concrete could disappear so completely. I have seen a caisson with two 3-foot shafts about 6 feet center to center, where the concrete was dumped down one shaft in an absolutely "sloppy" condition, and yet when we suspended work to examine the concrete, we found that the concrete was filling the shaft it was dumped in without filling the space under the deck to the adjoining shaft. I have seen concrete dumped into a shaft so wet that one would expect to see a couple of feet of water on top of the concrete, and yet when the work was stopped the concrete looked almost dry.

If mortar is to be made watertight the proportion should never be poorer than one volume of cement to two volumes sand, to insure filling all the voids in the sand. For the same reason the proportion of cement and sand should be the same for concrete where as much stone can be used as can be covered, depending on the smallness of the stone or gravel and the wetness of the mass; much more stone can be used if the stones are small and the mass wet. I have made

caissons watertight against a head of 80 feet of water by concreting to about 6 inches above the cutting edge and then placing a layer of mortar about 2 inches thick and covering this at once with good wet concrete, 1—2—4. And yet many say that it is impossible to make concrete hold water—which, however, is certainly true as far as "dry" concrete is concerned, that is, concrete that requires ramming to bring the moisture to the surface.

The concrete in the cofferdam above the deck should also be put in very wet, and though it is very customary to use a 1—3—5 concrete for this purpose, I would much prefer a 1—2—4 mixture, though the amount of stone could be increased as stated above if judgment is used.

Great care should always be exercised when pumping is necessary to avoid pumping the cement out of the concrete and thus ruining the mass. I have heard a contractor brag of using eight big pumps, with 6-inch, 8-inch, and 10-inch discharge pipes, on an open coffer-

dam 30 x 50 feet, while concreting. Small wonder he had not much confidence in concrete after such abuse.

The amount of concrete placed on the deck of the caisson while sinking often depends on the amount of weight required for the penetration. On shore, for instance, the friction on the sides starts at the surface and the concrete on the deck has to be kept above the surface of the ground until all the concrete is in that will be required for the finished structure, when pig iron or other temporary weight has to be added. But in river work, where the water is often from 20 to 60 feet deep to start with, the caisson would be too heavy if the concrete were kept up to the surface of the water; in fact, sometimes the level of the concrete in the cofferdam of the caisson is as much as 30 feet lower than the surface of the water, which requires very heavy cofferdam bracing and makes any leak in the cofferdam or deck of the caisson very troublesome and dangerous on account of the great head.

(To be continued.)

THE FLAMING ARC LAMP.

ITS PRESENT STATUS.

BY ALFRED A. WOHLAUER.

The flaming arc lamp has gained supremacy for certain uses in Germany over all other types of arc lamps, and promises soon to become a great factor in this country, particularly when the manufacture of its special electrodes is seriously taken up by American manufacturers. At first the new type was handi-

FIG. 1.—PRINCIPLE OF BREMER FLAMING ARC LAMP.

capped in competition with the inclosed arc on account of the shorter life of the electrodes, and also with respect to interior lighting, by the fumes given off. Nevertheless of late it has become recognized that the flaming arc lamp is without rival for many uses, especially for advertising purposes and numerous other cases of outdoor lighting, owing to its very high efficiency and its superior light qualities, the "cheerfully brilliant" yellow tint being more agreeable to the eye than the violet hue of the inclosed arc lamp.

The first commercial yellow arc lamp was placed on the market by H. Bremer in 1899. As in the case of all important inventions, the flaming arc lamp, however, had predecessors and a more or less gradual development. As early as 1844 Casselman suggested the mixture of salts of strontium, copper, zinc, etc., with the carbon of electrodes; his work was continued by others and considerable investigations along similar lines were carried on, especially by Carré and Archereau in France.

PRINCIPLES OF THE FLAMING ARC LAMP.

Fig. 1 shows the principle of Bremer's first success-

FIG. 2.—INFLUENCE OF PERCENTAGE OF FLUORSPAR UPON YIELD OF LIGHT.

ful lamp and represents at the same time the typical arrangement of the flaming arc lamp, the special feature of which is the use of a special flaming carbon in an inclined position. There are, it is true, other arc lamps in which flaming carbons are employed in

*Electrical World.

a vertically superposed position, often called luminous arc lamps; to this class belong the magnetic lamp, titanium carbide lamp, Blondel lamp, and others, which will not be discussed here. It is also beyond the scope of this article to treat of lamps, such as the Carbone and its derivatives, having also inclined carbons, but not impregnated with metallic salts.

Flaming arc electrodes consist of carbons to which mineral substances are added, mostly fluorides of alkaline earths, which permit the arc or vapor path to be drawn out to great length and at the same time rendered luminous, whereby the light intensity is considerably increased. While the common and especially the inclosed arc owes 95 per cent of its light to the incandescent crater of the upper carbon, 25 to 35 per cent of the light emitted by the flaming arc is due to the luminous vapor path.

The inclined position of the carbon suggested itself to Bremer owing to the formation of a kind of a slag due to mineral admixtures which, being non-conductive, render the arc unsteady or even extinguish it, or interfere with starting. Although by the addition of water-glass, boracic acid, etc., Bremer reduced the bad effects of the slag, the most efficient means to overcome the trouble consists in placing the carbons in an inclined convergent position, so that no slag can form in the vapor path. Moreover, this arrangement offers another advantage in that nothing remains to obstruct the light of the arc, thereby resulting in an additional increase of light.

Two more elements were added by Bremer to his well-known combination of a flaming arc lamp, namely, the "economizer" and the "blow-magnet." The "economizer," indicated in Fig. 1, consists in its original form of a truncated metallic cone, framing and supporting a porcelain disk through which the carbons are inserted. Closely surrounding the flaming arc, it augments its efficiency by concentration of the heat, and increases the life of the carbons by limiting the air supply. Moreover, being covered with white deposit from the arc flame, it acts as an excellent reflector, throwing practically all the light of the arc into the lower hemisphere.

In order to prevent the arc from climbing up and from destroying the "economizer," especially when the carbons are almost burned out, a blow-magnet is provided by means of which the arc is blown away from the "economizer" or even extinguished if necessary. The blow-magnet can furthermore be used to spread out the arc into the shape of a reversed umbrella and thereby increase its area. As a consequence, it is possible to increase the diameter of the carbons and thus lengthen the intervals between trimming. The electric arc, however, is itself the seat of a magnetic field which tends to drive the arc away from the tips, so that under some circumstances a blow-magnet is not required. In fact, for very high currents above 12 amperes it might be necessary to produce an opposite effect, the blow-magnet drawing back the arc toward the carbon tips instead of blowing it away from them.

FLAMING CARBONS.

Bremer's original flaming carbons were thoroughly mixed or impregnated with compounds of calcium, strontium, magnesium, etc., with the addition of boracic acid. According to Bremer, the efficiency of light production increases with the percentage of salts added to the carbons, and investigations carried on by Prof. W. Wedding proved this fact, but showed also that the light intensity does not increase rapidly with

increase of salt mixture above about 15 per cent. This is apparent from Fig. 2, which shows the light distribution with electrodes containing varying percentages of fluorspar; in Table I and in Fig. 3 the influence of the percentage of fluorspar upon the mean spherical candle-power, as well as upon the specific

FIG. 3.—INFLUENCE OF PERCENTAGE OF FLUORSPAR UPON ENERGY CONSUMPTION.

energy consumption, is numerically as well as graphically illustrated. It will be seen that the yield of light does not increase markedly above 20 per cent of admixture, and as the amount of slag increases with the quantity of the salts and the arc also becomes more unsteady, present-day flaming carbons do not contain more than 15 per cent admixture, and, moreover, the salts are only added to the core, the remainder of the electrode consisting of pure carbon. The formation of slag is perfectly nil for these carbons although the yield of light is smaller than it was for the original carbons containing a greater amount of salts.

The color of the flaming arc lamps is yellow when the electrodes are impregnated with calcium fluoride. By changing, however, the impregnating material, the color can be varied over a wide range. Three kinds of flaming carbons are now on the market—yellow, pearl white, and red. Calcium salts produce the yellow, strontium the red (which is, as a rule, rather a very light pink), and barium salts the white color. The most popular of course is the yellow carbon, all the more so for the reason that it gives the highest

FIG. 4.—INFLUENCE OF COLOR OF FLAME UPON YIELD OF LIGHT.

efficiency. The yield of light from the white flame carbon is only little more than from open arc with pure carbons, while the red carbon stands between. An approximate idea of the change of the efficiency with the color can be gained from Fig. 4 extracted from a recent paper by Mr. S. H. Blake.

In order to increase the steadiness of the rather long flaming arc, it is necessary to keep the diameter of the carbons at a comparatively low figure, whereby, of course, their life is reduced. The only direct means of increasing the life of the carbons is offered by an increase of their length (see Table II, first two columns). The resistance of the flaming carbons is therefore considerably higher than that of the old

away to cause a change of resistance sufficient to weaken the magnet operating the clutch, which then releases the carbons (Fig. 7). In another very recent mechanism of this order, the feed is limited by a friction brake acting upon a screw which otherwise would rotate under the influence of the weight of the downward feeding carbons. The hot-air lamp employs the expansion and con-

the case of street lighting where the lamps are placed at considerable distances apart, and it would be much better if the light just beneath the lamp would have minimum intensity, increasing with the angle from the vertical. The fact that the illumination below the lamp is maximum is not only due to the light emitted from the luminous vapor path, but to a much greater extent to the light from the incandescent carbon tips.

FIG. 5—CLOCK MECHANISM.

FIG. 6—BECK LAMP.

FIG. 7.—CLUTCH MECHANISM.

FIG. 8.—MOTOR LAMP.

SOME TYPES OF FLAMING ARC LAMPS.

carbons, for this reason and because the impregnating salts are rather poor conductors for the electric current, especially in a cold state. To remedy this, some electrodes contain a metallic vein or an electrolytic deposit of copper along the surface.

MECHANICAL FEATURES.

The question of mechanical construction is one of great importance to the flaming arc lamp, and while almost all flaming arc lamps are similar in the features illustrated in Fig. 1, the mechanical construction, especially of the regulating and feeding mechanism, differs considerably. At the present time we can distinguish five main types, all of which have found their field and have their merits and demerits. These may be classified as follows:

1. Clock mechanism.
2. Gravity feed mechanism.
3. Clutch mechanism.
4. Hot wire mechanism.
5. Motor mechanism.

The clock mechanism is identical with the clock mechanism of the old type of arc lamps. It consists of a frame (e, Figs. 5 and 9) which is actuated by a differential system consisting of a series (h) and a shunt (n) electromagnet. Under the influence of the shunt magnet, the frame releases a detent (f), which causes the carbons to feed down. When the carbons come in contact, a current flowing through the series coil lifts them up again, thereby striking the arc, which by the combined action of the series and shunt magnet is kept at its proper length.

An interesting type of gravity feed flaming arc lamp was devised by Beck which by its simplicity admits of a very reliable construction. It does not employ any electrical or mechanical mechanism for feeding and regulation since the carbons slide down into proper position by their own weight. They are prevented from sliding too far by a kind of a rib (b, Fig. 11) which protrudes from one of the carbons and rests on a little support attached to the "econo-

traction of a wire for the regulation of the arc. The hot wire is balanced against a spring which, in the case of expansion of the wire, contracts, or *vice versa*, and transfers its motion to the carbons, for regulating purposes (Fig. 10). The action is rather slow, but seems to give satisfactory results. The lamp can be operated on direct current as well as on alternating current, the arc being as a rule in series with the hot wire.

The motor lamp for alternating current contains, as illustrated in Fig. 9, a metallic disk which is influ-

It is erroneous to assume that all the light of the flaming arc lamps emanates from the luminous vapor, for, as has been demonstrated by Prof. Wedding, only about one-fourth of the light of the arc is emitted by the arc flame, while three-quarters is produced by the incandescent carbons. The effect of a maximum light intensity just below the lamp is somewhat modified by the ash receiver, which is just under the lamp and obstructs the light emitted in that direction.

Curve I of Fig. 14 is a typical candle-power curve of the flaming arc lamp, while curve II shows the

FIGS. 12 AND 13.—SHOWING ASYMMETRY OF FLAMING ARC.

enced by a differential magnet system, which produces a torque on the disk in either one or the other direction, or keeps at a standstill just as the series or the shunt coil preponderates or both are balanced against each other.

ILLUMINATING FEATURES.

It has been mentioned above that the flaming arc lamp is superior to all other arc lamps as to light efficiency. The specific energy consumption per mean spherical candle-power averages about 0.5 watt per candle-power, which is from four to six times better

FIG. 14.—TYPICAL CANDLE-POWER POLAR CURVE OF FLAMING ARC LAMP.

light distribution with globe and ash receiver. These curves are taken in a vertical plane through the axis of the two carbons. It must be borne in mind that the flaming arc is not a symmetrical source of light, for, owing to the arrangement of the carbons side by side, the extension of the arc is greater in a plane through the two centers of the carbons than in a plane at right angles thereto. This can be seen from Figs. 12 and 13, which show the approximate shape of an arc and illustrate its unsymmetry. The unsymmetrical appearance of the arc is, however, modified and equalized in practice by the globe which surrounds the arc.

ECONOMY.

It has been pointed out above that the yield of light of the flaming arc lamp increases with the percentage of salts added to the carbons. As indicated in Table I, the specific energy consumption per mean spherical candle-power is 0.34 for a percentage of 40 per cent of fluorspar, but, on account of the large amount of slag formed, such a high percentage of admixture does not seem practical and economical.

TABLE I.

Influence of Admixtures of Metallic Salts to Flaming Carbons upon Light Intensity.

Percentage of fluorspar, Per cent.	Mean spherical candle-power, L_s	Specific energy consumption, S_s
0	490	1.0
8	710	.7
15	1,050	.475
20	1,160	.43
25	1,350	.37
30	1,380	.36
35	1,400	.35
40	1,480	.34

This table is based upon results of experiments made

FIGS. 9 AND 10.—LAMP MECHANISMS.

HOT WIRE MECHANISM

FIG. 11.—SHOWING RIB OF BECK FLAMING CARBON.

mizer." Fig. 6 shows the mechanical connection between the two carbons and a small electromagnet which operates the carbon not supported in order to strike the arc.

The clutch mechanism also employs the gravity feed. The carbons are prevented from sliding too far by a clutch which grasps the carbon holder at the proper time, holding it until enough of the carbon is burned

than the efficiency of the inclosed arc lamp and almost three times better than that of the tungsten lamp.

While arc lamps with vertically superposed carbons produce the maximum light intensity at an angle of 45 deg. below the horizontal, lamps with inclined carbons give their maximum light intensity exactly below the center of the lamp. This is not very fortunate in

by Prof. W. Wedding. The values of the mean spherical candle-power are given in English candles and refer to lamps with an opal globe. The specific energy consumption is calculated for a total energy consumption of 550 watts across the terminals of the lamps and not merely across the arc.

Another factor to be considered in connection with the economy of the flaming arc lamp is the size, diameter, and length of the carbons. The diameter of the carbons depends on the construction and type of lamp and is influenced by the blow-magnet and "economizer" and other arrangements. Nevertheless, the diameter has to be kept within certain limits, in order to prevent the arc from climbing. It is therefore the length

TABLE II.

Influence of Carbon Dimensions upon Economy of the Flaming Arc Lamps.

Ten-ampere, 55-volt, 550-watt lamp. Mean spherical candle-power, 1,120 candles. Consumption, 0.5 watt per mean spherical candle-power. Diameter of carbon 5/16 to 3/8 inch. P = price for carbons and trimming per trim. C = renewal cost per kilo-candle power.

Length.	l	P.	C.	Rates per kw.-hour.					
				2.	4.	6.	8.	10.	
12	7	16c.	2.05	3.05	4.05	6.05	7.08	8.05	
15 1/4	10	18c.	1.6	2.6	3.6	4.6	5.6	7.6	
20	14	21c.	1.35	2.35	3.35	4.35	5.35	6.35	
23 1/2	17	23c.	1.2	2.2	3.2	4.2	5.2	6.2	

of the carbons which mostly influences their life and therefore the economy of the arc. An increase of the length of the carbons increases their life and therefore

TABLE III.

Economy of Flaming Arc Lamp for Various Currents.

A. V.	Watts.	Ls.	Ss.	P.	l.	Rates per kw.-hour.				
						2.	4.	6.	8.	10.
6	55	330	.68	13.5	10	2.8	4.2	5.6	7.0	8.4
8	55	440	.800	.55	15	10	1.9	3.0	4.1	5.2
10	55	550	1,100	.5	18	10	1.6	2.6	3.6	4.6
12	55	660	1,300	.5	19	10	1.5	2.5	3.5	4.5
15	55	825	1,700	.49	22	10	1.3	2.3	3.3	4.3
20	55	1,100	2,250	.48	25	10	1.1	2.0	2.9	3.9

reduces the expense from trimming. Table II shows to what an extent the cost of the kilo-candle hour of the flaming arc lamp is influenced by the length of the carbons for different rates for power. The table is self-explanatory, indicating that for very low power rates it is advisable to use carbons of the greatest possible length.

The size of the flaming arc lamp has also some influence on the economy. In most cases it is better economy to employ a large unit instead of using a number of smaller ones, not only on account of the higher initial cost, but also in view of decreased operating expense. This is evident from Table III, which requires no further explanation.

CONCLUSION.

The economical and practical advantages of the flaming arc lamp can be summed up as follows:

The disadvantages are frequent trimming, high price of carbon, fumes, deposits inside the lamp, and unfavorable light distribution for street lighting. All these disadvantages, however, appear to be compensated for by the extremely high efficiency, which insures a much better economy than can be obtained with any other illuminant on the market.

In the tables given, the abbreviations or symbols designate the following:

A = amperes.

V = volts.

W = watts.

Ls = mean spherical candle-power.

Ss = specific energy consumption per mean spherical candle-power.

P = price for renewal carbons.

l = life of carbons.

Cr = renewal and maintenance cost.

THE TANTALUM DETECTOR FOR WIRELESS SIGNALING.

DURING the past year or two innumerable detectors for electric waves, acting on the imperfect-contact principle, have been devised. Many of these have not been self-decohering, but occasionally a combination of metals or of a metal and some other conducting body is found which is self-restoring. Usually detectors of the latter type employ a compound of metal, such as a carbide. The arrangements using metal on metal generally call for a mechanical arrangement for restoring the high resistance of the receptive condition. An interesting detector of this type was invented a year or so ago, and used in the Lodge-Muirhead system. This device was formed by rotating a small metallic wheel, the lower surface of which just grazed a surface of mercury covered with a thin film of oil. The rotation of the wheel served to restore the high resistance of the device, which apparently was due to a very thin film of oil adhering to the surface of the disk. This film appears to be so thin that it is punctured by the potentials produced when an electric wave is received by the antenna.

A wave detector has recently made its appearance

which employs mercury as one of the contacts and a tantalum wire as the other. The wire is exceedingly fine, being only about 0.05 millimeter in diameter; in fact, it is nothing more than a short piece of filament taken from one of the ordinary tantalum lamps. Tantalum is not wetted by mercury, and when this fine wire is just in contact with a mercury surface the contact resistance is from 1,000 to 2,000 ohms. This resistance is not high compared with the receptive resistance of certain other receivers, but when an oscillation is received the resistance drops to about one-eighth of its original value. This ratio can even be increased if desired and the great change gives rise to very loud signals. The inventor of the detector, Mr. L. H. Walter, says that in this respect his detector is superior to most others, although it is not so sensitive as some other types for very weak oscillations. This characteristic he thinks makes the detector particularly suitable for wireless telegraphy, since the oscillation currents used in that system of communication must necessarily be relatively powerful.

Finding the combination of tantalum and mercury so excellent, Mr. Walter tried various other combinations of metals, both with mercury and with other metals; none of them, however, compared with the tantalum-mercury couple. He did find one combination of solid metals, namely, tantalum and oxidized iron, which gave fairly satisfactory results. Such an arrangement would be well adapted for use on ship-board, where the vibration of the mercury surface of the other detectors would render them useless. However, the inventor has devised an arrangement of his mercury-tantalum detector in which the tantalum wire is in contact with a small globule of mercury entirely inclosed, and which therefore does not vibrate.

It is an interesting question as to what gives rise to this high resistance of contact. One would at first attribute it to a thin film of oxide, similar though not so strong dielectrically as the coating of oxide which forms on the aluminium plates used in electrolytic rectifiers or condensers. Such a film might be easily formed if the tantalum and mercury were momentarily separated, but when the surface of contact is entirely below the upper surface of mercury, one would hardly expect such a coating of oxide to repair itself after puncture. Another explanation might be that a thin film of air adhered to the mercury. This would prevent the latter from wetting the tantalum, but the same difficulty of explaining the self-restoring effect is met. If this thin film of air behaved as a liquid, it might be said that its surface tension repaired the break; possibly there is some such effect.—*Electrical Review* (New York).

THE POWER MEASUREMENT OF ENGINES.

At the summer meeting of the American Society of Mechanical Engineers there was read a paper by Prof. L. S. Marks which expounded a new view of the power of steam and other vapor engines. It is proposed to call the new measurement of power the "total power." Prof. Marks suggests that the difference between it and the indicated power, as ordinarily reckoned, is not of great practical importance in modern steam engines, but is generally large in gas and oil engines. If the fairly accurate measurement of "total power" be practicable, we venture to say that the distinction is of practical commercial consequence in all classes of engine, while from the scientific point of view it is quite essential. The difference between total and indicated power has, however, never been overlooked in any really scientific exposition of engine action, although it may not be found insisted on in popular treatises such as satisfy most college examiners and the students who grind only for examination passes.

It is a quite commonly known fact that the top admission line of an indicator card falls well below the boiler pressure, and it is a not uncommon practice to rule in a line showing the boiler pressure and the loss between it and the pressure of admission into the cylinder. A similar difference in height between the exhaust line on the indicator card and the real exhaust pressure in the condenser or the atmosphere is well recognized. The two areas thus lost at the top and bottom of the card measure power actually exerted by the "working substance," but possibly wasted in overcoming injurious mechanical resistances. These resistances are of various kinds, and it is unnecessary to detail them here. The main point is that essentially they ought to be classified along with those other resistances, such as piston and stuffing-box, and crosshead and bearing friction, which result in a difference between indicated and brake horse-power. All these are equally, no more and no less, injurious and waste expenditures of the mechanical power actually developed by the working substance. This actual or "total" power developed is the brake power plus all these wastes; it is the indicated power plus such of these wastes as occur before the working substance acts upon the piston. So far as concerns the thermodynamic efficiency of the power-

developing process to which this substance is subjected, Prof. L. S. Marks points out that the only just comparison must be made with this "total," and not, as is usual, with the indicated power. The real thermodynamic efficiency of the working fluid is therefore higher than it is usually stated to be.

The items of waste work, which are mainly due to friction and irrecoverable acceleration of momentum, require to be very carefully distinguished from those done upon the working substance in such a manner as to increase its recoverable energy. Such work is done by every kind of feed pump, the water feed to the steam boiler, the feed of air and gas on the charging strokes of the gas engine, the feed of oil and air to every form of oil engine, alike when this work is done in a separate pump barrel and when it is done in the main working cylinder.

In the steam engine this feed work is of so small amount as to be of little practical consequence, the power spent on the feed pumps being mostly wasted on frictional pump resistance. But in gas and oil engines it forms a large fraction of the total action involved, and Prof. Marks points out that the usual process of subtracting the area of the "negative loop" from that of the "positive loop" of the gas engine indicator diagram involves a somewhat serious misinterpretation of the meaning of the diagram, which results in crediting the engine with less than its just thermodynamic efficiency. These negative feed-pump areas in the complete indicated power are quite properly subtracted in order to arrive at the "total power" giving the real thermodynamic efficiency; whereas the waste frictional and inertia areas—which do not appear on the indicator card—are, on the contrary, to be added.

While it is easy fully to grant the justice of the argument for this new measure of total power and new reckoning of thermodynamic efficiency, it may be pointed out that it will be seldom easy to apply the new measure correctly. Take, for instance, the drop between boiler pressure and the cylinder admission line. The whole of this is not due to mechanical waste arising from frictional and inertia resistance to the steam flow; part of it is due to the cooling effects of the transmission pipes, the valve chest, the steam ports, and the cylinder walls. It is true that these cooling effects appear more in the form of contraction of volume than in drop of pressure; but the area of the indicator is the product equally of volume and of pressure. Especially along the expansion curve is it extremely difficult to differentiate accurately between waste drop of pressure and waste loss of volume. To do so would require more exact means of measuring weight of feed water and degree of wetness of generated steam than we can at present use in non-laboratory boiler tests. Again, during exhaust, the indicator card pressure is raised and volume increased by conductive receipt of heat from cylinder walls.

These two opposite kinds of heat waste clearly ought to be debited against the thermodynamic efficiency. They are of very much greater amount, and are much more difficult to measure, or even to estimate, in gas and oil engines than in steam engines. The practical importance of separately measuring the thermodynamic and the purely mechanical efficiencies of power engines cannot be doubted. The object of ascertaining efficiency is to guide and promote efforts to reduce inefficiency; and the methods to be pursued in lessening thermodynamic and in lessening mechanical waste losses are as different as any two sets of processes could be. It is to be hoped that the subject may be further pursued, and that means of more thorough analysis of the wastes in all kinds of engine may be discovered in easily applicable forms. It is quite necessary to remember that some of the waste that occurs before the indicator card is taken, that is, before the working substance reaches the piston and works upon the piston, is mechanical waste; it is equally necessary to remember that some of the waste occurring after the taking of the indicator card is heat waste.—*The Engineer*.

The following figures show the mileage of steam and electric railroads in operation in California, together with the mileage completed in 1907, and the steam and electric lines projected: Steam railroads in California, 6,700; electric lines in California, 1,500; steam railroads completed in 1907, 490; projected, 1,400; electric lines projected, 700. The Tonopah and Tidewater line, starting from Ludlow, on the Santa Fé line, and running northward past Death Valley and into Nevada's mining camps, stands first in construction, with 138 miles of line added in 1907. The Western Pacific Railroad is second with 119 miles, in three sections, along its route from San Francisco to Beckwith Pass on the Nevada border. The company now has no difficulty in securing men. When this line is finished it will add another transcontinental line from the Atlantic to the Pacific. The Southern Pacific Company has added 107 miles to its system in various parts of the State.