Hugh G. J. Aitken

The Continuous Wave: Technology and American Radio, 1900-1932

PRINCETON UNIVERSITY PRESS
PRINCETON, NEW JERSEY

Published by Princeton University Press, 41 William Street,
Princeton, New Jersey 08540
In the United Kingdom: Princeton University Press, Guildford,
Surrey

Library of Congress Cataloging in Publication Data will be
found on the last printed page of this book

ISBN 0-691-08376-2 (cloth)
0-691-02390-5 (pbk.)

This book has been composed in Linotron Sabon

Clothbound editions of Princeton University Press books
are printed on acid-free paper, and binding materials are
chosen for strength and durability. Paperbacks, although satisfactory
for personal collections, are not usually suitable for library rebinding

Printed in the United States of America by Princeton University Press
Princeton, New Jersey

Contents

financial side of the affair, the original plan had been to issue to the stockholders of American Marconi one million shares of RCA common stock of no par value and one million shares of RCA preferred of $10 par value. Each holder of two shares of American Marconi common ($5 par value) would have received one share of RCA common and one share of RCA preferred. It turned out, however, that several American Marconi stockholders held odd numbers of shares; so, for convenience, it had been thought better to split the preferred into shares of $5 par value, so that each shareholder of American Marconi common could get, in the exchange, an integral number of RCA preferred. In the aggregate, two million shares of RCA preferred of $5 par value would be issued to the American Marconi stockholders instead of one million of $10; and the corresponding change had been made for RCA common. What it amounted to was that each holder of one share of American Marconi common would end up holding instead one share of RCA preferred and one share of RCA common.

And that was all there was to it. It was purely a matter of arithmetic and meant no dilution of the original stockholders' stake in the company. As for an issue of RCA shares to the general public, none had ever been planned. There would be no attempt to raise capital from the investing public. This did not mean, of course, that no RCA stock would be traded on the market. General Electric had no intention of selling any of the RCA common or preferred that it would acquire in exchange for the American Marconi shares it had agreed to purchase; but the private stockholders were free to do so as and when they pleased.

John Gray's intervention seems to have had some effect. To make assurance doubly sure, Young cabled to Admiral Bullard early in November asking him to issue a statement making it clear that, in his judgment, the merger was desirable and stockholders should vote for it. This may have been done at Isaacs's suggestion, for it was public knowledge in Europe as well as in America that the U.S. Navy had other plans for the future of radio. Bullard obliged; in view of his past role in the affair he could hardly do otherwise. "I am entirely in accord," he wrote to Young, "with the proposition that the British Marconi Company should vote its stock in favor of the proposed transfer. . . ."[51] The letter was forwarded to Isaacs as soon as received. By the time it reached him (probably between 14 and 17 November) there was very little time left.

Was there ever any real danger that the stockholders would not approve the merger? In the case of the American stockholders, probably not. Those

[51] Young to Bullard (cablegram), 5 November 1919, and Young to Isaacs, 7 November 1919 (Young Papers, Box 71).

who felt pessimistic about future prospects had ample opportunity to dispose of their holdings on a rising market between the time when the merger plans became known and the date of the vote. There was no rival group bidding for the company. But to count on the American votes plus the proxies Nally held from British Marconi meant, as we have seen, relying on a fraction of a percentage point for a majority. The foreign proxies were needed, and could not be taken for granted. Many if not most of the foreign stockholders looked to Isaacs for leadership, and his confidence in the Americans was clearly paper-thin. It was not unreasonable for Young and Davis to be concerned.

After all these anxieties the outcome was almost an anticlimax. By noon on 14 November a total of 1,001,729 proxies had been received. Of these 750,126 were from Britain, including 365,000 from the British Marconi Company. The remainder were American. At the stockholders' meeting in Jersey City on 20 November, with thirty-five people present, 1,192,092 shares were voted in favor of the merger and only 6 against it. After Nally had read the resolution approved by the board of directors a motion for unanimous approval was made, and it was so voted.[52]

* * *

What exactly had the stockholders of the American Marconi Company done? Their action did not bring the Radio Corporation of America into existence. That occurred when the company received its charter under the laws of the State of Delaware on 17 October 1919. Nor did it affect the so-called "Radio Agreement" of 20 November by which RCA became the exclusive sales agent for all GE radio equipment and GE the exclusive supplier of radio equipment to RCA. Nor had they been asked to approve directly the terms of the Preliminary Agreement between British Marconi and General Electric, nor the Main Agreement between British Marconi and RCA, although in general terms the provisions of these agreements had been made known to them.[53] In the narrowest sense, indeed, all they had done was approve the terms of a sales contract—a contract by which the American Marconi Company conveyed to RCA all its assets and property except the New Jersey manufacturing plant and its unsettled claims against the government and private firms for patent infringement, in return for two million shares of common stock in RCA and two million

[52] Young Papers, Box 71, memoranda from A. H. Morton to Young, 10 November, 14 November, and 20 November 1919.

[53] These agreements are conveniently reprinted in the Federal Trade Commission's *Report on the Radio Industry* (Washington, D.C., 1923), pp. 116 ff.

shares of cumulative preferred stock. There were, of course, a few ancillary details—provision for a cash dividend of 25 cents per share, for payment to RCA of the first $500,000 from settlement of patent claims, and for the lease to GE of the New Jersey factory—but in a technical sense that was the essence of the matter.

That action, however, was the critical move that let all the other elements fall into place. On 20 November the Main Agreement with British Marconi was signed. This finally cut the link between American Marconi and its British parent by transferring ownership of British Marconi's equity to General Electric. Assured now of title to American Marconi's property, RCA was transformed from a mere paper entity into a major communications company, a corporation with important responsibilities for reconstructing and reequipping the world's long-distance radio circuits. In particular RCA now bore the responsibility for asserting and defending American national interests in radio. In effect if not by formal charter (for the proposed "Navy Contract" had never been approved by Congress), it was the chosen instrument of American telecommunications policy. There had been, it is true, in the discussions leading up to the assumption of this role by RCA, an occasionally rather shrill and strident note of chauvinistic nationalism. But the other side of the coin was a new confidence in American radio technology and in the ability of American business to manage that technology and profit from its use.

What kind of corporation was RCA at this stage of its existence? It was, of course, different things to different people. Financially its structure was simple. Its capital stock consisted of five million shares of preferred stock of a par value of $5.00 per share. This stock was to receive preferred dividends of 7 percent per annum, and these were to be cumulative after 1923. There were also five million shares of common stock of no par value. The preferred stock was supposed to represent, in a general way, tangible property while the common represented patents and goodwill. Share for share, preferred and common stock had equal voting power. From the point of view of the individual shareholders, or at least those of them who were well-informed about RCA and its prospects, the common stock was held in the hope of future capital gains while the preferred was held for income. No one expected RCA to pay dividends on its common stock for many years to come; indeed, the struggle in the beginning was to make sure it earned enough to start paying dividends on the preferred in 1923. There was no bonded debt, and the corporation began its life with no fixed interest notes or obligations—a prudent strategy in the circumstances.

Of the preferred stock, 235,174 shares were issued to General Electric upon the formation of RCA, along with two million shares of common

stock. The preferred represented the funds that GE had expended to buy out British Marconi; the common reflected the value of GE's radio patents, present and future.[54] In addition, it was agreed that GE would accept RCA preferred stock in payment for the alternators and other equipment it would supply, at a price of $127,000 per alternator. There were to be twelve of these machines in the initial purchase order, and for them GE was to receive a total of 304,800 shares of RCA preferred (the equivalent of $1,524,000 at par value).

To the former stockholders of the American Marconi Company (excluding of course the British Marconi Company) there were allocated two million shares of RCA common and two million of RCA preferred. Many of these shares were held by people who were not United States citizens. To limit the possibility of foreign influence, RCA's charter provided that not more than 20 percent of the stock could be voted by foreigners, and to this end foreign stockholders received "foreign share certificates" instead of the usual preferred and common stock.

As a functioning business unit, RCA in the closing months of 1919 was an anomaly. It was, on the one hand, exclusive sales agent in the field of radio equipment for General Electric. On the other, it was a communications company. As radio sales agent for GE, however, it had at that time only a single customer in sight (apart from its own equipment needs), namely the British Marconi Company. And as a radio operating company it had no stations, since those previously operated by the American Marconi Company were still in the hands of the United States Navy. As far as manufacturing facilities were concerned, RCA had none; nor did it have any independent research facilities.

What RCA had to sell was, in terms of hardware, the Alexanderson alternator and its associated equipment. Other product lines would soon

[54] There is a problem of evidence here. Young stated at the *Cable Landing Hearings* of 1921 (p. 335) that GE agreed to contribute "something over $3,000,000" to RCA, against which it was to receive preferred stock at par. This implies that GE should have received at least 600,000 shares of RCA preferred. According to the Cases, 235,174 shares of RCA preferred were issued to GE on the formation of RCA. Added to the 364,826 shares of American Marconi acquired from the British company (each converted into one share of RCA preferred and one share of RCA common), this would give the expected 600,000 shares of RCA preferred. I have therefore used the Cases' figure in the text. According to the FTC *Report* of 1923, however, GE received only 135,174 shares of RCA preferred on the formation of RCA, and this figure also appears in the Main Agreement between RCA and American Marconi of 20 November 1919 as it is reprinted in the Appendix to that *Report* (p. 118). See Case and Case, *Young*, pp. 186-87.

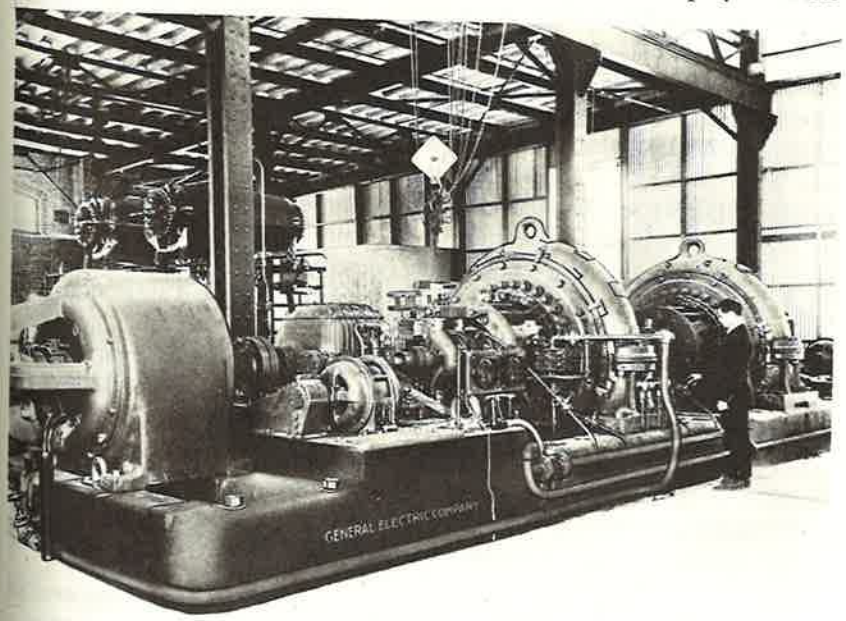
become important—vacuum tubes in particular—but in 1919-1920 the Alexanderson system was what counted. British Marconi had the exclusive right to this system within "Marconi territory," which as we have seen meant essentially the British Empire, those European countries in which Marconi-affiliated companies held exclusive concessions, and perhaps China. But it was not, of course, required by contract to buy any alternators at all. For the shorter distances (less than 2,000 miles) it could rely either on vacuum tube transmitters, which for intra-European traffic were by this time quite adequate, or on advanced spark equipment, still very common for marine use. Alternators would be used for long-haul traffic. By 1919-1920 it was becoming clear that the British Marconi Company would play no role in the Imperial Chain as the British government then conceived it. For that system the Norman Committee, which reported to Parliament in 1920, recommended tube transmitters operating through relay stations not more than 2,000 miles apart; it had dismissed, for what it deemed good technical and economic reasons, the possibility of using arcs or alternators.[55] The Marconi Company, after submitting in 1919 a large and ambitious proposal that was rejected, had refused even to testify before the committee, so there was clearly no market for alternators to be found in that direction.

That left the Marconi long-haul circuits. As far as revenue was concerned, the most important of these was the transatlantic service from Britain to North America. Reopening this circuit would require reequipping the Marconi station at Carnarvon in Wales, or building a new one; this would call for two alternators (one on standby). The circuit from northern Europe to North America depended on the Marconi-equipped station at Stavanger, Norway, operated by the Norwegian Telegraph Administration. In 1919 this station was still using a timed-spark transmitter; modernization could not long be delayed. As for the rest of Europe, the French had their new arc station at Croix d'Hins, near Bordeaux, built by the U.S. Navy, and the station at Lyons, equipped with a Bethenod alternator and arcs designed by Elwell. It was unlikely that either the Compagnie Générale or the French government, if it elected to play a direct role in radio, would buy American equipment. The Germans, through Telefunken, would certainly use their own alternators or tube transmitters. For the Low Countries, Italy, and Spain, the prospects in 1919 were still uncertain. The Poulsen arc was, after all, free from patent restrictions by this time, and Cyril Elwell was available to build low-cost arc transmitters of proven reliability for anyone willing

[55] *Report* of the Imperial Wireless Telegraphy Committee 1919-1920, The Right Hon. Sir Henry Norman, chairman (London, 1920).

to pay his fee, as in fact he did for the British Admiralty, the Italian government, and numerous others. Sweden and Poland were "neutral territory," and thus open to direct competition with RCA, as well as other suppliers hungry for orders such as Telefunken. In the Far East prospects for Marconi expansion were uncertain. For Imperial traffic, any Marconi circuits would have to meet the competition not only of the submarine cables but also of the projected government-owned Imperial Chain.

What all this added up to was that British Marconi's requirements for Alexanderson alternators would probably be quite limited, even ignoring the possibility of rapid development in tube transmitters. When negotiations had first been opened with GE, the talk had been of possibly ten alternators for British Marconi. By the end of 1919 a conservative estimate might have cut that figure in half, and even that would have proved too high. The surviving record leaves much to be desired, but it appears that GE never sold more than two alternators to the British Company.[56] In view of the role that prospective sales to Marconi had played in the



Pl. 15: Twin 200 kilowatt alternators at the Marconi Carnarvon station.
Source: Science Museum, South Kensington

[56] Attempts to locate relevant records of the American Marconi Company for this period have been unsuccessful.

formation of RCA, that outcome is ironic. If the contracts for the Imperial Chain had gone to the Marconi Company, the situation would have been entirely different; but, for the moment at least, that possibility had disappeared.

This drastic attenuation of the Marconi market for alternators gave added importance to the acquisition and modernization of RCA's own stations, to the expansion of its radio circuits, and to the vigorous exploitation of market opportunities in countries where it was free to compete for business. Events moved quickly. RCA opened its doors for business on 1 December 1919. On 1 March 1920 the Navy relinquished control of the high-powered stations and RCA took over. This was a remarkably quick transition and testifies both to the efficiency of the operating personnel whom RCA inherited and to the way in which the drive for government ownership, once formidable, lost its force in Congress and in the Navy Department once the specter of foreign control was banished.

The stations that RCA took over immediately included the transmitting station at New Brunswick, New Jersey, which operated in partnership with a receiving station at Belmar, New Jersey; a transmitting station at Marion, Massachusetts, with a complementary receiving station at nearby Chatham; the station at Tuckerton, New Jersey, acquired from the Compagnie Générale, which also operated in conjunction with Belmar; on the West Coast, the former Marconi transmitting station at Bolinas, California, near San Francisco, with its complementary receiving station at Marshalls, about thirty miles away; and in Hawaii a transmitting station at Kahuku, with a complementary receiving station at Koko Head. The Navy retained control of the former German-owned station at Sayville.

Of these facilities the only ones with reasonably adequate facilities in 1919 were the New Brunswick–Belmar system, where the 200 kilowatt Alexanderson alternator carried the load, and Tuckerton, where the Navy had installed a Federal arc. Marion and Bolinas both had Marconi timed-spark apparatus.[57] The circuit with Great Britain, between New Brunswick and Carnarvon, was opened for commercial business on 1 March 1920. This was essentially a continuation of the operation that the Navy

[57] The Marconi-built stations at Marion, Stavanger, and Carnarvon were all originally timed spark stations. According to Haraden Pratt, who worked on a similar transmitter at Bolinas (with, as he recalled, "a copy of Steinmetz's 'Transient Phenomena' at my elbow"), "it worked pretty well and to listen to it at a receiving station it did sound like an undamped wave except for some side mushy sounds and it generated a whole lot of strong harmonics." (Pratt to Lloyd Espenschied, 12 July 1963, Pratt Papers).

had conducted in the closing months of the war and since the Armistice. On the same date the circuit between California and Hawaii was opened, but without new equipment.[58] A circuit with Norway was opened on 17 May 1920, between Marion and Stavanger, after the American station was reequipped with alternators. Marion also took responsibility for handling traffic with Nauen, in Germany, beginning on 1 August 1920, and on 15 December a circuit was opened with France, using the New Brunswick transmitter. Tuckerton was intended to serve as the American transmitter for the French circuit, but installation of an alternator there was delayed by problems with electricity supply to the site, and Tuckerton was not brought into operation until early 1921.

Efforts expended in getting these circuits into operation had as one of their objectives the generation of income-earning traffic. Results were encouraging. Operations up to 31 December 1920 showed, probably to no one's surprise, a deficit of $45,728.44, but by the end of the following year this had been converted into a profit from operations of over $400,000 and Young was beginning to feel hopeful that by 1923 the corporation might be able to earn enough to pay dividends on its cumulative preferred stock.[59] Over one million words of paid traffic were handled in December 1920, and the trend was sharply upwards on all circuits then open—reflecting, probably, not only the congested condition of the submarine cables but also the fact that radio rates per word were significantly less than by cable.[60]

There was, however, an element of haste and improvisation about all

[58] According to Espenschied, the Marconi station in Hawaii was never able to maintain a commercial service with Japan. "Try as the Marconi boys would on Hawaii, they could not 'make' Japan. Compared to the c.w. stations of the Germans on the East Coast and those of the Navy on both coasts (arcs) and with Federal arcs, the Marconi spark stations of the 'Imperial Chain' were white elephants." (Espenschied to Pratt, 18 July 1963, Pratt Papers) The Marconi station in Hawaii was never, of course, officially part of the British Imperial Chain. According to Young, RCA's transpacific service handled 210,653 paid words in December 1920, before the equipment was modernized. This statistic may refer, however, to traffic between California and Hawaii only. See *Cable Landing Hearings*, testimony of Owen Young, p. 351.

[59] Young to Hon. Herbert Hoover, Secretary of Commerce, 6 March 1922 (Young Papers, Copy Book 802); Young to Hon. Eliot Wadsworth, Assistant Secretary of the Treasury, 10 May 1922 (ibid.).

[60] *Cable Landing Hearings*, testimony of Owen Young, pp. 329-31. The radio tariff from New York City to Great Britain was 18 cents per word for ordinary commercial messages while the cable rate was 25 cents per word. For press traffic the radio rate was only 5 cents per word. (See *Cable Landing Hearings*, testimony of W. A. Winterbottom, RCA Traffic Manager, p. 339)

these installations. Their purpose was not only to earn revenue but also to demonstrate to foreign administrations and to the American public that an aggressive and technically competent organization was now running American radio. For its long-term needs, RCA was counting on its ambitious plans for a new "Radio Central" to be built on a ten-square-mile site just east of Port Jefferson on Long Island. This was intended to be the most powerful radio station in the world, and an impressive demonstration of the capabilities of American radio technology. With its giant twelve-spoked antenna system and five alternators—one intended for South American service, the second and third for supplemental service to France and Germany, the fourth for traffic with Italy, and the fifth for communication with Poland—this was to be a transmitting complex capable of laying down a signal of commercial quality anywhere in the world, twenty-four hours a day, three hundred and sixty-five days a year, under any conditions of static and interference. Four of the alternators were in place and one span of the antenna system completed by November 1921. If it had ever been completed according to its original conception, this mammoth project would indeed have demonstrated GE's alternator-based technology in its ultimate form. By 1923, however, developments in tube transmitters and the discovery of new modes of radio propagation threatened to make that conception obsolete and further work on the project was suspended.[61]

In the meantime, the export market was not neglected. The years after 1919 saw, indeed, a scramble among the industrialized nations to acquire new long-distance radio facilities if they did not already possess them, to modernize them with continuous wave equipment if they did. By no means did RCA have this field to itself. The Germans had their own alternator systems; so did the French; by the early 1920s Japan had entered the competition; the British were aggressive in pushing the virtues of tube transmitters; and there were always the arcs—easy to build, simple to maintain—as a technical alternative. The proven efficiency of GE's alternator, however, had become something of a byword in international radio circles. In a sense the machine advertised itself, for New Brunswick's radio signal—stable, consistent, free from the mush and harmonics that were making arcs unpopular—could be heard by anyone with a suitable receiver. David Sarnoff's Commercial Department at RCA exploited these advantages vigorously, with strong support from Alexanderson. Contracts were signed for the installation of alternators with the government of Sweden in 1921 and with Poland in the following year. And lower-

[61] Elmer E. Bucher, "A History of RCA" (Sarnoff Research Center Archives), chap. 10, pp. 240-41.

powered stations were sold to the governments of Venezuela, Mexico, and the Philippines.[62]

Of all the radio alternators that General Electric built in these years—and there seem to have been, in total, about twenty of them—only one survives today. This is the machine at Grimeton, in Sweden, and in view of Alexanderson's origin and ancestry it is hard not to see something appropriate in this. It is still maintained in prime condition, almost as it left the shop floor in Schenectady in 1921. And about once a month it is started up and carefully brought to full operating speed.[63] The Warsaw alternator was destroyed in the closing phases of World War II. As for the rest, in Europe and the United States, they were scrapped long ago, to be replaced by the versatile vacuum tube. The same is true of the arc transmitters, once the last word in continuous wave technology; the only specimens surviving today are in museums.[64]

This, then, was RCA in 1919-1920, as far as its formal organization and functions were concerned. To the individuals involved in its future, however, it was much more than this. Like most organizations, it served as a vehicle for a multitude of hopes, ambitions, and fears. There were those who were disaffected, who thought that RCA was either superfluous or potentially pernicious. Even Major Gen. George Squier of the Army Signal Corps was ungallant enough to indicate in congressional testimony that the Army did not entirely agree with the way the Navy had handled the matter, and that he personally saw no reason why GE should need a separate corporation to sell its radio equipment since it already had an efficient sales organization of its own. And some radio operators thought it made no difference, that the radio business was really going on much as it had before. Consider, for example, the sentiments of E. T. Quinby, outward bound on a tramp steamer in 1919, who was informed via the radio station on St. Paul Island in the Bering Sea of the name of his new employer and, returning to New York almost a year later, took the opportunity to check in personally. "Imagine my pleasant surprise to discover Jim Sawyer and Jack Duffy ensconced amid mahogany desks and green plush carpet, doing business as the RCA Marine Supervisors, along with practically the entire staff of former de Forest–Marconi of-

[62] Ibid., pp. 243-44.

[63] For information on the history and present condition of the Grimeton alternator I am grateful to Kaye Weedon, who visited the station in 1979 and provided me with many photographs.

[64] Early models of Federal arc transmitters may be seen in the Foothill College Electronics Museum, Los Altos, California.

ficials. They had all become High Priests in the new Cathedral of Commerce. . . ."[65]

Comdr. Stanford Hooper observed the same continuity of personnel, but not with unalloyed pleasure. He thought the housecleaning had not been thorough enough. To complaints by Young in 1921 about the difficulty, despite Hooper's optimistic forecasts, of making money in long-distance radio, Hooper replied caustically that he had not chosen RCA's management. His private belief was that, if RCA got into real financial trouble, Congress would come to the rescue; but he did not share that thought with Young. Most Navy officers who had anything to do with radio, however, thought the new corporation a decided improvement—better, in the opinion of some, than government ownership would have been. Captain D. W. Todd, for example, commanding the USS *Pittsburgh* off the Dalmatian coast in February 1920, sent his congratulations to Nally: "From the time when the Marconi Company opposed *any* radio regulation . . . it has been very difficult for many of us who have had to do with radio matters in the Navy to deal sympathetically with that company. . . . Now that the Department has a strong, real American company to deal with, I feel sure that progress will be rapid, and the United States has a good chance of leading all countries in the development and use of radiotelegraphy.[66]

This "strong, real American company," however, struck some observers as potentially dangerous. What they feared, of course, was the concentration of power that it implied—the concentration that had in fact been deliberately created. Even Hooper worried about the monopolistic position that RCA soon acquired in the supply of radio equipment to the Navy, particularly after Westinghouse, AT&T, and United Fruit contributed their patents to the RCA pool (see below, pp. 432-79). A single organization to represent American radio in dealing with the outside world was a concept of which he heartily approved. For naval procurement, however, he would have preferred competition.

How to reconcile these conflicting requirements was to prove a recurrent problem. Already in 1921-1922 the Federal Trade Commission had launched an investigation of the radio industry, and of RCA in particular, triggered by complaints that General Electric had set up the Radio Corporation as a "bogus independent" and was trying, by the use of tying contracts and price discrimination, to acquire a monopoly in the manufacture and sale of radio apparatus. Public resentment at the scarcity of radio tubes, after the phenomenal explosion of interest in popular broadcasting, added fuel to the fire and led to the passage by the House of Representatives, though not by the Senate, of a bill that would have denied radio transmitting licenses to any individual or corporation that sought to monopolize radio communication, directly or indirectly, through the control of the manufacture or sale of radio apparatus "or by any other means."[67] Any such legislation, if rigorously enforced, posed a lethal threat to RCA. Young and others might argue that, in dealing with foreign governments and foreign radio corporations, a monopoly was essential, while in domestic affairs it was either nonexistent or at worst transitory. Nevertheless, here was a vulnerability that had scarcely been anticipated when RCA was formed and that was to harass the corporation for many years to come.

[65] E. T. Quinby to Lee de Forest, 6 November 1950 (Emil Simon Papers, Bancroft Library, Box 4). The Cathedral of Commerce was the name given to the Woolworth Building in New York City.

[66] Dodd to Nally, 14 February 1920 (Clark Radio Collection).

To Young and his colleagues the RCA that existed in the closing months of 1919 was only a beginning, the mere skeletal lattice around which they intended to build a vastly more ambitious enterprise. Hooper, when the idea of a "truly American radio corporation" was first canvassed, had urged Young to make sure that it was a consolidation of all the principal interests in radio. What he had in mind was mostly a consolidation of patents, for the wartime immunity from prosecution that had enabled the federal government's suppliers to ignore the risk of litigation ended when the state of emergency ended. It was important that some means be found to integrate into usable systems the fragments of knowledge that the advance of the radio art had generated. These fragments were represented by patents; ownership of these patents was widely diffused; and there was great uncertainty over which were truly basic, which the courts might sustain, and which were mere paper claims that could safely be ignored. Consolidation was clearly called for. Some peacetime analogue had to be found for the umbrella of protection that wartime necessities had provided. This was a job for RCA. Created to defend American interests internationally, it could also serve a domestic function as the organizational framework within which the particular bits and pieces of knowledge that made up American radio technology could be integrated.

Such a conception was highly acceptable to Young. The organization he served—the General Electric Company—had itself been created in the first place to reduce conflicts over patents, by consolidating in the hands of a single entity the Edison and Thomson-Houston patents for electric

[67] FTC *Report* , p. 9.

light and power.[68] The same job now needed to be done in radio. Already signs of integration were evident. Despite the persistence of individual claims by inventors like de Forest and Armstrong, three major clusters of radio patent rights seemed to be emerging. One was the Marconi–General Electric complex over which Young himself presided. Another was in the hands of the American Telephone and Telegraph Company and its affiliates. And a third was being rapidly assembled by Westinghouse, as that corporation belatedly scrambled to establish a position of strength in radio—a position from which it could either move to establish its own operating company or alternatively bargain for a major role in any consolidation of interests that might emerge. None of these clusters was complete. Despite what engineers like Alexanderson might claim, none of them provided a basis on which could be constructed, without the high probability of extended litigation, an operating radio system that made full use of what was known to be feasible.[69]

For each of the corporations involved, some form of consolidation or pooling of radio patent rights seemed expedient. Even if it did not entirely eliminate the costs and uncertainties of litigation over patents, it at least promised to reduce them. And there were signs that each of them realized this. Gerard Swope, for example, while still with Western Electric, had sounded out his opposite numbers at General Electric as far back as 1918 about a possible unification of interests in radio. The Telephone Company, having staked its claims in radio by acquiring the de Forest audion patents and by its successful transatlantic radiotelephone tests in 1915, seemed disposed for the time being to confine itself to its traditional field of wired communications. If so, it might be persuaded to grant licenses for radio use to some organization that explicitly intended to confine its activities to radio and showed no inclination to invade the land-line business. If these two large organizations could be induced to cooperate, the smaller individual patent claims could be swept into the pool without too much trouble or expense.

The possibilities were there. RCA offered the means to explore them. And, in the person of Owen Young, there was a man who by personality and prior experience was disposed to move in that direction. Young did

[68] See Harold C. Passer, *The Electrical Manufacturers 1874-1900: A Study in Competition, Entrepreneurship, Technical Change, and Economic Growth* (Cambridge, Mass., 1953), pp. 321-29.

[69] General Electric, for example, although it could use the Fleming two-element vacuum tube by virtue of its alliance with Marconi, had no rights to the de Forest triode in any of its circuit configurations, and it had no claims to the Armstrong regenerative or superheterodyne circuits.

not care for conflict. He sought always the irenic solution. When conflict seemed to confront him, he looked for the underlying community of interest. And, time and again, he found it. This was the talent that had made him so valuable to General Electric and that, within two years, was to make him chairman of that company's board. RCA provided another field for his abilities.