

ELECTRICAL SECTION.

Stated Meeting, September 22, 1896.

MR. CLAYTON W. PIKE, President, in the chair.

A NEW SYSTEM OF SERIES ARC LIGHTING.

BY THOMAS SPENCER.

Any one who has watched the development of arc lighting within recent years cannot have failed to notice the gradual, but radical, changes that have taken place in the methods of delivering light from a central station. Originally the idea seems to have been to break up the source of current supply into a great number of small units. Whether, from an engineering standpoint, this idea was a well-worked-out scheme, or simply the outgrowth of circumstances, is, I think, very easy to answer; for it is usual to begin on as small a scale as possible, so that, in case of failure, the financial loss will be as small as possible. These first attempts proving successful, the conservative feeling, which to a great extent accompanies the investment of money, caused a continuance in the course which had been found practical.

Perhaps in no branch of the electrical industry is this so apparent as in that of arc lighting. However, at present there seems to be a general tendency towards a more economical system, as is attested by the number of large arc light dynamos that are now replacing the numerous small machines; further, by the rapid rise of arc lighting from constant potential D. C. circuits, and also by the general interest manifested in alternating arc lighting. The last named, which, of course, signifies the use of constant potential, is the direction towards which everything seems to be tending, and will be the system most generally employed in the future, unless some efficient method of directly converting heat into electricity is discovered.

There is no question but that a station equipped with large units and supplying one kind of current—and that a

current which can most easily be controlled—is the most efficient. Such is the alternating current. As far as the alternating arc lamp is concerned, it has some points which make it slightly inferior to the direct-current lamp; but experience has shown that these objections are not so serious as at first appeared.

Recently, attempts have been made to use a device by means of which the current is commutated into a fluctuating current, having always one direction, but not with conspicuous success. There are several such plants in England, I believe, and, from some of the criticisms, I should judge that the system is by no means as efficient as it should be to be generally introduced, especially in this country, where, I am sorry to say, a piece of apparatus is apt to fall into the hands of men who fail to give it even the most necessary care. As for the advantages gained by the use of such a device, there is no doubt but that the efficiency of the arc is improved. From my experience I should judge that, as the current is a fluctuating one, the arc would still be noisy, although less so than the unrectified alternating current.

As I have said before, the objections to the alternating arc have not proved to be as serious as they at first appeared. There is a growing tendency towards the use of the alternating arc for all kinds of lighting, and this is especially marked in street lighting. The system which, up to the present time, has been in use may be described as follows: Each lamp is burned separately from a 30- or 33-volt transformer (see *Fig. 1*). The amount of wire used in this system is not generally greater, and often less, than that required in the old direct-current series system. This system works very well and has many good features, perhaps the greatest of which are that each lamp is independent of the rest, and that the pressure on the lamp is low. Furthermore, the lamp has only one series spool of coarse wire, and is free from shunt spools and cut-outs.

There are a great many systems of this sort operating in this country, and some, I believe, have been introduced in England. The only objection to this plan is its high

first cost, occasioned by the necessity of a separate transformer with each lamp. To overcome this objection and at the same time be in position to use the same kind of lamp, Mr. William Smith Horry has devised what he calls his "Reactive System" of arc lighting, which I wish to bring before you this evening. Mr. Horry couples his lamps in series directly in the primary circuit, doing away with the separate transformers. Now, any one who has attempted to run arc lamps in series, which regulate only by variations in current (that is, have only a series spool), knows very well that they will not operate. The reason for this is readily apparent. An arc lamp should depend for its regulation on

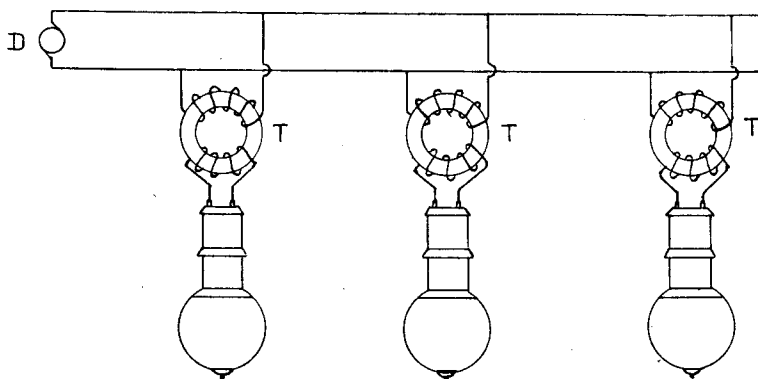


Fig.1.

something practically affected only by the burning of its own arc. This is evidently not the case with the current where lamps are put in series across a constant potential circuit. In general, when lamps are run in series, we must regulate by the change of E.M.F. around the arc; that is, regulate with a shunt spool. A lamp, of course, similar to the regular series arc lamp, might be used if it were provided with some device to keep the current constant, or a lamp similar to that used on street railway circuits could be devised, but in all of these cases we would have a much more complicated lamp than that used by Mr. Horry.

The principle governing Mr. Horry's system is briefly this:

In shunt with each lamp is placed a small coil of the type known as auto-transformer (*Fig. 2*). The coil *A* is in series with the lamp, and *B* in shunt. With this device the current in the lamp will always be greater than that in the line. Considering the current in the line as constant, which is practically the case where a large number of lamps are in series, we must, as shown above, by some means outside of the lamp itself, cause a change in the current passing through the series spool of the lamp, in order to enable the lamp to feed. This is accomplished by making the amount of iron in the coil small, so that it will soon become saturated and cause the coil to leak, lowering the pressure,

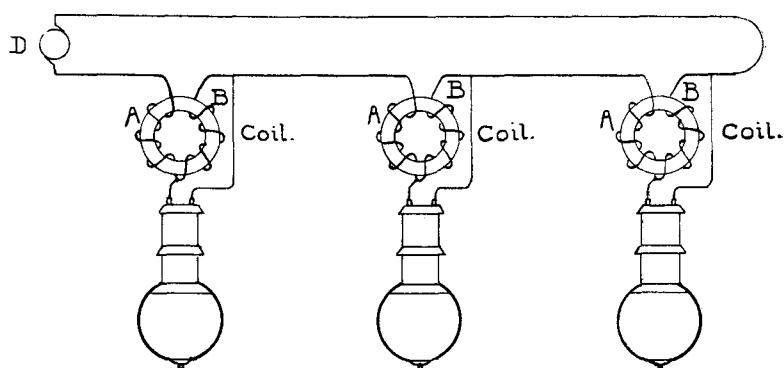


Fig. 2.

which in turn decreases the current and feeds the lamp. This can be more easily understood in the following way: The relation

$$N_1^2 I_1^2 = N_2^2 I_2^2 + \left(\frac{l B}{4 \pi \mu a} \right)^2$$

in a transformer, where there is no leakage between the primary and secondary, is well known. (Fleming, *Alternating Current Transformer*, Vol. 1, p. 273.) Here N_1 and I_1 are respectively the number of primary turns and the maximum current, and N_2 and I_2 represent the same for the secondary, B the maximum induction, μ the equivalent permeability, l the length of the magnetic circuit, and a its section.

Now the secondary E.M.F. is directly proportional to B , or $B = Ky$, where y is the secondary E.M.F. and K a constant. If in the first equation we write x for I_2 and substitute the value of B we have

$$N_1^2 I_1^2 = N_2^2 x^2 + \left(\frac{l K y}{4 \pi \mu a} \right)^2$$

$$\therefore I = \frac{x^2}{\left(\frac{N_1 I_1}{N_2} \right)^2} + \frac{y^2}{\left[\frac{4 \pi N_1 I_1}{K} \frac{l}{\mu a} \right]^2}$$

Now, if we suppose I_1 constant, and write

$$a = \frac{N_1 I_1}{N_2}$$

and

$$b = \frac{4 \pi N_1 I_1}{K}$$

a and b being constants, we have

$$I = \frac{x^2}{a^2} + \frac{y^2}{\left[\frac{b}{\mu a} \right]^2}$$

This is easily recognized as the equation of an ellipse. Plotting this (*Fig. 3*), it is plain that, when the current is small, the E.M.F. varies very little with an increase of current; that is, it behaves in this region as a constant potential circuit. Referring again to our last equation, we see that when

$$\frac{l}{\mu s}$$

becomes greater, that is, when the equivalent magnetic resistance becomes greater, the minor axis of the ellipse becomes smaller. This is accomplished, as before stated, by diminishing the amount of iron in the core of the coil, and, as a result, we will have a coil whose characteristic is an ellipse,

as represented by the dotted lines. In this case the maximum E.M.F. will not be so large; but, as the ellipse is nearly flat, there is a large region over which the coil produces practically constant potential.

There are a few other features in this system worthy of mention. The coil is so proportioned that when the carbons are consumed, and the arc in consequence breaks, the whole current is forced through that portion in shunt with the lamp. The choking effect in the coil is about the same as the E.M.F. taken by the lamp when burning; in fact, it is so close to this that 30 per cent. of all the lamps in circuit may

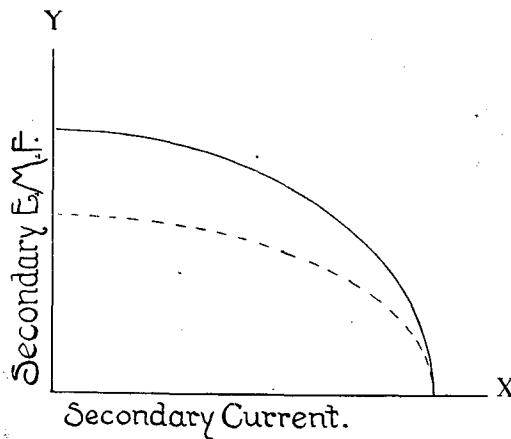


Fig. 3.

be put out without sensibly affecting the ampèremeter in the circuit. The coil then not only acts as a cut out, but also as a regulator.

The advantage which this system shares with that in which lamps are run from separate transformers, is that it is possible to run lamps of widely different candle-power on the same circuit, which is accomplished by changing the coil to conform with the lamp. In this particular, of course, it is an improvement over the ordinary series system, with shunt coil regulation. The number of lamps which it is possible to run in series from a 1,000-volt circuit or trans-

former depends upon the candle-power of the lamps. The coils, as now constructed, will, in this case, take care of twenty-nine 2,000 candle-power lamps. Mr. Horry has also devised a switch-board to be worked in connection with a special transformer in such a way as to give varying primary E.M.F.'s, so that any number of lamps can be run in series within reasonable limits.

As for the practical working of this system, I would say that it is in use in several places in this country. As far as I know, it has been very satisfactory, and there is little doubt that a great future awaits it.

CHEMICAL SECTION.

Stated Meeting, held September 15, 1896.

DR. H. F. KELLER, President, in the Chair.

ON A NEW PROCESS FOR THE MANUFACTURE OF WHITE LEAD.

BY MR. WM. TATHAM,
Member of the Institute.

The process I am about to describe is the joint invention of Wm. P. Tatham, of this city, and myself. Before going into details, I should like to give a very brief *résumé* of what has been done heretofore.

The oldest method of making white lead, commonly termed the Dutch process, is based upon the fact that, if metallic lead be exposed to a heated atmosphere of water vapor, carbonic acid, acetic acid vapor and oxygen, it is converted into a basic lead carbonate. These conditions are obtained, as is well known, by placing pieces of lead, of convenient size, in earthen pots containing a small quantity of acetic acid, and packing these pots in a bed of spent tan or horse manure. The fermentation of the tan, or manure, generates carbonic acid and water vapor, while the heat liberated by the process of fermentation causes the acetic acid to vaporize, and the lead is thereby corroded.