Technical Research

A FREQUENCY MODULATION CATECHISM

PREPARED BY

FM BROADCASTERS, INC.

Editor's Note: On May 18, 1940, the Federal Communications Commission made public a decision via which a greater range of wave-bands and permission to accept sponsored programs were granted to the exponents of a new type of radio broadcasting—Frequency Modulation. Subsequently FM has supplanted television in the broadcasting industry's mind as the No. 1 nominee for future success and rapid expansion. But—like all new methods—FM arouses many questions, and evokes much curiosity as to operating technique, patents, etc. To obtain answers to these questions, the VARIETY RADIO DIRECTORY *asked FM Broadcasters, Inc., to prepare a simple, easily understandable catechism on the new art. It follows:*

What is frequency modulation (as opposed to amplitude modulation)?

Frequency modulation is a new way of sending radio signals from one point to another. It displays several outstanding advantages which the present and universally used system of amplitude modulation lacks. To the average layman the electronic mechanics of frequency modulation—even as those of amplitude modulation—are a thorough mystery. Perhaps the simplest way to explain the matter is this:

Radio waves in general have two fundamental characteristics.

The first of these is "frequency"—the number of times they vibrate per second, usually measured in kilocycles (thousands of cycles) or megacycles (millions of cycles). *Frequency, in radio, is like a street address. It tells you where to find a station on your dial.*

The second characteristic is "amplitude"—the strength or intensity of the signal. When we impose modulation (voices and music) upon a radio signal as in radio telephony (broadcasting), we have to vary something in accordance with these voices and music. The standard method of "amplitude modulation," which is generally employed just about everywhere from Vancouver to Capetown, varies the intensity of the signal. Static, incidentally, along with most interference and reception-marring noises, is produced by variations in electrical amplitude.

Frequency modulation takes another tangent. An FM signal remains constant in strength but alters the number of vibrations very slightly within a given channel. When this transmission is picked up by a special form of receiving set, the result is noise-free. FM avoids the usual sources of interference, and is capable of sending over the air programs of extreme naturalness. Furthermore, the strongest FM station on one channel always predominates so that a number of stations cannot be picked up at once.

What are FM advantages in terms of: (a) High fidelity reproduction; (b) Elimination of electrical interference; (c) Elimination of station interference?

There are three outstanding virtues offered by FM. First, of course, is its naturalness and full range of tone, allowing orchestras or speakers to sound as if they were right in the same room with the listener.

Second, because FM operates on a different principle from amplitude modulation, it is impervious to electrical interference, static, and the bevy of man-made noises that so often mangle broadcast reception.

The third and—from an economic viewpoint—most surprising merit of FM is its ability to permit many stations to operate on identical channels at close range without a caterwauling of interference. An FM receiver discriminates automatically between two signals, always picking the stronger one, and giving no indication of the weaker. Hence, if stations in adjoining towns use the same channel, each may service its local area without interference from its neighbor. Potentially, there is no well-defined limit to the number of stations which might operate in this country.

Who invented FM?

Frequency modulation is the brainchild of Major Edwin H. Armstrong, one of the greatest living inventors in the radio and electronic fields. Among his other noteworthy discoveries are the superheterodyne receiver, commonly used throughout the world today for picking up standard broadcast and other types of radio signals. He also perfected the regenerative receiver (which took radio out of the crystal set epoch), and the super-regenerative circuit, used to detect ultra-high frequency signals.

A protege of the late Michael Pupin, electrical scientist who taught at Columbia University, Major Armstrong first began tinkering with vacuum tubes as a college sophomore in 1910. It was in 1913, shortly after graduation from Columbia, that he filed for patents on his first major discovery—the regenerative receiver.

During the past 25 years Armstrong has been universally recognized as one of the greatest minds in the science of radio. His superheterodyne receiver is in common use throughout the world, more than 40,000,000 such sets being used for broadcast reception alone in this country.

Despite the magnitude of his other inventive achievements, Major Armstrong has lavished the most attention on FM, and has spent close to a million dollars of his own money in developing the new art.

FM came about as the outgrowth of Armstrong's original efforts to find an antidote for that reception-buster, static. His crusade started as long ago as 1914—shortly after his graduation from Columbia University (where he now ranks as a Professor of Electrical Engineering).

In the years between 1914 and 1940, Major Armstrong has worked intermittently but doggedly at his pet idea. In 1935 he took his system to the Radio Corp. of America which permitted him to set up a demonstration receiver atop the Empire State Building, N. Y. Later, however, RCA asked him to remove the apparatus so room could be made for television (which at that time was commanding RCA's primary attention in the field of new electronic industries).

Undaunted by this turn of affairs, Major Armstrong then began building a giant laboratory with a special 500-foot experimental antenna tower at Alpine, N. J., a few miles north of New York, overlooking the Hudson

River. The money that went into the building of this plant—assigned the call letters of W2XMN—came from the Major's own pocket. All in all, by his own admission, he has spent more on FM than he received from the tangled royalties on all his other radio inventions.

What is the resultant history of FM?

Despite Major Armstrong's persistence to see FM accepted as a superior means of radio transmission, it is doubtful whether his determination alone would have been sufficient to turn the trick. It remained for certain pioneers in the broadcasting world to investigate FM, then add their strength to the impetus that is carrying frequency modulation so far and so fast.

FM was first introduced as an accomplished fact in a paper delivered before the Institute of Radio Engineers by its inventor in 1935. As a radical swing from standard technique, FM at once found its way into several technical journals and thus was brought to the attention of the broadcasting industry.

It was shortly after Armstrong had been requested to remove his apparatus from the summit of the Empire State Building that he discussed the future of FM with an old friend—Carman Runyon of Yonkers, N. Y., who is a veteran radio "ham." Runyon built an FM transmitter operating on 2½ meters, and got it operating only a few hours before Armstrong was set to offer his paper at the Institute of Radio Engineers. The resultant demonstration startled the meeting.

Runyon, an executive in a large New York coal company, has been a constant co-experimenter with Major Armstrong for many years, participating in several demonstration FM relays that have been staged to show the possibilities of station-to-station transfer of network programs.

It was in 1936 that Armstrong went to Washington and sought ultra-high frequency channels for FM. Simultaneously, so did television. The latter won a total of 120 megacycles—nearly one-third of the allocated ultra-short wave portion of the radio spectrum.

FM was awarded 2.7 megacycles in which to experiment.

Meanwhile, one of FM's most ardent boosters, Paul A. deMars, who is vice-president in charge of engineering of The Yankee Network, became converted to the virtues of frequency modulation. Returning to Boston, he lauded the new system of radio transmission to John Shepard III, pioneer broadcaster who heads both the Yankee and Colonial networks in New England.

John Shepard III was equally enthusiastic. Yankee set aside $150,000 for the construction of an FM broadcast transmitter atop Mount Asnebumskit, near Worcester, Mass.; also had Major Armstrong design a relay transmitter which sends a narrow beam from the roof of the network studios in Boston 43 miles westward to the top of Asnebumskit, thus eliminating wire lines and providing high-fidelity transfer from studio to transmitter at all times, in all weather.

Soon afterwards came another disciple for the new FM system, Franklin M. Doolittle, owner of station WDRC at Hartford, Conn., who built FM station W1XPW atop Meriden Mountain.

Next to fall in line was General Electric, following experiments at Schenectady and Albany which convinced G-E engineers that here was a bandwagon well worth climbing aboard.

In 1937 Major Armstrong rushed construction of his own giant station, W2XMN, at Alpine. When opened the following year, its 40,000 watts were heard clearly at distances of 100 miles and more—no less a service range than the highest-powered standard broadcast station can boast during daylight hours.

Things began moving faster. Other stations filed applications with the FCC to experiment with FM. Stromberg-Carlson at Rochester, N. Y., and WTMJ, owned by the Milwaukee Journal, soon were ready to go on the FM kilocycles.

But one of the major drawbacks was the tiny wave-band which had been assigned by the government to this type of broadcasting. FM needed, more than any other single thing, room in which to grow. And so the leaders in the FM movement put their heads together to map out a course of action.

Who are FM Broadcasters, Inc.?

The formation of FM Broadcasters, Inc., as a nationwide organization of a non-profit nature, devoted to the advancement of frequency modulation, took place in January, 1940. John Shepard III, was voted president, with John V. L. Hogan of WQXR, New York, as vice-president.

Elected to the board of directors, in addition to these two were Walter J. Damm of WTMJ, Milwaukee, Wis.; Franklin M. Doolittle of WDRC, Hartford, Conn.; C. M. Jansky, Jr., of Jansky & Bailey, consulting engineers, Washington; Ray H. Manson, general manager and vice-president of the Stromberg-Carlson Telephone Manufacturing Co., Rochester, N. Y.; Carl Meyers, chief engineer of WGN, Chicago, Ill.; Paul W. Morency of WTIC, Hartford, Conn.; and Theodore C. Streibert of WOR, Newark, New Jersey.

The aims of FM Broadcasters, Inc., which now counts some 60 active FM groups among its members, are to "foster and promote the development of the art of frequency modulation (FM) broadcasting; to protect its members in every lawful and proper manner; to foster, encourage and promote laws, rules, regulations, customs and practices which will be in the best interest of the public; to protect the interests of the members of the Association by opposing the enactment or adoption of any laws, rules, regulations, customs or practices which would discriminate against or in any way injure the members of this Association to any greater degree or in any different manner than licensees of broadcast stations who are ineligible for membership in this Association, it being understood that all problems of a general nature which affect the broadcasting industry as a whole should be handled by the National Association of Broadcasters."

All members must be active ones. Those eligible to belong include "any individual, firm, or corporation who is licensed to operate a frequency modulation sound broadcast station...or has been granted a construction permit...or who has filed an application with the Federal Communications Commission for authority to construct a frequency modulation sound broadcast station."

Membership is in periods of a year, based upon the payment of annual dues of $300. The term of officers on the board of directors also runs for one year.

The secretary-treasurer of FM Broadcasters, Inc., is Robert T. Bartley at the Association's main office, 21 Brookline Avenue, Boston, Mass.

A branch and promotional office, with Dick Dorrance, director of promotion, in charge is maintained at 52 Vanderbilt Avenue, New York City. The Washington attorney for FM Broadcasters, Inc., is Philip G. Loucks, Loucks & Scharfeld, National Press Building, Washington, D. C.

Who controls FM patents? What do license rights cost?

Patents covering the frequency modulation method of radio transmission are held by Major Edwin H. Armstrong, inventor of the system. Armstrong will grant "to persons who are engaged or propose to engage in either experimental or commercial broadcasting and who desire to use the Armstrong system therein, licenses under the Armstrong patents in accordance with a standard form of license agreement."

Licensing agreements call for payment of the sum of $25,000 by transmitter manufacturers, in return for use of patents and the technical advice of Major Armstrong. In addition, there is a scale of royalties on each F-M broadcast transmitter sold, ranging from $300 on 250-watt installations to $5,000 for 50,000-watt installations.

Manufacturers of receivers are also required to pay for the use of the Armstrong patents, at a rate of about 2¼% royalty on all wholesale receipts.

What waveband is now assigned to FM?

Following hearings in March, 1940, at Washington on the future of frequency modulation broadcasting, the FCC has assigned a new FM broadcast band ranging from 42 to 50 megacycles, sanctioned commercial operation, and established 40 channels designed for stations using "wideband" or 200 kilocycle swing.

The hearing, at which Major Armstrong, FM Broadcasters, Inc., John Shepard III, Paul A. DeMars, together with numerous engineers and other authorities testified, presented a complete picture of FM's phenomenal growth and practicability. After nearly two months of deliberation, a decision was finally handed down on May 18, 1940.

Characterizing FM as "one of the most significant contributions to radio in recent years," the Commission opened the new 40-channel band, taking from television its No. 1 channel (44 to 50 mc.) in return for a new channel opened between 60 and 66 megacycles.

Of the 40 new channels, five are set aside for educational, non-profit stations. On the other 35—from 43 to 50 megacycles—unlimited commercial operation, identical with standard broadcast stations, will be permitted after January 1, 1941. During the interim, many frequencies must be reshuffled to make room for opening of the new territory.

"Frequency modulation," declared the FCC in a unanimous report, "is highly developed. It is ready to move forward on a broad scale and on a full commercial basis. On this point there is complete agreement among the engineers of both the manufacturing and broadcasting industries. A substantial demand for FM transmitting stations for full operation exists today. A comparable public demand for receiving sets is predicted. It can be expected, therefore, that this advancement in the broadcast art will create employment for thousands of persons in the manufacturing, installation and maintenance of such stations."

Government recognition of FM has been the signal for heavy activity

on the part of receiver and transmitter manufacturers. Commercial status offers the prospect of operation on a profitable basis, with as many stations on the air as the country, in any given locality, can economically support.

At the time when the FCC made its decision there were pending in Washington some 136 applications to construct FM stations. Another 22 had already been granted on an experimental basis. All of these applications and licensees are now eligible to refile for regular commercial broadcast stations.

Is network operation of FM feasible?

Network operation via FM is not only feasible but an accomplished fact. On several occasions test networks for demonstration purposes have been hooked up between New York and the Canadian border, involving as many as eight stations.

Because of the high fidelity possible over FM, plus the fact that regular land-line wires are unable as yet to handle such high fidelity programs, makes radio relay from point to point the only satisfactory method of chain broadcasting.

Whether the FM network of the future will be based upon one station picking up and rebroadcasting the next one, or whether definite point-to-point relays on even higher frequencies using beam transmitters are to be established, is one of the developments yet to be worked out.

Because of the astonishingly low noise-level and freedom from background rush, FM signals may be relayed from station to station across many hundreds of miles without any appreciable loss of quality.

What are the costs of building, operating and maintaining an FM station in comparison with an AM station of similar rating?

Installation and initial cost of an FM broadcast station runs no higher than that of a standard AM station. Transmitters cost from $67,000 for maximum power to $10,000 and less for smaller units.

Maintenance, if anything, is less than that of a regular AM transmitter, since in FM circuits all current drains are constant and do not fluctuate under modulation. This is tantamount to a slight reduction in the operating power bill.

Furthermore, high power output is no longer a necessity for a large service area. Height of the antenna above the surrounding countryside is a very important factor, since a 5,000-watt station on a mountain peak can usually cover far more territory than a 50,000-watt station in a valley.

What is the situation as to receiver manufacture, prices, marketing, etc.?

At the present time there are several manufacturers with FM and combination FM-AM sets on the market. However, the FCC decision, opening up a far wider band to FM transmission, means that new receivers must be readied for the market. Those offered the public to date have usually had a tuning range from 40 to 44 megacycles. The new band runs from 42 to 50 megacycles.

Stromberg-Carlson, General Electric and Scott Radio have thus far been most prominent in manufacture and merchandising. However a dozen more firms, including Stewart-Warner, Farnsworth, Pilot, Zenith,

Philharmonic and others are now engineering FM chasses to be ready for the market almost immediately.

Prices range upward—under the present non-assembly line method of production—from approximately $60 for a plain FM table model. Combination sets, expected to sell best, run from $130 to as high as the consumer wants to pay, the expensive sets being based on the cabinet cost, as is the case with AM receivers.

Under heavy production, prices are expected to be only a trifle more than those of standard sets, the slight increase being traceable to the added cost for a superior speaker capable of giving more faithful reproduction. The actual wiring of an FM set is no more complex than that of today's ordinary sets.

It is impossible to guess what FM receiver sales for 1940 will be, but most large manufacturers are planning extensive advertising and promotional campaigns.

What is the situation as to the manufacture of FM transmitters and other necessary equipment?

There are today four companies outstanding in the manufacture of frequency modulation transmitters. Pioneer among these is Radio Engineering Laboratories, Inc., of Long Island City, N. Y., which has diverted most of its efforts toward the production of FM transmitting equipment. Most of the FM installations thus far in operation about the country are products of the R. E. L. factory.

General Electric, following a long period of experimentation, is also offering an assortment of FM transmitters to the broadcasting industry, while a third concern to move along these lines with a stock model is Western Electric.

In addition, RCA has announced the production of a one-kilowatt FM unit for sale to broadcasters.

What are the basic regulations set up by the FCC to govern the operation of FM broadcast stations?

In a new set of regulations, issued June 22, 1940, the Federal Communications Commission refers to FM as "high frequency broadcast" to distinguish it from standard broadcast. "Rapid development of FM stations throughout the nation," declared the Commission, "is expedited by FCC action in apportioning frequencies and otherwise stipulating operation of FM so as to make such broadcasts available to as many American homes as possible. Under the rules just approved, FM facilities are, in effect, available to every community in the land."

These rules require that all FM stations must operate a minimum of six hours daily, three during the day and three at night. At least one hour of each day and one hour of each night must be given over to programs not duplicated simultaneously in the same area (in other words, distinct from standard broadcast). The multiplex transmission of facsimile and aural programs is also permissible, provided the facsimile is incidental to the aural broadcast.

"To safeguard the public against monopoly," states the Commission, "no person or group can directly or indirectly control more than one FM

station in the same area. Likewise, no person or group may control more than one such station, except upon showing that such operation would foster competition or will provide a high-frequency broadcasting service distinct and separate from existing services, and that such operation would not concentrate control in a manner inconsistent with public interest, convenience, or necessity.

"In this connection, the Commission declares that control of more than six stations by the same person or persons under common control is inconsistent with the public interest."

FM ALLOCATION TABLE

The channels made available by F.C.C. Order 67 to FM broadcast stations, including the multiplexing of facsimile transmission simultaneously with aural broadcasting, are assigned to services as follows:

Non-Commercial Educational Broadcast Stations

42,100	42,500	42,900
42,300	42,700	

Stations in Cities of Less than 25,000 (*Service Area of* 500 *Square Miles*)

48,900	49,300	49,700
49,100	49,500	49,900

Stations in Cities of 25,000 (*Service Area of Less than* 3,000 *Square Miles*)

44,500	45,900	47,300
44,700	46,100	47,500
44,900	46,300	47,700
45,100	46,500	47,900
45,300	46,700	48,100
45,500	46,900	48,300
45,700	47,100	48,500
		48,700

Stations in Metropolitan Districts (*Service Area in Excess of* 3,000 *Square Miles*)

43,100	43,500	43,900
43,300	43,700	44,100
		44,300

TELEVISION: 1939-40

Television during the past year suffered as stormy a fate as ever beset a branch of the radio industry. As the VARIETY RADIO DIRECTORY went to press, the future of the new art was in such a muddle following F.C.C. orders and counter-orders that no predictions of coming progress may safely be ventured. To state the matter briefly: television has been returned to a strictly experimental basis after high hopes had been raised that partial commercialization would put the industry into high gear on Sept. 1, 1940. Furthermore, one of the channels assigned to television has been given over to Frequency Modulation. And finally, the order of things as they now stand, after months of tumult, undoubtedly works to the greatest disadvantage of television's foremost exponent—the Radio Corporation of America, which is said to have spent some $10,000,000 in fostering the growth of the new medium. Historically, the current situation came about as follows:

On Jan. 3, 1939, the F.C.C. appointed a Television Committee—composed of Commissioners T. A. M. Craven (chairman), Norman S. Case, and Thad H. Brown—to make proposals concerning the future regulation of the medium, with particular attention to the prospect of interesting the public in television developments. The appointment of this committee coincided with a television flurry largely created by RCA, Du Mont, the Don Lee Broadcasting System, and other interested parties. RCA, always in the van of this activity, on April 30, 1939, began a continuous service of television programs in New York City, and both curiosity and interest were rife. It was generally assumed in the trade press that television's first great "push" for public favor was beginning.

First Television Committee Report

On May 22, 1939, the F.C.C.'s Television Committee turned in its first report on the situation. Its principal recommendations were twofold: 1) that no fixed standards regarding transmission and allocation be adopted, thus avoiding an early "freezing" of the art on a fixed level; and 2) that the F.C.C. cooperate with the industry in helping television gain a foothold.

Throughout the summer of 1939, television continually was in the headlines. RCA-NBC kept pumping out programs in New York, and there was a general belief that television, as a whole, was now ready to be taken out of the laboratory and given a fair trial as a means of public entertainment and enlightenment.

Second Television Committee Report

In the fall, on Nov. 15, 1939, the F.C.C.'s Television Committee issued a second report. This new document fully agreed with the idea that television should be presented to the public. The committee advocated that two classes of television stations be established. The first group—called Class I stations—would be the laboratory-research group, carrying on a program of "research and experimentation in the technical phases of television broadcasting, not requiring a service directly to the public." The other group—called Class II stations—would directly bring television to the public by concentrating on experiments with programs at least five hours per week. Underscoring the importance of the second (Class II) group, the committee advocated that they might carry sponsored programs, "provided such sponsorship . . . and funds are primarily used for experimental development of television program service."

In the matter of transmission-allocation standards, the committee said: "While the future may require changes in the Radio Manufacturers Association standards by reason of improved and proved technical progress, this committee recognizes that, for the time being, these standards must be used for scheduled program service, and recommends that similar action be taken by the Com-

mission." It was the opinion of the committee that the lower television channels (44,000-108,000 kc) be distributed as follows: three channels to metropolitan districts in excess of 1,000,000 population; two channels to areas between 500,000 and 1,000,000; and one channel for districts less than 500,000. Meantime the committee pointedly demanded "protection of the public, as far as possible, against loss through obsolescence in receivers."

After the F.C.C. received this committee report, it mulled over the contents for a month. Obviously the industry would disagree with some of the conclusions. There was sure to be an uproar over the recommendation to adopt the Radio Manufacturers Association standards.* There was also much talk that the proposed partial commercialization was not legal, inasmuch as the F.C.C. is not authorized to regulate the disposition of money received from sponsored programs. In the end the F.C.C. adopted the report, and simultaneously scheduled hearings on it beginning Jan. 15, 1940.

The January Hearings

The hearings, as expected, were a stormy session. RCA clamored for the Radio Manufacturers Association standards, while the Allen B. Du Mont Laboratories clamored against them. Philco thought that commercialization was not as yet feasible. And so on for eight tempestuous days. After thousands of words had gone into the record, the F.C.C. made a tour of inspection of various television plants, thought the matter over, and then (Feb. 29, 1940) issued its rules. They differed only slightly from the original committee report.

Partial Commercialization Permitted

For one thing, they carried into effect the idea of Class I and Class II stations—the former for laboratory experiments, and the latter for public program experiments. The idea of fixing any transmission standards, allocating definite frequencies, or assigning stations by size of community, however, was completely dropped so as not to "freeze" the industry. Class II stations were ordered to operate at least ten hours per week (as against the committee's recommendation of five hours). Regarding commercialization, the F.C.C. ruled (Section 4.73, b):

"Beginning Sept. 1, 1940, Class II television licensees may make charges against program sponsors to cover the cost of programs produced for respective sponsors; and such sponsored programs, including advertising material, may be transmitted as part of the station's experimental program service, but without charge for transmission."

The rules concluded with a warning that "nothing should be done which will encourage a large public investment in receivers which, by reason of technical advances when ultimately introduced may become obsolete in a relatively short time."

RCA's New Plans

Apparently this was the "green light" which had been awaited, and RCA was the first to react overtly to it. On March 12, 1940, RCA publicly announced a three-point television program for the immediate future. It specified:

1) Elaboration of the program schedule for the RCA-NBC station in New York.

2) A reduction in television set prices, backed by a new merchandising campaign. Receivers priced at $600 were cut to $395; those listed at $450 were marked down to $295; and so forth.

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*RMA standards concern both transmission and reception. They call for high-fidelity pictures, incorporating 441 lines per frame; flicker elimination by interlaced scanning; adequate clarity via 30 frames per second, and a field frequency of 60 per second; single sideband operation at the transmitter. RMA standards of antenna height, power, etc., are too technical to be discussed here.

3) Construction of a relay system of "booster" stations between New York and Philadelphia in anticipation of chain-broadcasting. This system would be effected by means of little retransmission units perched on 100-foot steel towers at intervals of about thirty miles. The units would pick up a signal, convert it into a frequency of 500,000 kc, then pass it on to the next "booster" with a 10-watt impetus, until the signal automatically reached its destination.

Four days later, on March 16, RCA announced it had filed applications for television stations to be located in Philadelphia, Washington, D. C., and Chicago.

F. C. C. Rescinds Its Regulations

No sooner had this comprehensive program been publicly announced than the F.C.C. fired a bomb directly into the whole scheme. Without warning, the Commission on March 22 rescinded Section 4.73 (b) of the television rules (which had allowed partial sponsorship), and ordered new hearings "to determine whether research and experimentation and the achievement of higher standards for television transmission are being unduly retarded by the Radio Corporation of America." RCA's promotional activity, alleged the F.C.C., "not only intensifies the danger of these instruments (receivers) being left on the hands of the public, but may react in the crystallizing of transmission standards at present levels. Moreover, the possibility of one manufacturer gaining an unfair advantage over competitors may cause them to abandon the further research and experimentation which is in the public interest and may result in crowding them into the market with apparatus at present efficiency levels." With this dictum, the F.C.C. set April 8 as the date for further hearings on the whole matter.

This turn of affairs immediately provoked considerable anti-FC.C. comment in the press and in the halls of Congress, but to no avail. The scheduled hearings were held, much of the ground covered in the original January sessions was retrod, and on May 28 the F.C.C. released its conclusions:

Sponsorship Permission Revoked

"The positions of the different companies on this whole problem cannot be viewed with total disregard of the patent interests. . . . It has been . . . decided that there should be no commercial broadcasting, with its deterring effects upon experimentation, until such time as the probabilities of basic research have been fairly explored . . . The provision in the rules for Class II stations will be eliminated . . . With the view to encouraging research and experimentation on a wholly flexible basis, the Commission is prepared to authorize broader experimental operations by existing stations and a number of additional stations . . . Revised rules designed to carry into effect the conclusions reached herein will be issued in the near future. . . ."

Therewith television's minor boom abruptly came to a halt, for the time being at least. Making the outlook even blacker, the F.C.C. allotted the so-called No. 1 television channel to the Frequency Modulation broadcasters, which means that several television exponents will have to readjust television receivers and shift to new wave-lengths. (For a digest of new F.C.C. rules anent television, see Page 443).

RCA's Experiences

RCA, however, undoubtedly can salvage some valuable facts from its experiments which will be useful when television's future looks brighter. Set-owners in New York (about 3,000) have been polled for their program preferences, and have indicated that they prefer dramatic programs to any other type of current program. Outdoor events (sports, etc.) received the second largest vote, with film features and shorts running in third and fourth positions. Experiments with advertising materials also have been carried out (free of charge to the advertisers). And on May 7 RCA showed its stockholders a new large-screen television apparatus which projects an image 4½ by 6 feet.

TELEVISION CHANNELS

The following channels have been assigned by the F.C.C. for the use of experiments in television. The channels in what is known as Group A include numbers 1 to 7 inclusive. This is the regular station band. Group B comprises channels 8 to 18. There is also a Group C which is defined as "any 6,000 kc band above 300,000 kc excluding band 400-401,000 kc." Groups B and C are for auxiliary and relay purposes.

Channel No. 1	50— 56,000	Channel No. 10	186—192,000
Channel No. 2	60— 66,000	Channel No. 11	204—210,000
Channel No. 3	66— 72,000	Channel No. 12	210—216,000
Channel No. 4	78— 84,000	Channel No. 13	234—240,000
Channel No. 5	84— 90,000	Channel No. 14	240—246,000
Channel No. 6	96—102,000	Channel No. 15	258—264,000
Channel No. 7	102—108,000	Channel No. 16	264—270,000
Channel No. 8	162—168,000	Channel No. 17	282—288,000
Channel No. 9	180—186,000	Channel No. 18	288—294,000

CONSULTING RADIO ENGINEERS

Altec Service Corp.
250 W. 57th Street
New York City

Victor J. Andrews
6429 So. Lavergne Avenue
Chicago, Ill.

Stuart L. Bailey
Jansky & Bailey
National Press Bldg.
Washington, D. C.

John H. Barron
Earle Bldg.
Washington, D. C.

Herbert Lee Blye
1014 West High Street
Lima, Ohio

William W. L. Burnett
William W. L. Burnett Radio Laboratory
4814 Idaho Street
San Diego, Calif.

Joseph A. Chambers
McNary & Chambers
National Press Bldg.
Washington, D. C.

Commercial Radio Equipment Co.
7134 Main Street
Kansas City, Mo.

A. Earl Cullum, Jr.
2935 N. Henderson Avenue
Dallas, Tex.

John H. De Witt
Radio Station WSM
Nashville, Tenn.

George C. Davis
Page & Davis
Munsey Bldg.
Washington, D. C.

Dr. Lee De Forest
5106 Wilshire Blvd.
Los Angeles, Calif.

Doolittle & Falknor, Inc.
7421 S. Loomis Blvd.
Chicago, Ill.

Edwards & Martin
Union Guardian Bldg.
Detroit, Mich.

Herman Florez
1 Nevins Street
Brooklyn, N. Y.

Glenn D. Gillett
National Press Bldg.
Washington, D. C.

Paul F. Godley
10 Marion Road
Upper Montclair, N. J.

Dr. Alfred N. Goldsmith
444 Madison Avenue
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1407 S. E. Howard Street
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