(f) Reduced cost of installation. Disadvantages:

- (a) Greater derangement of service in case of breakdown.
- (b) Greater cost of repair.
- (c) Reduced capacity obtainable in self-cooling units.
- (d) Greater difficulties in bringing out taps for a large number of voltages.

(a) Lower Cost.—In the first place, the three phase transformers should be cheaper to manufacture than three single phase of equal capacity, because owing to magnetic phase relations there is less active material. There is also only one case, one set of end frames and one cooling system, and there is less labor on one large unit than on three smaller ones. On account

(b) Higher Efficiency.-Owing to the peculiar magnetic relations in the active iron in a three phase transformer, this iron weighs less for the same magnetic density than the equivalent capacity in single phase transformers and as the losses depend on the amount of active iron, the three phase unit shows a gain in efficiency over the single phase unit.

Performance curves of two representative transformers are given in Figs. 4 and 5.

(c) Less Floor Space .- The floor space occupied by the three phase transformer is very much less than that occupied by three single phase units. This floor space usually extends between forty and fifty feet in height, and as this class of building may be figured roughly at 20c. per cubic foot, it will be readily seen that this waste space costs for building alone of the higher efficiency of three phase units a smaller radiating in the neighborhood of \$10.00 per square foot floor surface.



surface is required to dissipate the heat, and this tends largely to reduce the cost of self-cooling units.

If we capitalize the saving in power due to the higher efficiency of the three phase unit, it will show a large balance in favor favor of this latter type of unit.

Curves 1, 2 and 3 give the cost (installed) per K.V.A. of three phase transformers, and are the results of quotations from three phase transformers, and are the results of quotations from three phase transformers. three responsible firms. They form a quick and reliable means of estimated and reliable means of estimating the cost of a three phase installation.

When completely installed and the piping connections made for oil and water, it will be found that two three phase units will not will not cost any more than three single phase and one spare, and the cost any more than three single phase and one spare, and the three phase spare will have twice the capacity. The three phase spare will have twice the capacity are to be ready three phase transformers can also be arranged so as to be ready for some the transformers can also be arranged so as to be ready for service up to full capacity a great deal sooner than the single methods and the brackdown. single phase arrangement in case of a breakdown.

When we get up into the higher voltages, such as 110,000 volts, this waste space forms a very large percentage of the total floor space due to the large clearances necessary for insulation at these voltages.

(d) Less Weight .--- A three phase transformer weighs considerably less than three single phase transformers of equal capacity, and hence this leads to smaller transportation charges by rail. However, if the power house is in a rough, mountainous country, where heavy' weights are extremely difficult to handle, the fact that the weight is concentrated in one unit instead of three may outweigh all other advantages. However, there are usually heavier weights in the generators and turbines than in the transformers, and as provision has to be made for these weights, the extra weight of the three phase transformer is no disadvantage.