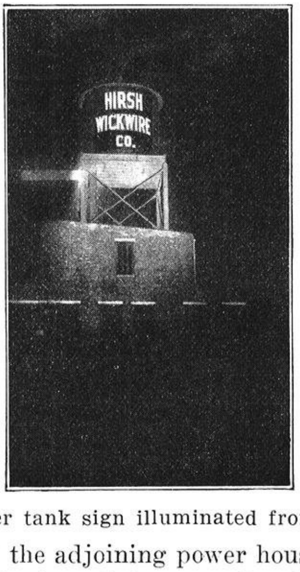


FIG. 5.—Water tank sign illuminated from a distance.

cated on the roof of the adjoining power house. These signs are invaluable, when illuminated, because they loom up against the dark sky background, and are visible for long distances. The projector provides the only economical and convenient means of securing the desired results. Fig 5 shows a water tank sign illuminated from the nearest readily accessible point on a roof about 100 ft. below and some 200 ft. distant. At this great distance, it was impossible to confine all the light from the projector to the sign, but despite some loss, the results secured are highly satisfactory.

Sign lighting by means of projectors has a number of advantages over the old style local lighting now in common usage:

(1) Signs have a better day appearance, since no reflectors, arms, conduit and wiring extend out in front of the board.

(2) The lighting is uniform, eliminating the spotted and glaring effect noticeable with local lighting.

(3) The equipment is less expensive to purchase and install.

(4) Cost of electrical energy is lower, since a few large wattage lamps may be used, and a board illuminated with a lower total power consumption.

(5) Cost of maintenance and lamp renewals is lower. Since the reflectors and lamps are enclosed in a weatherproof housing, cleaning is not necessary except about once in 1,000 hours when the lamps are renewed.

(6) The projectors may very easily be dismounted and moved to another location. This is important to the man in the sign advertising business, since he must sometimes lease a location to his customer unlighted, which already may have a complete lighting equipment installed, which means he will have an investment lying idle for the term of the lease.

NIGHT WORK

Projector units, because of the facility with which they may be transported from place to place and quickly installed, are being used in night construction work. This enables contractors to prosecute work in two and sometimes three shifts. In many sections of the country where the natural ice harvest is an uncertain quantity, it is essential that the ice be cut quickly when the time is opportune. Efficient lighting for night harvesting is solved by the use of projectors, which may be set at a few convenient points, dispensing with the need of the old overhead method, with its poles to be set, wires to string and globes and sockets to attach. Other uses that suggest themselves are for the assembling of large machinery, freight unloading, the lighting of coal piles, grain elevators, quarries, mines and oil wells.

OUTDOOR SPORTS AND FESTIVITIES

For the foregoing reasons also, projectors are very satisfactory for illuminating athletic grounds, parade grounds, rifle

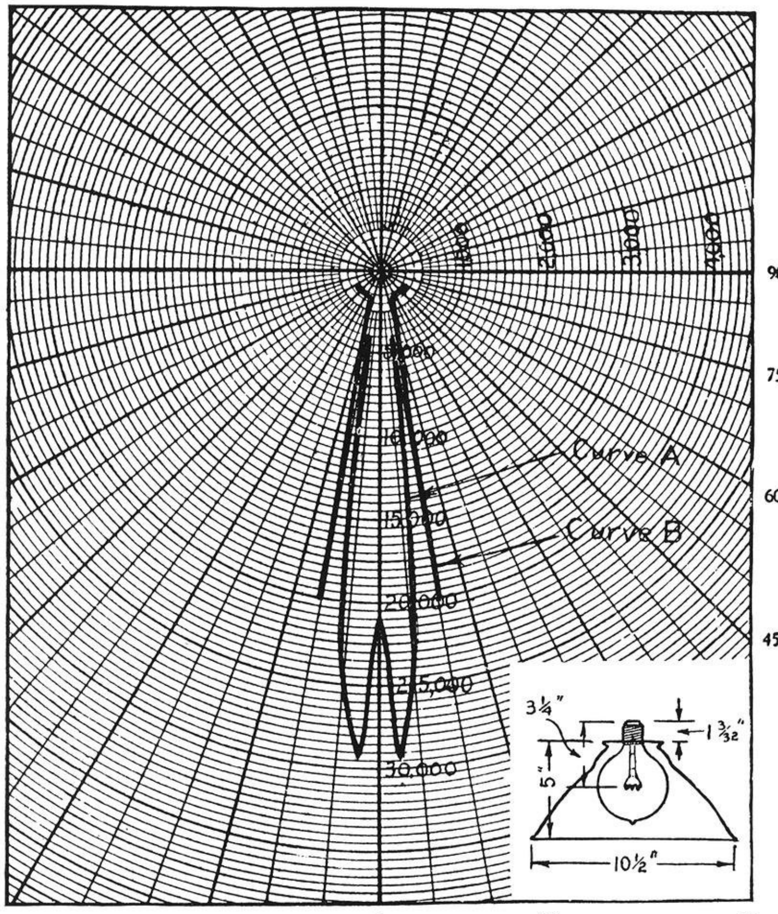


FIG. 6.—Light distribution of projector shown in Fig. 2, with 250 watt, concentrated filament lamp of Fig. 1, when lamp is at focus. This is the condition of greatest concentration of beam.

ranges, toboggan slides, playgrounds, bathing beaches, outdoor theatricals, pageants, trap shooting, and winter sports.

PROTECTION LIGHTING

Perhaps the most effective means of protecting arsenals, munition plants, and industrial plants from malicious intruders at night, is to virtually fence them in with a "wall of light." For this purpose projectors are particularly valuable, since they may be located where they cannot very easily be put out of commission by the persons bent on mischief. Similarly prison walls

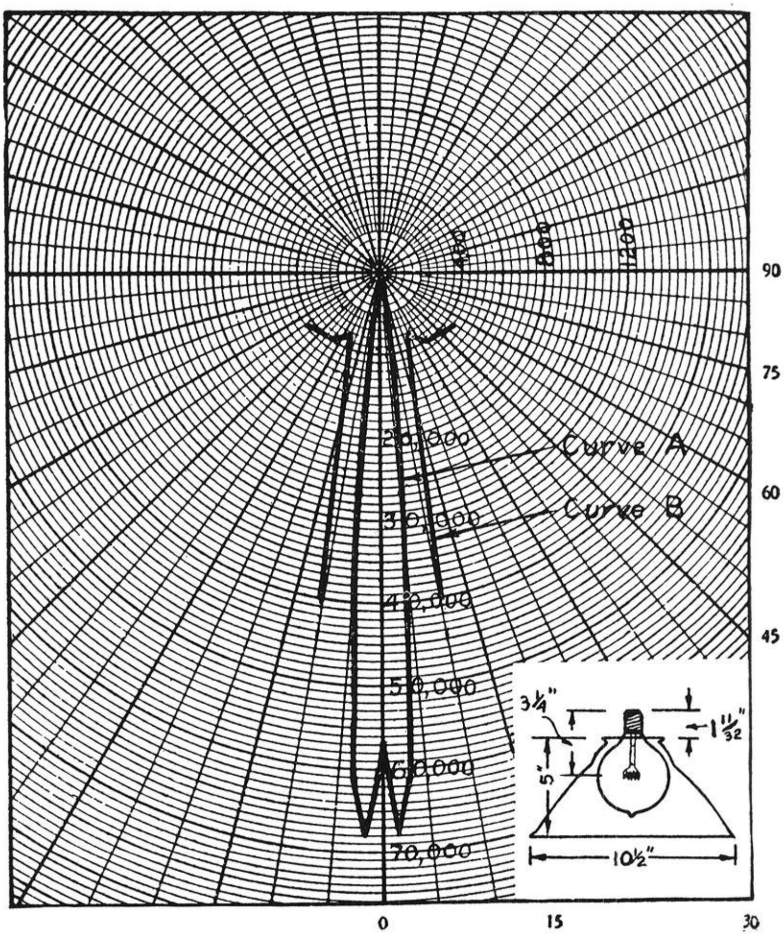


FIG. 7.—Light distribution of projector shown in Fig. 2, with 250-watt lamp of Fig. 1, when lamp is ¼ inch in front of focus. This is the condition of greatest spread.

may be illuminated. Lighting of this character makes the watch more effective, and even permits a reduction of the number of watchmen required to patrol the works.

ILLUMINATION DATA

In order that the illuminating engineer may be in a position to solve his flood-lighting problems and forecast accurately the results he will secure, he requires specific photometric data on the lamps and reflectors offered him for this purpose by the manufacturer.

Figure 6 gives the light distribution of the projector of Fig. 2 with the 250 watt lamp at the focus, and shows the greatest concentration of light obtainable with this reflector. Table I gives the data from which this curve is plotted. The small diagram of the reflector in the lower right hand corner shows the lamp position. Curve "A" is for the zone 0°–10°, and the vertical scale gives the candle-power values, whereas curve B is for the zone 10°–60°, and the horizontal scale gives the candle power values.

Figure 7 gives the light distribution with the same lamp ¼ inch in front of the focus, and shows the greatest spread of light obtainable with this reflector. Table II gives the data from which this curve is plotted.

The beam of light from a projector is conical, and hence when it strikes a surface perpendicularly it illuminates a circular area. On the other hand, if the beam is directed to the surface at an angle, it illuminates an area which is elliptical in shape. The greater the angle at which the beam strikes, the larger the area of the ellipse lighted and as a consequence the lower the intensity of illumination. When the beam is perpendicularly directed to the surface to be lighted, the field is illuminated with a practically uniform intensity, but when the beam strikes the surface at an angle, the portions of the field nearest the projector are brightest, and the remote portions less bright. The greater the angle of projection, the greater this difference.

Table III gives the length and width of area illuminated, and the average foot-candles intensity of illumination, for various angles of projection, at various perpendicular distances from the surface, when the angle of divergence of the beam is 12°, as for the condition of Fig. 8 and Table I. The square feet area of the illuminated field may be obtained from the formula, area = .7854 L. W.

Table IV gives the same data for an angle of divergence of 20° as represented by the conditions of Fig. 7 and Table II.

The value of illumination intensity represents the average over the entire field, and of course is a lower quantity than the intensity at the center or nearer portions of the illuminated field.

All data above is for the lamp and reflector only, and does not take into account the absorption of light in the glass cover of the housing. The clear glass cover of the projector absorbs about 15 per cent of the light flux, allowance for which must be made in making calculations. When color screens are used over the projector, account must be taken of the absorption of these screens, when calculating the resulting intensity.

TABLE I

Lamp—250 Watt; Concentrated filament; gas-filled tungsten; Voltage 115; Lumens, Clear-lamp 3520; WPC (Hor.) 0.80; Reduction Factor 0.896; Bulb—G30 clear.

Angle	Candle Power	Angle	Candle Power
0	56750	8	3630
1	63100	9	2060
2	67750	10	1300
3	61200	15	523
4	43750	25	363
5	26800	35	399
6	17200	45	403
7	7190	55	423

TABLE II

Lamp—250 watt; Concentrated filament; gas-filled tungsten; Voltage 115; Lumens, Clear-lamp 3520; WPC (Hor.) 0.80; Reduction Factor 0.896; Bulb—G30 clear.

Angle	Candle Power	Angle	Candle Power
0	20800	8	12980
1	22250	9	7860
2	27130	10	4070
3	28400	15	675
4	27000	25	347
5	24700	35	363
6	22500	45	388
7	17850	55	391

NOTE—The writer is very much indebted to Mr. H. H. Magdsick of the National Lamp Works, for the illustrations of the Woolworth Bldg., and First National Bank, both of which installations were planned by him.

TABLES III AND IV

TABLE III — Length and Width of Area Illuminated, and Average Intensity for 12° Angle of Divergence

Angle of Projection	Dist. 25 ft.			Dist. 50 ft.			Dist. 75 ft.			Dist. 100 ft.			Dist. 200 ft.			Dist. 300 ft.		
	L.	W.	F.C.	L.	W.	F.C.	L.	W.	F.C.	L.	W.	F.C.	L.	W.	F.C.	L.	W.	F.C.
0°	5.3	5.3	70.2	10.5	10.5	17.6	15.8	15.8	7.8	21.0	21.0	4.4	42.0	42.0	1.1	63.1	63.1	.49
15°	5.6	5.4	63.3	11.3	10.9	15.8	16.[illegible]	16.3	7.0	22.5	21.7	3.9	45.2	43.6	.98	67.7	65.3	.44
30°	7.0	6.1	45.6	14.1	12.1	11.4	21.1	18.2	5.1	28.1	24.3	2.9	56.3	48.5	.71	84.4	72.8	.32
45°	10.6	7.4	24.5	21.3	14.9	6.1	31.9	22.3	2.7	42.5	29.7	1.5	85.0	59.5	.38	128.0	89.3	.17
60°	21.7	10.5	10.3	43.5	21.0	2.6	65.2	31.5	1.1	87.0	42.0	.65	174.0	84.1	.16			
75°	92.8	20.3	10	185.0	40.6	.3												

TABLE IV — Length and Width of Area Illuminated, and Average Intensity for 20° Angle of Divergence

Angle of Projection	Dist. 25 ft.			Dist. 50 ft.			Dist. 75 ft.			Dist. 100 ft.			Dist. 200 ft.			Dist. 300 ft.		
	L.	W.	F.C.	L.	W.	F.C.	L.	W.	F.C.	L.	W.	F.C.	L.	W.	F.C.	L.	W.	F.C.
0°	8.8	8.8	24.5	17.6	17.6	6.2	26.4	26.4	2.8	35.3	35.3	1.56	70.5	70.5	.39	106.	106.	.17
15°	9.5	9.1	22.5	18.9	18.2	5.6	28.5	27.3	2.5	37.9	36.5	1.40	75.8	73.0	.35	114.	110.	.16
30°	11.9	10.1	12.6	23.7	20.3	3.2	35.7	30.3	1.4	47.5	40.7	.79	95.0	81.3	.20			
45°	17.5	12.4	8.9	35.1	24.9	2.2	52.5	37.2	.99	70.2	49.9	.56						
60°	38.9	17.7	2.8	77.8	35.3	.71	117.0	53.1	.31	156.0	70.5	.18						
75°	230.	34.0	.25															

Glass cover of housing absorbs approximately 15%

INERTIA DISTURBANCES AND TORQUE REACTIONS IN MULTIPLE CYLINDER ENGINES

R. B. WHITE

A consideration of the potency of the forces and moments which tend to vibrational disturbances in the internal combustion motor, or a consideration of the extent to which these forces may be balanced and of the conditions requisite thereto, involves a subject which may prove of considerable interest to those who have watched the successful evolution of four-, six-, eight-, and even twelve-cylinder engines. Vibration, and the means by which it might be eliminated, have always been

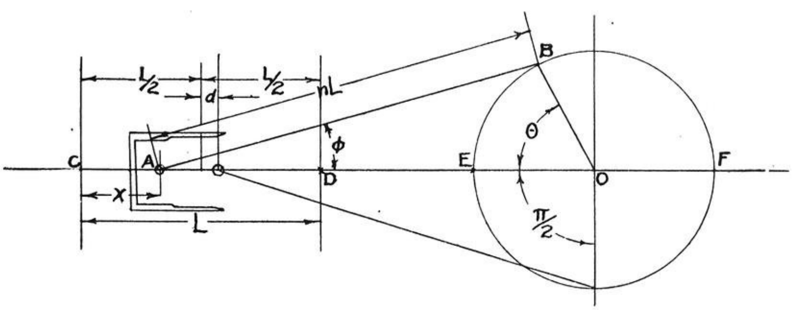


FIG. 1.—Arrangement of piston, connecting rod, and crank.

the constant problem of the engineer, for one's susceptibility to distinguish vibrations of the smallest character has demanded smoothness—smoothness for true appreciation of the engine. In order to understand completely the nature of the principal causes of vibration, it is necessary for one to gain both a physical and a mathematical viewpoint of these disturbances, and it is with this intention that the author introduces the following outline of the two fundamental causes of vibration in multi cylinder engines.

(1) Unbalanced reciprocating parts.

(2) Torque fluctuations and reactions due to constructional resiliency and resonance.

As is well known, the fundamental deficiency in the balance of the four-cylinder engine lies in the synchronizing of the octave components of the motion of two pairs of pistons. To explain this defect, which arises from connecting rod angularity, consider the typical arrangement of piston, connecting rod, and crank as diagrammatically represented. With reference to Figure 1, it is manifest that in order to ascertain the position of the piston for a given angular position of the crank, some algebraical relation between the angular displacement and the linear displacement must be established. In view of this fact,

Let nl = length of connecting rod
Θ = crank angle
ϕ = connecting rod angle
l = stroke
W = weight of recip. parts
g = 32.17 ft. per sec^2.
n = revolutions per minute

$$x = OA - OC = \frac{l}{2} + nl - \frac{l}{2}\cos\Theta - nl\cos\phi$$

$$x = \frac{l}{2}[1 - \cos\Theta] + nl[1 - \cos\phi] =$$

$$\frac{1}{2}[1 - \cos\Theta + nl(1 - \sqrt{1 - \sin^2\Theta})]$$

Now

$$nl\sin\phi = \frac{l}{2}\sin\Theta$$

$$\sin\phi = \frac{l/2\sin\Theta}{nl}$$

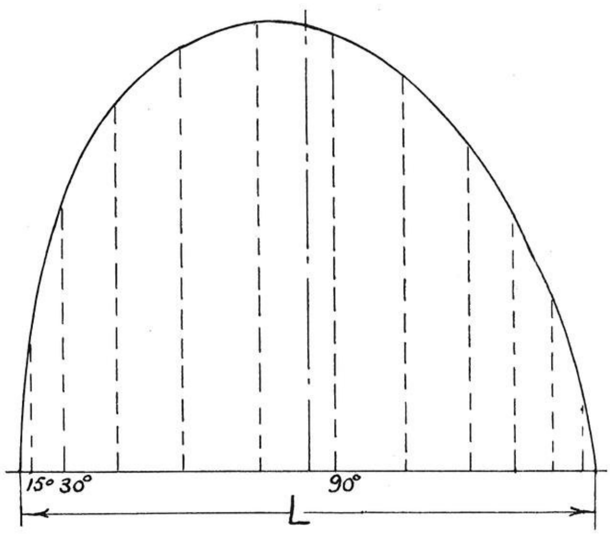
Then:

$$x = \frac{1}{2}[1 - \cos\Theta] + nl\left[1 - \sqrt{1 - \frac{l^2/4\sin^2\Theta}{n^2l}}\right]$$

Now since it is desired to ascertain the distance the piston has travelled for crank rotation of $\frac{\pi}{2}$, an expansion of our hypothesis to include a stroke of unity, and a ratio of 2 to 1 between connecting rod length and stroke, will be advantageous. Then

$$x = \frac{1}{2} + 2\left[1 - \sqrt{\frac{15}{16}}\right] = .564$$

From this reasoning, it is manifest that when one fourth of a revolution of the crank is swept out 56.4% of the stroke of the piston is covered. Inasmuch as it was assumed that the crank motion was uniform circular motion, it is obvious that the first half of the stroke is traversed at a far higher velocity than the last portion, and in like manner, that the last half of the upstroke is similarly traversed at a relatively higher speed. For graphical illustration of the variation in piston velocities see Figure 2, in which piston velocities have been plotted as ordinates with linear displacements as abcissae.



The importance of eliminating the vibration that arises from this cause is difficult to state; but in an attempt to bring out the magnitude of these octave vibrations, let us find the piston acceleration and by this means the inertia forces existing in the four-cylinder engine. Since velocity V, is the derivative of X with respect to time, t, and since acceleration is $\frac{dv}{dt}$, we may learn the acceleration by twice differentiating the following equation:

$$x = \frac{1}{2}[1 - \cos\Theta] + nl\left[1 - \sqrt{1 - \frac{\sin^2\Theta}{4n^2}}\right] = (\text{approx}) =$$

$$\frac{1}{2}[1 - \cos\Theta] + nl\left[\frac{\sin^2\Theta}{8n^2}\right]$$

Then:

$$\frac{dx}{dt} = \frac{1}{2} \sin \Theta \frac{d\Theta}{dt} + \frac{2nl}{8n^2} \sin \Theta \frac{d\Theta}{dt} \cos \Theta$$

$$\frac{d\Theta}{dt} = \frac{\Theta}{t} = \frac{2\pi n}{60}$$

$$v = \frac{1}{12} \cdot \frac{\pi nl}{60} \left[\sin \Theta + \frac{1}{4n} \sin 2\Theta \right] \text{ ft./sec.}$$

$$a = \frac{dv}{dt} = \frac{\pi nl}{720} \left[\cos \Theta + \frac{1}{2n} \cos 2\Theta \right] \frac{d\Theta}{dt} = \frac{\pi nl}{720} \cdot \frac{2\pi n}{60} \left[\cos \Theta + \frac{1}{2n} \cos 2\Theta \right]$$

and

$$F = m.a = \frac{m.dv}{dt}$$

Therefore the force necessary to produce this acceleration is

$$F = \frac{W}{g} \frac{\pi^2 n^2 l}{21600} \left[\cos \Theta + \frac{1}{2n} \cos 2\Theta \right] = .0000144\ Wn^2l \left[\cos \Theta + \frac{1}{2n} \cos 2\Theta \right]$$

which is representative of the inertia forces in one cylinder.

To adduce the real import of this formula, it may be advantageous to analyze its individual quantities. Fundamentally, it consists of the product of a constant ($.0000144Wn^2l$) and a binomial ($\cos \Theta + \frac{1}{2n} \cos 2\Theta$). The constant, of course, points out that inertia forces and consequently their reactions increase as the square of the angular velocity. In point of the binomial it is intuitionally obvious that its first member, when plotted, is the typical sinusoid and that the second member is a sinusoidal wave of twice the frequency of the primary reciprocating effect. When these two forces are sheared, a curve FLS as shown in Figure 3 is produced, in which two interesting characteristics are to be observed. As another proof of that which I have endeavored to bring out heretofore, the curve betokens that at 0° of crank travel the free force tending toward vibrational disturbances is decidedly greater than the free force at 180°.

So far in this investigation, we have been limited to one reciprocating unit, but this has been done in order that the similar forces inherent to eight-and twelve-cylinder engines may be brought forth in a comprehensive manner. Notwithstanding the fact that in four cylinder engines the reciprocating masses have coplanar center lines of motion, are of equal weight, and move always in opposite direction, these inertia forces are not countervailed by each other. The explanation lies in the variation of linear velocities of the piston while in the upper and lower portions of its stroke.

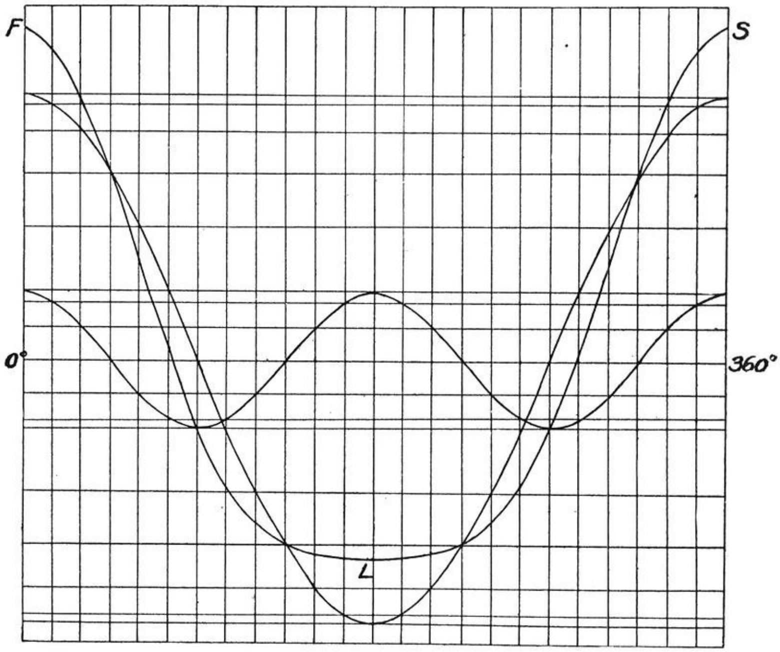


FIG. 3.—Unbalanced forces for one reciprocating unit.

The presence of this unbalanced state may be brought forth to better advantage in the following manner. Let us again consider the inertia forces in one cylinder.

$$F = c \left[\cos \Theta + \frac{1}{2n} \cos 2\Theta \right]$$

Obviously the forces acting on a pair of pistons whose center lines of motion lie in the same plane and whose motions are equal and simultaneous are represented by

$$F_1 = 2c \left[\cos \Theta + \frac{1}{2n} \cos 2\Theta \right]$$

For two pairs of pistons 180° out of phase with the first pair,

$$F_2 = 2c\left[\cos(\Theta + \pi) + \frac{1}{2n}\cos 2(\Theta + \pi)\right] =$$

$$2c\left[-\cos\Theta + \frac{1}{2n}\cos 2\Theta\right]$$

$$F_3 = F_1 + F_2 = 2c \cdot \frac{1}{n}\cos 2\Theta = .0000288\ Wn^2r \cdot \frac{1}{n}\cos 2\Theta$$

the forces due to reciprocating parts in a four cylinder engine.

The eight cylinder engine, which consists essentially of two blocks of four cylinders at right angles to each other, is by no means exempt from the effects of inertia of the reciprocating parts. In truth, these forces can be balanced only when the cylinders are diametrically opposed; but such an arrangement is impractical by virtue of the fact that proper spacing of expansion stroke is seriously affected thereby. The explanation of this truth will follow, or be brought forth following, the mathematical development. However the magnitude of the components of the two inertia forces in the eight is not as great as the summation of the two four cylinder vectors but has a direct relation, as shown thus:

From equation (12), $F_3 = 2\frac{c}{n}\cos 2\Theta$. With respect to the forces unbalanced in the right hand block of cylinders the existing forces may be represented, by

$$F_{3r} = \frac{2c}{n}\cos 2\left[\Theta - \frac{\Psi}{2}\right] = \frac{2c}{n}\left[\cos 2\Theta \cos\Psi + \sin 2\Theta \sin\Psi\right]$$

while in the left hand block,

$$F_{3l} = \frac{2c}{n}\cos 2\left[\Theta + \frac{\Psi}{2}\right] = \frac{2c}{n}\left[\cos 2\Theta \cos\Psi - \sin 2\Theta \sin\Psi\right]$$

Since it is desired that we ascertain the total unbalanced force of any eight cylinder engine whose V-angle is Ψ, by resolving the inertia forces into their respective horizontal and vertical components, by finding the summation of these components, and by taking the square root of the sum of the squares of the latter forces, the nature of the unbalanced force as well as the characteristics of certain angles of Ψ will be developed. Thus the horizontal force component of the right hand block is

$$\frac{2c}{n} \sin \frac{\Psi}{2} \; [\cos 2\Theta \cos \Psi + \sin 2\Theta \sin \Psi]$$

of the left hand block,

$$F = \frac{2c}{n} \sin \frac{\Psi}{2} \; [\cos 2\Theta \cos \Psi - \sin 2\Theta \sin \Psi]$$

Similarly the vertical component of the left and right hand blocks may be represented respectively, thus:

$$\frac{2c}{n} \cos \frac{\Psi}{2} \; [\cos 2\Theta \cos \Psi - \sin 2\Theta \sin \Psi]$$

and

$$\frac{2c}{n} \cos \frac{\Psi}{2} \; [\cos 2\Theta \cos \Psi + \sin 2\Theta \sin \Psi]$$

Inasmuch as these forces are coincident, their vectors may be added, or the vertical components,

$$F_v = \frac{4c}{n} \cos \frac{\Psi}{2} \sin \Psi \sin 2\Theta$$

and the horizontal components,

$$F_h = \frac{4c}{n} \sin \frac{\Psi}{2} \cos \Psi \cos 2\Theta$$

Then the resultant force may be represented in the following manner

$$F_8 = \frac{4c}{n} \sqrt{\cos^2 \frac{\Psi}{2} \cos^2 \Psi \cos^2 2\Theta + \sin^2 \frac{\Psi}{2} \sin^2 \Psi \; \sin^2 \Theta}$$

From this it should be evident that for the inertia forces are functions of the angle of V, Ψ, and the angular displacement, Now if $\Psi = \frac{\pi}{2}$ as in practically all eight cylinder engines, this equation reduces to

$$2\sqrt{2} \frac{c}{n} \cos 2\Theta$$

while if the cylinders are all in line, it becomes $\frac{4c}{n} \cos 2\Theta$

Furthermore it will be observed that the only value of Ψ which will eliminate all vibration of this nature is 180°. That which demerits this position has been already pointed out. If the inertia forces in the eight cylinder engine be plotted, it will be seen that the curve is a graphical illustration of that equation.

Another way by which it is possible to explain the resultant component of the octave vibrations in "eights" is the graphical center-of-gravity method. Thus assume that the center of gravity of the left reciprocating unit lies on the axis of the gudgeon pin, as shown in Figure 4. After obtaining the position of lower and upper sets of pistons, it follows that the center of mass of the whole left block lies equi-distant from these two points. In like manner, the right center of mass is ascertained so that when the middle point on a line joining these two points is found, it will represent the entire mass center. Obviously,

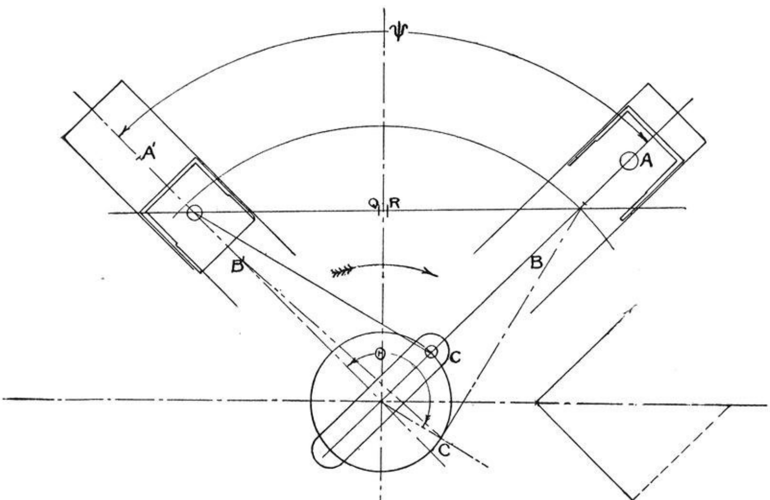


FIG. 4.

this point does not lie in the vertical plane through the functional axis, but vibrates transversely as the angular velocity. In this manner, the vibrations inherent to eight cylinder engines tends to, or is of equivalent force to, oscillate the entire mass of the engine through the distance QR, twice for each revolution.

Anent the mechanical balance or inertia disturbances as may concern the six and subsequently the twelve cylinder engine, there is relatively less to be said. Perhaps it may be less difficult to understand if it is assumed that at some given instant two of the pistons are at the extremities of their stroke undergo-ing the reversal of direction in motion. Now since the cranks are spaced at 120° intervals for proper firing, the remaining four pistons are in their mean pcsition—that is to say, two have negatively accelerated motion while the other pair has positively accelerated motion. As we have just seen, the four-cylinder loses its balance by reason of the fact that four pistons together gain their highest velocities and together undergo the reversal of motion. Thus it is that the six and twelve have perfect static balance.

Let us now investigate the second of the fundamental causes of vibration. It is well known that the torque applied to the crankshaft of an engine varies from instant to instant throughout each revolution. This cyclic fluctuation is due directly to two main exciting causes, namely:

1. The alternations of turning moment.
2. The nature of the inertia disturbances and the inertia of all functional parts.

Of course, for a given cylinder, this torque reaction arises from the periodic fluctuation of energy—that is to say, the varying in the rate of production and absorption of energy. To assimilate this variation by means of acting as an accumulator and distributor of energy, is the function of the flywheel. As is understood, there must be some short interval of time between expansion cycles; hence the energy absorbed by the flywheel rim during the working cycle is expended throughout the scavenging and intake strokes. Consequently to assert that the flywheel actually maintains uniform angular velocity with this periodic torque variation is untenable.

Before going further into this discussion it is of advantage to study the nature of these fluctuations and the relation of those to the multi-cylinder engine. The graphical construction of crank effort diagrams or curves which demonstrate the variation in the tangential components of the combined gas and inertia components of force on the piston will afford, perhaps, a better means for this study than a mathematical development. As it is imperative that some data be assumed, let a manographic diagram be our source of information regarding cylinder pressure, and let the scale of this diagram be the same as the inertia diagram to be constructed. To accomplish this end, let us again refer to the equation in which inertia forces are represented, thus:

$$F = .0000144\ Wn^2 l \left[\cos\Theta + \frac{1}{2n} \cos 2\Theta \right]$$

and to the equation where piston displacement from one extremity of travel is expressed as a function of the crank angle,

$$x = \frac{1}{2} [1 - \cos\Theta] + nl \left[1 - \sqrt{l^2 - \frac{\sin^2\Theta}{4n^2}} \right]$$

Let $W = .203\#$ $r = 2.5''$
$n = rpm = 3000$ $l = 10''$

If these assumed values be substituted into equations and for some unit amount of angular displacement, and if the value of inertia forces so obtained be plotted along some axis

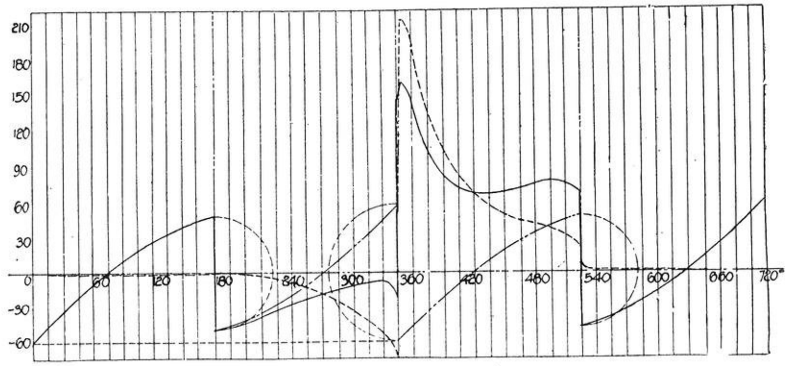


FIG. 5.

or base line AB in Figure 8, the curve shown will be obtained. Now let us superimpose upon this curve a continuous indicator diagram in order that we may ascertain the total piston pressure at any instant. By taking the algebraic sum of the ordinates of the two curves, the shear obtained will represent the actual pressure. To transform graphically these pressures to tangential crank pressures, for any position of the gudgeon end of the connecting rod, lay off a vector to represent the pressure just obtained. Resolving this into two components, that is, cylinder wall thrust and the force acting on the connecting rod, the actual force acting aiong the connecting rod is obtained. Then by similar resolution of forces, tangential and radial forces are obtained. By plotting the first of these forces against angular displacement, the curve evolved affords an excellent means for the determination of crank pin pressures, the variation in connection rod pressures for every cycle, and for any general study of torque reactions. Diagram 6 represent-

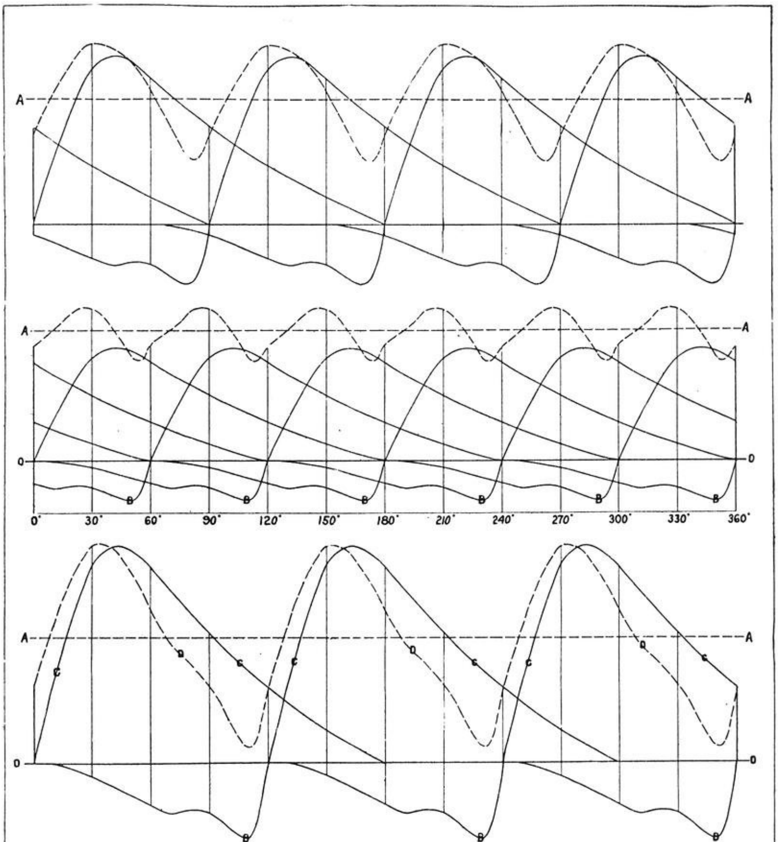


FIG. 6

ing six, eight, and twelve cylinder torque curves has been constructed in this manner.* Although the detrimental effects consequent to lack of uniform torque may not be evident at first glance, a further consideration of their reactions on the engine

* These curves were reprinted from S. A. E. bulletin by the permission of J. G. Vincent of the Packard Motor Car Company.

frame and the crankshaft itself should bring their magnitude into full light. Throughout this discussion, it has been assumed that the engine were bolted to a base of overwhelming magnitude and that the materials of construction were absolutely rigid. As soon as the element of the resiliency in steel becomes pertinent, a different aspect of vibration is taken. To bring out the character of this fundamental cause of vibration, compare the crankshaft to a thin rod of steel clamped in some permanent position. Now if this rod be twisted by means of suitable levers and if the torsional force be suddenly removed, the rod and its handles will oscillate with respect to its position of equilibrium with the motion of a physical pendulum. To imagine that the crankshaft is slightly distorted by the tangential forces applied to its cranks is by no means difficult. In this light, the force of the explosion which takes place in one of the forward cylinders accelerates the crank pin and cheeks with respect to the flywheel and out of phase with the crankshaft rotation. With the expenditure of the explosive energy, the shaft necessarily twists back, beyond its position of rest, and is again accelerated by the explosion in a cylinder nearby. Now if this oscillation be so timed as to be isochronous to hte natural vibrations of the crankshaft or with any other periodic disturbance associated with the speed, a serious vibration is set up. However, the true harm from this type of vibrational disturbance lies not in the vibration produced by the crankshaft oscillation, but in the tendency of this motion to throw the pistons out of phase with the rotary motion, as aforesaid, and even more potent in the disturbance of the reciprocating balance of six and twelve cylinder engines. Indeed, it is found that this slight flexure of the crankshaft of a six is sufficient to throw the motor completely out of static balance. It is on this fact that the chief arguments of the eight protagonists are based. Critical speeds in the twelve cylinder engine are nevertheless of little harm since the explosion frequency is twice that of the six, since each explosive impulse is relatively smaller, and since the crankshaft is comparatively heavier. As a proof that the presence of these vibrations is no theoretical digression, perhaps the reader has noticed certain periodic disturbances in the operation of marine or automobile engines.

Since we know by Newton's third law of motion that to every action there is an equivalent reaction, we may conclude that to every force producing crankshaft rotation or deflection, or to any other existing force, an equal moment is imparted to the engine frame and chassis. Then, if the engine be mounted on some perfectly elastic support, it will be found that the inevitable torque variations tend to oscillate the entire engine about its position of equilibrium. Under these circumstances, however, is a beautiful illustration of the fact that the amplitude of vibration is inversely as the period of the impulse and directly as the force; for if the speed of the engine be increased, it is found that the amplitude is constant. Of course, the explanation of this phenomenon lies in the fact that for an increase in the angular velocity the time for each impulse decreases to such an extent as to offset totally the variation of inertia forces with the speed. Naturally, when the engine is bolted into the chassis, the frame is resilient to a greater or less degree, so that some vibration will occur and vary. In this same consideration it may be shown that displacement of reciprocating parts is to the displacement of the whole engine inversely as their weight, thus

Let W = weight of engine
w = weight of recip. parts
D = displacement
d = displacement of piston, etc.
g = gravity

Now, $v = \frac{Fg}{w}$ (18) whence $\frac{v}{V} = \frac{W}{w}$ (20)

and $V = \frac{Fg}{W}$ (19) Then $\frac{d}{D} = \frac{W}{w}$ (21)

has been drawn. Inasmuch as the engine revolves clockwise, an equal and contrary reaction $\frac{R}{2}$, which forces the left support down and the right support up, is set up by the torque variations. Simultaneously, lack of reciprocating balance acts upon the crankcase supports in the manner illustrated.

There undoubtedly exist several classes of secondary vibrations inherent to high speed engines. Although the frequencies of these disturbances are fortunately high enough to be beyond our range of hearing or feeling, these small defects which enter into the designing and proportioning of parts can by no means be neglected. Anent vibrations of this character or even in regard to centrifugal whipping, it is often advanced that such disturbances are negligible. Nevertheless we should contemplate that great aphorism of the designers of the Peugeot racing cars, viz: ''The automobile engine is a true summation of infinitesimals''—and design OUR engines accordingly.

The following is taken from a letter received from Arthur Howson, who also writes that he expects to be back in school next year:

''During the month of January I was on a Location Party at Prescott, Wisconsin, and saw several days of 37° below zero weather. Although it was mighty cold we were getting considerable exercise, so that we did not mind it. * * *

''Up to the first of February, when I was transferred to the Aurora Division, I'd always thought of maintenance work as a ''pipe'' job, but I hit a busy season on a busy division. We had some thirty-five bridge locations and drainage areas to get in besides the cross-sections for numerous passing track extensions and storage tracks in connection with the budget. Besides this we had the usual leases and contracts, alignment changes, etc., so we were kept busy. We left Chicago every Monday morning and were out all week.

''A couple of weeks ago I had an opportunity to hear Mr. Waterman, head of the company timber treating plant at Galesburg.

''About a week after the lecture I was at the tie plant setting grades for a tile drain and while waiting for the train went over to the treating building. There are five tubes, each holding fifteen cars of 7 in. by 9 in. by 8½ ft. ties, or 450 ties. The process, on which I have not much data, takes nine hours, so that with twenty-four hours a day about 2,000,000 ties may be treated in one year. A 5% solution of zinc chloride is pumped in under 174-pound pressure. The cost of treating a tie is about 22 cents with the zinc chloride and about 40 cents with pure creosote.''

STATE INSPECTION OF PUBLIC UTILITIES

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Presented before Wisconsin Society of Engineers

The purpose of this paper is to give a brief outline of the extent of regulation of public utilities by the Wisconsin railroad commission, the effect of such regulation, and the attitude of the utilities toward regulation.

Stated briefly, the railroad commission is vested by law with authority to regulate rates and service of all railroads and public utilities operating in the state. The term public utility includes all companies or municipalities operating water, gas, telephone, electric light, water-power, or heating properties. Railroads, including street and interurban railways, are not classed as utilities under our laws. There are, however, a number of limitations, legal or economic, to the commission's authority, some of which will be pointed out later.

Broadly speaking, there are two methods employed by the commission of regulating service of public utilities; one may be termed the *complaint* method. The statutes provide that upon receipt of a complaint signed by a certain number of citizens, alleging that the service of any utility, either privately or municipally owned, is inadequate, the commission shall cause hearings to be held, receive testimony, make investigations, and issue such orders as may be necessary in the case. These orders are enforcible through the courts. Usually the engineering department is called upon to make investigations to supplement the information obtained at the public hearings, in order that the commission may have sufficient data upon which to issue orders. Furthermore, if it appears that the furnishing of adequate service may be so expensive as to affect earnings to any considerable extent, then a valuation of the property together with a complete audit of the books and accounts of the utility may be ordered. Thus a seemingly insignificant complaint of service may result in a very extended investigation before an order can be issued. Public utilities, as their name implies, have their existence primarily for the purpose of serving the public needs. There was a time when their service was considered as a luxury to be enjoyed by the few, but this service has now become a necessity in all urban communities and is rapidly becoming such in the rural communities as well. Therefore, being a necessity, it follows that standards of service must be determined which are adequate for the public needs and rates for such service must be so adjusted that the utilities will be able to meet all obligations imposed by the public requirements, including extensions into new territory where necessary.

It often occurs that complaints are received by the commission from individuals and that not enough signatures are attached to permit the commission to proceed formally. In such cases, the engineering department is usually directed to make an investigation and if the results indicate that conditions warrant it, the commission commences action on its own motion and the proceeding is similar to that in cases of regular legal complaints. Discovery of such conditions by any member of the commission's staff is also followed by similar action.

The second method of regulating service may be termed the *service rules* method. To a large extent adequate service to be supplied by utilities is capable of being standardized and described in definite rules. A number of years ago, the commission prescribed certain rules of service for electric and gas utilities. These rules relate to variation in voltage and gas pressure, quality of gas, testing of meters, reading of meters, rendering of bills, etc. Later rules were issued relating to telephone service. Tentative rules have also been prepared relating to water service, and also relating to operating methods of street and interurban railways. The commission is also about to issue rules relative to construction and operation of high tension electric lines.

Rules are of little value unless they are carefully followed by the utilities, and in order to be assured that they are being followed the commission keeps a force of engineers whose duty it is to visit the various utility plants, inspect their records, test the service, and assist the operators as far as possible in performing the service in compliance with the prescribed rules. One engineer gives a large proportion of his time to the inspection of the service of the 35 gas utilities, while five or six others spend almost all of their time inspecting the service of electric and telephone utilities. There are in the state about 400 electric utilities, and 806 independent telephone utilities with over 1,000 exchanges, besides the Wisconsin Telephone Company with 78 exchanges.

These engineers do not confine their attention to the narrow field of electric or telephone service, but handle a multitude of matters which arise in the territory in which they find themselves. The engineering department knows at all times just where each man is to be found and his work is laid out for him in advance. To give an idea of the variety of subjects receiving the attention of the inspectors, the following is copied from a paper recently read by the writer before the Illinois section of the American Water Works Association (Journal Am. W. W. Ass'n., Vol. 2, No. 3 Sept. 1915). It is a brief summary of the work carried on by one of the engineers during one month in 1914.

"The inspector visited Mineral Point where a routine electric service inspection was made, including the taking of four voltage records by means of a recording instrument installed in each of two localities. A complete inspection of the meter and station records for the past year and a half was made and three persons were interviewed regarding electric service matters. A detailed report was made of considerable new electrical construction work. While in Mineral Point two telephone utilities were inspected, data collected regarding the equipment and operating conditions on each for the state telephone directory, as well as a report regarding the compliance of each company with the various rules of telephone service. Data were also collected for the water works directory.

"While the recording instruments were still connected at Mineral Point, the inspector checked up the service conditions at Linden which included the meter operating records of the electric utility, the checking up of telephone service conditions and the collection of data for the water works directory. While in Linden the inspector received an informal complaint regarding the routing of telephone toll messages, and controversy between the disputing companies was partly adjusted by the inspector and the questions which he was unable to settle in the field were reported to the commission for further attention.

"Dodgeville was next visited where routine electric and telephone service inspections were made and the data for the water works directory collected.

"A formal investigation regarding the service of the Leeds Farmers' Telephone Company necessitated that the inspector meet with the stockholders and directors of this company at an inland town 8 or 10 miles from the railroad at which time several hours were spent in discussing in open meeting the various solutions cf the difficulty pending to determine as far as possible which of the several possible solutions would best suit the subscribers. After this meeting the inspector made definite recommendations regarding the telephone engineering features involved. This matter was handled on a Saturday and was not far from headquarters.

"During the following week routine electric, telephone and water works matters were covered for Hazel Green, Benton, Cuba City and Shullsburg.

"It was also necessary for the inspector to visit Galena, Illinois, where the main offices and plant of the Interstate Light & Power Company are located. This utility supplies the service in Platteville, Shullsburg, and to many mines in Wisconsin, and sells current to the municipalities of Hazel Green, Benton and Cuba City that supply service within their own limits.

"On the following Monday the inspector returned to his routine work in the southwestern part of the district, visiting Platteville where one routine electric and two telephone service inspections were made, including the various phases of the work handled above. Eight voltage records were taken in Platteville and the records summarized for the past ten months. Data for the water works directory were also collected in this city. The inspector also investigated the origin of two fires which were caused by high potential wires coming in contact with secondaries entering buildings. This was made upon informal complaint by the president of the Business Men's League, who requested the inspector to make the investigation stating that he had just sent a letter to the commission requesting that this be done.

"The inspector next visited Lancaster and checked up the routine matters in connection with one electric and two telephone utilities. This involved the description of the equipment and practice of seven telephone centrals; also report regarding construction of transmission lines by the Lancaster utility. Water works directory data were also collected.

"Fennimore was then visited where the routine work was carried on in connection with one electric and three telephone utilities. Material for the water works directory was collected and local conditions regarding a formal complaint on electric service, rates etc. were investigated. A routine inspection was made at Belmont covering electric and telephone utilities, and Dodgeville was again visited on the way to headquarters to check up the complaint of a consumer alleging inadequate and interrupted power service. This complaint had not reached the commission in time to be investigated at the earlier visit to Dodgeville.

"During the following week two days were spent at Muscoda in connection with the routine electric and telephone inspections. Investigations were also made in connection with a formal telephone service complaint after which recommendations were made regarding the decision in the case. Several meters were tested to acquaint the local superintendent with the commission's method of testing and to investigate an informal complaint regarding the accuracy of a certain meter adjustment for assumed, overcharge of a meter which the inspector found to be accurate. Another informal matter handled in Muscoda was in connection with an alleged discriminatory rate charged the railroad company for lighting the depot. In addition to the above matters handled in the field, the inspector spent two days on office work writing up reports and looking over records of previous inspections."

The results accomplished by the *service rules* method are very important, since service is kept at a much higher standard than would otherwise be the case, and complaints with their long drawn out and expensive investigations are reduced to a minimum. When a utility is found persistently violating service rules after its attention has been drawn to the specific violation several times, the operating officials are called before the commission to explain the reasons for such violations, it being understood that unless good reasons exist the matter will be put into the hands of the attorney general. Thus far the commission has not found it necessary to begin any prosecution for violation of its service rules, and in only one instance has a utility been prosecuted for violation of an order issued after an investigation following complaints of service rendered.

What has been the effect of state inspection of service? Our records of any one plant show, almost uniformly, a decided improvement in present day conditions as compared with conditions found at our first inspections. Our engineers have been persistent in patiently informing operators of their shortcomings, and explaining how this or that difficulty is overcome at some other plant operating under similar conditions. Gradually the best practices of each utility are being adopted by others until the standards of almost all are being raised considerably above these in existence when this inspection was started. Utilities which are so small as to make it impossible to employ operators of great experience and ability are receiving the benefit of trained engineers whose intimate contact with a large number of the plants in the state fits them especially to give advice in these matters.

Such has been our experience and success with the electric and gas utilities. It was hoped that the same type of supervision might be applied to telephone service. The rules have been issued and no doubt they are of some value as a guide, but the limited appropriation under which the railroad commission is operating makes it impossible to give a great deal of attention to the service of the telephone utilities. It has been found necessary recently even to curtail the inspection work of the gas and electric utilities.

From a consideration of the above remarks it may appear that all efforts of the commission are directed along lines that tend to impose burdens upon the utilities without in any way providing relief. This is by no means the case. There are several reasons for this. Our public utilities laws recognize the utility as a monopoly which may be assured of freedom from competition as long as it continues to perform its functions properly and render adequate service. This feature alone is of great value to the utilities. Many applications have been made to the railroad commission for permission to construct competing plants. With but one exception the commission has denied such applications. Usually these applications have been made on the grounds of inadequate service rendered by the present company, and the commission points out that the remedy lies in a complaint against the existing company because of such service, for it considers that competition will ultimately result in poorer service at higher rates. It has ample authority to enforce adequate service and by refusing permission to a competing concern, it prevents the community from becoming saddled with several plants which it must support and ultimately pay for.

Again, if the commission has a right to demand certain standards of service, it also has a right, and is under obligation, to see that rates are such that sufficient funds are available to permit the utilities to fulfill its requirements. Therefore rate regulation is quite as important as that of service. In fact the two are so closely associated that it is quite impossible to deal with one without considering the other.

It should also be borne in mind that a large proportion of the requirements for better service do not result in any increase in cost to the utilities performing the service. They consist in bringing to the attention of less informed operators the methods that are being employed in more modern and up to date plants, pointing out how savings may be made with no injury to the service, or showing how certain changes or improvements in operation can be made at little or no cost which will result in positive increases in revenue through the acquisition of new customers, or the more extended use that can be made of the service by the customers already connected.

Of course, not all situations can be handled as easily as might be inferred from the above outline. When the public utilities law went into effect, many cities had two or more plants of the same kind competing for the same business; two or more sets of distribution wires occupied the same streets, and two or more sets of machinery had been installed. In some cases the owners were still competing, and in some cases the almost inevitable had taken place, that is, the owners had consolidated. The property was there, however, installed by legal authority and it must be permitted to live and earn a fair return above operating expenses. These cases are among the most difficult for the commission to handle and they illustrate the commission's reluctance to permit a competing concern to enter a field already occupied as long as the existing company can be compelled to render adequate service.

Another type of limitation on the commission's ability to work out adequate returns for good service is to be found in places where large investments have been made in anticipation of healthy growth of the communities and where such growth has not been realized; and again where investments have been unwisely made far in excess of the needs of the community. In such cases it is difficult to deny the utilities the right to earn as nearly a fair return as possible, while on the other hand, rates that would produce adequate returns will be unreasonable or prohibitive. Each such case is given fair consideration from all points of view and rates and service standards installed which appear most equitable for all concerned.

The statutes invest the commission with authority over municipal as well as over private utilities. There is some doubt, however, as to the commission's jurisdiction over fire service or street lighting service that a municipal water or light plant may supply to the community owning the plant, since the municipality owning such plant would probably be held to have a right to determine for itself what it would consider adequate service for municipal purposes. Municipal electric or water service to individual citizens would, however, be under commission control as would also all service both to citizens and to the municipality which would be furnished by a private utility.

It is difficult to determine just what attitude the utilities in general take with respect to commission control. During the last legislature several bills were introduced seeking to limit control over municipal authorities. The arguments themselves indicated the woeful lack of knowledge that some of the adherents of the bills had of the very fundamentals of operation of utility property. It is believed that had they laid politics entirely aside and sought only the best interests of the communities and taken the trouble to acquaint themselves with all the facts relative to the advantages to be obtained by commission control, there would have been very little agitation against it.

As for private utilities, there is little doubt that they prefer commission control, with its strict service requirements, to the conditions existing where such control is lacking. Occasionally protests come from them but usually they are not serious. Freedom from competition, in most cases, more than offsets the hardships imposed by service regulation. Securities are on a much sounder basis because of this fact, than they could ever be under regulation through franchise agreements with municipal authorities. The indeterminate permit which makes the franchise virtually perpetual, subject to acquisition of the property by the municipality, removes the ever present dread of an expiration of a franchise, often short-lived in itself, with the necessity of appearing before councils, begging for a renewal upon such terms as may suit the particular councilmen then in office.

In conclusion it may be said that regulation has not brought about perfect conditions. It is a large undertaking of a nature requiring pioneer work, but it appears to have improved conditions to a very large extent. Another point that has not been mentioned is the great saving to individuals in overpayment of bills and attorneys' fees. If a customer feels that he has been overcharged or otherwise unfairly dealt with, his case is given impartial consideration by the commission practically free of charge; and in almost all cases, if he is right, the utility corrects the error without formal proceedings. Without the commission to appeal to, how many people who have been overcharged a few cents or even a few dollars, will go to the expense of a law suit for redress? They pay the bill and swallow their chagrin. With the commission at hand, with each utility knowing that it stands ready to investigate all claims, the mention of the railroad commission is usually enough to insure consideration that might otherwise be denied. It is probably not too much to say that the amounts thus saved the people in law costs and corrections of overcharges, more than pay the entire expenses of the commission to the people of the state of Wisconsin, to say nothing of the value of better service and just rates.

THE WATER SOFTENER AND BOILER FEED WATER

H. R. Dorman

Presented before Wisconsin Society of Engineers

The Mechanical Dictionary defines the word "Boiler" as "A vessel in which water is evaporated into steam for the generation of power or for heating purposes." In the early days of steam engineering when pressures were low and furnace temperatures moderate it is probable that steam was thus generated with little or no trouble from any serious deposits of scale. As time passed and higher steam pressures came into use the trouble from scale deposits increased accordingly, with the result that in the endeavor to overcome the scale formation, the boiler from being a vessel to evaporate water was also forced to take upon itself the work of a chemical laboratory. Within the last few years the tendency toward large size boiler units carrying high overloads and working twenty-four hours per day has grown enormously, till at the present time the importance of relieving the boiler of its work as a chemical laboratory and allowing it to return to its primary duty of evaporating water is beyond estimate, especially so when it is realized that under modern conditions the major gains in power plant efficiency must be looked for in the boiler rooms.

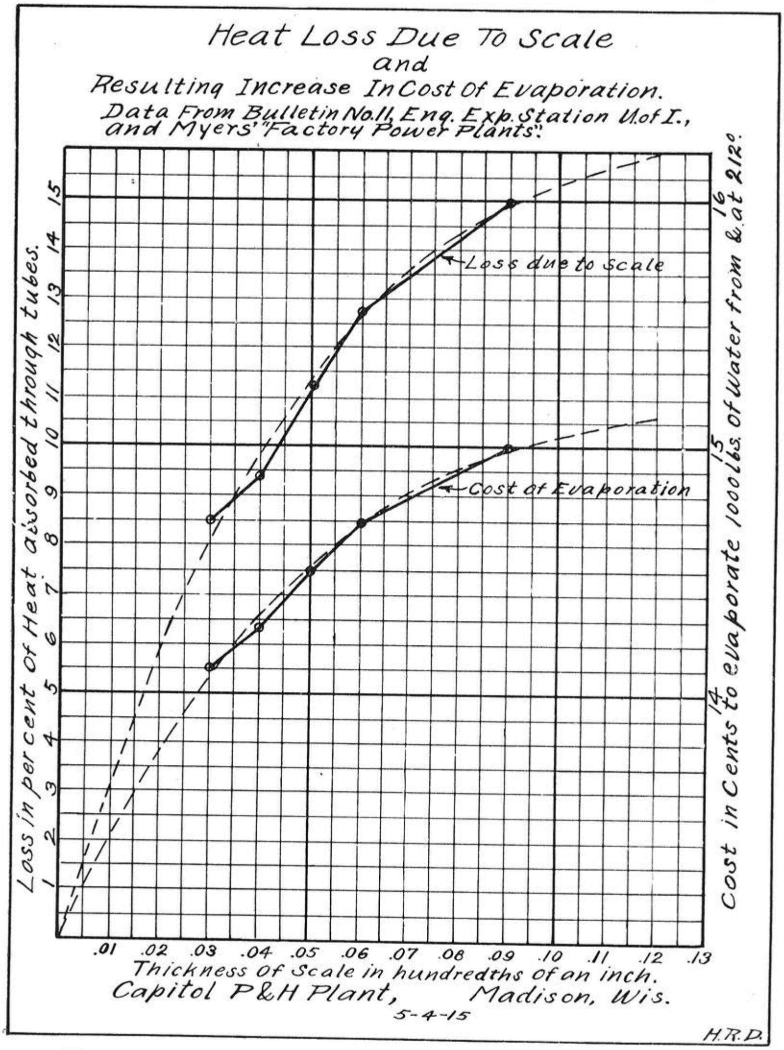
There are three principal methods of counteracting scale in boilers:—

1st. The use of boiler compounds, when the boiler acts as a chemical laboratory in addition to its duty of evaporating water.

2nd. Mechanical Cleaning.

3rd. The treatment of the feed water with resulting precipitation of scale forming substances before the water enters the boiler. The first two methods though costly, are merely temporizing with the trouble and should be regarded as only a partial relief since it is only temporarily beneficial—it may be likened by trying to pump out a leaking ship, since the scale begins to build up again the day after cleaning, and the operating efficiency begins to decrease.

The internal treatment of feed waters has been practiced for many years but in view of the present heavy duty expected of boilers it is not to be commended. To secure sustained efficiency from boilers is a problem of either securing a supply of water naturally free from objectionable matter, or of so treating the water before going to the boilers that the scale forming and



corroding substances are precipitated or rendered inert. When water of sufficient natural purity is not at hand the available supply may be rendered suitable by the modern method of a chemical analysis of the water and its treatment in a water softener, or in some cases by the use of evaporators for distilling the boiler feed water. That these methods of treatment are worthy of serious consideration by all engineers or owners of steam plants may be shown by a brief review of the 1914 report of the Hartford Steam Boiler Inspection and Insurance Company. This is the latest report available and reveals the fact that out of 368,788 boilers inspected during that year, 190,882 defects were found, and of these 116,000 were plainly due to bad water. To quote from the concluding words of the Hartford Company's report—"It will be seen that by far the greater portion of the defects discovered were due to impure feed water."

Of the two methods outlined:—Treatment in a water softener, or by the use of evaporators to distill the boiler feed supply, the latter method is prohibitory through expense of equipment and operation except in peculiar and limited cases such as occur on sea going steamers. For the usual run of stationary steam producing plants the treatment of boiler feed water by a water softener offers the best solution of the problem. To those who may not be familiar with this appliance a definition given by the Bartlett-Graver Co. may be instructive; "A water softener and purifier is a mechanical apparatus which removes both the soluble hardening ingredients and suspended matter from water. To satisfactorily accomplish this a Softener must:—

1st. Accurately proportion the chemical to the water.

2nd. Intimately mix the water and the chemicals.

3rd. Contain sufficient reaction capacity to insure completion of the chemical precipitation. (This requires from 2 to 5 hours to treat cold water, with an average of about 4 hours).

4th. Deliver clear water.

5th. Contain efficient sludge removal means. I have added another clause the need of which has been demonstrated by operating experience.

6th. Allow convenient access for cleaning chemical tank and chemical feed line.

There are several firms in this country engaged in the manufacture of water softeners with some difference along lines of mechanical construction but the principle of chemical precipitation has remained generally the same. The lime-soda ash method of treatment is the one in widest use—perhaps because both lime and soda ash are the cheapest chemicals utilized to secure precipitation. This method was devised in England about 60 years ago by Dr. Clark, an English scientist, who introduced the method of treating water with lime to remove the carbonates of lime and magnesia and the carbonic acid. Following this another Englishman, Dr. Porter, used soda ash to remove sequently combined into the Porter-Clark process which is in the sulphates of lime and magnesia. These methods were subgeneral use today.

The salts usually responsible for the scale forming propensities of a water are carbonates and sulphates of lime and magnesia, and the treatment of boiler feed water in a water softener consists mainly in getting rid, as completely as possible, of these salts. Water for boiler use may be classed as temporarily hard, or permanently hard. The scale of hardness is usually based upon the number of grains of solids per gallon, and waters may be divided roughly as follows:—

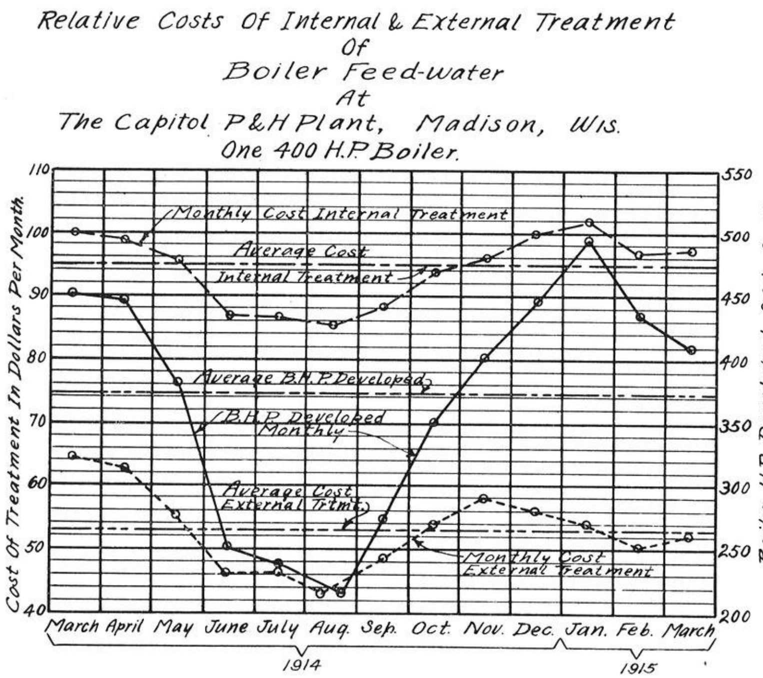
1 to 10 grains per gallon, soft water.
10 to 20 grains per gallon, moderately hard water.
25 and above per gallon, very hard water.

Temporarily hard waters are those containing carbonates of lime and magnesium held in solution by an excess of carbonic acid in the water. The greater part of these carbonates can be precipitated by boiling at atmospheric pressure, or by the addition of hydrated lime, when, if there are no other scale forming ingredients present, the water becomes soft.

Permanently hard waters are those containing mainly the sulphates of lime and magnesia, which are only precipitated at the high temperatures found in a boiler at working pressure, or by concentration, or decomposed by a combination of high temperature and a reaction with the steam, as in the case of magnesium chloride.

The process of water softening is one in which the water to be treated is freed from the salts producing temporary or permanent hardness. It is accomplished by chemical precipitation; the hydrated lime added to the raw water in the softener causing precipitation of the carbonates of lime and magnesia, while the salts causing permanent hardness are treated by the addition of soda ash.

The advantage of eliminating these salts before evaporating the water is greater than persons who have never cleaned a boiler or given the matter any consideration imagine. A 400 H. P. boiler evaporating 50,000 gallons of water per day, which deposits 20 grains of sediment per gallon, would contain nearly 1,000 pounds of dirt after a run of one week. This deposit is cumulative in a boiler fed with hard water—the boiler may be



COSTS INCLUDED

Internal—Cost of compound + attendance @ 1½c per 100 H. P. per day, + 4 cleanings per month @ $16.00 each + 4 tons coal @ $2.70.

External—Cost of chemicals + attendance @ 5c per 100 H. P. per day, + 10% of cost + 1 cleaning per month @ $8.00 + 1 ton coal @ $2.70.

Time out for cleaning—Internal—and higher sustained efficiency—External—not considered.

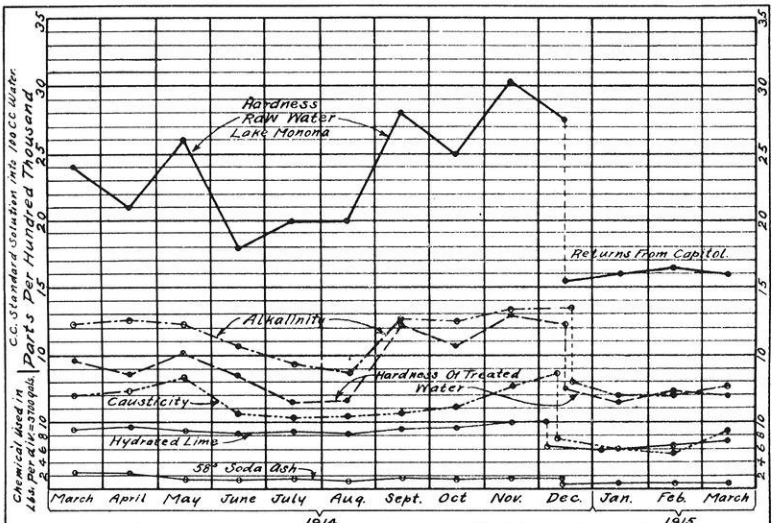
perfectly clean when fired and, in a week or two, contain a deposit of scale $\frac{1}{16}$ to $\frac{1}{8}$ inch or more in thickness. This scale causes burned and bagged sheets, bagged tubes, and leaking flues. It reduces the efficiency and shortens the life of the boiler; it increases the boiler installation necessary to carry the load, increases the coal bill, and increases the work and cost of boiler cleanings and repairs, besides causing delays and shut downs.

The introduction and increased use of water softeners in this country is due, in a great measure, to the railroads. The constantly increasing traffic demanded an increased mileage from each locomotive between lay-ups in the repair shops, and when it is stated that over $\frac{3}{4}$ of all boiler repairs to locomotives were due, in some manner, to bad water, it was but natural that attention should be directed towards finding some means of purifying the feed water and eliminating, as far as possible, the frequent trips to the repair shops. That the water softener met the requirements is evidenced by the fact that the C. B. & Q. R. R. in three years reduced the locomotive failures due to leaking boilers from 106 the first year to 1 the third year. The C. & N. W. R. R. reduced in one year the number of boiler failures on one division 79% by the installation of water softeners. Another road increased the engine mileage between boiler failures from 100,000 miles to 250,000.

Stationary boiler plants during the past few years have adopted the idea, and, while the first cost of installing a water softening system in a small plant may seem prohibitive, it should be balanced by the consideration that the life of the boilers may be doubled by the use of soft water, the evaporative efficiency increased, cleaning and repair bills reduced, and, in line with the "Safety First" movement at present so widely exploited, the reduction in hazard from boiler failures with attendant loss of life and property, would certainly seem to justify an investment of even 50% of the boiler costs in some system of providing soft water for boiler feed purposes.

The softener in use at the Capitol Power Plant is a top operated Northern Water Softener, of the cold process, continuous type, with a capacity of 96,000 gallons per 24 hours.

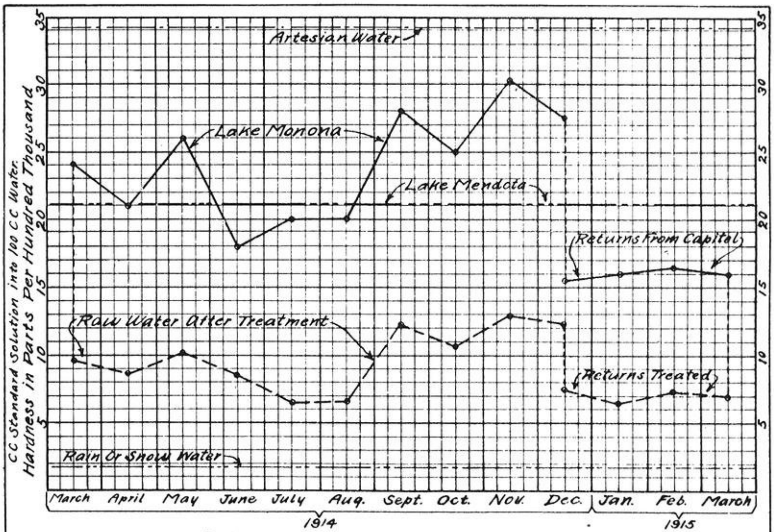
All water for station use is taken from Lake Monona through a 24 inch line about 1800 feet long, extending about 500 feet into the lake, and the normal submergence of the intake opening is 8 feet, to avoid drawing surface water or silt from the lake bed into the line. The water flows by gravity through this line into an intake well 20 feet in diameter by 24 feet deep, just outside the boiler house. From this well it is pumped by two 12″x8″x12″ duplex steam pumps through a reducing valve (which maintains a pressure of 7 or 7.5 pounds) directly into the operating mechanism, which is a small water wheel for stirring and feeding the chemicals from the chemical tank, and also



Relation Between Raw & Treated Waters & Chemicals Used.
Capitol P&H Plant — Madison, Wis.

mixing the water and the chemicals in the downtake of the softener, thence into the tank. The chemical tank is above the main tank and has a capacity of 390 gallons. For convenience in measurement and computation the tank is divided into 13 divisions of equal volume. The ratio of the mixture fed from the chemical tank to the total water passing over the wheel is approximately one ounce to the gallon. This is fed to the raw water by means of an endless bucket elevator discharging into a cup, thence through an orifice of known area to the downtake. A constant head is maintained above the orifice in the cup so that the discharge will be uniform at all times. After mixing, the water settles to the bottom of the downtake and rises on the outside to the discharge opening near the top of the softener. Precipitation occurs during this period, but any foreign matter that has not settled out is caught by an excelsior filter just below the water line. After treatment in the softener, the water passes to make up or storage tank, then to the open heater, then by the boiler feed pumps to the boilers.

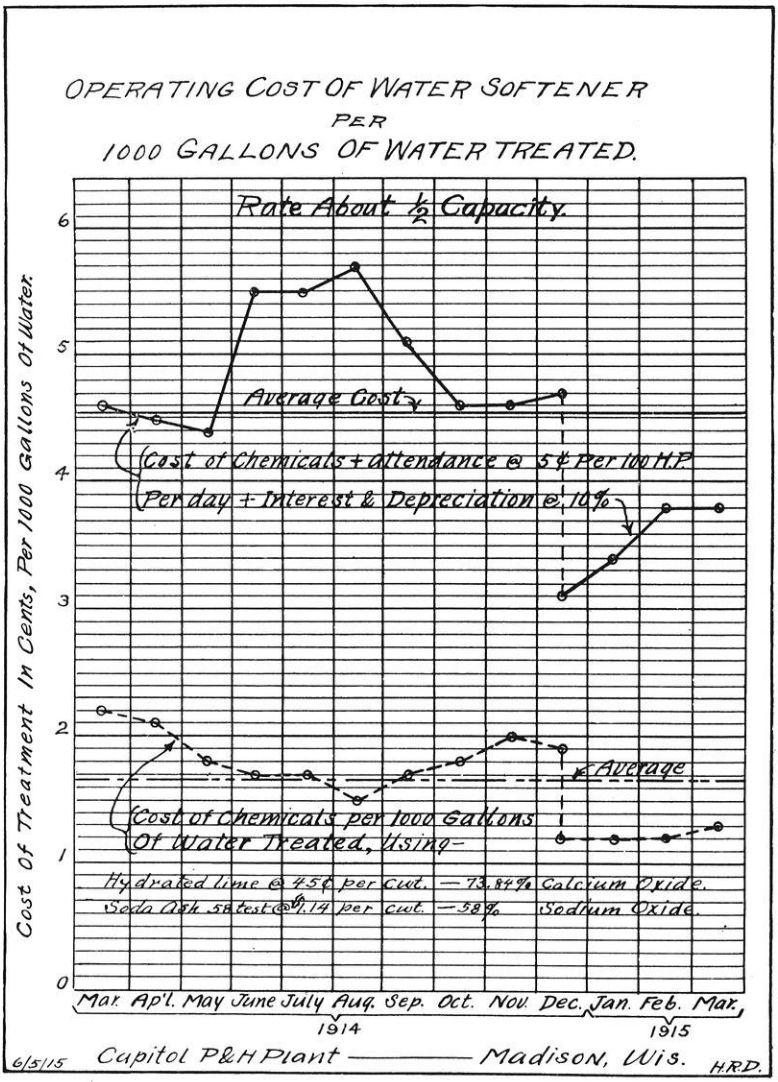
During the heating season the return water from the heating system at the Capitol building supplies the boilers. This return is a mixture of condensed steam and cooling water and shows about one-half the hardness of the lake water. Hence there is a considerable saving on the chemicals used, and likewise in fuel, due to the higher temperature of the returns over that of the lake water.



Relative Hardness Of Madison Waters and Effect Of Treatment On Monona Water At Capitol P. & H. Plant

The chemical tank is charged once or twice in 24 hours, depending upon the quantity used. The quantities of lime and soda ash necessary to recharge are determined by measuring the chemical mixture remaining in the tank. Tests of both the treated and the raw water are made every morning, and oftener if conditions seem to demand it. These are simple and quickly performed with the aid of a small testing cabinet furnished with the softener.

For four years before the installation of the softener at the Capitol Plant, different makes of boiler compounds were used.



During this time it was customary to cut out and clean a boiler after one week's run. In nearly every instance it was found necessary to use the turbine tube cleaner to dislodge the hard scale formation, besides chipping and pounding loose the scale accumulated on the tube sheets. Since the softener has been in commission the boilers are operated from three to six weeks at a time, and the work and cost of cleaning and repairing has been materially reduced.

Data taken from the station records of the softener and a computation made from the average of the bids received from different concerns for treatment with boiler compounds show the cost of the former to be only about one-half that of the latter. Results might be somewhat different in another plant owing to different conditions, but all observations made while using boiler compounds and while treating the water in the water softener have clearly demonstrated the superior efficiency of treatment by the external method.

To express an opinion formed during over two years experience with a softener, I would rather see one of our boilers at the Capitol Plant torn out than to have the softener removed. I would feel safer carrying an overload on three boilers with the water softener, than carrying rated capacity on four boilers without the softener.

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EDITORIAL

Summer is coming. It cannot be too strongly emphasized what an opportunity it offers to the undergraduate. Three things may happen to him: he may spend it in a vacation; he may get a job at some work not in his line of study; or he may busy himself at acquiring the necessary early experience in the profession he has chosen. It is not necessary to point out to most students that the latter is in the long run the best course; but it is worth while to mention some of the more vital factors that make it the most valuable.

Everyone preparing himself for a professional career must at some time begin actual work in his profession. Nearly all technical professions, especially engineering, require a certain amount of elementary training before any responsible work is intrusted to him. The actual training for this work comes very early in the college course; and to put the ideas thus gained immediately to work not only fix them in mind indefinitely, but serve to build up a stronger foundation of general useful knowledge and of interest for what is to follow in the course. Everyone will agree that normally success is wrought from untiring work; yet the key-note of continued labor is interest. Tenacity of purpose is the result, and the mainspring for the whole career.

It is very often true that the graduate engineer finds that he is not really cut out for the engineering profession. Nearly every case is attended with the fact that as a student the man did not seek work in the vacation that applied to his profession. He may then have avoided the unfortunate result that was inevitable.

Financially no great sum can be laid up from the vacation work. It is a very unusual job that will pay in three months enough money to the student to put him through another year's schooling. As a rule the margin offered by the average job over that in summer work in engineering is not sufficient to be worth while. Again, since this elementary work must at some time be done, it is far better to have it over with during summers than to save it up to begin on after graduation.

The coming summer is an unusually bright one for the engineer. Much work is to be done, and many positions are already being offered. Perhaps your department or your Dean can be of some assistance to you in locating a place for the summer. "The early bird" is a sufficient word to the wise.

* * *

The advantage of being able to explain a technical problem in a satisfactory manner or to present it in a comprehensible form and style can not be over-emphasized. Wide-spread criticism of the weakness of technical graduates in the use of English is undeniable, and with this deplorable condition has come the feeling among college teachers and professional men that the engineering student should graduate with a far better equipment for technical writing. However, with the difficulties that arise in Freshmen English courses, the average engineering student either considers himself adequately equipped for his future writings or considers the results of future training too meagre when compared with those of important technical subjects. But experience has proved conclusively that the present training is deficient, that the engineer of today must be more than the technically trained man, and preeminently that he must be broadened in spite of specialization.. Undoubtedly the acquisition of the ability to write intelligently is anything but easy, and those to whom this applies should realize, if never before, that the engineer, of all men, requires knowledge of the technique of his language, that preparation of technical papers is a most important phase in the work of the engineer, and that upon the ability to express ideas correctly and forcibly depend his chances for promotion and ultimate success.

DEMAND FOR ENGINEERING GRADUATES.

A good evidence of the activity in industrial lines is the unusually large demand this year for engineering graduates. This is particularly true in the manufacturing industries; in addition to the large concerns which have sent representatives here regularly for a number of years to secure men, many other concerns are calling for men for both their technical and sales departments. Whenever a Wisconsin man secures a foothold and a position of some responsibility the college is quite sure to hear from such establishment whenever additional men are needed. As an illustration of the variety of business now demanding technical graduates, the following are a few selected from the list of firms which have called for men:

Chemical Engineering.—The Aluminum Company of America, Laclede Gas Company, Milwaukee Gas Company, American Tar Products Company, and General Roofing Manufacturing Company.

Mechanical and Electrical Engineering.—Westinghouse and General Electric Companies, Telephone Companies, Allis-Chalmers Company, Chain-Belt Company of Milwaukee, Conron-McNeal Company, manufacturers of skates, Edwards & Bradford

Lumber Company, and the Dravo-Doyle Engineering Company of Pittsburgh.

Civil Engineering.—Various railroad companies, for employment in departments relating to valuation, signals, bridges and buildings, and maintenance of way; bridge companies, Knoxville Power Company, Tennessee; Oliver Iron Mining Company, Duluth; assistant city engineers, sewer inspectors, highway engineers, publicity engineer for Universal Cement Company, and engineers for contractors.

An interesting and significant feature is the growing practice of the smaller and more miscellaneous manufacturing companies to make use of technically educated men in both manufacturing and sales departments. It would seem that the opportunities for good men to achieve success in the industrial field were never better than they are today.

R. J. Meisekothen, e '14, is with the Sloan-Huddle company at Chicago.

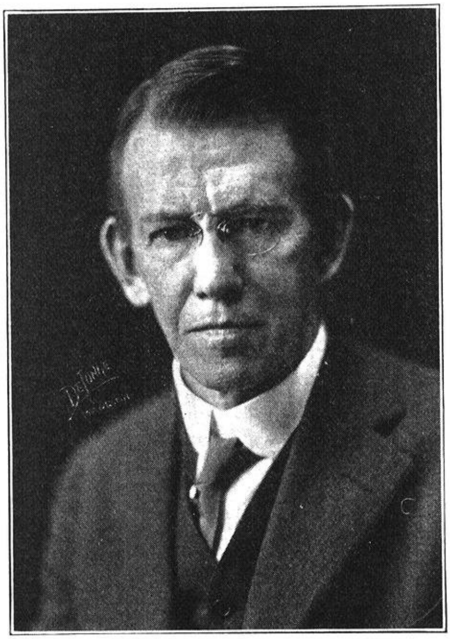
F. W. Charlesworth, c, has opened an office in Kaukauna and has been handling a considerable portion of the city's engineering work.

* * *

In a letter received from Les Rogers he tells of some of his experiences in connection with tunnel work at Glacier B. C. He had tentatively promised to prepare an article on some of the interesting features of the work, but as his letter tells, the conditions are hardly favorable; an extract follows:

"In the last six days some thirty tons of rock have fallen on our work, in amounts varying from a few hundred pounds to ten, and in one case, thirty tons. All of this roof will have to be timbered before it can be safely concreted, and it keeps me going night and day checking the work of the timber and concrete gangs."

Successful Wisconsin Engineers.



DANIEL W. MEAD

Daniel W. Mead and F. W. Scheidenhelm have opened offices in the Equitable Building, 120 Broadway, New York, for the continuation of their practice as consulting engineers. Mr. Mead has been in engineering practice about thirty years, during part of which time he was engaged in contracting work. Since then he has been engaged in consulting practice at Madison, Wis., in addition to fulfilling the duties of professor of hydraulic and sanitary engineering at the University of Wisconsin. His field of engineering work has been extensive, but his main work has been along hydraulic and hydro-electric lines. In 1914, as a member of the board of consulting engineers acting for the American Red Cross and for the Chinese Republic, Mr. Mead spent some months in China investigating the problem of flood control and river regulation along the Huai River. He is also now acting as consulting engineer for the Miami Conservancy District, which is handling the problem of flood protection at Dayton, Ohio. As an author, Mr. Mead is best known for his book on "Water Power Engineering," though he has written a number of other books and many papers on hydraulic and related subjects. He will divide his time between Madison and New York. Mr. Scheidenhelm comes to New York from Pittsburgh, which has been his headquarters for a number of years, and where he has been engaged in private and consulting capacities in hydroelectric and other hydraulic works. For several years, as vice-president and chief engineer of the Hydroelectric Company of West Virginia, he was in charge of the Cheat River developments of that company. He has been specializing to a considerable extent in dam design and construction. Recently, he completed the reconstruction of the Stony River dam, which failed in January, 1914. Both Mr. Mead and Mr. Scheidenhelm are graduates of Cornell University, and members of the American Society of Civil Engineers, as well as of many other technical societies. They will continue to give their attention to hydraulic and electric developments, water supply, flood prevention and reclamation works.—*Engineering Record*, March 11, 1916.

ELEVATORS

JOHN H. JALLINGS

American Technical Society, Chicago, Publishers

It has been difficult in the past to locate definite and useful information concerning the design and construction of passenger and freight elevators for buildings. Mr. Jallings' book will render a distinct service to those who are in any way interested in building equipment. The author is a recognized expert in his line of work, and his experience has equipped him to authoritatively write such a book.

The book has been divided into three parts. The first of these deals with hand elevators, ranging from the sling freight elevator to the dumb waiter; the second part treats of steam and hydraulically operated elevators, the development of the engines and control valves; the last part covers the design, construction and operation of electric elevators, including motor design, automatic control and safety devices, and wiring diagrams.

The book is very clearly and concisely written, and is abundantly illustrated by cuts and diagrams.

ALUMNI NOTES

Howard A. Parker, c '08, who was formerly engineer with the Knoxville Power Co. at Alcoa, Tenn., and who just recently moved to Sacremento, Cal. is now with the Missouri Valley Bridge & Iron Co., at Tulsa, Oklahoma.

F. W. Cunningham, Ph. D. '11 has now accepted a position with the Powdered Coal Engineering & Equipment Company at Chicago. Mr. Cunningham was formerly with the General Electric Company at Harrison, N. J.

Edward H. Tashjian, who just recently underwent a treatment at the Mayo Brcs'. Hospital at Rochester, Minn. has fully recovered, and is now working for Frederick A. Little Co., at Fond du Lac, Wisconsin, as assistant engineer.

Eugene C. Noyes c '13 who was formerly assistant of the Dunphy Fridstein Co., Milwaukee, is now engineer and salesman of the Klein Mfg. Co., at 110 S. Dearborn St., Chicago.

Paul N. Elderkin e '15, who was formerly connected with the municipal electric lightplant at Westby, Wisconsin, is now at 302 L. Way East, South Bend, Indiana.

W. A. Hoyt c '00, civil and architectural engineer and reinforced concrete specialist changed his address from 2114 Fisher Building, Chicago, to Altoona, Pennsylvania.

J. T. Hurd, c '01, who has been connected with the State Highway Commission of Wisconsin for the past year, has been appointed city engineer of Chippewa Falls. Mr. Hurd has been doing surveying work for the commission. He has had considerable experience of this nature in the government service in China and the Philippines.

K. W. Erickson, ch '13, who was formerly employed by the Markor Galvanizing Company of Evanston, Ill. is now with the Forests Products Laboratory at Madison, Wisconsin.

Arthur C. King m '01, formerly deputy commissioner of gas and electricity of Chicago, announces that he has resumed consulting engineering practice and is prepared to undertake valuation, rate, and other public utility problems, as well as general consulting engineering work.

C. H. Ramien, m '96, has changed his position from that of engineer with the C. O. Bartlett and Snow Co., to that of mechanical engineer with the Detroit Radiator Company, Detroit.

D. H. Keyes e '06, who was formerly with the Michigan State Telephone Co. is now with the American Telephone & Telegraph Co. at New York.

M. H. Li, ch '13, who was formerly research chemist for the American Roller Mill Co., is now with the Inland Steel Co., at Indiana Harbor, Ind.

J. C. McLean, C. E. '13, who has won great esteem in his efficient work on the Cedar County Highway Commission, has now accepted a position on the highway commission of Sioux County, Iowa, as county engineer.

C. K. Textor, ch '13, has been shifted from work in the Forest Products Laboratory at Madison, to the laboratories at Wausau, Wisconsin. He is now principally engaged in the wood pulp grinding done at Wausau.

E. L. Leasman ch '07, Ch. E. '13, is now with the Indian Refining Company at Lawrenceville, Ill.

W. J. Gibson m '02, who was formerly foreman in the machine shops of Lofemann Bros., Milwaukee, is now foreman in the unloading department of the Ford Motor Company, 670 51st Street, Milwaukee, Wisconsin.

E. F. Johns m '09, who was formerly engineer in the University Heating Station, Madison, is now with the Bayley Mfg. Co., 732 Greenbush St., Milwaukee.

C. A. Olson e '15 has accepted a position as electrical draftsman with the Wisconsin-Minnesota Light & Power Co., Eau Claire, Wisconsin.

H. F. Ilgner e '11, who was formerly in the distribution department of the Eastern Michigan Power Co., is now with Vaughn, Meyer, & Sweet, Consulting Engineers, Milwaukee, Wisconsin.

L. E. Gibson e '10, has changed from electrical engineer to that of contractor, with headquarters at 423 Northwestern Bank Bldg., Portland Oregon.

R. Boissard '13, who was formerly employed by the National Lamp Works of the General Electric Co., at Nela Park is now engineer for Scanlon & Morris Co., Madison, Wisconsin.

W. G. Butler c '13, has recently taken a position of statistician with the Chicago, Milwaukee & St. Paul railroad at Chicago. To accept this position he left one of highway construction in West Virginia.

R. H. Cahill c '13 is one of the superintendents of construction upon the new intercepting sewer tunnel on the north side in Milwaukee. This tunnel which is being built under the new sewage bond appropriation just passed by the city council, is for the purpose of taking sewage in the new Jone's Island disposal plant.

H. Larsen c '13 who was formerly assistant engineer with R. Adams of La Crosse, Wisconsin, is now in Milwaukee doing railway valuation which starts in Wisconsin this year, on the Northwestern Railway.

F. C. McIntosh c '13 who was formerly in the Track Elevation Office of the Pennsylvania Railroad is now chief of the construction corps at Chicago, doing inspection work on the new freight terminal.

F. S. Halliday c '13, formerly land surveyor at Plover, Wisconsin, is now in complete charge of the valuation of the Green Bay & Western Railway.

B. H. Lampert c '13, who was formerly manager of the L. Larson Co., Oshkosh, Wisconsin, is now in the contracting field, with offices in that city. His special line is roads.

H. L. Algeo, c '13, spent a part of April at the University, working out some problems in connection with the effect of steam on concrete.

N. M. Isabella, c '14 is working with the State Highway Commission. His headquarters are at the Court House, Green Bay, Wisconsin.

C. H. Luckey, c '14 is another member of the Green Bay colony. He is working with the Green Bay and Western Railroad.

B. E. Anderson, c '15, has left the service of the Pennsylvania Railroad and is now with the Standard Steel Car Works at Butler, Pa.

A. W. Crump, c '15, is with the Sloan-Huddle company, engaged in the valuation of the Peoples Gas, Light and Coke Co. His address is 4516 Indiana Ave., Chicago.

CAMPUS NOTES

The unquestionable success of the Engineer's Mixer on April 28, is an excellent demonstration of the loyalty of the engineers to their college, and of the general efficiency of the committee appointed from the various clubs for the entertainment of the evening. Thanks for this success certainly should be extended to the following committee of students and members of the faculty:

Students:	*Faculty:*
Goldammer (tags)	Millar (chairman)
Barnett (eats)	Van Hagan
Heuser (mixer plans)	Schwada
Cooper (programs)	Phillips
Bennet (posters)	
Andrae (chairman)	

Then too, we must consider the absence of our propitious friends the L. & S., or our embryo Blackstones, or even the Agrics to adduce the virtual reasons for the success of the affair. Not only this, but the interesting attempts to formulate long words by means of the lettered "mixees" proved to be quite interesting, especially when the words ranged anywhere from "bull" and "Ford" to "hypozeikloidal bewegungen."

Needless to say, several official tests for taking efficiency on Dean Turneaure, Prof. Larson, Prof. Maurer, and Dr. Elsom showed curves which were exceptionally steep. Music by Johnson and the Roustabout Musicians, followed by a course in toruses and apples, completed the entertainment with the motor still knocking them off on all eight cylinders.

* * *

The following men have recently been elected to Tau Beta Pi:

S. C. Hollister '16	C. C. Dodge '17
D. L. Hay '17	W. C. Helmle '17
A. G. Hoppe '17	P. T. Norton '17

M. E. Skinner '15

Since the erection of the 185 ft. aerial from the tower of Science Hall to the cld stack of the Mining Laboratory, more or less comment has been heard concerning the wireless station that we now have in Science Hall. The equipment of the station is indeed quite complete, and better is quite modern in every respect. In this may be included a detector of the latest type—the ultra-audiom—equipped for receiving either the damped spark or continuous waves. It might be interesting to state that Professor Terry and Karl Kottler '18, those to whom the success of this station may be accredited, have been able to listen to calls from Eilvees, Germany to Sayeville or Tuckerton, New Jersey. In fact, the writer was able to hear a call from one of the stations on the Pacific coast, while static conditions prevented calls from greater distances.

* * *

Of course those who are not eternally in the Steam and Gas lab have wondered as to the cause of the foul odors and noises that have recently filled the air of the Engineering Building. However, it is nothing more than a few thesis tests on an oil engine of a relatively new type. We are told that on the morning of the initial run Mr. Thorkelson telephoned Professor Callan that such unearthly sounds need must stop immediately and without further argument. Hence the placing of a 1,000 gallon water tank for a muffler.

* * *

Even more strange than the phenomena adduced in the Physics Building and in the Chemistry Department, are some of the daily instances that occur in the Engineering Building. On what possble basis can we explain the presence of law students in the libe, an Agric at our mixer, and women working in the far-famed odoriferous laboratories of Steam and Gas? To think that it should come to this!

* * *

Prof. Callan states that the new Sprague Electric Dynamometer, which is to be used for testing automobile engines up to 150 horsepower, will soon be installed in the Steam and Gas lab and that the initial run will be made some time before the end of this semester.

The U. W. Engineers Club recently held their semi-annual election and initiation of new men. Among these were:

White, R. B. Whitcomb, K. F.
Shaw, H. N. '18 Morse, E. B. '18
Hanson, W. G.

Following the customary initiation, the party paraded down State Street in lockstep to the second show Orph.

* * *

Special attention is called to the recent gift of the R. T. Crane Co. of Chicago to our Engineering College. Due to the efforts of Mr. Hyland of the Machine Design department, specimens of Crane specialties now occupy a place in our school. According to Mr. D. G. Park, 2nd Ass't. Secretary of the Crane Co. Wisconsin has the distinction of being the first of the technical schools to receive such a gift, following out the purpose of the Crane Co. to place one of their exhibits in each of the leading technical schools. The exhibit is of unusual importance considering its extent, its cost, and the excellent workmanship of each specimen. The larger specimens, nickel-plated and mounted upon ball-bearing stands includes a 4 in. pop safety valve, a 6 in. stop check valve, a 6 in. cast steel angle valve, a 6 in. blow-off cross-valve, a 6 in. back pressure valve and a 6 in. by-pass gate valve. The smaller specimens, which, since their arrival have been placed in oak, display cases, include check valves, gate valves, radiator valves, steam cocks, globe valves, safety valves, stop cocks and all types of malleable iron pipe fittings. Each specimen is of standard design. The entire exhibit of eighty-two pieces, reaching the neighborhood of fifteen hundred dollars in cost has been gratefully received by the faculty and students of the Engineering College and many thanks extended to the Crane Co. for their liberality and to Mr. Hyland for his efforts in our behalf.

THESIS STUDIES

The following subjects are being studied as theses in the hydraulic laboratory:

Submerged Weirs.

C. P. Conrad, c' 15, Fellow in hydraulic engineering.

Wm. H. Fowler, C E '16, Scholar in hydraulic engineering.

R. H. Parker, c '16.

The experimental work on this thesis is an effort to determine an accurate coefficient of discharge for submerged weirs of various shapes of crests, as for instance, Ogee, sharp-crested, etc.

For the past three years experimental work has been carried on in the hydraulic laboratory on submerged weirs. The first work was done by C. T. Wiskocil, who developed an accurate means of measuring the downstream head, and who later made studies to determine where the downstream piezometer opening should be placed in order to obtain the best results. He is arranging a bulletin on his part of the work, which is to be published some time during the summer. Last year Mr. Conrad followed these experiments with a similar series, in his work on his undergraduate thesis.

Cranberry Marsh Pump.

H. W. Tabor

M. C. Steuber

J. A. Shad

The hydraulic laboratory has been at work on this type of pump for the State Cranberry Marsh Experimental Station, to determine the efficiency of the performance of different pumps used for such service. The work being carried on at the present time is for the purpose of determining the effect of changes in the pump propeller and casing upon the efficiency of the pump.

Pitot Tube.

Ira Lamphire, graduate student.

C. J. Johnson, graduate student.

Mr. Weidner, of the hydraulic department, has for some time been conducting a series of experiments on the Pitot Tube. The present work is a study of the change in value of the coefficient to be applied to different types of Pitot Tubes now on the market, with respect to different rates of flow in pipes.

Trump Medium Head Turbine.

T. E. Bennett.
F. P. G. Mueller
W. A. Olson.

The object of this thesis is the determination of the characteristics of the above turbine under heads up to fifty feet. The completion of the concrete reservcir on the hill back of the laboratory has made possible for the first time such a range of heads.

Sewage Disposal.

John Broyles is making an extensive study of processes of sewage purification. R. W. Gamble is working on design problems met in the sewerage and sewage purification work being done at Juneau, Wisconsin. J. P. Woodson is designing an experimental disposal plant for the University creamery, for the purpose of determining the effectiveness of the activated sludge process on sewage of this nature. The activated sludge process of sewage treatment has been developed in the last year and a half, and is attracting wide attention. It is largely due to the experimental work at Milwaukee that the process has been perfected so rapidly to its present state.

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