THE

F-15 PROJECT

ED GAMMILL
ACCESSORY DRIVE SYSTEM

I moved back into the Journal Building in early 1970 and joined the F-15 Project, which was just setting up manpower requirements. At this time, Tom Williams was the Program Manager and Pete Engel was the Senior Project Engineer. Wade Brock, John Irwin and I came on as Project Engineers. The system consisted of a Jet Fuel Starter (Model JFS190-1), a Left Hand Airframe Mounted Accessory Drive (LH AMAD), a Central Gear Box (CGB), a Right Hand Airframe Mounted Accessory Drive (RH AMAD), and two Power Takeoff Shafts (PTO).

Because it was a very large system, the work load was assigned as follows: Wade was responsible for the JFS, John was responsible for the three gear boxes, and I was responsible for PTO shafts and all reports and data. Dick Mejdrick became the Controls Coordinator, Bob Wells became the Preliminary Design Coordinator, and Andy Bouche, Jerry Cargill, Tom Donaldson, Art Eckstat, Fred Fuller, Dick Luther, and Jim Sanger joined in various assignments. Ben Ross was our Contract Administrator and Faye McDonald, ably assisted (?) by Sheela, was the office boss who maintained order and managed to keep most of the personnel in line.

Before I start presenting the details of the JFS/AMAD system, I should review the history of AiResearch and the Accessory Drive System (ADS). Sometime early in the 1960's, Del Getz and Walt Ramsaur initiated a company sponsored program to develop an ADS system. It was assigned to my ATM/CSDS project. We designed, fabricated and tested a boiler plate system to demonstrate the concept. Evert Chapman did the major design work and Maury Davis and Bruce Tice accomplished the testing. Figure 1 presents the system schematic.
A conceptual mockup of the system is presented in Figure 2 and Figure 3.

The boiler plate accessory drive gearbox, which is the heart of this system, is presented in Figure 4. The system capabilities were very successfully demonstrated.
During an October 4-8, 1965 meeting, SAE Paper No. 650828, titled Integrated Secondary Power System (ADS), by Palmer Wood and William Spragins, was presented at the National Aeronautic and Space Engineering and Manufacturing Meeting in Los Angeles, Calif. As a result of this Independent Research and Development (IRD) program, the Airframe Mounted Accessory Drive (AMAD) system became a preferred method to separate a large gear box with its attendant accessories from the main engine. The concept resulted in many aircraft improvements.

The F-15 system layout work was done by Ron Kubinski, Carl Warner, John Robertson, Carl Tamarin and John Foster. The system is required to provide self-contained main engine starting and ground check of all aircraft systems utilizing a small gas turbine (JFS), the mounting of an Integrated Constant Speed Drive and Generator (IDG), a Power Control Hydraulic Pump and a Utility Hydraulic Pump on each gearbox (AMAD) that receives power from either the JFS or the main engines via a Power Takeoff (PTO) Shaft.

The Jet Fuel Starter Model JFS190-1 consisted of a gas generator, composed of a single radial compressor stage and a single axial turbine stage, delivering the required energy to a single axial power turbine stage. The required ancillary components were mounted externally on the unit. The Model JFS190-1 mounts directly to the Central Gearbox (CGB) by a V-Band clamp mounting pad arrangement. The CGB contains a spur gear train, two high-speed bevel gear sets, a dry multidisk clutch and two isolation decouplers. The spur gear train provides the power from the power turbine to the input side of the multidisk clutch. The bevel gears provide the power transfer path between the output side of the clutch to either of the AMADs through the isolation decoupler mechanisms. The isolation decoupler is a pawl-and ratchet mechanism. A ratchet is located on each outboard side of the CGB and can be selectively and singularly extended by oil pressure to engage the ratchet mechanism located on the inboard side of the AMAD. Retraction by a coil spring is automatic upon completion of the function. The CGB contains sensors, controls, a wet sump lubrication system and a cooling system required for the JFS/CGB to function properly. The CGB also mounts a small permanent magnet generator and a small hydraulic pump/motor that charges a hydraulic accumulator which is the means for JFS starting. The CGB becomes the manager of the system.

The AMAD utilizes a high speed crossover (lay) shaft, which incorporates the pawl mechanism of the pawl and ratchet clutch, to transmit power directly from the CGB to the engine PTO via a bevel gear set located at the engine input pad. Other features of the AMAD are a spur gear train (to drive the IDG, two hydraulic pumps) and a wet sump lubrication system. The port AMAD has a manually operated mechanism that permits ground maintenance operation of the accessories by disconnecting the AMAD from the left-hand engine.

The general arrangement of the system is displayed in Figure 5. Note that General Curtiss LeMay, a member of his staff and Garrett’s Mark Bradley signed while visiting the F-15 Project. They must have used LeMay’s CIA pen for over the years it has faded very badly!
An increased work load and interface with MCAIR required additional personnel including reorganization of the Project. The revised organization is displayed in the following functional chart.
Much of the detail design was completed and by April 19, 1971, DATA ITEM Z2002, PS-5044-ZZ titled “ODE TO A MATURING PROJECT OR FROM PROTOZOA TO AMEBA” was prepared by Anonymous A-1 and approved by Anonymous A-2. The following is a direct copy and identifies many contributors to this effort.

Our growing pains are over, we're now an adult team;
Included are all the people, in the Project P-15.
The bosses Williams and Engel, have the group well spanned,
With offices at opposite corners, they can "eye-ball" every man.
Our golf pro Slim Jim Plunkett, can talk to you for days
About his terrible putting, or about his lousy lays.
Wells and Bishop have two offices, one here, another below -
They're rarely in either one of them, they're "in-between" you know.
Dale Walker the money handler, doesn't have a care,
It's obvious he gets his numbers, from somewhere in the air.
Pete Condy handles contracts, an enviable life -
Because of his relationship, with Cornelia Forsythe.
To our secretary Faye, we're bees and she's the "Queen",
She can make a eunuch out of you, with her typewriting machine.
Ed Gammill as you know, is the Systems Engineer,
When we're late with the progress letters, his words you should not hear.
Little gears and little seals, are under John Irwin's care,
And he must design a lightweight box, to satisfy MCAIR.
Wade Brock and all his people, are very fast we say,
They've already designed the JFS, a hundred different ways.

Being a softball manager, is Leroy Anderson's aim,
But it's obvious that the team he has, knows nothing of the game.
Dick Luther has revealed, a very manly trait
By siring a little daughter, after a normal nine-month wait.
To us came Maury Davis, from the Propulsion Engine gang,
We hope that he got started here, with an ultra bang-bang-bang.
Our resident Tommy Tomkins resides in Old St. Louie,
When asked about the weather there, all he could say was "Phooie".
Fred Fuller is our warrier, he has the "scar" to show
You can find it at the navel base, or a just a mite below.
Of course all knew that this wonderful report was the work of Chuck Bishop. By this time Chuck and I had become firmly entrenched in reports and data writing and management. He and his people were very good. Chuck and I became very good friends.

As detail design was being completed, I became responsible for mock-ups and the Power Takeoff (PTO) Shafts. The fabrication of the mock-ups was divided between Arizona Pattern and Excel Model Shop in Los Angeles. We also had a complete AMAD prepared in Plexiglas. A successful mock-up review was conducted in the 101 Building with a large group of McAir and Air Force personnel in attendance. Ben Ross was a busy man. During the review, removal and replacement of all Line Replaceable Units (LRU) was demonstrated. The method of AMAD assembly was demonstrated utilizing the Plexiglas unit. This was a specific task required by a previous design review.

The system as reviewed is shown in Figures 6 and 7.
During this design activity, there were many trips back and forth between AiResearch and MCAIR. On my first trip to St. Louis, I had an interesting encounter! I went to my counter part’s office, which was on one side of a large hanger, overlooking an area where people were working at many drafting and lofting tables. After he and I had finished our business, he said “Let’s go out here, I want you to meet some one.” So we stepped just outside of his office and there was young man at a very beat-up old desk. This is when I was introduced to John McDonnell, grandson of THE MAN! He was truly starting on the ground floor, but a quarterly dividend yielded him more than our two annual salaries! John McDonnell ultimately became the President and CEO of the Corporation.
Bendix Red Bank became the selected PTO shaft vendor which required me to visit their New Jersey facility. The Bendix unique shaft design utilizes a pack of e-beam welded disks at each end of the shaft with a ball and socket arrangement located at the center of the disk pack to provide the axial retention means. This lightweight arrangement tolerates radial misalignment and movement between the engine and AMAD. Axial movement during operation is tolerated within the AMAD using a long female spline mating to the PTO shaft. Bendix performed critical speed analysis and ultimately conducted testing to prove a stable system without a critical speed occurring from zero to 120 percent PTO shaft speed. During one of my visits, I met Potter, the Bendix generator engineer, who was well known for his brushless, oil cooled generator designs.

Fabrication of the development and qualification systems was initiated by the Development Fabrication Department. Hank Tom and Dick Carpenter coordinated this task while Ed Quail, Charles Crapo, Clyde Wheeler and many others spread out over the country to have all of the hardware created. Hank also worked with Laboratory Engineering to have the laboratory test cells and equipment ready. This was an unusual task, since a dual engine aircraft with all of its features had to be represented. The new facility required brick and mortar, dual fly wheels and dual dynamometers to represent the engines. Dual electrical load banks and four hydraulic load banks were required along with programmed control equipment that reduced the test technician work load. Lou Smith, Earl Reynolds and their people did an excellent job and had the facility ready for all future development and qualification testing.

Development testing proceeded, problems were corrected and redesign was accomplished where required. The first systems were delivered to McAir and on June 22, 1972, F-15 Roll Out occurred in St. Louis and many Garrett personnel attended. The F-15 successful accomplished its maiden flight July 17, 1972. The location and arrangement of the JFS/AMAD in the aircraft are shown in Figure 8 and Figure 9.

![Figure 8-General Arrangement in Aircraft](image1)

![Figure 9-Specific Arrangement of the JFS/AMADS in Aircraft](image2)
Qualification testing was underway. One test cell was dedicated to endurance testing. It was interesting to watch the system be exercised through a complete flight cycle by the automatic controller. A cycle was initiated with a JFS start, followed by starting both engines, termination of JFS operation, take-off followed by a program flight schedule with electrical and hydraulic loading as required. The test technician just monitored the system and recorded data and maintained the test log information. The system was operated 24 hours a day and was very successful in accumulating system hours.

During containment testing of the JFS190, Jerry Cargill had an interesting experience. The specification required test demonstration to prove containment of three piece hub burst at the maximum allowable over speed of all high speed rotating elements. On this occasion, the objective was to demonstrate containment of the power turbine wheel, which had been prepared with three thin slots Anocut to a specified depth in the wheel disk. When over speed was induced and the power turbine attained the failure speed, there was a loud BANG. Flame and smoke issued from the far side of the JFS190. It became very obvious that it was a failure, for the containment ring and portions of the power turbine wheel were missing! Since the test cell was next to the airport boundary, the exited material was on airport property! Now, Jerry did not want the airport people to be aware that he had been firing large chunks of hot metal over there. So he and the test technician strolled up to the test cell roof. They sat there with binoculars and casually scanned the area. Location of the errant parts was duly noted. Late that afternoon, a lazy walk, by Jerry and his technician, with an occasional investigation of something of interest resulted in all parts being recovered and returned over the fence. Back to the drawing board, redesign of the power turbine wheel containment features. After which, all elements of containment were successfully demonstrated.

Larry Derksen’s office was directly across the hall from the F-15 offices. Larry was the Personnel Manager (a politically incorrect term today) of the Journal Building. I enjoyed visiting with him and talking about the Larry Toschik sketches and art he displayed in his office. It was through Derksen that I met Joe Toschik a purchasing agent for Garrett and the brother of Larry Toschik. I recently received a Christmas greeting from Larry which displayed beautiful winter art by Toschik.

The development and qualification programs continued without major problems. Some time during 1973, Wade Brock left the company, Pete Engel and John Irwin were reassigned to other programs and Milt Parker joined the program as the Senior Project Engineer. Milt was a General Motors trained man, who personally interviewed each man in the privacy of his office. I remember his first question “Well, what can you do?” He probably received some interesting answers! I know I told him that I was the best damned technical writer and design engineer he would ever have working for him. We got along very well after our meeting.

He initiated weekly group meetings, in which, one of our personnel had to present a talk on any subject of their choice. Some were very technical and some were humorous. I remember Dick Luther told how to make wine and furnished samples of his white wine made from Thompson seedless grapes, it was awful! Dick violated company rules concerning alcohol on company property that day. Anyway some of the presentations were fun and they gave everyone experience in making a presentation to a critical audience. Milt reorganized the project as shown in the following chart.
Our test programs and MCAIR flight tests proceeded very well. In the summer of 1974, a TF-15 (a two seat version) flew from Loring AFB, Maine to Farnsworth in England and later to Germany for demonstrations during air shows. In December 1974, operation was initiated at Luke AFB. By this time MCAIR had assembled 30 aircraft, 12 development aircraft, 8 service evaluation aircraft and 10 for delivery to Luke AFB.

Some difficulty occurred between Garrett and MCAIR. I do not know if it was financial or specification, but it was to be settled in court. MCAIR sent in a team of engineers and lawyers and a period known as “DISCOVER 9-74” was initiated. The team reviewed every document in the F-15 office, resulting in everything being stamped with a large red “DISCOVER 9-74” indicating completion of a task. I still have stamped catalogs. Paul Hildenbrandt, a former Garrett employee, was a member of the MCAIR discovery team. I imagine he enjoyed this activity very much, for he remained bitter over what he considered bad treatment by Del Getz during his ATM days. This legal matter carried on for some time, until the judge called all parties in on a Saturday for an informal meeting, in which, he indicated that both parties had nothing to gain and suggested that the case be terminated and both parties go on about their business. Thereby, the case was dropped.

February 1975, a F-15 called the Streak Eagle broke eight time-to-altitude records. Three records previously held by the Soviet Foxbat (Mig-25) were broken by as much as 28%! Some time after this, MCAIR showed a film, in which a camera was mounted looking aft over the pilot’s shoulder. The audience could see the runway, from the high angle rotation on takeoff continually through the steep climb to maximum altitude. As the climb continued, the airport runway stayed in view and it became smaller and smaller until it finally appeared to be about the size of a postage stamp. It was very impressive.

The F-15 Project soft ball team, SCREAMING EAGLES, was formed and issued the following:
WILLIAMS, WALKER & WELLS
1515 E. 15th Street
Phoenix, Arizona

SELLERS, CONNER & CUNEO
1625 K Street, N.W.
Washington, D.C.

LATHAM & WATKINS
555 South Flower Street
Los Angeles, California

UNITED STATES DISTRICT COURT
CENTRAL DISTRICT OF MESA-TEMPE-CHANDLER

WHIRLING GADGETS,
a corporation,

)  
)  
)  
)  
)  
PLAINTIFF,

VS.  
) Civil Action CV 75-932-Z

RONALD McDonald,
a bad guy,

) NOTICE OF SUMMONS AND ORDER
) TO SHOW CAUSE

) DEPANDANT.

Comes now counsel for plaintiff with notice of summons
which is hereby duly served, in accordance with applicable law and
that stuff, upon Edward L. Gammill, AKA Captain Eddie

1. For the purposes of providing true and accurate test-
imony, under oath (four letter oaths abolished by CV 27-92, R93,
Circuit 23, ad infinitum) the appelee named herein is summoned to
an EVIDENTIARY HEARING before the court (bring tennis racket, etc.)
on Saturday the 21st of June 1975.

2. The hearing shall be called to order at exactly 6:30
p.m. Mountain Non-standard Undaylight Time. Failure to respond
promptly to the role call of litigants will be cause for severe and
punitive assessment, including, but not limited to, CONTEMPT OF
COURT.

3. This motion for summons, made pursuant to Fed. R. Civ.
P. F-15, provides litigant; AKA, appellee; AKA, plaintiff; AKA,
dumb____; to engage the services and assistance of other applicable
persons (spouses, dependants...no dogs, cats, etc.) to be duly sworn
and deposed from time to time and any other time at the Court's sole
discretion.

4. This truly auspicious occurrence will convene in the
Temple of Tempe; AKA, United States District Court, AKA Tempe Racket
Swim Club on the date and at the time heretofore cited.

5. Notice is hereby given that each litigant will be ex-
pected to give testimony on such claims as tennis, volleyball,
racket ball, basketball, handball, swimming, eating... and most
important, DRINKING.

6. This notice has been filed and lost by the Clerk of the
Court. However, the motion still stands based on the points and
authorities filed herewith, and upon such other further oral and
documentary evidence as may be presented at the time of hearing
thereon.

Dated 6 June 1975

Amanda Squelch
Clerk of the Court

ORDER TO SHOW CAUSE

GOOD CAUSE APPEARING THEREFORE, IT IS HEREBY ORDERED
that all duly summoned litigants appear and be sworn as notified
herein.

IT IS FURTHER ORDERED that good things to eat and drink be
served on plaintiffs, and that all parties negotiate and participate
in good faith.

Dated 12 June 1972 (X-4932)

Large Litigants ______
Small Litigants ______
Signed ____________________________

R.S.V.P.:
<table>
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<tr>
<th>Name</th>
<th>AKA</th>
<th>Nickname</th>
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<tr>
<td>Dee Castanier</td>
<td>AKA</td>
<td>Secretary, Mother Hen</td>
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<td>Keitha Murray</td>
<td>AKA</td>
<td>Instant Secretary, WOW</td>
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<td>Peter Engel</td>
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<td>The Invisible Man</td>
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<td>Dale Walker</td>
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<td>James G. Gleason</td>
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<td>John T. Irwin</td>
<td>AKA</td>
<td>The Quiet One</td>
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<td>R. J. Von Flue</td>
<td>AKA</td>
<td>Crew Cut</td>
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<td>Fred Fuller</td>
<td>AKA</td>
<td>Rosie</td>
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<td>Richard Luther</td>
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<td>Richard Mejdrich</td>
<td>AKA</td>
<td>The Beekeeper</td>
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<td>Ed Gammill</td>
<td>AKA</td>
<td>Captain Eddie</td>
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<td>Jess B. Lee</td>
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<td>Dennis Thomason</td>
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<tr>
<td>Charles Bishop</td>
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<td>P.D.Q.</td>
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<td>Pete Gerba</td>
<td>AKA</td>
<td>P.D. X-pert</td>
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<tr>
<td>Adrian Norris</td>
<td>AKA</td>
<td>Paper Doll</td>
</tr>
<tr>
<td>Ray Hand</td>
<td>AKA</td>
<td>Exchecquer</td>
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<td>S. Hamilton</td>
<td>AKA</td>
<td>Legalizer</td>
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<td>D. L. Cauble</td>
<td>AKA</td>
<td>Top Secret</td>
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<tr>
<td>W. G. Orr</td>
<td>AKA</td>
<td>BIG BIG DADDY</td>
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As a result of the challenge to the Garrett Engineering Department, the Screaming Eagles received several takers. After much negotiations and drafting of Memorandum of Agreements (very important to specify who supplied the food and beer), Howell’s Raiders became the Screamers first victims. All activities, practice sessions, preparations and results were reported via NEWS REPORTS by well known reporters as Howard Gushsell and Walter Dobius. Over the Slow Pitch Softball season, the Screaming Eagles also met Dr. Butch E. Nelson’s Raiders, Newlon’s Souper Eagles (became The Keystone Kop-Outs) and Newlon’s Noodles. I am pleased to report that the Screaming Eagles did not loose a game. This great accomplishment is well document in another Chuck Bishop report. I present only the following from this document:

THE F-15 SCREAMING EAGLES
Back Row-Chuck LaGrone, Jim Sanger, Pete Engel, Fred Borns, Stan Byzanski, Cliff Lewis, Dick Luther, Jack Papke
Middle Row-Terry Shelbourne, Ed Gammill, Earl Reynolds, Adrian Pakvis, John Killoran, Milt Parker, Jerry Cargill, Fred Maynard
Front Row-Tom Donaldson, Fred Fuller, Tom Williams, Hank Tom, Bill Shoup, Clorice Bafford

A family affair with wives and many children. The ladies brought much pot luck food and the teams furnished the drinks. After the game there was much eating, drinking, victory
celebrating and review of the spectacular plays. And of course I had to have my victory cigar! A photograph of the SCREAMING EAGLES cheering section is presented below.

THE CHEERING SECTION-OR WHAT MAKES THE EAGLES SCREAM-SOMETIMES

It was late in the year when a major failure of the JFS/AMADS occurred. The outer splined-disk retainer of the CGB clutch failed. Debris from the failure exited straight down through the lower skin of the aircraft fuselage and bounced around on the tarmac. Thankfully the debris went in this direction, for if it had gone in any other direction there could have been major damage to the aircraft or to engine systems. Killoran (MCAIR resident Engineer), Fred Maynard and I spent the Christmas and New Years Holidays performing a failure analysis of the returned center gearbox.

We were in the middle of the Cold War and the general who was in charge of the F-15 Program was extremely upset and interested in our activities. Killoran and I were on the phone reporting to him everyday during this time.

The clutch displayed failure due to high temperature. During talks with the using activity, we learned that the aircraft, in which the failure occurred, was undergoing maintenance troubleshooting, that required many engine starting cycles. Since this was not a normal duty cycle, we were able to convince the general that it was not necessary to ground the F-15 fleet. I
had to inform the general that, in the interest of weight savings, aluminum had been selected as the material for those parts where it was thought to be satisfactory for normal duty cycles. I also agreed that the clutch would be improved and more temperature tolerant if the material of the failed parts were changed to steel. He logically indicated that the weight increase would be well worth the improvement and directed a change be submitted. He would see that it was accepted. Ultimately this was accomplished and all systems were modified.

Some time in this period, Garrett abandon the Journal Building and the F-15 Project moved into the temporary buildings east of the 503 Building. We continued to correct problems, but in general the system performed very well. In 1977, the JFS/AMADS program was turned over to Production Engineering. The F-15 Project people began moving to new assignments. April 1977, I transferred into Project 22. Milt remained with the F-15 program until November of 1978.

The F-15 is truly an EAGLE and continues to service our country well in these trying times. All of those mentioned and the many who I have failed to mention due to fading memory can be proud of their creation. It is a job well done!

NOTES

1-The cover and Figure 5 are creations of our award winning Commercial Artist Dick Aleith (The winter scene of Garrett’s MUST Hospital, the winner, is presented below it is spectacular in color.)
2-Figure 8 is from the November 1974 issue of Automotive Engineering Magazine.
3-Figure 9 is from the 1 May 1975 FLIGHT International Magazine.
4-Jim Brink created drawing 366800, F-15 JFS-CGB-AMAD LAYOUT-STACK, dated January 9, 1973. Unfortunately, it is too long (even after being reduced to 11 inches in width) to be included. It is a real work of art!
5-My thanks to Dick Carpenter, Dick Lonney, Faye McDonald, Herb Johnson and many others who prodded my memory.
6- And to Bill Spragins for once again editing and correct my poor punctuation and grammar.