A. C. vs. D. C. ARC SYSTEMS.

A Paper read by W. L. McFarlane before the Canadian Electrical Association.

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Arc Lamps.

Having examined into the different arrangements of station apparatus, we now come to the lamps themselves, in the consideration of which we must pay due regard to the requirements or opinions of the customer or others depending on or using the light. Generally speaking, the systems available are the constant potential or multiple, used mainly for interior lighting, and the constant current or series, using both direct and alternating current, for street lighting. Multiple lamps are supplied for use on both alternating and direct current, but with few exceptions direct current for the operation of multiple lamps is not available in Canada; therefore, multiple A. C. lamps are all that need be considered here. These are of both the open and enclosed type, but the open lamp has not met with as much favor as the latter on account of the short life of the carbons, the poor quality of the light as compared with the D. C. lamp, its unreliability, and the noise made by the arc and lamp mechanism. The multiple enclosed lamp is much superior in this respect, the power factor also being better.

Multiple lamps are used mainly to supply customers' premises where the high voltage series arc system is objectionable, or the flat-rate charged for it does not meet with approval, as the multiple lamp can be charged for by meter, and supplied from the low potential lighting system. These lamps, being under control of the customer, permits of his using them at any time of the day or night. This is of great advantage during dull weather, or when the lamps are used in dark buildings or in basements. Then, in the case of long days or early closing, the customer is not compelled to pay for light which he does not need, as is the case when the series lamp is in use, and customers located beyond the reach of the series of commercial circuits are now as well supplied with light as those located nearer the station. The preference shown for the constant potential lamp for interior lighting is illustrated in the case of a plant which I have in mind, in which the commercial series constant current arc lamps connected are at present almost nil, where a few years ago they numbered almost 400; this in spite of the fact that the output of the plant in all other respects has increased enormously.

Constant current series lamps, either direct or alternating, give the best commercial satisfaction when they are of the differential rather than the shunt type. The direct current lamps are either open or enclosed. Open lamps cost about 15 per cent. less than the enclosed, and, owing to the E. M. F. of the former being about 50 volts as compared to 72 volts in the latter, there is a corresponding saving in the cost of the circuit insulation, etc. The enclosed direct current lamp is much more reliable than the open lamp, the maintenance of the lamps and the outages being reduced about 50 per cent. The most noticeable saving when enclosed lamps are used is in the operation, the cost of carbons and trimming being reduced nearly two-thirds. For mechanical reasons we cannot expect a saving in line copper to correspond with the difference in current required by the two styles of lamps, as No. 6 wire will probably be required in any case; there will, however, be a slight saving in the copper losses.

The enclosed A. C. series lamp, as far as reliability of service is concerned, compares favorably with the enclosed D. C. lamp; the cost of the lamp and the maintenance is slightly more, however, as there seems to be a greater tendency for the insulation of the A. C. lamp to become punctured. This I attribute to surging, resonance, or other high voltage conditions which occur on the circuit at times of grounds, short or open circuits, and believe that this trouble is reduced to a minimum by the use of suitable spark gaps connected across each lamp, as well as occasionally across the line. With the use of high voltage circuits comes the necessity of installing an absolute cut-out for each lamp as a protection against accidents to inspectors. Table No. 4 gives the approximate annual line costs of the three different types of series arc lamps. The costs, as stated above, are nearly equal for the two types of enclosed lamps, but the open lamp costs are nearly double that of the enclosed lamps.

Showing Comparative Approximate Annual Line Costs for Different Arc Lamps.

Account	Items of Cost / Sub-Account	Open D.C. Lamps	Enclosed D.C. Lamps	Enclosed A.C. Lamps
		$	$	$
Construction..	Reconstruction of Circuits	....	2550	2550
	Lamps	10000	11500	12500
	Total	10000	14050	15050
Maintenance..	Interest and Depreciation	1500	2107	2257
	Lamps	1000	500	750
Operation.....	Carbons	3285	700	800
	Trimming	3120	1040	1040
	Inspection	520	520	520
	Inner Globes	....	300	350
	Outer Globes	75	125	125
	Total	7000	2685	2835
Grand Total		9500	5292	5842

Illuminating Qualities.

The maximum candle power of the open arc is higher than that of the enclosed arc, but the light is not so steady owing to the more frequent feeding of the carbons, their poorer quality, and the action of the wind on the arc. Owing to the shortness of the open arc, and to the fact that most of the light comes from the crater of the upper carbon, this light is in a downward direction, being greatest at an angle of about 45 degrees, while a large area under the lamp is poorly lighted and affected by shadows. In the enclosed arc, the wandering of the arc is the main cause of what variation there is in the light, but by the use of an opal inner globe these variations are greatly reduced. The increased length of the enclosed arc allows the light to diffuse in a more horizontal direction, the result being much less light