used in the electrical and other trades. There are two theories as to the origin of mineral hydrocarbons. Some scientists believe in their inorganic origin, and others assume that petroleum is the product of the decomposition of organic matter. The first theory assumes that at the beginning of things, when cooling of the original molten mass of the earth commenced, a condensation of vast clouds of vaporized water took place towards the molten center, these supplying the conditions necessary to formation of hydrocarbons; namely, high temperature and tremendous pressure, causing the hydrogen of the water to combine with the carbon of the carbide, and the oxygen to combine with the iron. The second theory, supported by most American geologists, holds that hydrocarbons of this nature are derived from both animal and vegetable sources, by being subjected to the right pressures and temperatures. Products rich in nitrogen may be traced to the decomposition of animal fats, while those free from nitrogen are probably derived from the disassociation of prehistoric wood and vegetable fibre. A table presenting a general idea of the ultimate composition of American petroleum is as follows:

	Hydrogen	Carbon	Nitrogen
Ohio.....	13.07%	86.31%	0.23%
West Virginia	13.36%	85.20%	0.54%
California....	11.82%	86.93%	1.11%

Sulphur in crude petroleum averages 0.5 per cent. This sulphur is always in combination with the hydrocarbons. Sulphides of hydrocarbons will not react with copper. Free sulphur, however, readily attacks copper, forming a conducting salt known as cuprous sulphide. Oil from American fields comes from strata of varying depths, the shafts of the different wells ranging from 60 to 1,200 feet in depth. Access to the oil bearing sands is had by means of drills, and sometimes by use of nitro-glycerine. Practically all petroleum from the oil fields is transported by pipe-lines to the refineries and

shipping points on the sea-coast. By filtration through charcoal, many of the viscous oils may be used without further treatment. These oils are known as "natural oils". The better grades of lubricating oils are distilled by the vacuum process at very low temperatures and sold as reduced oils. Most of the commercial illuminating and lubricating oils are produced from crude oil by fractional distillation. The average American still is about 30 feet long by 12 feet in diameter and holds about 600 gallons.

The so-called "cracking" process revolutionized the mineral oil industry, since by its use the burning oil output was increased from 50 per cent to 80 per cent. This method was discovered accidentally in 1861 in Newark, New Jersey. A still had been left over a very hot fire longer than planned, and it was found that a light colored distillate of lower density had been collected. This led to many experiments, with the result of increased production, as stated above. For insulation of oil-immersed electrical apparatus, it is desirable to have as light an oil as possible, in order more readily to carry away the heat. The lighter oils have, however, low flash and burning points, so that great care has to be used in the selection of oil for given conditions. Water is the greatest enemy of oil for insulating purposes, even 1/10 of one per cent reducing the dielectric strength one half. Although many methods have been proposed for the removal of water from oil, probably the best, and at the same time the simplest and cheapest, is that using ordinary filter paper.

Transformer Installations*

BY M. H. COLLBOHM

Transformer installations may be classed under the following heads: (a) Choice of transformers with regard to size and construction; (b) Location of transformers with regard to accessi-

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bility and fire hazard; (c) Methods of Cooling; (d) Testing of oil and treating of deteriorated oil; (e) Choice of connections for high pressure windings, whether star or delta. In making a choice of transformers for plants up to 5,000 or 6,000 kw. capacity having only one transmission line, two banks of transformers connected in parallel, each bank comprising three single-phase units, and one extra single-phase unit for use in cases of emergency, are preferable. For larger stations, and especially those supplying several independent transmission lines, preference should be given to the three-phase type of transformer on account of its space economy.

In placing transformers each unit should be put in a separate fire-proof compartment, as nearly air-tight as possible. The compartments should be located so that the transformers may be rolled out to positions where they may be handled readily by the power-house crane. Two systems for cooling are worthy of attention; the forced oil, and the forced water system. The latter is preferable for the following reasons: First, because the required piping is less and the cooling water for all transformers may be supplied by one pump. This system is less expensive to install and more convenient to operate. Secondly, the cooling coils inside the transformer can be made absolutely water tight by welding at the factory, while in the forced oil system the piping in the tail-race must be made up in the field, and as it is submerged the inspection and repair is very difficult. Thirdly, when necessary the oil can be withdrawn with much less difficulty from the transformer. Fourthly, the indicating device to show the cooling system is in operation is much more simple.

The transformer oil should be tested regularly by means of a spark gap and testing transformer, and, when deterioration shows, should be treated either by drawing or blowing heated air

through the oil, or by filtration through lime and sand. The latter method is recommended for the following reasons: First, the floor space required is small. Secondly, the speed of filtration may be adjusted according to the degree of deterioration. Thirdly, only one oil pump is necessary for the whole system. Fourthly, oil showing only slight deterioration may be circulated through the filter tank and back to the transformer without interrupting the operation of the transformer.

Regarding the high tension connections of a bank of transformers, there are two principal systems in common use; namely, the ungrounded delta, and the Y connection with the grounded neutral. The delta connection has the advantage, on account of the non-existence of the combination of capacity in series with a large enough inductance at times of an accidental arcing ground with the low-tension transformer winding also accidentally opened, resonance with high power effects cannot take place. It has the other advantage that if one line conductor gets grounded, the service need not necessarily be interrupted except perhaps if the ground is an arcing ground which would set up a continual high frequency surge producing high potential strains on the station apparatus. It has been claimed that the ungrounded delta system would come more into favor due to the ability of the new electrolytic type of lightning arrester to take care of continued high voltage surges. The writer has, however, experienced several instances where this kind of arrester in a delta-connected system became disabled apparently by the effect of inductive disturbances in the system due to improper switching operations, and the very strong claims which the manufacturers make for this construction are not fully borne out in practice. It would seem wise, therefore, not to depend too much upon the electrolytic type of arrester in claiming the advantages of a delta-connected system.