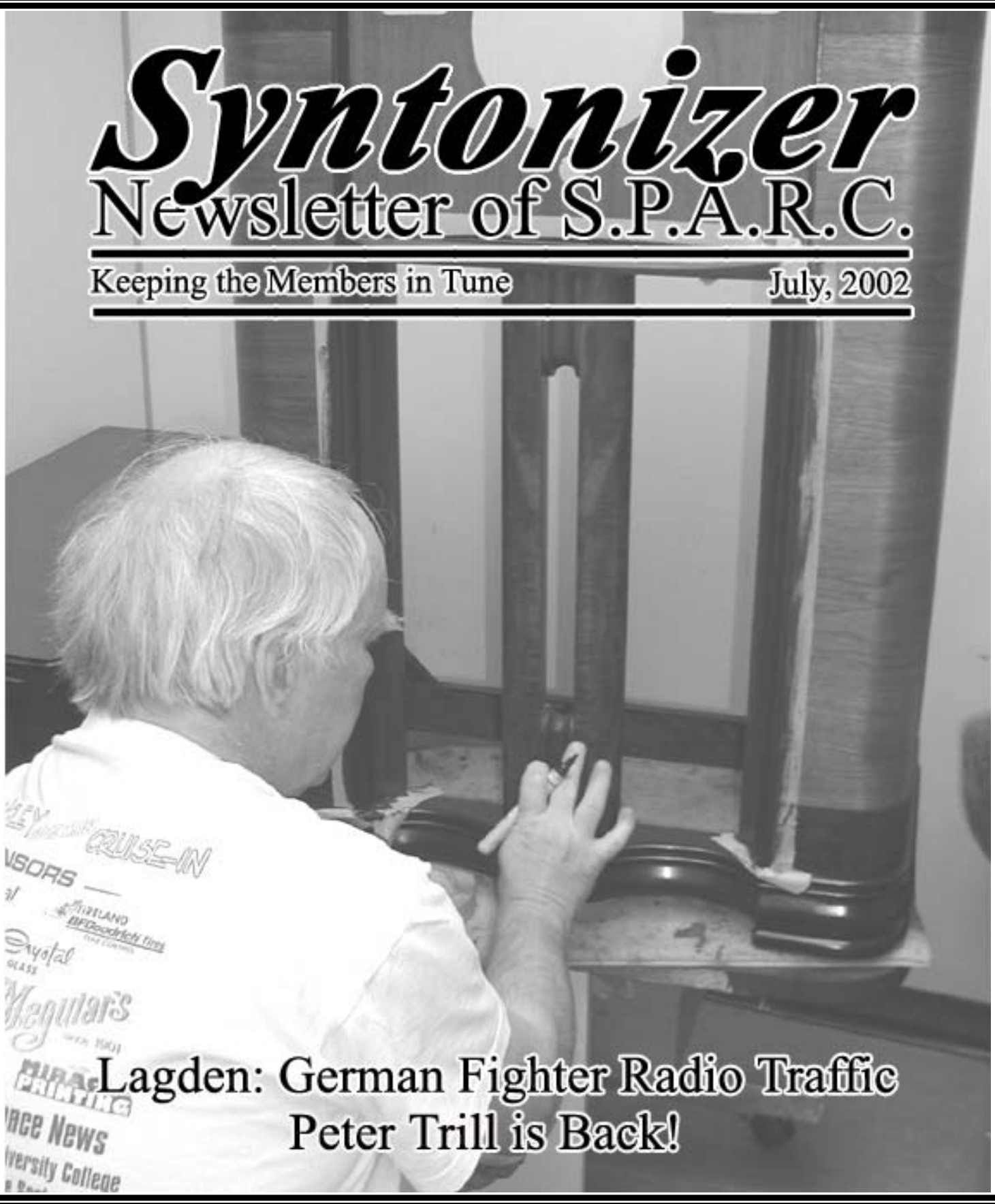
Syntonizer

Newsletter of S.P.A.R.C.

Keeping the Members in Tune

July, 2002



Lagden: German Fighter Radio Traffic

Peter Trill is Back!

Syntonizer

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The Society exists for the purpose of preserving for future generations the electrical and radio-electronic communications artefacts that defined the 20th Century and to pass on the now rapidly diminishing expertise in their maintenance. Membership is open to all those interested in furthering those aims.

The Society operates a museum located on the campus of Riverview Hospital, Coquitlam, B.C. Call 604-777-1885 for up to date information on opening hours. Children are especially welcome. Special openings and extra display interpreters can be provided for large groups by prearrangement.

Tour and technical enquiries may be directed to the President. Enquiries regarding tax exempt financial donations and bequests should be directed to the Society's solicitors, Russell and Company, Suite 220, 4411 East Hastings Street, Vancouver, B.C., V5C 2K1.

Editorial Comment

Back to Blighty

In this month's column, Brian Lagden takes up his duties in the south of England in *Luftwaffe* radio traffic interception and direction finding after the overrun of much of France by the Germans and the establishment of the Vichy government in the rest of that country.

New readers may catch up on Brian's story by reading back issues at the museum or by looking at *www3.bc.sympatico.ca/radiomuseum/news.html* . Briefly, Brian's radio intercept unit was dispatched to France in 1939 and then ordered home when the *Sitzkrieg* was abruptly terminated by the Germans in the Spring of 1940.

Last Month's Cover Subject, Marian Rejewski

In the intellectual tradition of their culture and away back in 1929, the Poles took a very modern approach to code breaking. At the University of Poznan, three brilliant students who were graduating in mathematics were selected for a course in cryptography. Those students were Marian Rejewski, Jerzy Rózycki and Henryk Zygalski. In 1930, in Pozan, they began practical cryptography and in 1932 went to Warsaw to undertake work on the Enigma cipher. Rejewski, last month's cover subject, developed a mathematical technique for breaking the settings of the Enigma machine and in early 1933 the first German messages were decrypted.

Remember, there were no computers around. All the theory and practical decryption were done by brain power. In the following years, these Poles decrypted a large number of German messages using hand methods supplemented only by relatively simple, manually operated machines that they developed as they went along to ease a part of the work. Because of the use of these hand methods, the final result was available only long after the message had been sent. Sometime weeks might elapse before a message's clear text were available. As a consequence, the techniques were generally of value for messages providing strategic and background information and not for information of immediate operational importance.

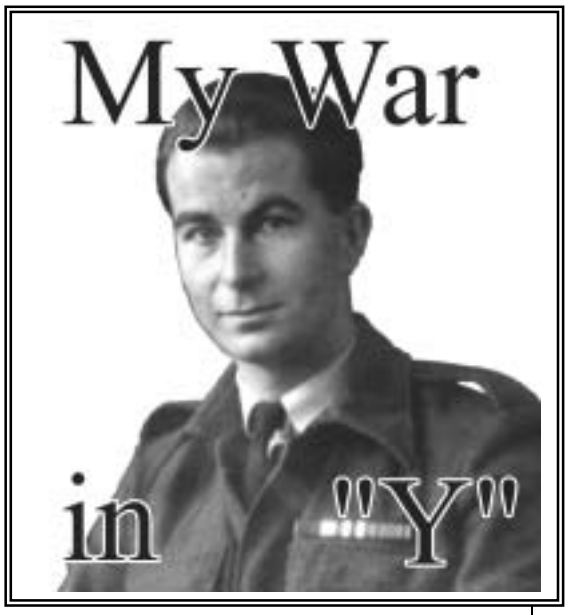
By the end of the decade, these hand methods of determining Enigma machine settings had been rendered valueless even for messages of less immediate relevance because of a change in German encoding procedure, a technical improvement to the Enigma and the explosion in traffic volume that accompanied German mobilization.

In light of these realities, in mid 1939, well before the collapse of Poland under the *Blitzkrieg*, in the greatest secrecy the Poles had briefed the British on their techniques. The British had not been idle during the 'thirties themselves nor were they short of high powered intellectual talent. With this Polish input to their own efforts and the construction by the British of increasingly sophisticated computers to do at high speed the stupendous volume of "grunt work" now required to break Enigma machine settings, Bletchley Park was able to produce the vast volume of real time Ultra intelligence that we all now know about.

This Month's Cover

Bruce Russell, the moving force in the cabinetry department as elsewhere in the museum, works his magic on a deteriorated console in our new spray booth. Bruce and Phil MacCormick are the members who work most in this area and who produce the exquisite restorations we all admire out on the display floor.

Editorial concluded on Page 4.



By
Brian Lagden

Back in England

Not an Officer and a Gentleman

Memories of that atmosphere of frosty hostility, that had prevailed as we were dismissed from our last parade of Y Section A.A.S.F. were pushed into the background by the warmth of our welcome back to Cheadle. The local pub clientele greeted us enthusiastically and some members, returning to their former civilian billets, even had parties thrown in their honour. Embarrassing, of course, since I, for one, felt we had achieved little; perhaps we were fortunate that, in our line of work, we were absolutely forbidden to say a word about it!

Technical Innovation

Most of the O.R.s were absorbed back into the regular watch roster, but there was a dearth of jobs for N.C.O.s, since supervision of the watches was still in the very capable hands of the civilian "charge hands" who had been there for some years. Accordingly, other jobs were found for us and in retrospect, I can only regard them as not much more than "make-work" assignments; I spent some time assisting in the development of an experimental variation of the B/T Loop D/F antenna system (really, just one technical officer's "hobby horse"). Following this, three of us were detailed to wire and install equipment install equipment in a "duplicate" station for use if ever 61WU were put out of action. "Duplicate" was hardly an accurate term, since the receivers we installed were Eddystone 358s!

These were o.k., in their way, but were in no sense comparable to the formidable and massive R-1084s at the existing station. These latter, battery-operated, monsters were quiet and, with their optional 40 kHz second I.F.s *(plugged in!)* and an 800Hz audio filter, had astonishing adjacent channel selectivity!

Brief Assignment, Gorleston

Life was becoming somewhat boring when, in early 1941 a fellow corporal and I were dispatched to Eastbourne to install a portable Marconi-Adcock HF DF system at the Beachy Head H.D.U. "Home Defence Unit" was the innocuous designation given to interception stations whose job was to monitor fighter R/T traffic. When we had the D/F up and running, a few days later, I was ordered to Gorleston-on-Sea, just South of Great Yarmouth, were I was to perform a similar installation and remain "for a month or two" to train the W.A.A.F. personnel

Girls of Good Family

The WAAFs fell into two classes; firstly young ladies fresh from finishing schools in Germany or France and secondly, Jewish refugees from Germany, Hungary, Czecho-slovakia, Poland *etc*. Characteristics shared by all were fluency in German, "good ears", high intelligence and a great enthusiasm for their job. *All* had the protective rank of Sergeant, which used to puzzle the local citizenry tremendously! They were headed up by a rather awe-inspiring slightly older Flight-Sergeant who, although pleasant in manner and definitely "one of the girls", left no one in doubt as to "who was the boss"!

At the time of my arrival, the atmosphere was very relaxed but things started to tighten up as we began to have officers added to the strength, finally even a WAAF Admin. Officer assisted by a wonderful, motherly WAAF Flight Sergeant (Admin). A technical officer arrived in the person of a fellow "ham", G2UJ, who became a good friend of mine over the years.

Another important addition was a small group of ACH (G/D)s who were employed as armed sentries at the front entrance; this ensured that no snooper could peer into the Operations Room and see the large map of the North Sea and surrounding coastlines with two different grid systems, *the Luftwaffe grid* and *the RAF fighter grid* marked on it!

Office Politics

"Politics" rears its ugly head in nearly all aspects of our lives and HDU Gorleston was no exception!

In 1942 a new Commanding Officer arrived; I never felt completely comfortable working with him and two incidents served to crystallize my feelings.

A Big Ear

The first followed the construction of an intercom that the WEM (Wireless and Electrical Mechanic) Sergeant had put together, at the C/O's request, to connect his office with the Operations Room; this made sense, since he could then be notified immediately when anything of operational importance came up. The system consisted of a small amplifier and two standard permanent magnet speakers, which were to be switched into circuit as microphone or speaker under control of whomever was speaking at a given moment; the obvious, practical way to make the installation was to have both in "receive" condition when on "stand-by", so that either end could call the other as needed. The C/O alarmed "Sarge" by asking him to wire the system so that the Ops. Room end would be activated as *a microphone* at all times when the system was on stand-by!! This smacked too much of "Big Brother" for my liking and the matter had to be resolved by my approaching the Signals Officer for help; he, as I had been, was thoroughly shocked, but assured me that he would "fix it", advising the C/O that the request was technically impossible to meet! We all knew that was absolute nonsense, but the demand was dropped because, presumably, to insist would have confirmed our "Big Brother" suspicions!

Torpedoed Commission

The second incident arose when I had somehow become engaged in a discussion with the C/O concerning

what I felt was bullying on his part. The victim was one of the Linguists in whom he supposedly had a personal interest, as did I, to be honest! He gave me an opening when he remarked: "You know, Flight, it's not as easy as you might think, running this unit! Perhaps *you'd* like to sit in this chair!" My reply, of course, was, "Yes Sir, I would. I'd like to apply for commission as a Y Signals Officer. I believe I could make the grade".

The handling of my application was unusual, to say the least; as an opener I was sent to Coltishall for a regular aircrew medical; at the conclusion of which the M.O. said, in clearly pejorative tones, "Well, ***I*** can't find anything wrong with you!" No one else that I knew of had this kind of experience when applying for a "Y" commission. Time dragged on with no response to my application until, months later I discovered, through a Kingsdowne contact, that it had *never been received there!* My contact told me to lie low and that H.Q. would write enclosing new forms and suggesting me as suitable officer material. The letter duly arrived and I was summoned to the C/O's office where I was told, with elaborate casualness: " Oh, Flight! – It seems we did something wrong and we have to re-submit your application!" Before any processing of the new application could take place, a different opportunity had presented itself and put the whole matter to rest for good

Recreation

Off duty activities at HDU Gorleston consisted mainly of an informal Classical Music Club, cycling (East Anglia, similar to Holland, is as flat as a board so it's not hard work!), "pubbing", dances at the Floral Hall, which boasted an unusual octagonal dance floor which was easily the best sprung floor that most of us had experienced. This did away with crowding on the corners and made everything much more comfortable. The flat-roofed house in which the unit was located had nothing in the back garden but an excellent *en-tout-cas* tennis court. One of the WAAF sergeants, who hit the ball with accuracy and an apparent desire to remove its cover would occasionally give me a game; on a good day, I might manage to hold two of my service games in a set!

Volunteer Volunteers

Many evenings, if there were a "big show" on and business promised to be brisk, instead of going out somewhere, we would voluntarily put in two or three extra hours at the station, manning a spare receiver, in preference to any other activity, just to be "in on the fun". The general enthusiasm was exhilarating and we enjoyed ourselves thoroughly.

The S/Ls (Signals Linguists) developed many skills, recognizing individual *Luftwaffe* pilots by their accents and generally developing a feel for what was going on in a given *Jagdgeschwader* (fighter group), noting any new type of traffic that cropped up and taking an active role in trying to work out its significance. One such was traffic in which the code words *Kleine Schraube* ("Little Screw") were used frequently. A controller would, for example, instruct a pilot, *Bleiben sie bei Kleine Schraube!* ("Stay near Little Screw"). After some months it was discovered that *K.S.* was a sophisticated night-fighter control system in which searchlights, integrated with flak batteries, two types of radar and, of course, the fighter formations in a formidable defense system code-named *Himmelbette* ("Heaven Bed") by the Germans. Each pilot was stationed in one of a number of overlapping boxes constituting the Kammhuber Line (after its originator), which eventually stretched from Northern Holland to the Swiss border. The fighter would wait on station, "orbiting" a radio beacon, until given the intercept course to a target. Hearing these directions given we liked to hear the pilot reply *"Ich suche"* ("I'm searching"); *"Heil Hitler!"* on the other hand, made our hearts sink for it signified a "kill"!

Brian's story continues in the next issue

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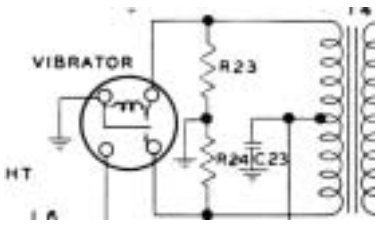


Editorial, concluded.

Not a Wholesaler

The S.P.A.R.C. Museum is a museum and it is a charity. The museum does not make money. None of us involved in the operation makes a dime out of it and none of us trades on our memberships or access to the museum's priceless collection of equipment or documents. Some of us, in fact, have made financial inputs and many have made "in kind" contributions.

Individuals have begun to emerge in the geographical area served by the museum who see the museum in a different light: an adjunct to their business interests. It is, after all, a vast repository of parts, tubes, cabinets and complete receivers, all important elements in expanding their personal asset, a collection, or in their for profit trading activities.

Measures are being undertaken now to convey the message, quite distinctly, that the museum is not some sort of wholesale parts distributor established for the convenience of their personal undertakings. People with such views are unwelcome at S.P.A.R.C. A definitive remedy can be applied in persistent cases.

Those who wish to engage in the *business* of "old radio" are welcome to do so but they will do that *outside* S.P.A.R.C.

Beating the Electronic Bushes

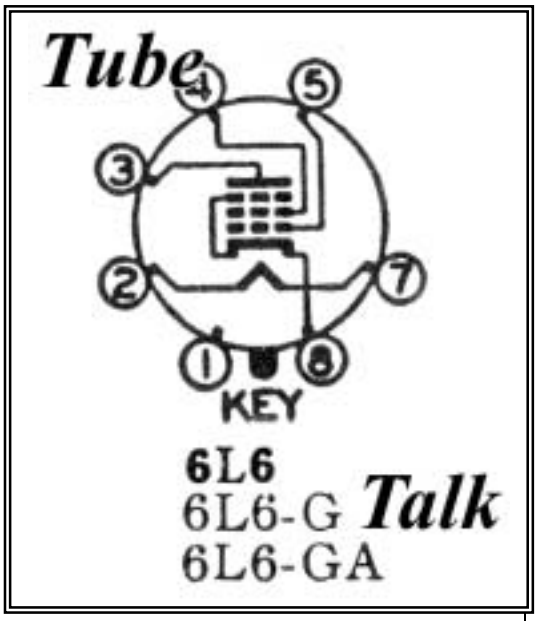
Your editor is delighted to report that readers of these pages can look forward to another original, first person series on old radio, this one about radio history in British Columbia. It's "in the can". A third such series is in production. To paraphrase our d.j., Peter Trill: "Stay syntonized"!

Back Issues

Web sites and their u.r.l.s are notoriously evanescent. So it may prove with the location of the *Syntonizer's* back issues. The site has been stable for some weeks, a long time on the web! Have a look: *www3.telus.net/radiomuseum/news.html*

Mini Poster

Is there something polite that can be said about this month's mini poster? How about: "A visit to S.P.A.R.C. promises a complete radio experience"? As to *where* to post it, no problem!



The Multi-grid Tubes

By

Neil Sutcliffe, **Tube Troll**

Last time we looked at the ubiquitous triode, the father of the amplifying tubes. This time and next I will cover the multi-grid receiving tubes and, in a future article, the special purpose types of receiving tubes.

Compared to the development of the triode, the development of the multi-grid types was somewhat more straightforward, since the operation of the vacuum tube was, by then, much better understood.

'Miller Capacitance' Limit

As mentioned in the last article, the typical 3 stage TRF (Tuned Radio Frequency) sets were limited in stage gain by the 'Miller Capacitance' of the triodes. In very simple terms, this is the plate to grid capacitance multiplied by the tube gain. Thus, a tube with, say, 2pF of plate to grid capacitance (not much at broadcast frequencies) running at a gain of 100, would appear to have a capacitance of 200pF which is more than the tuning capacitance at the higher end of the band! Neutralization helped a lot, but it is imperfect and high gain in a tuneable stage was not really practical in consumer receivers.

Tetrode

In October, 1927 RCA released the UX222 which had a second grid, placed between the control grid and the plate. This grid was intended to act as a shield to greatly reduce the effective capacitance between plate and control grid (8.1pF for the '26 triode vs. 0.02pF for the '22 *tetrode*). To operate effectively, the tetrode *screen* grid needed to be at a substantial positive DC potential, while held at an effective RF ground potential. If the screen grid was simply grounded, it not only shielded the control grid from the plate, but also shielded the electrons from the attraction of the plate's positive electrostatic field, thus reducing current to almost zero. By holding the screen grid at a steady high voltage the electrostatic field attracted the electrons through the control grid and, as long as the plate was more positive than the screen grid, through the screen to the plate.

Other Factors

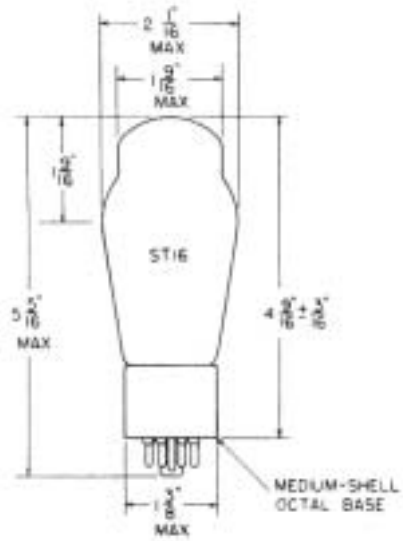
An added bonus of the constant voltage field from the screen grid was a substantial reduction of the effective plate impedance. It was soon noted, however, that there were some drawbacks as well. If the plate voltage, in its swing under signal conditions, became more negative than the screen grid, then some of the electrons striking the plate and bouncing off (secondary emission) and usually attracted back to the plate (since it is normally at the highest potential) would, instead, be attracted to the screen. Since this would cause an electron flow out of the plate instead of in to it, as would normally be the case, this resulted in a 'negative impedance' which is potentially unstable (prone to oscillate). Arranging the circuit parameters to ensure that the plate never became less positive than the screen severely limited the available plate swing and the available gain in larger signal stages.

Another Grid

What to do? Well why not place an electrostatic shield grid between the plate and the screen grid to prevent the electrons bouncing off the plate being attracted to the screen. This was done and it worked very well and became the UX257 *pentode*. The pentode provided very high gain, low capacity (plate to grid) as well as low output (plate) impedance, all very desirable characteristics and none of the bad side effects of the tetrode.

Consumer "Superhet." Arrives

Since, at the beginning of the 1930s and the Depression, the TRF was being supplanted by Armstrong's 'Super-hetrodyne' design, a very effective receiver could be built using only 4 amplifying tubes: An 'autodyne' converter triode, tetrode or pentode; a pentode IF amplifier; a triode detector/1st audio and a tetrode or pentode audio power amplifier. It was a design relatively simple and potentially cheap to manufacture. The marketplace, however, had a problem in urban areas where there might be 2 or more relatively powerful stations as well as the numerous more distant stations of the surrounding areas. This problem was cross modulation, where the carrier of a strong station would push the front end high gain tube into distortion even when not tuned in (poor RF selectivity due to simple design) and cause images, whistling and interference with weaker distant stations.



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Clever Grid Design

If a tube could be designed to have a variable gain depending on the signal level on the grid, then a high level from the local station would not force the tube into cut-off and distortion. This was cleverly done by winding the control grid not

as an even pitch but with a wide space between wires near the middle and progressively closer spacing together near the ends. The effect of this was that with small signals, the close spacing near the ends of the grid had an effect on the total electron flow but it took a very large negative voltage to completely cut off the flow between the widely spaced grid wires at the centre.

Variable μ

This became known as the varimu or remote cut-off pentode, introduced as the UX258. For comparison, the UX257 cut-off at about -3V on the grid, while the UX258 needed about -30V to cut-off. These two types, with refinements and modernization provided the bulk of RF/IF/AF pentode applications in radio receivers to the end of tube use (the 6AU6 is from the '57 and the 6BA6 is from the '58).

More Sophistication

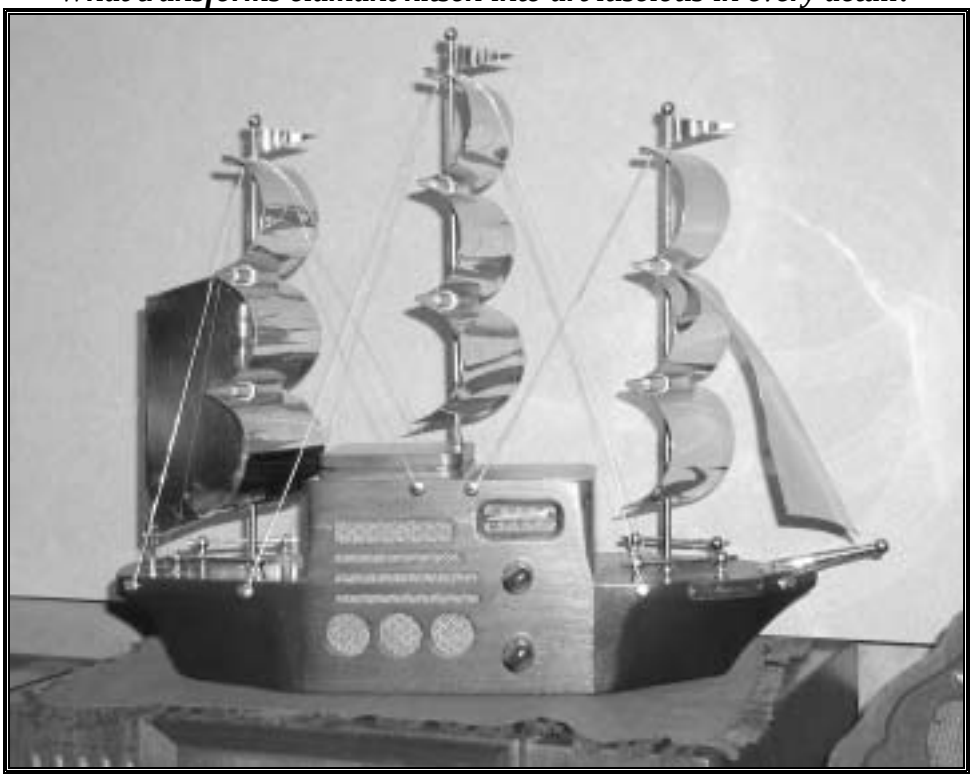
While the 'Autodyne' converter worked, it had severe limitations for anything more than broadcast use and without a preceding RF amplifier stage for isolation, was prone to radiate the local oscillator signal through the receiving antenna. The alternatives were to use a separate oscillator tube and couple this into the 'mixer' (still radiates, but works to much higher frequency short waves) and to have an RF stage to isolate the 'mixer' from the antenna. Neither of these helped to keep the cost and complexity of the set down. What was needed was a tube with a built in oscillator well shielded from the signal input grid to provide a wide range stable source for the local carrier and inherent suppression of carrier radiation. To meet this need a 5 grid tube was developed (2A7) to have a triode nearest the cathode with a grid like spiral plate, surrounded with a shielding grid, then a control grid for the incoming RF signal, a further shield grid and all surrounded by the plate. This functioned by having the oscillator triode operating with grid bias such that it modulated the electron stream flowing to the plate from virtual cut-off to saturation. This pulsing electron stream was then modulated by the control grid at the RF signal rate and amplitude. The resulting signal at the plate contained the oscillator and the RF signals as well as the sum and difference signals, one of which was chosen as the IF. While this type worked well, it had noise problems and certain problems when used at higher short wave frequencies.

Since it is necessary, in the converter tube, to cause the 'modulation' of one signal by the other (oscillator and RF input), it is perfectly possible to apply the RF signal to the grid nearest the cathode and then control the resulting electron stream by the local oscillator signal on a grid further out in the structure. This was done in the integrated triode/*heptode* 6J8, where a separate triode structure, common to the cathode, directly fed the third grid. While this type had superior performance to the 2A7/6A7 type, it was more expensive to make and use. A substantial renovation of the *pentagrid* structure of the 2A7/6A7 to better isolate the oscillator from the RF signal and improve the stability of the oscillator by reducing its sensitivity to supply voltage fluctuations and 'pulling' by the RF grid circuit resulted in the 6A8. This type was very commonly used throughout the '30s. An improved 'short wave' version with a more or less isolated triode section for the oscillator but still inner grid injection was introduced in the mid '30s as the 6K8. Also introduced was the 6L7 pentagrid mixer which required a separate oscillator triode.

The multigrid story is concluded next issue with the refinement of the pentagrid mixer and the appearance of the beam power pentodes such as the 6L6 and its derivatives.

Reference material:
Gerald F. J. Tyne "Saga of the Vacuum Tube"
R.C.A./ Cunningham Tube Manuals
General Electric Tube Manuals
F Langford-Smith "Radio Designers Handbook, 4th Edition"

What transforms clamant kitsch into art luscious in every detail?



A Bruce or Phil restoration!

with

Peter Trill

This column in our January 2002 newsletter opened with the statement that computer technology has largely taken over audio operations in broadcasting. Considering that we are a museum, we take such a statement as a lament.

No longer does a control room have the visual impact of a bank of turntables with discs cued up for play, large-reeled tape machines with the warm glow of their VU meters and ordered bins of LPs, 45s and tapes at the ready for air-play, interspersed with folders of hand-typed commercial copy to be read by the duty announcer -- live!

Hanging nearby is the long clipboard with the station's log, on which the operator places his initials beside each completed program item. Press hard! The log has four carbon copies! In this issue, the discussion turns to a piece of broadcast hardware that has enjoyed a briefer legacy than turntables, microphones and reel-to-reel tape machines - the tape "cart" machine, one of the (nearly) bygone contributors to the "visual impact".

Why the Cart?

Why did tape cartridge machines enjoy a rapid acceptance? Before the appearance of tape recorders in the late forties, any commercials on your local radio station would be either live or on transcription discs that were sometimes pressed in quantity but more likely were individually cut on lacquer-coated aluminum discs. Most commercials were aired live, because only larger national advertisers could afford disc as a source.

Live commercials certainly were a necessity for a station that had only three turntables. Imagine juggling three disc-commercials between part one and part two of a program that itself was on two discs. About 1955, after tape machines came into use, ad agencies began to distribute their spots on open-reel tape. Cueing these tapes for air play was even more cumbersome than cueing discs. (For a discussion of cueing, see our October 2001 newsletter.) As programs themselves moved to tape, the same playing dilemma developed for lack of reel-to-reel tape machines.

Development of the Endless Tape Loop

Early interest in endless tape loops was kindled by the need for a store-display that played a recorded message over and over endlessly.

Experiments were based on an existing 8-millimeter endless-loop film cartridge. Tape on a single small spool had to be pulled from the inside at the hub, passed over the play head, then wrapped onto the outside of the same spool. Once it was learned that a conductive graphite-based back-coating would prevent binding due to friction and static electricity, the successful "Audio Vendor" was marketed in 1952. A later fully enclosed version was called the "Echomatic". About the same time, another inventor designed and patented a similar cartridge that came to be known as the "Fidelipac", which fathered the present-day cartridge format. The design was licenced to a number of manufacturers.

By the early 60s, robust cart players built to meet broadcast standards were available that would play these carts. Auto-stopping was a key feature. A non-broadcast branch from this design resulted in the familiar "8-track", through the efforts of Bill Lear (of "business-jet" fame), and Earl "Madman" Muntz (car stereos). The principle is similar, but the 8-track is quite different, having its own rubber idler and a different track format.

Broadcasters Welcome the Cart Machine

The appearance of reliable cart machines in control rooms provided the answer for local production people to have more professional-sounding commercials. They now could include background music and sound effects, use multiple voices and make each spot exactly the right duration. Live announce "fluffs" were never heard again.

Operators never had to cue up the material (unless an impatient operator had stopped the cart before it had recued itself… then the next operator would be jolted by a silent run-out!). For those on-air staff who worked as combined announcer-operators, being freed from doing commercials live allowed them to concentrate on the next task at hand while the commercial played. The stand-alone cart machines kept the turntables and open-reel machines free as prime program sources.

An important aspect of playing sponsor's commercials was that of "rotation". The ad agency might supply a transcription or tape with several "cuts" or versions. Since no two were alike, variety was the benefit. When played from disc, the program log would have to specify which cut was to be aired. Suddenly with carts, the several versions could all be on one cart and rotation would be guaranteed.

How Do Carts Know where to Stop?

On later cart machines, the method of stopping the cart was a brief tone on a separate track. When a cart was re-recorded, the audio along with the stop tones would get bulk-erased. On earlier cart units (that I remember doing battle with), stopping was triggered by adhesive-backed conductive foil when it passed over a head with electrical contacts. To create a cart containing more than one item, the extra foil patches were maddening to stick on with tweezers at the correct spot. To re-use these carts required removal of all those added foil patches. Usually the tape became wrinkled, covered with greasy finger-prints and there was the difficulty in deciding which foil was the factory original!

The "Aristocart"

Vancouver's own CKNW had a daughter company that designed a "better mousetrap" in the form of a cart that had very stable playback characteristics thereby allowing the use of carts for playback of stereo music. For the first time, turntables were supplanted by a convenient program music source medium.See our Cart Machine Collection

In our broadcast booth, you can hear working examples of the major manufacturers of cart machines – ITC, Fidelipac, Broadcast Electronics and others – playing our own 1960's examples of radio jingles.

"This is Heritage Radio"


Broadcast radio,
serving mankind's
Federal
every need!
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