will pass through the second machine working as a generator. As these machines are identical in all respects, either will act as motor or generator according as the necessity arises, and in this way maintain a balance in the voltage. On account of the voltage drop in the armatures of the balancer, the simple arrangement shown in Fig. 48 will not maintain a perfect balance. To effect this compounding must be resorted to. Various other arrangements are used for balancing, but the system above described is perhaps the most satisfactory, although a little more expensive than some others.

Generators for suppying current to three-wire systems are usually compounded to give 220-230 terminal volts at no load and 240-250 at full load. Any number of such generators may be operated in parallel.

In the systems above described, commonly known as "constant potential" systems, the lamps and other consuming devices are all connected in parallel. Any one lamp can thus be turned off without affecting others on the same circuit. When, however, a large number of lamps or other devices, each of which requires the same amount of current, and all of which may be turned on and off together, it is more convenient and economical to connect them in series. Street lamps, for example, are all the same size, and require to be turned on and off at the same time. In this case the transmission wire is

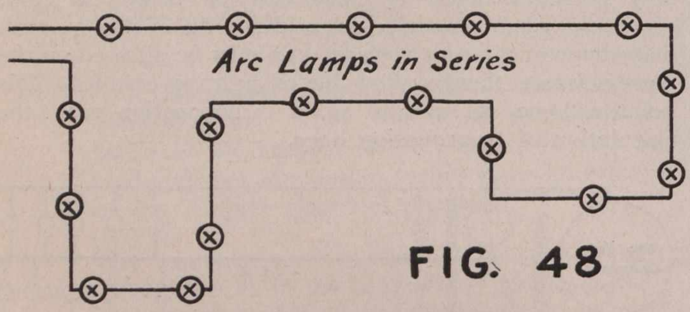

FIG. 48

required to carry a current equal only to that required by a single lamp, and, since the lamps are in series, the out-going wire may pass along one street and the return wire may be placed on another street. A considerable saving of copper is thus effected. The voltage which must be impressed on the terminals of such a system must obviously be equal to the voltage required by one lamp multiplied by the number of lamps. If one or more lamps are taken from or added to the circuit, the voltage at the terminals must change in proportion, but the current must be maintained at a constant value. For this reason such systems are known as "constant current" systems. Generators for supplying current to these systems are of special design, and are known as "constant current" machines, for the reason that they are usually equipped with some device which automatically maintains the current at a practically constant value. A constant current system is shown in Fig. 48.

When electric power was applied to the propulsion of street cars it was necessary to increase the voltage above that used for lighting and other purposes to avoid the excessive cost of transmission wires. Accordingly the voltage of 500-550 was adopted for railway service, this being the highest that was considered practicable at the time. As the electric service was extended and the traffic became heavier, the voltage was gradually increased up to 650, and at the present time some systems are operating at a voltage of over 1,000. In the case of very large systems, where the amount of power involved and the distances are great, the transmission of power is effected by means of alternating current at high voltage, the power being first transmitted to substations placed along the railway line. At these substations the alternating current is converted into direct current, which is utilized on the cars at a comparatively low voltage. Within recent years there has been a tendency to eliminate the substations and use the alternating current directly on the cars (or electric locomotive), which are equipped with alternating current motors. This point will be discussed more fully in a later chapter.

While the voltage on railway systems varies considerably, these systems are essentially of the constant potential class. The trolley wire or third rail is the positive wire while the track rails serve as the return, and the cars all operate in parallel.

REPORT ON THE DUST PROBLEM.

Mr. Angus Smith, city engineer of Victoria, B.C., in a recent report on the dust problem of Victoria, went very fully into the matter. He made enquiry as to the methods of laying the dust in other cities upon the roadways. It appears that there is no universally accepted method of laying dust. The results of experimentation of the last few years and the study devoted to it by highway engineers and chemists, demonstrate that the road surface is constructed to advantage with bituminous binders exclusively. The experiments for the last year or two, both in Great Britain and in the United States, demonstrate that the laying of the dust can be satisfactorily accomplished by the calcium chloride method and by the application of oil.

During the year 1909 the city of Bedford, Mass., spent $14,000 on dust-laying preparations. It was a popular expenditure, although there were some complaints from owners of bicycles that the oil caused a rapid deterioration of the rubber tires. The press recorded a few complaints of injury to carpets, but the general opinion was one of approval. The city was unable to comply with the requests for oil. The dust layers were dustoline and a heavy asphalt oil and standard road oil.

The city of Victoria has approximately 23 miles of macadam roadway. The roadways are of varying ages and are in various conditions of maintenance. The older roadways are quite dusty. It will be necessary for the city in the immediate future to confine its attention to the using of dust layers, and it should experiment in the direction of dust prevention by using, in the construction of a macadam roadway, a more homogeneous and harder stone, together with some form of elastic binder.

There are several of the older macadam roadways that should be spiked, cultivated, graded and rolled. Afterwards resurfaced with a material mixed with a binder.

The city has recently received from England, ten tons of calcium chloride. The solution used for watering is made by dissolving 100 lbs. of calcium chloride in 100 gallons of water. The roads should be watered thoroughly twice with this solution, an interval of one day being allowed to elapse between the first and second watering. Three hundred gallons should be made to cover 800 square yards at each watering. For subsequent waterings, one thorough watering will suffice, using 300 gallons for 800 square yards. The solution may be applied with the ordinary street sprinklers. Calcium chloride is a chemical and in its ordinary commercial form is a solid mass, and is handled in hermetically sealed drums. It is a deliquescent salt with the property of absorbing water from the air and retaining it in solution. The quantity of this

(Cotinued on page 104.)