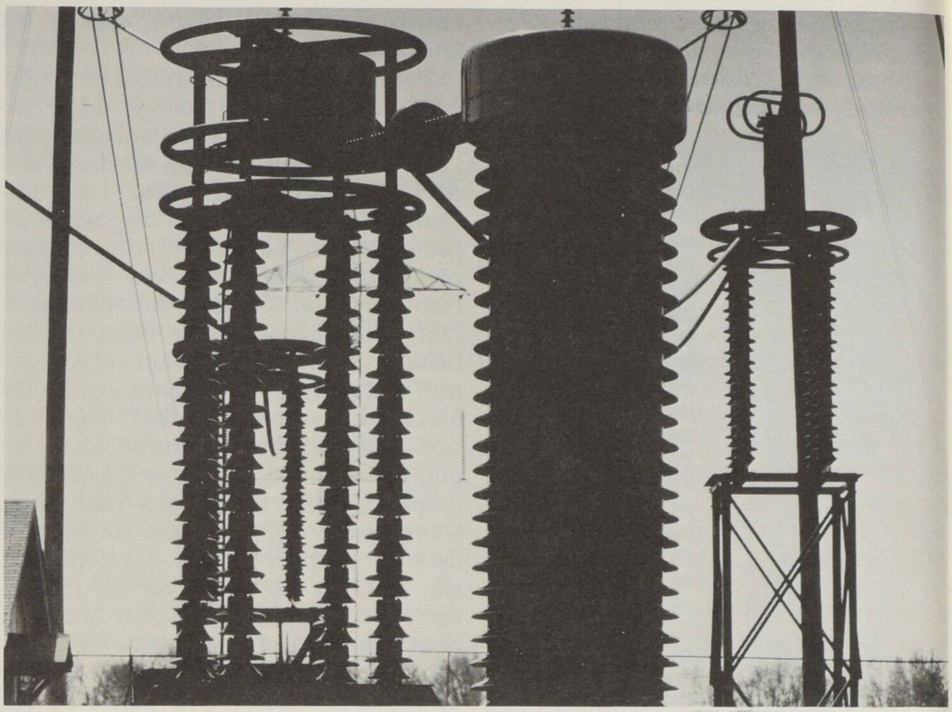
DC versus AC
The war of the currents

For the transmission of electrical power over long distances, direct current has advantages over alternating current, the method now widely used. Largely neglected in the development of the electric power industry, direct current is making a comeback.



Bruce Kane, NRC/CNRC

The high voltage rectifier in the centre produces DC current for study at NRC's Albion Road field station in Ottawa.

Le courant continu étudié à la station expérimentale du CNRC, rue Albion, à Ottawa, sort du redresseur haute tension que l'on voit au centre.

Long, long ago before television, refrigerators and automatic garage doors, electricity was a genie trapped in a bottle. Most engineers and a few entrepreneurs realized the power of this genie, and in releasing it they began the "War of the Currents".

This "War of the Currents", as it was popularly called at the turn of the century, centred around the best way of transmitting electrical energy from a generating station to the consumer. Thomas Edison placed his bets and empire on direct current (DC) which, at low voltages, could be more conveniently produced than alternating current (AC). However, for a given amount of power, high voltages are preferable to low voltages in transmission because electrical losses in the lines fall off rapidly as the voltage is increased.

It was Nikola Tesla's invention of the polyphase induction motor in 1888 which swung the balance of favor from DC to AC. Motors of this type could provide an effective and economical way of utilizing alternating current produced by the AC generators at power stations. With the development of high voltage transformers, it became possible to convert low voltage (high current) power from generating stations to high voltage (low current) power for transmission over distances. The "War of the Currents" was not won, however, without a noted mudslinging match in the newspapers and Tesla's theatrical demonstrations of high voltage electricity. In the end, however, Tesla sold his invention for $1,000,000 cash and the first AC power transmission lines were erected from Niagara Falls to Buffalo.

Today, engineers are taking a second look at the battle strategy in the "War of the Currents" and again are finding a place for DC — this time for power transmission at high voltages. The reason for the change of preference lies in the development of better high voltage "controlled" rectifiers, electrical components which make it possible to convert from alternating current to direct current or the other way around.

Electric utilities have found that high voltage DC has several advantages over AC for power transmission. An obvious gain is in cost savings for erecting DC transmission lines since, unlike AC which requires three conductors, DC needs only two lines to carry its current. Costs can therefore be reduced in the amount of basic materials used, in cheaper transmission line stringing and in the construction of less complex transmission towers. Offsetting this advantage, however, is the higher cost of the terminals which convert from AC to DC at the generating station for transmission, and back again to AC at the receiving station for industrial and domestic use.

By using DC transmission lines over long distances, it is estimated that many millions of dollars can be saved in Canada alone. Already, power from the Nelson River in Manitoba is being transmitted by DC lines and another ambitious project is being considered for supplying power to Newfoundland (from Labrador) using a combination of overhead lines and underwater DC cables.

At the Division of Electrical Engineering's Field Station in Ottawa, engineers are studying the characteristics of high voltage DC overhead lines. Since transmitting maximum amounts of power efficiently depends upon working at the highest voltages, scientists are finding ways of pushing working voltages even higher. Already, some DC lines are operated at voltages higher than conventional AC lines, but in either case, if the voltage is raised too high, electrical breakdown can occur. Breakdowns take place across insulators on transmission towers and in the air surrounding the lines themselves.

When the electrical field around a transmission line becomes too high, a discharge takes place in the surrounding air. This "corona discharge" tends to occur at places in the transmission system which exhibit "high curvature" — protrusions on a conductor that result from faulty manufacture, deposits of natural contamination, etc. In addition to producing power loss, corona discharges have undesirable environmental effects, such as audible noise, and radio and TV interference.

By making careful measurements on the high voltage DC test lines at the field station, NRC engineers are obtaining a better understanding of corona discharges and their undesir-