

# GBPPR 'Zine



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***"It is no longer acceptable that a small minority would dominate the politics, economy, and culture of major parts of the world by its complicated networks, and establish a new form of slavery, and harm the reputation of other nations, even European nations and the U.S., to attain its racist ambitions,"***

--- September 23, 2009 quote from Iranian President Mahmoud Ahmadinejad during the the 64th session of the U.N. General Assembly.

***"Once we squeeze all we can out of the United States, it can dry up and blow away."***

--- Supposed quote from Binyamin Netanyahu during his visit to Israeli spy Jonathan Pollard in his North Carolina prison cell.  
([onlinejournal.org/Special\\_Reports/092105Madsen/092105madsen.html](http://onlinejournal.org/Special_Reports/092105Madsen/092105madsen.html))

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# Toll/Tandem Switching Software Subsystem Description / #1A ESS

BELL SYSTEM PRACTICES  
AT&T Co SPCS

SECTION 231-045-160  
Issue 1, February 1981

## TOLL/TANDEM SWITCHING SOFTWARE SUBSYSTEM DESCRIPTION 2-WIRE NO. 1/1A ELECTRONIC SWITCHING SYSTEM

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# Toll/Tandem Switching Software Subsystem Description / #1A ESS

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**Table**

**A. Toll/Tandem PIDENTs . . . . . 2**

**1. GENERAL**

**INTRODUCTION**

**1.01** The toll/tandem software performs the actions needed to route toll calls and calls requiring a trunk-to-trunk connection through a No. 1/1A Electronic Switching System (ESS) office.

**1.02** When this section is reissued, the reason for reissue will be given in this paragraph.

**1.03** Part 6 of this section provides a defined list of the abbreviations and acronyms used in this section.

**PURPOSE OF THE TOLL/TANDEM SOFTWARE**

**1.04** The toll/tandem software provides a centralized stored program control system (SPCS) which enables a No. 1/1A ESS office to process toll and tandem calls in addition to local calls. These calls require the establishment of a trunk-to-trunk connection. This section also provides information about software which interfaces the ESS to operator/switchboard positions on toll calls requiring operator assistance.

**SCOPE OF SECTION**

**1.05** This section provides an introduction to the toll/tandem software operating in a No. 1/1A ESS office. This section is based on the generic programs through 1E7 (for No. 1 ESS) and 1AE7 (for No. 1A ESS).

**PIDENTS DESCRIBED IN SECTION**

**1.06** Table A provides a list of the PIDENTs which are covered in this section.

**2. FUNCTIONAL OVERVIEW**

**TANDEM CONNECTIONS PROGRAM**

**2.01** A tandem call is defined as an incoming call on an incoming trunk (ICT) which will not terminate at a line or tone circuit in the local ESS office, but will be routed over a nonoperator outgoing trunk (OGT).

**2.02** There are four types of tandem calls:

- (1) Local tandem—trunk-to-trunk connection set up when an ESS office serves as a local tandem office.
- (2) Centrex tandem—connects a pair of centrex tie trunks.
- (3) Tandem connection which occurs because an incoming call is to a customer line which has temporary transfer active to a line outside the local office.
- (4) Connection resulting from an incoming direct inward dialing (DID) call to centrex customer premises equipment.

**2.03** Routing of tandem calls is handled by PIDENT TAND. TAND provides supervision on the ICT while the called number is outpulsed on the OGT. It then establishes the talking path if outpulsing is successful. If outpulsing fails, it takes appropriate actions.

**TABLE A**

**TOLL/TANDEM PIDENTS**

PIDENT	TITLE	NO. 1 PR	NO. 1A PR
TAND	Tandem Connections Program	1A129	6A129
TOPR	Toll Operator Signaling Program	1A051	6A051
TSPS	Traffic Service Position System	1A150	6A150

**TOLL OPERATOR SIGNALING PROGRAM**

**2.04** The toll operator signaling program (TOPR) handles signals sent over intertoll trunks to and from switchboards. TOPR is entered from the scan point change director program when an operator trunk ferro changes states. TOPR then determines which of the possible signals has been received and takes appropriate action for that signal. It also processes operator answer and disconnect.

**TRAFFIC SERVICE POSITION SYSTEM PROGRAM**

**2.05** The TSPS program processes all calls routed to a traffic service position (TSP) or Traffic Service Position System (TSPS). This includes any calls requiring operator intervention such as collect or person-to-person calls. It takes appropriate actions for on- or off-hook reports and also processes coin collect and return signals on coin calls.

**3. TANDEM CONNECTION (TAND) PROGRAM DESCRIPTION**

**GENERAL**

**3.01** The primary purpose of the tandem connections program is to establish a trunk-to-trunk connection. It is entered from the incoming call digit analysis program ICAL or ISXS. TAND provides supervision on the ICT while outpulsing the called number over an OGT. If outpulsing fails for any reason, TAND takes appropriate action as further described in the following paragraphs.

**3.02** When TAND is entered, it performs initialization to prepare to outpulse the called number. It then calls the outpulsing program. The outpulsing program idles the digit receiver which was used to receive the called number from the ICT. It searches for an OGT based on a route index (RTI). The RTI is passed to TAND, which in turn passes it to the outpulsing program. The outpulsing program then seizes an idle transmitter of the proper type for the OGT, if a transmitter is required.

**3.03** The outpulsing program will attempt to outpulse the called number and will return to TAND with either a success report or a report of why outpulsing failed. Outpulsing may fail for one of the following reasons:

- (a) Transmitter preemption

- (b) Abandon during outpulsing

- (c) Non-POB failure

- (d) Busy or blocked condition

- (e) Hardware failure

The actions taken by TAND for these cases are described in the following paragraphs. A functional flowchart of TAND is shown in Fig. 1.

**OUTPULSING REPORTS**

**A. Transmitter Preemption**

**3.04** If a transmitter does not receive a start-pulsing signal within approximately 4 seconds, it may be preempted as further explained in paragraph 3.07 below and in Reference (b) in Part 7. If this occurs, TAND idles the network path in memory and restores the OGT and transmitter to idle lists. If the ICT is still off-hook, overflow tone is returned. If the ICT has abandoned, abandon procedures are taken.

**B. Abandon During Outpulsing**

**3.05** If an abandon (on-hook condition) is detected on the ICT while the outpulsing program has control of the call, the call must be taken down. The ICT and OGT are restored to the idle state, the path is idled, and all registers associated with the call are released.

**C. Non-POB Failure**

**3.06** If a trouble condition exists in the interoffice signaling equipment at either the local office or the distant office, a non-POB failure report is returned to TAND. When this occurs, TAND idles all memory associated with the outgoing portion of the call and will optionally try to outpulse over a different OGT if the ICT is still off-hook.

**D. Busy or Blocked**

**3.07** If the network is blocked (no network path available) the ICT is connected to overflow tone. If a busy condition exists because there is no idle transmitter available, an attempt is made to preempt a transmitter from another call. Preemption is done by the outpulsing control program. This program hunts for an outpulsing

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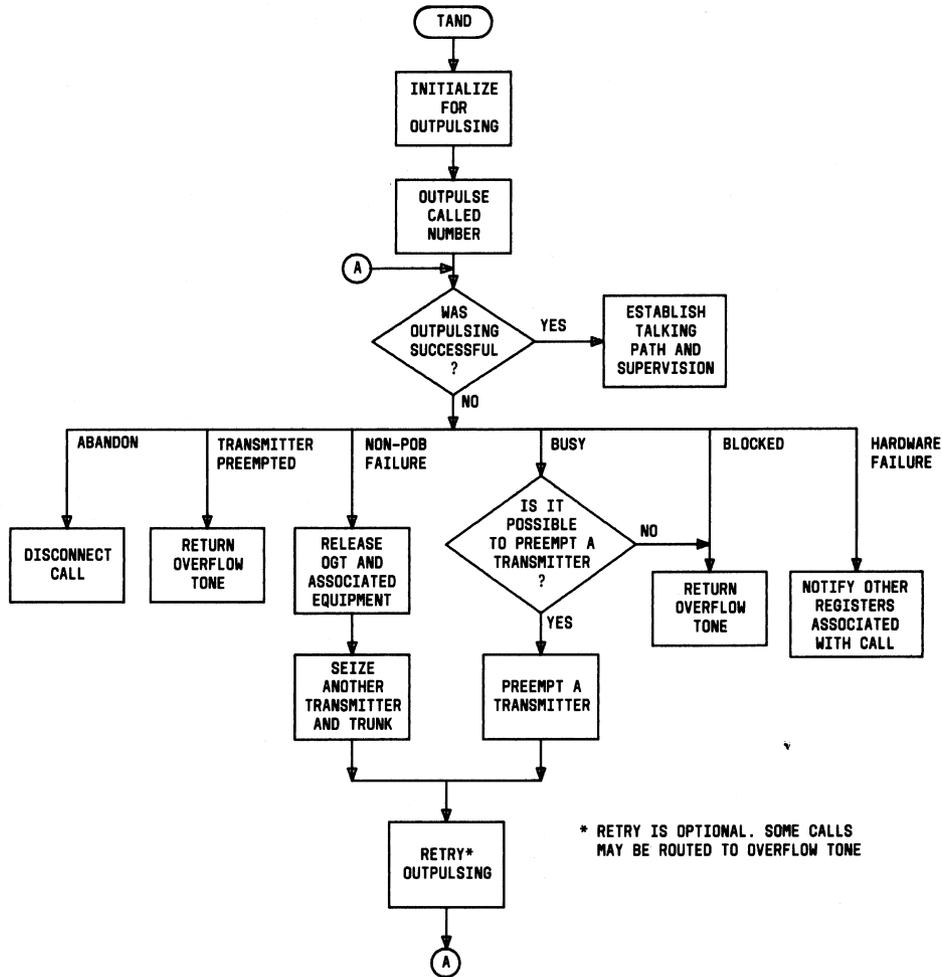


Fig. 1—Tandem Connections Program—Functional Flowchart

control register which has been in the start pulsing signal detection state for more than 4 seconds. If such a register is found, the transmitter associated with the register is made idle and the path to it is abandoned. Programs handling the call which had control of the transmitter are notified that

the transmitter has been preempted. The previously busy call can then use the newly idled transmitter. If a transmitter can be preempted, outputting is attempted using that transmitter. Otherwise the ICT is connected to overflow. If no OGT is available, the call is connected to overflow.

**E. Hardware Failure**

**3.08** If hardware troubles occur when the outpulsing program attempts to connect a transmitter to the OGT, the report is passed on to all registers linked to the incoming call register and the call is torn down. TAND then returns to the main program.

**F. Successful Outpulsing**

**3.09** If outpulsing is successful, TAND establishes a talking path between the ICT and the OGT. The transmitter is restored to the idle list and a peripheral order buffer (POB) is loaded with orders to set up the talking path which was reserved when the outpulsing connection was established. The POB is then loaded with orders to put the trunks in the proper states for talking. If these POB orders are successful, answer supervision is established on the OGT and disconnect supervision is established on the ICT. Supervision reports are processed by the call processing programs such as the disconnect programs and dialing connections programs. See Reference (a) in Part 7 for further information on these programs.

**SPECIAL TRUNKS**

**3.10** Digital carrier trunks (DCTs) or trunks with common channel interoffice signaling (CCIS) must be handled somewhat differently than other trunks by TAND since they do not use digit transmitters and receivers. When a CCIS trunk is used, the called number is sent over a data link. When a DCT with digital carrier address signaling is used, the called number is sent (on an OGT) or received (on an ICT) by a peripheral unit controller (PUC) rather than by a transmitter or receiver.

**4. TOLL OPERATOR SIGNALING (TOPR) PROGRAM DESCRIPTION**

**GENERAL**

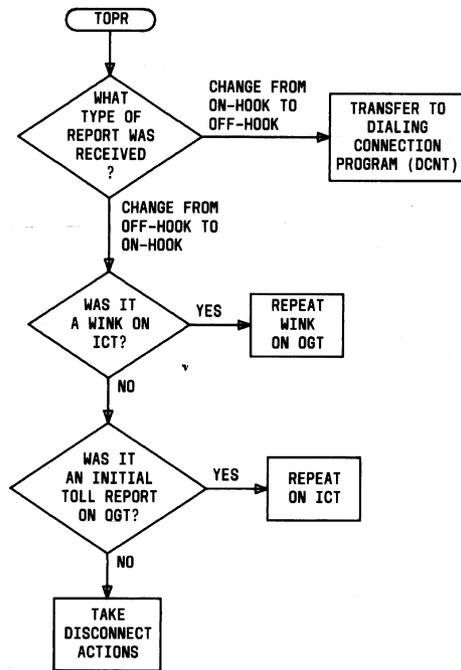
**4.01** The toll operator signaling program TOPR handles operator signals to and from switchboards. These signals are sent over intertoll trunks and include:

- Ringback
- Ring forward

- TSPS double ring forward
- Alerting wink

TOPR also handles answer and disconnect on calls routed over intertoll trunks.

**4.02** TOPR is called by the scan point change director program (CHGD) whenever it detects a change in state in a trunk ferrod. TOPR then determines what kind of signal is represented by the change in state and calls other routines to take the appropriate action for that signal. The operation of TOPR is described in the following paragraphs. Figure 2 provides a functional flowchart of TOPR.



**Fig. 2—Toll Operator Signaling Program—Functional Flowchart**

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### OFF-HOOK REPORTS

**4.03** When an ICT changes from on-hook to off-hook, TOPR interprets this as a seizure and calls the dialing connections program (DCNT) to connect a digit receiver.

**4.04** When a trunk side ferrod of an OGT changes from on-hook to off-hook, this indicates answer or end of ringback. In either case, TOPR transfers to DCNT to take appropriate action.

### ON-HOOK REPORTS

**4.05** If an ICT is reported to be on-hook, there are several possible reasons. It may indicate disconnect, in which case the disconnect program DISC is called to release all equipment and registers currently associated with the call. Supervision is then restored on the ICT to detect new seizures. The on-hook report may also indicate either ring forward or double ring forward. If it is ring forward, the on-hook condition will last for approximately 100 milliseconds. For double ring forward there are two on-hook winks of 100 milliseconds each, separated by 275 milliseconds. TOPR determines which type of signal was received and transfers to the peripheral order buffer execution program to repeat the signal on the OGT.

**4.06** If an OGT is reported to be on-hook, it may indicate disconnect, in which case the call is then taken down by DISC. It may also indicate an initial toll report. In this case an on-hook is passed on to the ICT.

## 5. TRAFFIC SERVICE POSITION SYSTEM (TSPS) PROGRAM DESCRIPTION

### GENERAL

**5.01** The traffic service position system program (TSPS) processes signals for all calls which are routed to a traffic service position (TSP) or traffic service position system (TSPS). It analyzes on- and off-hook reports received on OGTs to the TSP or TSPS. These trunks may be expanded inband signaling (EIS) trunks or ordinary inband signaling trunks. These trunks are scanned at a fast (50 millisecond) rate. Examples of calls which are routed to a TSP or TSPS are:

- Person-to-person

- Collect
- Credit card
- Charge to third telephone
- Time and charge requests
- Coin calls requiring operator handling

In the following paragraphs the notation "TSP/S" will be used to indicate that an item applies to either a TSP or TSPS.

**5.02** TSPS has two main entry points from the scan point change director program (CHGD). TSPNDN is entered when a change in state from off-hook to on-hook is recognized on a trunk using ordinary inband signaling. TSPEIS is entered when an off-hook to on-hook change in state is recognized on an EIS trunk.

**5.03** With EIS, the TSPS program must perform timing to distinguish a TSP/S wink from a TSP/S disconnect, then take appropriate action. With ordinary inband signaling, the timing is not performed because signals from the TSP/S are already identified as either a wink or disconnect when the TSPS program is entered.

### PROCESSING OF ON-HOOK REPORTS

**5.04** If a line side on-hook longer than a hit is reported to TSPS, the on-hook is repeated to the TSP/S unless the customer has add-on service. If the customer has add-on service and the on-hook condition lasts for less than 1400 milliseconds, it is recognized as a flash and a transfer is made to the add-on program. If a customer with add-on service wants to flash to recall the operator, they may dial a "110" code after they get the add-on service dial tone to try to recall the operator. If the customer with add-on goes on-hook for longer than a flash, the on-hook is passed on to the TSP/S. If the customer does not have add-on service and the on-hook is only a momentary flash, then the off-hook following the on-hook is also repeated to the TSP/S. However, if the on-hook persists for longer than about 1.5 seconds, a subsequent off-hook will not be repeated until a wink signal has been received from the TSP/S.

**5.05** Disconnect is under control of the TSP/S. If the TSP/S goes on-hook for longer than a wink (approximately 100 milliseconds), a transfer is made to the disconnect program (DISC) to idle the path in memory and release the registers associated with the call.

**5.06** Figure 3 provides a functional flowchart of the processing done by TSP/S when it receives an on-hook report.

**SIGNALING**

**5.07** On a non-coin call using regular signaling, ringback is recognized as a wink from the TSP/S regardless of whether or not an MF signal follows. With EIS the wink must be followed by the proper MF signal. A valid ringback signal will not be recognized until the MF signal is received. Thus EIS eliminates the possibility of false detection of ringback.

**5.08** Ringback is the only valid inband signal from the TSP/S on a non-coin call. For coin calls,

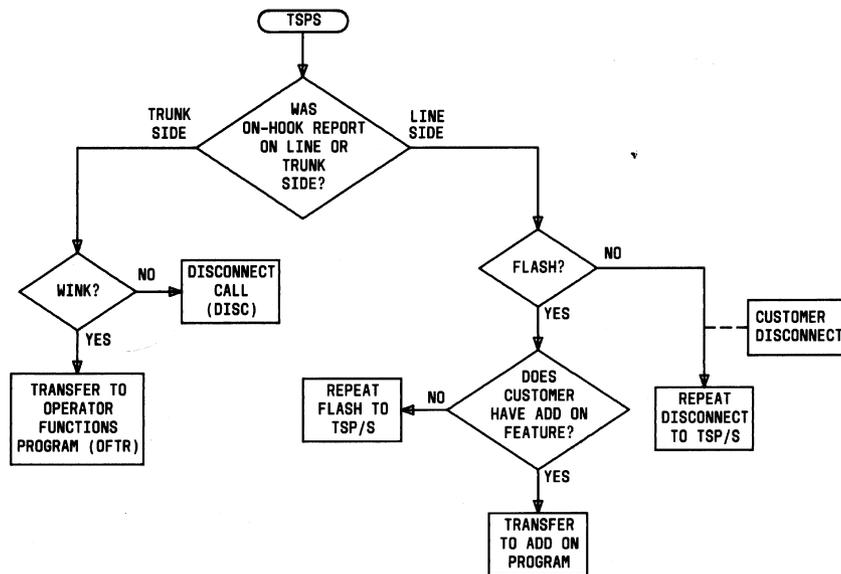
coin collect and coin return signals are also possible. EIS trunks provide additional signals. These additional signals include operator attached, operator released, and combined coin collect and operator released. All of these inband signals are sent as a wink which is normally followed by an MF tone.

**5.09** When a TSP/S wink is reported to the TSPS program, an operator register is seized and loaded with path information. Control is then passed to the operator functions program (OFTR) to process coin collect, coin return, or ringback, or the additional EIS signals.

**5.10** A traffic count is pegged each time an operator wink is detected to indicate that an operator function was requested.

**SIMULTANEOUS REPORTS**

**5.11** Occasionally TSP/S may receive reports on both the line side and trunk side almost simultaneously. When this occurs, the trunk side



**Fig. 3—TSPS On-Hook Processing—Functional Flowchart**

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report will be processed first. This gives the operator control over the call.

**PUT TRUNKS HIGH AND WET**

**5.12** TSPS also contains routines which process maintenance make busy signals on TSP/S trunks. If the maintenance ferrod on one of these trunks is found to be off-hook, the trunk is removed from the idle list and placed on the high and wet list until the make busy signal is removed. When a scan of the maintenance ferrod indicates that the make busy signal is no longer present, the trunk is removed from the high and wet list and restored to the idle list.

**5.13** For further software description of TSPS and related operator functions programs such as OFTR, see Reference (c) in Part 7.

**6. ABBREVIATIONS AND ACRONYMS**

CCIS	Common Channel Interoffice Signaling
CHGD	Scan Point Change Director Program
DCNT	Dialing Connection Program
DCT	Digital Carrier Trunk
DID	Direct Inward Dialing
DISC	Disconnect Program
EIS	Expanded Inband Signaling
ESS	Electronic Switching System
ICAL	Digital Analysis for Trunks Program
ICT	Incoming Trunk
ISXS	Step by Step Incoming Call Program
MF	Multifrequency
OFTR	Operator functions program—Toll Switch and Recording Completing

OGT	Outgoing Trunk
POB	Peripheral Order Buffer
PUC	Peripheral Unit Controller
RTI	Route Index
SPCS	Stored Program Control System
TAND	Tandem Connections Program
TOPR	Toll Operator Signaling Program
TSP	Traffic Service Position
TSPS	Traffic Service Position System
TSP/S	Applicable to either TSP or TSPS

**7. REFERENCES**

- (a) Section 231-045-105—Call Processing—POTS Software Subsystem Description
- (b) Section 231-045-115—Outpulsing Software Subsystem Description
- (c) Section 231-045-125—Operator Functions Software Subsystem Description
- (d) Section 231-090-095—Coip Features
- (e) Section 231-090-112—Feature Document Interface with Switchboards Feature
- (f) Section 231-090-114—Feature Document Interface with TSP and TSP 1A
- (g) Section 231-090-159—International Direct Distance Dialing Feature
- (h) Section 231-090-196—Operator Tandem Feature
- (i) Section 231-090-234—Operator signaling to and from the Toll Network
- (j) Section 231-090-372—Feature Document 2-Wire Toll/Tandem Operation Feature
- (k) Toll/Tandem PIDENTs—TAND, TOPR, TSPS

**Toll Diversion to Attendant Feature / #1A ESS**

AT&T PRACTICE  
SPCS

AT&T 231-090-321  
Issue 2, July 1984

**TOLL DIVERSION TO ATTENDANT  
FEATURE DOCUMENT  
1 AND 1A "ESS" SWITCH**

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<i>INCORPORATION INTO SYSTEM</i> . . . . .	6	SCOPE	
9. INSTALLATION/ADDITION/DELETION . . . . .	6	1.01 This practice describes the Toll Diversion to Attendant (TOLD) feature for the 1 or 1A ESS switch.	
10. HARDWARE REQUIREMENTS . . . . .	6	REASON FOR REISSUE	
11. SOFTWARE ENGINEERING . . . . .	6	1.02 Revision arrows are used to emphasize signifi- cant changes. This practice is reissued for the following reasons:	
12. DATA ASSIGNMENTS AND RECORDS . . . . .	7	(a) To provide coverage for the Carrier Intercon- nect (CI) feature	
13. TESTING . . . . .	7	(b) To delete references to inactive generic pro- grams	
14. ADVANCE PLANNING . . . . .	7		
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# Toll Diversion to Attendant Feature / #1A ESS

AT&T 231-090-321

(c) To make minor corrections.

## FEATURE AVAILABILITY

1.03 The TOLD feature is available in all active generic programs.

1.04 The CI feature is an optional feature group initially available with the 1E8 (1ESS switch) and 1AE8 (1A ESS switch) generic programs.

## 2. DEFINITION/BACKGROUND

### DEFINITION

2.01 With the *Toll Diversion to Attendant (TOLD)* feature, a toll call placed from a toll or code restricted centrex station is intercepted and routed to the attendant.

### BACKGROUND

2.02 The TOLD feature applies to calls such as direct distance dialing, message rate service, and code restricted calls originated from a centrex station that has been assigned some or total restriction on its calling ability.

2.03 Code restriction denies selected station lines completion of outgoing exchange network calls to selected office codes, area codes, and inter-LATA (local access and transport area) codes.

2.04 Toll restriction, a limited form of code restriction, permits station users to access the local central office and to dial local service area calls but prevents completion of toll calls or calls to the toll operator without the assistance of the attendant.

2.05 The TOLD feature provides the capability of diverting the calling station to the centrex group 'dial 0' attendant rather than connecting to reorder or to an announcement. Automatic diversion to the attendant allows the desired call to be properly handled without having to receive reorder or an announcement, go on-hook, and then initiate a call to the attendant. The TOLD feature minimizes system time and equipment usage to process a toll diverted (restricted) call to completion.

2.06 For the CI feature, code restriction was extended to inter-LATA codes. Implementation

of the inter-LATA carrier code restriction is the same as office and area code restriction.

## DESCRIPTION

### 3. USER PERSPECTIVE

#### CUSTOMER

3.01 The TOLD feature affects only centrex line originated Message Telecommunications System (MTS) toll calls. Calls over a nonrestricted access trunk (eg, tie trunk) are not toll restricted. If a user places an outgoing call to a *directory number (DN)* (intraoffice, interoffice, 3-digit service code) or inter-LATA carrier code (10XXX) that is restricted by direct dialing, the call is intercepted and routed to the centrex group "dial 0" attendant.

#### TELEPHONE COMPANY

3.02 Not applicable.

### 4. SYSTEM OPERATION

#### HARDWARE

4.01 Not applicable.

#### OFFICE DATA STRUCTURES

##### A. Translations

4.02 No unique translations are required for this feature. The TOLD feature relies on a combination of existing translations contained in the line equipment number (LEN) translations, rate and route translations, and the digit interpreter table translations for the centrex group.

4.03 Each line is associated with a chart column.

The chart column is obtained from the line equipment class 2 (LENCL 2) word. Based on the chart column and the first three or six digits dialed, screening and routing information is obtained in the form of the call indicator word (CIW) and supplementary call indicator word (SCIW).

4.04 Standard call screening (using the line's chart column, rate center, and the dialed digits) is used to identify toll calls that are to be toll diverted. Thus a line equipment number (LEN), which has toll restrictions, must use a chart column other than the

# Toll Diversion to Attendant Feature / #1A ESS

ISS 2, AT&T 231-090-321

chart column(s) used for lines that are not toll restricted. This may require a LEN auxiliary block; however, if several centrex group lines have similar toll restrictions, it may be possible (and advantageous) to use an abbreviated code.

**4.05** The codes which are toll restricted must yield (via the standard screening process) a SCIW which is contained in the chart class column table. The SCIW (Fig. 1) contains the treatment indicator (TRI). Toll diversion for a centrex line assigned the TOLD feature is indicated when TRI = 1.

**4.06** The digit 0 slot of the first centrex digit interpreter table (contained in the centrex common block) must contain an attendant DN (data type [DTYP] 6) or a timing entry (DTYP 1). The DTYP 1 and DTYP 6 words are shown in Fig. 2.

(1) The DTYP 1 word is a timing entry which contains the address of the next digit interpreter table. The DTYP 7 word provides critical timing (4 to 6 seconds) for the next digit after a variable number of digits are received.

(2) If a timing entry (DTYP 1) is used in the digit 0 slot of the first digit interpreter table, the digit 12 slot (end of timing) in the digit interpreter table pointed to by the DTYP 1 entry must contain a DTYP 6 entry.

(3) The DTYP 6 entry is used for routing calls to the attendant and contains the "dial 0" DN. The DTYP 6 entry also contains the override access restriction (OAR) item. The set OAR allows all stations, including fully restricted stations (originating major class = 16), to reach the "dial 0" attendant.

**B. Parameters/Call Store**

**4.07** The TOLD feature does not require any unique parameter words, set cards, registers, or call store areas. An originating register is used. A conference register is used if required.

**FEATURE OPERATION**

**4.08** A feature flow diagram of the operation of the TOLD feature is shown in Fig. 3.

**4.09** In centrex-type originating calls, all registers except the originating register (OR) and, if used, a conference register is released. The call is then treated as a "dial 0" call. Digit 0 is generated and stored in the OR; the digit count is reset to 1. The originating station call is routed to the attendant DN associated with digit 0 in the centrex digit interpreter tables.

**4.10** Calls from stations marked for toll diversion will be allowed to complete if the call is origi-

SCIW TYPE 1												
23	22	21	20	16		15	5		4	2	1	0
TRI			CHARGE INDEX				PREFIX					

**NOTE:**  
1. BIT 23 EXISTS IN 1A "ESS" SWITCH ONLY.

**LEGEND:**

- PREFIX - 0 AND 1 DIRECT DISTANCE DIALING PREFIX
- = 000 1 PERMITTED 0 NOT PERMITTED
- = 001 NEITHER PERMITTED
- = 010 BOTH PERMITTED
- = 011 0 PERMITTED 1 NOT PERMITTED
- = 100 1 MANDATORY 0 NOT PERMITTED
- = 110 1 MANDATORY 0 PERMITTED
- = 111 1 NOT PERMITTED 0 MANDATORY
- TRI - TREATMENT INDICATOR = 01 FOR BUSINESS

Fig. 1—SCIW for Toll Diversion

# Toll Diversion to Attendant Feature / #1A ESS

AT&T 231-090-321

DATA TYPE 1 ENTRY (DTYP - 001)

23	22	20	19	0
DTYP				ADDRESS OF NEXT INTERPRETER TABLE

DATA TYPE 6 ENTRY (DTYP - 110)

23	22	20	19	18	17	16	0
DTYP				OAR	DIRECTORY NUMBER		

**NOTES:**

1. BIT 23 EXISTS IN 1A "ESS" SWITCH ONLY.
2. DATA TYPE 1 IS USED ONLY FOR TIMING WHEN A TIMING CONFLICT CAN OCCUR.

**LEGEND:**

- DTYP - DATA TYPE
- OAR - OVERRIDE ACCESS RESTRICTIONS. WHEN OAR = 1, ALL ATTENDANT ACCESS RESTRICTED CALL TERMINATE TO ATTENDANT

**Fig. 2—Centrex Digit Interpreter Table Entries Used With TOLD**

nated through a centrex group attendant position as determined by the attendant originating major class. The centrex group attendant position may be equipped with any type of console used for either the 50A or 51A Customer Premises System (CPS).

### CHARACTERISTICS

**5. FEATURE ASSIGNMENT**

**5.01** The TOLD feature is provided on a per line basis.

**6. LIMITATIONS**

**6.01** When a call is toll diverted to an attendant console, no special *call indicator lamp (CIL)* will be lighted on the console to indicate toll diversion. Since the toll diverted call is regenerated as a "dial 0" call, the CIL associated with regular "dial 0" calls will be lighted. However, if intragroup calls to the attendant require a code other than 0 (eg, extension 3091), two different CILs could be lighted, one for regular calls and one for toll diverted calls.

**6.02** When arranging the dialing pattern for a centrex group using the TOLD feature, the digit 0 slot in the first level centrex digit interpreter table (contained in the centrex common block) must contain either an attendant DN entry (DTYP = 6) or a timing entry (DTYP = 1). A timing entry is required only if a conflict can exist involving the digit 0.

**6.03** Outgoing MTS toll calls originating from a tie trunk (for local network access) cannot be toll diverted. However, existing means of restricting stations from completing calls over a tie trunk can be used (eg, station being restricted from dialing tie trunk access code). These calls will be intercepted and routed to reorder or to a recorded announcement.

**7. INTERACTIONS**

**STATIC**

**7.01** Not applicable.

**DYNAMIC**

**7.02** With the TOLD feature, if a customer station user dials a call using a customer dialed ac-

# Toll Diversion to Attendant Feature / #1A ESS

ISS 2, AT&T 231-090-321

BUSINESS CUSTOMER - CO LINE ORIGINATED "DIAL 9"  
TOLL CALL TO AN INTRA-OFFICE, INTER-OFFICE DN,  
OR 3-DIGIT SERVICE CODE

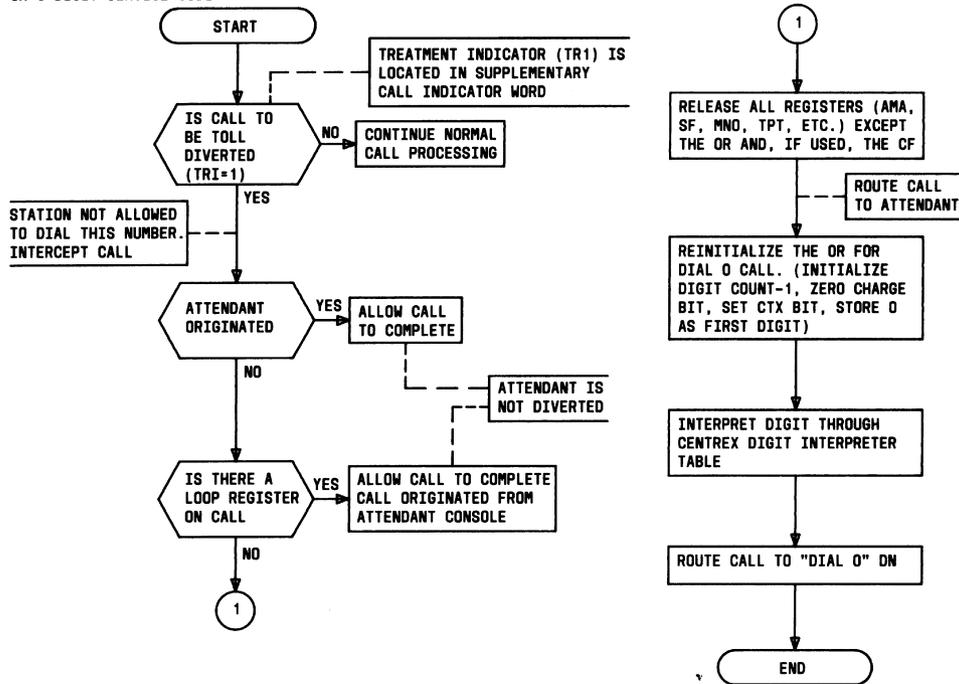


Fig. 3—TOLD Feature Flow Diagram

count recording (CDAR) access code, the call is allowed to continue without being diverted to the attendant.

**7.03** The TOLD feature operates with other features applicable to the "dial 0" attendant. For example, attendant calls can be queued. If the toll diverted call is to be completed to a busy attendant position with the queue option, the call is placed on queue. If the queue is full, the originating station receives busy treatment. If "dial 0" attendant position is on night service, the call is routed to the night DN. If the "dial 0" attendant position has calls forwarded (variable), the call is terminated to the remote station.

**7.04** If simulated facilities are used on MTS calls from the centrex group, the chart class column of the screening LEN associated with the *simulated facilities group (SFG)* can be used for screening purposes. The LEN expansion will yield the chart class column. This will cause restrictions to be placed on all stations using the SFG for screening.

## 8. RESTRICTION CAPABILITY

**8.01** Not applicable.

## Toll Diversion to Attendant Feature / #1A ESS

AT&T 231-090-321

### INCORPORATION INTO SYSTEM

#### 9. INSTALLATION/ADDITION/DELETION

9.01 The TOLD feature can be added, changed, or deleted for a line by using the recent change messages described in Part 12. Refer to Part 13 for testing.

#### 10. HARDWARE REQUIREMENTS

10.01 Not applicable.

#### 11. SOFTWARE ENGINEERING

##### MEMORY—1A "ESS" SWITCH

11.01 Software engineering data is provided herein for program stores (PS), unduplicated call stores (UCS), duplicated call stores (DCS), and file stores (FS), or where applicable (with 1AE7 and later), the Attached Processor System (APS).

##### A. Base Generic Program (PS and FS or APS)

11.02 The TOLD feature requires approximately 80 words of memory whether or not the feature is used.

##### B. Optionally Loaded Feature Packages (PS and FS or APS)

11.03 Not applicable.

##### C. Parameters (UCS and FS or APS)

11.04 Not applicable.

##### D. Call Store Requirements (DCS)

11.05 Not applicable.

##### E. Translations (UCS and FS)

11.06 A line may require additional translation words if some of its toll calls are to be diverted. For example, if a station's LEN translation could normally be abbreviated, the line may now require a LEN auxiliary block (three words minimum) to contain its individual chart column. If more chart column numbers are used, additional chart column subtranslators are required.

##### MEMORY—1"ESS" SWITCH

##### A. Base Generic Program (PS)

11.07 The TOLD feature requires approximately 60 words of memory whether or not the feature is used.

##### B. Optionally Loaded Feature Packages (PS)

11.08 Not applicable.

##### C. Parameters (PS)

11.09 Not applicable.

##### D. Call Store Requirements

11.10 Not applicable.

##### E. Translations (PS)

11.11 A line may require additional translation words if some of its toll calls are to be diverted. For example, if a station's LEN translation could normally be abbreviated, the line may now require a LEN auxiliary block (three words minimum) to contain its individual chart column. If more chart column numbers are used, additional chart column subtranslators are required.

##### REAL TIME IMPACT

11.12 The TOLD feature requires approximately 450 cycles (1ESS switch) or 900 cycles (1A ESS switch) more than a "dial 0" call and the digit analyzed. If digit 0 is associated with a DTYP = 1 (timing entry), approximately 300 cycles (1ESS switch) or 600 cycles (1A ESS switch) are also added to the call. Additional cycles may be consumed because of features applicable to the attendant DN (call forwarding is active, queuing is required, etc).

11.13 Cycle time for the 1A ESS is 0.7 microsecond. Cycle times for the 1ESS switch are 5.5 microseconds (no clock speedup) or 5.0 microseconds (10 percent clock speedup).

**12. DATA ASSIGNMENTS AND RECORDS**

**TRANSLATION FORMS**

**12.01** The following translation forms provide information for the TOLD feature:

(a) **ESS 1109—Centrex Group Record:** This form record provides centrex class information and screening and routing data for a centrex group. This data is used to build the centrex common block of translations which contains the first digit interpreter table. Of the data types (DTYP) contained in the first digit interpreter table, DTYP 1 and DTYP 6 are applicable for TOLD. For "dial 0" attendant calls, the attendant DN and data type entries must be shown.

(b) **ESS 1304—Rate and Route Chart:** This form is used to provide screening instructions for the routing of calls. Every line class code assigned on ESS 1306 is assigned to chart and column on ESS 1304 to provide screening instructions, charging conditions, and routing of calls.

(1) For the TOLD feature, the mnemonic for reverse battery (REVB) must be entered under the special route index for the appropriate screening code of the established chart and column. A treatment indicator equal to 1 indicates REVB. This treatment indicator (TRI = 01) causes the originating line to be diverted to the attendant for the TOLD feature.

(2) The appropriate 3-digit charge index is entered. Charge index 017 is standard in all offices for detail billing. Charge index 000 is standard in all offices for free calls. Charge indexes 001-016 are used for message rate service.

(3) Access codes of 1 and 0 (for direct distance dialing screening) are given as M (mandatory) and P (permissive).

(c) **ESS 1306—Line Class Code Record:**  
This form is used to assign a class of service for each subscriber line. A unique class code is established for each set of variations in charging, routing, and screening being provided in an office. Associated with a given class code entry are chart class assignments and major class codes. The appropriate chart and column class assignments (es-

tablished on ESS 1304) and assigned originating and terminating major class are entered.

**RECENT CHANGES**

**12.02** Recent change messages affected by the TOLD feature are as follows:

MESSAGE	FUNCTION
RC:LINE	Recent change messages for lines are used for adding or changing nonmultiline hunt and multiline hunt lines. The centrex major class and chart column data used for TOLD are entered by this RC line message. See reference A(3) in Part 18 for details.
RC:CTXDI	Builds centrex digit interpreter table entries for DTYP = 6 and DTYP = 1. See reference A(2) in Part 18 for details.
RC:CCOL	Used to set TRI bits. See reference A(1) in Part 18 for details.

**13. TESTING**

**13.01** The following TTY input and output messages, referenced in Part 18B, can be used to verify the TOLD feature.

(a) VFY-XDGNT—This input message is used to verify the centrex digit interpreter table entry for TOLD. The system response should be a TR18 output message.

(b) VFY-LEN—This input message is used to verify the TOLD feature for the line. The system response should be a TR03 output message.

**13.02** Test calls are made to verify that TOLD is operating properly. For test calls, no special CIL is lighted on a centrex group attendant console to indicate the call is being diverted.

**14. ADVANCE PLANNING**

**14.01** Not applicable.

# Toll Diversion to Attendant Feature / #1A ESS

AT&T 231-090-321

## ADMINISTRATION

### 15. MEASUREMENTS

15.01 There are no specific traffic measurements for TOLD. However, existing traffic counts for centrex calls (eg, count for "dial 0" calls to the attendant) are scored.

### 16. CHARGING

#### AUTOMATIC MESSAGE ACCOUNTING

16.01 No charges will be made on a MTS toll call intercepted and routed to the attendant. All registers except the originating register and conference register (if used) are released. If, however, calls to the "dial 0" DN require charging (eg, the "dial 0" DN has call forwarded to a chargeable DN), a new AMA register will be seized and the appropriate charges made.

## SUPPLEMENTARY INFORMATION

### 17. GLOSSARY

17.01 Not applicable.

### 18. REFERENCES

18.01 The following documentation pertains to or is affected by the TOLD feature.

#### A. AT&T Practices

- (1) 231-048-304—ARS, CCOL, CHRGX, DIGTRN, DITABS, DNHT, IDDD, IWSA, NOCNOG, NOGRAC, RATPAT, RI, RLST, TDXD, and

TNDM—Rate and Route Recent Change Formats (1E6/1AE6 and 1E7/1AE7 Generic Programs)

- (2) 231-048-309—CTXCB, CTXD1, CTXEXR, CXDICH, DITABS, DLG, FLXDG, FLXRD, and FLXRS Centrex-CO/ESSX-1 Recent Change Formats—(1E6/1AE6 and 1E7/1AE7 Generic Programs)

- (3) 231-048-312—ESS Service Order RC Formats—1E6 and 1E7 or 1AE6 and 1AE7 Generic Programs

- (4) 231-090-120—Carrier Interconnect Feature

- (5) 231-090-400—Feature Document Single Digit Dialing Feature.

#### B. TTY Input and Output Manuals

- (1) Input Message Manual IM-1A001—1ESS

- (2) Output Message Manual OM-1A001—1 ESS

- (3) Input Message Manual IM-6A001—1A ESS

- (4) Output Message Manual OM-6A001—1A ESS.

#### C. Other Documentation

- (1) Translation Guide—TG-1A

- (2) Translation Output Configuration PA-591003, 1ESS

- (3) Translation Output Configuration PA-6A002, 1A ESS.

# GBPPR Homebrew Radar Experiment

## Pulse Modulator

### Overview

While not the most electrically complicated section of a radar system, the pulse modulator is the one section I am not really sure about, and should still be considered *very* experimental.

The pulse modulator is essentially a system which charges a Pulse-Forming Network (PFN) up to a certain high-voltage, 2 kV in our case, and then quickly "grounds" the PFN's positive terminal through the primary winding on an external pulse transformer. This is done using some type of controllable high-speed switch, usually a hydrogen thyratron tube. The generated high-voltage pulse is what is eventually used to "fire" the magnetron, causing it to emit a RF pulse equal to the PFN's delay time, 1  $\mu$ S for our example.

Most commercial radars use a high-voltage thyratron trigger (5C22) or even spark gaps to rapidly discharge the PFN, but thyratrons are getting to be difficult to locate and can be quite expensive. For our modulator, we'll be using common high-voltage Insulated Gate Bipolar Transistors (IGBT), which are available from places like Mouser or Digi-Key for only a few dollars a piece. Two IGBTs will need to be used in series to equal the required stand-off operating voltage (2,000 volts) for our modulator. Single high-voltage IGBTs or IGBT blocks are available, and would be much easier to work with, but are still very expensive. A gate-drive transformer will be required to trigger both the IGBTs at the same time and to also provide the proper high-voltage isolation. Because of the voltage difference across the two IGBTs, you won't be able to use a single gate-drive circuit with a common ground.

The proper IGBT gate-drive circuit is the part of the system I had the most trouble with, and what is shown should be considered just a starting point. The key is getting the two IGBTs to fire at the same time – when you want them to – and with the proper high-voltage isolation. From experience, the two series transistors will require parallel resistors to "share" the voltage load across each of them so the transistor with the lowest leakage current won't be forced into avalanche mode, which can destroy it. Series resistor/capacitor snubbers will also be added across the transistors to help protect the transistors from transients if they both don't switch on time.

The IGBTs used here (ST Electronics STGF3NC120HD N-channel, 3A/1,200V) have an internal damper diode. These internal diodes will serve an important purpose for our radar application. If the impedance of the PFN and the pulse transformer's primary are not matched, a residual voltage charge can be left on the PFN during the discharge cycle. This residual voltage charge can distort the overall shape of next pulses or can even cause the magnetron to misfire or change frequency. The "reverse diode" in the IGBT will help to completely discharge the PFN after each pulse, thus allowing the PFN to be recharge to the same voltage potential for each pulse.

A *real* radar pulse modulator uses a "resonant" inductor/capacitor circuit to charge the PFN. A large inductor is added in series with the PFN charging line to resonate with the overall capacitance of the PFN at *half* the operating pulse frequency. The idea is to "add" the inductor's stored DC high-voltage charge onto the PFN's voltage. This is done because a PFN circuit outputs only *half* of its charging voltage, and this is a simple trick to get a voltage boost without requiring any more costly windings on the magnetron's pulse transformer secondary. Because of the low PFN operating frequency, the required value of this series charging inductor can be very high. A *five*

henry inductor would be required for the circuit we're building here, assuming a 2,000 Hz Pulse–Repetition Frequency (PRF). Some commercial radars have charging inductors with values of 30 henries or more. We'll just be using a series 88 mH torroid inductor (mostly as a RF choke) to protect the high–voltage power supply from induced spikes. The series charging diode also protects the power supply during the discharge cycle and allows for changing the modulator's pulse–repetition frequency when using a resonant DC charging network.

### **Pulse Modulator Operation**

A positive–going +5 volt input trigger (**TRIG**) signal causes a 2N2222A transistor to "pulse" the primary of the gate–drive transformer to ground. The primary winding is charged with a voltage of +24 VDC. This induces a positive–going signal of around 12 volts into the two transformer secondary windings, which in–turn feed the two IGBT's gate pins. A series 10 ohm resistor and a 33 volt TVS protect the IGBT's gate input from any overvoltage conditions. The IGBT is now "turned on" and there is a discharge path to ground for the high–voltage (2 kV) on the PFN. Current can now flow through the pulse transformer's primary winding – which we haven't made yet!

The PFN discharge develops a positive–going rectangular pulse in the pulse transformer's primary winding. When properly impedance matched, the pulse's amplitude will be equal to nearly half (1 kV) the charging voltage (2 kV) on the PFN. Also, the pulse width should be equal to *twice* the PFN's designed delay time (1  $\mu$ S).

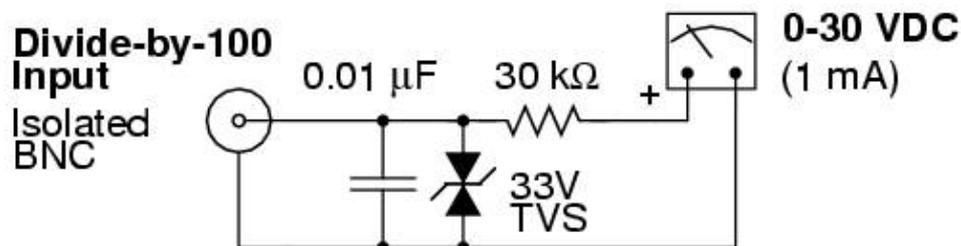
The pulse transformer is used to convert this high–voltage pulse to a negative–going one which is applied to the magnetron's cathode. The magnetron will emit a RF pulse for the duration of this voltage pulse. However, when the magnetron oscillates, it will cause an impedance mismatch between the pulse modulator circuit and magnetron as it goes in–and–out of resonance. Hence, a small negative voltage pulse is reflected back into the pulse transformer's primary winding. This reverse current will ever slightly re–charge the PFN.

The internal "reverse–current" diodes in the IGBTs will now conduct, draining this residual charge off the PFN. This action should help to keep the PFN's voltage constant from pulse–to–pulse.

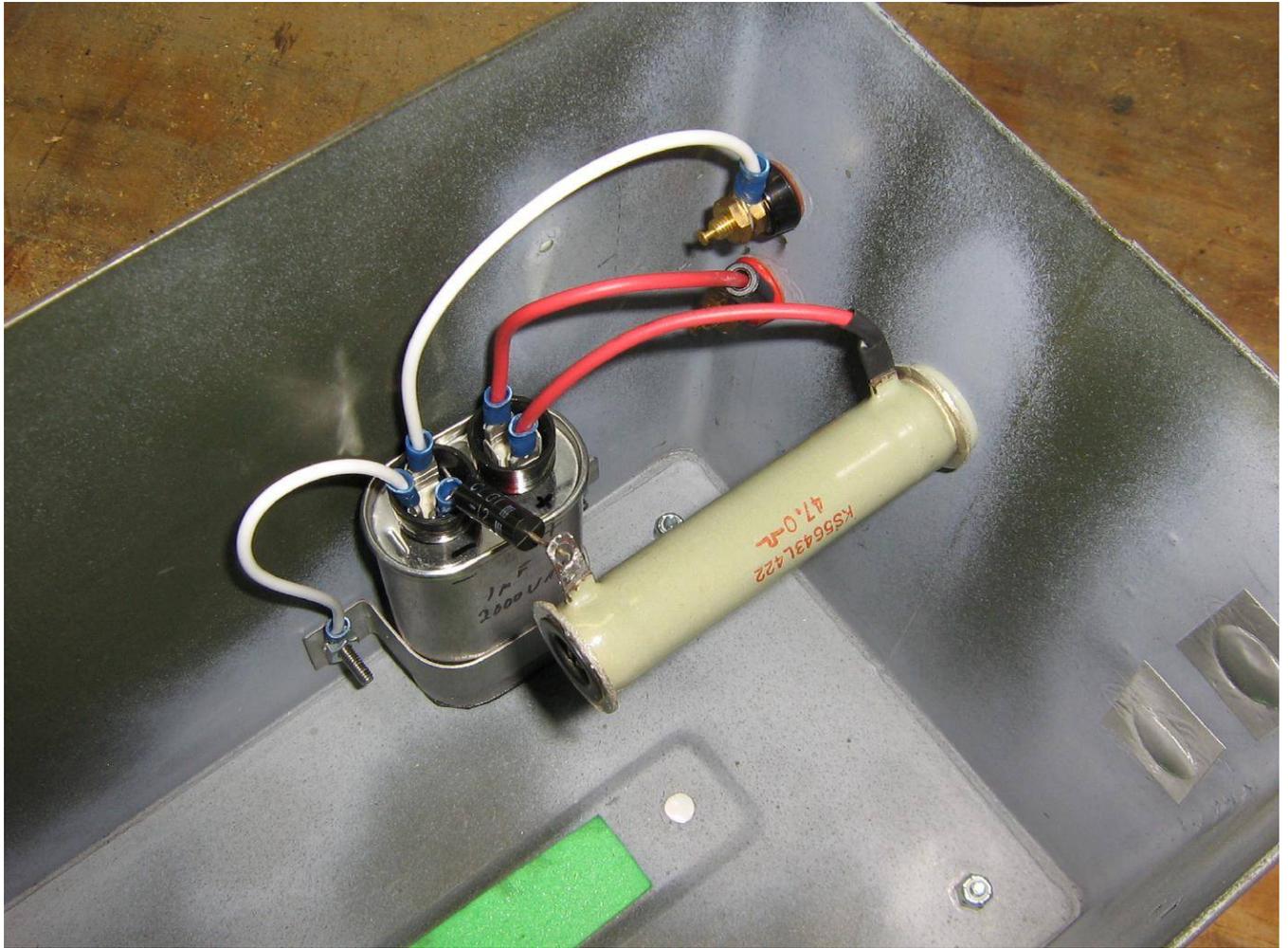
When the PFN completely discharges, the IGBT's are turned off and the charging cycle starts all over again. The IGBTs are triggered at the required radar pulse–repetition frequency. Only the component values of the PFN are used to determines the radar's overall pulse width.

### **High–Voltage DC Meter**

This is an optional meter which can be added to the modulator's project case to monitor the high–voltage input level. The meter is an analog 0–30 VDC meter which uses the "divide–by–100" output from the high–voltage power supply as the input. The meter has a standard 1 mA movement and a series 30 kohm or (33 kohm) resistor. A 33 volt TVS and 0.01  $\mu$ F capacitor remove any voltage spikes or RF interference. The meter also uses an (optional) isolated BNC jack to avoid any ground loops.



## Pictures & Construction Notes

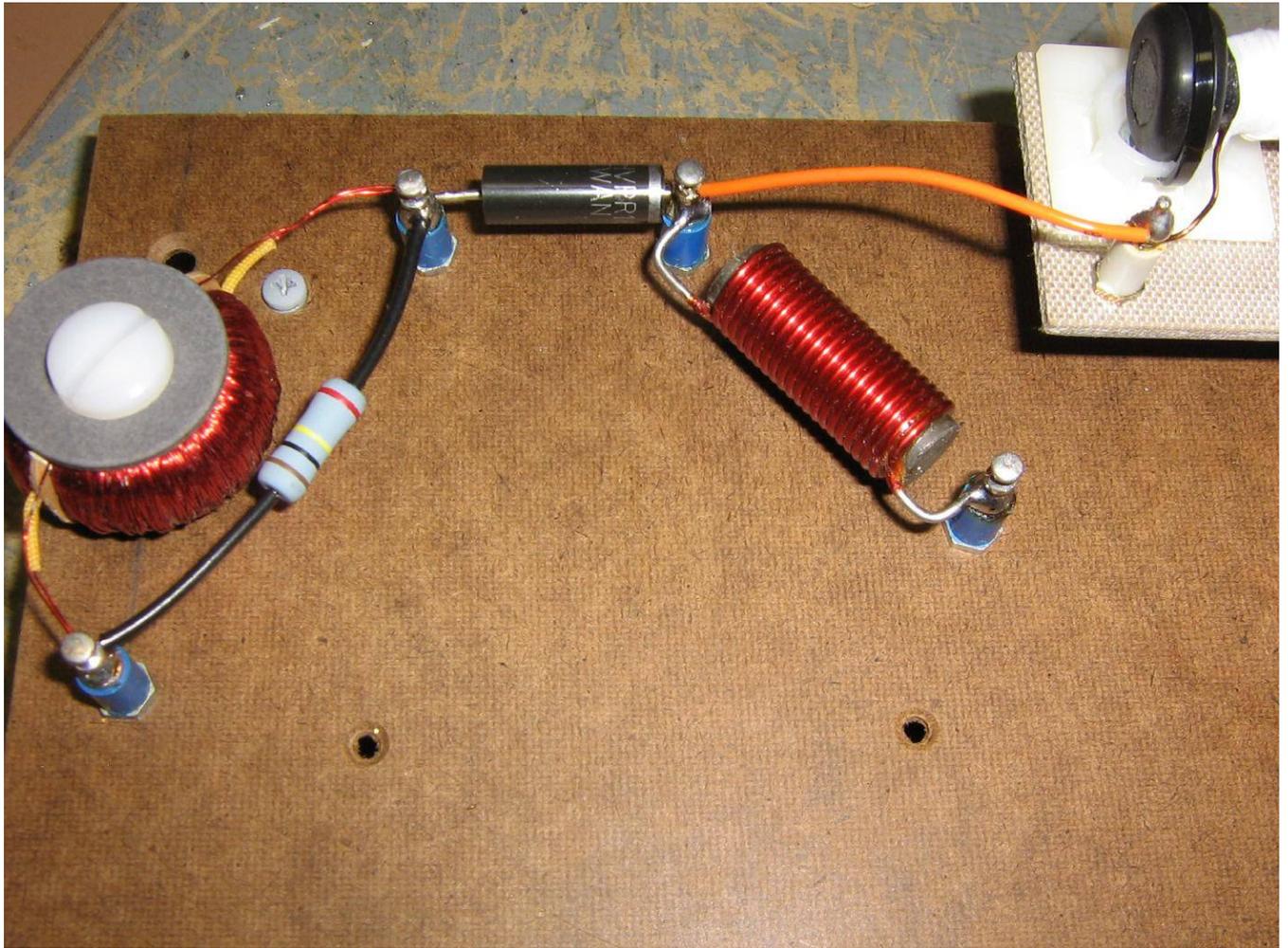


Overview of the pulse modulator's high-voltage DC input to the ammo box we'll be using for the project's case.

The input is via a pair of insulated banana jacks.

The  $1\ \mu\text{F} / 2\ \text{kV}$  capacitor is from an old microwave oven. The protection high-voltage diode is also from an old microwave oven. Note one of the capacitor's terminals is used as a common ground point which is then connected to the metal project case.

The high-power series 47 ohm resistor is probably optional, but will help to protect the high-voltage power supply in case anything short circuits.



Overview of the PFN charging network.

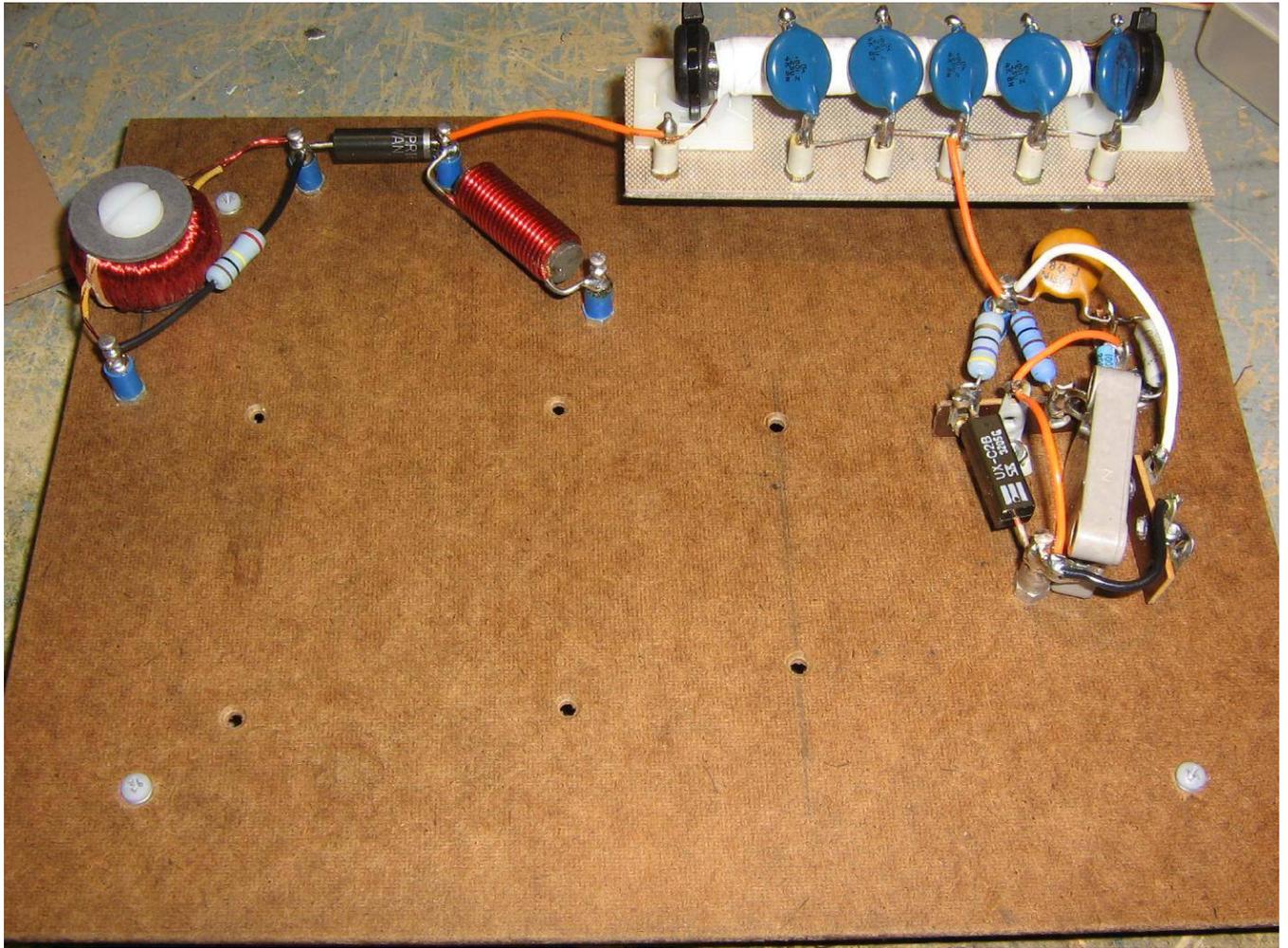
The positive 2 kV DC input comes in on the solder terminal on the lower-left.

The 88 mH charging inductor is the big red donut on the left. A 100 kohm parallel resistor is used to "de-Q" the inductor. Not sure if that resistor is required or not.

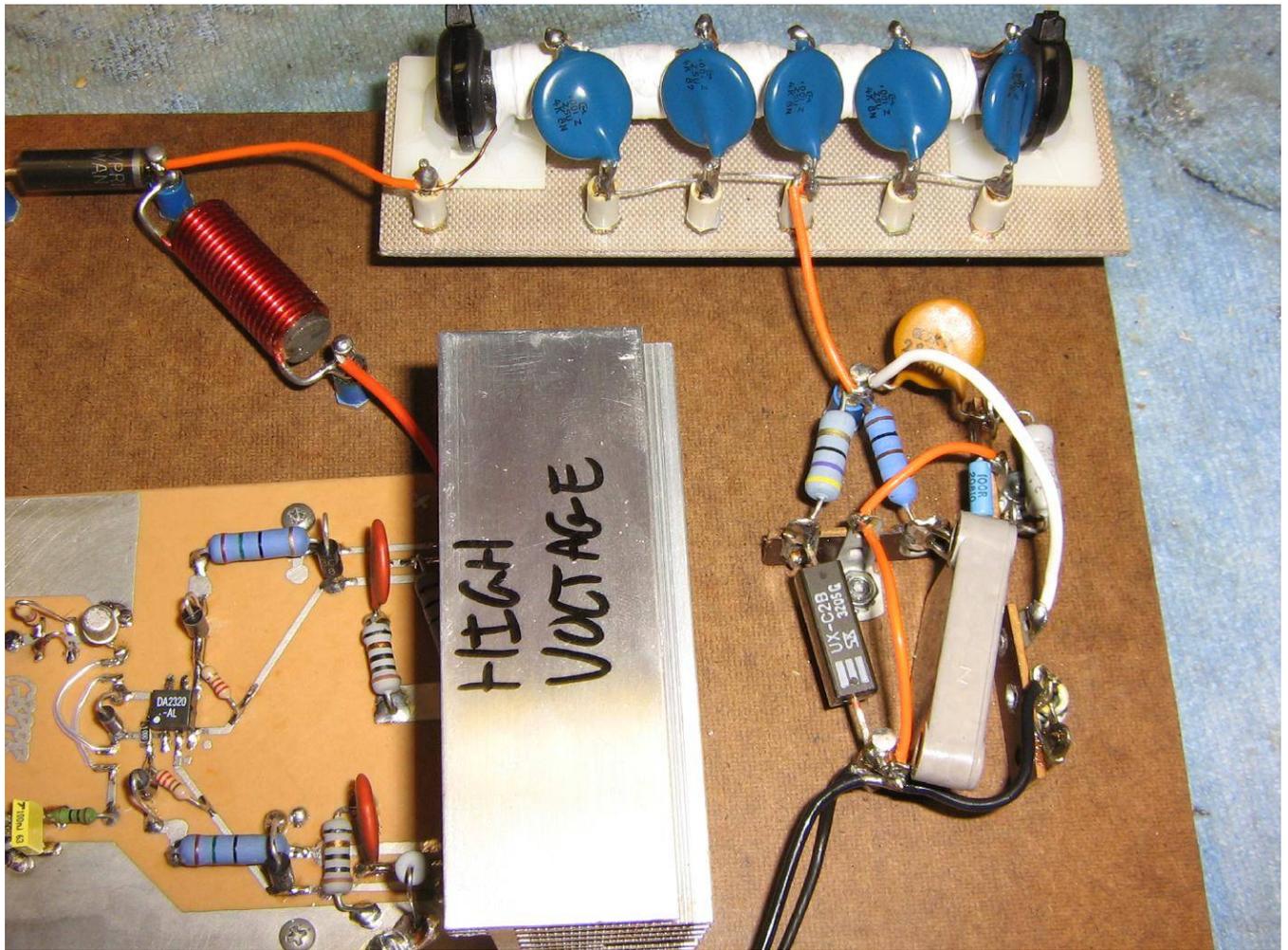
The series high-voltage diode is a HVPR16-06, or any voltage-doubler diode from an old microwave oven should work.

The large red coil on the right is a 10  $\mu$ H inductor used to help tame the large current spike when the PFN discharges through the IGBTs, and is probably also optional.

The circuit board for this pulse modulator is built onto the fiberboard base from an old clipboard and most of the connections will be made using solder terminals. This is to help with high-voltage isolation and to make component changes much easier.



Overview of the input charging network, the PFN, and the output pulse circuit.



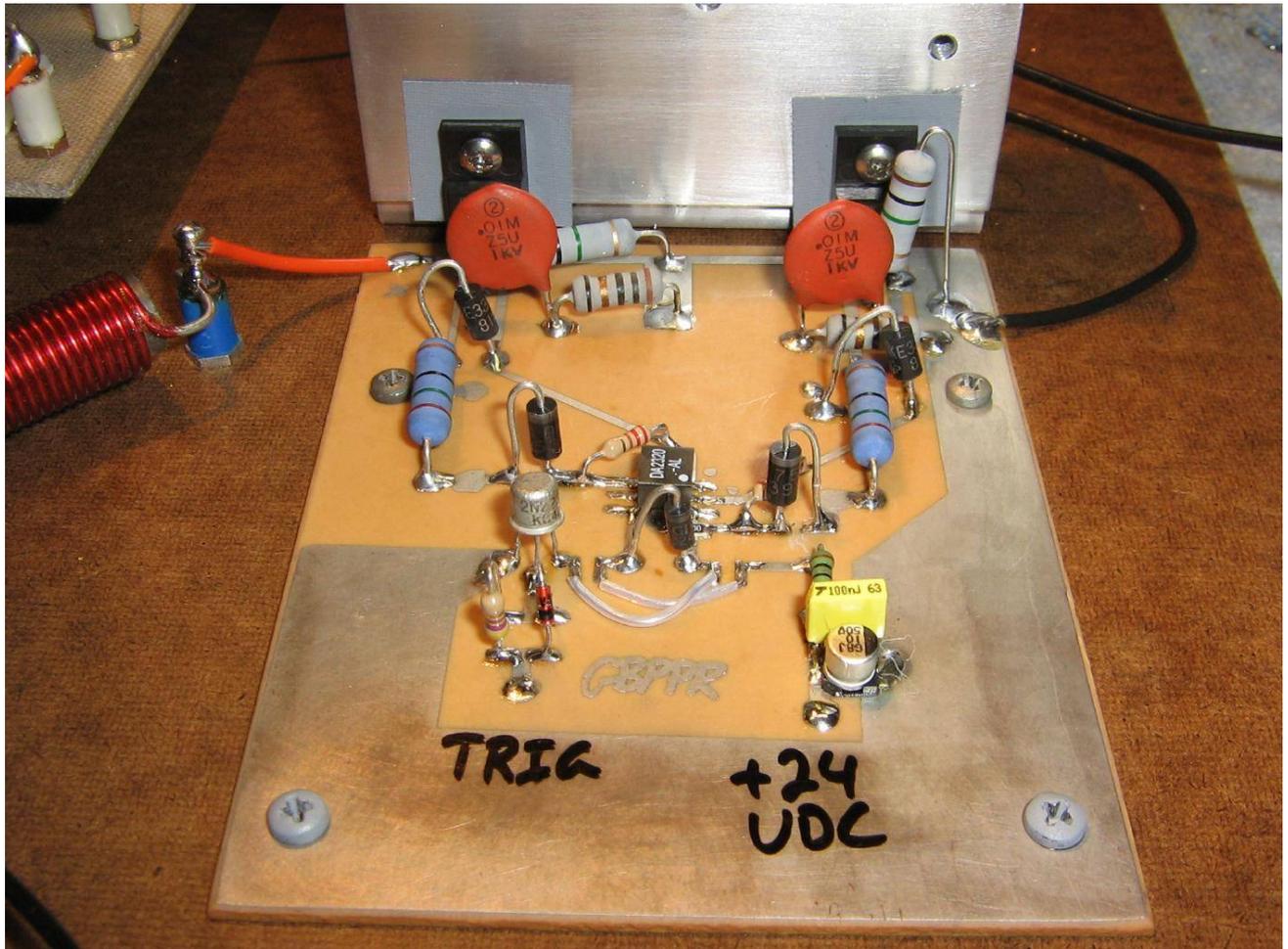
Close up picture of the output pulse circuit with the IGBT circuit (on the lower-left) now in place.

The series 100 ohm / 1,000 pF capacitor combination act as a surge de-spiker in case of an impedance mismatch with the magnetron. This can cause a large voltage "spike" from the pulse transformer.

The high-voltage diode is used as a "tail clipper" to clean up the shape of the final output voltage pulse. The series 47 ohm resistor is used to tame current spikes in the diode. The diode used here is a UX-C2B, or any voltage-doubler diode from an old microwave oven should work.

A series 220 pF high-voltage capacitor is used along with a 1,000 ohm resistor and 5.1 volt Zener diode to form an optional "pulse monitoring" circuit.

The final output pulse is via the **WHITE** wire on the left, with the **BLACK** wire being the common ground.



Overview of the two series ST Electronics STGF3NC120HD N-channel IGBTs and their gate-drive circuitry.

This is the section of the modulator which is still experimental.

The 2 kV DC input to the IGBTs is from the **ORANGE** wire on the left. The **BLACK** wire on the right is a common ground.

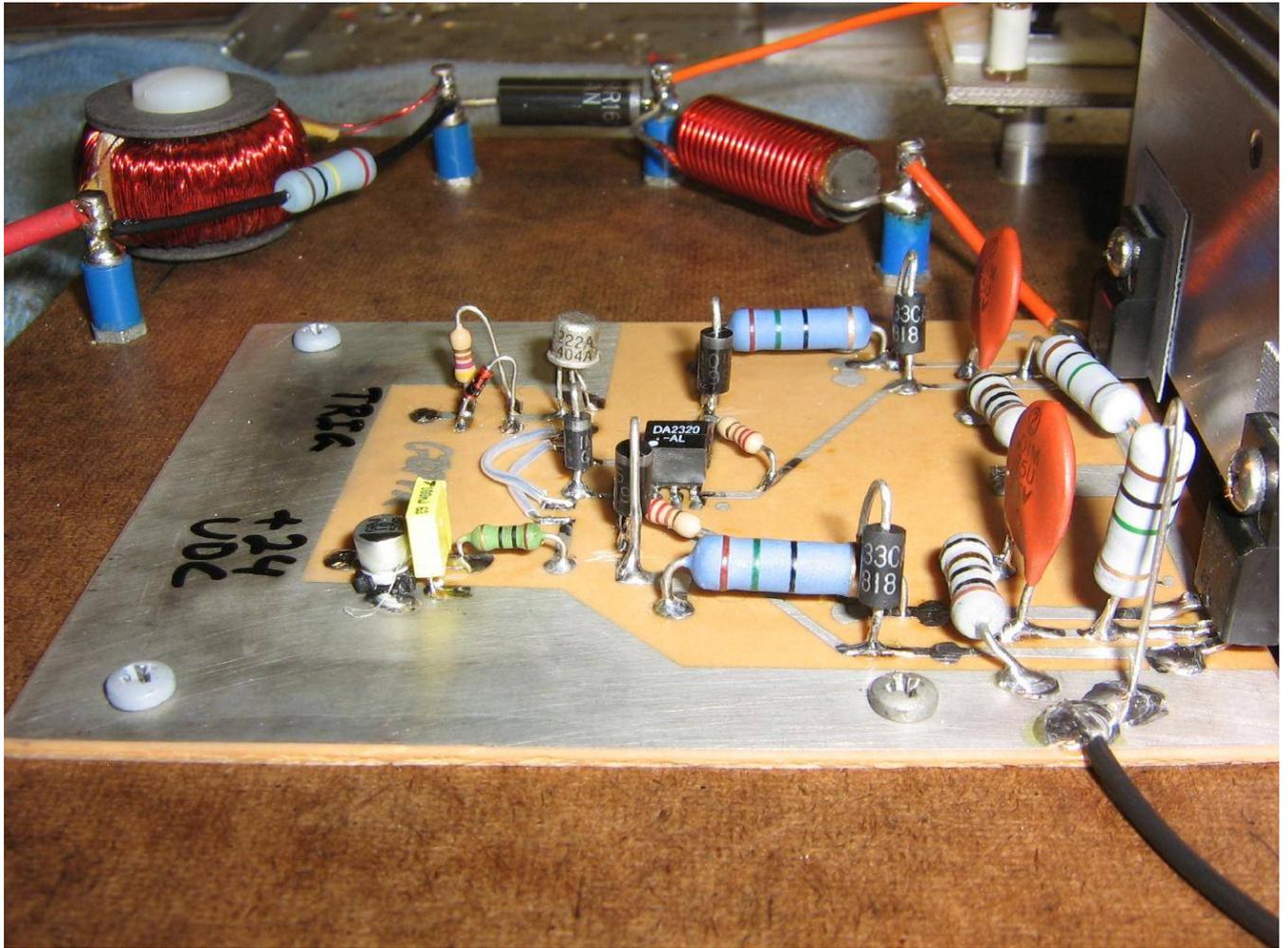
The +24 VDC for the gate-drive transformer's primary is on the lower-right. The trigger input to the 2N2222A is on the lower-left.

The little black box in the middle of the IGBTs is a Coilcraft DA2320 gate-drive transformer with a 1:1:1 turns ratio between the primary and secondary windings. This transformer is necessary to make sure the two IGBTs fire at the same time and provides proper high-voltage isolation. This transformer is a *must*. You can make your own using a ferrite core and some enameled wire. Google "gate-drive transformers" for a lot more information on doing that.

The two 15 ohm (should be 10) resistors go to the gate's on the two IGBTs. A 33 volt TVS clamps any voltage spikes on the gate-drive signal to protect the IGBTs.

The capacitors and resistors across the two IGBTs help to equalize the high-voltage across the two IGBTs so one isn't "triggered" before the other.

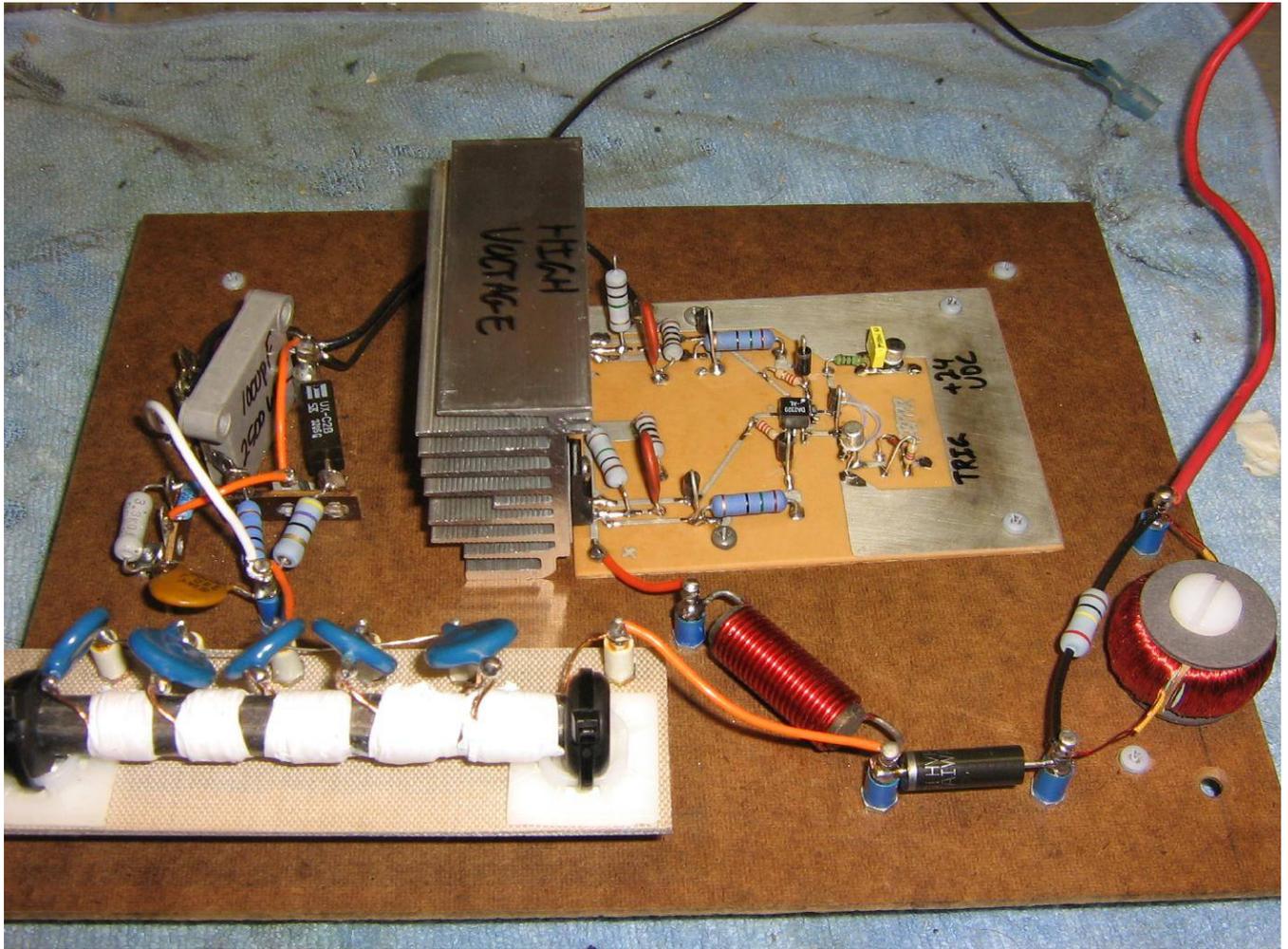
The schematic and the above picture don't follow each other due to constant re-working.



Alternate view of the gate-drive circuits.

I originally had series diodes and loading resistors on the gate-drive transformer's output, but this seemed to distort the output signal.

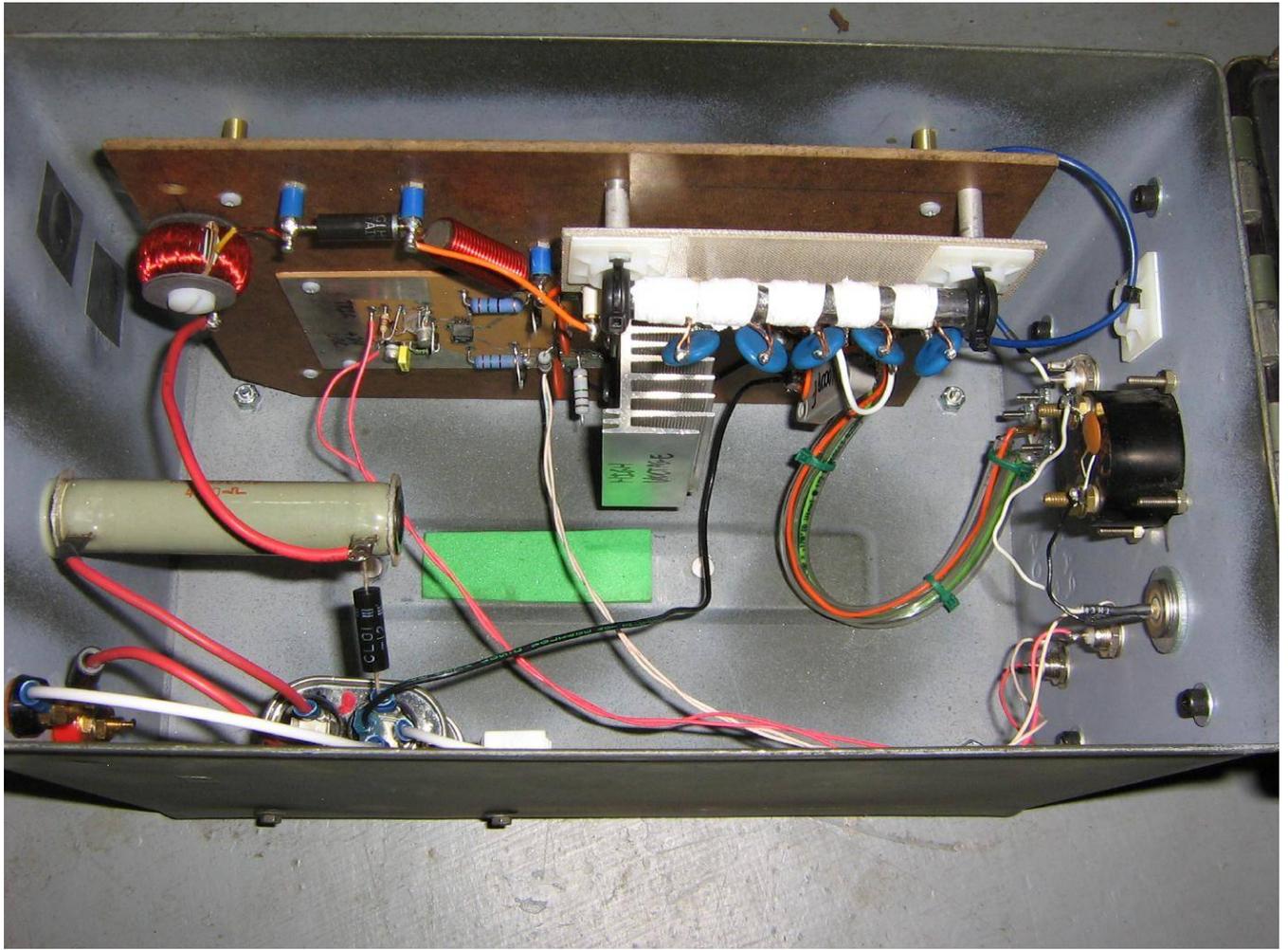
You need a fast, clean square wave pulse-drive on the IGBT's gate for proper modulator operation, and so you can quickly re-charge the PFN after each pulse firing.



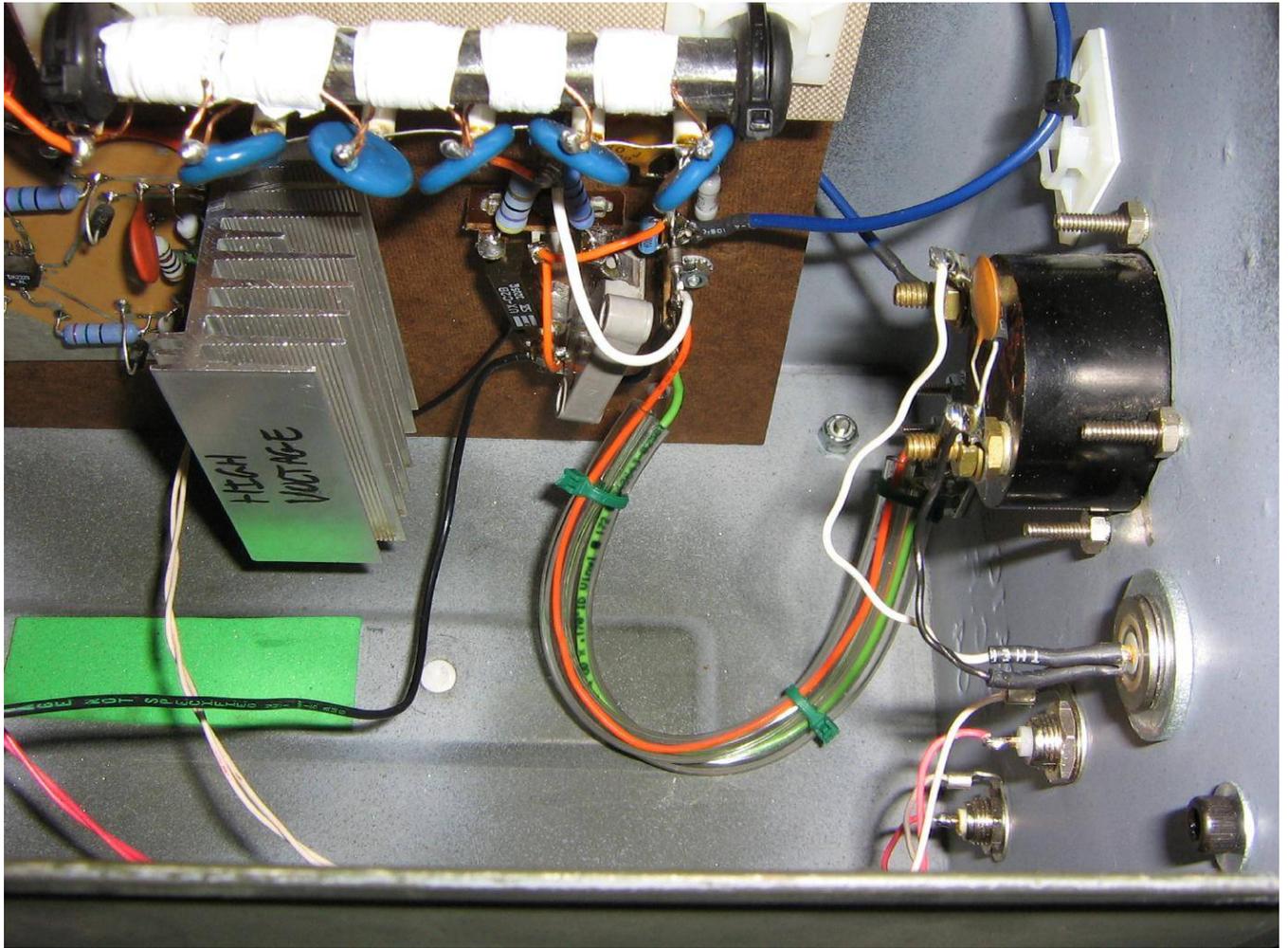
Overall view of the completed pulse modulator circuit.

The heatsink is isolated from ground, and probably overkill. The peak current through the IGBTs with this PFN and voltage is only around 10 Amps. The heatsink will help the pulse current handling of the IGBTs, but if not properly isolated, can arc from the high-voltage.

The IGBTs should have been mounted horizontally for a simpler layout design.



Overview of the pulse modulator's case.



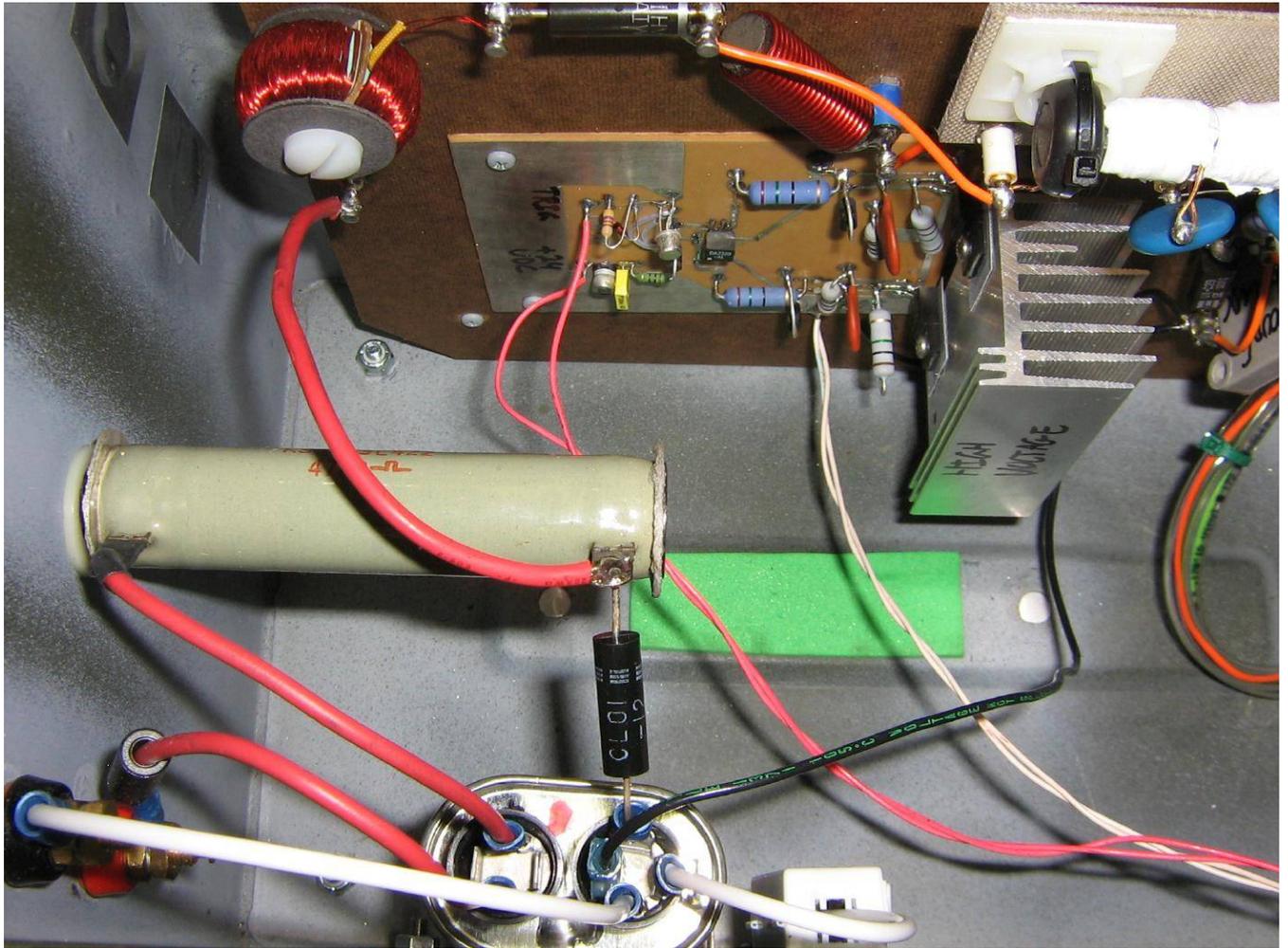
Close up of the pulse output connection.

The output is via the **ORANGE** wire and goes to the center pin on a panel-mount SO-239 connector. The **GREEN** wire is a common ground. Vinyl tubing is used to increase the high-voltage isolation on the output wiring.

The pulse modulator's output will be sent to the magnetron's pulse transformer via some RG-62 (93 ohm) coax. This will be covered in an upcoming article.

The **BLUE** shielded wire is the output of the optional pulse monitor.

The high-voltage metering, the +24 VDC input, and the pulse trigger connections (from top-to-bottom) are via the BNC connectors on the lower-right.



Close up of the high-voltage DC input network.

The positive for the 2 kV DC line is the via the **RED** banana jack.

The 1  $\mu$ F microwave oven capacitor is on the bottom and has some ferrite beads on the positive and ground leads.

The big green cylinder is the series 47 ohm / 50 watt resistor.

The input protection diode is a CL01-12, or any voltage-doubler diode from an old microwave oven should work.

Be sure to follow proper high-voltage construction techniques when building this circuit.



Finished outside case overview.

The high-voltage input monitoring meter is located in the top-center. Its "divide-by-100" input is via the female isolated BNC connector next to it marked "**HV**".

The **Trigger Input** is via the bottom female BNC connector on the lower left-side, marked "**TRIG**".

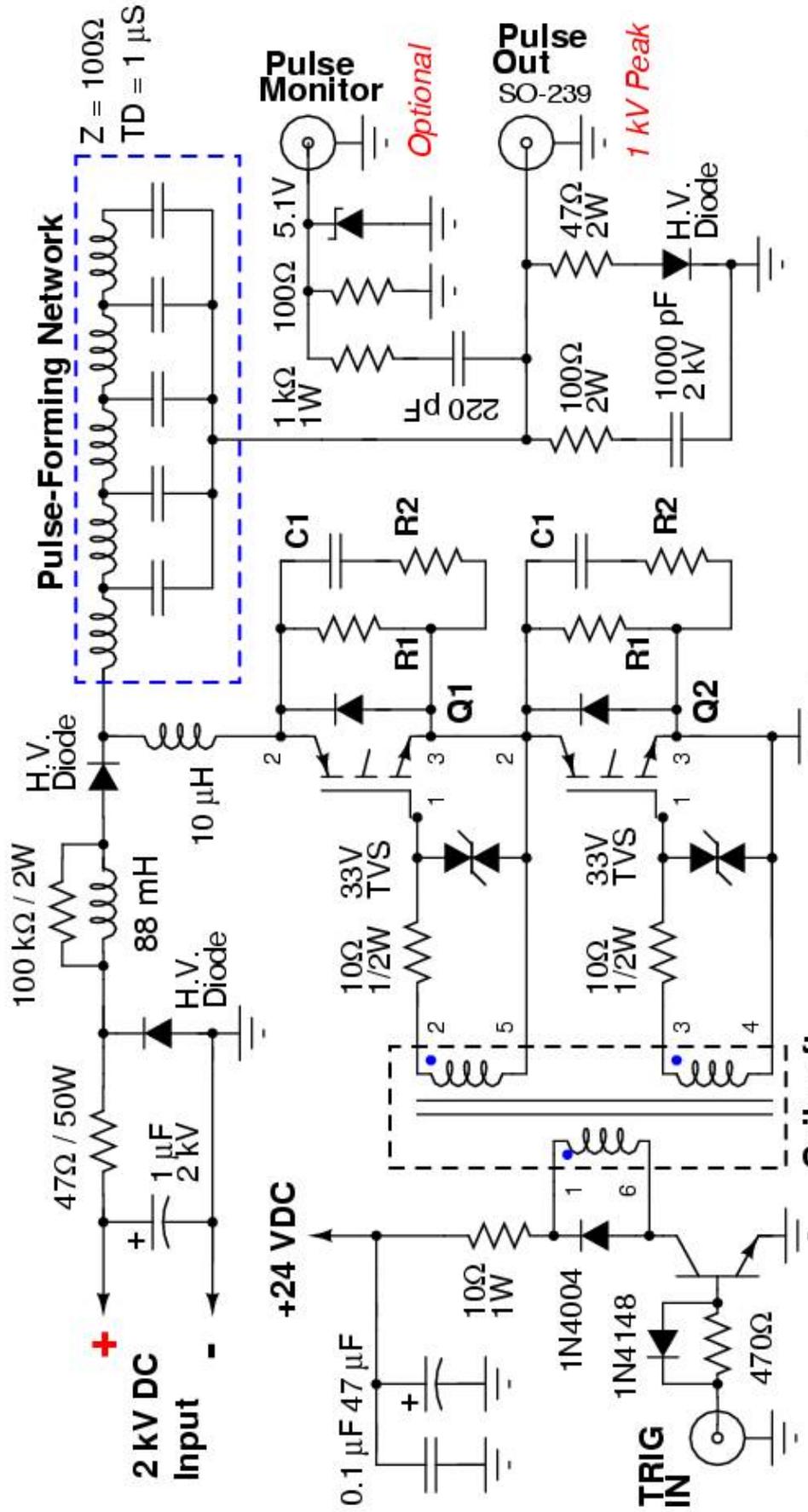
The **+24 VDC Input** is the female BNC connector above that, marked "**LV**".

The **Pulse Output** is via the SO-239 connector on the lower right-side, marked "**OUT**".

The optional **Pulse Monitor** output is via the female BNC connector above that, marked "**TEST**".

Final pulse modulator circuit testing can't really take place until the magnetron and its driving pulse transformer circuits are constructed.

# GBPPR Homebrew Radar Experiment: Modulator



- Q1, Q2 = STGF3NC120HD N-Channel IGBT
- R1 = 1 MΩ / 2W
- R2 = 10Ω / 2W
- C1 = 0.01 μF / 1 kV
- H.V. Diode = From old microwave ovens.

# Microwaves and Radar Electronics

(Excerpt from Chapter 5 – Pulse Circuits)

Commercial radar thyatron modulator schematic for a 2J49 X-band magnetron.

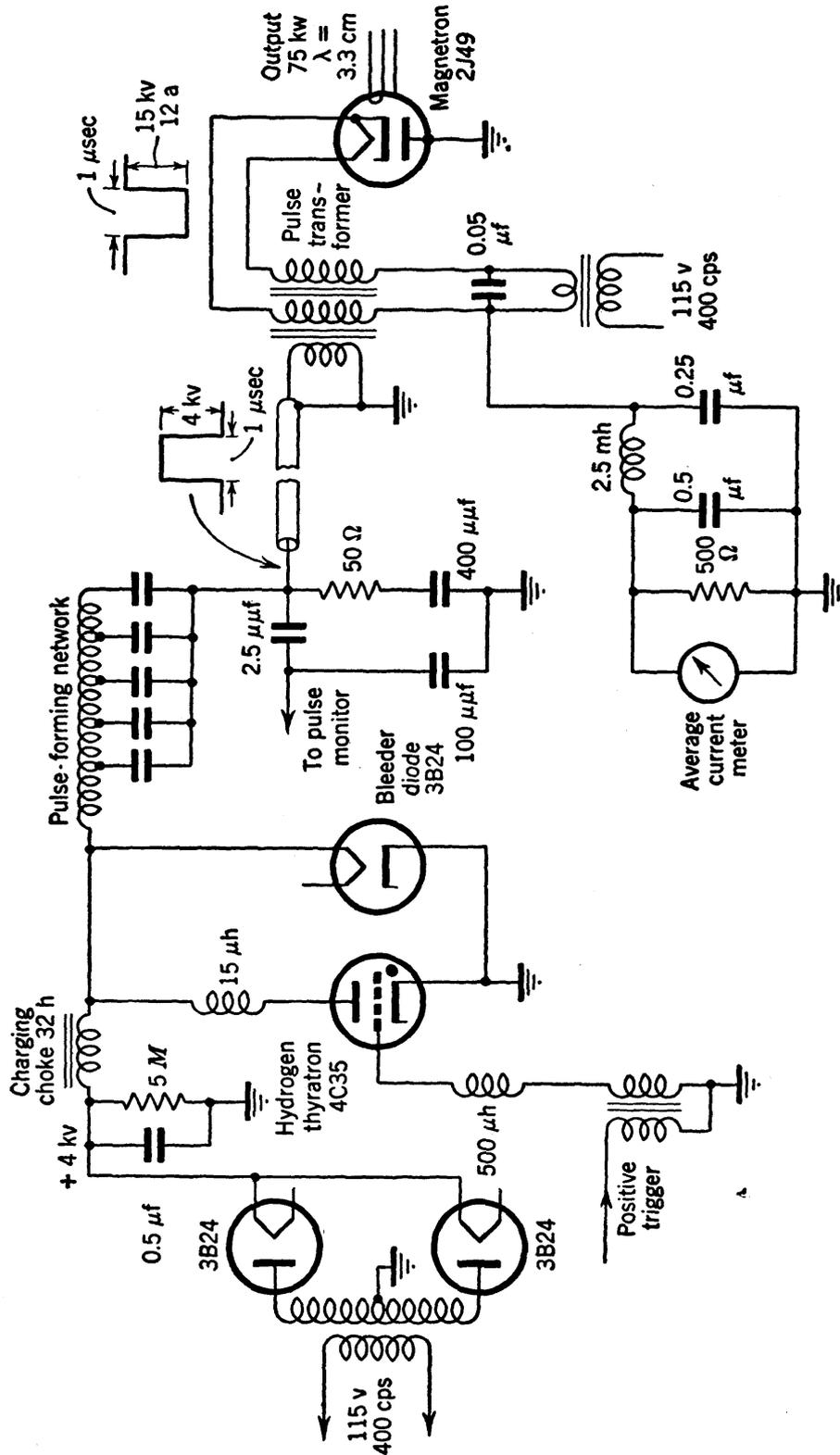


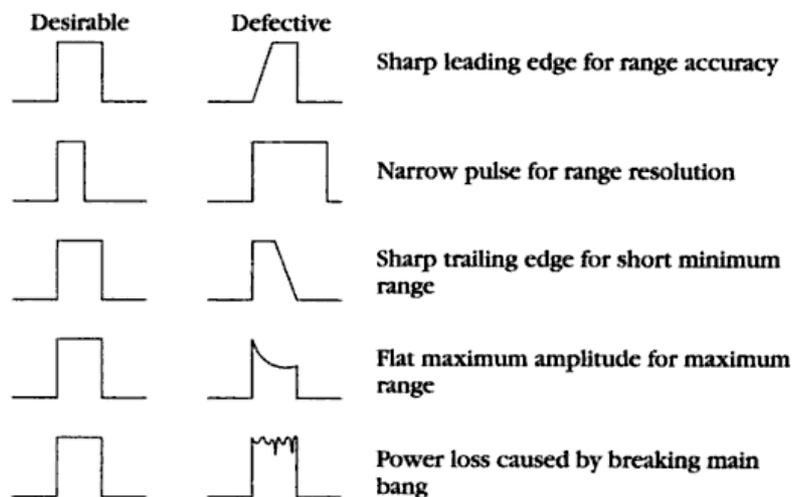
FIG. 5.25 Circuit diagram of a medium power hydrogen thyatron modulator.

## Radar for Technicians: Installation, Maintenance, and Repair

(Excerpt from Chapter 2 – Introduction to Radar Transmitters)

46

### Chapter 2



2-22 Transmitted pulse shapes and effects on system operation.

put power, lowering peak and average power. Decreased power out in turn will affect range resolution and maximum range.

The two most common types of radar modulators are the hard-tube and the line-pulsing. The *hard-tube* is based on the operation of a vacuum tube. Vacuum tube modulators are found in older radar systems and heavy-duty industrial X-ray systems. The vacuum tube functions as a driver. It forms a pulse from the trigger input, which is then amplified and routed to the modulator. Although the arrangement is effective, it suffers from several drawbacks, including lower efficiency, complex circuits, higher operating voltage requirement, and it is more susceptible to line voltage variations. The *line-pulsing* modulator is the more common modulator used in current radar designs. This type uses the same circuit components to store energy and form modulation pulses. It has the advantages of more compact size and less complexity than previous designs.

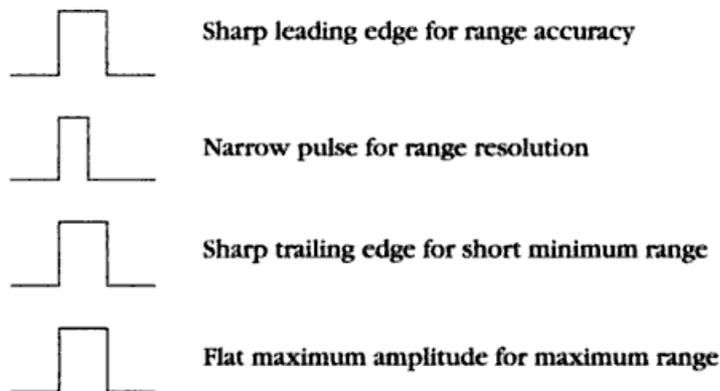
A line-pulsing modulator consists of a power supply, charging impedance, storage element, and a switching arrangement. The function of the power supply is to provide the correct amounts of current and voltage to the modulator. The time the energy storage element is charged is controlled by the charging impedance. Switching the energy storage element from charge to discharging through the RF oscillator and back to charge is controlled by the switching arrangement. The basis of this function is usually a vacuum tube called a *thyatron*. The most common type of energy storage elements are the pulse-

forming network (PFN) and artificial transmission line. The desired output from both is the same, a charge pulse that is rectangular in shape, with sharp rise and fall times, and of the required time duration.

## Radar modulator

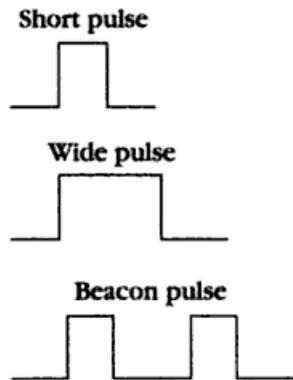
The radar modulator is considered to be a vital function within any radar system. The primary function of the modulator section is to produce accurately timed pulses of the proper high-voltage amplitude, current, duration, and polarity to allow for accurate system operation. The output pulses generated by the modulator are used as the high-voltage, high-current driving pulse to key the radar transmitter RF generator.

The pulse developed by a modulator must meet a specific criterion. As stated, the pulse must have a specific amplitude, duration, PRT, and shape. The pulse must have steep leading and trailing edges for accuracy and a flat top for maximum power. Peak power of radar is determined by the amplitude of the modulator pulse. Figure 2-23 illustrates desirable modulator pulses. The modulator pulse leading edge must rise from zero to its maximum value almost instantaneously to ensure accurate range measurements. As the transmitted pulse is the minimum range of any radar system, a sharp trailing edge is needed to connect the receiver to the antenna system as quickly as possible. The RF generator is unable to produce maximum power unless the top surface of the pulse is flat. If it is slanted, or even worse, breaking up, output power is greatly reduced. Reduced power decreases system maximum range and the ability to detect small targets, and it induces excessive noise levels into the receiver.



**2-23** *Transmitted pulse shapes.*

All radar modulators share several characteristics. For proper operation, they require stable high-voltage and high-current inputs at the proper time interval. The typical circuit consists of a high-voltage switching device, an energy storage component, and protection circuitry. It is common for many radars to be designed with more than one pulse width selectable by the operator to increase system flexibility. For example, short pulse, long pulse, and beacon are frequent pulse widths that are encountered in several radars. Figure 2-24 compares the three different pulse widths.



**2-24**  
*Radar pulse widths.*

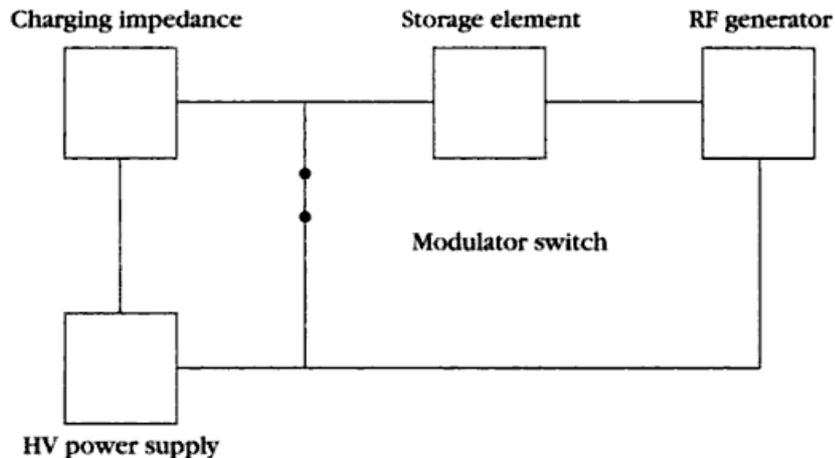
Short pulse widths are used for high-resolution applications, such as tracking close range targets, navigation in congested waters, separating multiple targets, or targets obscured by chaff and clutter. Short pulse is considered to be low-powered system operation because the RF generator is enabled for a shorter period of time. Long-pulse-width operation would be used for tracking long-range targets or targets obscured by electronic jamming, as both situations call for high-powered outputs. Beacon is a special-purpose operation that is becoming less common. In this type of operation, a radar system functions as a high-powered, long-range beacon to act as a navigation aid to other ships, aircraft, or personnel on shore. In this instance, a radar system generates two output pulses per PRT. It has been replaced by special equipment such as TACAN and VOR. TACAN is a military beacon, whereas VOR is used by civilian air traffic control organizations.

### Modulator components

The two most common types of modulators in use are the hard-tube modulator and the line-pulsing modulator. The hard-tube design is based on a vacuum tube that is used to form the pulse, which is then

amplified to a usable level by additional tube. The hard-tube modulator is being replaced, as it has several limitations, including the need for a larger power supply, less efficiency, a more complex design, and high rate of failure. The line-pulsing modulator is more common, as it is simpler in design, more efficient, and uses the same component for energy storage and pulse formation.

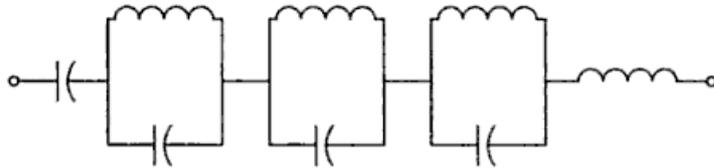
Figure 2-25 is an expanded block diagram of a representative radar modulator. Notice that it consists of four major subassemblies: high-voltage power supply, charging impedance, storage element, and switch. The power supply and energy storage element control the system's maximum power. The charging impedance has two functions: to control the charge time of the energy storage element and to prevent short circuiting the power supply during modulator pulse formation. The final component, the switch, fires to discharge the energy storage element into the RF generator.



**2-25** Radar modulator block diagram.

Although the energy storage element is vital to system operation, it is very simple in concept. Depending on the age and sophistication of a system, it can be as simple as a capacitor, or as complex as a massive encased, oil-filled LC network. Capacitive storage elements are found only in radars with a dc power supply, limiting its use to very low-powered applications. The more prevalent devices are either artificial transmission line or pulse-forming networks (PFN). Figures 2-26 and 2-27 illustrate the internal construction of both components.

The function of an artificial transmission line is to store energy between transmitted pulses and, when discharged, form the rectangular modulator pulse. A schematic diagram of an artificial transmission line energy storage element is illustrated in Fig. 2-26. As shown, it consists of a series of LC tanks. The duration of the high-voltage pulse developed by the modulator determines the length of time that the RF generator will produce and radiate an RF output.

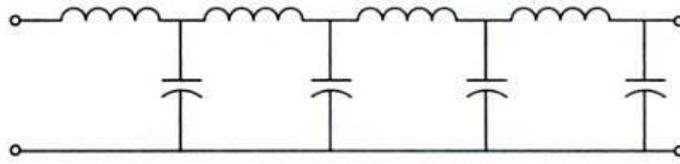


2-26 Artificial transmission line.

Modulator pulse duration in the artificial transmission line energy storage element is a result of the number of LC sections and their value. An artificial transmission line is fabricated so that the output end is electrically an open circuit. When voltage is applied, each section, starting from the input side, charges. Discharge begins when the modulator switch closes. The transmission line then discharges through the modulator switch and the primary of the pulse transformer. The discharge action develops a difference in potential. When the potential difference is felt on the output side of the transmission line, its characteristic open is reflected down the entire transmission line, discharging each section in turn.

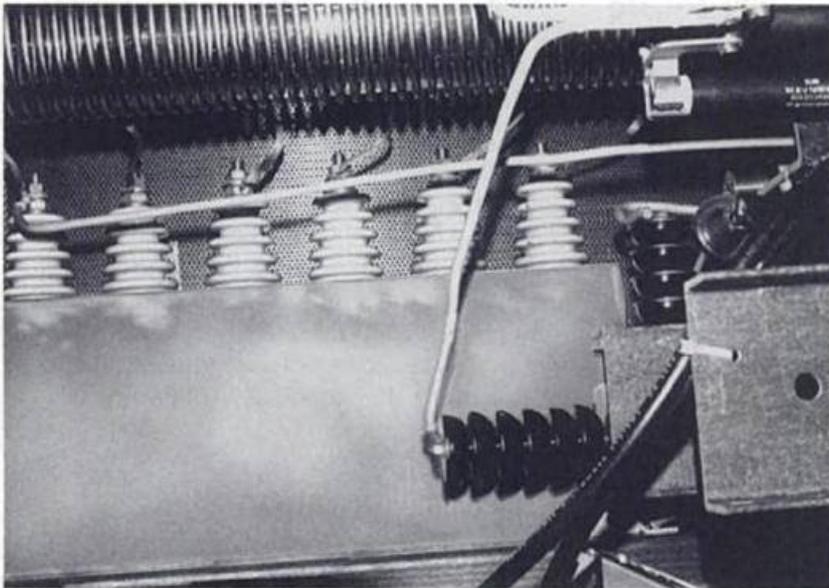
The pulse ends when the last section on the input side is discharged. Output pulse width is determined by the time it takes the voltage to travel from the input, output, and back again. The time is controlled by the number of sections in the line and values of capacitance and inductance of each section. Because each section of the transmission line feels the full potential of the applied voltage, insulation is vital to prevent possible breakdown and damage.

The pulse-forming network (PFN) is similar to the artificial transmission line, as it is constructed from inductors and capacitors. By examining Fig. 2-27, you will notice that the PFN consists of a series of parallel LC networks. Because of this arrangement, individual capacitors (with the exception of C-1, the input capacitor) do not have to be capable of carrying the full value of applied voltage. That is because the total applied voltage is divided equally among the series of LC networks.



**2-27** *Electrical characteristics of a pulse-forming network.*

A PFN is a one-piece, nonrepairable, electronic component. As high voltages and currents are encountered, the unit is immersed in oil to provide insulation, and it is hermetically sealed in a metal case. Figure 2-28 is a photograph of a typical PFN. This one is installed in a Linatron, which is a high-powered commercial X-ray system heavily based on radar technology and components. Notice that external connections are provided to couple energy into and out of the assembly. The connections are the six insulated bolts along the side of the PFN. Markings are provided on the case so that characteristics such as pulse width, impedance, voltage, and current are readily accessible by repair personnel. This is important, as manufacturers often fabricate different radar systems, each requiring unique parts. Also, the end user might have multiple radars to support, so it is imperative that parts are legibly marked.



**2-28** *Pulse-forming network.*

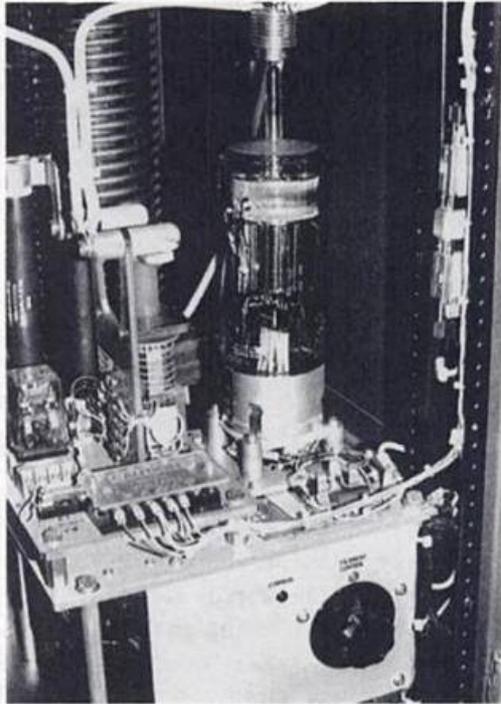
Maintenance is limited to cleaning all surfaces and components to remove dust, dirt, and oils. Cleanliness is vital because any foreign matter can form conductive paths to ground. Unwanted ground paths can lead to high-voltage components arcing, causing equipment damage plus exposure of maintenance personnel to electrical hazards. A leaky PFN must be replaced because the oil insulates the capacitors and inductors from the grounded metal case. If you look closely at Fig. 2-28, you'll notice the number of leads that are visible. All of them carry high voltages and currents. Cleanliness is vital, due to the close proximity of conductors.

During system operation, the energy storage device must alternatively charge and discharge. To allow switching between charge and discharge modes, an electronic switch is required. A suitable electronic switch must be able to rapidly switch states and handle high power. First, the electronic switch must close, or go into conduction, in less than a microsecond to allow the PFN to discharge. Secondly, it must open, or cease conduction in less than a microsecond to allow the PFN to begin the charging cycle. While it is rapidly going from conduction to cutoff, it must be subjected to a current flow in the hundreds of amps at a potential of thousands of volts. Finally, it must operate efficiently, consuming a small amount of power.

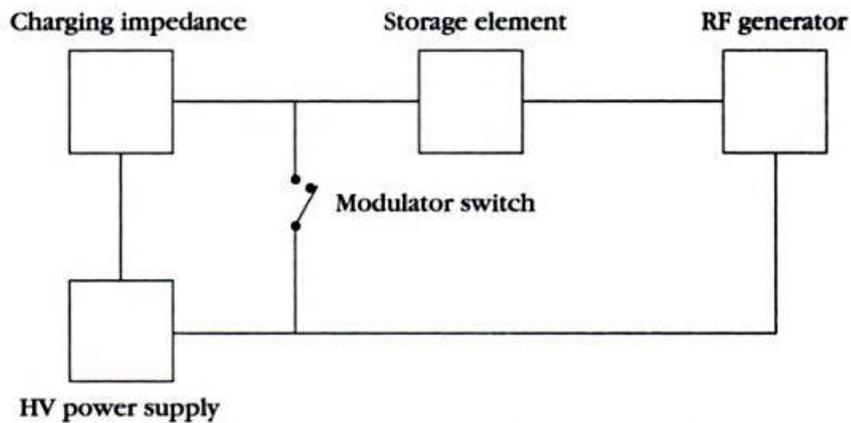
The requirements are best met by an electron tube called a *thyatron*. Figure 2-29 is a photograph of a typical thyatron vacuum tube. This particular tube is installed in a Varian 3000A, High-Energy Linatron. Just below the tube is a three-position switch to control the value of filament voltage applied to the thyatron. The filaments are selectable to compensate for minor differences between tubes. Ideally, a tube will function with the voltage set to midrange. A thyatron is a gas triode or tetrode that is designed specifically for high-powered switching and control applications. It differs from a conventional vacuum tube in the manner in which the control grid functions. Plate current begins to flow almost instantaneously when grid voltage achieves a particular value. At that time, the grid has no further effect on tube operation. Current continues to flow through the device until plate voltage is either cut off or reverses polarity. Operation should sound very familiar, as it functions the same as a solid-state device, the silicon-controlled rectifier (SCR).

## Modulator operation

Basic modulator operation will be covered using Figs. 2-30 and 2-31. Figure 2-30 is the simplified block diagram of a modulator. In this illustration, the modulator switch is open, which allows the storage ele-

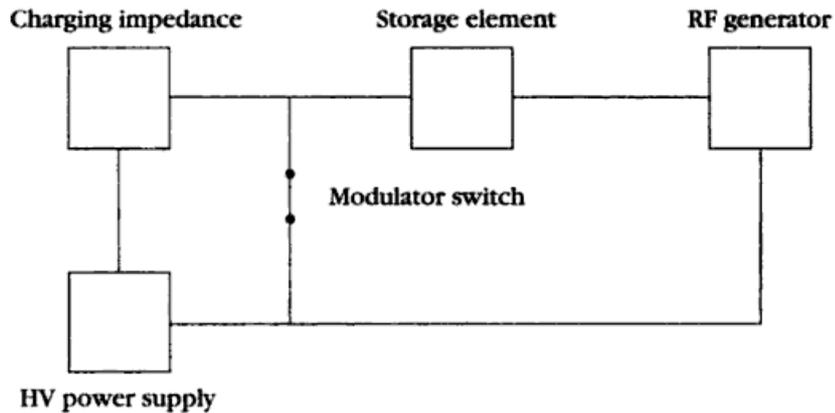


**2-29**  
*Thyatron deck.*



**2-30** *Modulator block diagram with electronic switch open and PFN charging.*

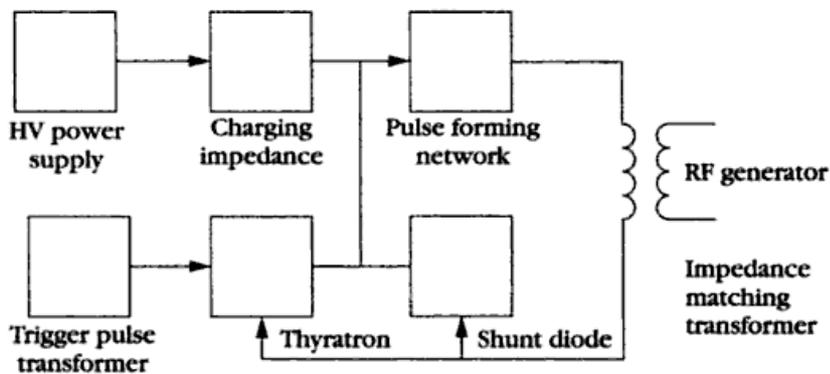
ment to begin charging. The charge path is from the storage element, through the charging impedance, the high voltage power supply, and back to the storage element. Figure 2-31 has the modulator switch closed. That condition occurs when the thyatron fires. The discharge



2-31 Modulator block diagram with electronic switch closed and PFN discharging.

path is from the energy storage element, through the modulator switch, the RF generator, and back to the storage element.

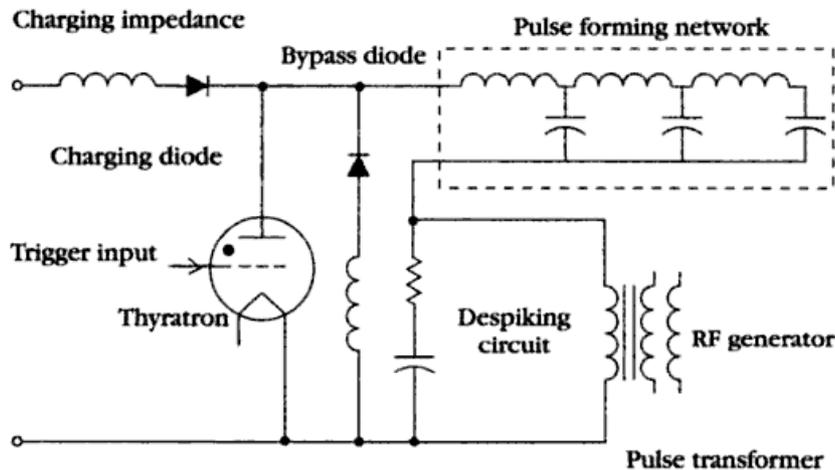
Actual modulator construction is more complex than four blocks, as can be seen in Fig. 2-32. Function operation begins on the left side of the diagram. The high-voltage power supply provides all voltages required by the assembly. The trigger pulse transformer, the lower-left block, couples the trigger pulse into the modulator and steps it up to a level high enough to trigger the thyatron. The PFN stores the high energy needed to form the modulator output pulse. Two new blocks are the shunt diode and the impedance matching transformer. The shunt diode is vital because often, when a PFN discharges, it will swing negative. That is due to the inherent impedance mismatch be-



2-32 Radar modulator block diagram.

tween the PFN and the RF generator. The final block, the matching transformer, is used to reduce or eliminate impedance mismatches between the modulator and the RF generator.

Because the artificial transmission line and PFN-type modulators function the same, only the PFN will be discussed. Figure 2-33 is the schematic diagram of a representative modulator. After the system is energized, dc high voltage is applied to the modulator, charging the PFN. Current flows from the negative terminal, through the primary of the pulse transformer, the PFN, charging diode, the charging impedance, and back to the positive side of the power supply. The internal capacitance and inductance of the PFN form a resonant charging circuit. With the application of dc high voltage, the PFN attempts to complete a sinusoidal rise to nearly twice the value of the input. After one-quarter cycle, the PFN attempts to discharge as the sinusoidal voltage is decreasing, but as the shunt diode is reverse biased, the charge voltage is maintained. The positive trigger developed by the trigger generator is applied to the primary of the pulse transformer. The transformer secondary develops the high-amplitude pulse required to trigger the thyatron into operation. The application of a positive trigger causes the thyatron to conduct, discharging the PFN. The resulting high-voltage, high-current pulse from the PFN is routed to the RF generator via the pulse transformer.



2-33 Radar modulator schematic diagram.

The function of a pulse transformer is to step up the output pulse from the PFN and provide impedance matching between the modu-

lator and the RF generator. The output waveform of a PFN is complex, consisting of many high-frequency components. Because of that fact, transformer design is crucial. To ensure that the pulse has a steep leading edge, leakage inductance must be minimized by the use of close coupling between the primary and secondary windings. That is accomplished by winding the primary directly onto the secondary. The secondary is typically *bifilar winding*. A bifilar winding is constructed with two insulated conductors wound next to each other. That results in the same value of voltage being induced in each one. Both windings act as separate secondaries with the same value of in phase voltage induced in each. The advantage of a bifilar winding is that it eliminates the need for high-voltage insulation.

After the PFN is discharged by the thyatron, it attempts to charge negative because of overshoot. That is because there will be an impedance mismatch between the PFN and the RF generator. To prevent the undesirable overshoot, the diode, called the *charge restorer sbunt diode*, is forward biased and conducts, totally discharging PFN.

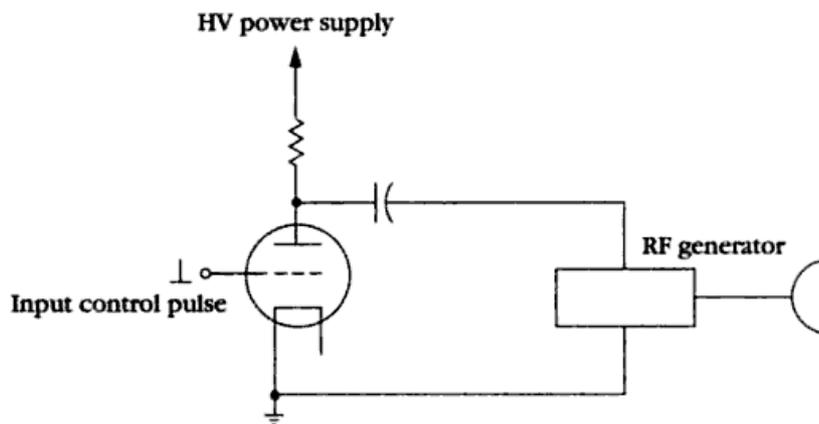
### Modulator protection

Although a modulator is designed to withstand high voltages and currents, protection is required to prevent unusual conditions from damaging components. One such condition is *overvoltage*. That happens when the energy storage element charges to a higher-than-normal value. It can cause excessively high pulses to be applied to the magnetron. Such an overvoltage condition can cause the magnetron to internally arc, possibly causing damage to the device. The installation of a spark gap connected across the secondary of the pulse transformer eliminates this problem. Stray capacitance and leakage current in the pulse transformer can cause oscillations to occur after the main pulse fires the RF generator. The resulting negative portion of PFN oscillations can cause spurious outputs from the magnetron. If this should occur, the most pronounced symptom is a loss of close-in targets. A damping diode, connected in parallel with the magnetron, eliminates this problem. The diode is reverse biased during the positive alternations of the modulator pulse. If the pulse goes negative, it is then forward biased and conducts the unwanted pulse to ground.

Despiking is warranted when a spike is present at the leading edge of the modulator pulse. A magnetron has a nonlinear impedance. As a result, under some operating conditions, an impedance mismatch with the output waveguide and antenna might be evident. If a mismatch does exist, the most common symptom is a spike at the leading edge of the pulse. A network to remove, or despice, the

waveform must have a resistance that is equal to the impedance of the PFN. The series capacitor must have a very low capacitance so that it will charge rapidly after the PFN output draws full-load current. With the proper selection of network components, any spikes are passed to ground and eliminated.

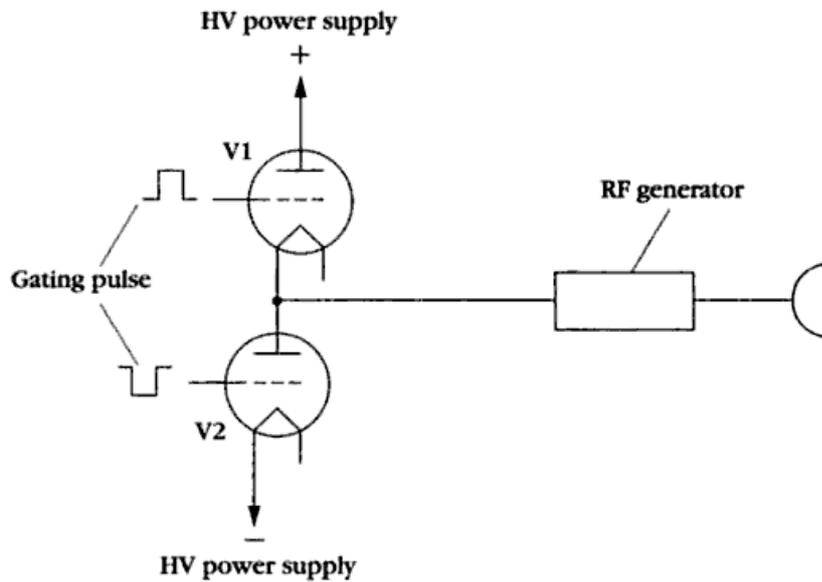
There are several other types of modulators that are in current use. One is called a hard-tube modulator, illustrated in Fig. 2-34. As shown, this circuit is a vacuum tube that is operated as a class C amplifier. Although it is more complex and expensive, it is one of the more versatile modulators. It can be configured with capacitors and transformers as the coupling elements to the load. It is very flexible in terms of duty cycle and pulse widths. Its main drawback would be its sheer size and cost.



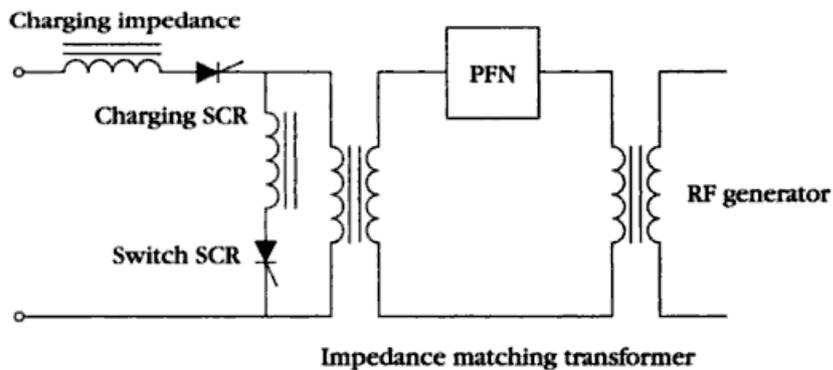
2-34 Hard-tube modulator block diagram.

A variation is the floating deck modulator, and it is illustrated in Fig. 2-35. This type of circuit is associated with RF generators such as the traveling wave tube (TWT) and the klystron. Tube 1 and 2 will never be in conduction at the same time. When the RF generator is not producing an output, tube 1 is conducting, and tube 2 is cut off. To bring the RF generator into operation, tube 1 is cut off, and tube 2 is conducting. Gating pulses are coupled to the tubes using either transformers or capacitors.

Solid-state modulators are gaining in popularity. A representative SCR modulator is depicted in Fig. 2-36. The higher cost of solid-state modulators is offset by an increase in reliability. The main limiting factor is a much lower current and voltage-handling capability. The



2-35 Floating deck modulator block diagram.

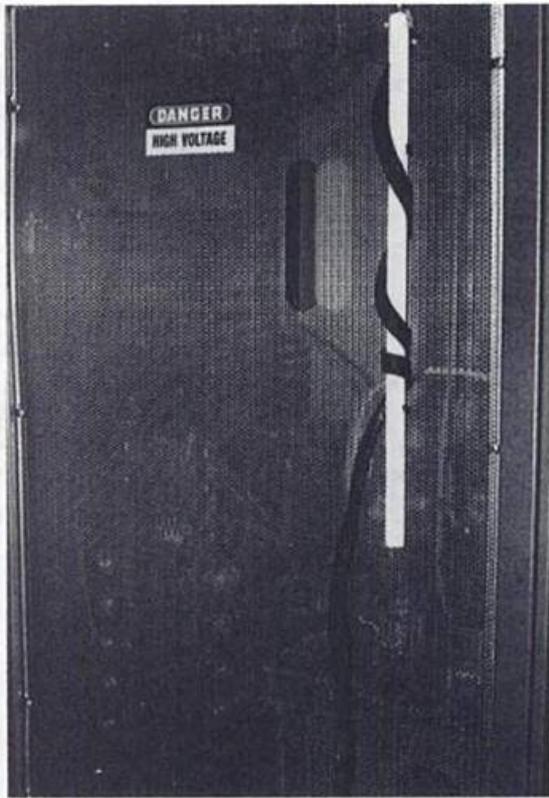


2-36 Magnetic SCR modulator.

lower power capabilities can be compensated for by using saturating magnetic cores in series with the SCRs. The time delay inherent with a charging coil limits the current flow through the SCRs until they are completely turned on.

## Troubleshooting hints

Any time maintenance is performed in the modulator, extreme caution is required. Figure 2-37 is a photograph of a modulator section. Notice the screen mesh enclosing the chassis. The screen has several



**2-37**  
*Modulator cage with  
shorting probe.*

functions. First, it prevents someone from accidentally coming in contact with high voltage. The mesh is held in place by eight screws, so it will take a conscious effort to enter the section. Secondly, it acts as an RF shield, grounding stray emissions to prevent interference with other equipment. To warn personnel of the possible danger, a high danger sign is prominently displayed.

All radar modulators are constructed from components capable of withstanding high voltages and currents. When the equipment is operating, never attempt to place your hands inside of the modulator subassembly. There is never a reason for anyone to do that. Because of the lethal voltages and currents, the presence of your limbs would provide a convenient path to ground, leading to injury or death. If any internal maintenance must be performed, a grounding stick is permanently installed on the cabinet for maintenance personnel. If you look at Fig. 2-37, the grounding stick is the white stick on the right side of the photograph.

If the modulator is the suspected failed subassembly, is it firing? If you have a vacuum tube thyratron, this is easy to determine. A

properly operating tube should glow purplish. That is because when triggered into conduction, the tube ionizes. If it isn't glowing, ensure that the modulator is receiving triggers of the proper amplitude and timing. Another good check is to ensure that it has the correct filament voltage. Due to differences in manufacturing, not all tubes will fire with the same filament voltage. Another common failure is the charging diode. Ensure that it isn't shorted or open. If you still have not isolated the failure, check all inputs to the subassembly. That includes triggers, low-voltage power supplies, high-voltage power supplies, and filaments.

Arcing in the modulator is more common than you would imagine. The most common cause is cables and wires too close together. If you suspect this problem, turn out lights to verify where it is occurring. With this type of problem, you must be patient because sometimes the arcs are barely visible. When you do locate the offending point, carefully move the cables. Exercise care because in curing one arc, you might cause another.

## RF generators

The function of an RF generator is to produce high-energy output pulses of the required waveshape, frequency, and repetition rate. To accomplish this task, it receives a high-powered input from the modulator and outputs the resulting high-energy, high-frequency pulse to the antenna system for transmission through free space. As always with radar equipment, the technology is constantly evolving, improving RF generator operation and characteristics.

Characteristics of a given radar design are determined by the primary application for the system. These vital and important characteristics include: peak power, average power, radiated pulse length, PRF, stability, distortion, tunability, bandwidth, system cost, useful operational life, efficiency, physical size, weight, and (gaining in importance with every passing year) mean time between failure (MTBF). MTBF is becoming more crucial as it drives support requirements such as spare parts, number of maintenance personnel, and level of maintenance training, all costly line items under constant scrutiny.

## RF generating devices

### **Klystron**

The klystron was first developed in the early 1950s. Due to its design, it is capable of a higher peak power than a magnetron, up to 20 megawatts (MW). The high power is possible as the major compo-

(Excerpt from Chapter 4 – Transmitters)

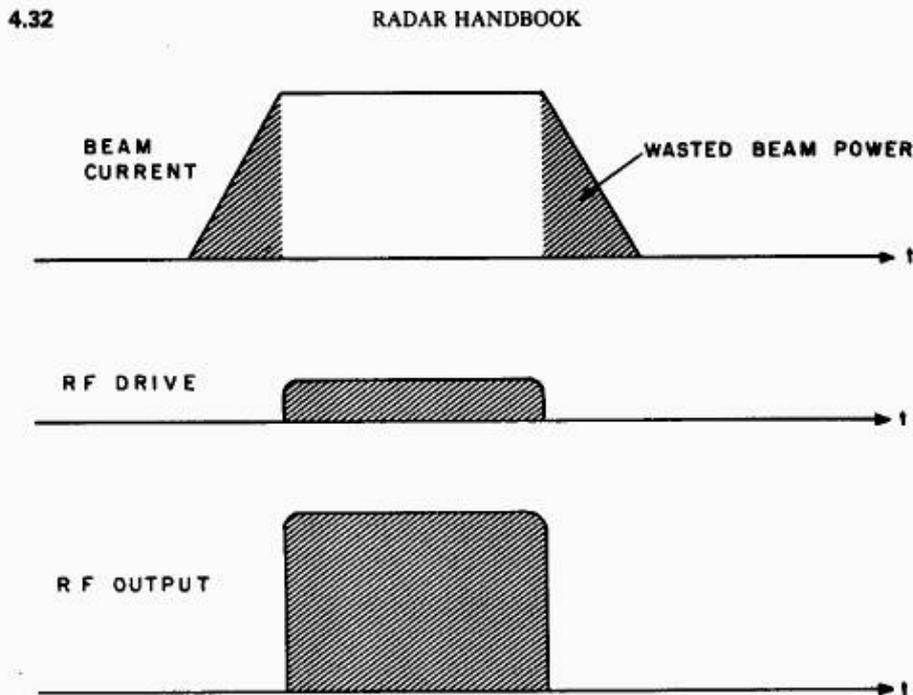


FIG. 4.14 Use of gated RF drive to avoid phase distortion. The figure also shows wasted beam power during modulator rise and fall times.

*Pulses with Shaped Edges.* A simpler and yet effective approach to spectrum improvement is to shape only the rise and fall of a rectangular pulse.<sup>57</sup> This attenuates the spectrum at frequencies far from  $f_0$ , while the flat-topped center portion of the pulse retains high transmitter efficiency for most of the pulse duration. Since a rectangular pulse has the best transmitter efficiency but the widest spectrum, whereas a gaussian pulse has the narrowest spectrum but very poor transmitter efficiency, the fraction of the pulse length to be used for the shaped rise and fall is a crucial decision.

Although the improvement attainable in practice is limited by phase modulation in the transmitter during the rise and fall,<sup>54,56,58</sup> significant improvements can be obtained. In a linear-beam-tube transmitter with properly shaped RF drive, for example, the spectrum width at 60 dB down can usually be narrowed by about an order of magnitude at a cost of about 1 dB in transmitter efficiency.

In practice, most amplifier chain radar systems, whether tube or solid-state, now use at least some shaping of the edges of the transmitted RF pulse to reduce RF spectrum width. This is usually done simply by slowing the rise and fall times of the exciter signal to the transmitter; this has generally been adequate to satisfy MIL-STD-469 and related system requirements.

#### 4.8 PULSE MODULATORS

Since pulse-modulator design is well covered in existing literature,<sup>59-61</sup> this section will mainly summarize and compare available modulator techniques. The type of modulator required is usually determined by the available type of RF tube. A grid pulser, for example, is the smallest, easiest, and least expensive type

of modulator, but it can only be used if the RF tube has a grid. Although grids have become more common, a grid may still not be feasible in a very high power RF tube. On the other hand, several types of modulators may be suitable for a given application; Table 4.3 compares some of the performance advantages and disadvantages of various modulator techniques. The final choice is then based on tradeoffs among cost, size, weight, efficiency, and life. The conclusions vary greatly as a function of system requirements and the type of RF tube to be pulsed, as proved by the wide variety of modulators in use.

**Line-Type Modulators.** The classic line-type modulator is shown in Fig. 4.15. In this type of modulator, the switching device  $V1$  (thyatron, ignitron, silicon controlled rectifier, reverse-switching rectifier,<sup>62</sup> or spark gap) merely initiates and carries the discharge of the pulse-forming network (PFN); the actual shape and duration of the pulse are determined entirely by the PFN and other passive circuit elements. The pulse ends when the passive elements have discharged sufficiently that current in the switch stops and allows the switch to recover its voltage hold-off capability.

The self-terminating nature of the pulse discharge is what permits the use of simple switching devices (fully on or fully off only), but this characteristic is also the greatest weakness of line-type modulators. The switching device merely times the pulse discharge and has no control on the pulse shape. Although the PRF can be varied if a series diode is used in the resonant-charging circuit,<sup>59</sup> pulse length can only be changed by switching the connections to multiple PFNs or PFN sections, which requires high-voltage switches. For similar reasons, the trailing edge of the pulse is usually not sharp, since it depends on the energy stored in multiple reactive elements all going to zero at the same time. Furthermore, a well-matched condition is difficult to achieve into nonlinear loads such as RF tubes and all their stray circuit impedances. Achieving the desired pulse shape into very nonlinear loads such as magnetrons often requires despiking or damping circuits.<sup>9,59</sup>

Heater power (if required) for the RF tube load is usually supplied either by a low-capacity high-voltage-insulated heater transformer or by a bifilar secondary winding on the pulse transformer, as shown in Fig. 4.15.

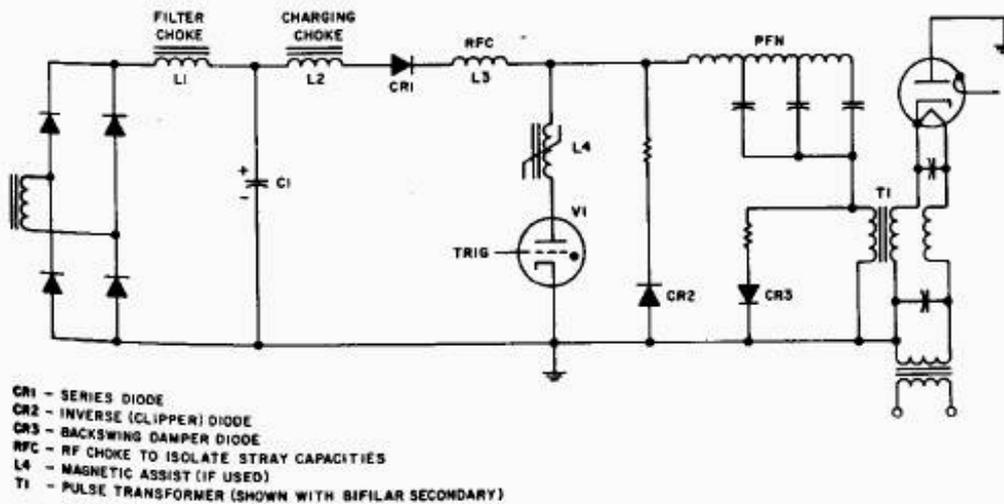


FIG. 4.15 Line-type modulator.

**TABLE 4.3** Comparison of Modulators

Line type	Modulator	Fig.	Flexibility		Pulse-length capability		Pulse flatness	Crowbar required		Modulator voltage level
			Duty cycle	Mixed pulse lengths	Long	Short		Load arc	Switch arc	
	Thyatron SCR	15	Limited by charging circuit	No	Large PFN	Good	Ripples	No	No	Medium Low
	Magnetic modulator	...	Limited by reset and charging time	No	Large C's and PFN	Good	Ripples	No	No	Low
	Hybrid SCR magnetic modulator	...	Limited by reset and charging time	No	Large C's and PFN	Good	Ripples	No	No	Low
Active switch	Series switch	16a	No limit	Yes	Excellent; large capacitor bank	Good	Good	Maybe	Yes	High
	Capacitor-coupled	16b	Limited	Yes	Large coupling capacitor	Good	Good	Maybe	Yes	High
	Transformer-coupled	16c	Limited	Yes	Difficult; XF gets big; large capacitor bank	Good	Fair	Maybe	Yes	Medium-high
	Mod-anode	17	No limit	Yes	Excellent; large capacitor bank	OK, but efficiency low	Excellent	Yes	Yes	High
	Grid	...	No limit	Yes	Excellent; large capacitor bank	Excellent	Excellent	Yes	...	Low

Operation of a line-type modulator into a mismatched load results in residual energy in the PFN at the end of the desired pulse length. If the load is lower than match (i.e., if the load impedance is lower than the PFN impedance as seen through the pulse transformer), the energy remains as a voltage of reverse polarity on the PFN. Within limits, this allows additional time for the switch device to recover, but an inverse clipper diode (*CR2* in Fig. 4.15) is required to discharge this energy so that the charging voltage on the next pulse will not be affected.

A well-designed clipper circuit<sup>59,63,64</sup> will prevent the charging voltage from rising more than a few percent on the next charging cycle even when the load arcs and presents a short circuit to the modulator. Observation of the peak charging voltage<sup>65</sup> while a grounding stick is used to simulate arcing of the RF tube will quickly show how effective a particular clipper circuit may be, and all line-type modulators should be subjected to this test. Crossed-field tubes must be allowed to arc occasionally without tripping off the modulator, especially during "burn-in," and modern modulators are usually designed not to trip off unless the arcing continues excessively.

When a line-type modulator is operated into a load impedance higher than match, a train of pulses of exponentially decaying amplitude is theoretically expected, leading to concern that the thyatron will not deionize before the next charging cycle begins. This indeed occurs on a pure resistive load and results in "hangfire" of the thyatron and trip-off of the modulator. However, the presence of the pulse transformer in typical line-type-modulator circuits ensures that the modulator can operate properly into a load higher than match. The buildup of magnetizing current in the pulse transformer continues to discharge the PFN until its voltage reverses (perhaps after several pulse lengths), just as if the load were lower than match.

Since a line-type modulator ordinarily runs at or near match, moderate variations in load impedance can be analyzed on the basis that constant power will be delivered by the modulator. This is true as long as the PFN charging voltage is constant, which depends on having an effective clipper circuit. Similarly, a 1 percent increase in peak charging voltage will produce a 2 percent increase in power delivered to the load, regardless of its dynamic impedance (Table 4.2).

Various line-type-modulator arrangements using more than one PFN are feasible in order to produce an output pulse at a different impedance level than that switched by the thyatron.<sup>59,66</sup> This may offer advantages in certain cases, but in general these techniques increase the PFN cost and make it harder to achieve good pulse shape. Since in these cases the voltage on the PFN has both polarities during normal operation, it is awkward or impossible to achieve effective clipper-circuit action. The result is that most multiple-network modulators tend to have multiple postpulses (extraneous pulse outputs following the desired pulse output) due to multiple internal reflections of the residual energy in the several PFNs. For these reasons multiple-PFN modulators are relatively uncommon in radar usage.

Throughout the history of line-type modulators, high-power applications have grown faster than switching devices, so two or more of the largest devices have often been used in series or parallel to handle higher peak or average power.<sup>61,67</sup>

**Active-Switch Modulators.** There is such a variety of active-switch pulse modulators that it is useful to categorize them as cathode pulsers, mod-anode pulsers, and grid pulsers. Cathode pulsers must control the full beam power of the RF tube, either directly or through a coupling circuit. Mod-anode pulsers must usually provide a voltage swing equal to the full beam voltage of the tube, but the

current required is only that needed to charge and discharge the circuit capacitances at the beginning and end of the pulse, since a mod-anode usually draws very little current during the pulse. Pulsers for gridded RF tubes perform the same kind of task as mod-anode pulsers, but since the term *grid* is used here to describe a high- $\mu$  control electrode, the voltage swing required from a grid pulser is far smaller and permits the use of lower-voltage components and techniques.

Before semiconductors became available, these types of modulators were all called *hard-tube modulators* because they used vacuum tubes exclusively. Active-switch modulators require switching devices that can be both turned on and turned off at will, since, unlike the line-type modulator, the switching device controls both the beginning and the end of the pulse. In active-switch modulators, the pulse is terminated when only a fraction of the stored energy available in the HVPS or modulator has been delivered to the load.

Transistors and gate-turnoff silicon-controlled rectifiers (SCRs) are the only semiconductors inherently capable of being turned off at will, but their power-handling capabilities are much lower than those of conventional SCRs. Therefore, because interest in using semiconductors for high power has been so great, special commutating circuits have been developed to make SCRs turn off at a desired time by means of other SCRs. Although the same techniques could be applied to hydrogen thyratrons and other switching devices normally limited to line-type modulators, it has not been done, probably because a multiplicity of hot cathodes is less palatable than a multiplicity of semiconductor devices.

In general, active-switch modulators provide great flexibility in pulse length and PRF, including mixed pulse lengths and bursts of pulses, since the pulse length is generated by low-level circuits. Maximum-pulse-length capability, within some allowable droop limit, is determined by the size of the energy storage capacitor used (and pulse transformer, if used). Since the energy stored in a capacitor is  $CE^2/2$ , a 5 percent voltage-droop limit (for example) means that the capacitor must store 10 times the energy delivered to the load in a single pulse. In high-power transmitters with long pulse lengths, the capacitor becomes very large, requiring series and/or parallel combinations of many capacitors, since the maximum practical energy in a single capacitor case is a few thousand joules. The collection of capacitors is then usually known as a capacitor bank (where the joules are stored), and such banks are reasonably common in the range of 10,000 to 1 million J. For example, a transmitter delivering 10 MW of peak power to an RF tube for 100  $\mu$ s (1000 J per pulse) requires at least a 10,000-J capacitor bank to limit droop to 4 percent, which will produce about a 13 percent droop on the RF output power of a linear-beam tube (unless droop compensation is used, as discussed below). The problem is about 4 times as severe for CFAs because of their low dynamic impedance (Table 4.2).

Special circuits can be used to reduce the effective droop for a given capacitor bank size or to reduce the capacitor bank size for a given allowable droop. Droop can be eliminated (although some ripple is likely to be added) by adding inductors to make the capacitor bank appear as a low-impedance PFN,<sup>68</sup> but this works well only for a fixed pulse length. Droop compensation is less critical and can be accomplished by inserting a parallel *RL* network in series between the capacitor bank and the pulsed load.<sup>69</sup> The drop across the *RL* network is highest at the start of the pulse and gradually decreases during the pulse, which tends to cancel the droop; but some energy is lost in the *RL* network. As an example, a 5 percent droop can be reduced to 2 percent with an efficiency loss of 2 percent.

In general, active-switch modulators are capable of excellent pulse shape if careful attention is paid to stray circuit inductances and capacitances, since there

is no lumped-section PFN to limit rise time and to introduce ripple during the pulse length.

Like line-type modulators, active-switch modulators must be designed to tolerate occasional load arcing without damage. Since the RF tube is connected directly to the energy storage capacitor bank in the case of dc-operated CFAs or in the case of a linear-beam tube using mod-anode or grid pulsing, a crowbar (Sec. 4.9) is required to protect the tube from being damaged by the discharge of all that energy when a load arc occurs. With a cathode pulser, the switching device should ordinarily be able to interrupt the load arc current, and firing the crowbar should not be necessary unless the switching device itself arcs.

*Cathode Pulsers.* The basic types of active-switch cathode pulsers are shown in Fig. 4.16. The triode shown represents any suitable active switch, either a hard tube or a string of solid-state devices, and the linear-beam tube shown as the load represents any cathode-pulsed RF tube, whether crossed-field or linear-beam and whether oscillator or amplifier. Table 4.3 provides a comparison of the features of cathode pulsers.

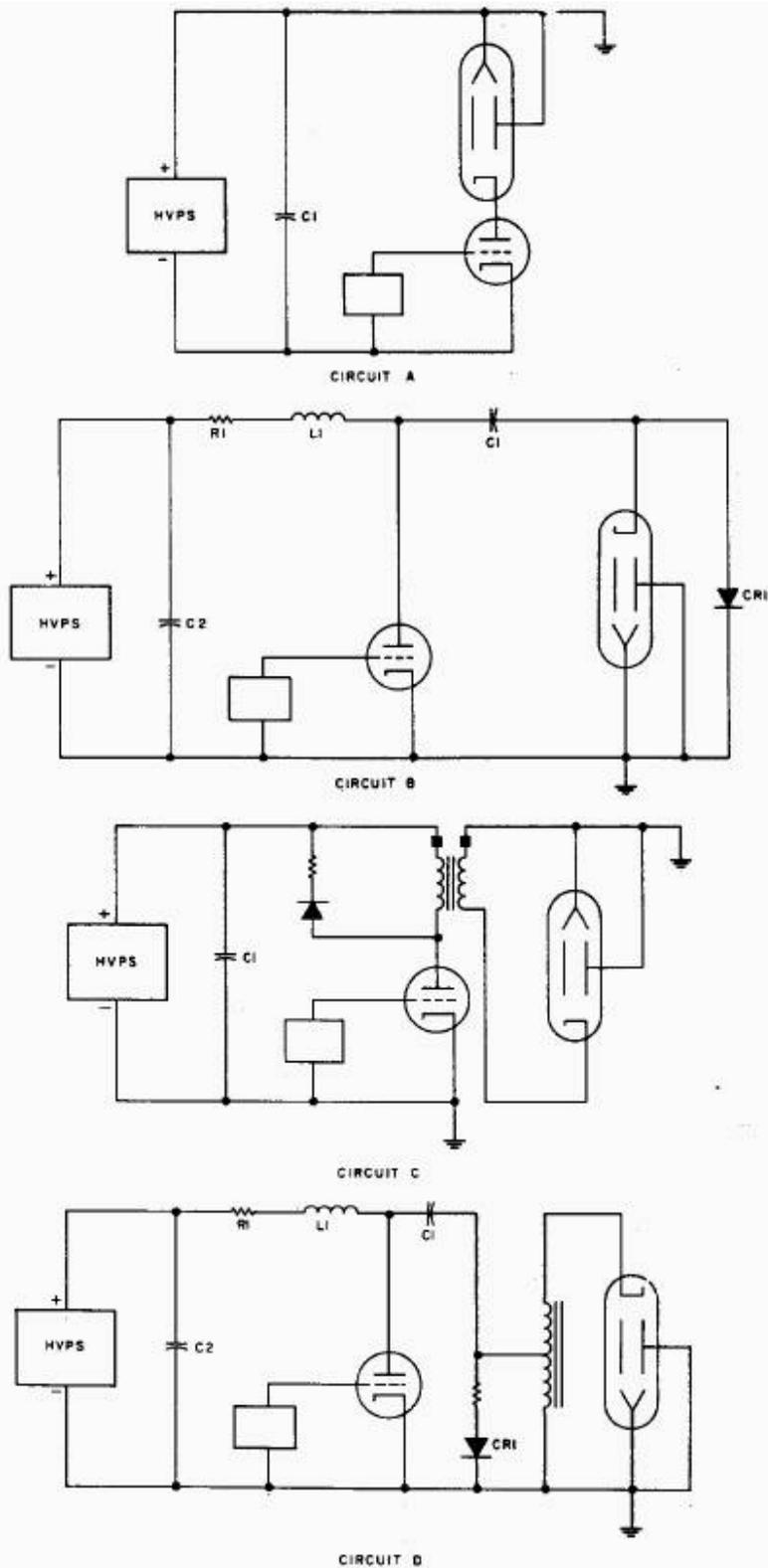
There are two basic types of cathode pulsers. Most often, the switching device is driven hard enough to bring its voltage as low as possible during the pulse; the device is said to be *bottomed*. This approach minimizes switching-device dissipation and maximizes efficiency, but variations in power supply voltage due to rectification ripple, line-voltage variations, or energy-storage-capacitor droop are passed directly to the load. The alternative is to operate the switching device as a *constant-current* device by limiting its drive signal. The effects of capacitor-bank-voltage droop and of power-supply-voltage variations on the load are then reduced by  $(R_p + R_L)/R_L$ , where  $R_p$  is the dynamic resistance of the device and  $R_L$  is the dynamic resistance of the load (Table 4.2).

Tetrode switch tubes are better suited to constant-current service than triodes because of their higher plate resistance. However, in constant-current operation, any fluctuations in grid drive affect load current directly, whereas if the switch tube is bottomed, variations in grid drive have relatively little effect. In constant-current operation, the grid drive may also be programmed to provide even better droop reduction than is provided by constant grid drive; for example, a rising *ramp* on the grid drive can be adjusted to compensate fully for the droop on the energy storage capacitor during the pulse.<sup>68</sup>

As the power ratings of metal-oxide-semiconductor field-effect transistors (MOSFETs) have grown, series strings of these devices have become attractive for use in active-switch modulators at increasingly high power levels, both as bottomed switches and as constant-current switches.<sup>70</sup>

*Mod-Anode Pulsers.* A basic modulating-anode pulser, sometimes called a floating-deck modulator, is shown in Fig. 4.17.<sup>71-73</sup> The klystron shown represents any linear-beam tube having a mod-anode, and the triodes shown represent any suitable active-switch device. During the pulse the ON tube holds the mod-anode near ground potential to turn on the klystron, and between pulses R3 holds the mod-anode negatively biased with respect to the klystron cathode to keep the klystron beam current cut off. The ON tube carries significant current only during the leading edge of the pulse when it is charging up the mod-anode stray capacitance  $C_s$  (including all associated stray capacitances, such as that of the ON deck), and the OFF tube similarly carries significant current only to discharge  $C_s$  at the end of the pulse. The OFF tube may be thought of as an end-of-pulse *tailbiter*, which is vital in this case since the load on the modulator is primarily capacitive.

Extremely good pulse flatness during the pulse can be obtained with mod-anode pulsers because the klystron is directly across the capacitor bank and because variations in grid drive to the ON tube during the pulse can readily be



**FIG. 4.16** Active-switch cathode pulser: circuit *A*, direct-coupled; circuit *B*, capacitor-coupled; circuit *C*, transformer-coupled; circuit *D*, capacitor- and transformer-coupled.

4.38



(Pulled from Google Books, so it is missing a few pages.)

# RADAR PULSE MODULATORS

# 25

Any continuous wave (CW) transmitter can generally be used as a pulse transmitter if a *pulse modulator* is added to provide the rapid turn on and turn off. Tube-type amplifiers can be operated with much higher instantaneous powers when they are pulsed. Tubes are primarily limited by their maximum anode dissipation (heat removal); the dissipation can be the result of either modest CW operation or high-power pulse operation. A CW amplifier can be converted for pulse operation by changing the output-matching circuit in order to present a lower load resistance to the tube. Some tubes are available in special pulse-rated versions; they are fitted with high-emission cathodes. Gridded tubes (triodes, tetrodes, and pentodes) can be pulsed by switching the grid bias from negative, for pulse-off, to positive, for pulse-on. The negative bias keeps the tube completely turned off between pulses. Since the grid voltage and current are much smaller than the plate voltage and current, grid control requires only low-power circuitry compared to anode control. At microwave frequencies, magnetrons and klystrons replace gridded tubes. Magnetrons have no control element and therefore require high-power anode pulsers. Klystrons may or may not have a modulating anode ("mod anode") by which the beam current can be cut off. If not, they need high-power pulsers.\*

Transistor amplifiers, unlike tube amplifiers, cannot make much of a trade-off between duty cycle and peak power. Transistors suffer one type of breakdown or another when operated much past their maximum continuous ratings. A high-power transistor amplifier for pulse service might differ from a CW amplifier only in that it will dissipate less heat (from the reduced duty cycle) and can therefore get by with a smaller heat sink.

No matter how an amplifier is pulsed, the power supply must furnish high-power pulses with minimum voltage droop. Duty cycles of pulsed transmitters are usually much less than unity so, in addition to at least one switching element, pulse modulators (pulsers) contain some form of energy storage element(s). The simple pulser circuit shown in Figure 25-1 stores energy in a capacitor. In this circuit the tube (magnetron, klystron, or whatever) is shown as requiring negative voltage. Microwave tubes

\*An air traffic control radar might have a peak power output of 2 MW and an efficiency of 50%. A klystron tube in this service could require 50 kV pulses at 80 A.

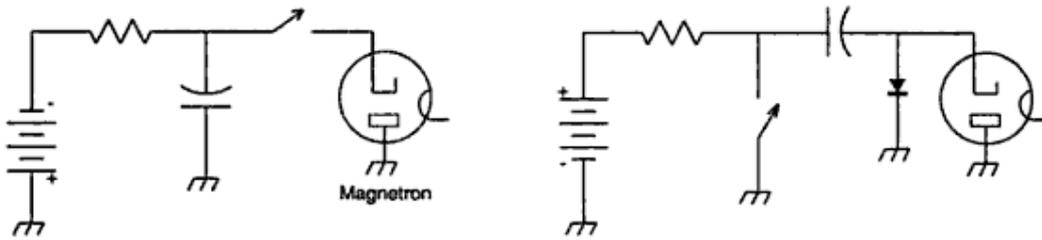


Figure 25-1. Capacitor discharge pulsers.

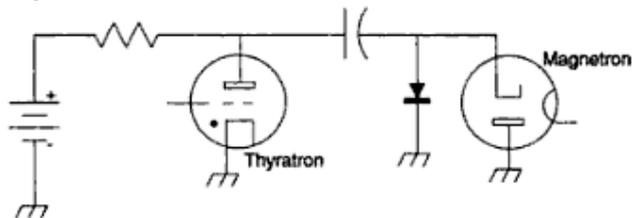
often use a negative supply voltage applied to their cathodes because it is convenient to ground the external heat-dissipating anode. The right-hand version of the circuit allows one side of the switch to be grounded, which is another convenience. The diode provides a charging path for the energy storage capacitor. The circuit of Figure 25-2 uses a thyatron (vacuum tube version of the silicon-controlled rectifier) as the switch.

The simple pulse modulators of Figures 25-1 and 25-2 have two main disadvantages:

1. The voltage droops during the pulse. The droop can be reduced by increasing the size (weight and cost) of the capacitor.
2. Not much of the stored energy is used. Even if a 10% voltage droop is permitted, only 20% of the stored energy is used for each pulse. This might be compared to a car, which would not run well if the fuel tank was less than 80% full.

Despite these drawbacks (they are not really limitations), capacitor banks are often used, as in the 430 MHz pulse transmitter used for ionospheric research at the Arecibo Observatory, because a more efficient circuit, the

Figure 25-2. Thyatron-switched pulser.



line modulator discussed below, does not easily provide the flexibility needed to change the pulse width. A capacitor bank cannot supply longer pulses without increased droop. (Normally inductors are not used as energy storage elements because, compared to capacitors, their maximum energy density is low.)

**LINE MODULATORS**

A length of transmission line (with the far end open) has capacitance and can therefore store electrostatic energy. When the line is discharged into a resistive load equal to its characteristic impedance, it will supply a perfect rectangular pulse rather than a drooping exponential pulse. The constant pulse amplitude during discharge is maintained by the distributed inductance of the line acting together with the distributed capacitance. In Figure 25-3 the line is a piece of coaxial cable, replacing the energy storage capacitor. As before, the tube is supplied with a negative pulse. A diode provides a path to recharge the line. Often the load has a higher impedance than the characteristic impedance of the line, and a pulse transformer is required.

The line supplies a pulse at half the charging voltage because, during the pulse, the charging voltage evenly divides between the load and the equivalent source resistance. The duration of the pulse is the time taken for the current to make a round trip through the line. At the end of the pulse the line is totally discharged; all the stored energy is delivered on every pulse. Waveforms of the line voltage and current are shown in Figure 25-4.

It is common to use an "artificial transmission line" or pulse-forming network (PFN), which is a ladder network of inductances and capacitances. A four-section network is shown in the modulator circuit of Figure 25-5. The network looks like a low-pass filter, and it is. Its cutoff frequency is given by  $\omega^2 = 4/(LC)$ . For frequencies well below cutoff, the network behaves like a transmission line with  $Z_0 = \sqrt{L/C}$ . Here  $L$  and  $C$  are in

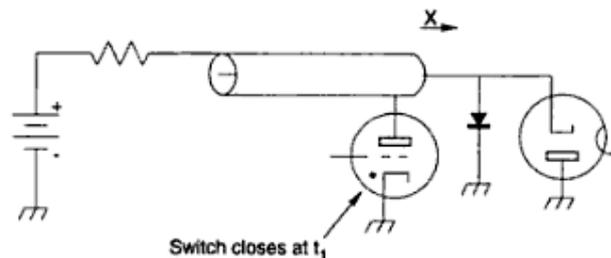


Figure 25-3. Line-type modulator.

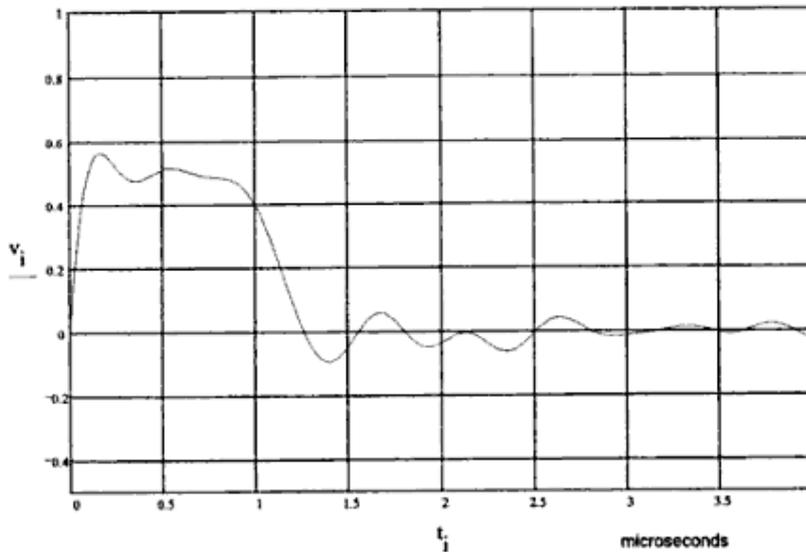


Figure 25-6. Waveform produced by a four-section PFN.

values become  $12.5 \mu\text{H}$  and  $1250 \text{ pF}$ , respectively, values that are more practical. Using these values in a Spice simulation of the discharge produced the voltage waveform shown in Figure 25-6. The voltage scale is normalized, that is, the capacitors were charged to  $1 \text{ V}$  so the nominal pulse voltage is  $0.5 \text{ V}$ . Lines with more sections provide better-shaped pulses.

The line modulator uses all the stored energy on each pulse but, precisely because of this virtue, deserves a more sophisticated charging circuit than the resistor shown in the circuits above. Remember that when a capacitor is charged through any resistive path from empty (no energy) to  $CV^2/2$ , the resistor will dissipate this same amount of energy,  $CV^2/2$ . Here the charging resistor, no matter what its value, would dissipate half the power consumed by the radar. The solution to this problem is to charge the line through an inductor instead of a resistor. Figure 25-7 shows the voltage waveform on a capacitor as it is *resonantly charged* through an inductor. The voltage is a sinusoid, building up to a maximum of twice the supply voltage. The modulator can be triggered just as the voltage reaches this maximum. The brief pulse discharges the line, and the charging curve begins anew. It would seem that the pulse repetition frequency is therefore determined rigidly by the charging time but, if a diode is put in series with the inductor, the charging stops at the maximum voltage and the next pulse can occur anytime. The resonantly charged modulator, with the diode and a pulse transformer is shown in Figure 25-8. Note that the primary of the pulse transformer provides a charging path, eliminating the diode originally in parallel with the magnetron. Also

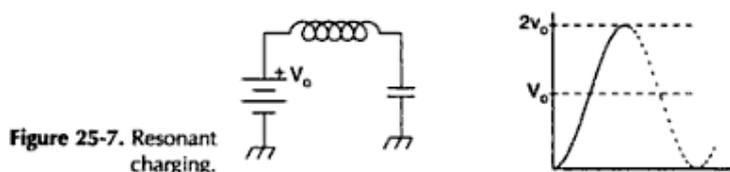


Figure 25-7. Resonant charging.

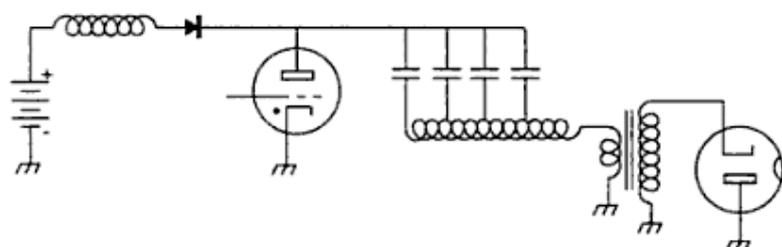


Figure 25-8. Complete pulser circuit.

remember that, because of the resonant charging, the supply voltage needs only to be half of the line charging voltage.

Line modulators present less risk to tubes than partial-discharge capacitor modulators because there is less stored energy available when an arc occurs in the tube.

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**PROBLEMS**

1. (a) Show that when an uncharged capacitor is brought to potential  $V$  by connecting it through a resistor to a voltage source  $V$ , the energy supplied by the source is twice the energy deposited in the capacitor ( $CV^2$  rather than  $CV^2/2$ ).  
 (b) The charging efficiency in Problem 1(a) is only 50%. Find the efficiency when the capacitor initially has a partial charge, that is, when the capacitor is initially charged to a voltage  $\alpha V$ , where  $\alpha < 1$ .
2. (a) Find the characteristic impedance of the artificial transmission line shown below. This impedance,  $Z_0$  (which is complex), can be

## 6.8 MODULATORS

The function of the modulator is to turn the transmitting tube on and off to generate the desired waveform. When the transmitted waveform is a pulse, the modulator is sometimes called a *pulser*. Each RF power tube has its own peculiar characteristics which determine the particular type of modulator to be used. The magnetron modulator, for instance, must be designed to handle the full pulse power. On the other hand, the full power of the klystron and the traveling-wave tube can be switched by a modulator handling only a small fraction of the total beam power, if the tubes are designed with a modulating anode or a shadow grid. The crossed-field amplifier (CFA) is often cathode-pulsed, requiring a full-power modulator. Some CFAs are d-c operated, which means they can be turned on by the start of the RF pulse and turned off by a short, low-energy pulse applied to a cutoff electrode. Some CFAs can be turned on and off by the start and stop of the RF pulse, thus requiring no modulator at all. Triode and tetrode grid-controlled tubes may be modulated by applying a low-power pulse to the grid. Plate modulation is also used when the radar application cannot tolerate the interpulse noise that results from those few electrons that escape the cutoff action of the grid.

The basic elements of one type of radar modulator are shown in Fig. 6.13. Energy from an external source is accumulated in the energy-storage element at a slow rate during the interpulse period. The charging impedance limits the rate at which energy can be delivered to the storage element. At the proper time, the switch is closed and the stored energy is quickly discharged through the load, or RF tube, to form the pulse. During the discharge part of the cycle, the charging impedance prevents energy from the storage element from being dissipated in the source.

**Line-type modulator.** A delay line, or pulse-forming network (PFN), is sometimes used as the storage element since it can produce a rectangular pulse and can be operated by a gas-tube switch. This combination of delay-line storage element and gas-tube switch is called a *line-type modulator*. It has seen wide application in radar because of its simplicity, compact size, and its ability to tolerate abnormal load conditions such as caused by magnetron sparking.<sup>1,24,25</sup> A diagram of a line-type pulse modulator is shown in Fig. 6.14. The charging impedance is shown as an inductance. The pulse-forming network is usually a lumped-constant delay line. It might consist of an air-core inductance with taps along its length to which are attached capacitance to ground. A transformer is used to match the impedance of the delay line to that of the load. A perfect match is not always possible because of the nonlinear impedance characteristic of microwave tubes.

The switch shown in Fig. 6.14 is a hydrogen thyratron, but it can also be a mercury ignitron, spark gap, silicon-controlled rectifier (SCR), or a saturable reactor. A gas tube such

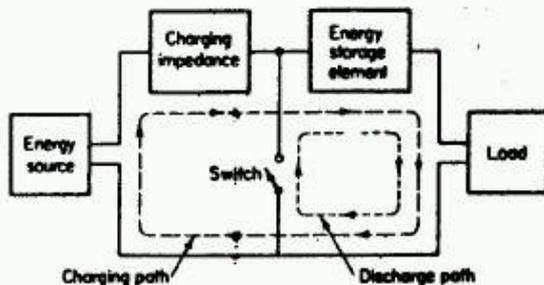


Figure 6.13 Basic elements of one type of radar pulse modulator.

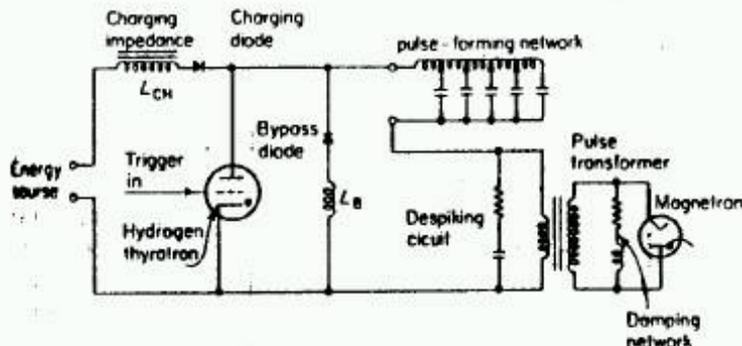


Figure 6.14 Diagram of a line-type modulator.

as a thyratron or ignitron is capable of handling high power and presents a low impedance when conducting. However, a gas tube cannot be turned off once it has been turned on unless the plate current is reduced to a small value. The switch initiates the start of the modulator pulse by discharging the pulse-forming network, and the shape and duration of the pulse are determined by the passive circuit elements of the pulse-forming network. Since the trailing edge of the pulse depends on how the pulse-forming network discharges into the nonlinear load, the trailing edge is usually not sharp and it may be difficult to achieve the desired pulse shape.

The charging inductance  $L_{ch}$  and the capacitance  $C$  of the pulse-forming network form a resonant circuit, whose frequency of oscillation approaches  $f_0 = (2\pi)^{-1}(L_{ch}C)^{-1/2}$ . (The inductance of the pulse-forming network and the load are assumed small.) With a d-c energy source the pulse repetition frequency  $f_p$  will be twice the resonant frequency if the thyratron is switched at the peak of maximum voltage. This method of operation, ignoring the effect of the charging diode, is called *d-c resonant charging*. A disadvantage of d-c resonant charging is that the pulse repetition frequency is fixed once the values of the charging inductance and the pulse-forming-network delay-line capacitance are fixed. However, the charging, or hold-off, diode inserted in series with the charging inductance permits the modulator to be operated at any pulse repetition frequency less than that determined by the resonant frequency  $f_0$ . The function of the diode is to hold the maximum voltage and keep the delay line from discharging until the thyratron is triggered.<sup>26</sup> Although the series diode is a convenient method for varying the prf, it is more difficult to change the pulse width since high-voltage switches in the pulse-forming network are required.

The bypass diode and the inductance  $L_b$  connected in parallel with the thyratron serve to dissipate any charge remaining in the capacitance due to tube mismatch. If this charge were allowed to remain, the peak voltage on the network would increase with each cycle and build up to a high value with the possibility of exceeding the permissible operating voltage of the thyratron. The mismatch of the pulse-forming network to the nonlinear impedance of the tube might also cause a spike to appear at the leading edge of the pulse. The *despiking circuit* helps minimize this effect. The *damping network* reduces the trailing edge of the pulse and prevents post-pulse oscillations which could introduce noise or false targets.

**Hard-tube modulator.**<sup>1</sup> The hard-tube modulator is essentially a high-power video pulse amplifier. It derives its name from the fact that the switching is accomplished with "hard-vacuum" tubes rather than gas tubes. Semiconductor devices such as the SCR (silicon-controlled rectifiers) can also be used in this application.<sup>1</sup> Therefore, the name *active-switch modulator* is sometimes used to reflect the fact that the function of a hard-tube modulator can

be obtained without vacuum tubes. Active-switch pulse modulators can be *cathode pulsers* that control the full power of the RF tube, *mod-anode pulsers* that are required to switch at the full beam voltage of the RF tube but with little current, or *grid pulsers* that operate at a far smaller voltage than that of the RF beam.

The chief functional difference between a hard-tube modulator and a line-type modulator is that the switching device in the hard-tube modulator controls both the beginning and the end of the pulse. In the line-type modulator, the switch controls only the beginning of the pulse. The energy-storage element is a capacitor. To prevent droop in the pulse shape due to the exponential nature of a capacitor discharge, only a small fraction of the stored energy is extracted for the pulse delivered to the tube. In high-power transmitters with long pulses the capacitor must be very large. It is usually a collection of capacitors known as a *capacitor bank*.

The hard-tube modulator permits more flexibility and precision than the line-type modulator. It is readily capable of operating at various pulse widths and various pulse repetition frequencies, and it can generate closely spaced pulses. The hard-tube modulator, however, is generally of greater complexity and weight than a line-type modulator.

**Tube protection.**<sup>1,27</sup> Power tubes can develop internal flash arcs with little warning even though they are of good design. When a flash arc occurs in an unprotected tube, the capacitor-bank discharges large currents through the arc and the tube can be damaged. One method for protecting the tube is to direct the arc-discharge currents with a device called an *electronic crowbar*. It places a virtual short circuit across the capacitor bank to transfer the stored energy by means of a switch which is not damaged by the momentary short-circuit conditions. The name is derived from the analogous action of placing a heavy conductor, like a crowbar, directly across the capacitor bank. Hydrogen thyratrons, ignitrons, and spark-gaps have been used as switches. The sudden surge of current due to a fault in a protected power tube is sensed and the crowbar switching is actuated within a few microseconds. The current surge also causes the circuit breaker to open and deenergize the primary source of power. Crowbars are usually required for high-power, hard-tube modulators because of the large amounts of stored energy. They are also used with d-c operated crossed-field amplifiers and mod-anode pulsed linear-beam tubes which are connected directly across a capacitor bank. The line-type modulator does not usually require a crowbar since it stores less energy than the hard-tube modulator and it is designed to discharge safely all the stored energy each time it is triggered.

## 6.9 SOLID-STATE TRANSMITTERS

There have been two general classes of solid-state devices considered as potential sources of microwave power for radar applications. One is the transistor amplifier and the other is the single-port microwave diode that can operate as either an oscillator or as a negative-resistance amplifier. The silicon bipolar transistor has, in the past, been of interest at the lower microwave frequencies (*L* band or below), and the diodes have been of interest at the higher microwave frequencies. Gallium arsenide field-effect transistors (GaAs FET) have also been considered at the higher microwave frequencies. Both the transistor and the diode microwave generators are characterized by low power, as compared with the power capabilities of the microwave tubes discussed previously in this chapter. The low power, as well as other characteristics, make the application of solid-state devices to radar systems quite different from high-power microwave tubes. The almost total replacement of receiver-type vacuum tubes by solid-state devices in electronic systems has offered encouragement for replacing the power vacuum tube with an all solid-state transmitter to obtain the advantages offered by that

# Simple Tension Wrench Tricks

## Overview

In a past article, we showed you some simple tension wrench tricks to utilize while practicing your locksmith techniques. These involved drilling holes in the handle of the tension wrench and hanging lead sinkers off them to adjust the pressure they were applying to the lock's cylinder.

While at a local hobby store, I found some small, thin pieces of adhesive-backed flexible lead meant for adjusting the final weight of a pinewood derby car. I think these adhesive-backed lead pieces are also used for stained-glass work. Since the lead sheets are very flexible, I tried wrapping them around the handle of the tension wrench so it can apply a constant cylinder pressure while you are working on the pins of the lock. This picking method also helps to keep a hand free. The overall results were very good. You can add or remove additional pieces of the lead sheet to change the final "pressure" on the tension wrench.

I also found some small, non-lead, adhesive-backed weights meant for balancing a ceiling fan. These will probably be much easier to find (and not as dangerous!), but should also work just as well. You can't really adjust the final weight too much, as the weights are of a fixed size. They are easily removable, though.

## Pictures & Construction Notes



Tension wrench weights.

On the left, is a commercial ceiling fan balancing kit you can buy for \$1.

On the right, are a bunch of tension wrenches.

Above the tension wrenches is a thin piece of adhesive-backed flexible lead weight.



Close up picture of the weights.

The ceiling fan weights have a piece of double-sided tape on their back. This brand only has two weights available; 5 and 3 grams.



Proudly not RoSH-compliant!

Wrap the thin lead foil around the handle of a tension wrench.

The final weight is easily tweakable by trimming or adding more of the lead sheet.

You should wrap the final lead "bundle" with some electrical tape, or other sealant, to protect yourself from lead exposure.



Adding the ceiling fan balancing weights to a tension wrench.

Not as physically compact as the lead foil bundle, but cheaper. This method makes it very easy to change the tension pressure by adding or removing the weights.



Example of the ceiling fan balancing weights in action. 13 grams total.

The weights can be easily reused by saving the little piece of paper which protects the adhesive.

**Bonus**

**It's MORE FOOD for LESS MONEY**

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# CARE

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- 1 lb. Braised Beef
- 2-8 oz. tins of Liver Pâté
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- 2 lb. Shortening
- 1 lb. Chocolate
- 2-8 oz. tins of Cocoa
- 2 lb. Whole Milk Powder
- 8 oz. Egg Powder
- 1 lb. Apricots
- 1 lb. Raisins
- 7 lb. Flour
- 2 lb. Sugar
- 1 lb. Coffee (for Britain 1/2 lb. tea)
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- 1/4 oz. Yeast

The entire cost of this advertisement has been donated.

**CARE** Cooperative for American Remittances to Europe, Inc., 50 Broad Street, New York 4, N. Y.

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(signature of sender) (Date)

**When's the last time a lazy Eurosave has done anything for YOU?**  
From *Popular Mechanics*, 1948.

## **End of Issue #66**



**Any Questions?**

### **Editorial and Rants**

*Why not ask Bill Ayers to fix this problem? LOL! Change!*

### **Chicago Violence Haunts Obama as Gun-Control Backers Left Cold**

October 7, 2009 – From: [www.bloomberg.com](http://www.bloomberg.com)

By John McCormick

**Oct. 7 (Bloomberg) -- At least 47 school-age children in Chicago have been killed in homicides, mostly by guns, since the month President Barack Obama took office.**

The latest youth homicide in his adopted hometown was different only in that the attackers used splintered railroad ties and were captured on video broadcast globally.

The Sept. 24 attack prompted Obama to send his attorney general and education secretary to Chicago today after the killing tarnished the city's drive to win the 2016 Olympics.

"The savage beating of Derrion Albert, recycled on television, embarrassed Chicago and the nation," said the Reverend Jesse Jackson, a civil-rights activist and founder of the RainbowPUSH Coalition. "You can't ignore the case."

U.S. Education Secretary Arne Duncan and U.S. Attorney General Eric Holder plan to appear at City Hall with Mayor Richard Daley in what the Obama administration described as a search for solutions to youth crime. They also will meet privately with students and parents.

Chicago's violence has long burdened Obama's political career, including the embarrassment of a missed vote as a state senator that hurt his 2000 bid for Congress. Duncan, 44, a Chicago native and Obama friend, admits to "total failure" in curbing violence during his seven years as chief of the nation's third-largest school system, which serves more than 400,000 students, 85 percent of them living below the poverty line.

Some gun-control advocates question the administration's timing as Duncan and Holder arrive after a highly publicized beating that didn't involve a gun.

## Missed Opportunities

"Where there have been opportunities for the president to speak out about the issue of firearm violence, he has missed any number of opportunities," said Thom Mannard, executive director of the Illinois Council Against Handgun Violence.

Doing so in the Albert case "provides the cover" to address youth violence without confronting the gun lobby, said Mannard, whose group's board of directors included Duncan until he left for his current post.

The administration defended its record.

"President Obama is committed to combating violence on our streets and in our schools, both in Chicago -- which has been particularly hard hit -- and around the nation," White House spokeswoman Amy Brundage said in a statement. "The administration has focused on the issue of youth violence from the outset."

The beating death of Albert, 16, an honor student, renewed outrage and prompted a call to action in a city where 398 students were shot in the past 12 months, said Monique Bond, a spokeswoman for the Chicago Public Schools. Four teens have been charged in connection with Albert's killing.

## Obama Sermon

The incident happened less than five miles from a church where Obama gave a sermon in July 2007 challenging the government, the gun lobby and the public to stop gun violence.

"Our playgrounds have become battlegrounds," he told a standing-room congregation. "Our streets have become cemeteries. Our schools have become places to mourn the ones we've lost. The violence is unacceptable."

Obama at the time called for better enforcement of existing gun laws, tighter background checks on gun buyers and a permanent assault-weapons ban.

Some of the students involved in the recent fatal fight live in Altgeld Gardens, a public housing project where Obama worked in the mid-1980s as a community organizer.

## At Risk

Like Obama, 48, Duncan is familiar with youth violence in Chicago. Duncan was replaced as Chicago schools chief by Ron Huberman, a former Chicago police officer and transit official who is experimenting with a \$30 million project to focus on about 1,200 high school students in danger of being shot.

The district identified those students based on grades, attendance and serious misconduct. The analysis suggests the 200 high school students most at risk have a 20 percent chance of becoming a victim of gun violence.

One of Obama's first high-profile brushes with the anguish associated with gun violence came amid his unsuccessful primary campaign for Congress against Representative Bobby Rush, a former Black Panther.

Rush's son was shot in October 1999 and died four days later, producing an outpouring of support for the incumbent.

### Gun Vote

Later that fall, the Illinois legislature was called into special session to consider gun-safety initiatives that Obama supported.

When a crucial vote came earlier than expected, Obama was in Hawaii visiting the grandmother who helped raise him. The legislation failed by five votes as he remained in Hawaii to help care for a sick daughter, sparking criticism.

Daley initially played down the impact of the Albert case on the city's Olympics bid. Still, his first public comments upon his return from Copenhagen were to address the violence and the "code of silence" surrounding it.

Gun issues in Chicago will remain in the national spotlight following the U.S. Supreme Court's Sept. 30 announcement that it will hear a challenge of the city's handgun ban, implemented in 1982 to combat urban crime.

Duncan said earlier this year that his attempts to curb violence were ineffective when he oversaw Chicago's schools.

"I thought I had made things better in some areas," he said April 14 in Chicago. "This is an area where I was a total failure."

---

**I wonder if all that Democrat/Obama-voter violence in Chicago will affect Obongo's bid to get the Olympics held there to help pay off his corrupt little buddies?**



**Obongo's Chicago Thugs: Martin Nesbitt, Valerie Jarret, and Eric Whitaker**

**NO**   
**HE CAN'T**

*It's time to strip the Narcissistic Nigger of his power...*

*Note that when a shit-skin moves to a White country, they themselves are engaging in "racial profiling."*

## **White House Strips Immigration Policing Powers From Arizona Sheriff**

October 9, 2009 – From: [www.guardian.co.uk](http://www.guardian.co.uk)

By Daniel Nasaw

A controversial Arizona sheriff known for taking a hard line against illegal immigrants has been stripped of some of his powers in what he described as a political move by the Obama administration.

Joe Arpaio, a gruff lawman who styles himself as America's toughest sheriff, has won acclaim from U.S. anti-immigrant forces for his relentless pursuit of mostly Hispanic illegal immigrants in Maricopa county, Arizona, a fast-growing county of 4 million people that is home to Phoenix, the nation's fifth largest city.

Arpaio's aggressive tactics include the jailing of illegal immigrants in tent cities surrounded by barbed wire in the middle of Arizona's searingly hot summers, the reduction of meal costs to 20 cents per day, the use of pink jail clothing for men, and chain gangs for women inmates.

Arpaio also came in for criticism when he appeared on the FOX reality show *Smile: You're Under Arrest*.

Under a two-year-old agreement with the federal department of homeland security, Arpaio and his deputies had been authorised to enforce federal immigration law by arresting suspected illegal immigrants in the field and by checking the immigration status of people arrested on other offences.

But after drawing thousands of complaints and a civil rights investigation from the justice department, Arpaio was this week stripped of his federal authority to make immigration arrests. County attorney Andrew Thomas, one of Arpaio's supporters, condemned the "setback in the fight against illegal immigration".

For his part Arpaio has promised to continue chasing illegal immigrants using state laws. In an angry press conference, he called U.S. homeland security officials "liars" and said he would personally drive those caught on the streets to the border if federal officers refused to take arrested illegal immigrants into custody. "I'll take a little trip to the border and turn them over to the border," he said.

Arpaio's critics decried his continued plans to arrest illegal immigrants and said the Obama administration should sever all ties with him.

The now-rescinded authority to conduct field sweeps of illegal immigrants yielded only about 300 out of the roughly 33,000 total arrests of illegal immigrants since 2007, the Obama administration has done little to curtail Arpaio, said Frank Sharry, executive director of immigration reform advocacy group America's Voice.

"He's going to go down in history as a man who terrorised the Latino community for the sake of his own visibility and political popularity," Sharry said. "The fact that the Obama administration would lend any of its legitimacy to any of his activities is surprising and disappointing."

Arpaio was first elected sheriff in 1993.

"The department of homeland security is making a historic mistake if it continues its relationship with Sheriff Joe Arpaio," said Paco Fabian, spokesman for immigration reform advocacy group America's Voice. "The federal government is lending its full force and legitimacy to a rogue cop certain to go down in history as a serial violator of civil rights and an enemy of the Latino community."

An estimated 12 million illegal immigrants live in the U.S. The federal government is virtually paralysed over how to react, with conservatives like Arpaio calling for the arrest and deportation of illegal immigrants and increased border enforcement. Obama, many Democrats and some Republicans call for a system that will allow most to gain legal status after paying a fine and learning English, but reform efforts in 2006 and 2007 withered under sustained rightwing opposition.

More than 60 law enforcement agencies across the country have signed onto the same programme under which local officers are effectively deputised to enforce immigration law. But critics of the programme say it wastes police resources needed to fight street crime, promotes racial profiling of Hispanics, targets peaceful workers, breaks up families and breeds distrust of police among immigrants, who become afraid to report crime for fear they will be asked for immigration papers.



**Obongo: Bringing Everyone Together**

## Obama FAIL!

### Before the Election:

pundits are focused on her. As a Democratic candidate in a historically Republican district trying to win the House seat being vacated by retiring Republican icon Henry Hyde, her 6th District race is becoming a Democratic Party priority and a talking point among political heavyweights.

"Very rarely have I met a more impressive person than Tammy Duckworth," said Sen. Barack Obama, D-Ill., in an article the day before she announced her candidacy Dec. 18. "She just has the poise and exudes the type of character that I think would make her an astounding public servant."

Duckworth is happy to point out that she and Hawai'i-raised Punahou graduate Obama have "a kama'aina connection."

Both were born outside the country — Obama in Indonesia, Duckworth in Thailand — and graduated from high school in Honolulu — Punahou and McKinley, respectively.

"The big thing for me is that I'm a McKinley High grad," said Duckworth. "That gives you a lot of street creds. I wasn't a rich kid."

Born in Bangkok on March 12, 1968, when her father was there working with a United Nations refugee program, Duckworth spent much of her childhood in Southeast Asian countries. Along with her parents, Franklin and Lamia Duckworth, and her younger brother, Tommy Duckworth, she arrived in Hawai'i at age 16. An honors student, she skipped ninth grade and graduated in 1985.

Richard Sakamoto, Duckworth's high school principal,

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The uncensored [Archive.org](http://archive.org) version from January 8, 2006.

## After the Election:

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Duckworth and her younger brother, Tammy

Lombard, Ill., brings an intense focus blended with a keen sense of humor to her latest mission: running for Congress.

Peter Thompson



Duckworth, shown in McKinley High School's 1985 yearbook, was an honor student and athlete.

McKinley High School

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From: [the.honoluluadvertiser.com/article/2006/Jan/08/In/FP601080334.html](http://the.honoluluadvertiser.com/article/2006/Jan/08/In/FP601080334.html)

*Whoops!* Looks like "change" just came to *The Honolulu Advertiser!*

This article was censored on October 16, 2009 after being linked from a number of blogs.

