The Signal

OFFICIAL MAGAZINE OF THE COLLINS COLLECTORS ASSOCIATION * Q3 2013 Anniversary Issue *

COLLINS RADIO
RISING TO THE CHALLENGE
- 1945 to 1970 -

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Collins Collectors Association


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The Signal Magazine

OFFICIAL JOURNAL OF THE COLLINS COLLECTORSASSOCIATION

Issue Number Seventy One - Third Quarter 2013

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Ass't Editor, Don Jackson, W5QN

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- In Memory -
of
Ben Stearns Jr. and Honoring the People of The Collins Radio Company

This issue is dedicated to Arthur A. Collins and to all of the people who worked for him over the years. It is written in deep appreciation for what they all gave to our country in the many instances of need. They showed us a path that leads to excellence. They showed us dedication and what the future of our country should look like.

Just prior to going to press here with this issue, the world lost Ben Stearns (January 8, 1927 - August 23, 2013) who passed away quietly after a long illness. Ben was retired from Collins Radio where he was in charge of Public Relations for Collins in Cedar Rapids, Iowa.

Ben had also served 15 months in the Philippines during World War 2 before returning to his career in newspaper journalism, and then public relations. He loved Art Collins and deeply respected him. In his later years he wrote and left the world his fine book on Arthur Collins, Radio Wizard.

We will miss Ben - as we miss so many good people that worked for Art, and dedicated their careers to a great company.

In this issue you will hear first hand from a number of people who "lived" this period at Collins. This is a rare privilege and we thank those people who contributed, not only during their career, but now for us here.

One of those people, Ed Andrade (SK 2007), gives us real insight into Art Collins with his previously unpublished essay on his "Boss".

In addition, in his personal papers, Ed left behind a hand written note on a piece of note paper. He wrote this not long before he passed away.

To All Engineers

Old engineers never die. They just keep writing equations in the sky !

In tribute to Arthur Collins and all my engineer friends who have reported to "THE" chief engineer !

E.A. Andrade 6/14/07

A Quick Look in This Issue

FROM THE STAFF

by Bill Carns, N7OTQ & Don Jackson, W5QN

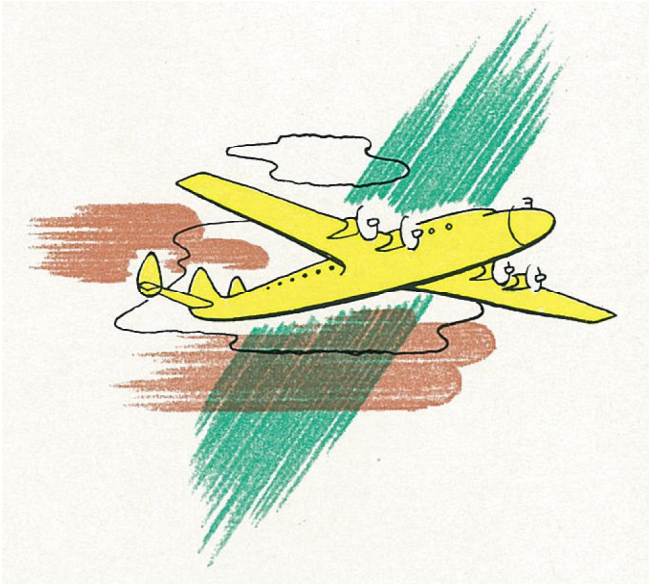
From the Desk of N7OTQ . . . .

First, I want to thank all of you who took the time to write and say that you were enjoying the *Signal Magazine*. The response to the last issue was overwhelming - to say the least. At the same time, the CCA membership ranks have swelled bringing us to a new high in membership and activities. Without a doubt, we are getting as much pleasure out of doing these anniversary issues, as you apparently are out of reading them. Just the research and learning process alone is an adventure that I would not miss.

When this all started, the concept of doing four quarterly anniversary issues of the *Signal* on the four periods of Collins' history was exciting. I looked forward and thought that the Q1 (Prewar) and Q2 (WAR) issues would be the toughest, because these were the periods that I was the least familiar with. In a vain attempt to keep my hobby somewhat under control, I had started out with a limit for my activity covering Post WW II through to the end of the Winged Emblem S-Line. Thus, overly confident about the Q3 and Q4 issues, I dug into the Q1 and Q2 periods to learn and recruit help. It worked….at least that part of it. Good contributors and research paid off and the results were apparently pleasing.

Now, the Q3 issue is seriously in progress and reality has set in. The Q1 issue covered only about 10 years. Q2, the WW 2 era, covered a mere 4 or 5 years. Now, suddenly I realize that the task is to try and capture the essence of the 25 years between 1945 and 1970.

Let's see….there were no less than 5 recessions, two more wars, the Space Race, the Cold War, the semiconductor revolution occurred, and the PC and ubiquitous computer controller came on the scene. Radio – stimulated by the returning troops and their war experiences – became a common denominator and the cell phone was right around the corner. Product design cycle times – stimulated by CAD – plunged from years to months and quality levels soared in the U.S. as we were forced to learn to compete with Japan and then Asia.



The Q3 issue would have to deal with these conditions and also tell the story of a company that – having blossomed into a full-fledged manufacturing operation during the war - effectively attacked and conquered almost all of the markets that it addressed.

To attempt to cover all of this landscape in the same detail as presented in the Prewar and War issues would drive the size of the magazine beyond reasonable bounds. An attempt has been made to present those facets of the environment that had really significant impact on the direction of the Collins Radio Company and to describe the result.

Along the way, we got lucky – all of us that is. It does not get any better than having the story be told by those who were there and lived that era. In this issue, we will hear from Warren Bruene, Dennis Day, Gene Senti (He gave me an article right before his death), Ed Andrade, and finally, Art himself.

FLASH! We are privileged here to have Arthur A. Collins speak to us directly. It is not often, if ever, that we get such an opportunity. Late in the production of this issue, a letter of great significance surfaced in Dallas. It is a letter written on November 1, 1945. This letter states clearly the policies of the Collins Radio Company that would be used as it moved forward past World War 2, and into its future.

It reveals a man of great patriotism who is challenged by the future and solutions to technical problems that are of significance. It shows a man who – first and foremost - loved his country, his fellow man, and (above all else) wanted to do what was right for the country, the general public and his fellow Collins Radio Company employees.

It also shows a man who, while concerned with the financial integrity of the company (he obviously knew this was necessary to accomplish all of the above objectives), considered financial management secondary in his thinking and priorities. He truly was a believer in the concept of "Build it and they will come".

Testimony to his leadership, and the strength of his character, is the fact that these philosophies did prevail, they did enable the technical leadership and outstanding engineering contributions that were achieved over the years, and they did endure for some 25 years to follow the letter. This was not a product of the efforts of one man. This was the product of an entire culture that Art encouraged and managed.

Would we change that - and change history? I think not. Would we paint the picture of what Art and his company did - and achieved - from 1945 up to 1970 with an off color brush? Certainly not! Such would be to wish the history of the cold war, aviation, our space efforts, and communication progress in this country, to be quite different.

Read the letter – get to know the man. Incredible!

The letter cannot appear here because of space allocation issues and the lateness of the hour, but if you will go to the CCA website at: http://collinsradio.org/signal/aacnov45letter, you can read this heart-warming, and eye opening, letter yourself.

My Best 73s - Bill, K0CXX/N7OTQ

email: wcarns@austin.rr.com

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3rd Quarter 2013 Signal Magazine

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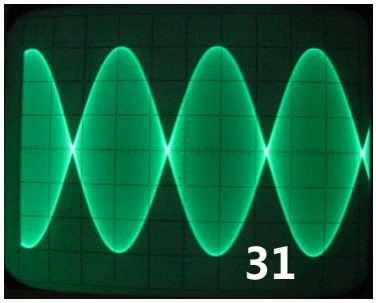
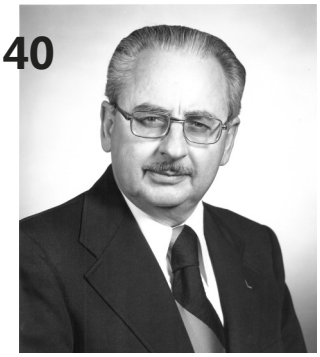
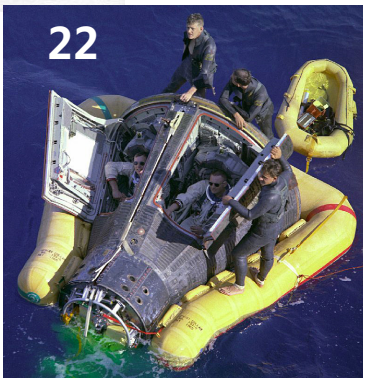




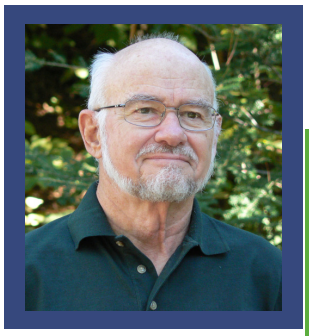


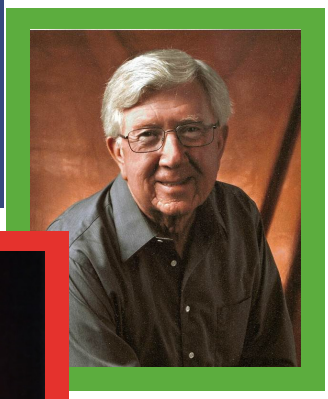
ON THE COVER: The launch of Apollo 8 symbolizes an era when Collins reached for the moon while serving our country.

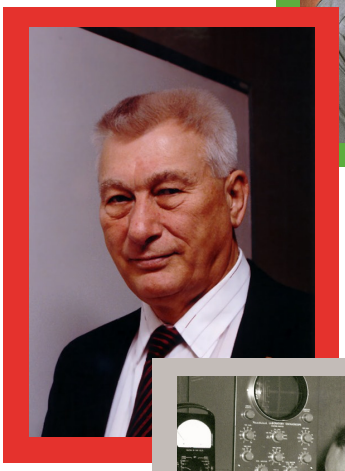
FEATURES

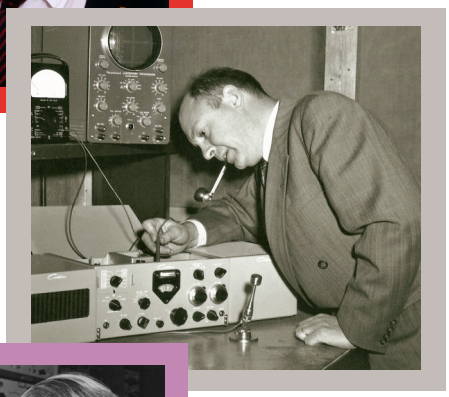
Regulars

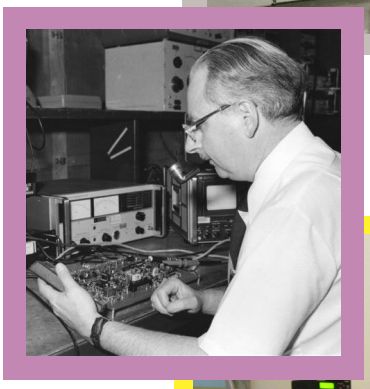
OUR CONTRIBUTORS











Bob Thomas, VE3TOU
"The 51J-5 Dream Receiver" *page 20*

Bob has been collecting Collins for over 15 years. He is a retired Electrical Engineer with design experience and founded and managed Treetop Circuits. He enjoys his Collins—particularly his KWM-2A. He is married with 2 grown children and grand kids and lives in Godfrey, Ontario, Canada

Dennis Day, W0ECK
"The 30S-2/3 Autotune Amplifier" *page 26*

Following an internship under Gene Senti during his college days, Dennis returned to Collins after graduation and was assigned as the Project Lead Engineer for the 75S-3. The result was our favorite S-Line receiver. He went on to become the Director of Engineering following Gene's retirement. He is now retired - and lives with his wife Pat - and his Studebakers - in Cedar Rapids, Iowa.

Warren B. Bruene, W5OLY
"Two Tone IMD Measurements", *page 31*

Warren Bruene here shares his experience in RF theory with his admirers. Warren retired from a long and illustrious career at Collins Radio and is well known for his work in RF design and theory. He developed the Bruene Coupler, tetrode neutralization and holds numerous patents in RF design and applications. He is the father of our 30S-1 and many VERY high power transmitters around the world - like 250 kW ! He now lives in the Dallas area.

Gene Senti, W0ROW
"The 75A-4 Described", *pg 32*

Prior to his passing, Gene shared this writing with your editor. It shows us his pride in his new "Baby". Gene retired from a career at Collins that closed with him leading the Amateur Radio Engineering at Collins. He gave us the KWM-1, the 30L-1, and with his leadership, the S-Line in general. Biography Q2 2008 *Signal*.

Ed Andrade, W0DAN
"Andrade on Art Collins", *pg 42*

Ed Andrade shares his perspective on Art Collins - written after Ed's retirement. Ed worked in various Product Engineering capacities over a 34 year career with Collins and Rockwell. He was the responsible Project Lead on the KWM-2/2A, the 51S-1 and the 30S-1.

Don Jackson, W5QN
"The 30S-1 20.5 foot Cable - Why?" *page 16*

Don Jackson shares some of his technical knowledge and sheds light on the "infamous" 20.5 ft cable. Don writes often for the *Signal* and is our Assistant Editor.

The Collins Radio Company - After the Wars - 1945 to 1970

by Bill Carns, N7OTQ

Prolog: This is a story of passion and service. As it proceeds, you will see a thread of financial data, both for Collins Radio and for the US economy. This provides important background for the environment in which Art Collins and his management team would operate the growing company founded not that long before World War 2 started.

We pick up at the end of the war. By the very nature of the definition of the four periods of the history of Collins Radio used to define the objectives and content of these four 80th anniversary issues of the Signal Magazine (Prewar, War, Postwar & Post-Rockwell), one might conclude that this issue was the story of a process leading to failure – the failure of Art Collins, his management team, and ultimately the company. Nothing could be further from the truth.

The series of events (really stretching over the entire 25 years from 1945 to the start of the Rockwell investment and rescue of Collins Radio) is most certainly a story of, not only Art Collins' journey, but also the story about, and tribute to, the people who worked for the company during that time period. It is, indeed, a story of vision, commitment and the pursuit of excellence.

Many of these people are gone now, but many are still alive, and we hope enjoying this revisiting of their performance during the postwar years at Collins Radio.

During this amazing Post-War period, the management team at Collins, strongly influenced by the philosophies of A. A. Collins, led the company to an ever expanding series of market entries, or penetrations, where – almost without exception – Collins managed to achieve a dominant position, if not in market share, then in product excellence and quality.

The period between 1945 and 1972 was unlike any other period in the history of the economy of our country. Following the recovery from WW2, there rapidly followed the Cold War, Korean War, Vietnam, the Space Race, the unbelievably rapid evolution of electronics technology catapulted forward by the semiconductor revolution, the ensuing computer revolution, television, the appearance of Japanese competitors and finally no less than five recessions during the 25 years. All of this provided a dynamic playing field for any company – let alone one focused on high tech and military products. This was indeed a minefield of notable proportions.

To tell this story adequately – to do complete justice to the subject and the people at Collins who accomplished so much – is quite beyond the scope of a magazine article. It indeed warrants a book, or maybe even two.

Here we will use a montage of text and photos, some perhaps boring economic data, and a sampling of product and company growth information to try and paint a picture of what happened in those 25 years at Collins Radio. It is a picture of service and dedication to the advancement of technology that led finally to deceptively rampant growth in the late 60s when a recession of severe proportions caught an unprepared company off guard. Fortunately for us and for Collins, Rockwell was there. At the time, there were actually five major players trying to become involved in the future of Collins Radio. Honeywell briefly, Schlumberger, TRW, and also Ross Perot, made overtures or serious attempts to purchase the struggling Collins Radio…The outcome could have been much worse.

In the long run, we all know the ending. Some things changed at Collins Radio – pretty abruptly in some cases. Art eventually was motivated by circumstances to move on to his next challenge not related to Rockwell (his passion for the computer continued). With Rockwell's help, Collins - imbedded in Rockwell - successfully navigated the recession minefield. Collins Radio reemerged another quarter of a century later as Rockwell Collins - divested by Rockwell in the course of breaking up Rockwell International. Rockwell Collins (ne … Collins Radio by another *now* brand name) would again bring the NYSE call COL back to the big board. Collins Radio was back in business, but that is another story for the Q4 issue.

What I hope you will see in this story is the breadth and depth, the quality and the significance, of the eventual Collins Radio product offerings that managed to dominate the markets that Collins Radio entered: Commercial Avionics, critical Military Communication and Aviation needs, the Broadcast Industry with the emergence of FM, Commercial Microwave, Aero Space, and yes, Amateur Radio. One should add Computer Systems and Data Services, but……well, in all honesty, they never really achieved what Art would have hoped for there.

It is often said that it was the expansion into the Computer Systems and Data Processing and Services that brought about the Rockwell Collins chapter of Collins' history…Watch closely and I think you will see a different version of the tale.

As I said, it is a tale of passion and service to his country and to the ideals that drove him…Excellence, Quality and the supply of critical solutions to technology needs and problems.

My thanks here to some people without which this could not have been written. Ms. Ellen Dennis, Sr. Administrative Assistant, Investor Relations, Rockwell Collins, provided great help locating financial data and Annual Reports from the period. Ben Stearns, Author and retired Director of Public Relations, Collins Radio provided his insight and historical perspective. Many Collins Radio associates – some retired - also helped with historical commentary. Finally, Lawrence Robinson was a big help when research was required from the Museum Archives at Rockwell Collins.

Celebration short lived - The celebration over the ending of the war in the fall of 1945 was short lived at Collins. The management team was facing a daunting task. They had a much expanded manufacturing capacity and a workforce totaling over 3500 employees. For the most part, all of the government contracts that were on the books at war's end (a total of $45.8M) were cancelled by an act of Congress immediately following the end of the war with Japan.

When the smoke cleared, Collins was left with $14.6M of contracts on the books. To put this in perspective, remember that they had shipped $44M worth of product in FY 1945 ending July. These remaining bookings (contracts) were for equipment deemed critical for post war modernization of the armed forces. The more difficult news was that these remaining contracts were being serviced (to a significant percentage contractually) by sub-contractors established during the war. This meant that the $14.6M worth of business, to be delivered over several years, was – on average - very low margin business and less than half of it would actually be built by Collins. This was not a pretty picture from a P & L standpoint.

In spite of this, in the 1945 annual report, Arthur optimistically related that "This backlog provides a body of work adequate to employ the company's facilities for a period approximating the fiscal year ending July 31, 1946, during which time, an orderly realignment of activities can be accomplished."

Later in that same letter to shareholders, and having just discussed the projected loss of profitability during the first period of FY 1946, he goes on to say; "Assuming a fair degree of stability in the industry and shipments as planned, it is expected that the last six months of the current fiscal year will be sufficiently profitable to more than offset the effects of the present period."

Collins Radio had 150,000 square feet of almost unused manufacturing space. They were in the process of downsizing from the war high of 3700 employees to just over 1000. Their backlog was heavily weighted towards low margin sub-contracted business and "a fair degree of stability…" in the marketplace was, as it turned out, not in the cards.

Recovery - Collins made frantic adjustments emptying and releasing leased space, cutting back unnecessary direct labor and trying to shelter critical indirect employees. At the same time, they were gearing up previously developed commercial product lines so some commercial business could be added to the mix. Meanwhile, with the returning glut of troops, similar business struggles were taking place all over the country as companies that had been commandeered for war production laid off employees and went through the same agony that Collins was going through. The inevitable happened. The recession of 1946 hit the country hard right at a time when it needed it the least.

Art Collins' prognostication that the company would correct things and return to profitability during 1946 turned out to be the furthest thing from the truth.

Postwar Net Sales & Net Income - 1946 to 1950

Year	Net Sales (M$)	Net Income (M$)	Net Profit After Tax (%)
1946	13	nil	0
1947 1)	12.2	0.017 2)	< 1
1948	7.5	-0.4	-4.9
1949	9.7	0.2	2.3
1950	12.7	0.5	3.6

Notes:

1) Postwar Net Sales adjustments f/ war contracts and reserves were $4M

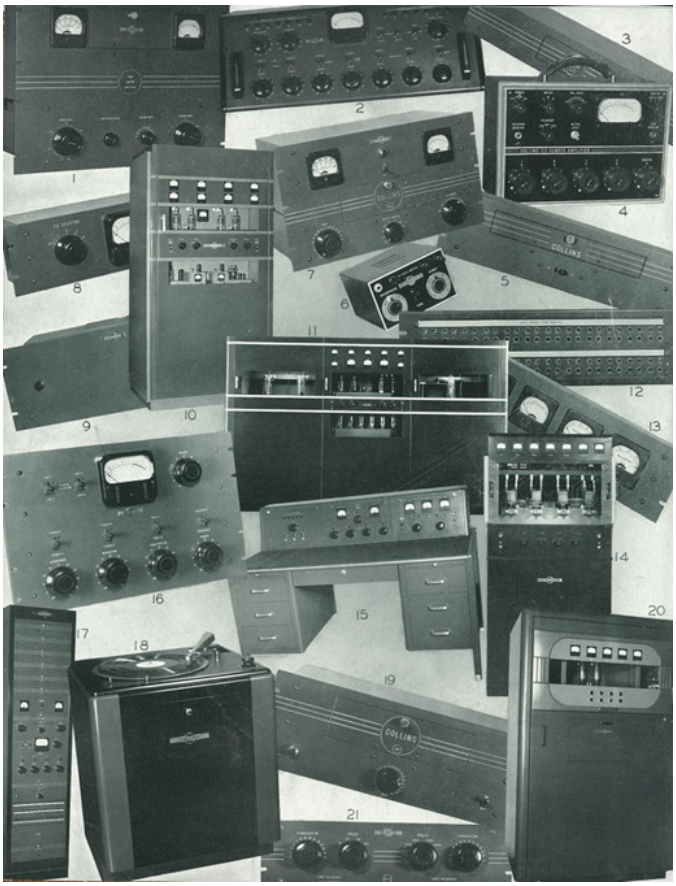
2) Net Income (Pre-Tax) was loss of $113,194 before these adjustments

In fact, it would be 1949 before the company returned to marginal profitability, and FY 1950 before the Net Sales would approach the 1946 level of $13M. The profitability, while appearing slightly positive in FY '46 ($1000 Net Profit - nil - was the result of a $404,000 Federal Tax Credit being used to offset a loss of $404,000 before tax), would be consistently negative for those 3 turbulent years between 1946 and 1949. Such war-related turbulent government profit renegotiation and P & L corrections would haunt Collins for the next 4 or 5 years.

It is interesting to note that Motorola, a company similar in structure, size and served markets, but entering the war somewhat more mature at $9M sales, grew to over $80M in sales during the war but never lost profitability. Motorola earnings per share during the war were modest at about $1 per share. (Collins was not a public company during most of the war.) The recession of 1946, reduced this to $ 0.80 per share but earnings bounced right back to over $3 per share in 1947 and continued very positive while their sales grew back to the $80M range by 1949. This was a much more rapid and controlled recovery than Collins - in large part due to the heavy consumer leaning of Motorola after the war, compared with Collins' commitment to Government, Avionics and the high tech commercial businesses.

During this four year period that it took to achieve some level of normal operations, life was not easy at Collins Radio. Reductions in the workforce, motivated by the much lower postwar sales level, were continuous and, in fact, Collins did not reach their postwar employment low of 1200 until early 1948.

During 1946, Collins purchased the 100,000 sq. ft. portion of Main Plant that had been built with government funds during the war for lease-back to Collins. Collins purchased this facility for the bargain price of $374,000. Also in 1946 they, with great optimism that read on the future, started construction of another 80,000 sq ft of building close to Main Plant that would be used for warehouse and manufacturing needs in the future. This would allow them to release more of their leased space in Cedar Rapids.



Broadcast Product Offering in 1946

The Broadcast Products were the first to be brought to market in volume. The 1946 Annual Report, along with the advertising of the period, focused on what would produce the fastest revenue. The advertising emphasized the Avionics, Broadcast and Amateur Radio products as sources of immediate income.

The previous page shows a figure out of the 1946 Annual Report showing the span of products being readied for this Broadcast market opportunity. Most will be recognized as existing prior to the war.

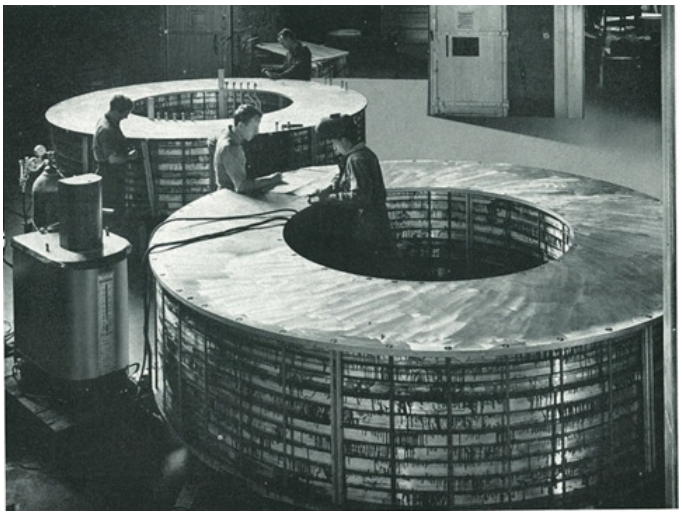
With the FCC's postwar decision to move the FM Radio entertainment band from the 42-50 MHz prewar band to the current 88-108 MHz frequencies, the FM broadcast business required new transmitters, and usually the associated equipment, as stations were modernized. FM took off slowly at first - impacted by the struggle between Armstrong and Sarnoff of RCA. Sarnoff (who had a vested interest in the old band), in his inimitable fashion threw out gobs of misinformation about the change – still trying to beat out the innovating Armstrong. Although delayed somewhat by this battle, FM took off by 1947.

In addition to FM requiring new equipment, AM stations, limited to no new equipment for the 4 years of war production, were starting the process of upgrading equipment. All of this was couched in the background of the emerging new media – Television – itself requiring new equipment. In addition to modernization, there was an extended period during the later '40s, and into the late '50s, where AM and FM radio were perceiving the new interloper TV to be a market threat. This resulted in a rush by the radio folks to increase power, buy better equipment, and put their stations in a better position to capture listener mind share. The broadcast business potential was very high. Art was very right to move the Broadcast equipment to the front of the line. It was a good future revenue producing decision.

In addition it should be pointed out that the HF Engineering Group at Collins immediately went to work on the next generation of Amateur Radio Products – quickly producing the 30K in December of 1946 and the 32V-1 and 75A introductions in November and October of '46 respectively.

Featured in the 1947 Annual Report to Stockholders, this new pair of AM 150 Watt transmitter and matching receiver was one of the key new products brought quickly to market in 1946. Roy Olson and Lou Couillard were the Project Lead Engineers responsible for the 75A while the 32V was developed by Ted Hunter. Ted was well known for his work before, and during, the war on the PTO. It is certainly interesting to note that such noteworthy engineers were employed to bring this pair into production before other commercial projects.

In 1948, looking to fill capacity and also provide service to the country (you will see more about that subject as we go along), Collins Radio accepted a contract to provide two Exciter Coils for the Brookhaven and Argonne Labs Cyclotrons located at the National Laboratories. These 250 ton coils are the heart of new atom smashers used in



Exciter Coils for National Labs Atom Smashers

nuclear research. Quoting Art Collins in the 1948 annual report; "Their design and manufacture are a feature of the expanded scope of operations of the company".

In addition to the opportunities in Broadcasting, the war had had another very dramatic effect. Airpower had proven to be a key element of national defense and the war efforts. The result was the much accelerated development of the technology of flight including the development of the jet or gas turbine engine. It also resulted in a significant acceleration of communication, navigation, and flight instrumentation and control technology.

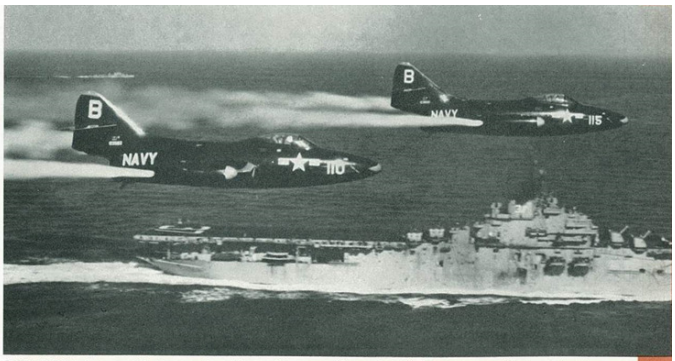
These advances, combined with the exposure of troops and the general public to the concept of rapid world travel, set the aviation and travel industries up for two decades or more of rapid equipment expansion and new technology innovation. First the expanded air travel industry, and fleet, capitalized on these changes during the late '40s and '50s and then the advent of jet powered aircraft in both the military and the airlines (and even private business flying) rung in another big burst of development related to the higher speeds and more dense air traffic.

The Jet Age Arrives
First Comet - 1952

Boeing 707 In Service
Quantas - 1954

Whether it was military related, and involved keeping up with perceived cold war enemies, or related to more dense domestic air traffic and faster aircraft speeds, the '50s and '60s particularly were both a lush plum waiting to be picked and a significant technological challenge. Collins was at the right place at the right time with the right stuff.

WAR Again !

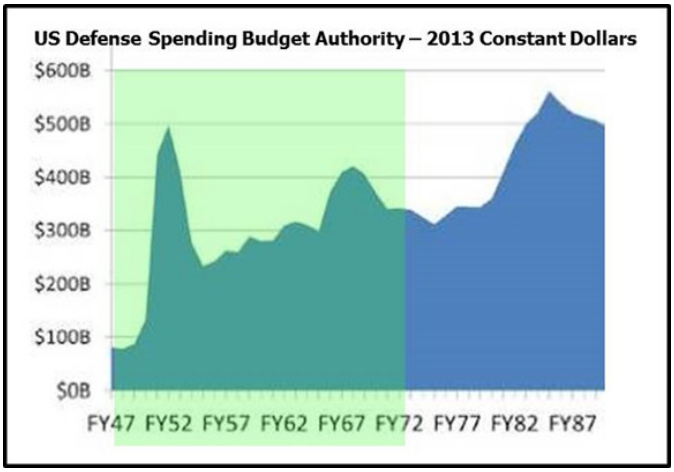


Collins designed communication equipment is used in most military aircraft. (Department of Defense photo)

Korea, 1950 – Overlaying the servicing of the burgeoning civilian aviation related opportunities which were accelerated by war technology development, the Cold War was heating up with the involvement of not only Russia, but mainland China and North Korea.

On June 25, 1950 what started as a 38th parallel-centric skirmish between the western aligned Right Wing South Korea and the Communist regime North Korea, turned into all-out war when North Korea invaded the southern peninsula across the 38th parallel. With Russia boycotting, the United Nations authorized military action with the United States eventually providing 88% of the troops required to support the war. There followed three years of costly combat. At first the UN drove the North Koreans back, almost to the Chinese border, but then - with the entry of mainland China into the conflict actively - the front fell back painfully to a dead stop at the 38th Parallel.

From a business standpoint, this conflict and several years of subsequent government spending on modernization and upgrade supplies (increased by fleet and jet aircraft modernization), led to a substantial increase in Defense Spending from the post war period level of $90B to almost $500B by 1952.



By 1952, at the height of the Korean War, and during this period where military jet aircraft and military technology in general was changing at warp speed, sales at Collins rose to $64M in revenue and $ 1.8M in net income, or 2.9 % of sales.

By 1952, Collins employment had climbed back to well above WW2 levels and topped 4600 employees with over 1000 folks in Engineering. At the same time, Collins broadened its served markets to include both trans-horizon and direct microwave product lines, and was now poised to be a major player in Microwave, Broadcast, Military, Avionics, Commercial Comm and Amateur Radio.

This increase in sales and employment, of course, required significant facilities expansion. In 1951, 25,000 sq ft of leased space was acquired in the Dallas area and construction was started on a 50,000 sq ft building to supplement this. Initially the emphasis in Richardson was on the avionics sector manufacturing and engineering. By 1953, total owned and leased space in Richardson would total 150,000 sq ft. In the meantime, the 230,000 sq ft of owned space in Cedar Rapids was augmented by 250,000 sq ft of leased facilities.

Additions:

Remodelled and enlarged quarters are being constructed for the Western Division at Burbank, California.

New production plant presently under construction at Dallas, Texas. Containing 50,000 square feet of floor space, this modern air-conditioned structure will be ready for occupancy in the early part of 1952.

Also, in 1951 and 1952, Collins Radio leased, and remodeled, a small facility close to the Burbank, California Airport. By late 1952, this space had been doubled to be used for Engineering and "Special Manufacturing". We now know that, at that time, this involved predominantly the mechanical filter efforts.

Business Snapshot FY End 1952:

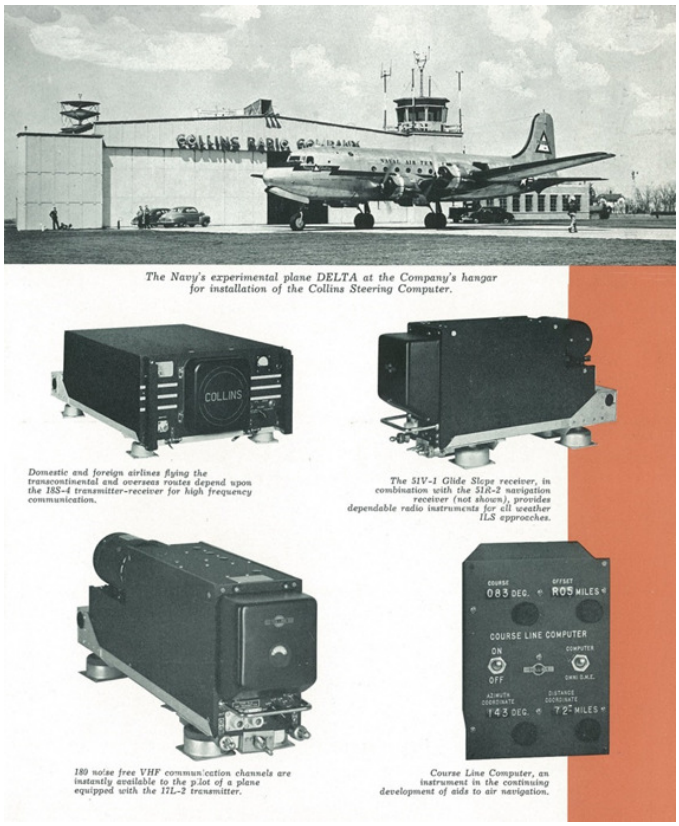
Total Space:	735,000 sq. ft.
(Approximately 290,000 owned) [2)]	
Employees:	4672
Sales:	$ 64.1 M
Net Income	$ 1.8 M (2.9 % of Net Sales)
Sales per Employee:	$ 13.7K
Sales/Sq ft	$ 87.3
Booking Backlog	$ 250 M
Total Liabilities	$ 23.6 M (36.8% Net Sales)

Note 2) Source: 1952 Collins Radio Annual Report

In 1950 Collins Radio made a significant contribution to the safety of Instrument Flying when they developed the Collins Flight System. This was the forerunner of the modern day Flight Director that is still used in one form or another—even in software form on glass cockpit panels. It consisted of an *Approach Horizon Indicator* instrument (center top panel) combined with a *Course Indicator* (usually just below the AHI). Together these two instruments replaced 4 harder to interpret instruments used during an instrument approach. This early version of the Flight Director would prove to be the pathway to the future and a business builder that, as noted, still endures. (see p 37)

Examples of Significant Introductions by 1952:

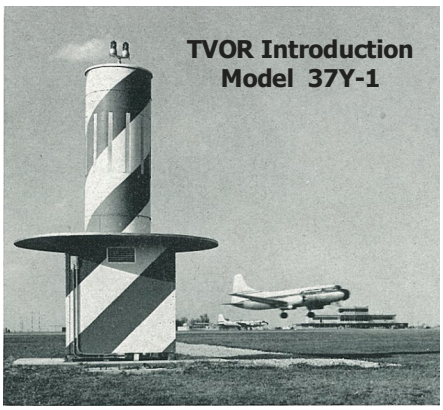
Avionics:	ART-13B, ARC-2, Model 3000A VHF, Diversity Tower Xmtr, 51R VHF Nav18S-1 through 4 HF Airborne Xcvr, 51V-1 GS, 17L-2 Xmtr, Course Computer (1st Entry into guidance & Computing), Flight System Display
Broadcast:	300G 250 Watt AM, 1 kW AM, 1 kW FM, 5 kW 21A AM, 212A Mixer, 10 kW FM Cedar, 20V 1 kW (1949-50)
Amateur Radio:	30K 250 Watt AM, 75A and 32V 100 Watt AM, 310(X) Exciters/70E-8 PTO, 75A-1 & 2, 32V-1/2, KW-1 (1950)
Commercial:	30K-2,4 & 5, 51J-1, Mechanical Filter (June, '52), 430 Series 1 kW Autotune HF Xmtr, 205E-1 50 kW HF, 231D & 207B VOA 50 kW



Collins Radio's R & D efforts, as well as Art Collins' work personally, was also responsible for the development and standardization of the TVOR (Very High Frequency Omnidirectional Radio Range) as the global standard for horizontal position location in the field of aircraft navigation.

In 1953, Collins announced their first ground TVOR product.

The new model 37Y-1 led to their successful participation in both the airborne and ground portions of this expanding market.



During this period, it is difficult to say what the mix of sales was across the various markets that Collins served - as this is not well reported in this time frame. In later years we will get a better look as Collins realizes (finally really realizes) that its heavy dependency on Special Military Sales is costing it margin and reducing profits. We do know that in the period leading up to 1952, and after the war, the Special Government Sales were probably responsible for more than 85% of their revenue. It was not until the late 60s (and the start of reporting the sales mix) that this percentage fell slowly to below 70%. This will turn out to be a problem.

At this time in the evolution of the company, the mix of non-government sales is heavily weighted towards Avionics and then Broadcast. Of interest to the Amateur collector is the fact that at almost no time in the history of Collins Radio did Amateur Radio Sales produce more than 1-2% of the total revenue.

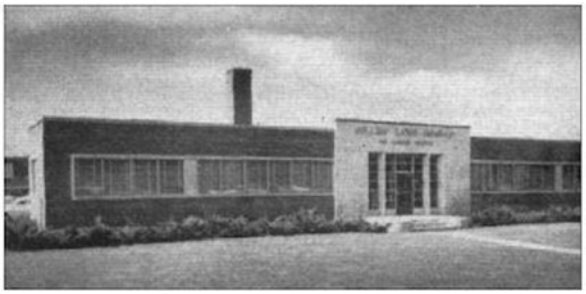
Finally we know from the 1952 annual report that Avionics sales more than doubled in FY 1951-52, and that the company was very satisfied with the new 75A/32V/30K Amateur equipment sales.

Two other happenings in this period are very noteworthy. The first is that, in 1952, Collins announced and made its entry into an entirely new area of business – The Microwave market. As it turns out, this will not only prove to be a favorable commercial market and help with reducing the dependence percentage-wise on the Government sales, but it will develop expertise that will contribute to the future requirements for Satellite and Missile tracking associated with the government and NASA Space Programs that are coming.

Second, and not surprising in light of Art's penchant for flying and his dead aim at the Avionics Markets, Collins Radio formalized and started a Flight Test and Aviation Research facility at the Cedar Rapids airport, and by 1952 it had a fleet of several planes (D-18 Beechcraft twin engines) dedicated to equipment testing and other company operations.

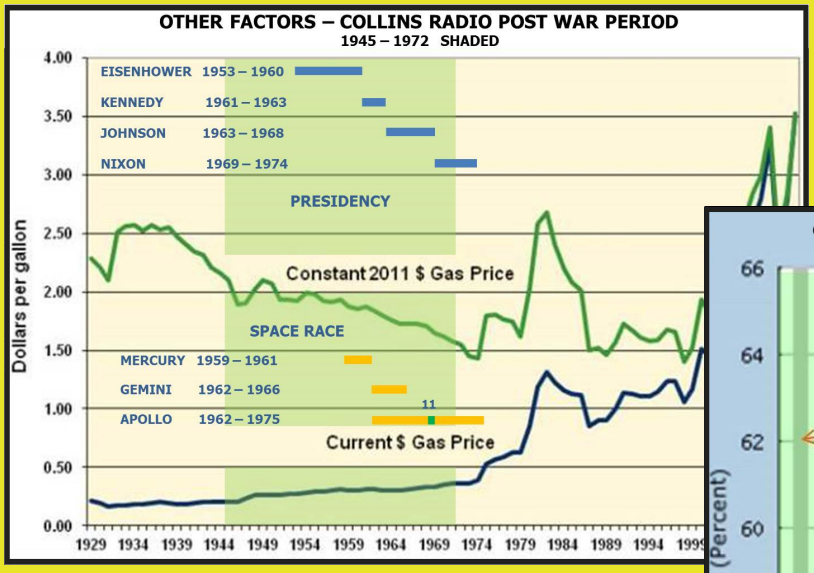
Flight Test & Avionics Research Laboratory
Cedar Rapids Airport – 1951

In October, 1953, a Collins Radio Sales Office was opened in Ottawa Canada. Then, in July of 1956, a production facility was opened in a leased building in Toronto. This provided Collins of Canada, a wholly owned subsidiary, with 30,000 sq. ft. of engineering and manufacturing space and employed 550 direct labor, engineers and management staff. The facility was located at 11 Bermondsey Road and existed until 1965 (30,000 Sq Ft).



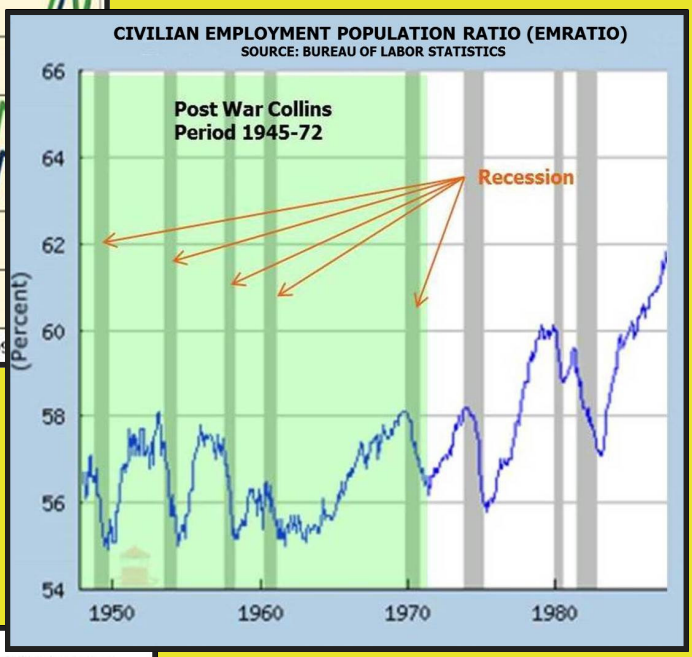
Bermondsey Road Building – Toronto

Economic Factors - A Summary Relating to Collins Radio Sales and Net Income - Period 1945 through 1972



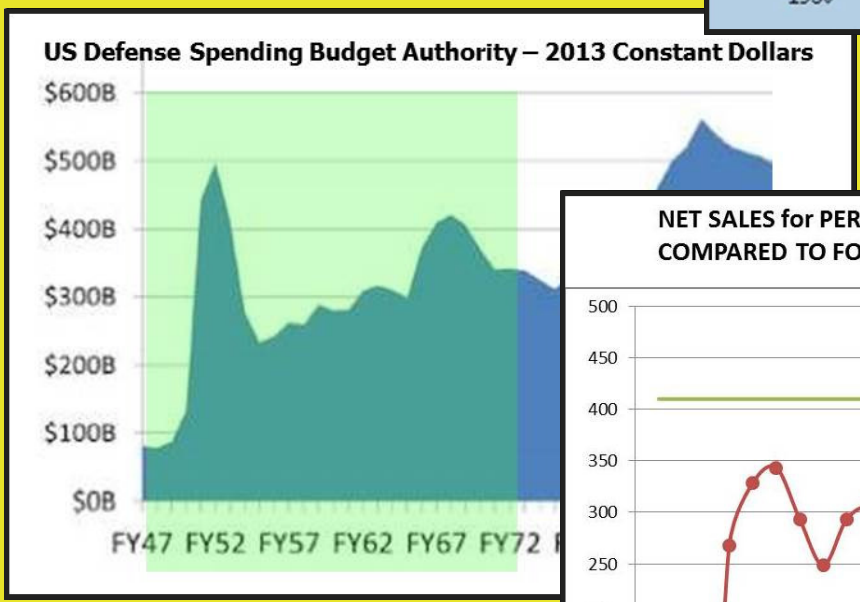
Source: U.S. Dept. of Energy, http://www1.eere.energy.gov

Source: Federal Reserve Bank of St. Louis, NBER 2007

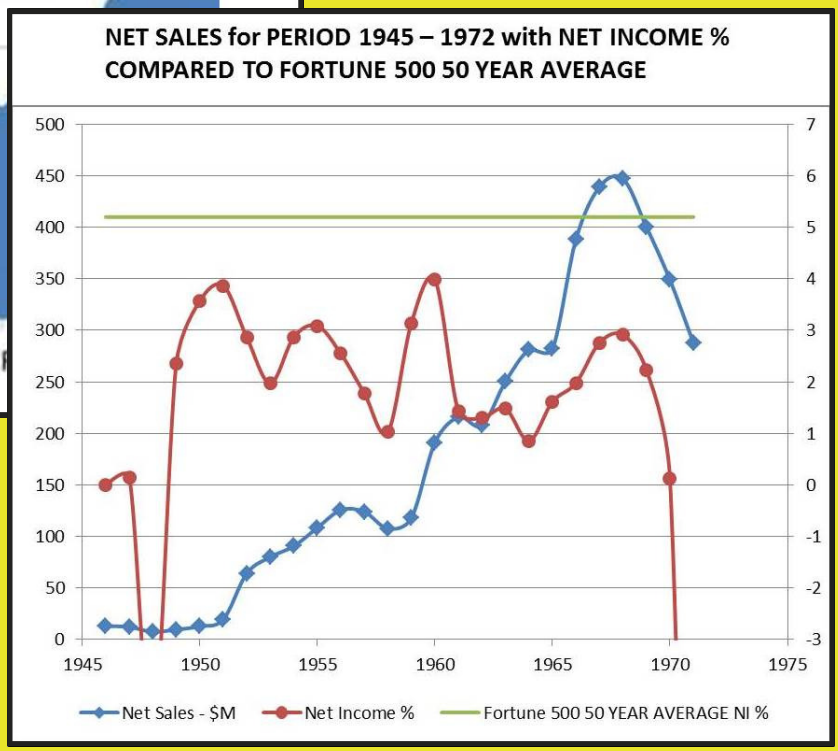


Factors

Source: Washington Post



Source: Collins Radio & Rockwell Collins Annual Reports



Sales & Net Income

In July of 1953, Collins also added another 35,000 sq. ft. of owned space in Dallas - bringing the total of either owned or leased Texas facilities to 150,000 sq. ft.

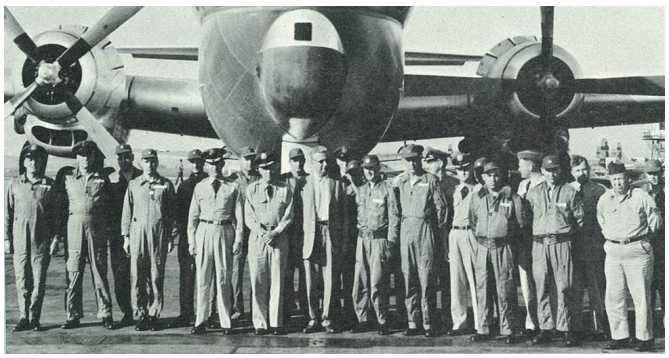
In this same time frame, with the engineering ranks now swelling to over 1500 Engineers and engineering support personnel, management made the decision to build a new Engineering Building in Cedar Rapids. Planning occurred in late 1952, with funding and construction started in 1953. The new Building 120 Engineering Facility was occupied in January of 1954 – just as the 1954 recession got rolling and the Korean War armistice resulted in Defense Spending being rolled back to less than $250B from its war high of almost $500B.

In the process of supporting the Korean War military demand - even with the increased sales from Avionics and Broadcast primarily - Collins had again become involved in subcontracted military deliveries of critical equipment. While sales increased modestly from 1954 through 1959, margins fell from a short term high of 3% on Net Sales to around 1% by 1958. (Even 3% is below par.) And then, just as they struggled to get the mix of subcontracted low margin sales under control (Estimated "by 1957" in the 1955 annual report), Collins was once more caught in the trap of the Vietnam era military spending increase. Their mix of products, while expanding in numbers in an attempt to capture more commercial sales, was still heavily weighted towards military special products which lowered their margins.

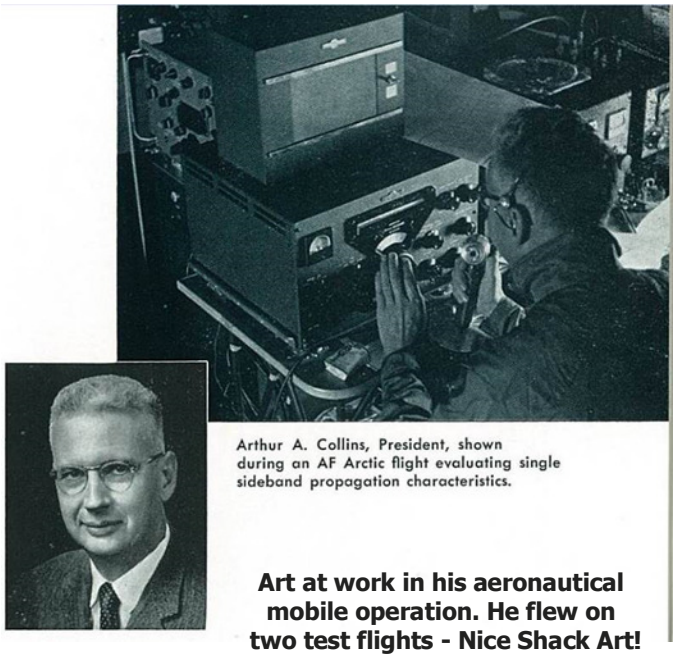
It should be pointed out that during the 1950s, Collins did make significant progress in refreshing their commercial, as well as military, product offering and technology. We note below:

For the Amateur Market, The 30K-1 250 watt AM transmitter, the 32V series and the matching 75A series of amateur equipment, along with the AM stalwart KW-1 were all on the ground running and fleshed out by 1957. In addition, the anchoring product – the 51J receiver – had evolved into the 51J-4 SSB oriented version employing the Mechanical filter.

Following the late '40s and early '50s introduction of their line of classical AM products, the Collins Ham line-up then benefitted from the maturing of Single Sideband Communication techniques. This new SSB mode took advantage of the underlying core technologies developed for the PTO and the Mechanical Filter. We (amateurs) benefitted from the announcement of the KWS-1 and 75A-4. This duo (dubbed the Gold Dust Twins for their significant price tag) was developed with a dual purpose in mind. Not only did it give Collins the top-of-the-line SSB T/R for the Ham market, but it provided – quietly - the proof of concept test vehicle that would go on to solve the SAC over-the-horizon cold war communication problem and establish Collins Radio as the future leader in military SSB communication for many years to come. Art had quietly worked with Generals Curtis LeMay and Butch Griswald (both were Hams) to use the Gold Dust Twins in Curtis LeMay's C-54 making "Ham" QSOs from every corner of the globe. In reality they were proofing SSB, and the Collins fundamental equipment design for use in SAC's new "Bird Call" communications network that would involve a whole new generation of ground and airborne equipment.

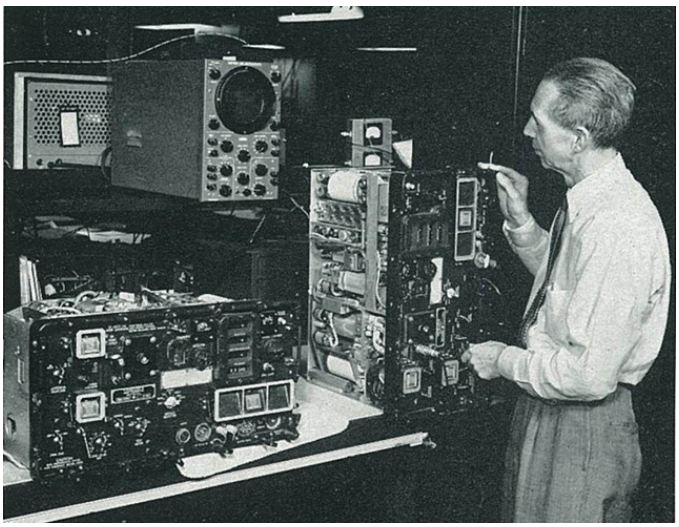


Art Collins Shown Center with Curtis LeMay's C-54 and the SSB Evaluation Team



Arthur A. Collins, President, shown during an AF Arctic flight evaluating single sideband propagation characteristics.

Art at work in his aeronautical mobile operation. He flew on two test flights - Nice Shack Art!



New GRC-19 Ground HF (T-195) in Test 1953 Believed to be Walter Wirkler in the Photograph

In the Military Field, Collins had scored big wins with the GRC-19 Ground AM HF and the ARC-27 Airborne UHF Transceivers. The ARC-27 UHF Transmitter became the standard for both the Navy and the Air Force for many years. (See imbedded story page 33). The GRC-19 AM HF ground system (T-195 Transmitter and R-392 Receiver) became the AM ground standard and would only eventually be driven out (slowly) by SSB and the Collins TRC-75 High Power ground and vehicular system in 1959. At the peak of production during the Korean War, Collins was manufacturing over 1000 ARC-27s a month.

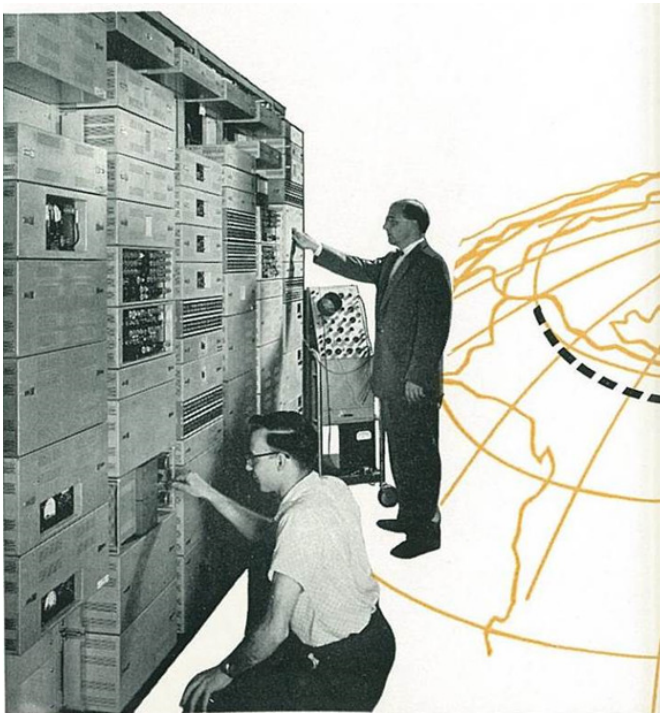
The ARC-27 work, and its success, at Collins had spawned the GRC-27 UHF ground version and it went on to become the standard ground UHF.

Following the success of the SAC testing of global SSB communication, Collins was quick to develop the KWT-6 commercial system and the AN/URC-32 military version of this channelized 500 watt SSB transmitter and receiver combination. This development work went on after the testing (above) with the KWS-1. These new KWT-6/URC-32 systems were introduced by 1959.

In the Broadcast Market offering, the basic 20V 1 kW AM Broadcast Transmitter and its accessories had morphed into a full lineup of AM and FM transmitters running from 250 watts (the 300J AM) up to the 21E series (5/10 kW AM). This fundamental "20V" styling and engineering work would serve this product line until the new 20V-3 styling (developed by consultant ZVS) was adopted in the mid '60s. Collins' Broadcast Products included a full range of Transmitters, Audio Processing and Audio Boards, Turn Tables, Microphones - everything required to set up a modern studio. Some of the accessory items, such as Microphones, Turn-Tables and Tape Decks were sourced from other manufacturers and branded with the Winged Emblem. By the late 50s, the lineup also included studio microwave links (STL) that evolved from the Collins main microwave business.

Wins came in all the fields that they pursued. It was a good time for their well-chosen technologies.

In the Microwave Market, having only entered three years before in 1952, Collins had installed systems on the ground and running by 1955 in both Transhorizon and Direct Link Microwave.



Early Transhorizon Microwave Installation – circa 1955

VHF (30-50 or 70 MHz) and UHF (700-1000 MHz) Transhorizon equipment would first start to appear in the General Catalogs in 1956 (Just high power – typically 10-40 kW transmitters - at first) and then a full line of Exciters, Modulators, Receivers, Antennas and accessories for both VHF and UHF - as well as Direct Microwave. By 1958 Collins was offering this full line-up and even Truck-Transportable or Air-Transportable fully established systems that could be brought in and set up in a matter of hours. See http://collinsradio.org/signal/mw link for more information and pictures of complete systems and complete transportables. Clearly the major customer for such systems was the government. A version of this equipment would be used in the DEW line communication Networks that were set up in the '50s.

For Direct Microwave, Collins offered a line-up of Receivers and Transmitters that covered the 6.0 to 8.5 GHz band as well as accessories and antennas. They looked a lot like the KWT-6 construction.

In addition to the transmission equipment involved - be it HF or Transhorizon VHF, UHF or Direct - Collins also developed and successfully marketed what would go on to become the next standard Data Processing/Modulation system named *Kineplex*. First announced in 1957 in the Collins Signal Magazine, the products were fully presented in the 1958 General Catalog and provided the capability to transmit quality data over wire line, cable, carrier or microwave transmission using synchronously encoded phase shift modulation. This system employed four equally spaced tones in the 21 KHz region. Each tone could accept data from two channels making a total of 8 shipped channels capable of (Do not laugh) a whopping 300 bits/second each. This meant that the overall data rate was 2400 bits/sec. This was a HUGE data rate in 1958.

In the Avionics Market, Collins Radio had stepped off of their late '40s success with the 18S-1-4, and 51R, to develop the 618S-1 (144 Channel Crystal Controlled) and the later generations of the 51R series – all to become industry standards. They also had introduced the TVOR, the Autopilot Coupled Flight Director – The PN-101 which would pave the way into the future of aircraft instrument flight panel displays and control. By 1957, this Flight System Concept developed by the Collins R&D effort had evolved into the FD-105 Flight Display System, which would become the industry leader and be adopted by many commercial carriers as well as by the business market.

After the Korean War - This brings us to the next period of business results at Collins. During the first painful period between 1946 and 1950, commercial sales were low and government sales, including the dreaded subcontract sales, pushed margins down. Between 1950 and 1957, following the efforts of the new product engineering developments of the period, sales started to rise steadily - about an 18% CGR over the seven years. Margins were a problem again however because of the increased percentage of military business from the Korean War and the several years afterwards. Collins was again clearing out the subcontractor business. During this entire period though, margins and the resulting Income on Net Sales (% of Sales) proceeded to fall steadily from 3% down to 1% again. War, it turns out is not a friend of Collins in the profit column. These results are summarized, along with the entire 25 years of financial perspective, on page 12.

As can be seen, and to make matters worse, during this period there were two fairly significant "Corrections" in economic growth, the second one hitting in the fall of 1957. This recession shows clearly in the Net Sales and Net Income graph on page 12. Looking at the Annual Report for 1957, Collins had just started construction of their first Dallas expansion and increased leased space when this recession hit.

To give you another feel for the size of the company at that time, from a small number of dealers and sales reps in the early '50s, by 1956 Collins Radio had 25 Executive Aircraft Dealers, 85 Amateur Radio Distributors, and 50 Foreign Dealers.

Computer Market Entry - It was in this late '50s time frame that the Computer vision started to really percolate at Collins Radio. The past experience that Collins had with the small amounts of digital computing that were then involved with their avionics developments had stimulated Art's imagination and thought processes. In the early '50s Collins Radio had acquired an IBM 650 – then State-of-the-Art technology – and had tried to connect it through telephone lines to another location. The results were very disappointing and it frustrated Art. The company went on to build their Information Sciences Center (ISC) in Newport Beach, California with the intention of exploring and developing computer and semiconductor technology to support the vision that was developing in the mind of Arthur and his cohorts. During the late '50s, there was a significant internal 3 month workshop/seminar held in Costa Mesa California involving 350 company employees. During that seminar, Art visualized the digital connectivity with email, the internet involving home computers, and peer to peer networks and connectivity. He was indeed way out in front from a concept standpoint. By the early '60s, he had formed the new Communication and Data Processing Division and built the CDS (Computer and Data Sciences) building in Cedar Rapids.

In late 1960 and early 1961, a new project (Code named COMO) was kicked off in Newport Beach at the ISC lab. The objective was to develop the first Collins Radio Company computer. Fred Johnson, Senior ME from Cedar Rapids was reassigned to Newport Beach (Pulled off the S -Line) to head up the significant work that would have to be done on housing, cooling and interconnect systems. The objective was to have a mock-up by July using the new Terracotta styling of ZVS (Including the new "meatball" emblem as the round emblem became known). This aggressive goal was met, approved by Art, and the C-8400 project was born.

By late 1961, a complete test system was developed and installed in the CDS building in Cedar Rapids, the Newport ISC facility and also linked branch terminals in Dallas and Toronto. By 1962, the sales and technical organization had identified and made contact with ARINC, who would become the first installed customer system in 1963. This system, originally conceived as being located in New York at the ARINC headquarters, was instead installed in Cedar Rapids to facilitate installation and debugging of the complex system. The system, the C-8451, was operational by 1963 and linked the central computer with 750 incoming and outgoing teletype lines going to as many airline terminals and offices around the world. It was the first high speed networked computer system and the first computer system to function 24/7 without scheduled downtime.

Following their success with the Cedar Rapids/Newport Beach test system, and with ARINC business looming, Collins Radio (in 1961) made the serious and formal decision to enter the computer business market with the C-8400. It was a costly decision.

Space and Beyond - As the country was coming out of the '57-'58 recessionary dip, the economy, and Collins, got a boost from a number of sources. The Mercury Project kicked off our Space Program in 1959 and ran through 1962. The combination of Mercury, Gemini (1962-1966) and Apollo (1961-1972) would pump $287M plus into the Collins economy and provide a significant amount of challenge to their engineering resources for the period 1959 through 1972 (See the sidebar on the Collins Space Programs on pages 22-23). At the same time, following a small recession in late 1960, the US economy went into what would become the longest period to that date of sustained growth in its history. Energy was cheap, growth was seemingly endless... But then the Vietnam War, a stimulant at first, started to spin down in late 60s.

Into the Roaring '60s: Now the trap is starting to be set. Collins Radio was enjoying successes in almost all of the commercial markets that it had chosen to engage in following the Korean conflict. During the late '50s, they had again struggled to get past their low margin sub-contract military contract commitments. When finally clear of these, the country promptly went into recession. When the renewed growth of the 1960s started, Collins was poised with a very effectively expanded commercial as well as military product offering including expanded production facilities to service the anticipated business. The results were gratifying. In 1960, Net Sales started to rise at a faster rate than ever seen before. That was the good news. At the same time government spending associated with the Vietnam war started to rise and so did, again, the military business mix at Collins. You can clearly see (Page 12) the impact on margins in 1961 where they plummeted back almost to the 1% level. Following that drop, it was a slow path back to almost 3% (still very low) before the major recession of 1969-1970 hit the country …. and Collins very hard.

From the 1964 financial statements (Total Net Sales $281M), we get our first good look at the evolved sales mix by functional segment and by military and commercial mix. Collins Radio has made significant progress in almost all areas, but there is still a heavy dependency on the military, and thus, government spending.

Segment	Net Sales(M$)**	Percent of Total Sales
Aviation	90.2	32.1
Special Military	64.3	22.9
Telecom	46.4	16.5
Space	34.6	12.3
Service	28.7	10.2
Other *	16.9	6.0

* Includes Amateur and Broadcast
(amateur sales estimated to be < $5M)
** Total Commercial Sales (non-government) were just 28% of total

Business Snapshot FY End 1964:

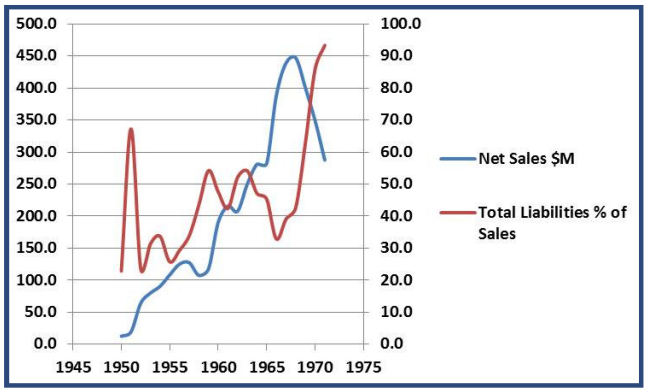
Total Space:	2,100,000 (Approximately 1M Sq. Ft. owned) [3]
Employees:	15908
Sales:	$ 280.98 M
Net Income	$ 2.4 M (0.9 % of Net Sales)
Sales per Employee:	$ 17.7 K
Sales/Sq ft	$ 133.8 K
Booking Backlog	$ 262 M
Total Liabilities	$ 132.3 M (47.1% of Net Sales – Very High)

Note 3) Source: 1964 Collins Radio Annual Report, The First 50 Years

The 1967 Annual Report states by 1969 1.5 M sq. ft. of additional facilities would be on line bringing the total to over 3.6 M Sq. Ft.

All of this was going on while we were getting our S-Line, KWM-2, 30L-1 and 30S-1. Amateur Radio sales were higher than they had ever been but they were still a very small % of the total. Collins Radio was growing its percentage of commercial business relative to the military business and its commercial sales were the highest they had ever been. Collins was enjoying successful sales growth, and leadership, in almost all of its commercial and military markets. And…toward the end of the '60s, as the percentage of commercial business rose, so did the margins – just as management had hoped.

But, it was not enough. The average of 2% Net Income on Sales could not, and did not, support the growing debt built up for expansion. By the mid to late '60s, just before the downturn, and while things still looked encouraging, Collins was still running almost 70% Special Military Sales mix, the Total Liabilities on their balance sheet had risen to almost 50% of Net Sales (almost twice other healthy benchmarked tech companies).



When the sales downturn of 1969 through 1971 came, there was no room for restructuring the debt, a great deal of which was coming due all too soon. The banking industry and shareholders lost faith.

At this point, several entities appeared – trying in one form or another – to help the foundering company. Ross Perot tried a hostile takeover which Art and his team fought off with vengeance. Several other companies (Honeywell, Schlumberger and TRW were players)

Continued on p 44

The Service Line

Your 30S-1 & That 20.5 Foot Cable "What is it For and Do I Need it?"

by Don Jackson, W5QN

The "20.5 foot cable" was specified in early 30S-1 manuals for connecting the KWM-2 (or 32S-x) to a 30S-1 amplifier. The subject recurs more than occasionally and has been dealt with in a number of publications by esteemed Collins designer Warren Bruene, as well as in an article by Floyd Soo in the 2nd Quarter 1996 issue of The Signal. The article here discusses the theory of the cable, and attempts to demonstrate how the theory works with the actual Collins equipment.

The short answer is that the cable was originally intended to improve intermodulation distortion (IMD) in a system consisting of a KWM-2 or 32S -x driving a 30S-1. There are two contributions to IMD that the cable addressed. One is phase distortion created in the KWM-2 driver caused by a nonlinear resistance change in the 30S-1 cathode circuit. The second is IMD caused by screen grid loading in the 30S-1, which is typically the major IMD contributor, and the cause of flat-topping seen when the amplifier is over driven. We will address these two mechanisms separately, but as we shall see, addressing the screen loading problem also solves the phase distortion problem.

The Phase Distortion Problem - In "SSB Principles & Circuits", Bruene states: "The RF coupling network between a linear amplifier stage and its driver should have a total electrical length of either zero degrees or some multiple of 90º. This is necessary to avoid phase distortion due to a nonlinear load on the coupling network."

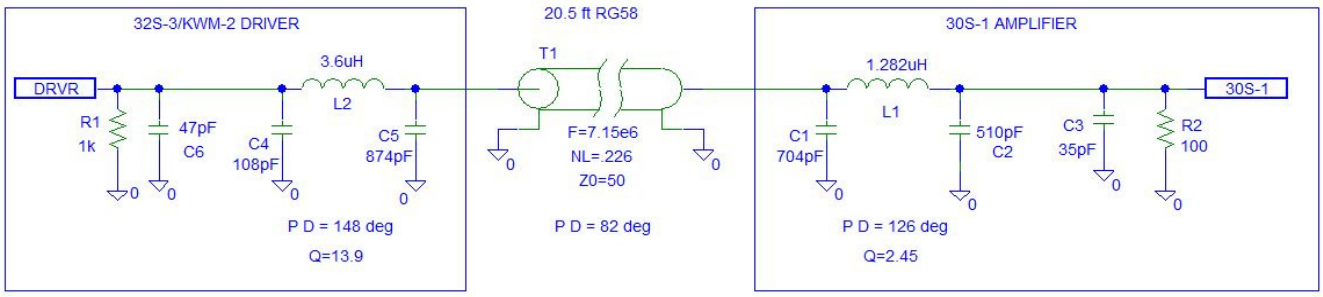


Figure 1 – Simplified System Example

In our case the non-linear load is the cathode resistance of the 4CX1000A, which is nominally 100Ω but varies with the level of the RF input envelope. It is important to note that the total electrical length, or Total Phase Delay (TPD), must be measured from the plate of the 6146s through the driver pi network, cable, and 30S-1 input network, all the way to the 4CX1000A cathode. Figure 1 is an example of such a system operating on 40m that uses component values reasonably close to those in the Collins equipment. In this case, the TPD is about 356º (close to a multiple of 90º), and the operating frequency is 40m. In this example we assume a driver Pi network that converts a 50Ω load to 2000Ω at the 6146 plates. The 30S-1 has an input Pi network that converts 50Ω up to the 100Ω nominal cathode resistance. This model, shown in Figure 1, includes 47 pF internal capacitance at the 6146 plates, and 35 pF capacitance at the 4CX1000A cathode as specified in the Eimac datasheet. The connecting cable is 20.5 feet of RG-58.

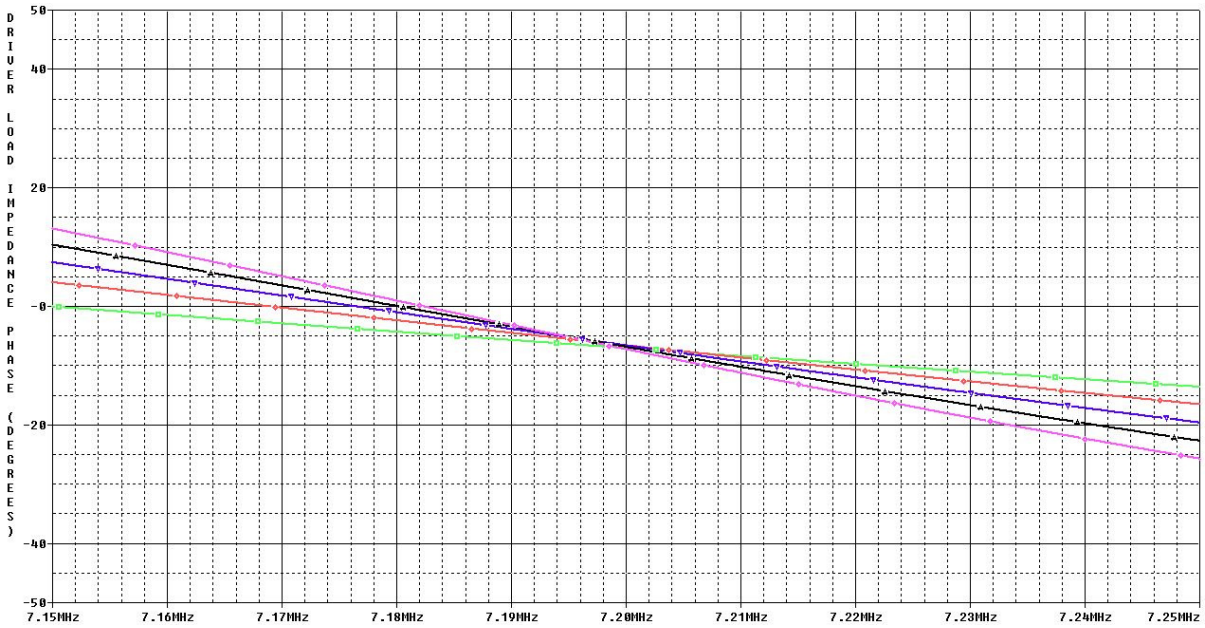


Figure 2 – Driver Load Phase Angle (TPD 360º)

Undesired phase modulation is introduced if a variance in the 100Ω cathode resistance produces a variance in the reactance of the load presented to the 6146 driver tubes. Ideally, if there is no reactance variation, the phase angle of the load will remain close to zero as the cathode resistance varies. Figure 2 shows the results of a Spice simulation of the system if the TPD is a multiple of 90º, or in this specific case, 360º. The cathode load resistance is varied from 60Ω to 140Ω in 20Ω steps. Note that the resistive part of the driver load changes, but this does not produce phase distortion. For purposes of quantitative comparison, let's define a figure of merit, Φ, as the peak-peak deviation of the 6146 load impedance phase angle for a change in 4CX1000A cathode resistance of 60Ω to 140Ω. We will use Φ throughout the article to compare the performance of various cable lengths. Figure 2 shows the variance of the KWM-2 6146 load impedance phase angle as the 4CX1000A cathode resistance is varied from 60Ω to 140Ω. The simulation of Figure 2 shows that Φ is about 1º at optimum frequency. However, note that there is a bandwidth associated with optimum performance. So….What would happen if the TPD were an odd multiple of 45º? Figure 3 shows the result.

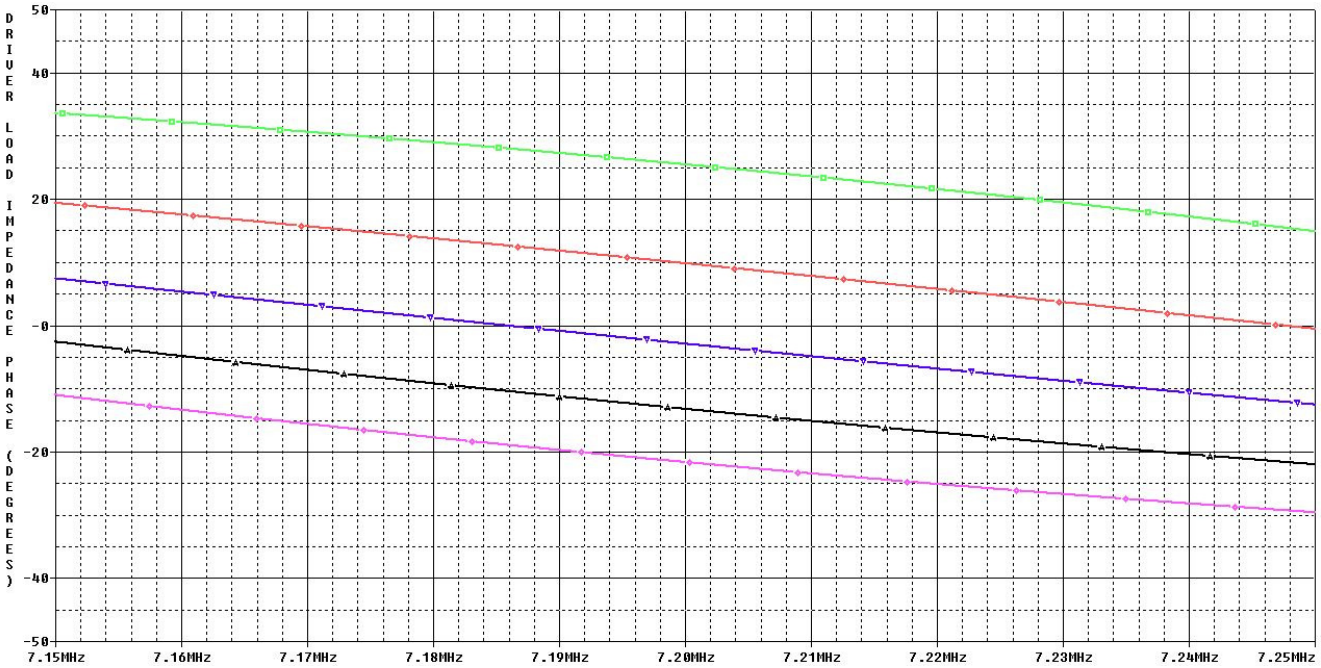


Figure 3 – Driver Load Phase Angle (TPD 405º)

Figure 3 shows the value of Φ (the maximum variation) to be about 48º, clearly much worse than when the phase delay is a multiple of 90º.

The Non-Linear Screen Grid Loading Problem

In Bruene's QST article "Inside the Grounded-Grid Linear Amp" he states: "...nonlinear grid-current loading causes flat-topping and becomes the major cause of intermodulation distortion at large signal levels. The effect of this nonlinear grid loading can be reduced by providing a low driver source resistance. This is the reason for the special length of coax specified to connect a Collins KWM-2 to a 30S-1 amplifier, for example. This special length, plus the phase delay in the KWM-2 output network and that of the 30S-1's cathode circuit, approximately equals some multiple of 180º on each band. This provides a low source resistance, which reduces the effect of nonlinear screen-current loading in the 30S-1's 4CX1000A tetrode, which is cathode-driven and operates in class AB1. The length of connecting coax is therefore important for minimizing IMD."

From the above statement, it is clear that we would like the impedance looking from the 30S-1 cathode toward the driver to be as low as possible. If the 32S-3 driver source resistance at its RF output port were 50Ω, it would not matter what the length of the connecting cable was, since the impedance seen by by the 30S-1 input port would always be 50Ω. However, due to RF feedback in the 32S-3, the impedance is lower than 50Ω. The following is from Bruene's 1963 QST article, *Inside the Grounded Grid Linear Amplifier*: "…..The internal Rs of a driver that uses RF voltage feedback (such as a Collins KWM-2) is relatively low. Measurements on one transceiver gave approximately 25Ω relative to a 50Ω coax impedance." To clarify, the KWM-2 Pi network steps 50Ω up to about 2000Ω (a 40:1 transformation) for proper loading of the 6146s. However with the RF feedback the "source" resistance, Rs, at the 6146 plates is lowered to around 1000Ω. The 40:1 impedance transformation steps this down to 25Ω at the RF output port. This 25Ω resistance is something of a double-edged sword, however. If implemented properly (phase delay a multiple of 180º), the impedance looking back from the 30S-1 input can be as low as 25Ω, improving IMD. Done improperly (phase delay an odd multiple of 90º), that resistance can be rotated to the right-hand side of the Smith Chart, transforming it to 100Ω and degrading IMD. Internally, the 30S-1 Pi network transforms the 25Ω up to 50Ω at the 4CX1000A cathode.

A bit of good news is that if the TPD is designed to be a multiple of 180º to provide a low source resistance for the 30S-1, the requirement for the phase delay to be a multiple of 90º for low phase distortion is automatically met. How does this work in real hardware? Let's refer again to our example in Figure 1, which shows the TPD of the circuit.

In Figure 4 (next page), we see that the TPD at 7.2 MHz is approximately 357º, which is close to 360º, a multiple of 180º. Figure 5 shows a plot of the resistive portion of the "source" impedance driving the 4CX1000A. For best IMD, we would like this resistance to be as low as possible.

Figure 5 (next page) shows that the resistive impedance driving the 4CX1000A is about 51Ω at 7.2 MHz. This is very close to our theoretical expectation of 50Ω. Theoretically, we should have the 25Ω resistance at the input end of the coax appearing at the output end of the cable because the phase delay is a multiple of 180º. This 25Ω is then translated to 50Ω by the 30S-1 Pi network. If the cable were a different length, resulting in a TPD of 450º, for example, we would have the results shown in Figure 6.

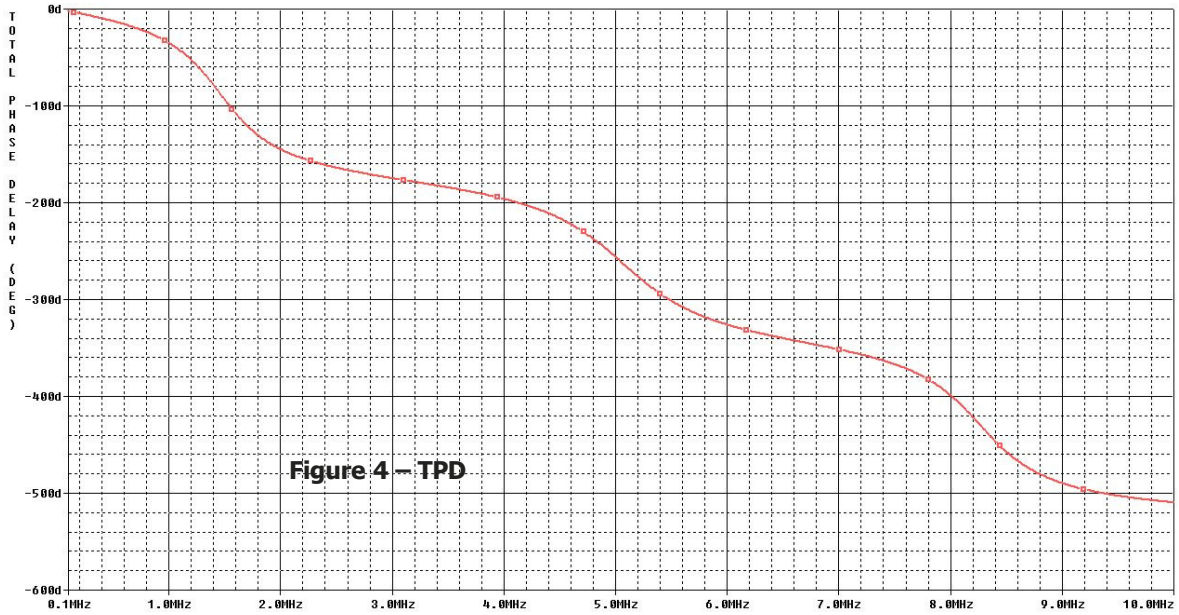


Figure 4 – TPD

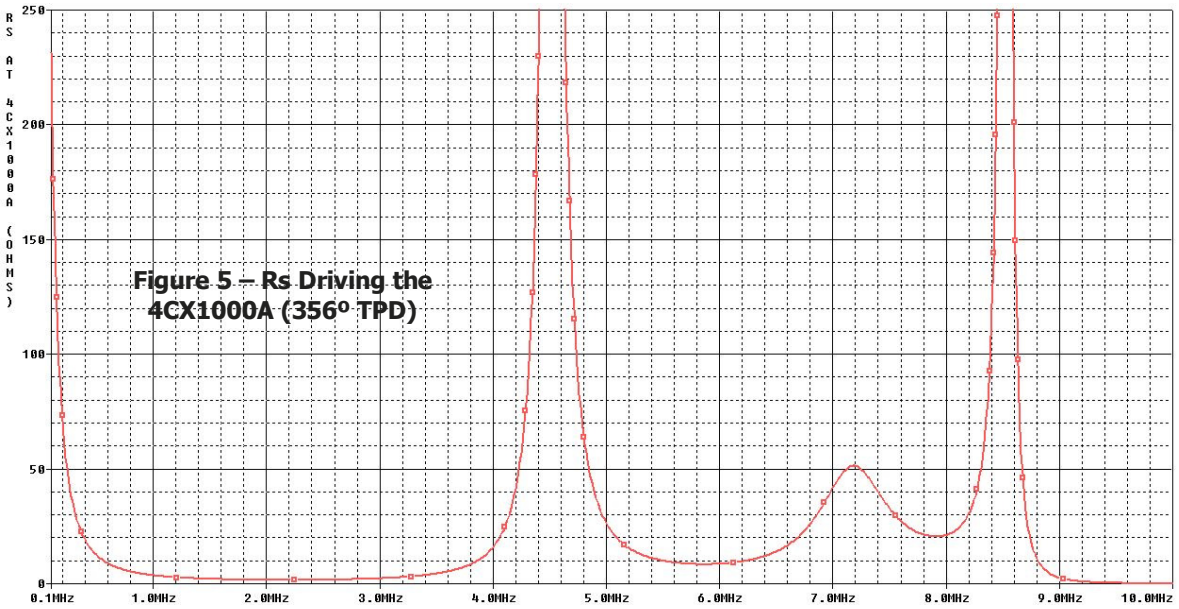


Figure 5 – Rs Driving the 4CX1000A (356º TPD)

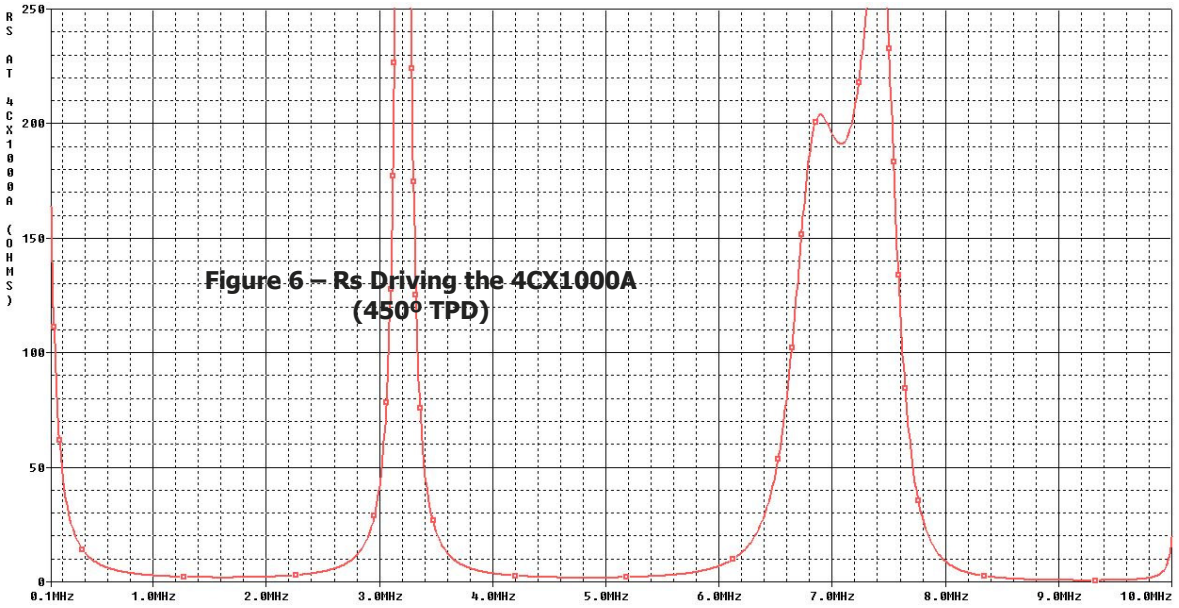


Figure 6 – Rs Driving the 4CX1000A (450º TPD)

Band	Total Phase Delay, TPD 20.5' Cable (deg)	4' Cable (deg)	Load Angle Delta, Φ 20.5' Cable (deg)	4' Cable (deg)	4CX1000 Source, Rs 20.5' Cable (Ohms)	4' Cable (Ohms)
10m	550	316	4	42	29	48
15m	518	329	6	39	46	62
20m	410	261	45	5	73	143
40m	356	279	2	25	36	112
80m	346	315	2	40	57	110

Figure 7 – TPD, Φ and Rs

In Figure 6 (left) we see that Rs is approximately 205Ω at 7.2 MHz. Again, this is what we would expect theoretically. The 25Ω at the input of the coax is translated to 100Ω at the input to the 30S-1 by the "odd number of 90º" phase delays. The Pi network increases the resistance to 200Ω. In addition, we see the Rs changing rapidly with frequency.

So, what is the bottom line performance of the KWM-2 and 30S-1 system on all bands with different cable lengths?

Do the components in the schematic diagrams reflect the total phase delays that theory says produce the best IMD?

To get some answers to these questions, the system was modeled for each band using reasonable component values. Rather than clutter up this article with a bunch of complicated schematics and graphs, the results are tabulated in Figure 7. For each band, TPD, Φ and Rs are simulated. In each case the simulations include cable lengths of 20.5 feet and 4 feet.

First note that the simulations that generated the data in Figure 7 are by no means claimed to be highly accurate. There are so many variables and unknowns in the simulation components that it would be foolish to claim a high degree of accuracy. But they are predictive.

In particular, the parasitic reactances throughout the circuitry become significant in the higher frequency bands. The intent here is to demonstrate that the basic concept is valid and the actual component values in the Collins units are reasonable. Looking at the data of Figure 7, we can make a few observations.

On all bands except 20m the TPD with the 20.5 foot cable is a reasonable multiple of 180º. On 20m the departure from 360º is 48º, but all others are within 22º of 360º or 540º. The result is that on all bands except 20m, Φ is much lower with the 20.5 foot cable. Similarly, Rs is better with the 20.5 foot cable than with the standard 4 foot cable, although the improvement is better on some bands than others. Even on 20m, the 48º departure from a multiple of 180º does not destroy the affect, leading to the conclusion that significant departure in the TPD from ideal is acceptable. I've tried many times to find a solution that brings 20m closer to the ideal phase delay, but have not had success.

Actual IMD Comparison Data - So far, efforts to get actual IMD data comparing the performance of the 30S-1 with KWM2/32S-X driver have failed. This data is really the bottom line for us, and would really be great to have. If anyone out there with a 30S-1 has the instrumentation to test 2-tone IMD, and the willingness to run the tests, I would love to have this data. We will present this data in the future.

What About the 30L-1? It is clear that the 20.5 foot cable was intended for use with the 30S-1 to lower IMD. There is nothing I have found in the literature to indicate the cable would help 30L-1 IMD. If there were such a cable, one would expect it to have a different length since the 30L-1 input matching networks differ from the 30S-1. However, the cable apparently did provide some improvement in the stability of early 30L-1 units, which is discussed in another article.

Conclusions and Acknowledgments

We can conclude that the initial intention of the 20.5 foot cable was to improve the IMD performance of a system consisting of a KWM-2 (or 32S-X) driving the 30S-1 amplifier. The cable was necessary to produce a few extra dB to meet Art Collins' desired IMD specification of 35dB. Although the specification could be met with the cable, Art apparently decided the special cable was undesirable and/or the 35dB spec was overkill for the amateur market. The cable improved IMD by addressing two contributions to IMD: 1) phase distortion, and 2) screen grid non-linearity. Both issues were improved by providing the 20.5 foot cable which was intended to create a multiple of 180º phase delay between the KWM-2 6146s and the 4CX1000A cathode on each band.

Later, the 20.5 foot cable was specified for use with the 30L-1 amplifier, but in this case the cable was used to improve stability on 10m and/or 15m. Eventually, component changes allowed the long cable to be deleted from the system requirement.

All the theory in this article is derived from Warren Bruene's books and articles, which are consistent in principle. One inconsistency found is in the 30S-1 manual, which states that the phase delay must be an "even" multiple of 180º, when actually any multiple of 180º is sufficient.

I'd like to acknowledge Dave Harmon, K6XYZ, Steve Sparks, WA6UAT, and Dennis Brothers for their valuable inputs. And, once again, a very special "Thank You" goes to Bob Jefferis, KF6BC, who should be considered a co-author for this article, considering all the time and effort he volunteered. Thanks for all the help, Bob!

de Don Jackson, W5QN

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"www.w8ji.com/neutralizing_amplifier.htm" - W8JI, Charles Rauch

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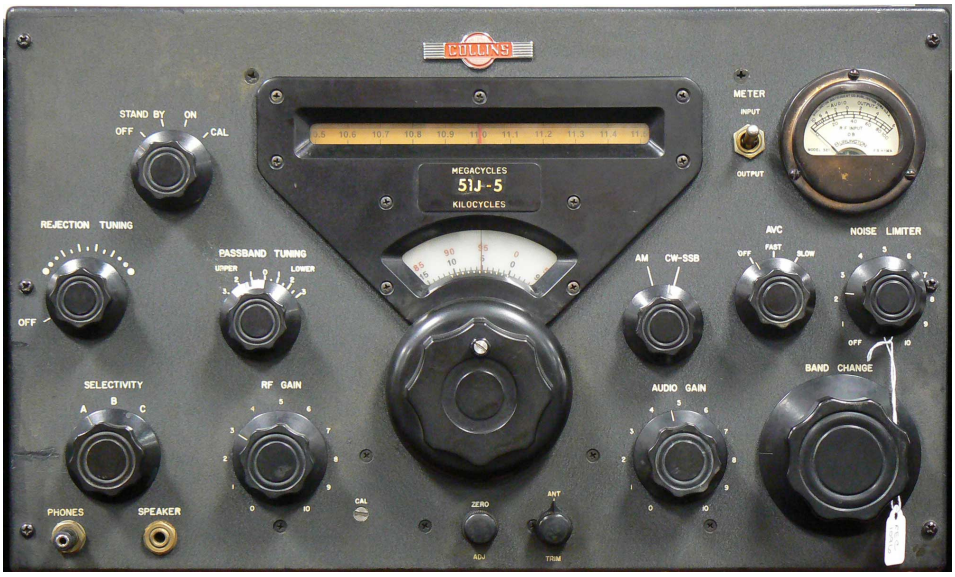
Please go to: http://www.collinsradio.org/signal/30S1cablestory for higher resolution figures and a substantial appendix. This includes an interview with Bruene.

Centerfold Credit: This "happening" was orchestrated by Rod Blocksome, then Curator of the Rockwell Collins Museum. The photo includes probably one of the most complete reassemblies of original S-Line models & is posed with six of the remaining S-Line Engineering staff. Since this photo was taken in 1997, Joe Jekerle, Joe Vanous and and Chuck Carney have left us. *Pages 24-25*

The Collins 51J-5: The Dream Receiver That Almost Was

by Bob Thomas, VE3TOU



It does exist

In 1957, Collins was in the process of manufacturing the 51J-4 and 75A-4. The J-4 had been introduced in 1954 and the 75A-4 in early 1955. The 75A-4 incorporated such advances as full SSB capability, pass-band tuning, and improved notch filtering. It was of course successful, but was limited to the upscale part of the amateur market. The 51J-4 provided continuous coverage from 0.5 to 30.5 MHz. Combining the capabilities of the 51J-4 and the 75A-4 would allow Collins to exploit the advanced technology of the 75A-4 in the much larger commercial/military market. So, the 51J-5 project, led by Walter Bratsberg at Collins Canada in Toronto, was born.

Figure 1 -- One good look at the front and I wanted to look inside!

While visiting the Hammond Museum of Radio in Guelph, Ontario a few years ago, I realized that it contains one of the three known examples of this radio shown in Figure 1 above. Since then, I've been curious about it. Our daughter lives close to the museum, and we wanted to visit her for a "grandkid fix", so this was a good chance to include the museum in our schedule.

Once Bill Carns had confirmed that he'd be interested in having an article for the *Signal*, I spoke with museum volunteer Larry Asp, VE3RF, and the curator Nori Irwin-Hann, VE3AQZ. Nori agreed that I could look inside the radio (important because I wanted to concentrate on the technical aspects), and take also take photos. So I appeared at the Museum on Thursday, May 30th of 2013, and was greeted by Nori, Larry, and Nori's husband John, VA3LKH.

We already knew that the design was based on the 51J-4 and 75A-4, so Larry and I opened the lids on all three radios for a side-by side comparison. These three units are shown in Figures 2a - 2c. …. (*how many places are there where you can do that?).* We also had Nori's permission to take the bottom plate off the 51J-5. Normally, we boatanchor people will pop the bottom off a radio without thinking twice. But I was a bit overwhelmed (as I think Larry was) by the importance of this one. "Slow and careful" was the result.

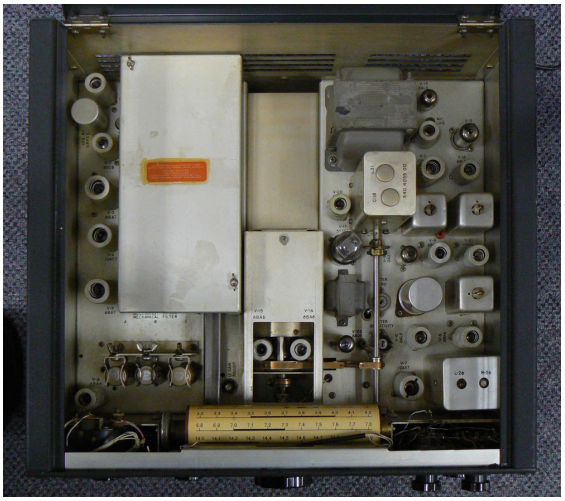


Figure 2a – Top View - 75A-4

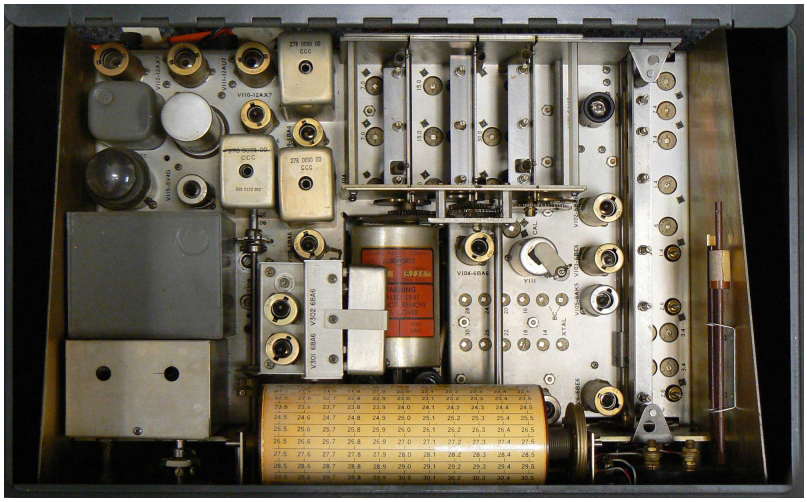


Figure 2b – Top View - 51J-4

I expected the utilitarian patchwork of tacked-in components and last-minute revisions that's typical of prototypes. It's just not there (Figures 3 and 4). This one looks more like a production unit -- proper terminal strips, neatly laced wiring, the whole bit. The most obvious sign that it's not a production unit is the lack of screening on the chassis -- the tube locations are all marked with pencil.

Knowing that I'd want to mull over details and cross-check things later, I used a tripod to get clear pictures, and took a lot of notes. It's been my experience that the camera records useful details that I don't even think of until later. I spent much of the morning and some of the afternoon at the museum.

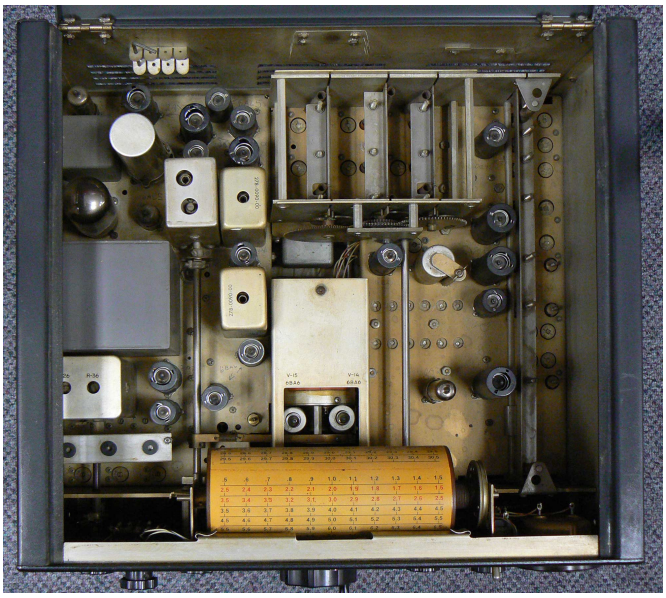


Figure 2c -- The 51J-5. On the right, the RF and first IF from the 51J-4. On the left, it's a 75A-4.

After my museum visit, I spoke with Peter Lower, VE3KWM, whose article on Collins Canada appeared in the *Signal* (3rd and 4th quarters, 1999), and with Jim Riach, VE3DSR. Jim joined Collins shortly after the 51J-5 project was shelved. He confirmed that the radio in the museum was taken home by Walter Bratsberg. Jim overhauled the radio some years later, so he was able to confirm some technical details for me. He also said that, subsequent to Walter Bratsberg's death, his son donated the radio to the Museum.

No schematic is available, but we can get a good idea of the design from the tube lineup and other visible evidence (Figures 2a - 2c).

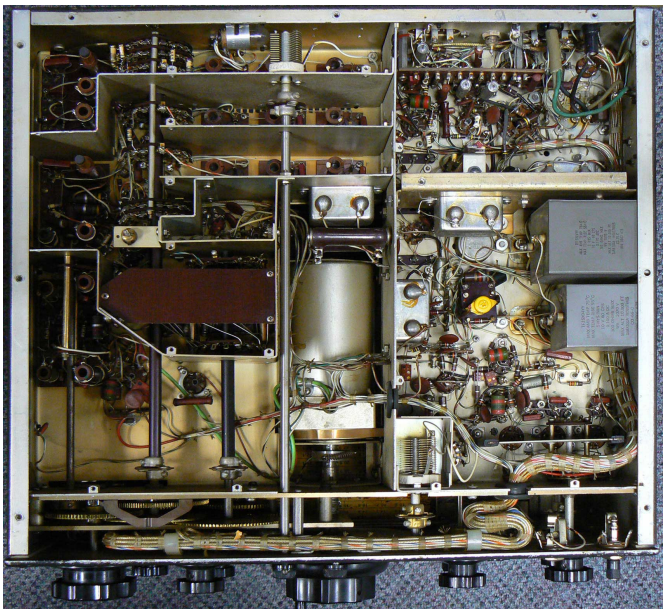


Figure 3 -- Under the chassis of the 51J-5. Not your average prototype.

The overall mechanical layout is taken from the 75A-4, with separate chassis on each side of the central PTO unit instead of the one-piece chassis in the 51J series. But, the chassis on the right which carries the RF and tuneable first IF circuitry is essentially the right half of the 51J-4 chassis. It's extended at the front because of the greater depth of the 51J-5 package, and different tubes are used. The 6BE6 mixers are replaced by 6BA7's, and the RF amplifier V101 is changed from a 6AK5 to a 6DC6. The slug racks and trimmers appear unchanged from the 51J series. The complex gearing and cams are probably unchanged as well; this would have meant a substantial savings in development and tooling costs.

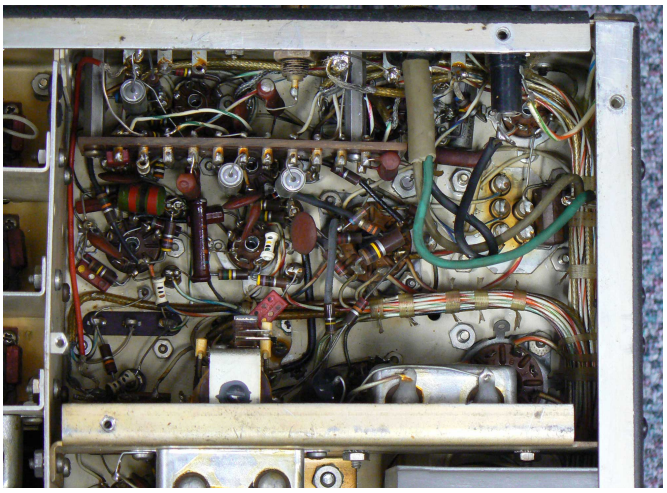


Figure 4 -- The detector, AGC, and audio circuitry. It is crowded by boatanchor standards, but the terminal board helps a lot. Looks like a Collins!

The changes in tube types reflect the changes Collins made in the 75A series of receivers over the years. As described by Andrade and Pappenfus (QST, July 1955), the original 6AK5 RF amplifier was replaced by a 6CB6, then by the 6DC6 as these tubes became available. The goal was to reduce intermodulation of strong signals. The 6BE6 mixer tubes were changed to 6BA7's for reduced noise. For some reason, these changes had never been made in the 51J series. Including these upgrades in the new design would have been an obvious move.

The frequency plan is taken from the 51J series, resulting in a 500kHz second IF.

Moving to the IF section on the left, the 75A-4 ancestry is evident. The mechanical filters are the 75A-4 "J Series" style. Larry told me they were custom made, which would be necessary because of the 500 kHz second IF. One interesting detail is the presence of six trimmer capacitors -- two associated with each filter -- which are not present in the 75A-4. Together with silver mica capacitors, they're connected across the inputs and outputs of the filters in place of the 100 pF fixed capacitors in the 75A-4. Possibly, they were put in to help determine the actual required value, and would have been eliminated in the final design.

The crystal filter of the 51J series is gone, made redundant by the high-Q notch filter from the 75A-4.

The two IF cans are clearly from the 51J series, right down to the part numbers stamped on the cans.

Single-sideband reception with a stock 51J-4 is unsatisfactory, mainly because the envelope detector has very restricted dynamic range and is prone to intermodulation. A good product detector is essential, and a "hang" AGC is also important. Also, the noise limiter in the 51J series will not work properly on SSB signals, because it depends on the carrier for a reference. So the "back end" -- second IF, detectors, AGC, and audio -- appears to have been taken from the 75A-4.

I didn't trace out the circuitry to figure out exactly which tube does what (there's a point where interest turns into obsession), but the tube count matches the 75A-4 from the mechanical filters on -- with one exception. I came up short one 6AL5 dual diode, and there's an

Continued on p 44

Aerospace Projects at Collins Radio

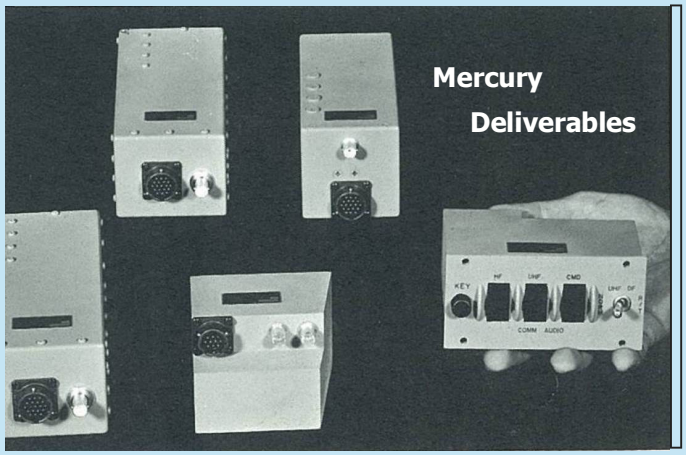
Mercury to Apollo - 1959 to 1972

Left: The Beautiful Aerospace Program Display at the Rockwell Collins Cedar Rapids Museum. On display are pieces from the three programs awarded to Collins Radio during the late '50s and '60s

GEMINI 8

Gemini 8 vehicle, and astronauts Neil Armstrong (port side) and David Scott, after their emergency descent and recovery following loss of control in orbit. The spacecraft had been docked with the target Agena rocket for almost a half hour when a OAMS thruster stuck open and caused a complete loss of control. Undocking only made it worse and roll and yaw rates approaching 1 revolution per second were experienced. Reverting to the Reentry Control System (RCS) thruster system saved the day, but used 75% of the RCS fuel - necessitating early reentry. During the entire emergency, the Collins Comm and Control equipment worked flawlessly. Of particular interest in this view is the HF Beacon and Emergency Comm whip antenna that can be seen re-stowed partially in its flight slot between the two hatches. HF Mobile at its finest. They could be heard on 15.016 MHz. Telemetry and Command signals were encrypted for security on both HF and UHF, but voice transmissions were in the clear.

Total Program Value for the three programs was $287M in 1960s dollars. Value today would be in excess of $2B. The Mercury Program Comm and Telemetry, Tracking, Rescue and Command was awarded to Collins in January of 1959 (Initially $4M) and first deliveries made by June of 1959. For Collins, Mercury consisted of 14 system with 14 deliverables per system.



Below: The Panel Control (VCC UNITS) and the two (HF and UHF) Transmitters used in the Gemini Project flights

Project Mercury was followed by Kennedy's Challenge to go to the moon by the next decade. The **Apollo Program** was officially commenced in 1961 followed by the announcement of **Project Gemini** as an interim (20 systems) Rendezvous and Docking program. Gemini commenced in 1962 and ran through 1966. Collins Radio was awarded Comm, Command and Control and Ground Support (& Air Support) contracts for both programs. They also obtained a contract for LEM Comm capability.


The Cedar Rapids Gazette

MOON FLIGHT JOB TO COLLINS

President, Mac Meet In Bermuda

C. R. Firm Is Awarded Biggest Job

Saint That Ain't

Pope Urges All Leaders Seek Peace

Tale of Big Cuban Fight Unconfirmed

Secession At an End --Tshombe

Collins' Award – Dec 21, 1961

Gemini I Thru V

76H-1 VCC

618N-1 HF Xmttr –Rcvr – 1 – 15.016 Mhz
618L-1 UHF Xmttr – Rcvr – 2 – 296.8 Mhz

Gemini VI Thru XII

76H-1 VCC

For a very thorough presentation on all three programs, please see the Rockwell Museum Club site:
http://rockwellcollinsmuseum.org/title_page_documents/10sep2012_CoP_Presentation.pdf

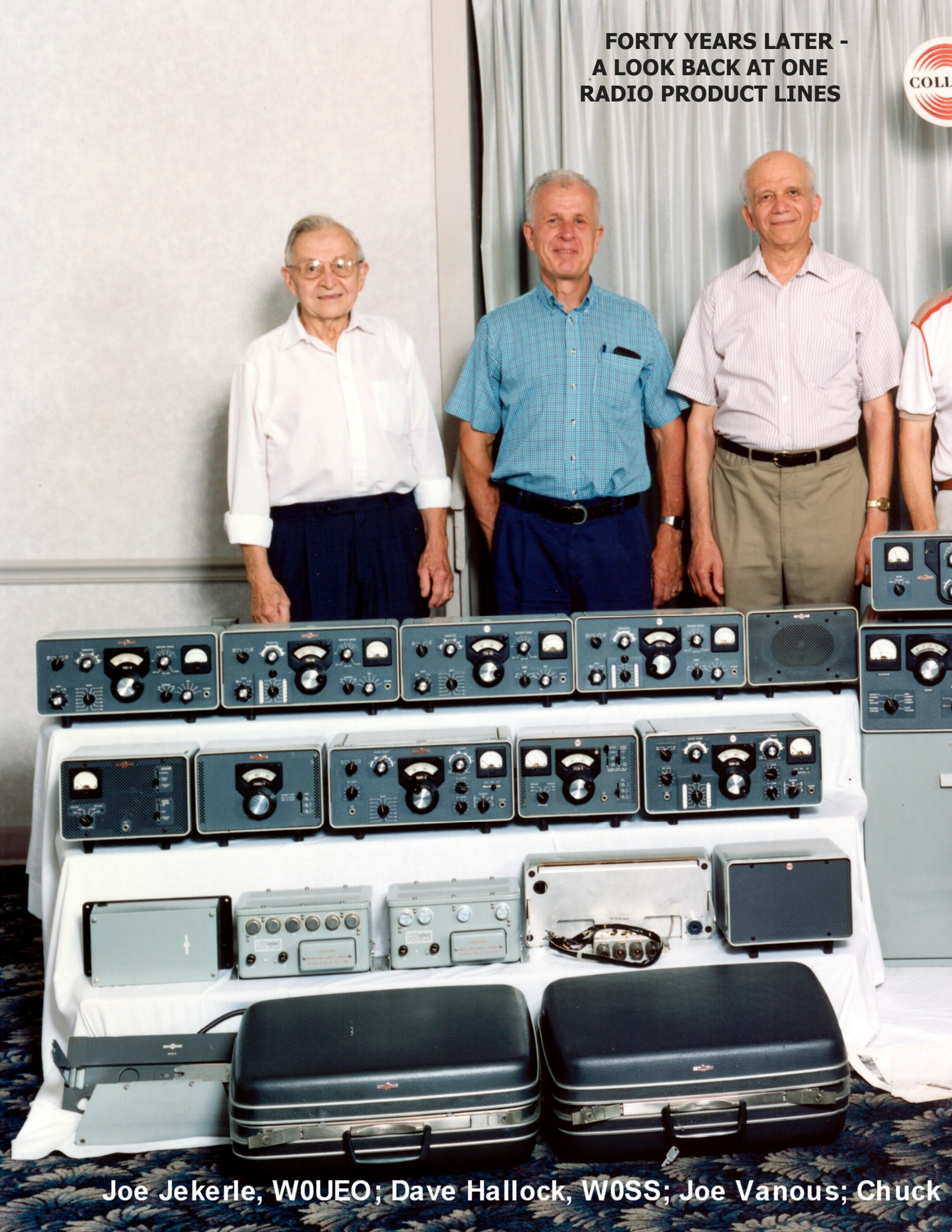
Apollo Block II - Example Deliverables

VHF AM Transmitter-Receiver
Redundancy
Voice – LEM/Moon Earth Recovery
Extravehicular, Docking
SSB 5 Watts 253.7 & 296.8 Mhz

VHF Recovery Beacon
Manual or Automatic Activation
243.0 Mhz 3 Watts

Close-up Examples of some of the Block II Deliverables for Apollo

FORTY YEARS LATER - A LOOK BACK AT ONE RADIO PRODUCT LINES



Joe Jekerle, W0UEO; Dave Hallock, W0SS; Joe Vanous; Chuck


- 1997 -
OF THE LONGEST RUNNING
IN HISTORY
W0GDJ
Carney, W0GDJ; Dennis Day, W0ECK; Jerry Vonderheide, W0NGL

The 30S-2/3 Linear Amplifier Development and Other Thoughts

by Dennis Day, W0ECK - AC94-01690

I propose to give the reader a "long way around a short story" regarding the development of the 30S-3. In 1999, your *Signal Magazine* carried a short story by Chuck Carney, W0GDJ. His previous writing, "*The Collins 30S-3, What is it? Why isn't it?*" was published in Q4 of that year in *The Signal*, Issue #16. Chuck had asked me to review the draft prior to his submission for publication.

As a little background about the management, size and location of Collins Engineering in the early '60s, I offer the following information as best I can remember. Hopefully, this will give the reader a little "feel" for where, and how Gene Senti's HF Equipment Group fit in the scheme of things, and give you a better picture of what was happening around the time that the 30S-3 was being developed.

Comparison 30S-3 Panel Above

30S-2 Front View Left

Joe Vanous Right

In early 1960 the KWM-2 was in production. In May of 1960, I had finished college and then went to work permanently as a Jr. Engineer in Gene Senti's (W0ROW) group. Gene's boss at the time was Warren Bruene (W0TTK/W5OLY) as Department Head (technical) and Leo Arthurs (W0DZV) as Department Manager (administrative). Next up the ladder was Ernie Pappenfus (W0SYF/W6EZ), Division A Director with Thane McConnell, Division A Manager. They then reported to John McElroy, Director of Development. How's that for a HAM dominated Engineering Division? McElroy also had Divisions B and C. There were approximately 170 engineers in our Division A, 85 engineers in Division B, and 55 engineers in Div. C. This did not include numerous lab technicians and draftsmen (all male)…. and secretaries (all female), and other support staff. There were several departments in each Division, and several Groups in each Division. There were about 5 to 10 engineers in each Group. Gene Senti's group consisted of Ed Andrade (W0DAN), Clyde Baxter (also a ham), Dennis Day (W0ECK), Gerry Nelson (also a ham), Joe Vanous and Jerry Vondereide (W0NGL). All of Cedar Rapids Engineering at that time was housed in the Engineering Building - later, and still today, called Building 120. Building 120 is located on the Northeast side of "C" Avenue and Collins Road, NE in Cedar Rapids.

This was a very dynamic organization and engineers were loaned and reassigned as expedient. To be noted, the HAM engineering aspect of the Collins Radio Company was miniscule….a few engineers out of hundreds in the company. Imagine all the other projects that were in process at Collins if only 1-2% of us were involved in HAM equipment. (And those doing HAM equipment were also doing commercial projects.)

I had been a co-op student in Gene's group the previous summer and had helped Ed Andrade put the KWM-2 into production in Animosa. When I arrived, Gene assigned me to perform the HAM equipment manufacturing collateral (engineering liaison to our factory in Anamosa). I'm not sure as to the exact chronology of the early 1960 events that follow, but it went something like this:

Ed Andrade (See biography in this issue) was designing/developing the 51S-1 Receiver with the help of Jerry Vonderheide and Gerry Nelson. Joe Jekerle (W0VEO—the call in the picture centerfold is a typographical error) was the lab technician. Joe had just finished building the first engineering model and was powering it up when "the word came down" that the project was cancelled. Somewhere between Ed, Gene and others, they decided to go ahead and debug the receiver and do some preliminary testing since they were so nearly finished anyway. I don't know if they did this on their "own time", or on company time. The receiver performed so well that the gamble was made to "surface" their results. Fortunately for all involved, the new word was: "go-ahead with the project". Jerry designed the 55G-1 Preselector for the 51S-1 sometime later.

51S-1 (Above) **55G-1 Preselector (Below)**

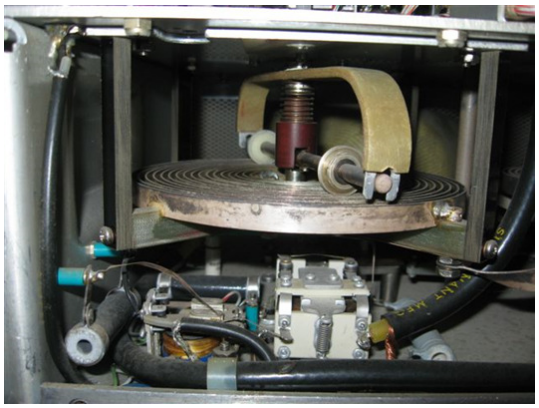
Working in Gene Senti's basement, and motivated by an idea for a lower cost amplifier than the 30S-1, Gene and Arlo Meyer (W0LBK) had designed and built a pair of very compact 1kw linear amplifiers for their own use. When Art was invited over to Gene's to see the units, Art was so excited about them that he said "build it" and even supported a "Green Room" (a secure room designed to keep a project secret) approach to moving the little amp into production…. How's that for a business plan? ….and that's about the way Art proceeded with a new product development. If the product is advanced/new technology and advances the "state-of-the-art", then a market must exist, or can be created for it!

Gene, Fred Johnson (head mechanical engineer over the entire S-Line), Leo Arthurs (parts procurement) and Harold Downing (WA0HQG) (lab technician) were hidden away in the Green Room cleaning-up the design of the 30L-1, testing the engineering model, releasing all the documentation and readying it for production. All of this was accomplished in just a few weeks.

About this time, Warren Bruene transferred to Dallas and A. Prose Walker (K5KZA/ W4BW) took his place as our Dept. Manager. Jerry Vonderheide was off doing the 32S-2/3 and I was doing the 75S-3/3A. Ed Andrade began the design of the KWM-5000 (which was also called the "Gold Plated Special" or "Cadillac" by some of us) using the same Green Room that Gene and company had just used to finish the 30L-1.

During this same time frame, commercial transmitters, particularly the high power HF ones, were adopting more sophisticated autotune capability using helical high L_{max} to L_{min} ratio inductors in their autotune PA designs. Discussion ensued as to whether it was time – and not very long after the introduction of the 30S-1 – to develop the next generation of true 1 kW PAs, using the newer autotune technology and a new no warm-up Eimac tube that would replace the venerable 4CX1000.

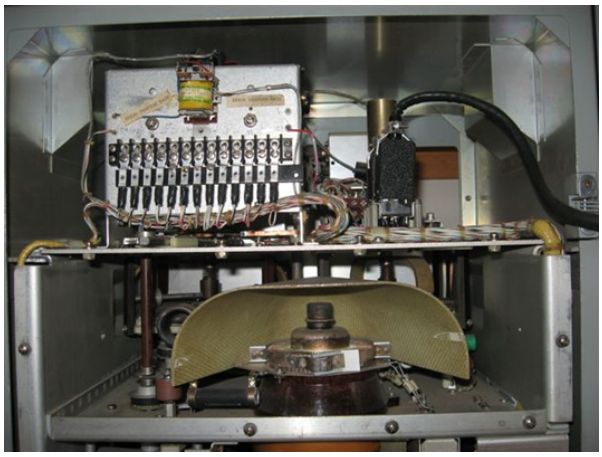
In early Fall of 1961, Joe Vanous was assigned as Project Lead Engineer of the new 30S-2 project (as it was then designated). Later, after final engineering changes, the final version of this new amp would be renamed the 30S-3/3A …..more on that later. Joe enlisted Doug Rhodes to do the output RF network, Glen Deen (W0BWS) to



Helical Inductor used in the Autotune PA Network ("L" Side of 30S-2 Output Pi-L)

do the power supply, me to do the solid state servo amplifier module design, Elmer Bruce to do the mechanical engineering and Joe Jekerle (W0VEO) to build and test the engineering model. I had taken just one course in Semiconductor Theory & Practice in school, so it was off to see the mentors immediately.

Advice, and learning, was sought from Ted Hedgecock, the existing servo expert at Collins, and also from a young upcoming servo engineer named Chuck Anema, KE5DOU, now living in Wimberley, Texas.



Good Look at the Servo amp (Left Upper), the Servo Motor (Behind the Jones plug and the new Eimac 3CX-1000 Instant on Tube with its Cooling Shroud

This first engineering model, silk screened 30S-2, and shown thusly in photos, has remained under my TLC (tender loving care) since being "liberated" from Collins (legally) in 1962 to keep it from being cannibalized for other projects. For many years it was on-the-air from my QTH with excellent results.

When we began the design/development phase of the 30S-3/3A (a 30S-2 with engineering improvements and more robust cooling (the 3A), our desks were all in Area 1 and our lab was on the deck of Lab 5 of the Engineering Building 120. At this same time Ed Andrade had finished the design of the first (and only) E-model of the KWM-5000 (now in the museum) and was in the process of de-bugging it on the 20 meter band. At that time, the L/C components for the other bands had not yet been calculated and installed.

This was now late fall of 1961 and during Ed's evening and Saturday hours he was designing and building his 80 and 40 meter solid-state mobile transceiver which he called "The Critter". It now resides in the Rockwell Collins Museum on top of the KWM-5000. It is appropriate that it hangs out in the museum, because its existence – even though a G-job, and never intended to be a product – had a dramatic impact on the future of Amateur Radio products at Collins Radio. For one thing, Ed had shot himself in the foot.

Overall Rear View with Back Cover Off – ROBUST STUFF !
The Two Helical Inductors are the Two Inductors in the Output Pi-L Network
(The two Pi Caps can be seen in the compartment below)

Ed was doing all this in the same lab that we were doing the 30S-3, so when we were working nights and Saturdays we knew well how Ed was progressing. The "Critter" was not a company project, but Ed's way of self-education for designing with these new devices called transistors. The irony of all this is that when Ed was finished with his "Critter", Mr. Collins saw it and felt that the KWM-5000 was nothing new and/or technologically advanced enough, and that Ed should cease work on it and wait until we could do an all new solid-state HAM line. Chuck Carney (W0GDJ/W5PVV), the Amateur Product Line Manager was besides himself, and all the rest of us were also very disappointed in Art's decision…..The Boss isn't always right but he IS ALWAYS the Boss!

Editors Note: Dennis Day relates that there was a lot more exploration going on at the same time as the development of the 30S-2 and 30S-3. From the Fall 1961 through the late summer of 1962 when the 30S-2/3 project was cancelled, and in addition to the projects mentioned above, the group, with Dennis and Ed Andrade very involved (along with Gene Senti) put out several other proposal and did work on the TMT and the follow-on Solid State proposal for the 75S-4/32S-4 (and KWM version) equipment based upon the URG work. There will be follow-up stories on this interesting period.

Back to the 30S-3……The original red pencil "mark-up" copies of Joe Vanous' hand drawn schematic for the 30S-3/3A (with revision dates from 3-14-62 to 9-5-62), the official schematic (dated 10-4-62), the Equipment Specification (9-19-62), the Production Test Requirements (9-19-62), and the Type Test Requirements (10-19-62) still exist.

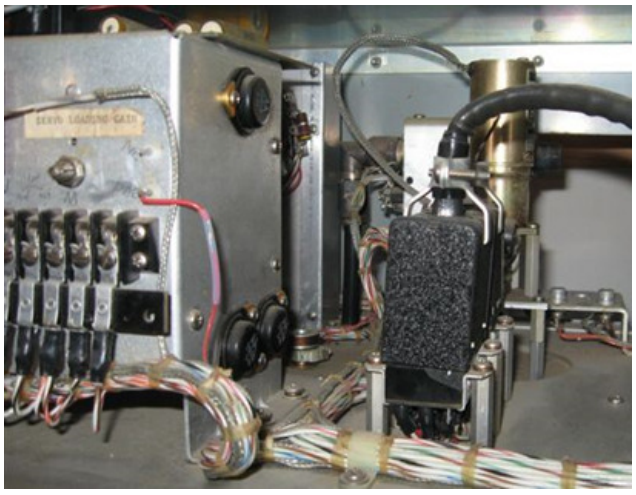
Also we have a copy of my Engineering Note Book design data for the Servo Amplifier Module (dated 10-29-61 to 1-3-62). The Engineering Project Number shown is EP 39-2395. Whether this was the charge number just for my part of the project or for the whole project, I do not remember. These dates verify that the design of the 30S-3 began about Oct. 1961 and finished about a year later. As my engineering notes show, my design/development effort took about 2 months. I did have some involvement as the overall amplifier development proceeded, but I was off doing the 75S-3B/C during most of that time.

We moved across the street to a new building in 1962 and finished the amplifier there. A set of parts were ordered off of the final production drawings and Joe Jekerly built a second, and final 30S-3 model. This model was in the TLC of Chuck Carney for many years, moved south to Dallas with him, got loaned to a friend for some years, and then returned to Cedar Rapids with Chuck before Chuck passed it on to his Son (K6RU). Its front panel is silk-screened 30S-3. Of note is the fact that on my 30S-2 model, there are definite signs of engineering work where the higher cooling capacity 30S-3A modifications could be installed for evaluation. I don't believe they ever were.

At this time, independent of this program, Collins had hired an outside consulting firm to design a new company image and logo. ZVS Styling, I believe, was their name and they came up with the new paint scheme, the aluminum extrusion strip across the top of all units with the terra cotta color and the new "meat ball" logo. With this "new look", another front door panel for the 30S-3 was designed according to this new design concept. It looked very nice but did not at all match with the S-Line and so it was scrapped for the 30S-3. It was adopted, as was the Round Emblem, on future Collins gear soon after that.

I imagine photos were taken of the new amp with this new styling, but I can't remember ever seeing any. (There is a possibility that Karl Stanley, W0YSD, a member of Chuck Carney's staff, if he is alive, could shed some light on this subject.) I do not remember if any of these ZVS related drawings were actually released to our records system before the amplifier production was cancelled – but I am getting ahead of the story.

An overall design goal for the 30S-3 was to use as many common/standard parts as possible. Of interest is the use of, then, everyday round screw base fuses (you could buy most anywhere) and a power supply "step-start" resistor that was then used in about all home electric space heaters. Both of these items are almost extinct today. Amazingly, these part types had been hanging around since the late 30s in other Collins gear. A very standard Jones connector was used for the remote control cable connector. A shallow S-Line style cabinet was designed to accept the removable front panel of the 30S-3 for remote operation of the amplifier and one of these still exists.



Detailed View of the Servo Amplifier Module and the "New" Germanium Technology Devices

Choosing the transistors for the servo amplifiers was not too difficult since in the early 60's there were not many to choose from. Collins had a Component Application/Specification Group that helped guide

us in selecting any component for a design. Frequently we needed devices that were not in our Collins inventory and we worked closely with our vender component representatives/ engineers. Many times we needed/selected a component that was not yet in the Collins inventory. In that case samples had to be acquired from the vendor, tested in the design and finally tested by our Component Engineering Group, a specification written, Collins Part Number assigned and the document release in our system. In the case of the output transistors for the servo amplifiers, the Motorola 2N618 device was chosen. The driver stages used 2N2374's. A similar issue arose in trying to find an appropriate gear head servo motor.

Most other components were of a standard "garden variety". The first engineering model of the servo amplifier module was built and tested and installed in the first engineering model 30S-2. Only minor changes in the design needed to be made during the integration of the overall amplifier. Toward the end of 1962 a preliminary List of Material was released for advanced purchasing of long-lead components for the planned manufacturing of the new amplifier.

It should be mentioned that the amplifier project had not at this time, been exposed to the light-of-day – meaning that Art Collins was not aware of the project and had never had eyes on it. When it was time to take it to production, we knew that this had to change. A demonstration was arranged and in came Art.

One quick look at the new amp, and its operation and configuration, and Art uttered an expletive and walked out of the room.

Once again, Art did not feel that the 30S-3 advanced the state-of-the-art far enough. He cancelled it immediately, even though it was ahead of anything else available on the HAM market at that time. It had such features as being automatically tuned from 2 to 30 mHz, used a single newly designed Eimac instant heat filament linear ceramic triode (3CX1000A7), a pi-L output network using the new flat pancake type coils for good harmonic reduction and loading characteristics, used solid state devices in the servo amplifiers and the power supply, and was "instant on" and smaller than the 30S-1. It also had remote control capability via a multi-conductor front panel extension cable.

Another Big Problem - Art had recently decided that all future Collins amplifiers should be able to be driven with low power (standard 500 mW level) and be computer controllable so as to be compatible with any future land, air, sea communications systems we would produce……This he rationalized was a more "universal" approach to our product design/usage.

Needless to say, there were a large number of very disappointed engineers hanging around the lab that afternoon.

Closing out the 30S-3 was almost the end of the story for Collins Ham equipment. We had a false start on what was called the TMT-1 (Transistorized Mobile Transceiver), for which I was project engineer. It was all solid-state except for the built-in PA using an Amperex glass 8300 dual pentode driven by a 6CL6. The power supply was also built-in for 12-14 dc or 115-230 ac power. We, Bill McKay (W0HRQ) and I, were several months along when it got cancelled for more important projects. A little later, Gene tapped me again to do a new HAM line and I wrote a Design Plan for the 75S-4 Receiver, 32S-4 Transmitter and matching TMT-1 (again) Transceiver. This project was also shelved because of more important projects. Artist renderings and the Design Plans still exist for both of these projects and I understand that they will be the subject of a future article in your *Signal Magazine*.

The final end of Amateur Radio at Collins came with the "Casper" line project in 1977….This is the project that led to the successful introduction of the HF-380/KWM-380 and the HF-281 and 282 channelized versions of the HF-380… and that's the end of the (Rockwell) Collins HAM story. …….. and fodder for the future Q4 *Signal* article.

de Dennis Day, W0ECK

More on the Author: Dennis retired in 1990 from Rockwell after becoming the Head of the Engineering Group for HF Commercial and Amateur Radio Communications Products. He worked at Collins Radio during the S-Line era and through the demise of Amateur Radio Products. He was very involved with Project Casper (in his group) and the subsequent move to future emphasis on Commercial and Military markets. He still lives in Cedar Rapids with his wife Pat and baby sits a couple of beautifully restored Studebakers. Pictured to the right is Dennis with Chuck Carney (W0GDJ), Marketing Manager for HF Comm before his retirement from Collins. (Now SK). Chuck and his son, Chuck Jr. (K6RU) wrote an earlier story about the 30S-3 that Chuck had owned. This appeared in our *Signal* in the Q4 1999 issue.

Did You Know?

Most of you (those of you who are really into the KWS-1 history) know that when Collins first planned the marketing of the new SSB, 1 kW, KWS-1, they made a couple of blunders.

First, the marketing group assigned this new transmitter the next available number in their power transmitter series, and it became – temporarily – the 30L-1 and was promoted in print as such in the 1955 ARRL Handbook which went to press late in 1954. Of course, Art changed that plan, wanted a number that reflected this new transmitter's capability and the "1" "kW" "SSB" transmitter became the KWS-1. We got our 30L-1 finally a few years later.

In addition to erring on the name, the marketing department also felt that the necessary pricing (It was very expensive to build) was perhaps too high, and they prepared (early) a price point strategy that offered a stripped down version of the KWS-1 - the KWS-1K w/ no power supply and no PA final tubes. They also initially offered a low powered exciter only version (the 32W-1) which was nothing more than a KWS-1 Exciter Head with no PA deck and a power supply built in the PA area which powered this lower powered unit with just the 6CL6 output.

This strategy proved unnecessary since Collins was swamped with KWS-1 orders. This – in spite of the fact that the cost was equivalent to a new car at that time. Collins quickly stopped promoting the KWS-1K and the 32W-1. Very few KWS-1Ks were ever ordered or sold and even fewer 32W-1 Exciters were sold - possibly only one or two. I have seen and heard of only one.

Now, from J. B. Jenkins, a 40 year employee of Collins Radio in both Cedar Rapids and Dallas, comes "The Rest of the Story" - as Paul Harvey used to say.

The fact is that Collins did their normal first build when they started production of this new family of products related to the KWS-1. They built 20 or 25 32W-1s (J.B. is not sure which). Then when they sold so few of them and stopped promoting them (and anticipating no more sales), they took the remaining 32W-1s and reworked them completely and turned them into KWS-1 exciter heads with a PA deck. This required changing out the chassis.

Bottom line, for those of you that are real died-in-the-wool collectors of KWS-1 memorabilia (and would die to own a 32W-1), you may already have one…… So, Enjoy!

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CCA Business & Activities

All I can say is that we all hope that you are having as much fun with these anniversary issues, the new website features and content, and the expanded events calendar as we are. It seems you all are because word is getting out, and the membership is climbing steadily at an unprecedented rate. Our membership count is now significantly higher than it has ever been (by hundreds) and seems that it is still rising at the same rate. Jerry Kessler, totally busy with his career, is doing yeoman's duty keeping up with the incoming paperwork. We all owe him a big "Thank You" for what he does. We also need to get a little business done here in the middle of all of this historical perspective focus and writing.

Events: The *AWA Rochester* meeting was a frustrating success. Thanks to Jim Green, WB3DJU, we had a great presence at their museum opening and a display of a complete KWM-1 station with Jim doing it justice. Yours truly (supposed to be there) was sitting in the airport in San Antonio, the victim of no less than two mechanical failures in a row with United Air Lines and then an added weather delay that made it impossible for me to make connections and get to New York in time. To show you how bad it was, they gave me my money back in full without any hassle. In the meantime, they did manage to get all the show supplies halfway there (to Chicago). It was not a fun day.

Our next events this year are the **ARRL Midwestern Convention** on November 8th and 9th, where the CCA is sponsoring the antique radio "Beauty Contest" and we will have a nice double booth like at Dayton as well as associated activities. That is all up on the website Events Calendar. Hope you can make it because the gang will be there in force and there will be some nice activities. And….it is now official, there will be a western event this year in conjunction with **Pacificon** in the San Francisco bay area on October 11-13. The CCA "California Team" headed by Billy Yates, N6YW and Tom Bonomo, K6AD are doing the legwork out there and Scott Kerr, KE1RR and N7OTQ will be there before it kicks off. There will be a dinner and other activities along with our booth at the show. See our Events Calendar and also the Pacificon Show website. For those that are counting, we now have 5 annual events spread around the country.

More Exciting News: A Grass Roots group in Cedar Rapids, involving Art's son Michael Collins, has just taken the wrapper off of a major effort and project to produce a Arthur A. Collins Legacy Video Documentary or "**The Collins Legacy Documentary**". This is not meant to be a testimonial for Art Collins, but rather a tribute to the creativity and very hard work of many people responding to his leadership. This wonderful project will produce two videos - first a short introductory one meant to be a quick show and a teaser, and then eventually, as funding is available, a 55-60 minute video about Collins Radio's visionary leadership in a number of exciting technologies.

The CCA and the AWA are supporting this effort which also serves to honor Ben Stearns who just passed away last month. Funding for the documentary will be from the Ben Stearns Memorial fund (He left provisions for this effort) and public donations. That is where we come in. The CCA has been supporting this general area of archiving of personal histories and technology. The AWA, in conjunction with the CCA, will provide a 501C-3 path for donations to this worthy cause. I say worthy because it not only is consistent with the "Heritage" pillar of the Rockwell Collins Brand Strategy, but it directly supports and impacts the STEM (Science, Technology, Engineering and Math) youth initiative that is supported by the CCA and the AWA. One of the target audiences of these videos is the impressionable youth of our country that are in the Middle School through High School age group. Please see the CCA website for more information on how to help. Any amount will help with this important project, so do not be shy. The donations go straight to the AWA for Tax Deduction credit processing and then to the project.

Scan to see more about the CCA

Coming Elections: As you all know, the CCA has an elected Board of Directors from which the board then elects it's officers. There are term limits written in the bylaws and charter and two of our board members are "timing out" at the end of the fourth quarter of 2013. Jim Stitzinger, WA3CEX - our Secretary - and Karl Bowman, W4CHX – Events – are going to be leaving the board and cannot stand for reelection. Both of them, by the way, have made a strong commitment to remain just as involved in our efforts and give us, and me, their support. But, we will be electing two new board members in the fourth quarter.

This is a good process. Every organization needs new blood and a fresh viewpoint. While we feel that our operations have been moving in a nice direction for the group, I am looking forward to having new faces to contribute ideas and efforts. I want to emphasize that this is not an honorary function – being on the board of the CCA. It is a responsibility and we need people who are thoughtful, team players, and not afraid to get their hands dirty. What we do always try to do is make sure that the responsibilities and work is distributed so that nobody gets overloaded.

We would, if you have the talents and the inclination, hope you consider running for one of these board slots. If you even start to consider it, please feel free to call one of the current board members or me and discuss what is required from an effort and time perspective.

The Election Procedure will be that we will take nominations through the fourth quarter's first two months. To be nominated, you must be a CCA member in good standing for at least the two previous years and you must get a second for your nomination. These should be communicated to any of the current board members with a copy to the President. At the end of November, the nominations will close and the nominees will be announced on the website. Then brief bios of each nominee will be printed in the Q4 issue of the magazine. A longer bio will be put up on the website if you desire. The Q4 issue mailing will include a ballot that must be returned no later than January 31st, 2014. The results will be announced on the website in early March, and included in the Q1 2014 *Signal* issue.

We all hope you will consider helping and running for one of these positions. We would like to talk with anyone considering running so that you have a clear idea of what will be expected if you win….Like I said, there are responsibilities and work - and travel is part of the effort.

I must say in closing that all of the current team have had a really great time these past years working together. I hate to see two of them go. But…. the good news is that they want to stay involved and they assure me that in a couple of years, they will be running again – the good Lord willing.

In the meantime, I look forward to seeing new faces in the organization, and to finding new team members who will keep such good spirit alive and well. We could not be achieving what we have done to date without really good cooperation. Let's talk.

Bill Carns, President CCA
(512) 618 2762 Cell + VM
wcarns@austin.rr.com

Two-Tone Intermodulation Distortion and Testing Methods

by Warren B. Bruene, W5OLY - AC94-02770/Life Member AC11-0001

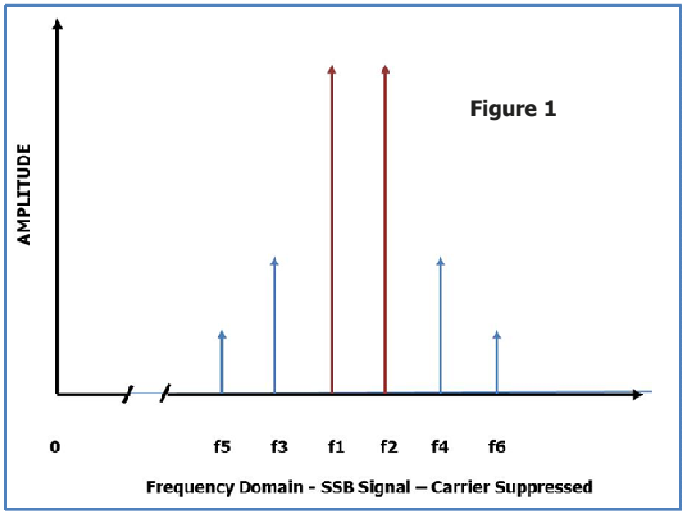
It is common knowledge that Art Collins was very particular about the distortion performance of any product that he manufactured. This became apparent very early in the history of Collins Radio. This facet of his focus on quality was no secret, and the attention to this detail was ingrained in the culture of the company.

The very early work in Single Sideband and, as it turns out not surprisingly, the early standardization of testing methods, was done by the people at Bell Labs in about 1940. Shortly before World War 2, Bell Labs published their methods for measuring 2 Tone SSB IMD in the *Prodeedings of the IRE*. This standard was *de facto* adopted by the industry, including Collins, as the years went by.

Before proceeding we should define the terms used.

The Two-Tone Intermodulation Test

Once a voice signal is translated to RF spectrum as a SSB signal, major harmonics of the SSB are of little consequence because they can be filtered off. However, system non-linearity inevitably leads to intermodulation between every two frequencies in the signal band of interest. These mix to produce undesired frequencies. These undesirable frequencies can and do occur within the system bandwidth and thus represent unwanted distortion of the recovered audio. Figure 1 illustrates an example of two equal amplitude test tones (f1 and f2) with a representative set of IM products (f3 through f6).



f3 =	2f1 - f2	a 3rd order product
f4 =	2f2 - f1	a 3rd order product
f5 =	3f1 - 2f2	a 5th order product
f6 =	3f2 - 2f1	a 5th order product

Note: All spacings are equal. Actually the 5th order nonlinearity produces small components on frequencies f3 and f4, however they can be out of phase with those already there and may serve to reduce the resulting distortion.

Collins Radio usually specified tone frequencies of 1200 Hz and 1900 Hz through the S-Line era, but lower tone frequencies were used in the original 1940 Bell Labs tests.

The IMD test signal is produced by summing two equal amplitude tones, f1 and f2. This test signal is applied to the SSB transmitter audio input. A sample of the resulting RF signal (Figure 2) is then observed in the frequency domain in order to measure the relative amplitudes of the resulting spectral components.

The most direct method is to use an RF spectrum analyzer capable of resolving the spectral components. Alternatively, the RF spectrum may be translated to the audio domain using a mixer and local oscillator, and an FFT software program used to measure the spectral components. It is also possible to use a narrowband RF receiver to measure the individual spectral components, but this approach has some practical difficulties.

The two-tone RF signal envelope referred to above is produced by two phasors rotating in opposite directions relative to the center frequency (carrier) phase angle. Theoretically the period between two peaks shown represents one full cycle of the difference frequency.

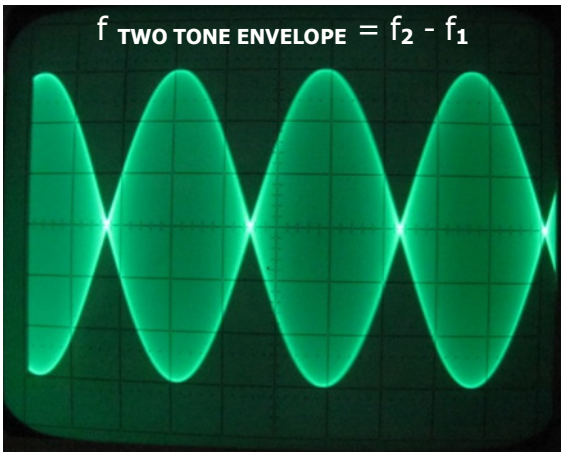
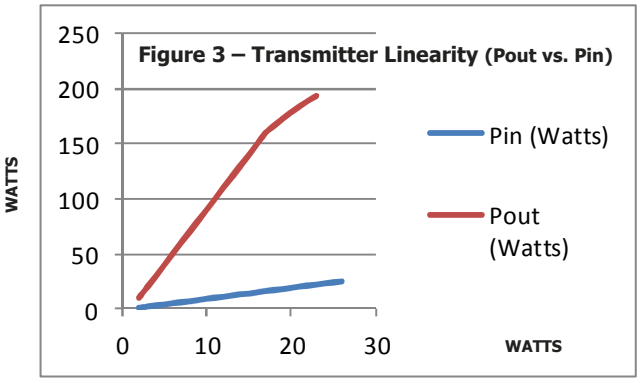


Figure 2 Two-Tone RF Signal Envelope – Time Domain

The magnitude of two-tone IM distortion is defined as the db down from one test tone to the largest IM product. The largest distortion product is usually one of the 3rd order products. This is the definition used by Bell Labs back in the 1940's and adopted by the industry. Collins Radio also adopted this definition when they started producing SSB transmitters for hams. Collins established 35 db as the absolute minimum performance for our equipment. Typical performance was for the IMD to be 40 db down or better.

The distortion itself can be visualized by looking at the plot of a linear amplifier Output (Pout) vs. Input (Pin) in Figure 3. Ideally, for no distortion, it would be a straight line. The line bends over sharply when overdriven, however, as represented in Figure 3 below. An article on a Linearity Tracer was published in QST, 1954 [1)]



Apparently, some of the SSB transmitter manufacturers had trouble meeting this 35 db specification using the standard (Bell Labs) definition of the test, so they changed their definition to refer the measurement to the amplitude of PEP (of the 2-tone envelope) instead of to

Continued on p 35

The 75A-4 Receiver Introduction

by Gene Senti, W0ROW

Editors Note: This writing was done by Gene in 1954 just prior to the introduction of the 75A-4 and the KWS-1. Gene penned this to provide material for the promotion of the new SSB receiver. Some of the material has appeared in print previously on the inside cover of early 75A-4 manuals. Just prior to his death in 2005 Gene gave this full text to this Editor. To our knowledge this is the first publication of the full document. Figure 1 is shown for reference but space does not permit a full scale version. Go to http://collinsradio.org/signal/SentiA-4article.

When a new product hits the market, be it an automobile or radio gear, the first question asked is "What does it have that last year's model didn't have?". The 75A-4 can't sport a 199 horsepower engine, or a panoramic windshield, but it does have a number of new features never before seen on an amateur receiver. One feature, Passband Tuning, is so new that it was necessary to coin a new name to describe its function. Other new features include: separate detectors for ssb and am reception, a Q-Multiplier Bridge-Tee filter in place of the crystal filter, a new avc system that works on ssb, a new low cross-modulation rf tube, a noise limiter that works on ssb, a built-in crystal calibrator, two 10 meter bands, and a new permeability tuned oscillator - all built into a cabinet nearly 4" narrower than the 75A-3.

This new ham band Collins receiver retains many of the time proven features of the earlier 75A series of sets. These features include: double conversion, crystal controlled front end for high stability and good image rejection; permeability tuned, sealed master oscillator for accurate dial calibration and long term stability; and mechanical filters in the IF circuits for the ultimate in selectivity. But this is where the similarity ends.

CIRCUIT DESCRIPTION

The circuit functions of the new 75A-4 can best be described by referring to the block diagram (Figure 1). The receiver uses a double conversion circuit with a crystal controlled front end, a variable if system, a low frequency converter stage and a fixed 455 kc if system. To illustrate the action of the various circuits, assume a signal being received at a frequency of 14, 000 kc.

A new rf tube is used which improves the cross-modulation characteristics of the receiver by about 3 to 1. This tube, a 6DC6, is a low noise, remote cutoff pentode. It has the low noise characteristics of a 6CB6, and the remote characteristics of a 6BA6. The remote cutoff characteristics allow greater grid voltage swing without cross-modulation distortion. However, don't rush out to buy a 6DC6 to plug into your 6CB6 socket and expect a phenomenal change in your present receiver. Stage gains and avc characteristics of the following stages must be just right to get the best performance out of this new tube.

This incoming signal is tuned and amplified by the rf amplifier and fed into the high frequency mixer. In the mixer, the 14, 000 kc signal beats with a crystal signal of 16, 500 kc and the difference frequency of 2500 kc appears at the plate of this stage. This 2500 kc signal is passed through the variable if coils and fed into the grid of the low frequency mixer. There the 2500 kc signal beats with a 2955 kc signal from the permeability tuned oscillator and the difference frequency of 455 kc appears at the plate. This 455 kc signal is fed through the mechanical filter and into the fixed if stages and amplified in the conventional manner. It should be noted that this type of double conversion results in both an increase in image rejection and also a great increase in stability and should not be confused with double conversion receivers using a high fixed if frequency for image rejection and a low frequency fixed if for selectivity. This latter scheme will not give any improvement in stability because the local variable oscillator must still operate near the signal frequency, and on the high frequency bands, drift of this oscillator can become serious.

In the 75A double conversion scheme, the high frequency signals are heterodyned to a lower frequency by means of crystals which

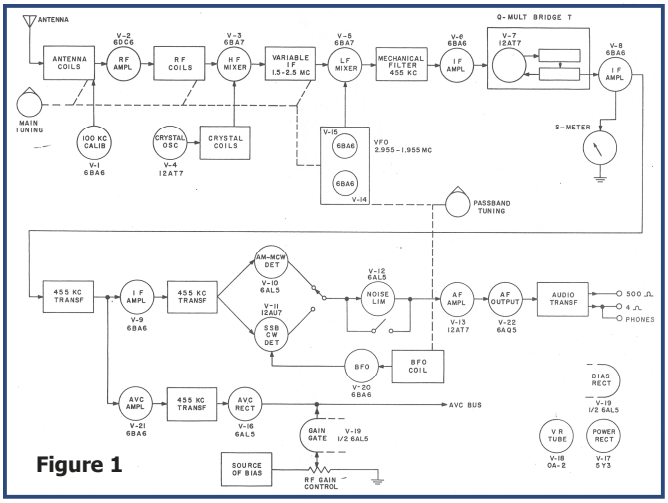


Figure 1

contribute very little drift to the signal. This low frequency signal is then heterodyned against a very stable variable oscillator which by virtue of operating at a low frequency, contributes very few cycles to the drift of the signal. This results in the excellent frequency stability of the 75A receivers.

After reaching the 455 kc stages of the set, the signal is passed through the mechanical filter which provides all the selectivity curve shaping.

Space has been provided for 3 mechanical filters. This allows the operator to tailor his set to his requirement. Matched pairs of filters are available for selecting either the upper or lower sideband at the flip of a switch. An 800 cycle filter is available for cw use and a 6 kc filter for phone use when interference is not a problem. The 75A-4 is normally supplied with a 3 kc filter as standard equipment. The other filters are available as accessories. After one stage of amplification, the signal is fed to the Q-Multiplier Bridge-Tee filter. This circuit replaced the conventional crystal filter and has several features which make it superior to the crystal filter. It has a deep narrow notch which has equal effectiveness anywhere in the passband. Conventional crystal filters become inoperative at frequencies very close to the resonant frequency of the crystal. This makes it impossible to reject low frequency heterodynes. Or if the bfo is off-set 1 ½ kc from 455 kc, as is generally done when receiving ssb, heterodynes in the vicinity of 1500 cps are not rejected. The Q-Multiplier does not have these limitations, nor does it distort the shape of the IF passband as is the case with crystals, resulting in much less loss of intelligibility while still doing a superior job of eliminating heterodynes.

The 455 kc signal is then further amplified and detected. A portion of the signal is split off ahead of the last if amplifier and is fed to a separate avc amplifier. This amplified avc results in a very flat avc characteristic and also allows avc operation with the bfo turned on since the bfo voltage is isolated from the avc amplifier.

A new avc circuit which has a fast attack and a slow release time is used. The avc system is fast enough to respond to the first few cycles of a sideband syllable and does not require the presence of a carrier for operation. Fast and slow release times are available on a panel switch. The fast is normally used for general purpose reception. The slow is useful for sideband or cw reception and prevents the receiver from "opening up" between words or cw characters.

Separate detectors are used for double or single sideband signals. The sideband-cw detector is a mixer type circuit which greatly reduces the intermodulation distortion which is generated when a conventional diode detector is used for detecting a sssc signal. Third order products of -50 db have been measured on this detector.

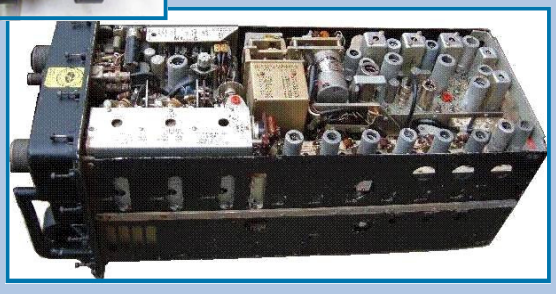
Continued on p 41

KEY MARKET WINNERS

AVIONICS - Commercial & Military

With the end of world war 2, and the start of commercial business, Collins' product offering was for the most part limited to the 18S, the ART-13, and then quickly the 51R and a new VHF transmitter. In 1951 they introduced the ARC-27 UHF transceiver for the new UHF band and sales of avionics ramped up significantly. Before it was over, Collins sold over 40,000 units of the ARC-27 and subcontractors made another 35,000 - impacting Collins' sales significantly. Collins radio went on - over the next two decades - to become the de facto leader in Military and Commercial Avionics with Sales approaching $100M per year by 1970. To the right, you can see the full range of their offering including Communication, Navigation and Instrumentation (CNI) boxes.

Military UHF ARC-27



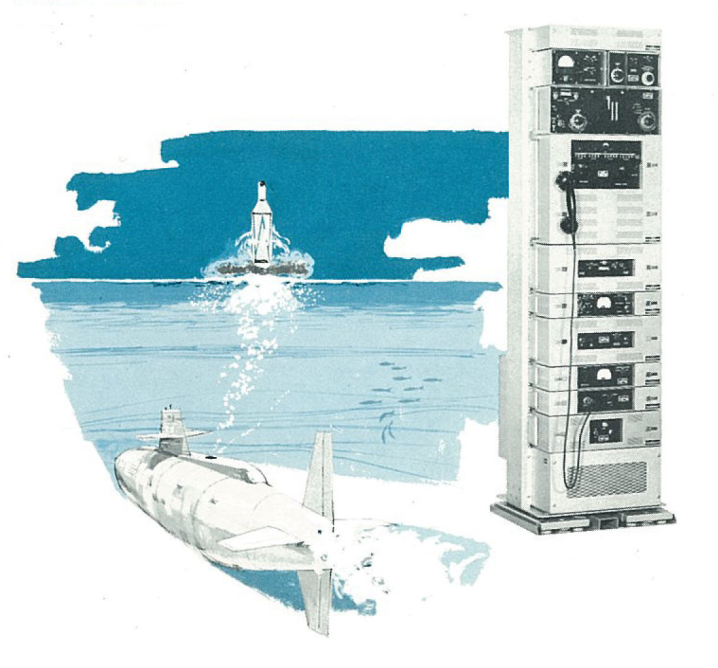
AMATEUR RADIO

75A-4 SSB Receiver - Growing out of the Collins line-up and evolution of the 51J and 75A series through the late '40s and early '50s, the 75A-4 capitalized on PTO stability, a novel frequency conversion scheme and the newly developed mechanical filter to make it one of the finest receivers ever made. It was introduced in 1955, the result of fine engineering in Gene Senti's group. Before the line closed, just over 6000 were manufactured. This beautiful receiver offers adjustable selectivity using 3 plug-in filters and novel pass-band tuning. This concept—invented by Gene—went on to be a standard in the industry. See Gene's story in this issue for more.

KWM-2/2A SSB Transceiver (Right)

This well known transceiver was the brainchild of Gene Senti as the natural evolution of the KWM-1 that he had developed in his basement as a winter project in 1956. This transceiver, designed in the same form factor as the individual S-Line transmitter and receiver, used the same power supply and developed over 100 watts of peak power from 2-30 MHz. The KWM-2/2A was one of the longest running product lines in amateur radio history - running from November of '59 through shutdown in El Paso in 1979. Due to continuing demand the line was restarted 3 times between 1980 and 1982 - See Rod Blocksome's survey on the CCA website under "Archives" FRLs. Over 26,000 units were built and the transceiver was still in use by the military during Operation desert Storm in 1991.

POSTWAR WINNERS



KWT-6 (and the **URC-32** shown above) were first produced in 1959. This system of component rack modules could make up various configurations of the basic 500 watt transceiver. This system of modular rack mounting was later used in microwave equipment and other application.

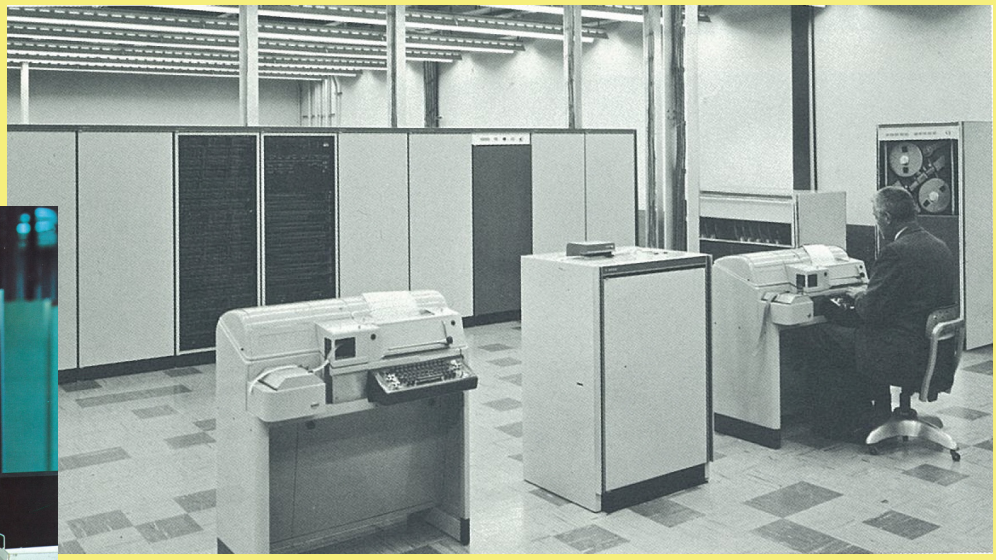
HF COMM (Commercial & Military)

Collins Radio was the king of high power - high quality HF transmitters during the '50s through the '70s. As a good example, start with the State-of-the-Art (no pun intended) KWT-6/URC-32 500 watt SSB Transmitter/Receiver built for the Air Force (commercial KWT-6) and the Navy. Then observe the follow-on 204F & H (growing into the 208) series, and some of the monster 250 KW transmitters built for the VOA. Collins was the top dog in quality high power HF.

To the right is a 204H-1 making power. This amplifier is probably one of the finest designs ever seen. The 204H is the autotune version of the 204F-1 to its right. The 204F & H are rated at 2.5 KW RTTY service key down 24/7 and will easily make 5 KW when run open loop. The lineup is dual 4CX1000s as originally shipped, driven by dual 6146s. It is one conservative amp. The drive required is 500 mW max. The pair were designed for use with the KWT-6 and URC-32.

COMPUTER

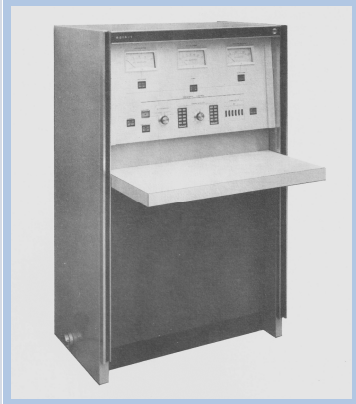
The new **C-8400 Computer** is shown in 1961 at the test installation in Cedar Rapids. During the mid 60s, Collins would put installs in at ARINC and several other companies including the New York Central and Union Pacific Railroads. Later versions helped control the VOA installations. During the 60s, the computer family took on several variants. The original C-8400 is shown at right.



The C-8451 was used for the

ARINC Teletype circuits. By 1966 (Left) Collins was showing their newly announced C-8500 model. The **C-8500** was more advanced and was squarely targeted at the Government and Military Integrated Communication/Computation/Control applications. (Packaging look familiar ?). The C-8500 was particularly successful and immediately produced good revenue. It ran in production right up to the point that the company started to struggle with the severe downturn and financial troubles of the '70s.

PROJECT LEAD (821A-1): # KEY MARKETS **WHO ELSE? WARREN BRUENE**



BROADCAST

Need to change bands and load up that Sterba Curtain with your 250 KW PA? Do you need to be heard in Caracas when the sun spots are cool? Then this **821A-1** is the transmitter for you. It may not be the biggest volume runner that Collins ever had, but it sure was an income generator.

It is estimated based on known installations that Collins sold about 15 of these high power monsters. Most of them went to VOA locations in Delano and Dixon California and to Bethany Ohio. Some went to Canada and several to Australia.

We've chosen this 821A-1 to represent the successes of Collins Radio in the Broadcast Market—both AM Band and Shortwave.

The 821A-1 took up a lot of real estate - requiring three install areas. The one for the water cooled plate transformers and other HV PS components was usually outside. The insert photo to the left shows an actual install at Delano, California.

Beautiful to look at, it could tune from 3.95 MHz to 26.5 MHz in less than 20 seconds using 10 preset servo tuned channels. Typical tune time was from 5 to 15 seconds. The big brute uses 4 each 3CV100,000Cs. Two are in the Modulator and two in the PA driven by a 4CX3000. Plate Voltages are 15 KV (PA) and 3 KV (Driver).

We could have shown the really successful 20V-3 and the 212 boards & other great stuff, but this is way better. Thanks Warren!

Bruene on IMD (Continued from p 31)

one tone. Since this makes the measurement for any given system look 6 db better, what they call 35db down is only 29db when compared to Collins', or any other commercial manufacturer's, measurement.

That is why Collin's transmitters had "cleaner" signals with less adjacent channel splatter than almost all other competing "Amateur" gear of its time. To facilitate accurate in-house measurements and provide customers with a quality measurement solution, Collins developed a large-screen spectrum analyzer so the various IMD products could be seen separately on the screen. It had an 80 db dynamic range.

Finally – Some comments: A 35db specification won't do much good regarding adjacent channel splatter and interference if the final amplifier is overdriven.

As a first order method of keeping your transmitter in specification and performing well, when you turn up the drive, watch the rate of rise of the output and you will see where the two are linearly related. Then, suddenly, you will notice that the rate of increase of the output will soften and fall off with respect to the rate of increase of the drive. When that happens, you have gone too far with the drive, you are into the non-linear operating region of your amplifier and you are guaranteed to be generating higher than specified distortion. Turn down the drive until the two are linearly related again and leave it there. Then… use your ALC if you can !

Following the Grid Drive adjustment – or Carrier Adjustment – instructions in the Collins Manuals (relative to the amount of ALC observed) will also get you this same result.

All transmitters should include an Automatic Load Control circuit. Its function is to reduce the gain to prevent overloading. A fast attack-slow release circuit is required. The microphone gain should be adjusted to avoid significant overload. It also helps to speak with a uniform volume.

Directional watt meters with mechanical meter movements don't kick up to actual peak envelope output because of time delay due to the meter movement inertia.

The 2-tone IMD performance should be 40 db for any high performance SSB transmitters.

de Warren Bruene 2), W5OLY (ex W0TTK)

Note 1) QST, Nov. 1954 – Distortion in SSB Linear Amplifiers - Causes, Cures and Methods of Measurement (W. B. Bruene, W0TTK).

Note 2) W. Bruene has written numerous articles on SSB Operation, PA design and Distortion Reduction. He is responsible for much of the material in the Collins Radio book on SSB as well as many contributions on the subject in Collins Manuals. Of note is his contribution of Chapter 7, RF Linear Power Amplifiers in the Collins 204F-1 2.5 kW Power Amplifier Manual. He also has written a hallmark article on "Distortion Reduction Means for Single-Sideband Transmitters" in the IRE Proceeding, Dec. 1956.

Author Information: Warren Bruene is now retired (1983) and living in the Dallas area. He served Collins Radio, and in the end Rockwell, for some 44 years. In his career, he became known throughout the industry as one of the masters of RF and particularly high Power RF. He holds 22 patents. He is the most proud of one of the last ones dealing with Pulse Width (or digital) AM modulation. - - - - CCA - - - - -

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. . . TARGET: 100 MILES UP! On a day surprisingly soon 45,000 feet above Wendover, Utah, North American's rocket-powered X-15 research plane will be released from a modified B-52 to take man 100 miles into outer space. Throughout the flight trajectory, radio contact between the X-15, the mother ship, chase planes and the ground will be maintained by custom-designed units from a Collins CNI (communication, navigation, identification) system, similar to the electronic packages Collins is providing for the new military jet aircraft.

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IN COLLINS POST WAR SHACKS - W9EVT, George

by Don Jackson, W5QN

George Ulm has a fascinating life story. In addition, his collection of ham radio equipment is truly astonishing. The collection includes an enormous number of items from every manufacturer and era, including Collins of course. What is unique about this presentation, which will feature his Collins equipment here, is that you also get a "peek" at the competition that Collins was faced with at the time.

Born in 1925, George became a ham in 1938, first licensed as W9ABU. By WWII he had established himself as the owner of the best collection of equipment manuals around. His first shack included a Hallicrafters Sky Buddy receiver, Millen exciter and homebrew equipment. His first piece of Collins equipment came soon after and was a pre-WWII transmitter. Later on, he moved up to the 32V series of transmitters, for which he still has a particularly warm place in his heart. In 1947, his call became W9EVT which he holds today.

George began his career as a window sign designer with his father, who had founded the Osgood Sign and Display Company of Chicago. After WWII, George realigned the company to be a designer of exhibits and display booths for radio manufacturers who advertised their wares at electronics shows. He designed exhibits for at least 11 World Fairs worldwide during his career.

It was in this capacity that George became acquainted with many well-known personalities in the early days of radio, including Art Collins. George operated this company until he sold it in 2000, retired from that business, and bought an apple and cherry farm on Washington Island, Wisconsin - currently the site of his home. Although this farm and Bed & Breakfast business was never a huge financial success, it has provided him a great deal of beautiful real estate for his home and his ham radio hobby. It also provides a very unique place to just kick back and enjoy some of the sights and sounds from the past. You are invited to explore his website and perhaps come and have a unique experience.

Current W9EVT projects include construction of a 1,000 foot long rhombic antenna. Wish I had the real estate for projects like that! Among George's many accomplishments is construction of the first 2m repeater in the Chicago area.

Currently, George enjoys operating his KWT-5 and KWT-6, using these to regularly check into the CCA nets. He also has a couple of 20V transmitters that he operates on 80m and 160m. These items are but a small part of his amazing collection, as is obvious when you check out the photos. George and his wife Susan now run Greengate Country Farm Rentals, renting out various properties, most of which are in close proximity to a top-notch Ham Shack.

WELCOME TO K0CXX - COMM CENTRAL SOUTHWEST

Ed Andrade, Family Man

Ed Andrade had two families. One at home that he cherished, and then there was his work family at Collins Radio. He loved them both. Here is his story.

There were two sides to Ed Andrade. One side was the consummate engineer – logical, curious and dedicated to performance excellence in his designs and in his work. That side gave us the KWM-2/2A and the 51S-1 among other wonderful rigs. Ed was the project lead on these fine radios during their design phase.

The other side of Ed was the caring and loving family man, a capable musician who played the piano in a dance band and was a master of the theatre organ. He not only played it, but he used his engineering talents to rebuild and restore one for the theatre in Cedar Rapids….but, I get ahead of myself. Along with being a wonderful engineer and musician, he was a man who knew how to take time for his family and always found time to share his love of boating with them. There were many memorable family trips on a succession of larger boats….that had radios on them of course. Along the way, a KWM-2A and a 30L-1 came home and he also enjoyed his radios at home.

Those who try to describe Ed in just a few words always seem to gravitate to the word "good". He was known for doing the right thing, whether it was at work or at home with his family or friends. He was also known for excellence and good work – hard work – in whatever he did. There was also time for public service and volunteering.

Ed was born on the North Side of Chicago on January 24, 1923 to Esther and Maurice Andrade. He had one younger sister Bettie with whom he was close. His father was a salesman for a local lead producer that sold lead to paint companies. He was assigned to handle Pittsburg Paint Company. As he grew up, Ed remained in the Chicago area and graduated from High School there in January of 1941.

While he was in High School, he moved from early experiments with radio and electronics to getting his Amateur Radio license. This work would greatly influence the path of his life and career. He also had been taking piano lessons as a boy and was moving towards being an accomplished musician.

Following graduation he went to work first for Motorola and then for Raytheon as a lab technician. During these years he continued to take engineering courses at the Illinois Institute of Technology. He then served in the Army from 1946 to 1947 where he worked in electronics. Following his service he went to work for the Rauland Corportion as a Junior Engineer, again attending night courses at IIT.

In 1948, in the same timeframe that he was playing the piano in a small dance band (pictured upper right), he met and subsequently married his wife Dolores on June 25, 1949. They shared 58 wonderful years together.

Shortly after their marriage, Ed left IIT and landed an engineering job at Collins Radio – hired personally by Art Collins. This is unusual on two counts. First, to be hired at that point by Art, and secondly – and more significantly – it is well known that Art did not cotton to non-degreed engineers. Few rose through the ranks and became engineers without a degree. Art respected technical knowledge and training, but he obviously was impressed by Ed Andrade and his qualifications. He was not wrong.

In 1950, Ed and his new wife moved to Cedar Rapids to begin a new career with Collins. His early assignments were working as a support engineer on the AN/FRR-33 Diversity Receiver, and then on the F4H program CNI project. Of course, Ed immediately got a small sail boat and shared this hobby with Dolores. In 1955, Dolores gave birth to their only child, a daughter Deborah.

In 1956, life at Collins changed for Ed…. He was ecstatic! He had been transferred to the HF Communication group to work on Amateur Radio equipment.

Working for Gene Senti (W0ROW), he became the Project Lead on the S-Line KWM-2/2A, the 51S-1, the Parametric Receiver Project and the 718T RF Translator. This work must have gone well because Ed was promoted in 1967 to Program Manager of the entire 718T program - while at the same time taking Project Lead responsibilities for the Receiver/Exciter. We can all testify to the quality of his work on the KWM-2/2A and the 51S-1… Ed was a fine engineer.

Also during the early 60s, Ed was intrigued by the new upstart semiconductor technology, and this led him to design and build a very early all solid state transceiver similar to his KWM-2/2A.

This small rendition of the KWM-2 was done as a "home project", but because Art Collins encouraged engineers to explore and experiment at home and at work, much of the construction was done on company time. Around the lab, the little transceiver got the nickname "The Critter". When completed, Ed showed it to Art, and much to his dis-

may, Art saw the future and canceled the KWM-5000 all tube "Cadillac" dual PTO transceiver the group was working on. Ed went ahead and mounted the transceiver in his car, and his daughter Debbie relates that for years to come, while driving on family vacations, all she heard from Dad was "CQ CQ CQ, this is W0DAN calling CQ and standing by". This little rig is now in the Rockwell Collins Museum, as is his ham station. His original KWM-2A and the 30L-1 are proudly displayed in the lobby of the building across the road from Main Plant.

All of this time, Ed and his family were also enjoying ever larger boats as the years went by and he spent time out on the Mississippi River with Dolores and Debbie. Debbie remembers these growing up family times fondly. In addition to his work and family activities, Ed found the time and the passion to volunteer and completely restore the old theatre organ that was in the Cedar Rapids Paramount Theatre. It was then used until the disastrous 2008 flood when the organ was ruined. In an ironic twist, Ed, on one of his TDY work assignments away from home, used his spare time at night to build a wooden model of the theatre organ. After his death, this model was gratefully accepted by the Cedar Rapids Theatre Organ Society (CRATOS) as the remaining vestige of Ed's restoration work. Ed would be very happy to know that the mighty Wurlitzer Organ has been replaced and the "new" vintage one due back in concert in the Spring of 2014.

In 1970, Ed was assigned as Project Manager of a proposed USMC project for a Ultra-Light HF Comm Pack Set. This work took him about a year. Following that, in 1971 and following a decision by the Avionics Group to move into the General Aviation Avionics Market, Ed then took an assignment as Program Manager of the new MicroLine VHF Avionics Comm Project. He followed this project through its successful introduction in 1975 and was then promoted to Engineering Manager for the ProLine HF & VHF Comm project. This work would eventually take him to Florida in 1979 where the ProLine development and production was located. The ProLine was so successful that it continued to evolve and remained in production for over 20 years.

Ed was very proud, and justifiably so, of the fact that he was the first recipient of the Rockwell *Engineer of the Year Award*. In 1976, Rockwell initiated this new reward program. After screening all of the suggested recipients from across the entire Rockwell engineering staff, Ed was selected from their new acquisition - Collins Radio - to receive the award. In an award letter that accompanied the plaque, he is credited with generating over $80M worth of Sales from his projects.

This performance had also resulted in Ed being given a significant Contributors Award for his ProLine work in 1975.

After 34 years with Collins Radio and Rockwell, Ed retired on September 30, 1983 and became a full time ham and boater in Florida. He, of course, then had another boat, a sailboat named Cygnus. Ed could often be found relaxing on board.

Life was good for Ed and Dolores and, in 1993, Deb blessed them with a grandson, Christopher. From that time on, the families spent every vacation together in Florida. Ed loved his little "Grundoon", as Chris got nicknamed. Chris is now 20 and attending college.

Ed Andrade, family man, passed away quietly on August 24, 2007. We all lost a good man.

- - - - - - - CCA - - - - - - Check the CCA website under Archives and "The People of Collins Radio" for a more complete biography of Ed Andrade and others - Coming in 2014.

Senti on the 75A-4 (Continued from p 32)

A conventional diode detector is used for am reception. After detection, the signal is fed into a new noise limiter circuit which is effective on am, cw, or ssb. This limiter is designed to clip both the positive and negative peaks of the detected signal. The operator can select the degree of clipping desired by means of a panel control. The signal is then fed to the audio amplifier.

Passband Tuning is a new system for receiving cw, ssb or exalted carrier am signals. It gives the effect of leaving the received signal stationary while allowing the if passband to be moved back and forth. Assume a received signal of 3900 kc. When the receiver tuning dial is tuned so that the signal is "on the nose", i.e. centered in the passband, the if frequency will be 455 kc. As the tuning dial is varied, the if frequency of the received carrier will vary. That is, if the dial is tuned 1 1/2 kc high, it places the carrier on the lower edge of the filter and allows only the upper sideband to be accepted. Conversely if the dial is tuned 1 1/2 kc low, the carrier is moved to the upper edge of the filter and allows only the lower sideband to appear in the output of the receiver. This much (also *sic*) happens every time a signal is tuned in on a 75A-2A or 75A-3.

Now what happens if the bfo is turned on? If the bfo is set at 455 kc (zero on the bfo dial) and the signal centered in the passband, zero beat will be obtained. As the signal is tuned across the passband the beat note will increase to 1500 cps either side of zero beat and then disappear sharply as the carrier drops off the edge of the filter. However, if the bfo were mechanically ganged with the main tuning dial so that the bfo frequency changed at exactly the same rate as the carrier, the signal would stay at zero beat anywhere in the passband. This is passband tuning.

On am, exalted carrier operation on either sideband is made easy. The signal is zero-beated in the passband and then the carrier is pushed off either edge of the filter, leaving only one sideband plus the bfo, which is at the carrier's if frequency. If interference develops on that sideband it is a simple matter to flip to the other sideband without retuning the main dial or bfo. It also allows rapid choice of sideband without retuning, for single sideband reception. On cw, the main tuning dial is detuned until the desired beat note is obtained. This beat note can be moved across the passband without changing pitch and at the same time interfering signals of a slightly different pitch can be pushed off the edge of the filter. This is a great help when copying weak signals through heavy QRM since the ear need not readjust itself to a varying beat note as an attempt is made to tune out an interfering signal. In the 75A-4 the bfo is not ganged directly to the tuning dial. Instead it is ganged to the body of the permeability tuned oscillator which is mounted on a ball-bearing-cradle. The Passband Tuning control rotates the body of the oscillator and tunes the bfo leaving the main tuning dial stationary. The main dial will always read true frequency of the received signal, regardless of the setting of the passband tuning control.

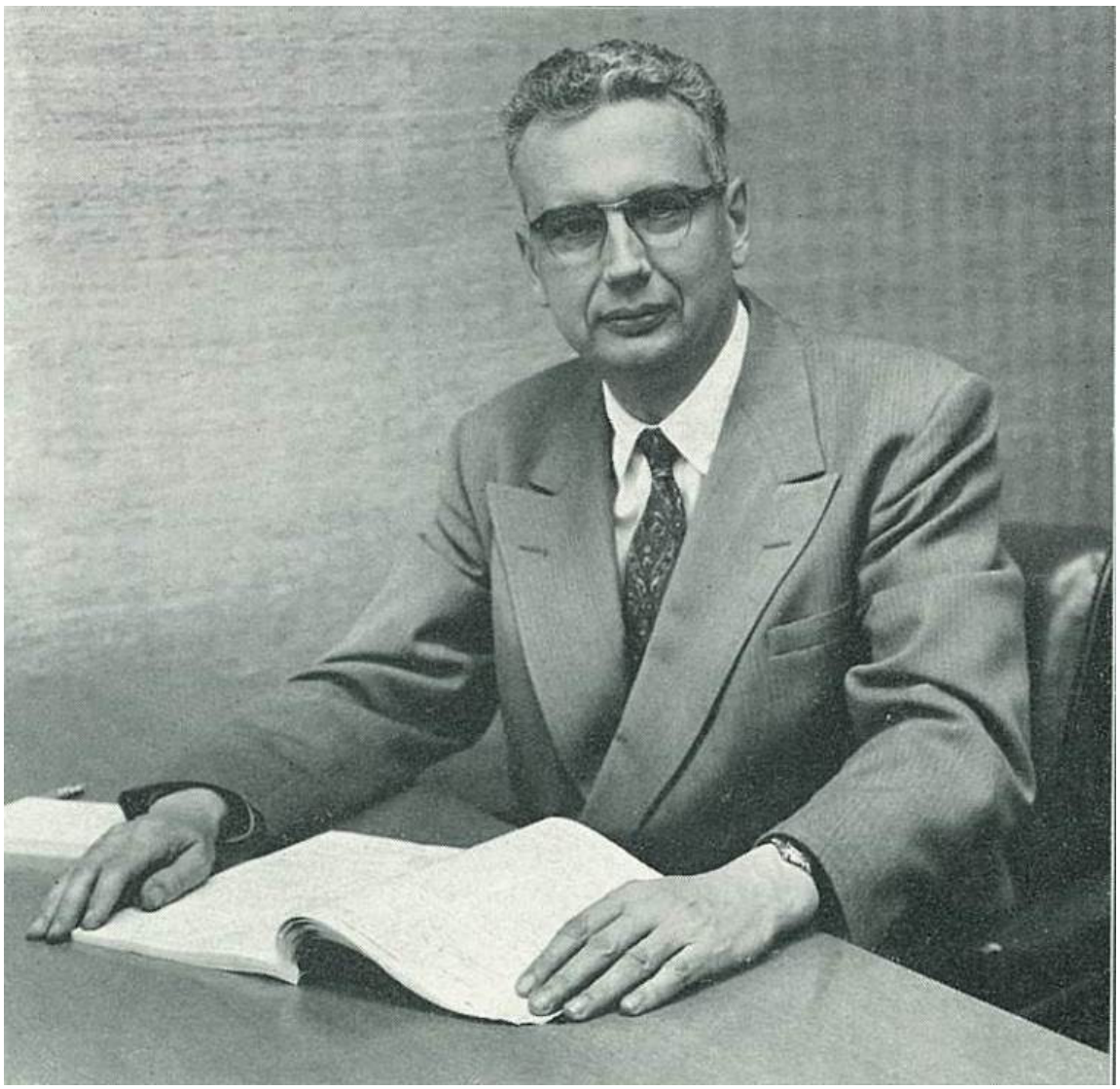
It has been said that a ham is a radio manufacturer's most critical customer. A commercial or military customer will generally present a manufacturer with a detailed set of specifications to be met for a specific application. However, each phase of ham radio has its own special requirements, not necessarily compatible. A cw dx man wants a very low noise and high selectivity. A phone man wants greater bandwidth with good skirt selectivity and low cross-modulation. A single sideband man has his own special requirements for stability, selectivity and ease of tuning. The traffic man wants good dial calibration, stability, and break-in features. The 75A-4 does all this and without compromise.

Eugene Senti, W0ROW
c/o Collins Radio Company
Cedar Rapids, Iowa

Editors Comment: Gene Senti was first a Project Lead Engineer, and then Group Head of the HF Commercial & Amateur Radio Engineering Group at Collins. He was responsible for the development of many fine pieces of Collins, but most notably the Gold Dust Twins, the KWM-1, and the 30L-1. Of course he then managed the group that gave us many more. After retiring in 1971 at the age of 54, he continued to develop significant inventions like his riding leaf blower. He passed away on October 20, 2005. See the Q2 2008 Signal for a complete biography. - - - CCA - - - - Note: This text was OCR recovered from Gene's original. Every attempt has been made to maintain original content and form.

Andrade on Arthur Collins

During my first encounter with Arthur, I wondered how to address him. "Mr. Collins" seemed appropriate at first. Later "Arthur" seemed OK. This was when I had noticed that the guys in his upper circles called him "Art" and that, later, many of them found themselves fired! I settled for a respectful "Arthur". It must have worked, I survived!



My First Encounter

In the very early 50's, I had been tasked with the design of a transmitter remote control system. I was to demonstrate the breadboard model to Arthur. It was a mess but it worked well. He seemed pleased, but remarked that the model looked like some fungus that grew in his basement - and he laughed! I didn't realize it at the time, but his vision of the radio systems of the future was that they be capable of remote control of all of their functions.

Early Solid State Days and the "Critter"....1962

The success of the "S-Line" ham gear created an interest to push forward along that basic concept, which resulted in the 51S-1 General Coverage Receiver (a yours truly effort) and the KWM-2 Multi-Band Ham Transceiver (also yours truly project). They both proved to be successful, though it took some persuasion by VP and good friend Dave Weber to convince Arthur that the 51S-1 should be produced - in spite of its vacuum tube technology. During the development of the 51S-1, I discovered that the receiver was about 10 dB short on audio gain. On weak signals, below AGC threshold, it just didn't have enough pizzazz to bring the noise level up enough to sound like it meant business! There was no room left for another audio tube, so I found a little room on a terminal strip to wire-in a silicon transistor audio amplifier. It solved the problem - thus becoming the first Collins HF Receiver to incorporate solid-state technology, in spite of its vacuum tube heritage! To the best of my knowledge all 51S receivers produced had this little secret hidden away in its innards.

Though the KWM-2 had been a huge technological and commercial success, many of us wondered; "Where do we go from here?" The thoughts at that time were to develop a "do all" dual oscillator version of the KWM-2/S-Line products with other enhancements. This project was nicknamed "The Cadillac". Arthur was not enthused, but tolerated it and funded the effort!

In the meantime, many of us were experimenting with the possibility of using state-of-the-art Germanium transistors (then 1962 technology) to build some solid-state ham gear! My efforts were to take limited portions of the KWM-2 block diagram and build an all transistor, 40/20 meter, version receiver/exciter. I used many of the company's parts, on my own time (many midnight sessions), and ended up with a working transceiver producing 15 to 25 milliwatts PEP drive, which later drove an instant heating tube PA, mounted in the trunk of our 1962 Plymouth coupe. It worked great! It was later named the

"Critter" by several of my cohorts! During this time, Arthur came by on one of his trips through the labs, to see how the "Cadillac" was developing. I had it working on 20 meters. During this visit, he spotted my "home brew" project, the "Critter", and wanted to know all about it. We spent about two hours talking about the details. The next day Arthur cancelled the "Cadillac" project and said "let's look into something like what Ed is doing". Wow, he didn't fire me for using Company parts in a home project! That was the great thing about Arthur, if you had a new look or idea about technology, he was willing to back you 100%.

Miscellaneous Nostalgia

a.) During the early days of the KWM-2, a design flaw by yours truly got Art his one and only pink ticket citation from the FCC. He was very kind, though. I had a note the next morning saying "fix it". We did.....pronto!

b.) When you worked as an engineer for Collins Radio, Arthur owned you! I can remember one three day weekend (he hated them) when he sent out the company airplane to find some engineers travelling in a canoe on a Canadian fishing trip because he had some ideas he wanted to discuss. As far as I know he never found them. He did the same with me and my family when we were spending a three day weekend on our boat in Dubuque, IA. We came home and I sat at my desk for three days, with no call (from Arthur), but we all still loved working for the guy!

c.) Arthur was always very interested in flying and boating. His career as a pilot ended rather abruptly when he did a wheels up landing in a corn field after an engine failure. The Board of Directors told him he was grounded!

Arthur had a crew design and build him a 70 foot fiberglass boat, powered by two very large GM diesel engines. It was the largest fiberglass yacht of its time, designed by the famous German rocket/aircraft designer, Dr. Alexander Lippish. When Arthur asked Dr. Lippish if he could design a boat, he said "Sure, just like designing airplanes, only thicker."

Art's second family included a young son who thought he would like to go fishing, so Arthur took the family out on the yacht, set out a fishing pole for the boy and opened both throttles to 40 knots. Obviously, Arthur didn't like to clean fish.

d.) My one and only visit aboard the yacht was to fix some long forgotten problem. The yacht had a very unusual layout; a very large saloon with a massive conference table surrounded by cabinets filled with just about every radio/navigation/computer product Collins produced at that time. Forward was a small stateroom and head with one double bed. I might guess that he didn't like a lot of company aboard. This must have been the largest yacht of it's time that only slept two.

5. Stirring Up The Animals

During the mid 1960's we were all intrigued with the realization that big changes were coming. The transistor was arriving and we were all very interested in trying to adapt this upcoming new technology to our business. I was intrigued of not only adapting the transistor world to analog circuitry as we knew it then, but also to see if there was some way to replace the bulky, complicated mechanical tuning systems with something more "Avant Guard". I had observed that some of the high dielectric ceramic capacitor's capacity could be controlled with high DC voltages impressed upon them. Was this the tuned filter of the future? In those days Arthur was very willing to dedicate a budget of $15-20K to look into any out-of-the-box investigation that had any hope or promise of new technology. I had set up a series of experiments trying to take advantage of the variable dielectric constant property, but there were too many problems to make it a useful technology. Arthur's comment was "boy you sure stirred up the animal on that one".

6. Arthur Had a Memory Like An Elephant's

We were all in an engineering review discussing progress on a big military project. My involvement was with the receiver/exciter section, which used a variable capacitor tuned oscillator, controlled by a phase locked-loop. As we were discussing potential problems meeting the vibration requirements for the equipment Arthur reached over to the equipment and "dinged" the variable capacitor plates with his fingernail. He commented that "the "ding" sounded close to middle "A" on his piano - Look for trouble there. Needless to say, we found trouble there and had to find a way to fix the problem. Two years later he saw me in the hall and said "Ed, how did that variable capacitor (condenser was his term) test come out?"

7. Arthur the Mentor

Sometime in the early 70's we were summoned to hop on the Company plane and meet with Arthur in Dallas. We had no clue to what was up. The group included several of us project engineers and two or three vice presidents. Arthur talked for about four hours on how he foresaw the computer as a huge switching function, allowing every walkie-talkie in the world to talk to every other walkie-talkie. We didn't get it, but he foresaw the cellular phone system we know today. Unfortunately, it would take far more resources than the Collins Radio Company had available to bring his concept to fruition. Of course the VPs' response was "The President of the Company has talked to us for four hours! What do we do now?" Some of the proposals were hilarious! Arthur's comment at the end of the lecture was "I suppose you guys thought I was going to propose some new HAM equipment", and he laughed. In retrospect, I believe Arthur was beginning to see himself as a mentor. He was finding that his grasp (and ours), was beginning to be replaced by younger people who understood his (and our) level of technology and absorb it as a next level component. This thought was furthered in my mind when once or twice I was called to a remote Company location to be involved in a college type situation whereby Arthur would assign us specific writing assignments in areas where he knew we had experience. The next day we would have a "class discussion" and new homework assignments. In my mind, here was a true leader who would not make major decisions until he heard from "the new kids on the block". Unfortunately, he listened only to the engineers and not the "bean counters" and eventually lost his Company.

8. The Up-converter (what a wild ride that was)

In early 1970 a group of us were working on a proposal for a military SSB transceiver. The requirements regarding size and weight were very demanding and seemed to be beyond anything we could come up with. At that time we had some fairly good silicon devices that could handle the rf requirements and even a few integrated circuits that could save space in the audio section. But, there just wasn't enough room for all of the tuned circuits and the machinery to drive them. About 11:00 PM one night we all retired to Shakey's Pizza Parlor for a few beers and some R & R. After a few beers I recalled that my old buddy Joe Vanous, and two fellow engineers from the research department and myself, had been assigned to investigate the parametric principle involving diodes to up-convert an hf signal to a very high frequency and then through a narrow band crystal filter in order to synthesize a very narrow band tunable filter. After a considerable effort by all four of us, we finally constructed a model receiver. It turned out to be completely impractical and did not perform well, so the effort was abandoned. After several more beers I began to wonder if the up-converting scheme might offer new opportunities to solve some long standing problems in hf radio design. After arriving home I began to look into an up-converting block diagram. Checking a lot of math, spurious responses, etc., I noted that if (big if) a lot of new technology that currently existed could be expanded and improved, it might just be the path to the future.

The most promising aspect of the new block diagram was that all of the bulky tuned circuits and associated machinery could be replaced by a series of compact fixed tuned band-pass filters. I worked all night and in the morning offered a summary of my findings to my boss, Gene Senti. After a day or so I was told that a lot of "the brass" (I think it included Arthur) liked the idea and encouraged me to investigate further. I felt myself getting farther and farther out on a limb. I managed to negotiate enough time to build a bread-board model (using some of the parts from the parametric up-converter project) to verify that "Hey, it might work."

Editor's Note: Unedited. Left just as Ed wrote it and intended it to be presented.

The Postwar Years (Continued from page 15)

showed interest in purchasing an interest in Collins Radio and helping them inject some cash, and restructure the debt and the company, for survival. This story is more than adequately told in the Rockwell Collins 50 and 75 year books as well as discussed in Ben Stearns' book, Arthur Collins *Radio Wizard*. Suffice to say, that Rockwell was the winner in the attempt to obtain a very valuable asset, and the rest is history. But that is for the Q4 issue of our magazine.

As we close this chapter of the history of Collins, we look at a company that consistently pursued excellence. This excellence was demonstrated in their technology and their quality as well as the demeanor of their people. It is a company and a management team that history tells us consistently placed service to country, product excellence, technology and people as their top priorities.

This excellence and service has to be laid squarely at the feet of one Arthur A. Collins, and it is in fact remarkable that his leadership built a culture that endured for some 30 years, and still impacts Rockwell Collins today. This story is not a story of the failure of the company. Had it not been for the philosophies and actions of Mr. Collins, the company would not have been what it was – or is today. I will venture that we would not change that at all. To change it might well change the outcome of some wars and the U.S. space exploits.

In fact, through a remarkable turnaround and course of events, the company endures today and is again its own entity – albeit a little changed-of-name….Good Marketing – That !

Author's Commentary: We were prepared some time ago to say that it was not, as some people like to say, Art's diversion into Computer Technology that resulted in the loss of the company. Indeed, as you look at the facts, the outcome was written chapter by chapter, using the same pen, as they grew from 1945 to 1969. The financials tell a consistent story.

As was stated in the editorial comments at the front of this issue, at a very late hour, we gained access to a newly found letter from Art that is dated Nov. 1, 1945. It sets out the policy by which the company would be run – and WAS run – for the next 25 years. The letter is heartwarming and illuminates the situation even more clearly. Please go to our website at http://collinsradio.org/signal/nov1945letteraac and you will see for yourself.

de N7OTQ

Some additional financial insight: In Feb 2, 1966, struggling for cash, the company issued $25M in 5 3/8% Senior Notes to raise money on the Long Term Liability Line. Retirement was planned for 1986. In addition, they issued $12M in 4 3/4 % Debentures due March 1, 1980 - also shown on the Long Term Liability Line (included in graph of total borrowing on the '66 Annual Report). The company also increased its short term debt authority to $50M but then currently owed $23.5M on this line – down from $45.8M last ('65) year.

In Jan of 1967 the company sold $40M worth of 4 7/8% Convertible Debentures due in 1987 - increasing long term liabilities by another $40M.

The short term debt increase really began in 1966 and went up steadily from there to $100M in 1970 with another $100M in Long Term debt. Total Liabilities (Long & Short – inclusive of payables and other obligations) increased from $127M in 1966 to $300M in 1970 before the Rockwell supported restructuring after the FY close. Cash on hand went from $6M in 1965 to $10.6M in 1970 and back to $5M right before the restructure.

Based on deceptively promising Net Sales and Earnings growth that started in '64 and accelerated in 1966, Collins continued to chase the rainbow of government spending that took off in '66 and increased until 1968. In 1969 and beyond, the spigot of both government and commercial spending closed.

From 1965 to 1970, Total Debt & Liabilities more than doubled (with an increase of 134%) from $128M to $300M. Sales during this same period increased only 24% from $282M to $349M with a burst up to $447M – admittedly during the peak appearing to be a 250% growth.

- - - - - - - - - - - - - CCA - - - - - - - - - - - - To read or download copies the Collins Radio Annual Reports, go to the CCA website and select "Archives. Then select "Annual Reports".

The 51J-5 Dream Receiver (Continued from page 21)

"extra" 12AX7. This could be related to the fact that the 51J-5 contains a muting relay (like the 51J series, but unlike the 75A-4), so a triode may have been needed to drive the relay. I'll leave this one to some future investigator.

When all this circuitry is included, things get a bit crowded (Figure 4). But it's still not as congested as a KWM-2, so would not have been regarded as impractical from a production point of view.

For the passband tuning to function properly, the change in BFO frequency must track the change in PTO frequency when the passband tuning knob is turned, so both the center frequency and range of the BFO must be correct. To accomplish this, both a variable inductor and a trimmer capacitor are present in the BFO can, which is clearly from the 75A-4, either retuned or perhaps modified a bit for the different IF. The 75A-4 alignment instructions describe a trial-and-error procedure for adjusting these. Similarly, the rejection tuning can is from the 75A-4, retuned or modified.

The PTO is taken from the 75A-4. It even has the same tube designations. But the metal drive belt between the PTO and the BFO shaft goes through holes in the PTO box, and the holes for this are on the wrong side because the BFO is now on the left. So there are extra holes. It appears that the PTO box was taken from the 75A-4 production line, the extra holes were drilled, and then it was put through the iriditing and stamping steps.

The required PTO tuning range is 3 to 2 MHz (as the main tuning dial is turned clockwise). The PTO in the 75A-4 tunes from 2.955 to 1.955 MHZ. This small change could have been achieved by taking parts from a 51J PTO, or by tweaking the 75A-4 PTO (ham radio style!).

A significant unsolved problem with the passband tuning arises from the fact that receivers in the 51J series use two different first IF ranges -- 2.5 to 1.5 and 3.5 to 2.5 MHz -- for even and odd-numbered bands respectively. Thus, the signal is inverted in the second IF on some bands but not others. As a consequence, for passband tuning to work, the PTO has to change frequency in the same direction as the BFO on some bands and in the opposite direction on others. This situation was never dealt with, at least in this particular prototype. As Jim Riach confirms, passband tuning will work correctly on half the bands. To make it work on the other half, the BFO coupler has to be loosened and the capacitor shaft rotated a half turn.

Letting my designer's instincts take over, I can think of at least two viable solutions to this problem, using a small relay or diode switch plus two BFO capacitors or a split stator capacitor. Therefore, I doubt that this issue would have affected the decision to abandon the project.

Turning to the reason for discontinuing the project, the imminent introduction of the 51S-1 is generally cited. Indeed, the 51J-5 project may have been undertaken as insurance in case the 51S-1 ran into serious problems. Since the 51J-5 re-used existing circuitry and mechanical parts, development and tooling costs would have been minimal, so it would make sense to carry it as a "plan B".

But the R-390, followed in 1955 by the R-390A, was taking over much of the military market, and Collins was already building some of these. So by introducing the 51J-5, they would have had not two but three entries in the same market space. Whatever the reasoning, it never saw production. ----- If it had, we might know it today as the most sought-after of all the boatanchor radios.

I've enjoyed exploring this piece of Collins history. My thanks to all those mentioned above for their help and co-operation.

de VE3TOU….Bob

- CCA -

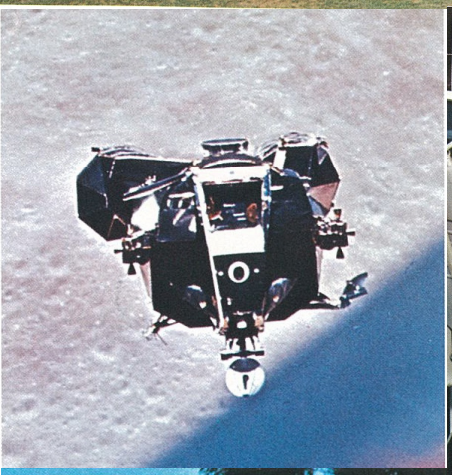
Project Lead Table

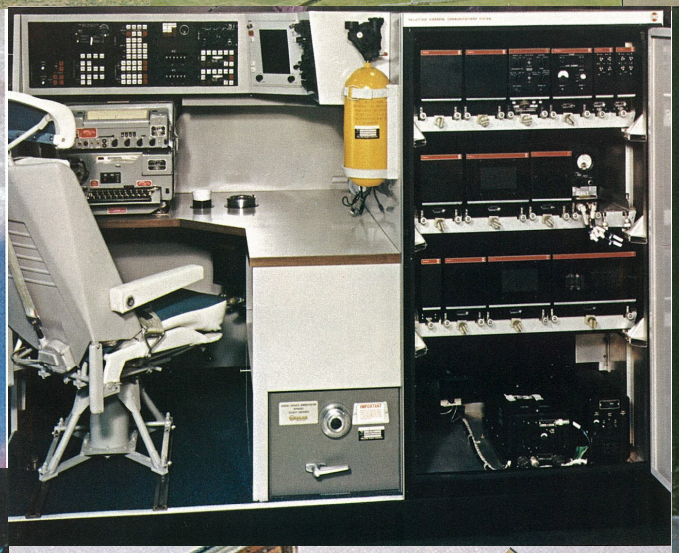
Some Key Product Introductions from 1945 through 1970

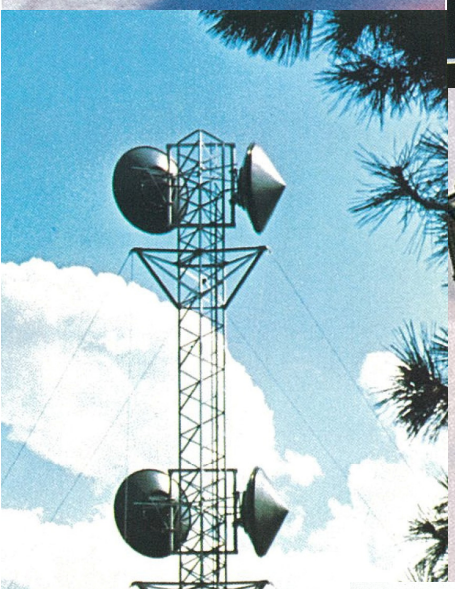
with Project Lead Engineer (Where Known)

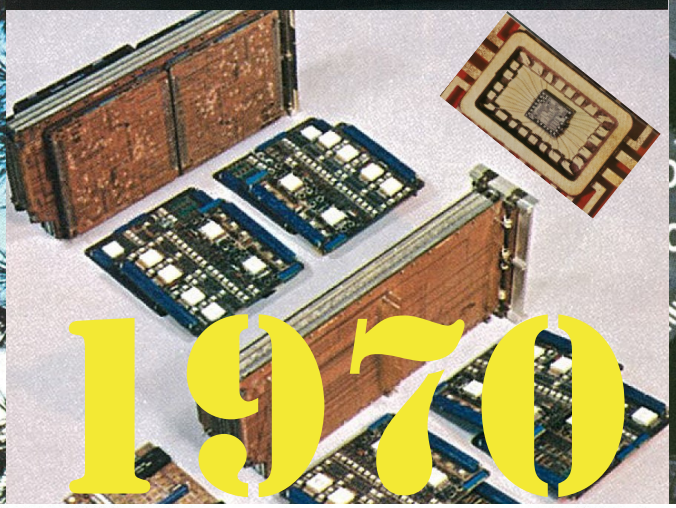
Model	Intro		Project Lead	Start	Quantity
18S1	Aug-46		Kenneth Vaughn		
75A	Oct-46		Roy Olson then Ray Cuillard		<25
32V/V-1	Nov-46		Ted Hunter	Jan-46	50/953
310A	Dec-46		?		
30K	Dec-46		Warren Bruene	1945	
30K-1	May-47		Warren Bruene		
75A-1	Jul-48		Lou Couillard	Jan-47	2000
32V-2	Aug-49		?	Jan-49	1028
51J/J-1-1	Nov-49		Roy Olsen	1945	120
51J-2	'50 - '51				1000
R-390	Mar-50				
T-195/GRC-19	Apr-50		Stewart Morrison Arlo Meyer assisted ME Fred Johnson		
75A-2	Jul-50		Gene Senti PL w/ John Foster	Jan-49	2200
KW-1	Oct-50		John Foster ME Guy Wright	Jan-49	152
R-392/GRC-19	1951		Gene Senti ME Everett Phillips Fred Johnson Coord. Both		
ARC-27	1951		Team: M.H. Hubbord ME Horst Schweiger		COL 40,000 SUBS 35,000
GRC-27	(Jan 49 Start)		Gene Vick & John Goetz	(Jan 49 Start)	
51J-3/R-388	'51 - '54	Production		Mar-50	1800
R-388	'51 - '58	Production		Mar-50	10,400
32V-3	Sep-51				1600
20V	Jan-52		L. Findley		
75A-3	Dec-52			Feb-51	1800
51J-4	'54 - '63	Production		Jun-53	9000
R-388A					R-388A app. 9K
AP-101	1955				
75A-4	Mar-55		Walt Zarris Started it Gene Senti Finished		6000+
KWS-1	Mar-55		Gene Senti		1604
32W-1	Mar-55		Senti		? < 5
KWS-1K	Mar-55		Senti ME Duane Hoffa		Small < 100

This chart & complete data for the period including 1955 thru 1970 (In a larger format) can be found at:
http://collinsradio.org/signal/modelintrodata

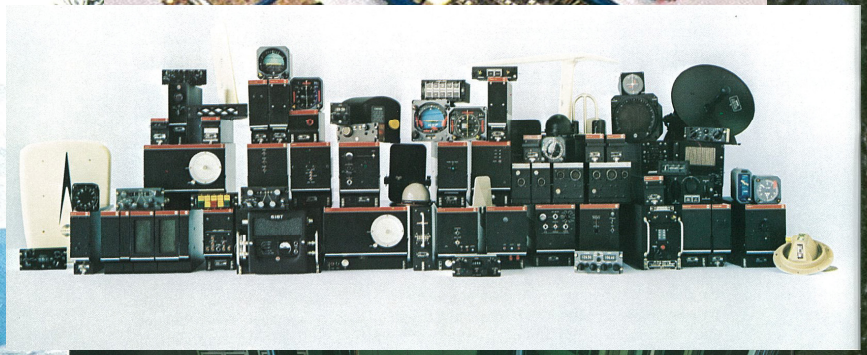


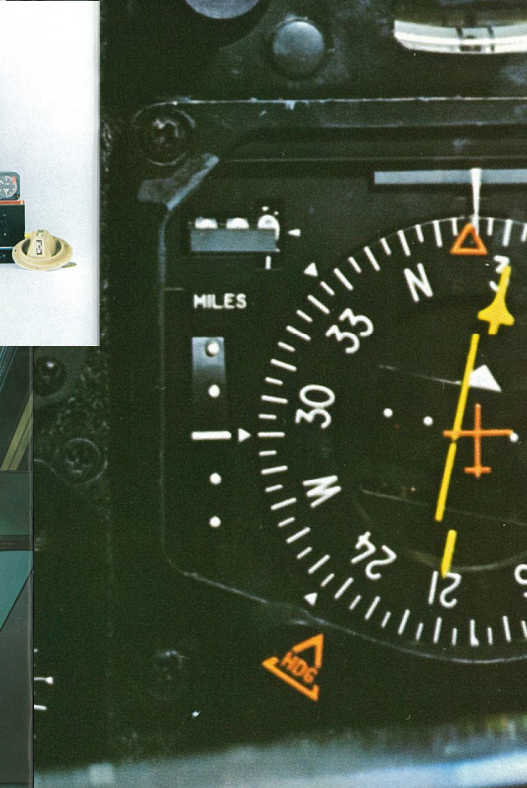


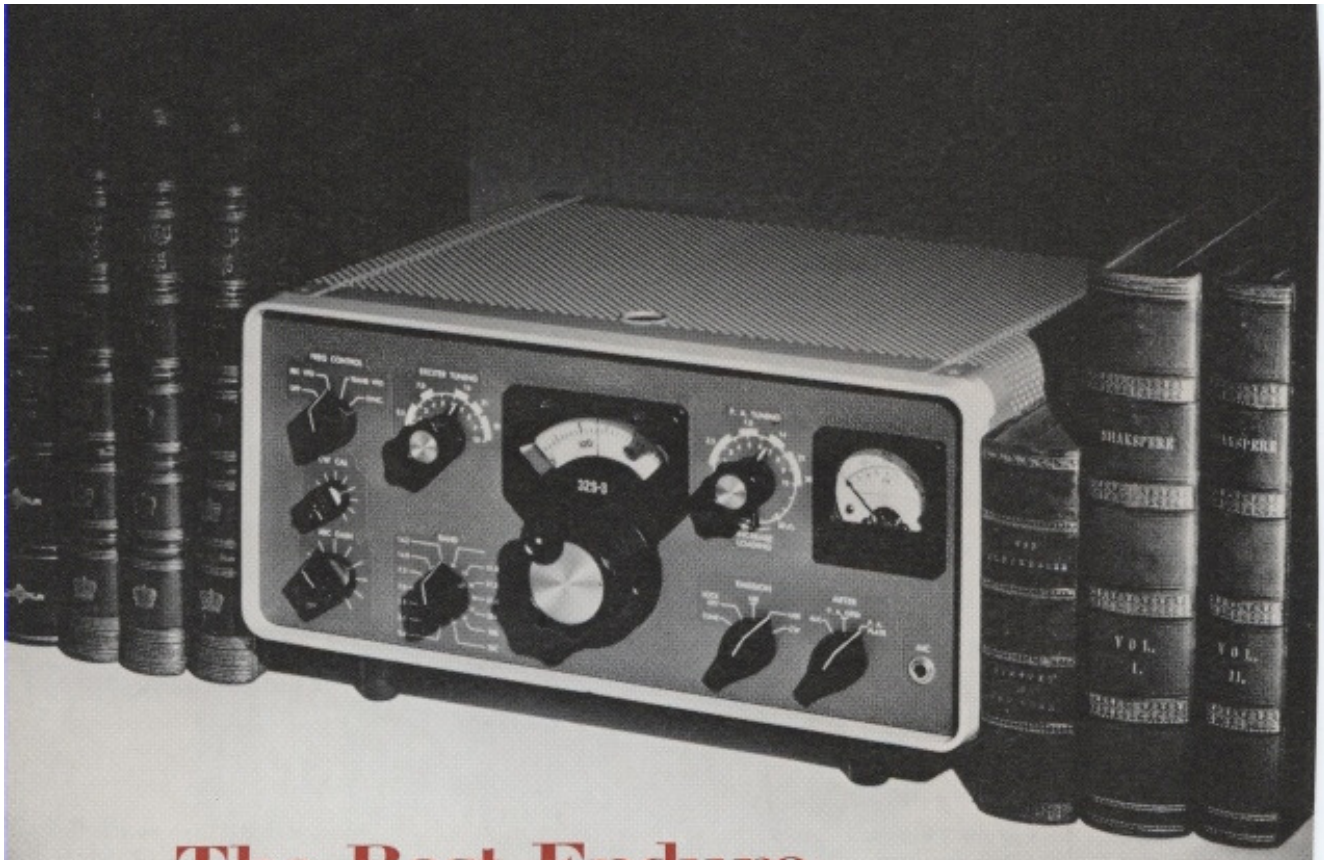




1970







The Best Endure

A classic is a work of enduring excellence. That's why the 32S-3 Transmitter is a classic in amateur radio. The 32S-3 offers USB, LSB and CW versatility, transceiver operation with S/Line receiver, mechanical filter sideband generation, permeability-tuned VFO, crystal-controlled HF oscillator, RF inverse feedback and automatic load control. Stop in at your Collins distributor and browse through the S/Line classics.

COLLINS