Here are Five Benefits From Installing Capacitors

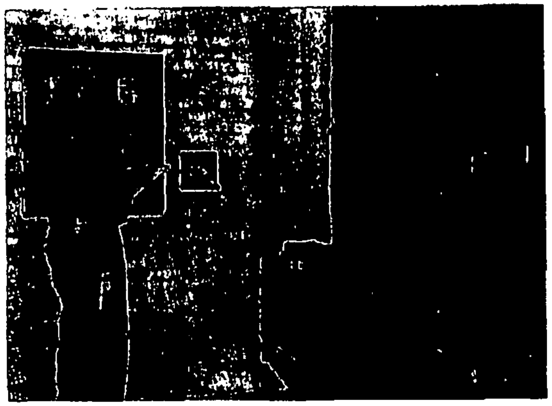
1 Load power factor is improved

2 Current, carried by supply circuits and the equipment, is reduced. Or more power-producing current can be transmitted over the existing circuit

3 System losses are cut

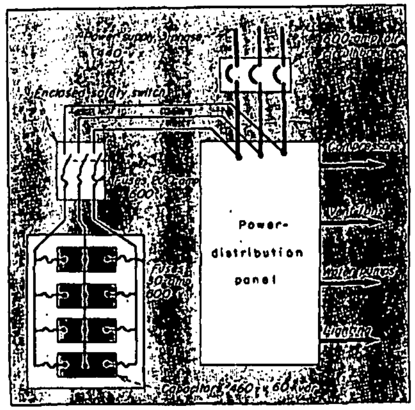
4 Voltage drop in the supply circuits is cut

5 Monthly power bill may be reduced if the utility company has a pf clause



POWER-BILL SAVING tallied about $645 yearly after 60-kvar capacitor bank was installed. Unit, *tucked snugly in far corner*, boosted pf at service to more than 95%

600-V FUSES tie in series between unit's incoming 440-v lines and individual capacitors; 3-pole switch ahead of the bank



CAPACITOR LOCATION at distribution panel rather than at load was best here since runs to loads were short and of ample size

Capacitors Pay Off Within First Year Zooming Pf From 72 to 95%

Installing shunt capacitors in Cleveland department store's basement chopped pf penalty levied by local utility. Similar units may be the answer for overworked feeders in your plant

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► CAPACITORS can pay big dividends and fast, as was the case at Halle Brothers Shaker Square store. The capacitor bank was installed in June 1950 with power factor hanging at about 72%.

A penalty clause of the local electric utility company, leveled against a demand of 147 kw per month, ran up a monthly penalty. Aim in installing the new capacitor bank was to raise pf to at least 95%. And by so doing the total in-pocket saving of penalty plus bonus amounted to about $645 yearly.

Location. Capacitors are connected in the power-distribution system adjacent to the central-distribution panel. They are set about 8 in. off the floor and fed through a 200-amp, fused, 3-pole safety switch tapped between the 600-amp main breaker and distribution breakers. Thus the main breaker kills power to all electrical equipment. The safety switch allows operation with or without capacitors.

Thought was given to installing individual capacitors at motor loads, but that plan didn't fit this setup. First off, cable runs between distribution and load were short. On top of that, cables in these runs were big enough to rule out benefits that might be reaped by reducing somewhat the ampere load through such feeders.

Capacitor Size. How did we arrive at the size capacitor needed for the desired pf improvement? As in all pf improvement, basic approach is through the right-triangle relationship of *true power* (kw), *reactive power* (kvar), *volt-amperes* (kva). Pf being cosine of the angle formed between volt-amperes and true power.

To determine size, knowledge of existing and desired pf is necessary. Here are the data collected and applied in our case. First off, metering is done on the main transformer's primary side. To get a representative picture of the power load a set of readings was tallied for three typical months. Then average of these three readings was used for calculations.

Here are the readings we came up with: 147 kwd, 71.6% pf, 29,600 kwhr, 28,500 kvar-hr. These figures represented readings taken over a period of 4.33 weeks, or 728 hr. Our desired pf was 95%, representing a pf angle of about 18 deg. Translating the desired pf condition into kvar-hr, we get kwhr × tangent of 18 deg, coming to 29,600 × 0.329, or 9720. This meant 28,500 − 9720, or 18,780 kvar-hr that had to be removed by capacitors.

From here on, it was simply a matter of considering the reactive power taken by the transformers and figuring the average demand hours' use. The latter was determined by dividing the monthly kwhr by the kwd, or 29,600 ÷ 147 = 201. Then an experience factor is introduced. This factor of 1.25, multiplied by the average use-hours demand, gives a more accurate picture. So 201 × 1.25 = 252 hr.

Total kvar-hr load figured out to be 8940. Taking this figure, dividing by 252 hr, and adding in the transformer reactive loss yielded a figure of 52 kvar of capacitors needed. A 60-kvar unit was selected since that is the nearest standard size.

Following through on above, note that the advantage offered by a particular number of capacitors appears as the difference between total energy-cost reduction and installed cost of new equipment. By determining this difference throughout a range of installed capacitative kvar, we arrive at the most effective installation.

Switching Capacitors. Let us leave this installation and discuss capacitor applications in general. In some setups automatic or manual switching may be needed to meet supply or load conditions that change continually. An unswitched shunt capacitor can increase circuit voltage permanently, but its effect on regulation is negligible.

A switched capacitor, however, can be arranged both to increase voltage and decrease regulation. The usual unit used to initiate switching of capacitor banks is voltage, but any other quantity that can be measured in the circuit is a likely candidate for this control job. Type of control selected depends on the prime objective in an installation.

A capacitor bank is conveniently switched in steps. This calls for a minimum of extra equipment. Size of steps generally depends on the maximum change-in-voltage permitted at critical points on the system. Contactors or breakers in a switched bank must be selected with proper regard for the momentary currents and the interrupting duty imposed by a large concentration of capacitance. Equipment suitable for this type of duty is available, and no difficulties result if it is properly selected and applied.

Objectives of automatic switching may sometimes be more easily attained by manual switching of capacitors directly with the load, or by switching that is interlocked with the load. A limitation on switching capacitors directly with induction-motor loads has developed, making it necessary to limit capacitor size applied with a motor to less than 25% of motor kva.

If this limit is not respected the motor-capacitor combination, when disconnected from the supply circuit with the motor still rotating, may build up overvoltage by self-excitation in the local circuit formed in the motor reactance and connected capacitance. The setting of motor overcurrent devices should be rechecked after capacitors are connected directly at the motor terminals to correct for any reduction in the line current.

A workable combination for many plants is to install (1) a permissible and reasonable amount of capacitance along with individual loads, and (2) the required remainder as a partly switched capacitor bank at some convenient location on the distribution system. This plan results in installing maximum corrective kvar, with minimum auxiliary switching equipment.

More and more industrial plants are thinking in terms of secondary unit-substations as the most feasible spot for the location of the bulk of their capacitors. At this point capacitors benefit the primary distribution feeders by lowering their ampere load. Units may be automatically switched as a function of plant voltage.

Capacitors may be installed right on or near bus duct running throughout the plant. They may be tapped direct into bus duct through a set of fuses and disconnect switch. This technique fits well with the rapid growth of bus duct for secondary distribution in industrial plants. When so used, total capacitor kvar needed for a plant is split into several units. Then each unit is installed in a specific location where it does most good from both pf and reduced-amp angle.