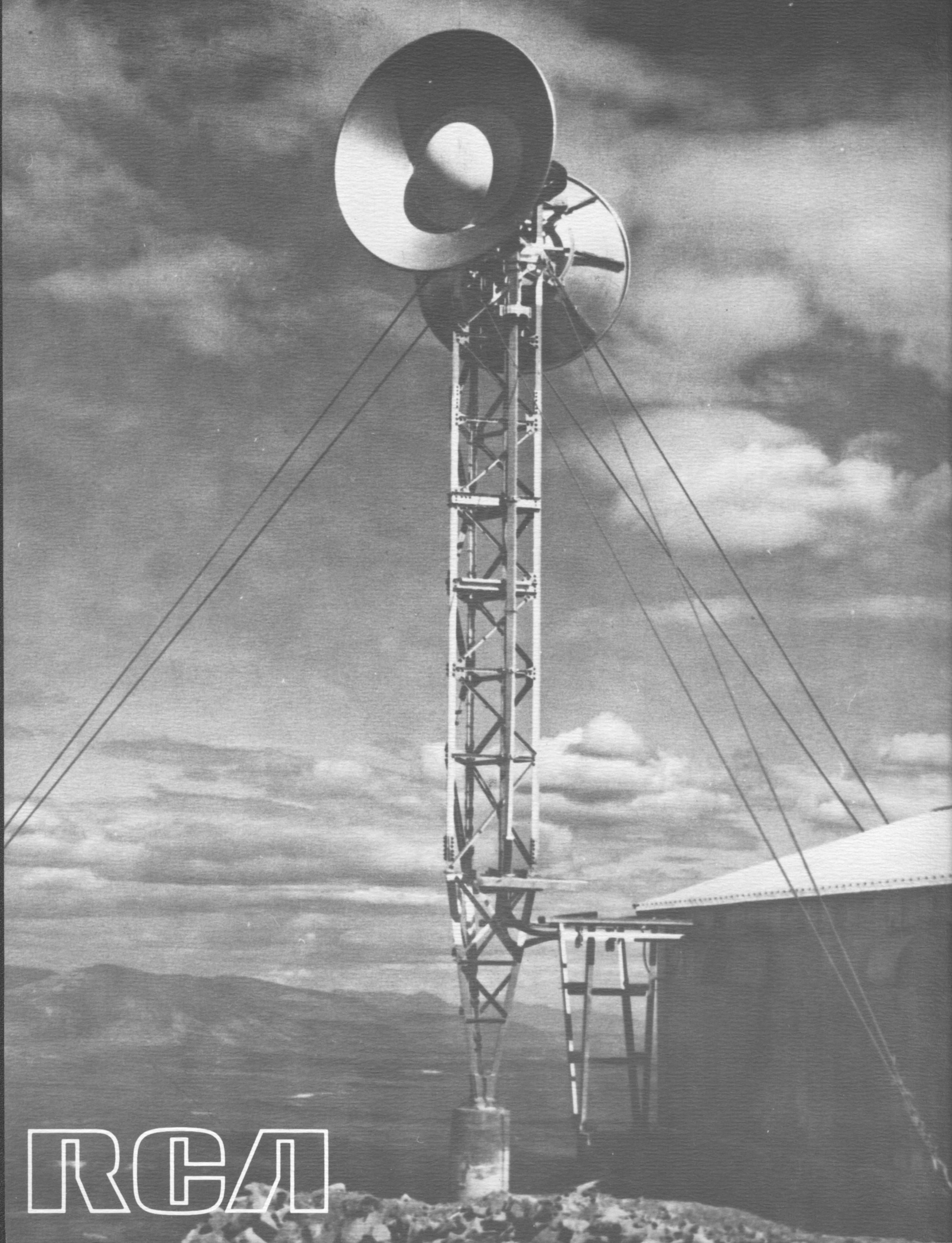


RCA Limited
in
Communications



RCA



RCA Limited in Communications

RCA Limited has played a leading role in establishing the current position of the Radio Corporation of America in the microwave communications field. A highly productive microwave organization has been developed and maintained, and RCA Limited is now the main source of supply of microwave equipment for RCA's overseas customers. This has resulted from the wealth of experience gained in meeting the requirements of the Canadian domestic market.

How has this effectiveness of RCA Limited materialized over the years, and what outstanding achievements have enabled the Company to establish itself as the leading supplier of microwave radio-relay systems in Canada and for RCA's international market?

The following pages tell a small part of the story.....

CANADA — microwave country



Photograph: Courtesy Canadian National

Because of its tremendous size and the fact that its heavily populated areas are widely separated, Canada has become, since about 1952, an ideal market for microwave radio-relay systems. Even though the Canadian population and the Gross National Product run at only about 8% of those of the United States, it is estimated that the existing long-lines requirement in Canada is in the order of 20% of that of the United States.

The rapid growth of Canada's microwave communications facilities has been due in no small part to the fact that, in many areas of the country, no well-developed wire line networks existed. The introduction of microwave communications was therefore a one-step operation for many communities.

Most of the potential customers in Canada are Government agencies, or have such affiliations, so that there has been a strong "Buy Canadian" motivation, which has led to the establishment of an "all-Canadian-designed, all-Canadian-manufactured" product.

The Canadian product requirements themselves are somewhat special and stringent and require particular considerations, partly due to the geographic and climatic conditions of the country. In many instances, system performance parameters are at a level much higher than those generally specified.

The contracts for systems in Canada range from equipment supply and installation to complete "Turnkey" systems (i.e. equipment, buildings, towers, roads and power, etc). It has therefore been necessary to develop the capability within our own engineering groups for the supply of the associated equipment such as power plants, buildings and roads to meet the particular requirements of Canadian operations. This experience and capability has proven well suited to RCA Limited's active and effective participation in the international microwave radio relay market.

The RCA logo is displayed in a large, bold, sans-serif font. The letters are white and set against a dark, rectangular background. The 'R' and 'C' are particularly prominent, with the 'A' following in the same style.

RCA Communications Systems –

The Development of an Outstanding Capability

The Canadian market for radio relay systems really began to develop shortly after World War 2, and today, in spite of competition from both domestic and foreign suppliers, RCA Limited is the leading supplier of these systems in Canada.

There have been four phases leading up to our present position which have characterized our participation in the telecommunications business. The first phase was a period of supply and installation of relatively small-capacity systems capable of providing up to 30 voice channels. These early systems made use of equipment already proven for the application elsewhere and designed either by RCA Limited in Montreal or by our parent Company in the United States. The second phase represents a natural evolution to more demanding requirements and higher-capacity systems using the same basic equipment, but with refined techniques wherever possible to reach new performance objectives. This was really a transitional period into the third phase, which was characterized by new equipment of far more sophisticated design, which met or exceeded the requirements of the time for transmission of 600 voice channels, Telex, data, and monochrome and color TV. Phase Four, another significant step forward, saw the application of solid state circuitry to microwave radio relay equipment. This new development brought further increases in voice channel capacity, and marked the introduction of systems employing totally solid state equipment. It also represented RCA Limited's entry into the era of space communications.

Today RCA Limited has a widely diversified product line of solid state equipment for both long and short haul applications in the various approved frequency bands.

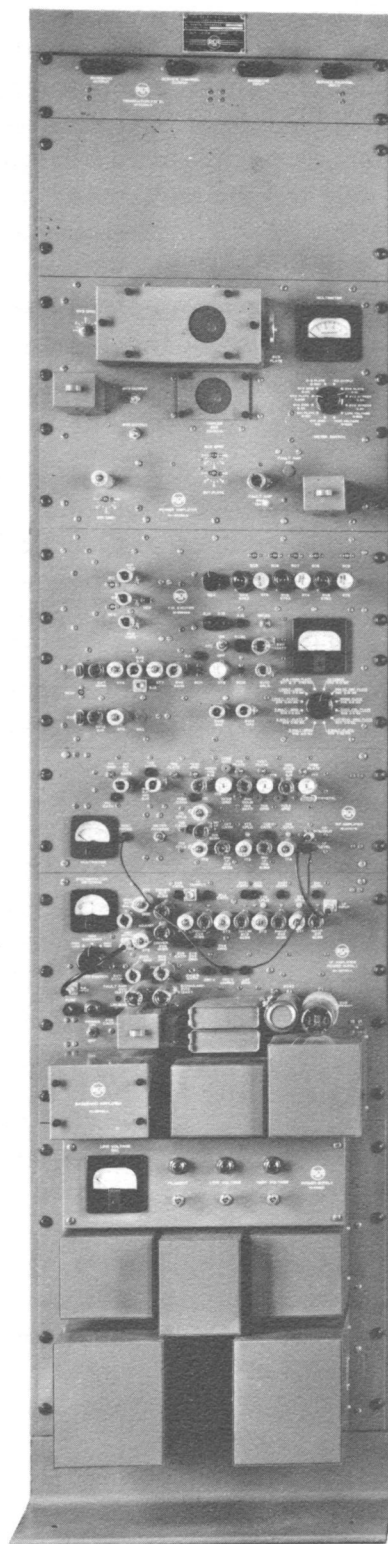
Phase I

Shortly after the end of World War 2, RCA Limited's Technical Products Division was able to switch from designing and developing communications equipment for the Armed Forces in order to concentrate on the next important task - that of establishing a strong communications engineering and marketing group for commercial development.

For the next few years, most of the engineering work was concentrated in developing what was then considered broad-band equipment, with 20 - 30 voice-channel capacities; the design authority in most instances was the RCA International Organization. One of the first radio relay equipments built in Montreal, the CW-1, was originally developed in the United States and was manufactured in the Montreal Plant for supply to Australia as part of an RCA International Contract.

At the beginning of the 1950's, the Montreal engineering group developed and produced the CTR-1 transmitter. Some of these were sold in Canada, but the majority of the equipment produced was directed to the export market, and sales of this equipment were made over a large part of the world. The complementary receiver, the CRR-1, was a purchased unit.

The next series of equipments to be designed and manufactured was the CTR-250, again for the RCA International Division. From 1954 until 1956 this equipment was sold for large systems in Colombia, East Pakistan and the Dominican Republic; at the time of writing, it is still in use on all of these systems. Concurrent with the production of the CTR-250 was the design and production of the CTR-140 which, in 1954, was sold in large quantities to North West Telephones in British Columbia.

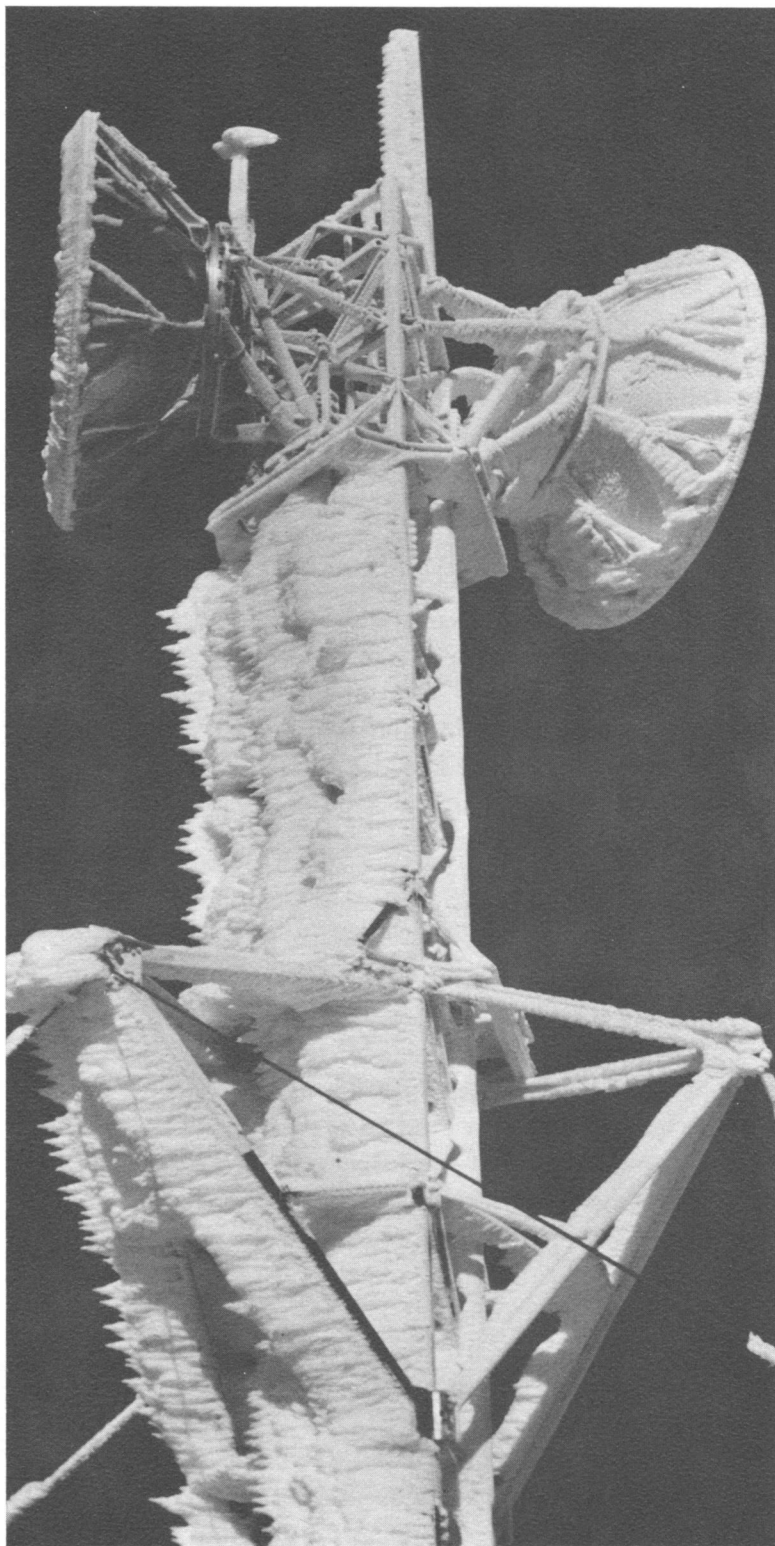


CTR-250 Radio Relay (1954)

Late in 1954, RCA Limited installed, for the Canadian Federal Government, three sections of an RCAF system, joining radar stations on the Pine Tree Radar Line. This system used RCA CW-20 equipment to provide 24 channels between the radar stations in the Quebec wilderness north of Montreal. Although the six repeaters were accessible only by train, followed by a long trek on snow shoes in temperatures as low as -45°F , the project was completed within the five months allowed. A year later, a contract for nineteen more stations in another section of this system was completed within eight months.

The first extensive commercial system undertaken by RCA Limited was for Hydro Quebec. It is well known that the Province of Quebec is rich in hydro-electric resources; however, in most cases, the potential generating sites are located at a considerable distance from the consumers. The Hydro Quebec microwave system connects the multi-million Bersimis developments with Montreal, over 300 miles up the St. Lawrence River, and provides over 30 circuits for voice, teletype, telemetering and control to the two Power Houses. Also, a special circuit was provided through a mobile system base station at each of the 14 repeaters, whereby instant communications were available to all maintenance vehicles along the 300 KV transmission line. In this system, RCA Limited had complete responsibility for the construction which included roads, towers and power equipment.

Systems in British Columbia, Alberta, Manitoba, Ontario and Quebec were some of the many supplied by RCA Limited to the Canadian market during Phase I.



Phase II

With the increasing demand for higher and higher traffic capacity, it became apparent that it would be necessary to expand the traffic handling capability of our CW-20 equipment. This was the beginning of Phase II of our participation in the microwave radio-relay market. RCA Limited's first project of this type was the provision of a one-hop 120-channel system over fifty miles of water from Vancouver to Nanaimo, B.C. Our customer had expressed some reservations concerning the ability of microwave to provide a reliable service over such a path, but the frequency diversity system used, after being closely monitored for a year, was considered acceptable in all respects. The data obtained made a significant contribution to the existing data on microwave propagation.

At this time, there was a considerable amount of activity amongst the Western Provincial Telephone Companies, members of the Telephone Association of Canada, to provide medium-capacity microwave systems to new or relatively new areas. RCA Limited successfully provided 120 channel frequency-diversity systems to the Manitoba Telephone System, Alberta Government Telephones and Saskatchewan Government Telephones, the last two systems being provided on a "Turnkey" basis. It was during this phase that RCA Limited had its first experience in the extreme east of Canada, with the award of a contract by Canadian National Railways to install 20 hops of similar equipment in Newfoundland and the extreme tip of Nova Scotia. This task was unusually complicated by the inadequacy of communications and transportation facilities in the sparsely populated areas.

During this Phase, many other systems similar to those mentioned above were installed across Canada by RCA Limited. In the overseas market, RCA Limited supplied Montreal-built CW-20 equipment for the communications system to the new Brazilian capital of Brasilia, located more than 700 miles inland from Rio de Janeiro. This was the first of the RCA Limited communications export projects to obtain insurance coverage from the Export Credits Insurance Corporation, a Crown Corporation of the Canadian Government.

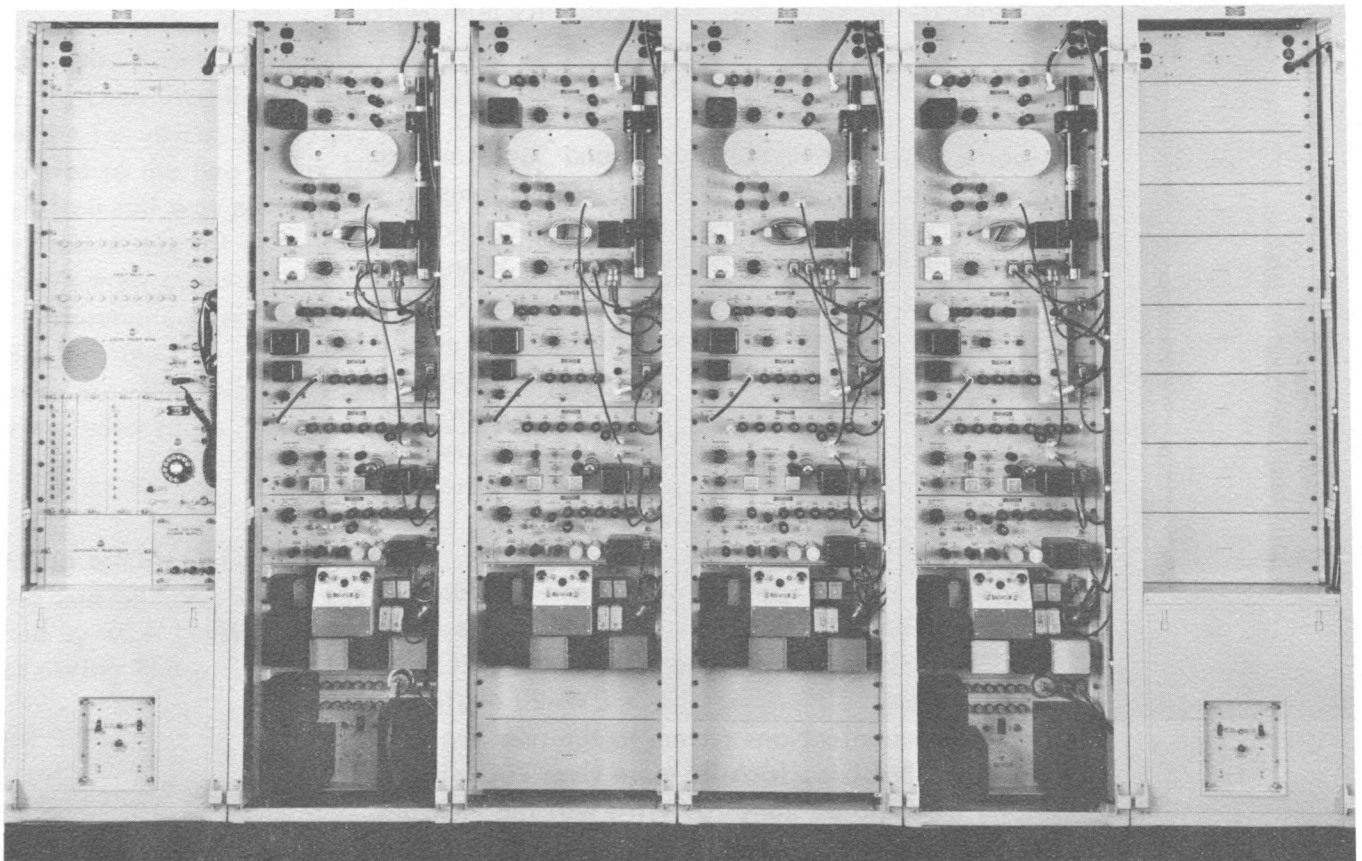
Phase III

The third Phase, which established RCA Limited as the major microwave radio relay supplier in Canada, began with the introduction of the 2 GHz MM-600-2 series of equipment. This was designed for long-haul requirements, with a capacity of either 600 voice channels or black and white or color TV, and was supplied on major contracts in Canada and throughout the world.

The design and development of the product was carried out within several areas of the Corporation, including Montreal, but the final product design, the first production and the installation of the first system was undertaken

in Canada.

The first application of the MM-600-2 equipment was a 7-hop system extending the Canadian National and Canadian Pacific Railways communication network from Rimouski to Mt. Carleton on the south shore of the St. Lawrence River, for the expansion of the French language TV network into the Gaspé and northern New Brunswick areas. Before the project was completed, the system was extended to continue the services for another 7 hops to Moncton, N.B. Since then, a further expansion to the facilities has been incorporated into the system, adding 600 voice channel circuits between Rimouski and Moncton.



MM-600-2 Diversity Repeater with Service Channel (1960)

The first MM-600-2 system to carry 600 voice channels was installed for the Alberta Government Telephones. A 2-hop system connecting Edmonton and Vegreville, this installation field-proved the MM-600 for CCIR performance on 600 channels, and also included a one-way video channel. The system was later extended by a further 4 hops to carry the video circuits to Lloydminster, and has since been expanded to carry the 600 voice channels to Lloydminster as part of the new Trans-Canada Telephone System network.

Late in 1959 RCA Limited was awarded a contract by Canadian National Telecommunications, which made the experience in all of the previous projects appear as nothing more than training. The contract called for the provision of a complete, operating "Turnkey" system, stretching 1,300 miles along the remote areas of the Alaska Highway, with 600 voice channels or television capability, to performance standards exceeding those of CCIR by some 3 dB. Including the time necessary for surveying and selecting sites, RCA Limited was allowed 22 months to complete the project.

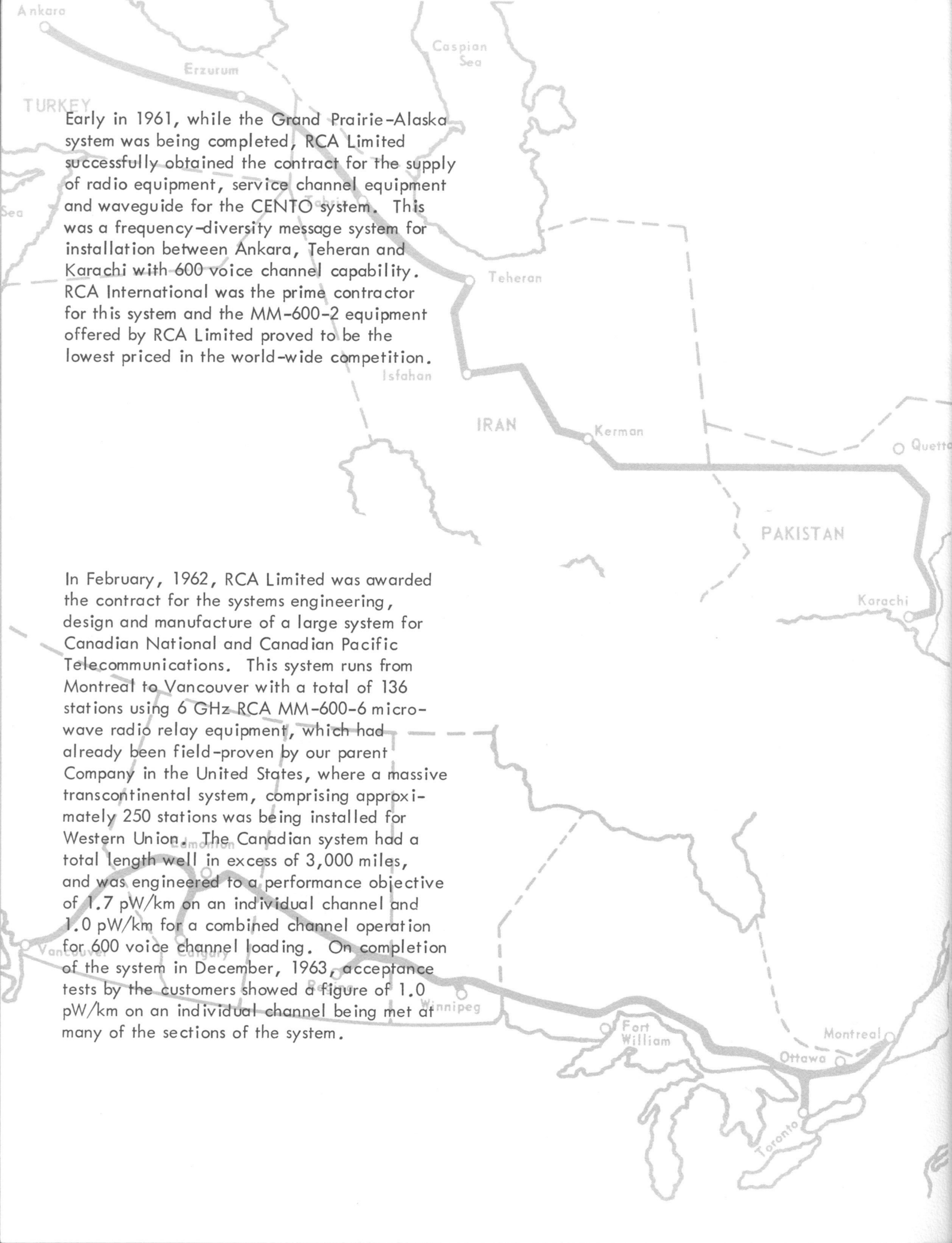
For this project, RCA Limited built 80 miles of access roads and two aerial tramways, erected more than 50 buildings and 8,000 feet of tower, and installed some 200 diesel alternators in various configurations, as well as 30 miles of power cable to provide main and standby power to the 42 microwave radio relay stations. The project was completed on schedule and in accordance with the specifications, marking two "firsts" - the completion of a project of this size in such a time cycle and the achievement of a standard of performance previously unrealized. The equipment performance was substantially in excess of international design objectives and the system reliability was 99.994% for the first nineteen months of operation.

ALASKA

ALBERTA

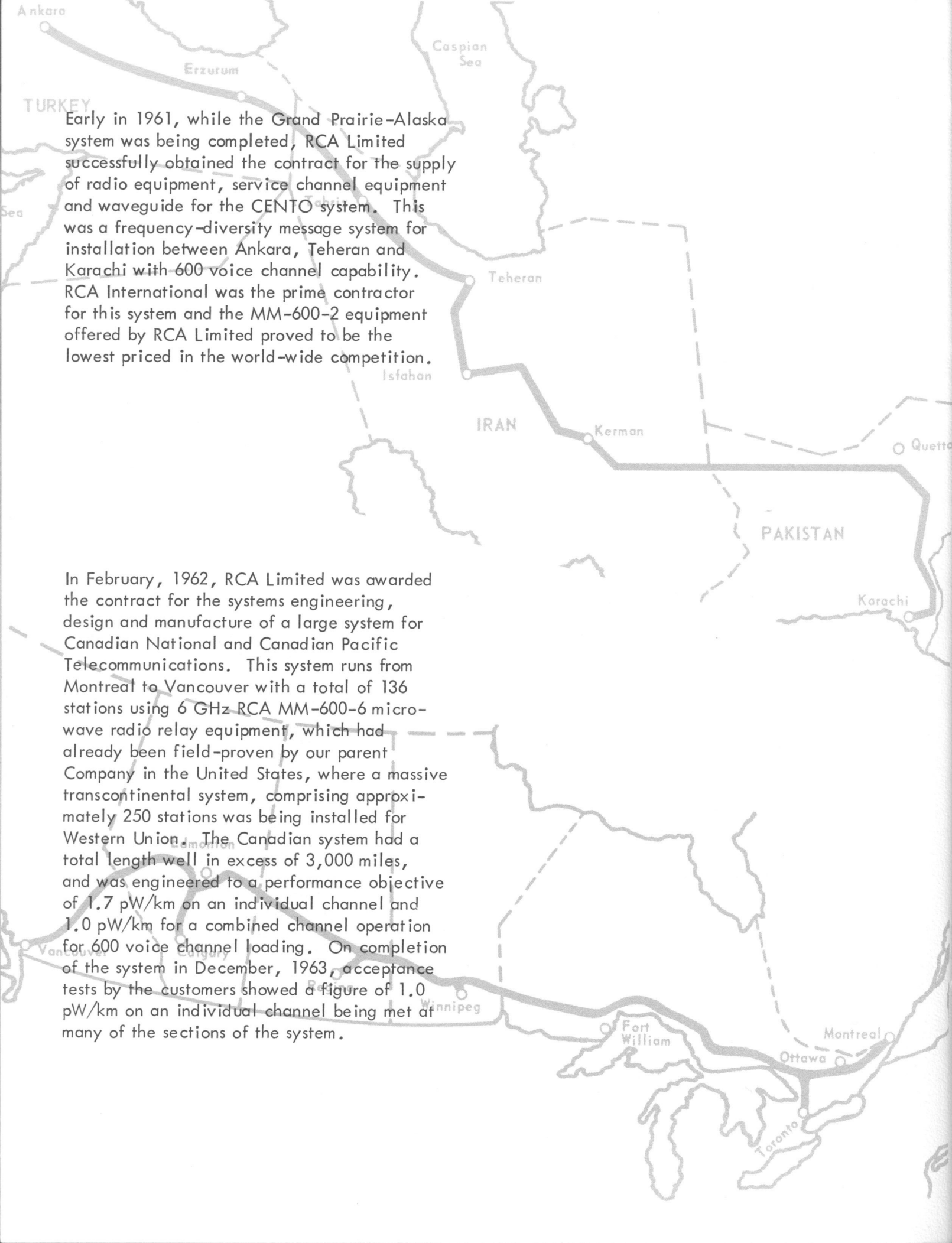
Grande Prairie

RCA



A map showing the route of the CENTO communication system. The route is a thick solid line starting from Ankara, Turkey, passing through Erzurum, Teheran, Isfahan, Kerman, and ending in Karachi, Pakistan. Dashed lines show other regional boundaries. The Caspian Sea is labeled to the north of Iran. The word 'TURKEY' is written in large letters across the top left, and 'IRAN' and 'PAKISTAN' are written across their respective regions.

Early in 1961, while the Grand Prairie-Alaska system was being completed, RCA Limited successfully obtained the contract for the supply of radio equipment, service channel equipment and waveguide for the CENTO system. This was a frequency-diversity message system for installation between Ankara, Teheran and Karachi with 600 voice channel capability. RCA International was the prime contractor for this system and the MM-600-2 equipment offered by RCA Limited proved to be the lowest priced in the world-wide competition.



A map showing the route of the Canadian National and Canadian Pacific Telecommunications system. The route is a thick solid line starting from Montreal, Quebec, passing through Ottawa, Toronto, Fort William, Winnipeg, and ending in Vancouver, British Columbia. Dashed lines show other regional boundaries. The Great Lakes are visible south of the route. The word 'CANADA' is written in large letters across the middle of the map.

In February, 1962, RCA Limited was awarded the contract for the systems engineering, design and manufacture of a large system for Canadian National and Canadian Pacific Telecommunications. This system runs from Montreal to Vancouver with a total of 136 stations using 6 GHz RCA MM-600-6 microwave radio relay equipment, which had already been field-proven by our parent Company in the United States, where a massive transcontinental system, comprising approximately 250 stations was being installed for Western Union. The Canadian system had a total length well in excess of 3,000 miles, and was engineered to a performance objective of 1.7 pW/km on an individual channel and 1.0 pW/km for a combined channel operation for 600 voice channel loading. On completion of the system in December, 1963, acceptance tests by the customers showed a figure of 1.0 pW/km on an individual channel being met at many of the sections of the system.

During this phase of RCA Limited's communications growth, two other significant international contracts established RCA Limited as the leading Canadian exporter of microwave systems.



In mid-1967, RCA International was awarded the contract to supply a total communications system to the Government of Liberia. This system was financed by both the American and Canadian Governments and the supply of equipment from the two sources was proportional to the financial undertakings of the respective Governments.

The system was supplied and installed in two phases, namely the International system for overseas traffic and air navigation, and the Domestic system which consisted of primary and secondary toll systems, ship-to-shore radio, and harbour control. RCA Limited supplied CW-20 AW and MM-24-05 radio relay equipment for the primary toll system, supplied the power generating equipment, took over the full responsibility for the engineering and installation of the total system and has since undertaken the maintenance contract.

The second system was awarded to RCA Limited by the Egyptian Government in March, 1965, for the supply of microwave radio relay equipment, television transmitters and power generating equipment for a video system between Cairo and Aswan in Upper Egypt. The system consists of a diversity one-way video channel from Cairo to Aswan with video drops at ten sites, where TV transmitters are installed. TV Sound Channels, Program Channels and Service Channel facilities are carried on a one-way diversity system in parallel with the video channels.

An unprotected RF channel in the opposite direction carries the service channel and facilities for video insert at any one of the TV sites. The system, installed by the General Egyptian Organization for Broadcast and TV was completed early in 1968.

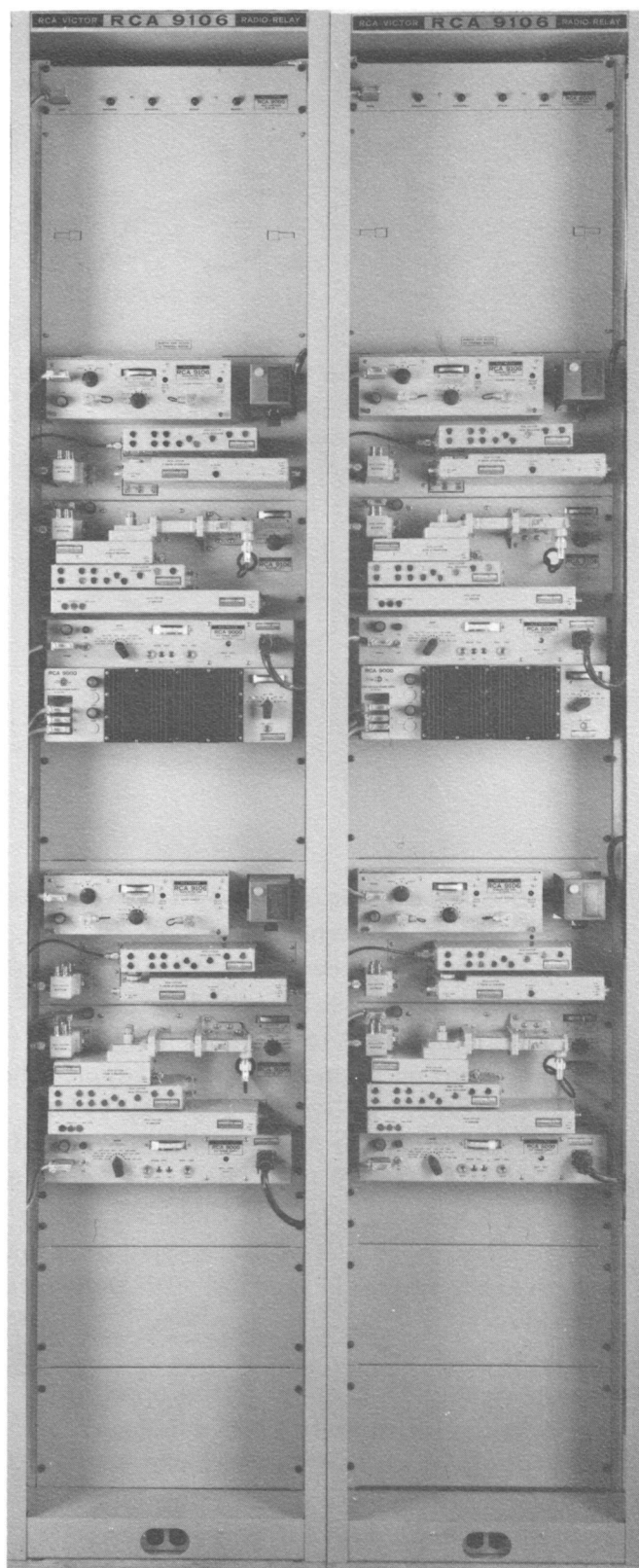


Phase IV

In years to come, the introduction of solid-state circuitry will probably appear as nothing more than a small stepping-stone in the field of electronics communications, but at this time, it is a most significant step forward and has brought about many changes in equipment design and performance.

RCA Limited's first major encounter with solid-state communications equipment came when the Company was given the responsibility for the design and production of the basic communications system for the Relay I spacecraft, launched from Cape Kennedy on December 13, 1962, to provide a satellite link between the United States and Europe. Many wide-ranging scientific experiments were conducted with Relay I, including measurements of noise, non-linearity distortion, linear waveform, steady-state characteristics, intermodulation insertion gain, bandpass characteristics, interference and crosstalk, to establish its capabilities in handling wideband (TV) and narrow band (voice, facsimile and teletype) traffic.

With the experience gained in Relay I, RCA Limited proceeded to develop a comprehensive line of high-quality solid-state microwave radio relay equipments. First in the program was a broadband long-haul equipment to replace the MM-600, and this commenced with the development of the RF sections of 4 GHz and 6 GHz equipments, designated RCA 9104 and RCA 9106; these equipments employ solid-state circuitry throughout, with the exception of the TWT transmitter output stage. A significant design feature is the extensive use of common modules and subassemblies, providing substantial economies in spares provisioning for customers operating both 4 GHz and 6 GHz systems. RCA 9104 and RCA 9106 radio relay equipment is currently in service with such major users as Bell Canada, Canadian National Telecommunications, Alberta Government Telephones and New Brunswick Telephones.

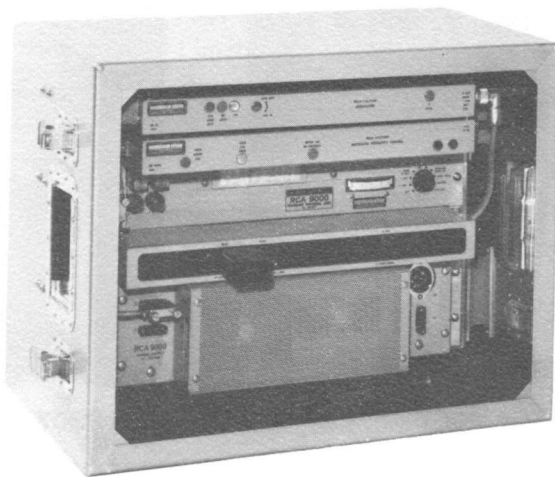


RCA 9106 Radio Relay Equipment

Work also started on the development of a broadband modulator and demodulator for the long-haul equipment, development of the modulator being further assisted by the award of a contract to RCA Limited for satellite ground station equipment at Rosman, North Carolina. The development of these modems has resulted in the large-scale production of the RCA 9000 Series FM Terminal Equipment, which is suitable for use with microwave radio relay systems other than the RCA Limited broadband RF equipment, and which has been purchased by communications manufacturers such as Northern Electric, Raytheon, REL and L.M. Ericsson. The RCA 9000 modem is extensively used by Bell Canada, together with most Canadian Provincial telephone companies and has also been purchased by AT&T and Western Union in the United States.



RCA 9000 Modem Equipment



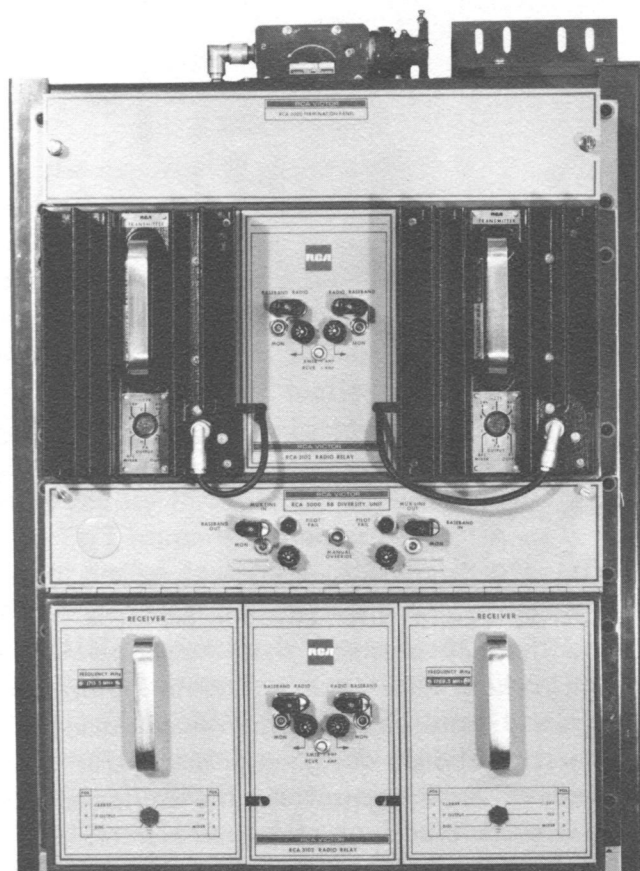
RCA 9000 Portable Modem

A program was also started to develop and produce a light-route, totally solid-state microwave radio relay equipment in the 2 GHz band. The first equipment of this type was the MM-120-2 which had a 120 voice channel capability, high reliability, and a compact design with the transmitter, receiver and duplexer together occupying a mere five rack units (8.75 in.) the equipment was suitable for very simple installation, and repeaters were of the remodulating type. Field maintenance was confined to "GO/NO-GO" testing and the replacement of a complete unit if the whole or some part proved defective. The MM-120-2 equipment was supplied for systems to Hydro

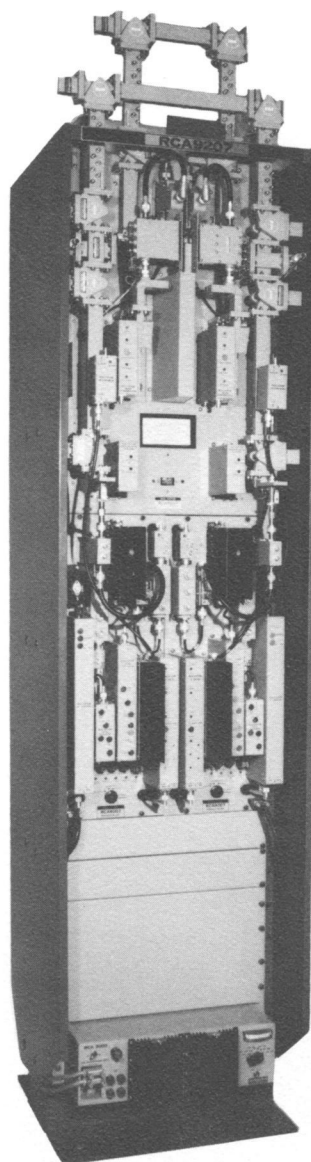
Quebec, Canadian National Telecommunications, Quebec Telephones and Saskatchewan Government Telephones.

The MM-120-2 was followed by the RCA 3102 Radio Relay Equipment. This equipment is designed for 300-channel, short-haul applications in the 2 GHz band and again features totally solid-state circuitry and remodulating repeaters. Although designed primarily for frequency-diversity operation, the equipment is also available as an unprotected system. An extremely high-performance equipment, the RCA 3102 is presently in service in Saskatchewan and Mexico.

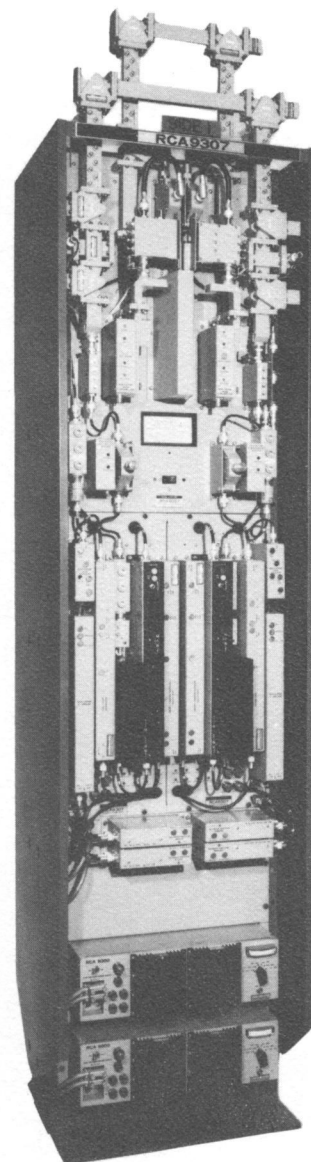
The latest equipments in the totally solid-state microwave radio relay production program are the RCA 9200 and RCA 9300 Series. These have been designed for medium capacity, long haul and short haul systems respectively and are currently available in the 2 GHz band (RCA 9202) and the 7 GHz band (RCA 9207 and RCA 9307). The equipments are extensions of the RCA 9100 Series and, in many instances, incorporate the same basic modules; the fundamental changes are in the transmitter RF stages which do not use travelling wave tubes. A complete diversity terminal, including the branching network, can be housed in a standard 7 ft. rack. Thus, RCA Limited, with its leadership in equipment design, is able to offer a product line of microwave radio relay equipment that has many common units, modules and parts, thus allowing reduced maintenance and sparring costs, particularly to those customers with more than one type of RCA equipment in service.



RCA 3102



RCA 9207



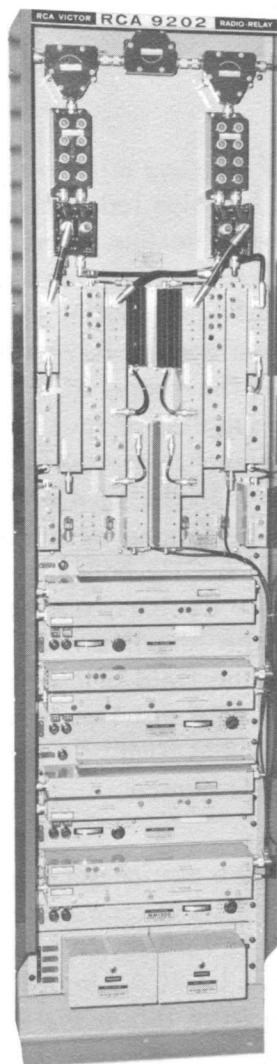
RCA 9307

The first contract to be awarded to RCA Limited for supply of RCA 9202 equipment was for a system between Winnipeg, Grand Rapids and Kettle Rapids, a joint venture of Manitoba Hydro and Manitoba Telephone System. This system, awarded in January, 1967, consists of 30 frequency-diversity hops, installed in four separate phases and includes, in addition to the radio equipment, the supply and installation of local order wire, antennas and feeders. A separate contract has also been awarded RCA Limited by Manitoba Telephone Systems for the supply of an unprotected one-way RCA 9202 video system running in parallel with the message system and using the same antennas and feeders wherever possible.

The second contract award, using both RCA 9202 and RCA 3102 Radio Relay, was signed with the Government of Mexico in April, 1967, for the provision of a "Turnkey" microwave system between Mexico City and Matamoros, to be operational by September, 1968. A further extension of the system between Matamoros and Monterrey has since been added. The 813-mile system, running from Mexico City to the United States, will carry message and television material simultaneously. The message capability will handle as many as 960 voice channels or the equivalent in telegraphs, Telex or data. Spurs along the system, capable of carrying as many as 300 telephone voice channels or the equivalent, use RCA 3102 equipment.

The 7-GHz medium-capacity equipment is being used in two contract awards. The first of these was awarded by Bell Canada for both the RCA 9207 and RCA 9307. The intent of this contract is for RCA Limited to supply equipment for various systems planned by Bell Telephones using the RCA 9307 at the terminals and the RCA 9207 at the repeaters.

The second contract was awarded by NADGECO, a NATO countries consortium, for the supply of a 7 GHz "Turnkey" system using the RCA 9207 equipment.



RCA 9202

RCA communications equipment is in service in the following countries of the world.

- | | |
|------------|------------------------|
| ● Brazil | ● Mexico |
| ● Canada | ● Norway |
| ● Chile | ● Pakistan |
| ● Colombia | ● Sweden |
| ● India | ● Turkey |
| ● Iran | ● United Arab Republic |
| ● Liberia | ● United States |

Other Activities

The establishment of a strong microwave marketing position, has also led to the development by RCA Limited of various forms of additional equipment and components for use with radio relay systems. The activities involved in this additional development have been wide and varied and, over the years, RCA Limited has become a major supplier of special communications test equipment, waveguide and waveguide components in the 2, 4 and 6 GHz bands, special high-performance parabolic antennas in the 2 and 6 GHz bands, microwave components and ferrite devices, and special electronic filters in the AF, IF and RF bands. A recent addition in the field of communications test equipment is the RCA FM Transmission Measuring Equipment (FM/TME) for measuring wideband systems performance.

In addition, much of the equipment originally designed for use with RCA microwave radio relay systems is suitable for use with existing systems supplied either by RCA Limited or others. An outstanding example of this is the RCA 9000 Series modems, which have been sold in large numbers to many North American and international manufacturers and operators of communications systems. Other equipments which have also sold successfully on their own merits are the MM-600 type modems, RCA 9000 Series Group Delay Equalizers - both variable and fixed, Baseband Regulators, Video Equalizers, RCA 9000 Series and RCA 3000 Series Frequency Diversity units, and various forms of Local Order Wire, Express Order Wire and Fault Alarm systems.

The establishment of a strong microwave communications activity also created the formation of additional engineering and service support within RCA Limited.

The communications engineering design group has, over the years, averaged about thirty engineers and engineering assistants, and this group has in turn been able to call upon the

services of the RCA Research Laboratories located in the Montreal plant.

Although, during the earlier years, equipment design was often the result of combined development by Canadian and American engineering groups, design of microwave equipment to be produced in Canada is now solely a Canadian program. This has been greatly emphasized since the introduction of solid-state microwave radio relay equipment and RCA Limited has designed and produced all the equipments in the RCA 9000 Series and RCA 3000 Series.

The Communications Systems Engineering Group has the responsibility for overall system design. If the contract awarded is for a "Turnkey" system, this responsibility includes associated equipment and services such as buildings, towers and tower foundations, power plants, roads, etc. The Systems Engineering Group has averaged about 18 engineers and engineering assistants over the years and on many occasions this group has had personnel working not only in various areas of Canada, but also overseas in such places as Iran, Pakistan, Liberia and Egypt all during the same period.

With the establishment of strong design and systems engineering groups, it was inevitable that a group would be formed with the responsibilities of implementing the system. This group was formed within the RCA Limited Technical Products Service Department and over the years has become a very strong force with the capability of implementing systems anywhere in the world. Among the many systems installed by this group are the Grande Prairie - Alaska system in the sub-zero temperatures of the northern ranges of the Rocky Mountains, the Brazilian system to the new capital of Brasilia, and the total communications system for the Government of Liberia in equatorial Africa.

The Future

We are approaching a new era in communications, in which the physical barriers of space and time will be abolished and in which a global system of instant sight and sound will link people everywhere, providing communications media with the ability for the first time to reach the entire population of the world simultaneously. Laser beams will provide communications "pipes" between the major population centres, and will have a total capacity millions of times greater than the most advanced systems today. Microwave channels carrying television, telephone, facsimile newspaper, telegraph message and computer data will be immediately available in the home or office. There will be continental and global networks of computer centres that will serve scholars, scientists and professional and business men as instant sources of all knowledge on any conceivable subject. Also, transmitting satellites of vastly greater power and versatility which, in synchronous orbit, will broadcast directly to anywhere on

earth. They will beam their programs simultaneously over vast areas and where necessary, provide the picture signals with a number of sound channels from which the viewer can select one in his own language. Radical changes will require a mastery of the complexities of the Space Age.

The technological signposts of this new age are clear, and already man's progress is being guided by them. We are now able to transmit all types of information across vast distances. Synchronous satellites positioned 22,300 miles over the equator enable millions around the world to view the same television broadcasts at the same time. These are the heralds of tomorrow's technical advances, as in equipment design where integrated circuitry and strip-line techniques are just indications of what is in store.

RCA Limited's wealth of experience in terrestrial and celestial communications increases daily. We are proud to be a leader in these fields and as the new concepts become realities in the communications revolution, RCA Limited will continue to be in the foreground, supplying the communications markets of the world.

RCA

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