penses, which can only be determined for individual cases. However, three men at least will be required for operating, and as the efficiency of this system will be about 54 per cent., the power required will be approximately 600 h.p. The conditions of operating necessary for an arc plant of this kind are too well known to require their being mentioned in detail here.

Table No. 1 is intended to show the comparative annual station costs when small arc dynamos are operated under the different conditions of motive power, namely: Water power with 60 or 25 cycle motors; steam power using an engine direct, or motors obtaining current from large A. C. units; and water power with steam reserve employing a combination of engines and motors. In the extreme right-hand column of this table the heading is "25 cycle motors driving shafting, the reserve steam power being obtained through frequency changers." No portion of the cost of these frequency changers has been charged to the arc installation, as doubtless frequency changers will have been installed for the incandescent service, and in the event of the 60 cycle steam reserve being required, these frequency changers will be available for use in connection with the motors driving the arc apparatus, changing the 60 cycle steam power to 25 cycles for the motors.

Large Dynamos of About 125 Lights Capacity.

We will here consider large arc dynamos of both the 9.6 and 6.6 ampere type, as they rank about the same as regards their convenience in the station, and should it be desired to change the current of the former, they can be rewound for approximately 25 per cent. of their original cost. Owing to their compactness and cleanliness, it may not be necessary to isolate these arc machines, whether engine or motor driven. About five dynamos will be required, which, if motor driven, can be connected direct, two to each motor, while, if engine, or engine and motor driven, it will probably be necessary to employ shafting, which, while occupying considerably more space, can likely be accommodated in the main station. If this arrangement is adopted, it is likely that the engineer on duty will be sufficient to attend to the engine, which might be driving the arc dynamos, and under most conditions it will not be necessary to employ additional dynamo attendants, although the men called upon to attend the arc dynamos will have to be more intelligent than would otherwise be necessary, and owing to the increased work an extra cleaner will have to be provided. Most modern plants operating twenty-four hours per day work their operators on eight-hour shifts, having them change shifts fortnightly, and as arc dynamos often have individual and variable peculiarities in their operation, this continual changing of operators often results in more or less deterioration in the service; this is reduced to a minimum, however, by employing a high class of operators. For the keeping of these dynamos in first-class condition, about half the time of a first-class attendant is required during the daytime; this work should always be done by the same man.

The type of arc dynamo which allows of the use of either the straight series or the multi-circuit arrangement of circuits is a decided advantage in allowing of the use of large dynamos without the necessity of increasing the P. M. F., and, to a great extent, the insulation of the circuits. It has been found, however, that the circuits have to be kept in much better repair when the multi-circuit arrangement is in use than is necessary when using small dynamos, because if any grounds or leakage occur between any of the circuits operated by means of the first-mentioned arrangement, it has a tendency to short-circuit sections of the armature, and act on the commutator, causing flashing to an extent which very materially affects the operation, making it necessary at times to separate the circuits.

Intermittent trouble of this nature is particularly annoying, and the linemen find it very hard to locate. In one place, where considerable trouble of this nature was experienced, the cause was found to be due, to a great extent, to the use of film cut-outs, having wooden mountings, enclosed in iron cases. In the place referred to the conditions are such that it is very hard to maintain the circuits in perfect condition, and, while the best of attendants are provided, and these dynamos have been in service for more than two

TABLE No. 2.

Showing Comparative Approximate Annual Station Costs, Using Large Arc Dynamos.

Items of Cost		Water Power 60 Cycles	Water Power 25 Cycles	Steam Power 60 Cycles		Water Power with Steam Reserve 60 Cycles		25 Cycles	
Accounts	Sub-Accounts	Direct Connected Sets	Direct Connected Sets	Direct Connected Sets	Engine and Shafting	Direct Connected Sets. Power A.C., G. Water or Steam	Engine and Motors Driving Shafting.	Engine and Motors Driving Shafting	Direct Connected Sets. Steam Power Through Frequency Changers
		$	$	$	$	$	$	$	$
Construction..	Engine	....	....	....	10000	....	10000	10000	....
	Motors Motor S.B. and Conn.	13500	13500	13500	....	13500	11000	11000	13500
	Shafting and Belting	....	....	....	2618	....	3893	3893	....
	Arc Dynamos Arc S.B. and Conn.	19200	19200	19200	19200	19200	19200	19200	19200
	Foundations	400	400	400	1400	400	1510	1510	400
	Total	33100	33100	33100	33218	33100	45603	45603	33100
Maintenance..	Interest and Depreciation	4965	4965	4965	4982	4965	6840	6840	4965
	Engine	....	....	....	200	....	50	50	....
	Motors Motor S.B. and Conn.	180	180	180	....	180	180	180	180
	Shafting and Belting	....	....	....	183	....	282	282	....
	Arc Dynamos Arc S.B. and Conn.	300	300	300	300	300	300	300	300
	Total	480	480	480	683	480	812	812	480
Operating.....	Wages	832	832	832	1317	832	832	832	832
	Supplies	176	176	176	276	176	176	176	176
	Total	1008	1008	1008	1593	1008	1008	1008	1008
Grand Total		6453	6453	6453	7258	6453	8660	8660	6453