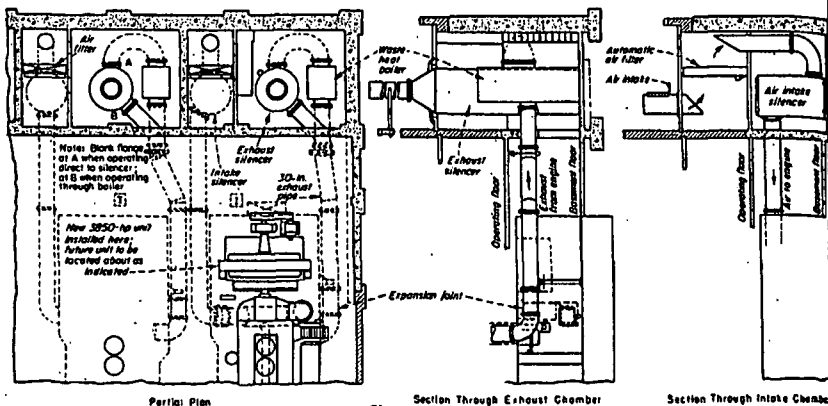




EXHAUST AND INTAKE LAYOUT: Plan and sections show the filters of the new 3850-hp engine and the future unit. This setup gives operators convenient access from operating floor.

the plant to install one 3850-hp engine and another similar machine for which specifications are out.

In selecting the new engine, consideration was given to larger cylinder bore but in view of the advantages of having units as nearly alike as possible, we chose a 21½x31-in. 225-rpm 2-cycle Nordberg diesel direct-connected to an Elliott 3390-kva 6900-7200-v 3-phase 60-cycle generator. The present 21x29-in. engine (2250 hp) will be converted to 21½-in. bore, and, since the new unit duplicates the 1941 engine, a measure of ring and piston-head standardization will be effected.

Accessories. Completing the new installation are: 1836-sq-ft 150-pai Foster Wheeler extended-surface waste-heat boiler, Maxim exhaust and intake silencer, Struthers-Wells oil coolers and jacket-water heat exchanger, two Allis-Chalmers 965-gpm soft-water circulating pumps, Blackmer auxiliary oil pump, Dollinger Staynew automatic air filter.

New building extension is 54x57½ ft (crane-way) plus an additional 25 ft, 3-in. extension to rear which houses waste-heat-boiler and muffler rooms, air-intake silencer and filter rooms at basement and operating-floor level. Additional space above provides lockers and washroom, chief operator's office and an entrance foyer. A balcony at crane-rail level provides space for cooling-water surge tanks, air-starting bottles, day tanks, etc.

Experience with an arrangement not

particularly favorable to operation led us to take pains in designing the waste-heat-boiler and air filter layout. As shown in the drawing, operators have easy access from basement and operating floor to the boiler room. Doors from boiler and muffler room into each section of filter and silencer rooms make these compartments readily available. In the past, snow entrainment in air entering the filter rooms was considerable, the snow covering the filters. Now if this happens, we will open doors between filter and muffler rooms and hot air will prevent icing on screens. Houls louvers on the intake will also help. Similar louvers used in revamping the 4-cycle intakes can be seen under the windows in photo of building front.

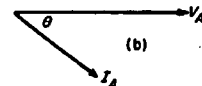
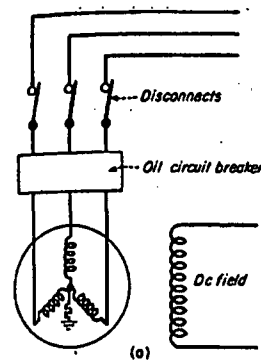
The 1941 and 1948 engines are air-injection units, for which we find advantages when heavy oils are burned. We now use straight-run residual from Michigan refineries, with a viscosity of 500 to 1000 ssu at 100 F. We are burning about 7000 gal per day. Total storage capacity is 770,000 gal: 420,000 in a tank above ground, in the hills and 350,000 in three tanks buried in sandy soil near the plant (see photo). The sand is not particularly corrosive; tanks are stiffened by specially designed annular angle-iron rings inside, to carry the sand load. Burying the tanks not only improves plant appearance, it helps reduce amount of heating necessary to keep the oil fluid. There is also an 8000-gal underground lubricating-

oil storage tank close to the plant. Fuel Oil. We have given considerable study to handling and burning our heavy fuel, which has a pour point of 34 to 42 F. Besides heating the adjacent municipal water filtration plant, and an electric-distribution service building to be erected, steam from waste-heat boilers heats the fuel oil. All fuel piping is insulated and soil heating cable runs parallel with piping under the insulation. It is used to heat oil in an emergency. Two Sharpless centrifuges clean all fuel oil. It also passes through Nugent filters, and is heated and settled in conical-bottom tanks before going to the engines. All lube oil goes through Honan-Crane and Youngstown-Miller earth-type filters.

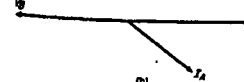
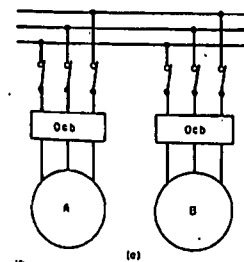
After installing the next unit, as provided for in the building extension, further expansion must be handled by replacing the older 4-cycle engines with large 2-cycle units, as on the plan (preceding page). This would permit increasing total plant horsepower to about 23,400. These older engines are still going strong, however, and what is done will depend on future load conditions and the fuel market.

Grand Haven power system is operated separately from other city utilities by a board of five elected local business men serving staggered 5-year terms. Separate accounting gives an accurate record of all operations. The system's own organization handled all engineering and construction of the recent extension.

Vector Analysis



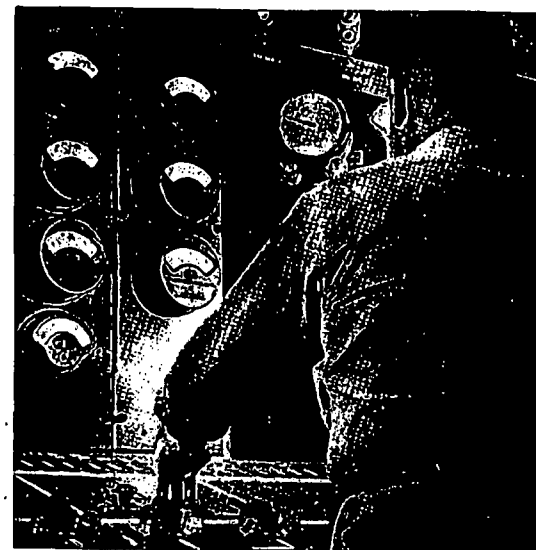
1 Angle between voltage and current is decreased as power factor improves



2 Generator B floating on line. Power to prime mover supplies only losses



3 Increasing field of B causes current I_A to flow through both generators



SYNCHRONIZING GENERATORS is first step in parallel operation. Machine voltage has to equal that of bus; also frequency and phase relationship must be the same

Parallel Operation Of Ac Generators

Here's how machines pick up and distribute load after synchronizing. E J Kelley gives clear analysis of what happens to current and power factor if dc field and power output vary

PARALLEL OPERATION of generators means that two or more units, connected to the same bus, supply power to the load. In parallel operation of dc machines, load division between them is handled by varying field rheostats. Since voltage varies with field strength, machine with highest voltage takes larger load. This is not true in parallel operation of ac generators.

Fundamentals. Let's start our analysis of ac units by considering a single generator connected to the bus and supplying power to load. A 3-phase

machine is shown schematically in Fig. 1a, and vectorially in 1b. Since load is generally balanced between the three phases of generators met with in ordinary practice, we will analyze what happens in but one phase. No attempt is made to keep vectors to scale.

Let's look further at Fig. 1b. The two vectors represent line-to-neutral voltage V , and current in one phase winding, I . Since the majority of industrial loads are inductive, current lags voltage as shown. If load were purely resistive, both vectors would be